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Cumulative Impacts to Environmental Conditions on the Presumpscot River and its Shorelands, As distributed at the June 2002 Public Meetings

Casco Bay Estuary Project

Presumpscot River Plan Steering Committee

Land & Water Associates

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(DRAFT -- As distributed at the June 2002 Public Meetings)

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Prepared by

the Presumpscot River Plan Steering Committee

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Note on the Scope of Analysis for this Cumulative Impacts Report: The geographic scope of this analysis of cumulative impacts is the Presumpscot River from its outlet at Sebago Lake, including its tributaries and adjacent corridor lands, to and including the Casco Bay Estuary. This report addresses the impacts of the regulation of flows out of Sebago Lake at the Eel Weir Dam on the river and Casco Bay Estuary, since the flow regime on the river is almost entirely controlled by management of the Eel Weir Dam, and the Presumpscot River is the largest source of freshwater to Casco Bay. However, it does not include or address issues related to Sebago Lake levels.

Comments received at the June 2002 public information meetings raised concerns about the impacts of flow regulation at the Eel Weir Dam on Sebago lake shorelands and wetlands. While it is acknowledged that the regulation of flows at the Eel Weir Dam has impacts not only on the river and estuary but also on Sebago Lake, these impacts are not addressed in this report, and there are no recommendations included in the report to change operations at the Eel Weir Dam. There is a separate process in place, involving the Maine Department of Environmental Protection and the Federal Energy Regulation Commission, to review and regulate flow management at the Eel Weir Dam.

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I. OVERVIEW OF MAJOR INFLUENCES – BACKGROUND, ABSTRACT AND CONTEXT

Since the earliest settlement of the Presumpscot River basin and the construction of the first dam at Presumpscot Falls (now known as Smelt Hill) in the early 1730's (McClellan, H., 1903, History of Gorham Maine), the Presumpscot River, its immediate environs and watershed have undergone continual change. Activities that contributed to these changes included:

- clearing of land and draining or filling wetlands for agriculture;
- timber harvesting for fuel wood, lumber, shipbuilding, and later pulp and paper manufacturing;
- extraction of sand and gravel;
- development of settlements;
- construction of roads, canals, and later railroads for transportation;
- industrial development, including development of dams for water power and later hydroelectric power; and
- use of the River by industry and municipalities for waste disposal.

The variety, number and magnitude of these activities relative to the size of the River are without parallel on other rivers in Maine, *e.g.*, no other river in Maine had a canal and commercial shipping for its entire length and, no other river in Maine has virtually all its hydraulic head captured behind dams (except perhaps Messalonskee Stream, which is about half the length of the Presumpscot and is a stream rather than a river). All of these activities contributed to the economic development of the area and environmental impacts.

The power and water supply provided by the Presumpscot were fundamentally important to the early development of the area. As was stated in <u>Images of America</u>, *"this river is the one and only reason that 16,121 people make their home in Westbrook. From the Native Americans to the Industrialists, this town would never have been settled but for the potential for life seen by those who gazed upon these waters. Saccarappa, Cumberland Mills, Westbrook; call us what you will, but we are the river."* (Dianne LeConte, 2000)

Dams, which now and have historically occupied most of the River's length, were essential for water power, and later, with the development of hydroelectric generation technology, provided a low cost source of electricity. Today, these older hydroelectric power facilities remain one of the lowest cost alternatives for energy available to the area. There is a price for development, however. For example, as a result of the obstructions to movement presented by the dams, access to the Presumpscot is no longer available for sea run fish. Further, only a few decades ago this was a moot issue as poor water quality rendered the habitat unusable even if it were accessible.

While use of the River for power and waste disposal were viewed as a normal part of economic development at the time, the impacts to the River, particularly its fisheries, were a concern from very early in the area's history. Orders from the Massachusetts Legislature (called the General Court) in 1735 and 1741 required that any dams constructed on the River provide passage for fish (See Appendices 2 and 3). In the 1840's concerns were raised over pollution of the River with bark and sawdust; in the 1850's the paper industry was established

on the River at Cumberland Mills, and a number of other industries including woolen and textile mills, iron works, and a gunpowder mill were adding to the pollutant loading of the River. (Collection and Proceedings of the Maine Historical Society, Second Series, Vol. V 1894 – The Story of the Presumpscot). The 1880's saw the introduction of the sulfite pulping process in Maine, which dramatically increased pollution loads on Maine's rivers. The early 1900's also saw the establishment of hydropower for electrical production.

By the 1950's the condition of the lower River was similar to most rivers in the developed northeast: it was heavily polluted and its primary value was as a conduit for waste. However, with the passage of time and changes in economic conditions, the stage had been set for revitalization of the Presumpscot. That is, virtually all the small non-paper mills along the River had disappeared (textiles, gun powder, etc.) replaced by larger, more modern mills elsewhere. Likewise, the Canal had long since been replaced as a major transportation route, first by railroad and then by automobiles and trucks.

The culture of environmental consciousness that grew in the 1960's, in reaction to the condition of rivers nationwide, led to passage of the Clean Water Act and marked reductions in water pollutant discharges by the 1970's. Initially focused on biological oxygen demand (BOD) and suspended solids, the Clean Water Act was subsequently amended to address other types of pollution including toxic chemicals and heavy metals. The effects of water pollution control efforts have been particularly noteworthy on the Presumpscot because the source for the River is Sebago Lake, a huge supply of clean water used by Portland as its water supply. In 1999 the S. D. Warren Company, now SAPPI, the major industrial user of the River, decided to cease its pulp manufacturing operation at its Westbrook mill. This further reduced discharges to the River. The water quality of the River now appears substantially improved. (Dave Courtemanch, DEP, personal comment).

While industrial discharges to the River have been dramatically reduced since the 1960's, municipal treatment plant discharges and non point sources of contamination have increased due to the rising population that accompanied the recent development boom in southern Maine. In addition, development has increased along the river, affecting wildlife habitat, wetlands and open space. Further, development elsewhere in the watershed has increased the percentage of land draining to the river that is impervious to water, resulting in an increased load of pollutants carried to the river by stormwater. The following discussion reviews how the various activities that have occurred since the original settlement of the Presumpscot River basin have cumulatively affected the river, its shorelands, and the fish and wildlife resources that inhabit the River and its riparian corridor.

A map of the River and a timeline, which reflects the timing of events which shaped the River, precede this discussion and are intended to provide the context for understanding the nature and magnitude of cumulative impacts.

The chronology which follows sketches the outlines of the Presumpscot's rich history. It was the site of one of the first serious disputes over water rights in Maine (fish versus dams). Further, it was the site of Maine's first pulp mill, first hydroelectric project, only significant canal, largest gun powder mill, and one of IF&W's most successful efforts to reestablish a salmonid fishery. It is also one of the regions of the State where air and water quality are most improved. The list goes on. Given this history it should be no surprise that the

Presumpscot is in the news once again, as society struggles to balance competing demands on its resources.

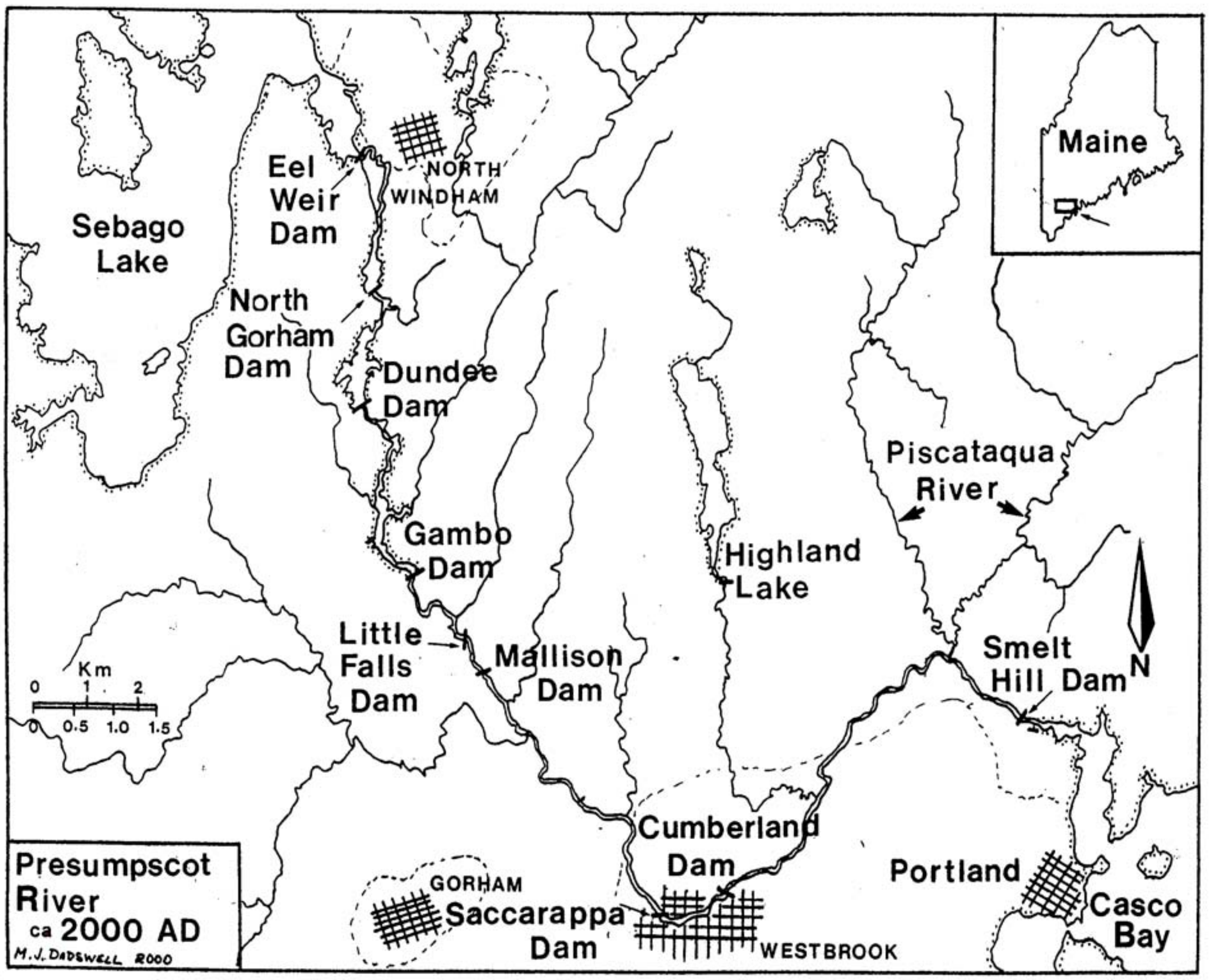
In brief, the most notable cumulative impacts include:

- Converting the River to a series of impoundments (currently 22 of 27 original miles of the River, from Casco Bay to White's Bridge at Sebago Lake, are impounded); of the approximately 5 miles of "free flowing: river, half is tidal – the 2.5 mile reach below the Smelt Hill Dam;

- Stabilizing flows and reducing spring floods;
- Increasing pollutant loadings of the River from both point, and non-point sources;
- Increasing the deposition of solids and pollutants in the estuary;
- Reducing the productivity and economic value of the estuary;
- Contributing to soil losses and slumping along the impoundments;
- Blocking runs of anadromous and catadromous fish;
- Converting a cold water to largely a warm water fishery;
- Converting riverine wetlands to those more typical of impoundments;
- Inundating shoreland terrestrial resources;
- Changing habitats for threatened and endangered species;
- Converting riverine recreational resources to a series of impoundments;
- Eliminating rapids and waterfalls;
- Inundating some cultural resource sites, and/or exposing them to increased erosion in some cases; and,
- Replacing the subsistence economy of Native Americans, which was largely dependent on the fish and other aquatic life present on the Presumpscot, with an agricultural, industrial, and then a post-industrial economy.

In summary, the development of the Presumpscot River and its corridor has resulted in important benefits as well as losses to the local and regional economy and environment. While the economy of the area has benefited from the use of its waters for industry, for power, and for the dilution of wastes; and residents have built factories and homes along its banks; the cumulative impacts of human use have eliminated most of the natural values of the rushing *"Pes-ompsk-ut,"* the *"river of many rough places."* More on each of these points, and others, follows.

FIGURE 1: MAP OF THE PRESUMPSCOT RIVER



Presumpscot River Timeline[1]

1500's	Ammonscongin was selected as Indian planting ground because of the great quantity of fish there. Fobes, 1894, p.379. *"At the foot of the falls was plenty of fish in the spring for food for the planters and 'to fish the corn.'"* Goold, 1886, p. 43.
1623	(Westbrook) Captain Christopher Leavitt (or Levett) explores to Presumpscot Falls which he calls *much bigger than the great fall at London Bridge." "Leavitt remarked on the abundance of fish."* MacDonald, 1994, p. 4.
1623	(Falmouth) Captain Leavitt: *"Just at this fall of water the sagamore or king hath a house where I was one day… This sagamore was Skitterrygusset, who was chief of the Aucocisco tribe, which dwelt between the Saco and the Sagadahoc. This chief was the first to give deeds for land in this section…"* Fobes, 1894, p. 367.
1630's?	(Falmouth) Oldest deed in Falmouth: land on the east side of the Presumpscot to Francis Small from Skitterrygusset for one bottle of liquor per year. Reiche map, 1978.
1632	(Falmouth) Arthur Mackworth settles on eastern shore.
1638	(Falmouth) Benjamin Atwell lived at Martin's Point. *"No doubt because of the fish and wildfowl in that river."* MacDonald, 1994.
1646	(Falmouth) Saw mill, Presumpscot Falls. Wallace, 1976, p. 10.
1650	(Falmouth) *"At certain time, the entire surface of the river for a foot deep, was all fish."* MacDonald, 1994.
1656	(Falmouth) Casko Mill, a gist mill owned by John Phillips at Presumpscot Falls. *"He staid here until driven away by Indians."* MacDonald, 1994.
1657	(Falmouth) Thomas Wakely family (8 people, except daughter who was taken captive) killed by Indians. Wallace, 1976, p. 5.
1690	(Falmouth) *"The intense fighting continued until 1690, at which time there was no one left in Falmouth."* Wallace, 1976, p. 5.
1699	(Falmouth) Fort New Casco, built as a result of peace with Indians, at Mackworth Point. Wallace, 1976, p. 5.
1700's to early 1800's	Extensive lumbering along the upper Presumpscot; Royal Mast Landing below Mallison Falls. *"the logs were floated down the river to tide-water."* Dole, 1916, p. 255. *"The whole surface of the river was often completely bridged for miles."* Jones, 1946.
1716	(Falmouth) General Court felt fort was no longer necessary for protection against Indians, and it had no money to spend for protection of settlers. Fobes, 1894, p. 374.
1729	(Falmouth) Power privileges at *"Saccarabigg"* disposed of to various men. *"This was the beginning of the lumbering business there."* Fobes, 1894, p. 375; and Smith, 1849, pp. 71-72.
1732	(Westbrook) First dam, paper mill and grist mill by Samuel Waldo & Colonel Westbrook at Presumpscot Falls. Reiche map, 1978.
1733	Samuel Waldo owned privileges of falls at Saccarappa, Ammonscongin and Mallison. Fobes 1894, p. 378.

[1] "Presumpscot River Time Line." Susan Russell, 2000. Prepared for the Casco Bay Estuary Project.

1734 (Presumpscot River) First ship built on river: 600 ton mast ship. Reiche map, 1978.

1734 (Falmouth) Parson (Thomas) Smith in his Journal for November 8, 1734, says, *I rode with my father to see the Colonel's great dam."* (Colonel Thomas Westbrook's and Samuel Waldo's dam at Presumpscot Falls). Smith, 1849, p. 81.

"It was here, and about this time (November 8, 1734), that the parson (Thomas Smith) saw the large shoal of salmon ('an acre of fish, mostly salmon') congregated below and stopped from going up the river by the dam then recently completed, and remarks that damming the river, and thus stopping the fish from ascending to the Pond, would be more damage to the population above the dam than they could receive profit from all the lumber they could manufacture." McLellan, 1903, p. 248.

1734 Two men of Marblehead, Massachusetts, petition for land in Maine as Marblehead was getting too crowded: *"They were much straitened in their accommodation…"* Dole, 1916, p. 9.

1735 (Windham) Proprietors of New Marblehead voted *"to build a Bridge across the Presumpscot above the falls at Sacaripy…"* Dole, 1916, p. 18.

1736 (Windham) First settlers in Gorham: *"In May, (Captain John Phinney), with his (14-year-old)son Edmund, paddled his bateau up the Presumpscot into Little River, hauling it around the falls at Ammonscongin and Saccarappa…"* McLellan, 1903, p. 74.

1737 (Gorham) First settler in Westbrook, Joseph Conant. MacDonald, 1994, p. 7.

1737 (Westbrook) Thomas Chute is first settler in New Marblehead. Dole, 1916, p. 33.

1737 (Windham) Captain John Phinney *"attempted to carry some of his first crop of melons to Falmouth for sale, and as presents for his friends at Presumpscot Falls, and with his daughter Elizabeth, started with a load in his boat. They got along very well til the transportation around the falls came up at Saccarappa and Ammonscongin. There they found that the thing would not pay…"* McLellan, 1903, p. 245.

1738 (Gorham) At a proprietors' meeting in Marblehead, Massachusetts, four men are granted *"said Proprietors' Rights to an interest in any one of the falls of water in the Main River, called The Presumpscot River, lying above the Great Bridge lately Erected over said River… (they) shall begin to Erect a Sawmill on the said falls on or before the first day of August next (1739). But before they had made much headway, the Indians appeared and strenuously opposed the proceeding claiming that they owned the land on both sides of the river and that the necessary dams hindered the fish from coming up the river, whereby their food was endangered."* Dole, 1916, pp. 28-29.

1738 (Windham) *"It is noted that there was built at the lower falls on the Presumpscot River a mill dam which was the most extensive piece of constructive work which at that time had ever been attempted in Maine, and that it was required to have included in it a sufficient fish way for the passage of the migratory fish that annually came in great numbers."* Moulton, 1926, p. 104.

1739 (Falmouth) Chief Polin visits Governor Shirley: Fobes writes, *"took a sloop"*; Wallace writes, *"walked"*.

1739 (Presumpscot River) Westbrook town meeting: *"Voted, that John Wait go to make answer to the presentment against the great dam across the Presumpscot River. This was for want of a fishway in the dam (at Saccarappa)."* Goold, 1886, p. 209.

1740	(Westbrook) Windham saw mill erected at Horse Beef Falls (Mallison Falls); accepted December 13, 1740. Horse Beef name said to come from one of the early mill men who opened a barrel of beef which he had purchased, and discovered *"snugly packed away among the meat, a horse's shoe."* McLellan, 1903, pp. 265-276.
1741	(Falmouth) General Court passes an act that *"all the owners or occupants of any mill-dam heretofore erected and made across such river or stream where the fish can't conveniently pass over, shall make a sufficient way either round or through such dam for the passage of such fish."* Goold, 1886, p. 209.
1742	(Presumpscot River) Two saw mills on the east side of Presumpscot Falls; *"Indians slept in the sawdust underneath the mills."* Reiche map, 1978.
1744	(Presumpscot River) Chief Polin burns mills at Presumpscot Falls and Saccarappa.
1747	(Presumpscot River) Community fish weir operated by Samuel Staples. Reiche map, 1978.
1750's (or earlier?)	(Falmouth) William Huston, an early settler of North Falmouth: *"having followed the ducks from the Presumpscot estuary to the lovely inland lake now known as Highland Lake,"* Duck Pond to him. Wallace, 1976, p. 32.
1750's	(Falmouth) General Court of Massachusetts gives permission to conduct a lottery to raise £1,200 to build a bridge below Presumpscot Falls
1751	(Falmouth) Presumpscot Falls dam carried away in July 31 freshet. McLellan, 1903, p. 248.
Before 1756	(Windham) Saw mill built at Little Falls by Major William Knight, operated for many years, the privilege remained unoccupied for many years, except for a grist mill and a carding mill. Dole, 1916, pp. 225-226.
May 14, 1756	(Falmouth) Chief Polin and his men canoe down Presumpscot, attack a group of New Marblehead men who had left the fort to plant a field. Polin was killed, and supposedly his body was carried back to Sebago Lake by canoe where he was buried. Dole, 1916, pp. 82-84.
1762	(Windham) *New Marblehead* incorporated as *Windham.*
1762	Bridge built with lottery money across river below Presumpscot Falls.
1763	(Falmouth) First bridge built across Horse Beef (Mallison) Falls. <u>Bi-Centennial Commemoration of the Incorporation of the Town of Gorham, Maine</u>, 1964, p. 13.
1767 – 1770	(Gorham, Windham) Saw mill at Great Falls, and probably bridge, built at same time. McLellan, 1903, p. 267.
1769	(Gorham, Windham) Gambo saw mill in use. Dole, 1916, p. 227.
1770's	(Gorham, Windham) Trout at this time were abundant in the river. *"Nicholas Harding ... when a young man lived from his fourteenth to his twenty-first year at the Falls (Great Falls) cutting timber, and sawing in the mill… He said that they considered a hook and line as much a part of their fit-out as they did an axe, and often he would stand in the mill and catch a dozen trout of such a size that they would be quite a load for him to take to the house."* McLellan, 1903, p. 268.
June 1775	(Gorham, Windham) Captain Thomas Coulson's mast ship and four sailors held captive for several days; he was a local Tory; his ship was to pick up masts bound for Royal Navy; masts were hidden by people of New Casco.
June 17, 1776	(Falmouth) Town meeting *"voted to concur with ye neighboring towns in a petition to ye General Court to let the Fish up the Presumpscot River."* McLellan, 1903, p. 249.

October 30, 1781	(Gorham) Selectmen of Gorham and Agents for Standish and Bridgton petition the Governor of Massachusetts and the Massachusetts Legislature for *"redress of this grievance"* which they cite as obstruction of the River by Dams. The reasons that they cite include the fact that *"Plenty of fish (they cite shad, bass and salmon) coming even to their doors would greatly contribute to their (the early settlers') support"* and that the runs of anadromous fish benefit cod fishermen. *"For it is well known that the small fish running in shore for fresh water streams draw the cod after them."* They went on to state their view that *"it appears to be a grievance that ought no longer quietly to be borne (?) that one great source of life which Nature has provided for Public Use should be destroyed to serve the interest of a few individuals."* This petition cites repeated previous petitions on this same issue but a continuing problem. (Records of the Maine State Archives.)
1785	(Gorham) General Court appoints three men *"a committee to open sluice ways on the mill dam on the Presumpscot River."* Fobes, 1894, p. 380.
May 9, 1786	(Falmouth) Gorham Town meeting *"voted to petition the General Court for an order for the removal of several Dams that obstruct the Fish, coming up the Presumpscot River."* McLellan, 1903, p. 24
1791	(Gorham) *"As early as 1791 a committee was chosen by several towns in the county to ascertain the practicability of operating a canal from Sebago Pond to the lower part of the Presumpscot River."* Hull, 1888, p. 31.
1793	(Presumpscot River) *"Proprietors of the dam at Great Falls were found guilty of not keeping open a good and sufficient sluice way for the passage of salmon, shad, and alewives, as required by law."* Fobes, 1894, p. 380.
1795	(Gorham, Windham) A charter was obtained to construct a canal from Sebago Lake to the Presumpscot River at Saccarappa. Hull, 1888, p. 31.
Early 1800's	(Presumpscot River) Rueben Merrill's brickyard on estuary at Sandy Point; the Presumpscot River is rich in marine clay. Reiche map, 1978.
1800's	(Falmouth) *"The Presumpscot was … rather famous for the full rigged brigs produced on its banks … (a) class of craft which were very popular in the West India business…"* Rowe, 1929, p. 82.
June 4, 1814	(Falmouth) Freshet carried away Gambo and Horse Beef (Mallison) bridges.
1818	(Gorham, Windham) Two men from Southwick, Massachusetts buy 25 acres, and erect powder mills at Gambo. McLellan, 1903, pp. 273-274.
1821	(Gorham) Charter for the Cumberland and Oxford Canal. Hull, 1888, p. 31.
1828	(Presumpscot River) Martin Point Draw Bridge completed; bridge took 21 years to build due to 1807 embargo and War of 1812. Reiche map, 1978.
1828 – 1901	(Falmouth) 25 explosions at Gambo Powder Mill, 45 men killed. <u>Bi-centennial…</u>, p. 13.
1829	(Gorham, Windham) Cumberland & Oxford Canal opened. McLellan, 1903, p. 226.
1830's	First textile mill at Saccarappa, produced sailcloth. MacDonald, 1994, p. 12.
1831	(Presumpscot River) *"May 5, 1831, a large slide occurred on the north side of the river near Pride's bridge."* Fobes, 1894, p. 365.
1840	(Westbrook) A pamphlet of the period lists 15 mills in Windham alone. MacDonald, 1994, p. 12.

1843	(Windham) Presumpscot experienced its largest flood, damaged Gambo Mills; wrecked Mallison Falls saw mill.
1845	(Gorham, Windham) Sawdust and bark from paper mill at lower falls source of complaints on river pollution. Reiche map, 1978.
1846	(Falmouth) Saw mill built at Little Falls.
1850's	(Gorham, Windham) Casco Iron Works produced iron to be sent by ship for sale in foreign countries.
1854	(Falmouth) Samuel Warren buys mill at Cumberland Mills Dam.
1856	(Westbrook) Largest ship built on river at Samuel N. Knight's yard: *Artisan*, 923 tons. Rowe, 1929, p. 82.
1859	(Falmouth) Oriental Powder Mill incorporated at Gambo.
1861 – 1865	(Gorham, Windham) Presumpscot Land and Water Power company proposed by F. O. J. Smith for an industrial park at Martin Point, with a canal from Staples Point to Martin Point. Two hundred men and 80 horses built the canal from Martin Point to Mile Pond, but the project was never finished. Smith died bankrupt, *"Maine's greatest failure."* Reiche map, 1978.
1862	(Falmouth) Gambo powder mills (Oriental Powder Company) *"ran night and day"* for the duration of the Civil War; powder transported to Portland by 4 & 6-horse teams. Dole, 1916, p. 229.
1866	(Gorham, Windham) Several Gorham and Windham men purchased waterpower on Windham side of the Presumpscot River, and erected a woolen mill on the site of the first saw mill. Dole, 1916, p. 237.
November 22, 1868	(Windham) A mudslide occurred about one third of a mile below the village of Cumberland Mills: *"the bed of the river some two hundred feet in width was filled for half a mile with debris… The old bed of the river was obliterated and the dam formed caused a rise of the water some fifteen feet, stopping for a time the mills above."* Fobes, 1894, p. 366.
1871	(Westbrook) *"the Presumpscot, for instance, is naturally a salmon river, but that species is now extinct there. It will be necessary in order to* (sic) *its restoration, that a large number of young salmon be introduced to the river, and it is very desirable that it be done as soon, at least, as the fishways are completed."* Atkins, 1871, p. 16.
1873	(Presumpscot River) No boats or repairs made to the C & O Canal; railroads and steamers on the Sebago had cut off its trade. McLellan, 1903, p. 267.
1875	(Presumpscot River) Waterpower on both sides of the river (at Little Falls) purchased by C A Brown & Company, who manufactured *"wood board."* Dole, 1916, pp. 226-227.
1882	(Windham) *"Smelt King",* Samuel Knight, runs smelt weir at mouth of Squitregusset Creek. Reiche map, 1978.
1889	First hydroelectric plant in Maine: Smelt Hill Power Station at Presumpscot Falls.
1892	(Falmouth) Nathan Winslow first to preserve corn in tin cans. MacDonald, 1994, p. 11.

1895 (Westbrook) Sokokis steamer of Portland Street RR Company. *"On leaving the wharf at Bridge Street, Westbrook, you first pass a number of fine farms on each side of the river. Soon you are winding your way through forests of trees, conspicuous among them the noble pine and hemlock. Continuing up the river, there are many crooks and bends, sometimes almost a circle… The terminus at Mallison Falls is a delightful spot where are pavilions, rustic seats and adornments beneath cool foliage."* From an 1895 promotions booklet for the Presumpscot River Steamboat Line, Windham 1976: bi-centennial issue, 1976.

1895 (Westbrook to Windham) Riverton Park constructed near current Route 302 bridge.

19__? Androscoggin Pulp Company mill built at Little Falls.

1913 Newspaper report of great catches of smelt at dam.

1946 Clam flats closed.

1950's Estuary stench so bad that helicopter dumped lime.

1976 SD Warren's cleansing and purification plant opens, as do Westbrook and Portland sewage treatment plants.

1999 Cessation of pulping operation.

2002 Projected removal of Smelt Hill Dam.

II. CUMULATIVE IMPACTS TO WATER RESOURCES

The River, with a drop of 267 feet over its original 27 mile course[2], was known historically as a rapid river. Because of the technological limitations of the day, it offered more opportunities for water power than larger Maine rivers. This led to its early development. Construction of nine dams, including one at Sebago Lake used by the Presumpscot Water Power Company in 1878 as a storage reservoir for the downstream dams, as well as the settlement and industrial development of the basin, clearing of land for agricultural uses, timber harvesting, all changed the hydrology, water quality, and aquatic habitat provided by the River. (Maine Historical Society, 1894; and numerous other sources that document the impact of settlement and development throughout the northeastern United States).

Maine including the Presumpscot Basin was almost entirely forested, with areas of open water and wetlands. Industrial, residential, commercial and agricultural development in the Presumpscot watershed have, as elsewhere in the State, reduced the amount of forested land and the acreage of wetlands, while it increased the amount of cleared land and impervious surfaces. Of the 108,756 acres in the lower watershed for which land use data is available, only 40% is now forested, 31% is occupied by industrial, commercial and residential development, 16% is farmland, and 9% is wetland and surface water. The remaining 4% is open or undeveloped acreage. In addition, there are 446 miles of roads in the watershed (Casco Bay Watershed Land Use Inventory, 1995).

While changes in land and water use contributed to the economic development of the area, their cumulative effect has impacted the water resources of the River in a number of ways. For example, changes in the character of the River and its watershed, have lowered dissolved oxygen levels, increased temperature, increased turbidity, increased contamination by pathogens and chemicals, blocked fish runs, fragmented aquatic habitat, and altered habitat conditions for fish and other organisms. All these impacts have resulted to one degree or another from the combined effects of several activities and are thus *"cumulative impacts."* For example, water quality is affected, not just by waste water discharges, but also by the effect of dams on flows and by development in the watershed at large. The paragraphs which follow examine the activities which have altered water resources and the cumulative impacts of these activities on the River. As explained in the text, the impacts of these several activities are often interrelated.

A. ACTIVITIES WHICH IMPACT WATER RESOURCES

1. Dams

The power and water supply of the Presumpscot are currently harnessed by 9 dams from the outlet of Sebago Lake to the Estuary. The first of these dams is reported by some sources to have been constructed in 1732. Originally constructed for hydromechanical power for lumber, grist and other early water powered mills, seven of these dams currently produce hydroelectric power, one provides water supply for

[2] The original river began in the vicinity of White's Bridge, at the natural outlet of Sebago Lake. Construction of the Eel Weir Dam in 1878 eliminated approximately one mile of the original river, so that the river now begins at the Eel Weir Dam and has a length of roughly 26 miles to the confluence with Casco Bay, 2.5 miles below the head of tide dam at Smelt Hill.

the SAPPI Paper Mill, and one (the last dam on the River at the top of the Estuary) is scheduled to be removed. Information on the characteristics of each of these dams follows.

Table 1: Summary of Information on Presumpscot River Dams

Characteristic/Aspect	Eel Wier	North Gorham	Dundee	Gambo	Little Falls	Mallison Falls	Saccarappa Falls	Cumberland	Smelt Hill Dam
Project Characteristic									
Location: River Mile	26.0	23.65	21.9	18.6	16.9	16.4	10.3	9.6	2.5
Dam Height		24 feet	44 feet	24 feet	14 feet	14 feet	12' (west);10' (east)	18 feet	15 feet
Dam Length		970 feet	1,492 feet	250 feet	330 feet	358 feet	102' W; 220' E	NA	300
Headpond Size	45.6 sq mi	98 acres	197 acres	151 acres	29 acres	8 acres	87 acres	107 acres	80 acres
Length of Headpond	12 miles	1.1 miles	1.7 miles	3.2 miles	1.7 miles	0.5 miles	5.5 miles	1.23 miles	6.8 miles
Normal full pond elev	266.65 feet	221.8 feet	187.22 feet	135.13 feet	108.7 feet	90.6 feet	69.95 feet	45.1 feet	17.7 feet
Bypass Length	1.25 miles	400 feet	1,875 feet	300 feet	300 feet	300 feet	390' W; 475' E	NA	NA
Rated Capacity	1.8 MW	2.25 MW	2.4 MW	1.9 MW	1.0 MW	0.8 MW	1.35 MW	NA	NA
Efficiency			60%	33%	48%	60%	64%	NA	NA
Average Yearly Gen		11,150 MWH	16,000 MWH	8,500 MWH	4,200 MWH	4,200 MWH	7,600 MWH	NA	NA
Project Operations									
Drainage Area	441 sq mi	444 sq mi	445 sq mi	493 sq mi	500 sq mi	501 sq mi	567 sq mi	577 sq mi	641 sq mi
Avg Yearly Flow	640 cfs	657 cfs					940 cfs[2]	940 cfs	1,000 cfs
Median July flows	600 cfs						600 cfs[2]	600 cfs	650 cfs[4]
Minimum Flow – existing limitations	300-450 cfs[1]	222 cfs or inflow	50 cfs during mtce						
Maximum Flows – Inst Historic Peak Maximum Flow	NA						12,500 cfs (1977)	12,500 cfs (1977)	NA
Releases – existing limitations	1,000 cfs mid Oct – mid Nov[3]								
Bypass Flows – existing limitations	Variable 25-75 cfs	leakage	leakage 5 cfs	leakage 33 cfs	leakage 26 cfs	leakage 2 cfs	leak 8 cfs W; 5 cfs E	NA	NA
Impoundment – WL Fluctuations		± 1 foot	± 1 foot	± 1 foot	± 2 feet	± 2 feet	± 2 feet	NA	NA

[1]Set by DEP depending on temperature at Smelt Hill Dam Monitor.
[2]Based on gauge located about 1 mile downstream of Saccarappa Dam.
[3]Except when Sebago Lake levels exceed target levels established in the amended license in 1997.
[4]Mean Flow July – September (U. S. Army Corps of Engineers, 2001)

These dams affect flows, water levels, water quality, wetlands, and aquatic habitat in the River – more on these points later.

2. Waste Water Discharges

Use of the River for waste disposal (coinciding with its earliest development for industry) has also significantly changed the River. The quality of the water in the Presumpscot has varied over time, reaching its worst in the 1950's. At that time, discharges to the River from industrial and municipal point sources added a number of constituents that are high in biological oxygen demand, plus suspended solids, metals, hydrocarbons, chlorine and other toxic chemicals, color, and thermal wastewater. While the lower reaches, especially below Westbrook, continue to exhibit problems, the water quality of the lower River has improved considerably in response to treatment of municipal and industrial discharges (most notably the SAPPI discharge, Lee Doggett, MEDEP, personal communication).

Major point discharges on the River, and the treatment they receive are summarized below.

Table 2
Wastewater Treatment Plants
Discharging to the Presumpscot River and its Tributaries

Name	Character of Discharge	Permitted Volume (million gallons/ day)	Level of Treatment
SA Union #15	Municipal; to Pleasant River	0.055	Secondary
GTE – Standish	Industrial Waste and Cooling Water; To Little River	0.05	Unknown
Little Falls (Gorham)	Municipal	0.04	Secondary
South Windham Correctional Facility	municipal-type waste, State facility	0.077	Secondary
Westbrook	Municipal	4.54	Secondary
SAPPI[1]	Industrial	21* 12**	Secondary
Falmouth	Municipal	1.56	Secondary

[1] With the cessation of the pulping operation, SAPPI's facility is now overdesigned for the amount of flow and the design flow numbers will likely decrease when the license is modified to reflect the closure of the pulp mill
*process waste water
**cooling/filter backwash water
Source: Gregg Wood, Maine Department of Environmental Protection

The design life of these treatment systems varies. The Little Falls plant went on line in June, 1997 and likely still has considerable design life left. The plant operates at about one half of its design flow except in wet weather. The MCC Windham facility is at the end of its design life and is currently violating design flows. The Westbrook Plant went on line in June, 1978. Facility design life is currently an issue, although design flows have not been reached yet. The Falmouth facility went on line circa 1971 and equipment life is reaching maturity. Flows are, however, only about one half of permitted design flows. [The information about the design life of the municipal and state facilities provided by Stuart Rose at Maine DEP.]

Collectively, the five permitted water treatment facilities discharging directly to Presumpscot River are licensed to discharge approximately 25 million gallons per day of wastewater into the River, although typical flows are lower Even maximum discharges would constitute less than 10% of August median flows in the River.

Portland Water District has proposed extending the Westbrook sewer out to capture their Little Falls treatment plant (which experiences problems in wet weather) and the aging Maine Correctional wastewater flow. The sewer extension would eliminate two discharges to the upper reaches of the Presumpscot. PWD, Maine Correctional and several communities are discussing ways to implement this idea (John Wathen, MEDEP, personal communication). The River has recently undergone a dramatic reduction in discharges, and concomitant improvement in water quality, due to the 1999 closure of the Westbrook pulping operation. Maine DEP has not sampled the River since the closure, and plans to initiate a sampling program to monitor the recovery of the River, after the flow at Smelt Hill Dam is stabilized (Dave Courtemanch, Maine DEP, personal communication). SAPPI has conducted Biomonitoring studies since pulping was discontinued, and submitted information to the Maine Department of Environmental Protection, that demonstrates that this stretch now has a 60% probability of meeting class B standards for aquatic life (insects) (SAPPI report submitted to Maine DEP).

3. Development in the Watershed

As pointed out earlier, originally Maine was almost entirely forested, except for areas of open water and wetlands. Today only 40% is forested, while 31% is industrial, commercial and residential development. In addition, there are 446 miles of roads in the watershed (Casco Bay Watershed Land Use Inventory, 1995).

Water quality in the Presumpscot River has been impacted as a result of nonpoint source runoff from existing urban, and industrial development (sediment, suspended solids, oils, hydrocarbons, fertilizers, herbicides, and pesticides, etc.). While some efforts have been made to reduce the transport of soluble pollutants carried by stormwater (especially hydrocarbons from runoff from roads), these pollutants continue to have a significant impact on the River.

4. Agriculture

Today 16% of the land in the Presumpscot watershed is farmland (Casco Bay Watershed Land Use Inventory, 1995). Agricultural use may have resulted in filling and draining of wetlands. This decreases the capacity of the land to store and infiltrate flood waters and adds to the problem of flooding on the River. Additionally, water quality on the Presumpscot River has been impacted as a result of nonpoint source runoff from agricultural, as well as urban, and industrial development (sediment, suspended solids, oils, hydrocarbons, fertilizers, herbicides, and pesticides, etc.). While some efforts have been made to reduce the transport of soluble pollutants carried by stormwater from agricultural operations (especially nutrients from fertilizers), these pollutants continue to have a significant impact on the River.

B. IMPACTS

1. Alteration of Flows

One of the most significant changes to the River, dramatically altered hydrology, resulted from controlling flows from Sebago Lake and the development of dams and impoundments on the River (see Figure 1). The construction of the dam at Sebago Lake added 252,000 acre feet of water storage to contain spring runoff, allowing it to be released more gradually than would occur under natural, unregulated, conditions. Figure 2 illustrates the frequency of historic flow rates. Records of weekly flow measurements taken at the outlet of Sebago Lake during the period 1952-1999 indicate flows ranging from 3,000 cfm (cubic feet per minute) to 210,000 cfm. Minimum flows (10,000 cfm or less) occurred at only 3% of weekly sampling events. Flows of 20,000 cfm to 50,000 cfm were measured 86.2 % of the time. Flows of 60,000 cfm or greater were measured at 10.8% of the sampling events.

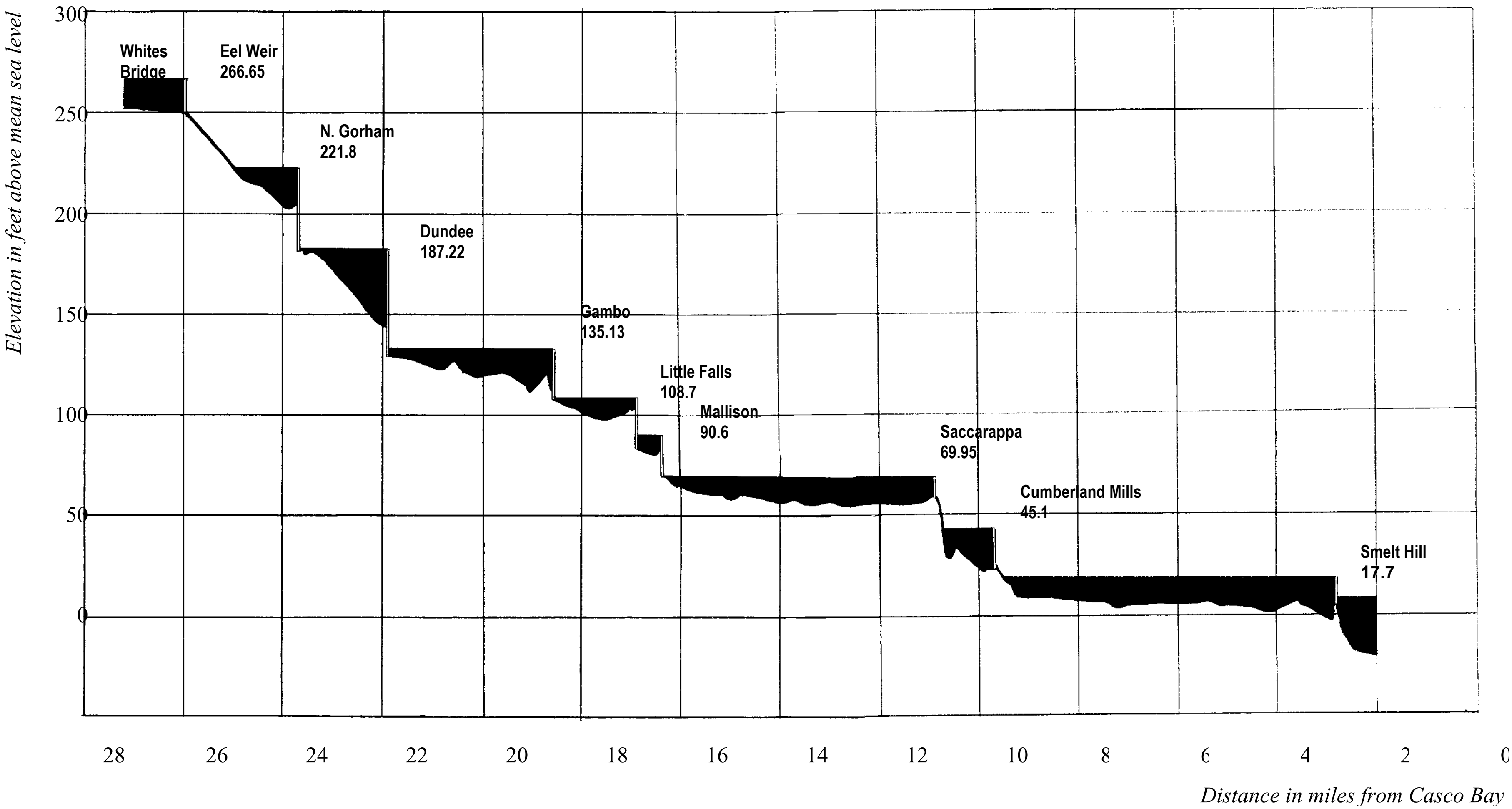
Naturally occurring flows were undoubtedly more variable than these. Figure 3 compares a typical hydrograph of flows in the Presumpscot River at Westbrook with a hydrograph for the Ossipee River, a comparably sized river (drainage area 452 square miles) with significant headwater storage (1.6 billion cubic feet at Ossipee and Silver Lakes and, Pine River, Bickford, and Colcord Ponds). This comparison indicates that the principal effect of the flow regulation at Sebago Lake has been to augment low flow periods. In addition, the hydrographs suggest that flow regulation also moderates high spring flows, and tempers the effects of summer storms (the river is less flashy in the summer).

In addition, current velocities have been decreased by the dams in place along the River, which have largely converted the River from free flowing to a series of impoundments.

How the dams affect flooding is not known. According to George Flaherty, Cumberland County EMA [personal communication], there is not enough information available on the hydrology of the River and its tributaries to be able to determine what overall impact

the dams have on flooding. They were not built historically for flood control, and floods have occurred with the dams in place, with most of the flood water coming from the tributaries that are not controlled by the head dam at Sebago. However, it is clear that the annual spring freshet flow on the Presumpscot has been reduced from what it would be otherwise, as have other flood flows, due to the operation of the dam at Sebago Lake. At a more refined level of geographic resolution, dams have undoubtedly increased flood water levels behind their structures. For example, the study on the removal of Smelt Hill Dam by the Army Corps of Engineers indicates that peak water surface elevations 50 feet upstream from the dam would decrease by 11.6 feet for the 10-year flood (The Smelt Hill Dam Environmental Restoration Study- Falmouth, Maine, U.S. Corps of Engineers, New England District, September, 2000).

Figure 2: River Profile – Current and Predevelopment



Sources: *Federal Emergency Management Agency: Flood Insurance Study. Portland (1998), Falmouth (1984) Westbrook (1980), Gorham (1981), Windham (1981); and Portland Water District (for data at White's Bridge).*

Prepared by*: Natalia Kassatova, Graduate Intern, Casco Bay Estuary Project*

Figure 3: Histogram of Current Flows

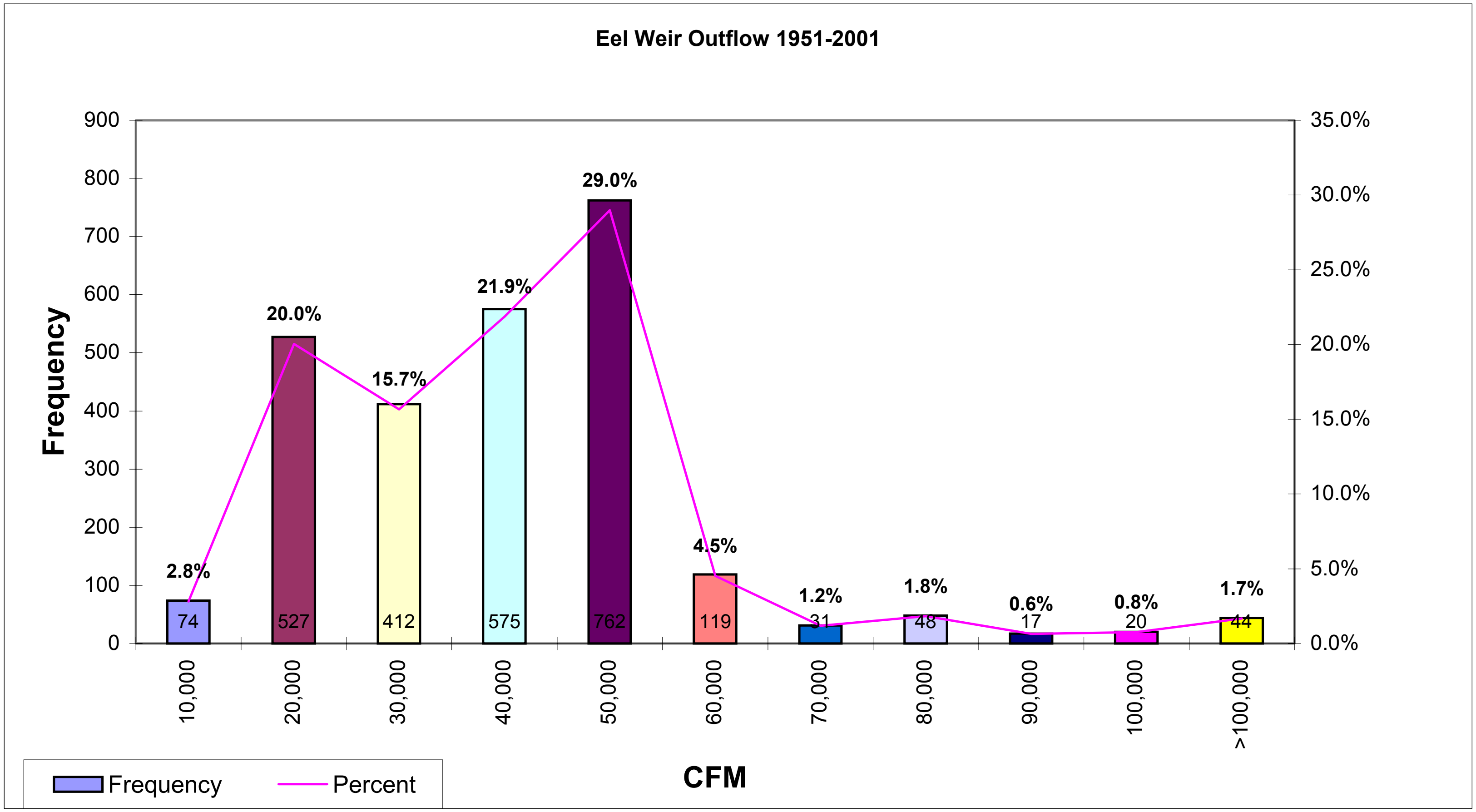
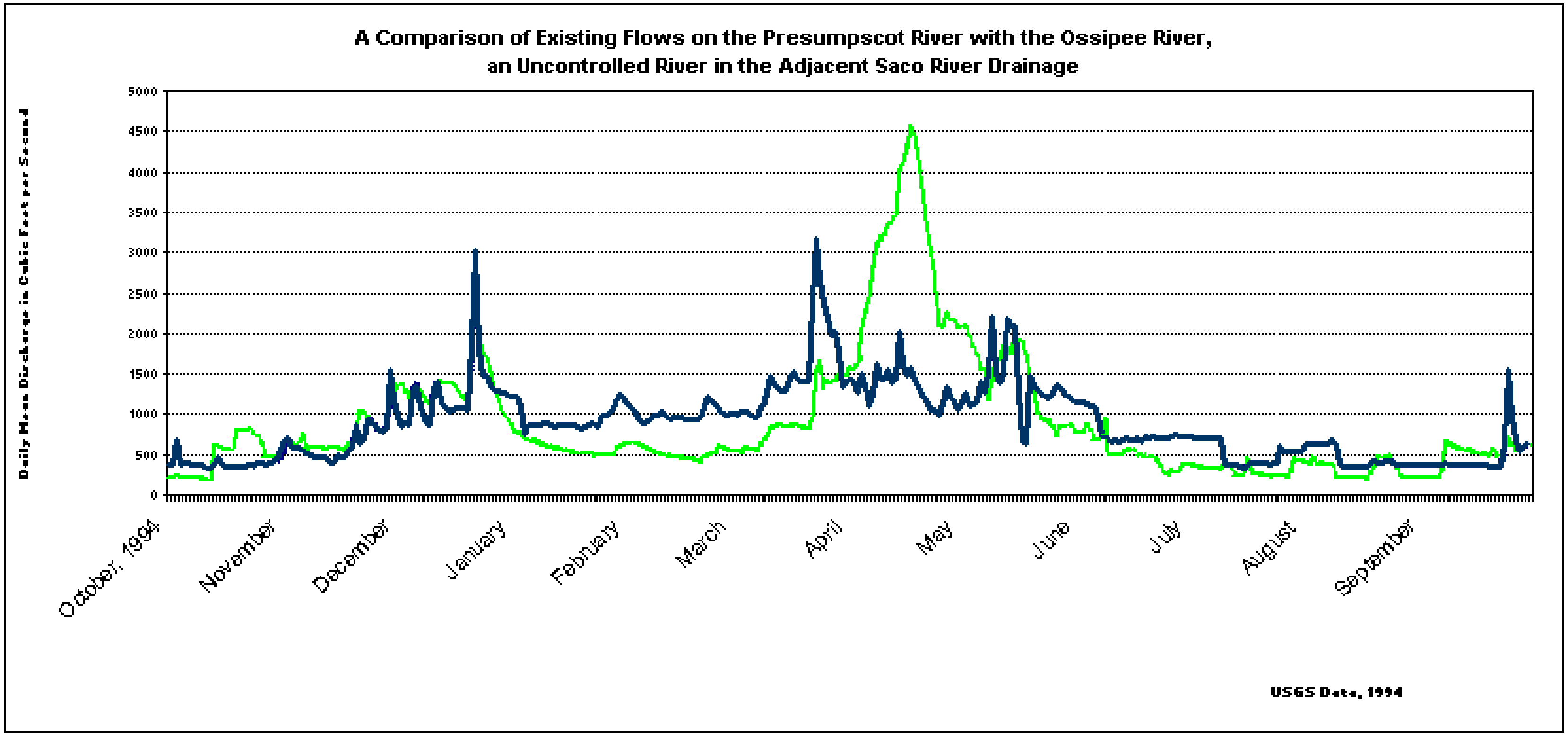


Figure 4: Current and Likely Predevelopment Flows



2. Changes in Water Quality

Because the basin was originally almost entirely forested, the original water quality naturally occurring in the Presumpscot River was in all likelihood very similar to that in Sebago Lake, its source. The following section examines the water quality of the Lake; subsequent sections discuss impacts and the water quality of the River today as it flows through developed areas and past dams and through impoundments on its way to the sea, displaying the cumulative impacts of human activities. The activities discussed earlier have all contributed to the differences observed in water quality at these two locations.

Sebago Lake Water Quality as a Basis for Comparison: In 2001, the Portland Water District's draft State of the Lake report notes that the Lake itself still has outstanding water quality. *"This fact is demonstrated by almost any scientific measure of water quality – clarity, nutrient levels, concentrations of dissolved elements, amount of attached and floating algae. But you do not need to be a scientist to see that the lake is unusually clean – any first time visitor to the lake notices immediately that you can see the bottom even in 20 to 30 feet of water. This is true of few other lakes in Maine or anywhere in the country."*

One way of comparing the water quality of Sebago Lake to other lakes in Maine is in terms of trophic classification, which is directly related to water column nutrient levels, algal populations and resulting transparency. Trophic Status or TS is used by the state DEP to compare Maine's lakes in the State of Maine 2000 Water Quality Assessment. Lakes with high nutrient levels, elevated numbers of algae (measured as chlorophyll a) and resultant lowered transparency, (measured as secchi depth transparency) are called "eutrophic." Sebasticook Lake, which suffers from nutrient enrichment and algal blooms is an example of a eutrophic lake. Lakes with low nutrient concentrations and low algal populations lie at the opposite end of the spectrum and are called "oligotrophic lakes." Sebago Lake is oligotrophic. The majority of the total lake acreage in Maine (61.8%) is classified as "mesotrophic" an in-between state which reflects some nutrient impacts. Lake Auburn is an example of a mesotrophic lake (see Table below).

Table 3: Trophic Status of Sebago Lake

Parameter	State Criteria Oligotrophic	State Criteria Mesotrophic	State Criteria Eutrophic	Sebago Lake (oligotrophic)	Auburn Lake (mesotrophic)	Sebasticook Lake (eutrophic)
Trophic Status	0 – 25	25 – 60	>60	21	28	115
Total Phosphorus	<4.5 ppb	4.5-20 ppb	>20 ppb	4 ppb	9 ppb	37 ppb
Chlorophyll a	<1.5 ppb	1.5 – 7ppb	>7 ppb	1.8 ppb	2.5 ppb	17.4 ppb
Secchi Depth Transparency	>8 m	4 – 8 m	<4 m	5.8 – 16.0 m	3.5-11.3 m	0.3-4.7 m

Table values are the historical cumulative average values of years on record according to the PEARL database at http://pearl.spatial.maine.edu/, with the exception of the Sebasticook chl a value which is the 1999 sampling average (historical value not available).

Sebago Lake supports a healthy indigenous biotic community. Serving as Portland's drinking water reservoir, Sebago Lake meets GPA (Great Pond) water quality standards (see Appendix) with one exception. All lakes in Maine are designated as not supporting fish consumption because of mercury contamination, resulting in a state-wide fish consumption advisory for pregnant women and children under 8 years of age. The Lake undergoes periodic water quality monitoring by the Portland Water District.

Activities Impacting Water Quality: The Twelfth Annual Report of the Maine Board of Agriculture (1867) called the Presumpscot *"a river of uncommon transparency"*. Today such observations are missing from reports on the river's water quality and the once notable *"transparency"* of the river has, except in the upper mile, been impacted by discharges of pollutants (both point and nonpoint).

The nine dams present on the river have also had an impact on the River's water quality. Dams reduce aeration, increase retention time, increase settling, and increase water temperatures. Today, even with the scheduled removal of the Smelt Hill Dam, over 50% the river will remain impounded. According to Paul Mitnik, MEDEP (personal communication) impounded areas generally have higher temperatures, which, together with increased waste loads and the elimination of rapids and falls, contribute to reduced dissolved oxygen levels. Further, he notes that impounded areas are also more susceptible to impacts from settled pollutants that can decrease dissolved oxygen. This effect, of course, varies in degree from river to river and by location on the river involved. On the Presumpscot, low dissolved oxygen has been measured in the Little Falls and Gambo impoundments (MDEP 1993, Woodard and Curran 1997 and by Presumpscot River Watch, 1999). Further, the State of Maine's Department of Environmental Protection reported that reduced aeration due to the damming of the river has decreased the river's overall capacity to assimilate pollutants (Biomonitoring Retrospective, A Fifteen Year Summary of Maine Rivers and Streams, MDEP 1999).

Changes to Water Quality in the River: The cumulative impacts of waste discharges, watershed development, and damming of the waters which spill from Sebago Lake and flow seaward through the river corridor, are quantifiable. State and volunteer monitoring studies have measured these impacts using indicators of water quality. Degraded water quality can be seen where there is an increase in total suspended solids, a shift to pollution-tolerant aquatic organisms, reduced dissolved oxygen, increased temperature, and elevated levels of bacteria. In some cases, the river's waters fail to meet state water quality criteria. The results of these monitoring studies are examined below.

Increased Total Suspended Solids: While the source waters are low in total suspended solids, both point and non-point discharges have increased the load of suspended solids carried in the River. For example, stormwater runoff from development and agriculture carry soils with a high clay content into the Pleasant River (a tributary which joins the mainstem in Windham, Corps of Engineers, 2000). Prior to 1999, the lower 6.5 miles of

the Presumpscot River were plagued by high total suspended solids (TSS), 80% of which came from the SD Warren outfall (Biomonitoring Retrospective: Fifteen Year Summary for Maine Rivers and Streams, Maine DEP, December, 1999). The high TSS created impaired aesthetic conditions that affected recreational fishing and swimming (Presumpscot River Supplemental Report to Waste Allocation, Maine DEP, March, 1998).

Increased Dissolved Solids: Total Dissolved Solids (TDS) refers to the total concentration of any minerals, salts, and metals dissolved in the water. TDS can originate from natural sources (such as mineral deposits or salt water intrusions) as well as from sewage, urban and agricultural run-off (e.g., road salt), landfills, industrial wastewater and wastewater treatment chemicals. Specific conductance, an indicator of the ability of water to conduct an electric current, is usually strongly positively correlated with TDS and is used as a way to approximate the concentration of dissolved solids. High quality drinking water, such as the water originating in Sebago Lake, has a low specific conductance. Elevated TDS can lead to problems with taste, staining, foaming or corrosivity. It can also indicate that elevated levels of metals are present (Wilkes University web site: //wilkes.edu~eqc/tds.htm). As the water travels downstream from Sebago Lake, the total concentration of dissolved solids entering the river from point and non-point sources increases, cumulatively degrading the general water quality. For example, in June – September 1996, the specific conductance of the river water at the Presumpscot Falls USGS monitoring site ranged from 68 to 233 microSiemens (uS) at 25 degrees Celsius. The average specific conductance for Sebago Lake for the year 2000 was 52 uS (PWD,2000, Sebago Lake Water intake analysis). It is not known how reductions in discharges at the SAPPI Mill, which occurred after the last available USGS data was collected, have affected total dissolved solids and specific conductance in the river.

Lowered Dissolved Oxygen: **Lowered Dissolved Oxygen**: While the upstream source waters of the River are highly oxygenated, failure to meet class C dissolved oxygen (DO) standards in the lower 2 miles of the river (60% saturation) led to the 1998 completion of a TMDL (total maximum daily load) for biological oxygen demand (BOD) and total suspended solids. The TMDL set limits on the BOD load of effluent from the Westbrook Mill. With the elimination of the pulping operation at the Mill, the BOD of the Mill's effluent has been considerably reduced. No monitoring data reflecting the reduced BOD is currently available; however, based on recent sampling for aquatic macroinvertebrates (mostly insects) SAPPI reports that the River below Westbrook has a 60% probability of meeting class B water quality standards.

In other parts of the River, water quality modeling and data taken in 1993 indicated minor non-attainment of Class B dissolved oxygen standards (75% saturation or 7 ppm) in the upper Presumpscot at Little Falls, Mallison Falls and Saccarappa Dam impoundments (Presumpscot River Supplemental Report to Waste Load Allocation March 1998, Maine DEP). Additional data was collected in the summers of 1998, 1999 and 2001 by Presumpscot River Watch and DEP (1999 data only). The Class B minimum of 7 ppm was not attained a number of times at the Gambo, Little Falls,

Mallison Falls and Saccarappa impoundments. Data was not collected at Dundee because it is classified as a lake (GPA), where DO criteria do not apply.

A dammed river is more sensitive to the impacts of non-point source pollution. Impounded water slows river travel times and allows waste inputs to deplete river oxygen. Also, settling sediments lead to higher bottom oxygen demand and the lowering of surface aeration. Low flows in the bypass channels also limit aeration of the river water. (DEP Memorandum to Dana Murch from Dave Courtemanch and Paul Mitnik, February 8, 2002). In summary, dams, nonpoint source pollution, and low to no flows in the bypass reaches are factors in DO non-attainment (MDEP communication by Dave Courtemanch and Dana Murch).

Increased bacterial levels: The clean waters flowing from Sebago Lake encounter bacteria in runoff from the land and from stormwater systems. For the present, the River will continue to be listed in partial attainment for bacterial standards due to ongoing combined sewer overflows (CSOs) in Westbrook (State of Maine Water Quality Assessment, 2000). CSOs can be a major source of pollution. For example, after Hurricane Bob in 1991, bacterial readings of up to 27,900 cfu/100 ml (nearly 30 times the State standard) resulted from CSOs at the Westbrook plant. The City of Westbrook is now on schedule working towards elimination of CSOs and will have completed the tasks in their CSO master plan by the end of October, 2001. Currently there are 5 CSOs in Westbrook down from an original total of 7 (*Annual CSO Progress Report for 2000*, Westbrook). In addition to CSO elimination, the city will continue to seek out additional sources of bacterial pollution (*e.g.*, illegal discharges, stormwater runoff) in the future**.**

Presumpscot River Watch data indicates that the tributaries can also serve as sources of bacteria to the mainstem. *E. coli.* abundance is highly variable and significantly higher in the tributaries than in the mainstem. Non-compliance events (using seasonal geometric means) occurred at 78.6% and 22.2% of the low order (tributaries) and high order (mainstem) sites, respectively (*Deciphering Rainfall Dependent Effects on Surface Water Bacteria Counts*, Pennuto *et al.*, 2001). As pollution sources are eliminated, it is expected that the River will meet Class C bacterial standards within the next few years (Steve MacLaughlin, Maine DEP, personal communication).

Shift to Pollution-Tolerant Aquatic Organisms: Because communities of aquatic organisms change (becoming less diverse and abundant) as pollution loads increase, under Maine law the community of aquatic organisms present in surface waters is monitored as a water quality requirement. In the Presumpscot the community of aquatic life has been adversely affected by cumulative impacts in the River. Macroinvertebrate sampling data collected by Maine DEP in 1984, 1994, 1995 and 1996 (using standard rock basket artificial substrates) indicated that the lower stretch of the River failed to support the indigenous biotic community; and, thus, did not meet class C aquatic life standards. The samples revealed a shift from pollution sensitive insect taxa to a predominance of snails and worms, adapted to utilization of settled solids (Biomonitoring Retrospective: Fifteen Year Summary for Maine Rivers and Streams, Maine DEP, December, 1999).

Macroinvertebrate data collected 1500 feet above the SAPPI Mill outfall in 1996, and data collected in the Gambo and Little Falls impoundments in 1997, indicated that in these areas the River also did meet class C aquatic life standards. With the elimination of the pulping operation from the SAPPI Mill in 1999, the major cause of the TSS loading below Westbrook has been removed. Qualitative observations during summer, 1999, suggest that the lower river currently does attain Class C standards for aquatic life, (Dave Courtemanch, Maine DEP, personal communication) and SAPPI has submitted the results of Biomonitoring studies which show that the River below Westbrook has a 60% probability of meeting Class B standards for aquatic life (insects). Some of the impoundments are likely to continue to remain out of attainment. For more information on impacts to aquatic life in the river, see the section on Cumulative Impacts to Fisheries and Aquatic Life.

Temperature: Water temperatures on the River have also been affected (see section on changes in habitat conditions which follows).

Summary: In summary, the clear, clean source water which flows into the River from Sebago Lake is degraded on its journey to the sea by the cumulative impacts of development in the watershed, sewage discharges, and damming along and in the River. The well-aerated, rushing river of the past carrying clean cool water to the coast now carries warmer, less oxygenated water, slowed by impoundments and dams and compromised by pollution. Table 4 summarizes the water chemistry at the PWD intake of Sebago Lake and compares it to downstream water quality at West Falmouth. Note that the available river data water quality predates the cessation of the pulping operation and the resultant improvements in water quality are not reflected.

Table 4 Comparison of Raw Water Chemistry of Sebago Lake and the Presumpscot River in Falmouth		
Water Quality Parameter	**Sebago Lake**	**Lower Presumpscot River****
pH (Standard Units)	6.9	7.3 (1995 field average)
Alkalinity (mg/l as $CaCO_3$)	4.4	2.5 (1979-80 average)
Dissolved oxygen (mg/l)	13	11.4 April, 1995 7.4 June, 1995
Specific Conductance (uS)	52	137 April, 1995 154 June, 1995
Total residue (mg/l)	25	73.4 (1994-1995 average, dissolved)
Turbidity (NTU)	0.25	4.9 (1980-1995 average)
Nitrogen, NO_2+NO_3, dissolved* (mg/l)	0.271	.14 (1994-1995 average)
Sodium, dissolved* (mg/l as Na)	3.39	17 (1995 average)
Calcium, dissolved* (mg/l as Ca)	2.54	6.4 (1995 average)
Chloride, dissolved* (mg/l as Cl)	6	16.3 (1995 average)
Sulfate, dissolved* (mg/l)	3.7	8.3 (1995 average)
Phosphorus, total(mg/l as P)	0.005	0.03 (1995 average)
Iron, dissolved* (mg/l as Fe)	Less than 0.03	.08 (1991-1995 average)
Manganese, dissolved* (mg/l as Mn)	0.004	.0286 (1994-1995 average)

Sources: Portland Water District – samples collected in 2000 in the lower bay of the lake at the PWD intake, and
USGS – monitoring site in West Falmouth (river sampling dates vary due to data availability)

*Sebago lake raw water samples are unfiltered.
**No figures are available for after the 1999 closing of the SAPPI pulp mill which significantly reduced discharges to the River

3. Changes in Aquatic Habitat

Increased amounts of cleared land elevate the temperature of rivers as runoff warmed by the land surface flows into the river (Paul Mitnik, MDEP, personal communication). In the past, the summer River temperature below the Westbrook discharge has often exceeded that allowed by DEP rule chapter 582, *i.e.*, no more than .5^{o} F above the EPA national ambient water quality criteria of 66^{o} F (18.9^{o} C) outside of the effluent mixing zone. An increase of more than 2^{o} F above the standard has been observed at low flow (Presumpscot River Waste Load Allocation Final Report November 1995, Maine DEP). Upstream, in the mainstem and tributaries, temperature changes have occurred due to land development and to the slowing of the water by the presence of the dams. This is evidenced by the switch from native cold water fish species, such as trout, to warm

water non-native species such as bass. The river has a low reproductive rate for cold water species, such as trout (Baseline Fisheries Study conducted for the SAPPI license application); thus, trout populations are supplemented by IF&W stocking, because suitable spawning areas are now limited and because temperatures are too warm for long-term survival on most of the River. With the building of dams, the influence of coldwater springs that feed the river and the tributaries has likely been lessened. Impoundments which are larger than the original river and less shaded by shoreline trees expose more water to heating by the sun. This can also increase water temperatures.

In addition, increases in the amount and rate of runoff resulting from development and clearing, increase erosion and sedimentation into rivers and tributary streams. According to Leon Tsomides, MEDEP, in streams and rivers impacted by sedimentation, the aquatic community shifts to one more tolerant of turbid water, and the overall abundance of fish, snails, aquatic insects, and other invertebrates decreases. Even in watersheds that have reverted from largely agricultural to forested cover, research has shown that these impacts last for at least 50 years (Milius, 1998). The changes in biodiversity of the macroinvertebrate community, combined with increases in water temperature and turbidity, as well as the effects of ponding, have cumulatively impact the fish in the river (see the discussion under Cumulative Impacts to Fisheries and Aquatic Life and Alteration of Flows).

Streams such as Otter Brook, Colley Wright Brook, Inkhorn Brook, Pleasant River, Little River, Nasons Brook, and Tannery Brook, have all been altered by the impacts of development in the watershed. For example, sedimentation from runoff has changed the channels of these streams and increased turbidity. These streams were reportedly once coldwater sources for the River, with large populations of trout and even salmon in predevelopment times. Today the hydrology of the smaller streams has changed into slower, wider streams that carry sediment from land use into the mainstem of the Presumpscot (Francis Brautigan, MEIF&W, personal communication). The transport of this sediment is also effected by the by the presence of nine dams, which have reduced flooding, slowed travel time, and changed the deposition of sediments along the River. Suitable spawning habitat in these streams and on the mainstem has been limited, as well, so natural reproduction has decreased and fish populations are sustained mainly by a stocking program from MEIF&W (Francis Brautigan, MEIF&W, personal communication).

As pointed out earlier, communities of aquatic organisms change (becoming less diverse and abundant) as pollution loads increase. In the Presumpscot the community of aquatic life has been adversely affected by cumulative impacts in the River. Macroinvertebrate sampling in the Presumpscot between 1984 and 1996 revealed a shift from pollution sensitive insect taxa to a predominance of snails and worms, adapted to utilization of settled solids (Biomonitoring Retrospective: Fifteen Year Summary for Maine Rivers and Streams, Maine DEP, December, 1999). However, recent Biomonitoring efforts below Westbrook show that the River below the SAPPI mill has a 60% probability of meeting Class B standards for aquatic life (insects).

For more information on impacts to aquatic life in the River, see Section V. Cumulative Impacts to Fisheries and Aquatic Life.

C. RELATIONSHIP OF IMPACTS TO WATER QUALITY CLASSIFICATION OF THE PRESUMPSCOT RIVER

The mainstem of the Presumpscot River is divided into segments with different water quality classifications, which reflect decreasing water quality (Class A to C - increasing cumulative impacts) as the River flows seaward from the Lake. From the outlet of Sebago Lake to its confluence with the Pleasant River, it is Class A. Dundee Pond, which lies in the middle of this segment, is classified as a great pond rather than a river, and is GPA From its confluence with the Pleasant River almost to U.S. Route 202 (Little's Island, just upstream of the bridge), the River is Class B and additionally, no new discharges are allowed under State law. From Little's Island to Saccarappa Falls, the River above the Saccarappa Dam is Class B. The impoundments are classified as B for all water quality criteria except aquatic life, for which they must only meet Class C standards (the minimum required by law for impoundments, ME legislature, 1985). From Saccarappa Falls to tidewater the River is Class C.

The water quality classification standards for rivers are included in the Appendix but the essence of the difference between Class A, B and C standards is as follows: statute Class A waters are to be as they would occur naturally, and populations of aquatic life are allowed to reach their full natural potential. In Class B waters habitat must be maintained "unimpaired" and organisms protected, but populations may not necessarily reach their full natural potential and may occur as community assemblages different from what might be observed in the natural state. Class C waters may be modified to an even greater extent and some community characteristics need not be maintained, and the loss of sensitive organisms may occur. Two examples may be illustrative of these points. For example, the Dissolved Oxygen standards for class A, B and C streams, range from 7ppm or 75% of saturation (Class A) to 5ppm or 60% of saturation levels (Class C). Further, the aquatic life standard for streams requires that the native fish and insects they depend on must in the case of Class A streams, be able to reach their full natural potential, while in Class C streams, the fish species must be maintained while the insect food supply may be significantly altered, but not lost.

Historically, portions of the mainstem of the river as it flows downstream towards the ocean have not met State water quality standards. In 1993**,** DEP modeling and actual data taken indicated nonattainment of Class B dissolved oxygen standards in the Little Falls, Mallison Falls and Saccarappa impoundments (Presumpscot River Supplemental Report to Waste Load Allocation March 1998, Maine DEP). Also, Presumpscot River Watch data showed dissolved oxygen violations in the upper portion of the river in 1999. The Maine 1998 Water Quality Assessment noted that the lower 7 miles of the main stem below Saccarappa Dam did not attain riverine Class C bacteria or aquatic life standards. Water quality modeling indicated that the lower 2.0 miles did not attain the Class C dissolved oxygen standard (60% saturation). The causes of non-attainment were considered to be discharges

of combined sewer overflows (CSOs) in Westbrook and inadequately treated industrial wastewater (from the Westbrook plant).

Table 5
Comparison of State Water Quality Parameters for Sebago Lake and the Presumpscot River

Water Quality Parameter	Sebago Lake	Lower Presumpscot (prior to cessation of pulp operation at SAPPI)	Lower Presumpscot (Current Conditions)
Dissolved Oxygen	Meets Class GPA 99%	Meets Class SC 70% Presumpscot River Bridge, FOCB data	Not Available
Bacteria (*E. coli*)	Meets Class GPA 0 - 5 cfu/100 ml	May exceed Class C 142 cfu/100 ml, PRW data	Not Available
Aquatic Life	Meets Class GPA	Failed to meet Class C in the past, MEDEP data	60% probability of meeting Class B Standards
Total Suspended Solids	Meets Class GPA 1.2 mg/L	Failed to meet Class C aquatic life standards in the past due to high TSS loading from SD Warren (which has been discontinued) 10.5 mg/L (PRW summer 1996 average, Westbrook)	Not Available

Source: Sebago Lake data was collected by PWD multiple times per year at White's Bridge (at the outlet of Sebago Lake to the river) during the period 1977 to 1996.

III. Cumulative Impacts to Estuarine Resources

Changes in the River's water resources are also felt in the estuarine portion of the Presumpscot, where the fresh water meets the salt water of Casco Bay. Historically, the estuary was a rich feeding ground for fish and birds, including migratory birds who used the estuary as a staging area (Guide to the Presumpscot River, MacDonald, Butler and Ricardi, 1994). While birds still feed in the estuary and migratory fish still move into the River from the sea each summer, the diversity and abundance of life historically supported by the estuary has been diminished by the load of pollutants carried to the sea from upstream and the continuing loss of populations of anadromous fish, some of which served as food sources for larger predatory fish, birds and mammals in the estuary.

A. Impacts to Salinity

The Presumpscot estuary lies between the Smelt Hill Dam (Presumpscot Falls) and Martin's Point (where Route 1 crosses the river between Portland and Falmouth). The upper part of the estuary is largely fresh water, but tidal, while the lower part of the estuary is brackish water which varies in terms of its salt content depending on the River's flow. However, because the Presumpscot has such a large volume of storage available in Sebago Lake, and hence flows can be closely regulated to even them out over the course of the year, fresh water flows to the estuary are much more consistent to the Presumpscot estuary than they would be if flows on the river were not dam controlled. This relatively stable condition has in turn undoubtedly affected the biota of the estuary which are closely tuned to changes in the brackishness of the water in the estuary. Stable fresh water flows have likely resulted in a more stable biological system in terms of the distribution and abundance of aquatic organisms than would be the case if the estuary were more dynamic. This hypothesis is born out by recent investigations on the distribution of clams in the estuary. These investigations show a clear and relatively stable boundary between areas where clams have existed, and where they have not.

Investigations showed:

> Southern Section: From the Route 1 Bridge to the rocky shore on the 295 side, no clams are currently growing; however, 6" down in the sediments, there are dead shells, "monster" clams, and lots of them. It is not known when they were alive. This area has seemed to "set in" similarly as the middle section since Spinney Creek has been in there. It may prove to be a future productive flat.
>
> Middle Section: All of the clams are in this section. There is an older set that is almost too big to harvest. They go all of the way out to the Bay from 295. There is also a tremendous new set that could be ready this year (about 1,000 to 2,000 bushels). This area has a good mix of fresh and salt water and sandy mud – what clams like!
>
> Upper Section: 295-North – the upper wide section of the estuary. This section has no clams nor any remnants of old clams. This area seems to have mostly river (fresh) water in it. It also is mucky mud. There is almost a line drawn where the fresh water is dominant and the clams stop.

There are no flats on the other side of 295 up to Smelt Hill Dam.

(As reported by the Casco Bay Estuary Project)

It is unclear what estuarine species are benefited or disadvantaged by the existence of more stable fresh water flows to Presumpscot estuary, but it is clear that the system is different (more stable, less dynamic) that it would be under natural conditions.

B. Impacts to the Chemistry of Estuarine Sediments

The Presumpscot River estuary is a large depositional area where fine-grained sediments carried downstream by the River are accumulating. A sediment study undertaken by the Casco Bay Estuary project in 1991 showed that the fine-grained sediments of the River's estuary have moderately elevated levels of metals and high levels of PAHs (polycyclic aromatic hydrocarbons). The highest concentrations of PAHs – the most widespread contaminants in the bay at large – occur in the Fore River, Back Cove, and the Presumpscot estuary. PAHs are a family of over 100 chemicals that reach the environment primarily through the incomplete combustion of coal, petroleum products and other organic material. They tend to stick to particles in water and settle to the bottom with deposited sediments. In laboratory studies of animals, PAHs have been linked to impaired reproduction and cancer. They may be carcinogenic to humans (Agency for Toxic Substances and Disease Registry website http://www.atsdr.cdc.gov). PAHs in the sediments of the Presumpscot estuary probably result from chronic nonpoint and point source pollutants characteristic of urban activities (Kennicutt, *et al*., 1994).

An analysis of sediment dioxins and furans in the Presumpscot River estuary and the bay was undertaken by the Casco Bay Estuary project in 1994. Dioxins (polychlorinated dibenzo-para-dioxins) and furans (polychlorinated dibenzofurans) are toxic chemicals that may be formed during the bleaching process at pulp and paper mills, during chlorination by waste and drinking water treatment plants, as by-products in the manufacture of certain organic chemicals, and through incomplete combustion in municipal solid waste and industrial incinerators. They can accumulate in the bodies of animals and have been linked to cancer in humans (Agency for Toxic Substances and Disease Registry website http://www.atsdr.cdc.gov.)

The results indicated that the highest levels of dioxins and furans found in the bay were found in the Presumpscot estuary, 10 miles downstream from the SD Warren pulp and paper mill (Wade, T. L., T. J. Jackson, L. Chambers, and P. Gardinali. 1995. Texas A & M University. Assessment of Contaminants in Sediments from Casco Bay. Casco Bay Estuary Project). Casco Bay Estuary Project is re-testing the sediments in the Presumpscot estuary in 2000 – 2002.

Mammals and birds that feed on benthic organisms or fish may absorb concentrated amounts of contaminants. Some of the tidal mudflats that represent the most important feeding areas for shorebirds, waterfowl, and wading birds – the Fore River, Back Cove, and Presumpscot River – also have the highest concentration of contaminated sediments

in the bay. Until approximately 30 years ago, these areas received high levels of untreated waste from residences, businesses, and industry.

Dioxin levels in clams in the Presumpscot River were approximately one-third higher than clams sampled from Scarborough, but only half as high as clams samples in the Kennebec/Androscoggin and Penobscot rivers. The levels in clams at all sites sampled were not high enough to issue a consumption advisory. Dioxin levels in lobster meat were elevated only slightly, but were greatly elevated (20 to 30 times greater than the meat) in the tomalley (the lobster's liver and pancreas). In February 1994, an advisory was issued cautioning against consumption of tomalley for all lobsters caught in Maine waters. Continued testing results determine that this advisory will remain in effect indefinitely.

A freshwater fish consumption advisory that was issued for the Presumpscot River south of Westbrook in 1990 was lifted in 1992 because of reduced dioxin levels in fish tissues.

C. Impacts on the Volume of Sediments Reaching the Estuary

As stated earlier, the estuary is an area where suspended materials carried by the river's water settle out. In this regard, conditions on the river have affected the estuary in two ways. First, movement of the coarsest particles originally carried by the river (bedload consisting of cobbles, pebbles and coarse sand) has been impeded by the dams on the river. This has affected both the river itself and the estuary as these coarse materials remain in the river rather than being flushed out into the estuary. It is not clear what the volume of these materials reaching the estuary would be if dams were not present on the river, nor what influence the deposition of these materials would have on the estuary itself, except that, as regards coarse substrates, estuarine conditions are more stable then they would be under natural conditions. It is important to note that there has been no evidence that coarse materials are accumulating behind the dams, or settling out in the slack water higher in the impoundments.

Second, regarding finer sediments, the estuary has, as a result of human activities, received far greater loads of suspended materials in the smaller size categories (fine sands, silts and clays) than it would have under natural conditions. The increase has resulted from changes in land use in the watershed, particularly conversion from a forested condition to agricultural uses and urban development, and wastewater discharges – developed watersheds in the northeast generally yield more sediment to watercourses than undeveloped watersheds. According to Wayne Munroe (NRCS, personal communication), conditions during the last ten years have significantly impacted the sediment load of the river. In the 1990's, dairying and other livestock production farms in the Presumpscot watershed decreased by approximately 30%, opening up land for development. This has had a twofold effect on the sediment load reaching the river and ultimately the estuary. In the short-term, as heavy equipment stripped protective cover from hayfields, pasture land and some cropland to create house lots, the physical disturbance exposed the soil and increased the dissolved and suspended sediment load entering the river via stormwater runoff. Longer term, the increased impervious surface

created by development has increased runoff into the streams feeding the Presumpscot and a increased the overall sediment load. In addition, Munroe noted that the increase in major storms through the 1990s has had an impact on the hydrology of the river. Hurricane Bob in 1991 (classified as a 100 year storm) and the "Storm of the Century" in 1996, plus numerous smaller storms have taxed the natural system resulting in considerable damage to the physical infrastructure of the river, eroding banks and scouring sediments from the beds. As flooding waters blow out culverts and other river structures, the sediments released are carried downstream to the estuary. The fact that significant parts of the watershed are overlain by marine clays predisposes the watershed to erosion of small size soil particles, which settle out in the estuary and the ocean rather than in the River proper. The impact of increasing the extent and depth of fine deposits in the estuary on water circulation or the character and productivity of the biological community is not clear.

D. IMPACTS TO ESTUARINE WATER QUALITY

Friends of Casco Bay have been monitoring dissolved oxygen saturation at the Presumpscot River Bridge (Route 9) in the estuarine portion of the river since 1995. While samples have occasionally been described as murky and bad smelling, dissolved oxygen levels met the Class SC DO standard (70% saturation) in all but one sample. The most recent samples (May 9, 2000 and July 17, 2000, Friends of Casco Bay data) exceeded 95% saturation, suggesting that the elimination of the SD Warren pulping operation upstream has lowered the biological oxygen demand of the water at the mouth of the River.

Water clarity is important to the health of an estuarine plant community. The extent of eelgrass beds is often used as an indicator of estuarine water quality. A 1993-1995 eelgrass mapping project undertaken by MEDMR did not detect the presence of eelgrass in the estuary of the Presumpscot although it was present during the 1960's (based on interpretation of aerial photographs, Seth Barker, MEDMR, personal communication, maps of marine environment prepared for Maine's Coastal Program by Barry Timson). Eel grass may be reestablishing itself in the estuary. Because they are too small to be observed in the new aerial photographs taken in summer 2001, a field survey would be necessary to determine if the estuary is recovering its vegetative community.

Improvements in water quality in the Presumpscot River will affect the estuary in other ways as well. For example, with well oxygenated water restored, the estuary should become more diverse in terms of the species present, and the areas where pollution intolerant species are found should expand. Consistent with this assumption, surveys of clam resources indicate areas where clams used to grow, but have not in recent years; however, these same surveys have identified areas where the clam resource is recovering and young clams are repopulating certain areas.

E. IMPACTS TO ESTUARINE ANIMALS

Pollution traveling downstream with the River has impacted estuarine faunal resources. The intertidal mudflats still support shellfish populations including clams and mussels, but the shellfish beds have been closed to harvesting since 1946 (Guide to the Presumpscot River, MacDonald, Butler and Ricardi, 1994). In 1991 MEDEP data indicated that dioxin, a carcinogen, was present in soft-shelled clams in the estuary in significant amounts, presenting a cancer risk of 1:1,000,000. While the discharge of dioxin from SD Warren has been discontinued, significant concentrations persist in the sediments. Dioxin levels are a problem in many parts of coastal Maine; for example, an advisory on eating lobster tomalley due to elevated PCBs and dioxin continues along the entire coast of Maine (Dioxin Monitoring Program, State of Maine, 1996, December 1998).

Below the Smelt Hill Dam, the estuarine part of the River continues to support nearly every saltwater species that is found in Maine coastal waters (Guide to the Presumpscot River, MacDonald, Butler and Ricardi, 1994). However, the runs of anadromous fish (river-spawning sea fish), runs that extended from the estuary upriver and continued intermittently into the nineteenth century, ended in 1889 because of dams without fish ladders, and because of water pollution (see Section V. Cumulative Impacts to Fisheries and Aquatic Life).

Eliminating the runs of anadromous fish and reducing the runs of American eels (a species that lives in fresh water and spawns in the ocean) has impacted the estuary as well as the river. As explained in the report on fisheries, also prepared as part of this planning exercise, runs of approximately 34,500 – 136,500 adult American shad and 150,000 – 200,000 adult alewives, and 450,000 blueback river herring potentially could be restored to the river. If these potential runs develop, hundreds of millions of juvenile shad, alewives and bluebacks would be hatched in the river each year and tens of millions would migrate out of the river each year.[3] These fish would be supplemented with thousands of Atlantic Salmon smolts[4] and an unknown number of juvenile sturgeon, tom cod, striped bass, and rainbow smelt. Improved access to the river for American eels would also increase the number of juvenile eels ascending the river each spring and the number of adults leaving the river each fall. The yearly migrations of these adult and juvenile fish would make the Presumpscot River estuary and Casco Bay more attractive for a wide variety of predators including, but not limited to, kingfishers, great blue herons, osprey, bald eagles, striped bass, and seals. In addition to restoring ecological conditions, this would improve conditions for activities like wildlife viewing and fishing. Restoring river herring could also be a boon to lobster fishermen who use alewives as

[3] Based on ratios of young fish to returning adults determined by studies by the Pennsylvania Fish and Boat Commission conducted on the Susquehanna River, outmigration on the order of 70 million juvenile fish could be expected. These studies indicate that only one out of every four hundred and fifty American shad fry stocked returns to spawn, and that approximately one out of every one hundred fish that reach fingerling size and migrate to the sea will return. Further, marine scientists report that the ratio of young fish to returning adults is likely to be in the same range for alewives and blueback river herring.

[4] According to calculations from the Maine Atlantic Salmon Commission.

their preferred bait during certain times of the year. Restored fish runs could also provide a food resource for humans.

Scientific studies in other areas of the northeast bear out the legitimacy of these expectations. For example, Public Service Electric and Gas Company (PSE&G) investigated the expected production of river herring (both alewives and blueback herring) that would result from building fish ladders at ten sites in New Jersey and Delaware that are all on tributaries to Delaware Bay. Their researchers then estimated the production of predatory fish (striped bass and weakfish) that would result from feeding on the juvenile alewives and bluebacks. They developed high and low range estimates for the production of both river herring and predators. To generate these estimates they used known reproductive rates for river herring (1,000 – 4,000 young fish per acre of surface area) and previously validated bioenergetic models for the conversion of prey to predatory fish biomass. The habitat area opened to river herring from the construction of the ten fish ladders in Delaware Bay is 733 acres (roughly ½ of the habitat area of 1383 acres that the Maine DMR calculates could be opened to these species in the Presumpscot system if fish ladders were installed or dams removed).

PSE&G's researchers concluded that between 736,665 and 4,194,959 juvenile river herring would be expected to outmigrate from these 10 sites, and that these juveniles would weigh between 9,398 and 53,256 pounds at the time of outmigration. They further estimated that depending on when the juvenile river herring were consumed by predators (instantaneously upon outmigrating, or later, after growing further), they would produce between 539 pounds (instantaneous consumption – low prey production) and 73,696 pounds (delayed consumption – high prey production) of striped bass and weakfish. Their report concluded *"This level of predator production will represent a significant contribution to the production of predators in the Delaware Bay and will provide significant recreational and commercial fishing opportunities. Further, the establishment of spawning runs for alewife and blueback herring also enhances community diversity in the Delaware Bay System." (Hartman and Kitchell, 1999)*

An increase in the abundance and productivity of top level predators can also be expected to occur in the Presumpscot estuary if anadromous and catadromous fisheries are restored.

IV. CUMULATIVE IMPACTS TO GEOLOGIC RESOURCES AND SOILS

Over time, the geologic and soil resources of the Presumpscot River Basin have been changed by land use activities and development of the River for water power. Major changes to riverine resources resulting from alterations to the flow regime (Poff, N. L. *et al.,* 1997) include:

- the flooding of low lying areas behind dams;
- changes to the dynamics of river flows and riverbed processes including reduced bedload movement, reduced soil deposition on floodplains, and reduced or increasing stream bank erosion;
- increased sediment loads of fine particles resulting from land development and waste discharges;
- increased danger of soil slumps along the river due to land use changes; and
- loss of waterfalls and rapids.

The geologic setting of the Presumpscot has influenced the cumulative effects of human activities on the river and its shorelands. Sebago Lake, the source of the Presumpscot River, lies at the boundary of two geographical regions, the coastal plain, dissected by the Presumpscot River, and an upland region to the northwest, with maximum elevation of more than 3,000 feet above sea level. The great depth of the Lake is primarily a by-product of ice scouring which occurred during Pleistocene times. The regional bedrock of granite and pegmatite represents remnants of early Cenozoic uptilting of a Devonian pluton (Bloom, 1959). This was eroded throughout the Cenozoic period and overridden by glacial ice which deepened the Sebago Lake area and its feeder streams. At the end of the last ice age an intrusion of the sea over the land occurred when the earth's crust was depressed by the weight of the glaciers; since the minimum height of the marine transgression appears to have been ca.95m above modern sea level, the Sebago Lake region, including its northern tributaries, was invaded by this terminal Pleistocene sea. The 'Presumpscot Formation,' marine clays (actually silts) which resulted from this invasion, are exposed at least as far north as the Sebago Lake Basin (Yesner *et al*., 1983). The presence of resistant bedrock along the river's course and clay deposits along its banks and throughout the watershed have been important influences on the character and magnitude of cumulative impacts of development of the River and its watershed.

The thick deposits of marine clays which resulted from the marine transgression, predispose the area to increased movement of fine soil particles which settle out slowly. These move down the River to the estuary before settling to the bottom. Soil movement in such "clays" occurs both slowly throughout the watershed through sheet, rill and gully erosion, and quickly during major mass movement erosion events. For example, in 1868, the *"Great Cumberland Mills Mud Slide,"* occurred in an area located about a third of a mile below Cumberland Mills in Westbrook. As a result of this slide, 25 or 30 acres of

land sank and slid into the river, completely blocking the water flow on the lower river for 8 or 9 hours. It filled the river for half a mile, and turned the course of the river from its original channel about 300 feet (Guide to the Presumpscot River, MacDonald *et al.*., 1994). Steven C. Devin and Thomas C. Sanford in Open File Report No 90-24, 1990, *"Stability of Natural Slopes in the Presumpscot Formation"* note that massive mudslides can result from an unstable slope due to *"1) oversteepening of the slope; 2) an excessive surcharge loading near the top of the slope; 3) increase in ground water level and/or 4) the remolding of the soil as the result of a major disturbance. Oversteepening may result from natural erosion by streams, rivers… It may also result from regrading or excavation near the toe. Surcharges can result from placement of fill or building near the top of the slope. Changes in drainage patterns from regrading or cutoff of natural drainage can cause an increase in ground water level. Pile driving, well drilling or possibly an earthquake can cause remolding of the soil."* While we don't know what finally precipitated the 1868 slide, the changes that had occurred in the watershed, including deforestation and accompanying increased runoff and erosion at the toes of slopes, development (including regrading for roads which changed local drainage and the placement of structures at the top of the slope in Westbrook), dams, and possibly vibration from railroads, either individually or cumulatively, helped to destabilize the area that eventually slumped into the river.

Construction of dams on the Presumpscot River has affected geologic resources in a number of ways. First, the inundation of 22 miles of the Presumpscot River's 27 mile length by dams submerged the river and the adjacent floodplains. These floodplains would have served as deposition areas for sediments carried into the river during flooding, and likely supported rich floodplain wetlands although no predevelopment surveys of wetlands exist.

Secondly, flow regulation from Sebago Lake and the development of dams along the Presumpscot River, has, undoubtedly changed the patterns of erosion and deposition within the River. Under natural conditions, river flows on the Presumpscot would have fluctuated over a much wider range than they do currently (see hydrographs in section II comparing flows on the Presumpscot with an unregulated river). These more dynamic conditions would have resulted in more erosion within the River itself, accretion in certain areas, and floodplain renewal in others. Hence, the more stable flow regime created by the dams and the upstream storage system has, as on other rivers, likely had several effects:

- reduced streambank erosion and deposition in some areas;

- the downstream progress of bedload (generally coarse material on the river's bed) that occurs during flooding events has halted, or been reduced by lowering flood flows and the existence of dams along the river;

- reduced rates of flow in impounded areas may have increased sediment deposition in some areas that are now slack water areas (Poff, N. L., *et al*, 1997[5],

[5] Although the sediment appears to be flushed from the impoundments periodically (*e.g.*, during spring high flows).

- erosion of shorelines due to high water levels and the fluctuation of headponds (from 0 to 2 feet on any given day, in addition to maintenance drawdowns), has caused undercutting of banks, exacerbating the effects of wave action on trees and soils (SAPPI FERC Application, January, 1999). During high water, the river currently inundates more area than it would have under natural conditions, because the dams elevate water levels, thus exposing additional areas to erosive forces and potentially more sediment movement than would be the case with the natural banks that had been scoured for thousands of years.

In addition to impacts from dams, erosion and sedimentation processes have been further modified by basin-wide vegetative clearing for development, including industrial, commercial and domestic construction, forestry, and agriculture (which exposes soils to natural erosive forces each year). This has cumulatively increased run-off, soil erosion and sedimentation of surface waters within the Presumpscot Basin (see the land use discussion under II. Cumulative Impacts to Water Resources).

In short, erosion, deposition, and stream morphology on the River today, is different than it would be without the upstream storage system, downstream dams, and human induced development patterns.

In addition to the other cumulative impacts visited on the River, the construction of dams along the Presumpscot inundated or de-watered virtually all of the River's major waterfalls and rapids, once prominent landscape features formed where the area's resistant bedrock constituted the River's bed. Waterfalls are a logical place to site hydro facilities due to the dramatic elevation changes within a short horizontal distance (see Section X. Cumulative Impacts to Scenic and Aesthetic Resources). On the Presumpscot River all but one of these sites (Steep Falls) have been utilized for their power potential.

V. CUMULATIVE IMPACTS TO FISHERIES AND AQUATIC LIFE

The waters flowing from Sebago Lake were said to be *"remarkably clear and abounded naturally in gravelly rapids"* according to *"The Fisheries and Fishery Industries of the United States"* a report issued by the United States Commission of Fish and Fisheries (USCFF) in 1887. Historical documentation of the fishery noted that *"The Presumpscot is a … rapid river … frequented by salmon, shad and alewives, but seems to have been best adapted to salmon"* and that salmon ascended the River to Sebago Lake and beyond (USCFF, 1887) . The US Army Corps of Engineers in the Smelt Hill Environmental Restoration Study, September 2000, notes that *"Fisheries in the Presumpscot River historically included large runs of Atlantic salmon, shad and river herring (including alewives and less abundant blueback herring)."*

Major changes to the fish resources of the basin include:

- blocking (by dams) of fish passage for anadromous (salmon, shad, alewives) and catadromous (eels) species;

- fragmentation of habitats as a result of dams on the River;

- a shift from fast moving cold water riverine habitats to a series of slower moving impounded areas, (22 of 27 miles of the original river. The total length of the river includes the river's tidal portion, about 2.5 miles below the Smelt Hill Dam). This change favors fish species such as bass and panfish at the expense of native salmonids; and

- deterioration of water quality (including depressed dissolved oxygen conditions) resulting from industrial and municipal discharges. These impacts are discussed in more detail below.

Impacts of the Dams on Fish Passage: Dams have eliminated anadromous fish runs from the Presumpscot River. As an indication of the magnitude of these impacts, the Maine Department of Marine Resources has estimated that if access were restored to 3 species of anadromous fish (American shad, alewives and blueback river herring) that fish runs totaling approximately 634,000 – 786,000 fish could be supported by the river and its tributaries, accessible as far upstream as the North Gorham Dam. Therefore, it seems reasonable to assume that the original anadromous fish runs, which included more species and a greater geographic area, exceeded these numbers.

Prior to dam construction on the Presumpscot, Dadswell (2001) reports that fish passed easily up the River to Sebago Lake. According to Dadswell, of the 16 historically named falls/rapids between Sebago Lake and tidewater, many would present little obstacle to the upstream movement of fish.

This conclusion squares with the reports, such as the USCFF report cited earlier, on the diversity and abundance of fish on the River prior to dam construction. Island Falls , now

submerged in Dundee Reservoir (Murray 1989), and Presumpscot Falls (Lower Falls, location of Smelt Hill Dam) are two examples of typical falls which many species of fish could pass over. According to Dadswell (2001) Island Falls is reported to have been a series of rapids with an elevation change of 2.4 ft/0.10 mi. Presumpscot Falls drops in two chutes for an elevation change of 6.2 ft/0.10 mi, and the falls at this location (Presumpscot Falls – now the location of the Smelt Hill Dam) reverse during high water of spring tides according to the US Army Corps, 2000. According to FEMA river profiles the height of the rise at Saccarappa is 24.5 feet and at Little Falls is approximately 20 feet.

Dadswell's assessment that the river was passable is supported by the reports of the abundance of anadromous fish on the Presumpscot before it was dammed. When the Presumpscot was first dammed in 1732 at Presumpscot Falls (now called Smelt Hill), to take advantage of the waterpower of the River, *"an acre of fish, mostly salmon"* accumulated below the dam where they were stopped from proceeding upstream (McClellan, 1903). The need to protect the fishery became evident. Chief Polin of the Abenaki tribe, fought the early settlers of the region and tried to destroy the dams that blocked the fish from passing upstream. His was a peaceful people before the dams interfered with their food supply. In 1739, the Chief walked (or perhaps went by boat) to Boston to get a declaration from the Governor that fishways would be installed at all dams (Macdonald, *Presumpscot River Guide*, also transcripts from the original meeting and Samuel Thomas Dole, 1916, *Windham in the Past*). As the number of dams grew, laws were enacted to provide for fish passage around each of the dams (See Appendices 2 and 3). A citation from the "*Great Basin Dam War*" states that in 1793 the proprietors of Great Falls Dam (two miles downstream from Sebago Lake) were *"found guilty of not keeping open a good and sufficient sluiceway for the passage of salmon, shad and alewives as required by law and were subjected to a fine of six pounds per day for every day the way was closed."* By 1800, there were five dams along the river, each with a fishway, often in disrepair, perhaps due to flooding. The Cumberland and Oxford Canal, which opened in 1829 (Knight, 1976) ran alongside the River between Portland and Sebago Lake and may have served an important role in fish migration (Wheeler, 1996). However, Atkins (1871) stated the salmon were extinct from the Presumpscot River in 1871. In the mid 19th century the Commission of Fisheries for Maine began a program of fishway construction and stocking, so that all the dams on the Presumpscot were passable by 1879. As a result of the fishways and the canal, Atlantic salmon at times had access to Sebago Lake (Stillwell and Smith, 1880) even after the dams were in place.

Sea-run salmon were apparently thriving in Sebago Lake in the late nineteenth century, despite having had access to the upper watershed interrupted by dams at various times in the eighteenth and nineteenth centuries. In 1886, the average size of lake salmon was 11.2 lbs (Kendall, 1935). With the development of hydroelectric power at Smelt Hill in 1889, however, the River was completely blocked to fish passage above the Smelt Hill Dam.

In the early 1900's, there were nine dams on the River from Sebago Lake to tide water. Of these, seven are still in use for hydroelectric power. As new dams were constructed or

converted to hydroelectric power generation, no fish passage structures were installed, denying fish access upstream. By 1917, the size of the average angled salmon on Sebago Lake had declined to 3.5 pounds (Harvey and Warner, 1970).
Smelt Hill Dam was not operational between 1943 and 1985 (Dube, personal communication cited in Dadwell, 2001) and as a result its condition deteriorated. By the late 1970s, Atlantic salmon were seen upriver as far as Cumberland Mills (Dube, 1983). When Smelt Hill Dam was reactivated, a fish lift was installed, which offered passage to a growing alewife population. During 1995 and 1996, thousands of alewife (*Alosa pseudoharengus*) and a few American shad (*Alosa sapidissima*) passed through the Smelt Hill fishway. The 1996 flood on the Presumpscot rendered the hydroelectric facilities and the fish lift at the dam inoperable and anadromous runs again ceased on the Presumpscot.

In recent years, the gates at the dam have been left open to allow limited passage of alewives seeking return to Highland Lake to spawn. With the proposed removal of the Smelt Hill Dam in 2002, anadromous species will once again have unimpeded access to Presumpscot River habitat up to Cumberland Mills, including access to the Piscataqua River and Highland Lake via a tributary to the Presumpscot.

The National Marine Fisheries Service has designated Essential Fish Habitat for several species including Atlantic salmon (Smelt Hill Environmental Restoration Study, Army Corps of Engineers). Additionally, the USFWS has also set goals to reestablish anadromous species to their historic range. Today, agency management goals for the Presumpscot have been reviewed and revised due to the expected removal of Smelt Hill Dam. These restoration goals are described in the companion paper *A Summary of Fisheries Conditions, Issues and Options for the Presumpscot River* (prepared by the Presumpscot River Plan Steering Committee), as well as the potential for restoring estimated runs of approximately 600 Atlantic salmon and approximately 670,000 American shad, alewives and blueback river herring to the Presumpscot, as well as unknown numbers of sturgeon, smelt, tom cod and stripers

Habitat Alteration: Approximately 22 of the original 27 miles of the river are now inundated by impoundments[6]. Altering the River habitat created an additional 700 acres of shallow and relatively slow moving impounded areas support primarily bass and panfish fisheries (Table 4 in "A Summary of Fisheries' Conditions, Issues and Options for the Presumpscot River." Prepared for the Casco Bay Estuary Project, 2002). According to a recent summary of 15 years of study of Maine rivers and streams published by the Maine DEP (Biomonitoring Retrospective, December, 1999) these types of habitats are not well suited to either riverine or lake aquatic communities, and show a *"severe loss of both the structure and function of the aquatic communities."* The report explains that *"In effect, the ponded area assumes some of the characteristics of a lake, but typically the ponded water volume has a much shorter retention time, as compared to a natural lake. Thus the riverine biological community is subjected to quasi-lake conditions for which they are not adapted. Lake-dwelling organisms generally find run-of-river conditions unfavorable. The short retention time precludes the possibility of the*

[6] Of the approximately 5 miles of unimpounded length, 2.5 miles is a tidal section below the Smelt Hill Dam.

development of a planktonic community, the typical base of lakes. High flow volumes experienced by the river in spring and fall are also reflected in riverine impoundments, frequently causing scouring of accumulated organic mater in the substrate, and partially restoring the riverine, mineral-based substrate. This constitutes a resulting periodic disturbance of benthic habitat for typical lake-dwelling organisms, resulting in lower production."

The baseline fisheries study conducted for the SAPPI licensing of the Dundee, Gambo, Little Falls, Mallison, and Saccarappa Projects states that *"with some exception for the Dundee impoundment, and to a lesser degree the Gambo impoundment, the study impoundments support fish communities that are of relatively marginal quality. Growth of smallmouth bass is slow, and larger individuals of most species are uncommon. The Dundee impoundment has well established, self-sustaining smallmouth bass and panfish populations, with some larger bass, yellow perch, and brown bullhead available to support a recreational fishery. The Gambo impoundment is also capable of supporting a limited fishery for smallmouth bass and yellow perch"* (Ichthyological Associates, Inc. for S.D. Warren Company, 1998). Some of the habitat produced in the slow moving impoundments is of poor quality for these introduced species. For example, the Smelt Hill impoundment area has a smooth rocky bottom, steeply sloped bedrock sides, little substrate for nursery habitat and poor substrate for the bass and panfish species or benthic fauna that serve as a food source.

Lack of in-stream cover also limits the suitability of fish habitats in impoundments. Fish need cover, or structure, in order to hide/ holdover during times of inactivity. More specifically, predator species use cover to hide while waiting for prey. At the same time, smaller fish and/or juveniles need cover in order to hide from large predators and to feed. In addition, most areas of cover also provide substrate for aquatic invertebrates necessary as food items. Minimal cover exists where riverine habitat substrate is submerged. Further, during various times of the year even this cover may not be available to many species of fish due to dissolved oxygen depletion in the deep layers of the impoundments (see also discussion of Cumulative Impacts to Water Resources: Lowered Dissolved Oxygen). In addition, where it occurs periodic oxygen depletion precludes the colonization of the existing cover by diverse invertebrate populations. (Smelt Hill Dam Environmental Restoration Study, US army Corps of Engineers, January 2001) As a result, while some of the impoundments are classified as B for other water quality parameters, the impoundments on the Presumpscot are Class C for aquatic life and may not even meet this standard in some cases. *"Samples of benthic community of aquatic insects collected within impoundments in the Presumpscot River generally reflect the unfavorable ponded conditions by revealing a lower number of organisms, a reduced number of different types of organisms, and a greater or lesser loss of typical riverine organisms, with replacement by sediment dwelling organisms having faster generation times"* (*Biomonitoring Retrospective*, MEDEP, 1999). This correlates with the findings of the SAPPI licensing baseline fisheries study noted above which states: *"the study impoundments support fish communities that are of relatively marginal quality."*

Dams have also fragmented fish habitat on the river. While the acreage of bass habitat has been increased as a result of impounding the River, habitat for native species which thrived in continuous riverine habitat has declined. In the 1770's, reports indicate that trout were abundant in the River at Great Falls, now the site of the North Gorham project (See Presumpscot River Timeline included earlier). Even where the River has not been impounded, changes in flow regimes favor introduced species such as bass and brown trout, at the expense of the native brook trout that prefer higher velocity water. Due to the limited potential for reproduction in the altered flow regime that exists at present, only stocking the river for native species will improve the fishery for these species (Maine IF&W, Francis Brautigan, personal communication).

The most radical change in a riverine environment potentially resulting from the development of dams is the creation of dryways or bypass reaches. In cases where river stretches are bypassed to increase head, or otherwise facilitate hydroelectric power development, flows are either much reduced or are absent, except during periods of high water. This limits or removes these stretches as suitable fish habitat. Fortunately bypass reaches are limited on the Presumpscot River. The largest dryway section on the river occurred from the outlet of Sebago Lake to Eel Weir Station; but, flows have been restored to this area since the early 1990's and today, fishing is supported by annual stocking. As a result, it is one of southern Maine's premier trout fishing areas. The remaining bypass sections of the River are much smaller, and the recent proposal by SAPPI to restore flows to these areas will, if implemented, improve conditions for fisheries on the remaining bypass reaches.

Pollutant Impacts: Besides being impacted as a result of hydrologic changes to the River, fishery resources have also been cumulatively impacted for over 100 years as a result of non point sources of pollution and waste water discharges to the lower Presumpscot River from industrial and municipal sources. During the summer of 1965, dissolved oxygen measurements downstream from Cumberland Mills indicated 0 ppm of oxygen, total anoxia (DeRoche, 1967). Water quality began to improve after 1976 when waste treatment was initiated at the Westbrook and Portland sewage treatment plants and the SD Warren cleansing and purification plant (MDEP, 1999). (For further discussion of the impacts of water pollution on the habitat quality, see Section II entitled Cumulative Impacts to Water Resources).

In addition to the immediate impacts of polluted water, rivers may suffer from residual effects to riverine habitat related to pollutant discharges. The most likely source of residual effects of past discharges is the resuspension or mobilization of pollutants which accumulate in river sediments (Lee Doggett, Maine DEP, personal communication). To test for these potential effects, Presumpscot River sediments were collected and analyzed for toxic contamination by the Maine DEP during 1989-1991. The coarse sediments encountered in 1989 and 1990 indicated that the River is not generally a depositional area. Following a period of low rainfall in 1991, some fine-grained sediments were recovered from Cumberland Impoundment upstream of SAPPI's Westbrook Mill, but not elsewhere. These samples showed elevated levels of metals and PCBs (Lee Doggett, DEP memo, 1999).

The lack of fine sediment buildup behind the dams, and hence the lack of concern with resuspension as an issue, has been corroborated by other studies. According to S.D. Warren, sediment has not been accumulating behind the dams and is unlikely to pose a water quality problem in the future. S.D. Warren's FERC submittal "*Responses to FERC March 16, 2000 Schedule A Additional Information Requests, July 2000*" noted that visual observation of the impounded areas behind the Little Falls, Mallison Falls and Saccarappa dams during maintenance drawdowns showed little if any sediment build up. According to S D Warren, no sediment-related maintenance problems have ever occurred nor has maintenance dredging ever been required. Photographic records of maintenance drawdowns at Dundee in 1989 and Little Falls in 1993 indicate no sediment buildup.

Analysis of bottom samples taken in the impoundment at the Smelt Hill Dam during 1989-1991 also supports this conclusion. Sampling results were recently reviewed by DEP technical staff, who concluded that the Smelt Hill Dam was not a deposition site for fine-grained sediments and that samples collected did not show contamination of concern. *The Smelt Hill Dam Environmental Restoration Study- Falmouth, Maine*, U.S. Corps of Engineers, New England District, September, 2000, also supports this conclusion. Sediment samples collected by the Army Corps of Engineers in October 1999 from the impoundment beneath the Route 100 Bridge were analyzed for contaminants including metals, PCBs and pesticides and PAHs. None of these was found at levels considered to be a danger to aquatic life, with the exception of mercury, which was present at slightly above the biological effects level. Dioxins levels were comparable to other New England impoundments considered to be non-contaminated. Thus, the problem of resuspension of contaminated sediment appears to be limited in the Presumpscot River itself but it may be more of an issue in the estuary where more fine materials have settled out over the years (see section on Estuarine Impacts).

Pollutants can also be retained by the biota. On the Presumpscot, as on other rivers, residual pollutants have been found in fish tissues. The Maine Dioxin Monitoring Program (established in 1988) samples fish yearly below bleached paper mills and municipal wastewater treatment plants. The 1997-1998 monitoring report (DEP, 1998) reflected that samples of smallmouth bass and white suckers collected at a reference (clean) site upstream of the Westbrook Mill had for 6 consecutive years the highest concentrations of dioxins, furans, dioxin toxic equivalents of any reference site in the State. These concentrations likely represent materials from undiscovered local sources as well as long-range transport and atmospheric deposition. Concentrations of DTEh (Dioxin Toxin Equivalents) taken downstream of the Westbrook Mill, while not exceeding the Fish Tissue Action Level, were significantly greater than in fish from the upstream reference site in Windham during 1997 and 1998. With the tightening of dioxin regulations (EPA 1997 Cluster Rule, Maine 1997 Act LD1633) and the elimination of the pulping operation at the Westbrook Mill in 1999, dioxins in fish tissues in the River below the Mill will likely decline to levels similar to the reference site, which, as noted above, are higher than other presumably *"uncontaminated"* areas in Maine.

VI. CUMULATIVE IMPACTS TO WETLANDS

Changes to riverine wetlands on impounded rivers with a headwater storage regulating flows to the river (Sebago Lake), and developed watersheds typically include:

- Changes in type, extent and distribution of wetlands due to hydrologic changes on the river including the construction of dams and regulation of flows: These changes typically include –
  - conversion of riparian scrub-shrub and forested floodplain wetlands to emergent and aquatic bed wetlands as a result of the impoundment of the river and stabilization of natural water level fluctuations; and
  - a reduction in the diversity and productivity of remaining floodplain forests as a result of less frequent flooding and the increased urbanization of the watershed.
- Loss of wetlands and wetland values due to development in the watershed, including –
  - loss of wetlands from clearing and draining wetlands for both development and agricultural use; and
  - impairment of the values and functions of wetlands due to increased urbanization of the watershed which impacts the volume, quality and temperature of the surface waters.

A. IMPACTS TO THE TYPE, EXTENT, AND DISTRIBUTION OF WETLANDS DUE TO HYDROLOGIC CHANGES

In the northeast, wetlands occurring on undeveloped portions of moderate gradient rivers like the Presumpscot are typically of three types associated with widely fluctuating flows:

1) aquatic beds in shallow areas with moderate current,

2) scrub-shrub wetlands that form a band of varying width along the banks except in areas scoured to rock, and

3) floodplain forest on rich alluvial terraces created by frequent flooding.

The types and extent of wetlands that occurred along the Presumpscot River prior to extensive development of dams and flow regulation at Sebago Lake is not known. However, wetlands along this river may have had a different configuration, both in types and extent, than other rivers in the region due to the relatively stable flows of the Presumpscot resulting from the large amount of natural storage capacity at Sebago Lake. In fact, one of the reasons the River attracted so much development (dams) was presumably that it was less prone to flooding and severe spring freshets than other rivers. As a result, it may have had less

extensive floodplains and a narrower band of shrub-scrub wetlands than other rivers in the area**.**

According to a study conducted as part of SAPPI's relicensing effort for the dams, today there are approximately 108 acres of wetlands located in and adjacent to the impounded areas of the Presumpscot River from the Dundee impoundment to the Saccarappa dam. The study conducted for SAPPI identified most of the acreage of wetlands as occurring outside the project impoundments in the adjacent shorelands. In fact, the study does not identify any of the wetlands as riverine, suggesting that no wetlands were identified in the river proper. However, the descriptions of a few of the wetlands refer to them as being within the river channel. Therefore it is unclear from SAPPI's study how thorough the identification of the wetlands actually in the river was. Over 50% of the wetlands identified in the SAPPI study are categorized as palustrine forest, with most of the acreage in this type located adjacent to the Saccarappa impoundment. Thirty-two percent of the wetlands are palustrine scrub/shrub; again, a large portion of these are located on the Saccarappa impoundment. The remainder of the wetlands present on the Presumpscot and identified on the SAPPI study are classified as palustrine emergent, with a few acres classified as palustrine unconsolidated bottom. The character of existing wetlands along the River as identified in the SAPPI study is summarized in the table that follows:

Table 6
Wetlands along the Presumpscot From Dundee to Saccarappa Dam

Acres	Wetland Type
56.5	Palustrine Forested
34.7	Palustrine Scrub-Shrub
13.9	Palustrine Emergent
2.6	Palustrine Unconsolidated Bottom
107.7	**TOTAL**

Source: S. D. Warren, 1999.

The construction of dams along the Presumpscot River impounded over 80% of the river's length from Sebago Lake to the Smelt Hill Dam, and likely eliminated many riverine wetlands, although no inventory of the River's original wetlands exists. Removal of the Smelt Hill Dam will reduce the percent impounded to roughly 58%, still a majority of the length of the river. Since the dams on the River are operated as run-of-river, stable water levels have resulted in the development of new emergent and aquatic bed wetlands in the impoundments, although these are apparently not entirely reflected in SAPPI's study. Table 6 shows there are roughly 14 acres of emergent wetlands in or in most cases nearby the 5 impoundments currently undergoing relicensing – from Dundee to Saccarappa (according to license applications – S. D. Warren, 1999). FERC analyses at other projects in Maine (*i.e.*, FERC, 1993 and FERC, 1996) determined that emergent and aquatic bed wetlands benefit from stable water level regimes as employed at the

dams on the Presumpscot. Thus, it is likely that, as a result of dam construction and operation, the balance of wetland types present on the Presumpscot have shifted, with fewer acres of shrub/scrub and forested floodplain wetlands, and more acres of emergent wetlands and aquatic beds. Emergent and aquatic bed wetlands benefit certain types of aquatic life and wildlife (like waterfowl), but other values may be reduced, such as the value of riparian wetland travel corridors for certain birds, mammals, reptiles and insects[7]. Woody riparian vegetation also provides shade to temper water temperatures, and forested and scrub/shrub wetlands are reported to have greater capacity than other types to slow and store floodwaters.

In addition to causing shifts among the types of wetlands, creating impoundments can change the distribution of wetlands. That is, in free flowing moderate gradient rivers in the northeast, shrub/scrub wetlands generally occur as a continuous band of wetlands on each shore. Further, forested floodplain wetlands occur in level floodplain areas back from the river and above hydrological controls (places where the river's course is constricted by steep banks or blocked by ledge or by deposits of boulders). These controls can make good spots for dam construction, thus flooding out the forested wetlands upstream. The resulting impoundments will also inundate and may break the continuity of the shrub/scrub riparian strip wetland.

Finally, as a result of these changes, the acreage of wetlands available after dam construction may be more or less than was originally present. On the Presumpscot we can not be sure what the extent of these changes has been, since no predevelopment inventories of wetlands are available. However, it is likely that some acreage of forested wetlands was inundated in areas above the larger impoundments, *e.g.,* Dundee and North Gorham, and other wetlands of different types were created.

In addition to inundating and changing the distribution of forested wetlands, the diversity and productivity of floodplain forested wetlands has likely been impacted by changes in the River's flow regime. For example, a wetlands assessment for the International Paper relicensing (FERC No's 2375 and 8277) documented that the herbaceous plants typically found in the rich habitats associated with forested wetlands were relatively sparse in those forested wetlands which remained on the Androscoggin, a river which, like the Presumpscot, has extensive headwater storage and regulation which reduces flooding. The species assemblage present in the floodplain forests of the Androscoggin was impoverished when compared to other floodplain sites, reflecting the reduced frequency of floodplain inundation under conditions of hydro regulation (FERC, 1995a). However, the level of study conducted on the Androscoggin has not been replicated on the Presumpscot; therefore, it is not certain that conditions on the Presumpscot are the same as on the Androscoggin.

[7] Wildlife species which use shrub scrub riverine wetlands in southern Maine for some important aspect of their activities are likely to include: northern harrier, marsh hawk, merlins, sharp skinned hawks, coopers hawk, yellow warblers, common yellow throats, wilsons warbler, alder flycatcher, willow flycatcher, blue green gnat catcher, northern water thrush (Ron Joseph. USFWS – personal communication), little brown bat, big brown bat, red bat, black racer snake, certain dragonflies, certain butterflies (Mark McCullough. IF&W – personal communication).

B. Impacts to Wetlands from Development

1) **Loss of Wetlands:** Human activities beyond dam construction and regulating flows, also affect wetlands directly and indirectly. For example, logging; agriculture; road and railroad construction; and urban, suburban, and rural development along the Presumpscot River and in the watershed have undoubtedly affected the acreage, variety, values and functions of wetlands found in association with the River.

   Many of these activities involved clearing and draining or filling of wetlands to create suitable *"upland"* land for buildings, roads and railroads, and even farming

   Riparian wetlands along the Presumpscot were also undoubtedly altered by the building of the Cumberland and Oxford Canal in 1830 and the coming of the Portland and Ogdensburg Railroad in the 1870's. These activities changed the banks and floodplain of the River. Further, the railroad embankments and the towpath for the canal are in some cases directly adjacent to the River, (*e.g.,* in places along the Saccarappa impoundment and near the covered bridge) altering the hydrology of the river and its floodplain.

   It is estimated that approximately 20% of the original wetland acreage in the State of Maine has been lost to development and conversion to other uses(FERC, 1996). Wetlands losses along the Presumpscot River may also have been significant: about 32% of the Presumpscot River Watershed is developed, and an additional 16% has been cleared for agriculture (NRCS, 1995, Casco Bay Watershed Land Use Inventory) but no inventory of the watershed's original wetlands exists.

   The loss of wetlands due to conversion to other uses can alter the hydrology and ecology of rivers and the estuaries into which they empty. Many wetlands affect water quantity and quality by holding water back during wet seasons and feeding clean water slowly to streams and rivers through groundwater during the drier months of the year. This water contributes to what is called *"base flow,"* and it is what keeps streams from drying up during drier months. Base flow also helps keep streams cool and dilutes pollution loads by creating sufficient flow during low flow periods. Thus, drainage of wetlands that recharge groundwater can decrease contributions to base flow (Loucks 1990). In coastal regions such as the lower Presumpscot, this flow of fresh groundwater may help maintain a proper balance between fresh and saltwater in estuaries.

2) **Impairment of Wetlands:** Wetlands are also indirectly affected by use of the lands which surround them. For example, a ten-year comprehensive study of development impacts to wetlands carried out in the Puget Sound Basin (Azous and Horner, 1997) found that in an urbanized watershed in that area, a greater proportion of the precipitation reached wetlands as surface, rather than ground water, inflow. Because storm runoff is delivered more quickly and in greater short-term volumes to these wetlands, the result was greater and more rapid water level fluctuations. It is likely that these changes would also occur in wetlands in other regions where substantial development occurs in the watershed.

Changes in the hydrology of wetlands can affect their functions. Hydrologic disturbance of a wetland can cause it to shift from functioning as a sink for nutrients and metals toward becoming a source of these materials. This can affect other functions within the wetland and downstream biological communities as well (Brinson, 1988 quoted in Protecting Natural Wetlands). The hydrologic conditions in a wetland affect abiotic factors such as salinity, as well as soil oxygen and nutrient availability. Water depths and the natural hydroperiod in wetlands directly influence: vegetative composition and density, primary productivity, the accumulation of organic mater, nutrient cycling and availability, as well as wetland animal life. For example, increasing water levels can increase the dominance of tolerant, opportunistic species, such as cattails or invasive exotics like purple loosestrife, which may reduce vegetative diversity and degrade habitat for certain wildlife species.

Changes in the quality of water transported to wetlands can also affect wetlands. Pollutants found in runoff from urban areas often include sediments, oxygen-demanding substances, nutrients, heavy metals, pesticides, hydrocarbons, trash and debris. Urban runoff also tends to be warmer than flows from natural systems. This can result in changes in oxygen levels, and water temperatures in wetlands, which can have direct impacts on wetland flora and fauna. Beyond this, the assimilation of heavy metals, pesticides, and hydrocarbons associated with stormwater runoff can result in negative impacts to the ecological characteristics of wetlands. For example, pesticides and heavy metals that are contained in stormwater runoff may be toxic to some organisms, such as wetland invertebrates and amphibians, and may also bioaccumulate in the food chain affecting fish, mammals, birds, etc., thereby negatively impacting overall ecological values.

Related to the points above, macroinvertebrates are an important part of wetland biota as they are an essential component of wetland food webs. They consume algae, detritus, plants and smaller prey organisms, and provide an important food source for fish, waterfowl and other wildlife. Macroinvertebrates also play an integral role in nutrient cycling and energy transfer, both within wetland ecosystems and between wetlands and other habitats. Therefore, changes that occur in the macroinvertebrate communities of wetlands impact the overall function and value of wetlands. The MDEP is currently (1998-2001) carrying out a biological assessment of the wetlands in the Casco Bay Watershed. This study includes 10 wetland sites in the Presumpscot River Basin. Preliminary results show elevated concentrations of nutrients, anions and cations in urban wetlands. Elevated levels of these materials correlate with changes observed in wetland macroinvertebrate communities (Jeanne DiFranco, MDEP, personal communication, 2000).

For example, researchers are concerned with the build-up of toxins in such marsh species as sharp-tailed sparrows which have *"suspiciously high levels"* of mercury and are of management concern throughout the northeast (IF&W, 2001).

VII. CUMULATIVE IMPACTS TO TERRESTRIAL RESOURCES

Major changes in terrestrial resources on rivers developed for hydroelectric power and in developed watersheds typically include:

- alteration and fragmentation of habitats and wildlife travel corridors, particularly in the riparian corridor;
- reduction in certain wildlife populations, including extirpation of some species;
- increases in other wildlife species favored by human activities; and
- a shift in wildlife and plant communities adjacent the River resulting from stabilized river flows (Poff, N. L. et. al, 1997, The Natural Flow Regime, *BioScience*, 47:11)

Stabilized flows alter natural cycles of flooding, distribution of sediments and seeds, the processes which lead to variations in terrain, as well as the composition of vegetation in riparian areas. Development in these areas disrupts their continuity and development in close proximity can cause wildlife to abandon such areas or force them to change the timing of their movements, even if the habitat itself is retained (*e.g.,* certain species will use such areas close to development only at night). Riparian areas are particularly important for certain wildlife species, and are used for a variety of purposes (nesting, feeding, roosting, etc.). For example, riparian habitat is valuable to deer and other mammals. Telemetry studies in Maine indicate that fur-bearers preferentially select riparian habitats over adjacent area. In one study 85% of fur-bearers (including coyote, bobcat, red fox, fisher, and martin) were found within 100 meters of water. These species use riparian zone as route for travel within their extensive home ranges. They also feed in riparian habitat, which usually includes higher densities of their food than less diverse adjacent habitats (The Identification and Management of Significant Fish and Wildlife Resources in Southern Coastal Maine. Maine Department of Inland Fisheries and Wildlife, June 1988). In addition, a survey of 350 deer-wintering areas in Maine found that 85% of these areas occurred in riparian conifer stands. The lowland topography and dense vegetation of these areas shelter wintering deer from low temperatures and high winds. In addition, snow on the adjacent waterway may be shallow or densely packed, offering better travel opportunities (The Identification and Management of Significant Fish and Wildlife Resources in Southern Coastal Maine. Maine Department of Inland Fisheries and Wildlife, June 1988).

In addition, some animals use the natural shrubby portions of riparian corridors for travel, but along the Presumpscot and other rivers with stabilized flows, forests extend right down to the shoreline, changing habitat characteristics and their suitability for some wildlife species (Andy Warner, The Nature Conservancy, lecture. See also footnote 7).

As settlers and industry moved into the Presumpscot Basin, lands were cleared for agriculture while forests were harvested heavily for firewood and lumber, industries that were typical of this part of New England in its early history. Upland and floodplain areas were unavoidably inundated by the construction of dams along the River. New types of habitats for wildlife and plants communities developed through a shift in the types of riparian vegetation and wetlands from those associated with free flowing rivers to those

associated with impoundments (see section on the Cumulative Impacts to Wetlands). The wetland communities that have developed on the impounded river continue to support wildlife, albeit of a different type.

The development of the Presumpscot River (including the Smelt Hill impoundment) inundated 22 miles of riverine habitat. Certain terrestrial and riverine wildlife populations have undoubtedly been diminished by this habitat loss. The inundation of the river likely resulted in the loss of habitat for species dependent on riverine habitats such as river otter and may have flooded out lowland forests favored by deer as deer-wintering areas. However, no predevelopment data exists to support or contradict this possibility. Conversely, certain wildlife species that prefer still or slow moving waters may have benefited from the increase in lacustrine habitat (*e.g.* waterfowl such as wood ducks which nest in cavities in riparian trees, and other species with similar requirements, may have benefited from the increase in lacustrine habitat that resulted from creation of impoundments along the river). However, as also noted earlier, these impoundments are not ideal for either riverine or lacustrine communities and hence generally have lower productivity. The marginal quality of fish populations limits their utilization by piscivorous species such as kingfishers and herons.

VIII. CUMULATIVE IMPACTS TO THREATENED AND ENDANGERED SPECIES

In general, impacts to threatened and endangered plant species inhabiting the river corridors in Maine include loss of habitats, particularly floodplain forests, which provide habitat for State listed rare, threatened and endangered species. Loss of floodplain forests on the Presumpscot may have occurred in the areas of the Gambo, Dundee and North Gorham impoundments, as these impoundments flood significant areas of land adjacent to the river; however no predevelopment information exists to document the precise nature of these losses. In addition to impacts from habitat losses, species which are now rare, threatened and endangered may have been affected by changes to habitats that have altered their value or suitability for these species, *e.g.* reduced productivity and diversity of remaining floodplain forests (Don Cameron, Maine Natural Areas, personal communication. See also the section on geologic impacts.). Again, none of these impacts can be specifically documented on the Presumpscot, due to the lack of predevelopment studies.

Two plant species identified by the State as Threatened or as Species of Concern have been observed on the north end of Dundee Pond: *Isotria medeoloides* (small whorled pogonia; also listed as a Federal Threatened Species and is extremely rare) and *Lindera benzoin* (spicebush) [SAPPI license application, January, 1999]. *I. medeoloides* is typically found on the lower slopes of hills in midsuccessional mesic forests and may have lost habitat where impoundments inundated such areas; however, this cannot be ascertained due to the lack of predevelopment information. In Maine, *L. benzoin* (a State Species of Concern) is found along streams, seeps and in small pocket swamps. It is possible that this species lost habitat due to the impoundments (Don Cameron, Maine Natural Areas, personal communication).

Historical records from 1918 documented two other State listed plant species along the River Corridor in Falmouth: *Allium canadense* (wild garlic) and *Elymus hystrix* (bottlebrush grass). It is not known if these species are still present, but they may persist if suitable habitat exists (Maine Department of Conservation, Natural Areas Division, letter to Army Corps of Engineers, 1999).

Land clearing for agriculture, timber harvesting, inundation of forested areas by impoundments, increased disturbance as well as predation from humans, loss of anadromous fish which served as food for avian predators, development and widespread pesticide use prior to the early 1970's have all contributed to cumulative impacts on Threatened and Endangered animal species (*e.g.,* bald eagles). Pesticides resulted in the drastic declines of many wildlife species, particularly avian predators such as eagles and peregrine falcons (Environmental Defense Fund, Petition to United States Department of Agriculture, 1967). Since 1971, when persistent pesticides (*e.g.*, DDT) became strictly regulated under the Federal Environmental Pesticide Control Act and were replaced by pesticides which usually break down rapidly into less harmful compounds, populations of pesticide-sensitive species have begun to recover (Peek, 1986). At present, while eagles have been sighted passing through the River Corridor, no nesting pairs have been recorded along the Presumpscot, (Charlie Todd, MEIF&W, personal communication).

With the recovery of the eagle population and improved water quality, hopefully nesting pairs will establish themselves on the Presumpscot.

State Species of Special Concern that live along the River Corridor are the New England Cottontail Rabbit and the Least Bittern (in the estuarine area). The cottontail prefers brushy habitats which are becoming less numerous as old agricultural fields grow up into forests, and developments replace forests and fields.

IX. CUMULATIVE IMPACTS TO OPEN SPACE AND RECREATIONAL RESOURCES

A. IMPACTS TO OPEN SPACE

Shoreline development along the Presumpscot has been relative modest when compared with development on other bodies of water in the area. As of the year 2000, only 13% of the land adjacent to the River above Westbrook was developed, while from Westbrook to the Smelt Hill Dam, development occupied 23% of the River corridor. This relatively low level of development is in part because industrial development along the River impacted its attractiveness for other shoreline development, and in part because other more attractive opportunities for residential shoreland development also exist in the area: *e.g.*, the coast and lakes and ponds. Until recently waste discharges to the River from industrial processes have made many areas immediately adjacent to the lower Presumpscot River less attractive for residential and recreational development than they would have been if the water were cleaner. Most of the area immediately along the river (84% of the area within 250 feet) is undeveloped, providing a significant opportunity for efforts to keep it as open space near an urban area (see Table 7).

Table 7
Cumulative Shoreline Development on the Presumpscot River
Year 2000

Municipality	Total River Frontage (mi)	Developed Frontage Miles (%)		Undeveloped Frontage Miles (%)	
Gorham	14.40	1.61	(11.2)	12.79	(88.8)
Windham	13.60	2.01	(14.8)	11.59	(85.2)
Subtotal above Westbrook	28.00	3.62	(12.9)	24.38	(87.1)
Westbrook	9.75	3.66	(37.5)	6.11	(62.5)
Portland	3.80	0.13	(03.5)	3.67	(96.5)
Falmouth	5.30	0.13	(02.5)	5.17	(97.5)
Subtotal Westbrook-Casco Bay	18.85	3.92	(22.8)	15.00	(79.2)
Total River	**46.85**	**7.55**	**(16.1)**	**39.33**	**(83.9)**

Trends in development since the mid-1950’s have been documented through comparisons of USGS topographic maps and recent air photo interpretations (analyses in the Casco Bay Estuary Project by Doug Roncarati, 2001). Since the mid 1950's, open space along the River (undeveloped land within 250 feet of the river with at least 500 feet of frontage) has been reduced only slightly, (6%, with roughly half of that loss above Westbrook and half below). Most of that loss occurred in the time period from the 1950’s to the 1970’s (See Table 8).

Table 8 Loss of Open Space (Undeveloped Land with 500 feet of Shore Frontage) 1950 – 2000							
Municipality	Total Shorefront (miles)	Developed Shorefront 1950's miles (%)		New Development 1950's – 1970's miles (%)		New Development 1970's – 2000 miles (%)	
Gorham	14.4	1.18	(8.2)	0.29	(2.0)	0.14	(1.0)
Windham	13.6	0.83	(6.1)	1.09	(8.0)	0.10	(0.7)
Westbrook	9.75	2.44	(2.5)	0.94	(9.6)	0.28	(2.9)
Portland	3.80	0.00	(0.0)	0.13	(3.5)	0.00	(0.0)
Falmouth	5.30	0.17	(2.2)	0.02	(0.3)	0.00	(0.0)
Total River	**46.85**	**4.62**	**(9.9)**	**2.47**	**(5.3)**	**0.52**	**(1.1)**

Since the elimination of the pulping process at the SAPPI mill, water quality has improved in the lower reaches of the River. Air quality is also improved, particularly in terms of strong odors. These two changes in the River environment are expected to increase development pressure along the lower River. Planning for these changes could also help to protect valuable habitat and recreational resources. (See report on Open Space for more on this topic.)

B. IMPACTS TO RECREATIONAL RESOURCES

The natural character of the Presumpscot played an important part in earlier times when Native Americans and settlers alike used the River Corridor for travel and fished its cold, rushing waters for salmon and other cold water species. While river travel and fishing were necessities to the River's early inhabitants, they are largely considered to be recreation by modern society. Dams on Presumpscot have changed the character of the River from a fast moving river falling 267 feet from Sebago Lake to the sea over more than a dozen falls and rapids to largely a series of impoundments. As a result, cumulative impacts to modern day recreational resources include loss of opportunities for whitewater boating and extended river canoe trips as well as loss of coldwater fishing opportunities on the mainstem of the Presumpscot River. Even the existing bass and panfish fishery is stressed by fluctuations in flow (John Boland, IF&W, personal communication). In addition, until recently water pollution associated with wastes discharged to the River discouraged recreation.

The Presumpscot River today serves statewide, regional, and local recreationists primarily in low intensity activities such as fishing, swimming, canoeing, and motor boating in small boats with low horsepower motors. The regulation of flows from Sebago Lake provides recreational opportunities on the Presumpscot River during what would normally be low flow periods. For example, the recreational value of the River for anglers in the Eel Weir bypass and for flat water boaters and anglers is improved by increased water flow and depth during low water periods. Levels of recreational use are expected to grow in the future, as, with recent improvements in water quality, recreational use of the Presumpscot River is increasing.

Salmonid Fishery: The fishing in Eel Weir Bypass is an especially notable example of an effort to reverse cumulative impacts to recreational fisheries on the Presumpscot River. Native salmonids (trout and salmon) have lost habitat due to flows being diverted from the natural river bed for hydropower purposes (bypasses), and the creation of impoundments on most other fast flowing sections of the river. However, in 1992 flows were restored to the dewatered river (bypass) below the Eel Weir Dam under an order from the Federal Energy Regulatory Commission aimed, in part, at restoring a trout and salmon fishery in the bypass reach. It required restoration of a minimum flow to the then virtually dry river channel, which is approximately 1.25 miles long. This has created one of the most popular year-round fishing sites in the State of Maine. This area is stocked with brook and brown trout plus landlocked salmon. According to a Creel Survey done by Maine IF&W, there were 6800 visits to the site in 1995 (*Presumpscot River Eel Weir Bypass Fishery Report*, May, 1997). Further, IF&W reports that brown and brook trout are stocked below all the other impoundments as well. The section below the North Gorham Pond Dam (where Otter Brook enters) is another favorite fishing spot for trout.

Falls along the Presumpscot once provided places where migratory fish gathered and where fishing took place. Today, dams block the passage for migratory fish and reduce recreational fishing opportunities for these species. Long stretches of rapid water originally provided opportunities for fishing for trout and salmon. Today, the only unimpounded segments of the River are the Eel Weir Bypass and small segments of tailwaters and bypass reaches below each dam. As a whole, the Presumpscot has only 5 miles out of 27 that are unimpounded, and approximately half of this is the tidal section of the river below the Smelt Hill Dam. The other unimpounded sections are generally small segments, ranging from 300 feet to 1075 feet long, except for the Eel Weir Bypass Reach which is 6700 feet long. Thus, the construction of the dams has eliminated the opportunities to fish for anadromous species, and dramatically reduced the recreational opportunities for trout and salmon fishing while offering some opportunities for bass and panfish fishing on the impoundments (see also Section V. entitled Cumulative Impacts to Fisheries and Aquatic Life).

Bass and Pan Fish Fishery: Of all the impoundments along the Presumpscot River, the North Gorham Pond and Dundee Pond are the best fishing sites for bass and various pan fish species. Species present on the River include small mouth bass, pickerel, white perch and large mouth bass (present in small numbers). There is suitable habitat for reproduction of these species, but John Boland, of Maine IF&W, feels that the populations are below normal for bodies of water of this type. He attributes this to fluctuations in River flow, which he believes affects reproduction, as well as the loss of eggs and juvenile fish. According to Boland, fishing pressure from anglers seeking these species is probably light because the quality of fishing is below average and access is problematic in some areas. Maine IF&W has asked for a study to help provide information for resolving the impacts of flow on the fishery.

X. CUMULATIVE IMPACTS TO SCENIC AND AESTHETIC RESOURCES

The native name *"Pes-ompsk-ut"* has been translated as *"river of many rough places"* or *"falls at standing rock"* (Dadswell, 2001). Cumulative impacts to scenic and aesthetic resources include elimination of all the major falls on the Presumpscot River. This impact resulted from development of the River's hydraulic head for hydro mechanical power and later hydroelectric power. The developed falls were inventoried in 1867 as part of an assessment of the potential to restore anadromous fish to Maine rivers. These falls, as named in that 1867 report, included from Head of Tide to Sebago Lake: Presumpscot Falls (now the site of Smelt Hill Dam which is slated to be removed in the near future); Cumberland Falls; Saccarappa Falls; Mallison Falls; Little Falls; Gambo Falls; Great Falls (now the site of the North Gorham dam); Steep Falls (just below the Eel Weir Hydroelectric Station); and Lindsleys Falls (the outlet of Sebago Lake Basin, now the site of the Eel Weir Dam). Dundee Falls was at the time of the 1867 report still undammed although it was the site of one of the locks of the Cumberland and Oxford Canal. All but one of these sites (Steep Falls) is now dammed; and most of the falls were dammed very early in the nation's history, prior to the mid 1800's. The earliest dam was constructed in the early 1730's. A fall, not mentioned in other references, Leavitt's Falls rapids, was located in the vicinity of the covered bridge in Windham and noted in *The Old Maps of Rural Cumberland County, Maine, 1871*.

A report evaluating the scenic quality of Maine's waterfalls by Alvin Swonger (1988) listed falls that are now dammed but were highly scenic in their natural state (based on evaluations of early lithographs and written descriptions). This list included four of the five falls on the Presumpscot River. They included Cumberland Falls, Saccarappa Falls, Mallison Falls, and Dundee Falls. This report also lists Steep Falls as modified by a dam. Located below the Eel Weir hydropower plant, Steep Falls has been altered by regulation of flows from the Eel Weir dam and the tailwaters of the Eel Weir power plant. However, the modification is one of alteration of flows, rather than elimination due to damming.

Development along the River has also impacted its scenic value in some other areas, *e.g.*, in Westbrook where 37.5% of the shoreland is developed (see Section VII, Cumulative Impacts to Terrestrial Resources, and Section VIII, Cumulative Impacts to Terrestrial and Estuarine Species above).

Table 9
Falls With Dams on the Presumpscot and Present Status
(showing drop in river bottom or ledge drops, not height of falls, at the Falls' locations[1]

Name of Falls	Drop in Riverbed	River Mile[2]	Current Status
Presumpscot Falls (Smelt Hill)	14 feet reverses with tide[3]	2.7	Dammed, inoperable
Cumberland Falls	17 feet in two steps	8.9	Mill Dam only
Saccarappa Falls	24.5 feet	10.4	Hydroelectric
Mallison Falls	14 feet	16.4	Hydroelectric
Little Falls	19 feet	16.9	Hydroelectric
Gambo Falls	15 feet	18.6	Hydroelectric
Dundee Falls	16 feet	21.9	Hydroelectric
Great Falls (North Gorham Falls)	20 feet	23.7	Hydroelectric

[1] Drop in riverbed elevation, as it exists today after modifications from dam construction; this does not represent the height of the Falls, since the normal depth of the river above and below the Falls is not included in the FEMA profiles.
[2] Miles from Casco Bay
[3] Height of ledge drop above low tide is 4.7 feet; water rises to 4.3 feet above ledge at high tide.
Source: Federal Emergency Management Agency, Flood Insurance Studies; US Army Corps of Engineers, Smelt Hill Dam Environmental Restoration Study, 2001 (for Presumpscot Falls).

XI. CUMULATIVE IMPACTS TO CULTURAL RESOURCES

Cumulative impacts to cultural resources along the Presumpscot River have included:

- damage to sites from activities associated with the settlement and subsequent industrial development of the Basin (*e.g.*, logging; agriculture; industrial, road and railroad construction; and urban, suburban, and rural development);

- the loss or inundation of archaeological sites and artifacts at and around falls due to the construction of dams; and

- inundation of upland areas that may have contained sites.

Indigenous Cultures: There is evidence of continuous human habitation along the Presumpscot River for the past 9,000 years. Middle and Late Archaic (ca. 3500-6000 BP) sites have been found at Basin Island adjacent to the headwaters of the Presumpscot, at Indian Island in Sebago, at Outlet Brook on the east side of the Basin near the narrows from Sebago to the Basin and at White's Bridge, on the eastern shore of the narrows between the Basin and Sebago Lake (Yesner *et al.*, 1983, Landlocked Salmon). State Site # 8.10 (located approximately 900 feet upstream from the Smelt Hill Dam on the right bank) and the Walker site (located at the confluence of the Piscataqua and Presumpscot rivers) are archeological sites that have been eroded by the high waters behind the Smelt Hill Dam (Smelt Hill Environmental Restoration Study, US Army Corps of Engineers, September 2000). Numerous archeological sites have been studied in the River with FERC dam relicensing; however, due to the risk of site disturbance this information is not publicly available.

Since the Middle Archaic times (ca 7000-9000 BP), Native American cultures in the Sebago Lake region and the Presumpscot River Basin had *"…an aquatic based subsistence regime, focused on anadromous fish such as salmon, shad and alewives, as well as other fish, turtles, aquatic mammals and birds. This diverse, abundant, and stable resource base led to the development of increased regional populations, as more sedentary encampments developed in the lake fringes, particularly near outlets to important spawning grounds"* (Yesner, 1983). With the coming of European settlers to this region in the early 1600's, centuries of dependence on food from the River were altered. The runs of anadromous fish were stopped by dams and a variety of factors including the settlement of the areas along the River and inland, resulted in the decline of the local Native American population and their subsistence-based culture.

Under predevelopment conditions, prior to regulation of flows from Sebago Lake, flows in the Presumpscot River fluctuated over a much wider range than they do currently (see earlier section on water resources). Pre-European Indian settlements and encampments along the Presumpscot River were located on level landforms with well drained soils along the river banks, especially immediately upstream or downstream of falls and rapids, and near confluences with tributary streams and rivers. The landforms used for camping occur at multiple elevations, from 1 to 10 meters above seasonal river levels. The sites at

lower elevations have been subject to flooding over time, which has generally either covered the occupations with alluvial deposits or damaged sites due to erosion. While inundation may protect some archaeological sites, dams on the River have in some cases (*e.g.,* at Smelt Hill) been particularly destructive since they raised water levels exposing higher areas to erosion. Sites on higher riverbank landforms, above impoundment levels, have apparently survived without much erosional damage (Arthur Speiss, Maine Historical Preservation Commission, personal communication). The FERC licensing process for the dams on the Presumpscot has contributed considerably to knowledge of archaeological sites on the Presumpscot.

Euro-American Historic Resources: As throughout the northeast, adverse impacts to the cultural resources in the Basin have been accelerated by development along the River. By exposing the ground protecting cultural resources to increased erosion, damage to artifacts likely resulted from the clearing of land for the development, logging and agriculture that has occurred in the watershed over the last century. Losses from the cultural record also occur when artifacts are scavenged from sites which become exposed.

Cultural and economic resources of the European settlers and their descendants are intertwined with the history of the Presumpscot. Windham and Westbrook, in particular, were settled at locations where the power from the River could be harnessed to run mills of all sorts. Industries such as logging used the Presumpscot to float their logs to tidewater. One such early log landing, used as a launching spot for the trees cut as masts for the Royal Navy in England, was at Mallison Falls. The first sawmill in Windham, which was the first mill of any sort to be built in the town, was at Horse Beef Falls (now Mallison Falls). Another saw mill was built at Little Falls, by Maj. William Knight , sometime previous to 1756. The settlement grew around these sites, and the area continued to be the center of Windham's manufacturing activity into the mid-twentieth century (Dole, 1916).

Falmouth also had numerous industries located at Presumpscot Falls (now called Smelt Hill) and at the mouth of the River in the estuary. Shipyards flourished at the Smelt Hill location. The first ship (600-ton displacement) was built on the River in 1734. Ferries took passengers up and down the River between Presumpscot Falls, Cumberland Mills and Riverton in the early twentieth century (taken from the map *Past Activities in the Mouth of the Presumpscot River*, Ford Reiche, 1978, in McDonald *et al.*, 1994, *Guide to the Presumpscot River*).

Westbrook's history with the Presumpscot reaches back as early as 1729, when the first lumber business was built in Saccarappa (today's Westbrook). In 1814, the tax assessor's list contained nine saw mills, three carding mills, and two grist mills in the Saccarappa section of town alone. Work at these mills and other projects along the Presumpscot, such as the digging of the Cumberland and Oxford Canal, brought French laborers from Quebec, Danish farmers and Irish immigrants, as well. This influenced all aspects of life in a city whose development was made possible by the power produced at the falls on the Presumpscot. In the Images of America series, under a picture of the Presumpscot River

raging during the spring run-off, the text reads, *"this river is the one and only reason that 16,121 people make their home in Westbrook. From the Native Americans to the Industrialists, this town would never have been settled but for the potential for life seen by those who gazed upon these waters. Saccarappa, Cumberland Mills, Westbrook; call us what you will, but we are the river"* (*Images of America: Westbrook on the Presumpscot*, Westbrook History 2000 Committee and Dianne LeConte, 2000)

The Cumberland and Oxford Canal was built along side the Presumpscot in 1830. It provided transportation for raw materials from inland southwestern Maine, all the way from Harrison and beyond, to Portland for shipment to ports all over the world. It also brought supplies upriver to settlers inland and provided a safer means of transportation than the roadways of the day. Without the River and the controlled flows provided by the dams, this Canal would not have been able to operate. Dams raised the level of Sebago to a height that allowed boats to enter the mouth of the Songo River in Naples, extending the waterway above Sebago into Long Lake and provided water to fill the locks that made the journey along the Presumpscot possible since the River drops 267 feet from Sebago to the sea. Regarding safety, the Canal was reportedly the safest route to transport the gun powder from the Oriental Powder Mill at Gambo to ships in Portland since the river boats moved more smoothly than wagons using the rutted and bumpy roads of the day. This powder, which was a major source of supply for the Union Army in the Civil War, was unstable and prone to accidental explosions, so canal boats were the transportation of choice. Some sections of the Canal remain today, especially near Babb's Bridge on Hurricane Road in Gorham (Knight, 1976, *A Guide to the Cumberland and Oxford Canal*, 1976).

Remnants of many of these historical sites still exist along the River while others have been inundated, covered over by more recent developments or deteriorated to the point where they are unrecognizable.

XII. CUMULATIVE IMPACTS TO THE LOCAL AND REGIONAL ECONOMY

The subsistence economy of the Native Americans who first inhabited the Presumpscot River area was based largely on the food resources provided by the River including *"salmon, shad, alewives, as well as other fish, turtles, aquatic mammals and birds"* (Yesner, 1983). This economy was in place for thousands of years before Europeans settled the area (Yesner, 1983). This economy was replaced in the 1700's by a mixture of agriculture and early industrial development.

The power and water provided by the Presumpscot River were the reasons for the growth of industry and population centers on its banks. For example, the community of Westbrook was originally called Saccarappa after the falls which attracted settlement. Changes to the local and regional economy, from the development of the earliest industry along the River to the present day, have both caused and resulted from changes to the River. For example, the reliable flows which resulted from damming and managing the water level on Sebago Lake provide power to industries and have enabled the growth and development in the Greater Portland Area.

It would be difficult to overstate the importance of the River to the region's early industrial economy – in fact the River is why an industrial economy existed at all. Further, the River and its management continue to impact the region's prosperity. For example, dams on the River are still a low cost producer of electricity and contribute to the economic viability of the SAPPI paper mill in Westbrook. SAPPI reports that the Westbrook Mill obtains 25% of its power from the dams combined and it is SAPPI's lowest cost power. The cost savings (estimated SAPPI's from FERC license documents) to SAPPI from the power produced by these dams is approximately $1,953,600 per year. The SAPPI mill provides more than 500 jobs in Westbrook pays $1,500,00 in local property taxes/year, and the value to the local economy from direct spending (no multiplier added) on wages, purchased services and materials is approximately $85 million per year. However, the future of SAPPI's Westbrook mill depends on many factors beyond the energy production at these dams. Utilization of Sebago Lake as a reservoir through controls at Eel Weir Dam at the head of the river (which is not included in any river restoration option in this or other reports from this planning effort) has provided a higher more constant summer time flow in the Presumpscot River which allows sewage treatment plants and industrial waste discharges to be designed for higher discharge levels. While economists would argue that all costs including waste water treatment should be internalized for the price of goods to reflect their true value and others would argue that all waste discharges should be strictly minimized to reduce their impacts, under present law and regulation higher, stable summer flows reduce wastewater treatment costs for downstream municipal and industrial dischargers. This has reduced the need for capital, improved the competitiveness of local industries, and has reduced the cost of municipal treatment plants, hence, reducing local taxes and improving the local economy.

The waterpower of the River has literally fueled the area's industrial economy, but there has also been an economic price to pay. Part of this price results from the external costs

of industrial development borne by the public, *e.g.,* the cost of public programs to reduce pollution, public health costs, etc. While enhanced opportunities have been created for flat water recreation and bass fishing, and these are undoubtedly valued by a segment of the public, other portions of this price result from reduced water quality, reduced opportunities for trout and salmon fishing, loss of recreation opportunities and aesthetic impacts. All of these have economic impacts, as well as impacts on the quality of life enjoyed by residents and visitors. Today, leisure time has increased and outdoor activities are a prime draw for tourists and local residents alike. For example, inland freshwater fishing is a multi-million dollar industry in Maine. While no economic studies have been done specifically for the Presumpscot, a Statewide study done by Professor Kevin Boyle and Mario Teisl at the University of Maine, Orono, indicates that Maine's inland fisheries accounted for direct spending in retail sales of $196.2 million in 1996. This figure does not constitute the total economic impact of inland fishing when considering salaries and tax revenues, as well as indirect and induced effects. For example, the authors estimate that approximately 5,230 jobs are supported by this activity (Boyle and Teisl, 1998, *The Economic Impacts of Hunting, Inland Fishing and Wildlife-Associated Recreation in Maine*). Boyle and Teisl estimate total economic output from inland fishing at $292.7 million in 1996. Of course, only a very small portion of this total resulted from fishing on the Presumpscot. However, it is likely that the loss of the fish populations that are most sought after by recreational fishermen (cold water species: salmon and trout) has resulted in a loss to the regional economy. The thriving trout and land-locked salmon cold water fishery at the Eel Weir Bypass (6,800 angler visits in 1995 and 12,000 visits in 2001), one of the few unimpounded sections of the River, suggests what the fishery could be like if larger sections of the River were flowing freely, and productive cold water fisheries were reestablished.

Since information on the Statewide economic activity related to fishing is reported above, in the year 2001 the pulp and paper industry employed 13,200 people in Maine and comprised about 4.5% ($1.45 billion) of Maine's Gross State Product (information from the Maine Pulp and Paper Association), of which only a small portion is attributable to the economy of the Presumpscot Basin.

In summary, the development of the Presumpscot River and its corridor has resulted in important benefits as well as losses to the local and regional economy and environment. While society has benefited from the use of its waters for industry, for power, and for the dilution of wastes; and many factories and homes were built along its banks; the cumulative impacts of human use have eliminated most of the natural values of the rushing *"Pes-ompsk-ut,"* the *"river of many rough places"*. The challenge faced by this collaborative planning effort, which involves a variety of organizations and individuals with different objectives, perspectives and interests, is to find solutions to problems which reduce cumulative impacts, improve the quality of life for residents and visitors, increase economic activity based on improvements in environmental quality and not damage existing industries.

XIII. OPTIONS FOR ADDRESSING CUMULATIVE IMPACTS

Option 1: Encourage local citizens to perform Stream Habitat Walks within the tributaries of the Presumpscot River.

NEED: Although some information on water quality and fisheries already exists for the tributaries of the Presumpscot River, protection of the Presumpscot may be increased by additional information gathering on these rivers and streams. Tributaries are important to the Presumpscot River because if they are in relatively good condition:

- they may act as important riverine habitat for coldwater fish and invertebrate species that may migrate to and from the impounded habitats of the main stem Presumpscot River

- and they may serve as a source of colder, high quality water to the river due to adequate riparian vegetation groundcover and shading of the channel.

On the other hand, if the tributaries are in poor condition (e.g., lacking intact riparian vegetation zones):

- they may act as a source of warm water

- and they may act as a source of sediment and other forms of nonpoint source pollution to the main stem of the Presumpscot River.

Encouraging citizen groups, school groups, and municipalities to get involved with efforts to survey and document conditions of tributaries to the Presumpscot River has the potential to bring a lot of useful information to the knowledge base of the system in addition to locate and highlight areas in these watersheds that could be restored and, hence, contribute to the overall improvement of the Presumpscot River Watershed.

HOW: Encourage citizen groups, school groups, and municipalities to contact the Maine Stream Team Program [MSTP] (under the Maine Department of Environmental Protection) to learn how they can organize Stream Habitat Walks workshops for their local rivers and streams. Stream Habitat Walk workshops, lead by the MSTP, teach citizens how to record meaningful stream and river habitat condition data using a techniques that is consistent with similar efforts being launched by the MSTP around the state. Habitat conditions which are observed and documented include: riparian zone and streambank condition, channel bottom quality (and any evidence of sedimentation), shading and temperature characteristics, evidence of trash or obvious water quality problems, and an estimate of average velocity through stream reaches of interest. If groups are very enthusiastic and amenable to some more training, additional habitat scoring and other forms of monitoring may be incorporated into efforts.

WHEN: The recommended period for conducting these Stream Habitat Walk surveys is between June 1 and September 1, the time when riparian trees generally are fully "leafed-out".

WHERE: Tributaries to the Presumpscot River

WHO: Citizen volunteers in the Presumpscot River Watershed, the Maine Stream Team Program, and Presumpscot River Watch.

COST: - *Minimal* - Workshops are often nearly free and include light refreshments. Generally equipment needs are low: basic things such as data sheets, cameras, meter sticks and tapes are required. Waders or knee-high boots are strongly recommended. The MSTP has a limited supply of these items, which often can be loaned out when a workshop is being held. A place to hold the indoor portion of the training often is free, but occasionally demands a rental fee. (This version of workshops might run $0 - $200 per session.)

- *Intensive* - If permanent resources and equipment, in addition to Maine Stream Team Program reserves, are desired, then those costs must be considered. Optional costs may include additional hip-waders, cameras and film, copies of data sheets, copies of summary reports of the Stream Habitat Walks, temperature data loggers, macroinvertebrate sampling equipment, water quality monitoring equipment, etc. Costs will depend on which equipment is desired. (As workshops and equipment supplies became more advanced and expensive, and if the steering committee decides to buy a set of loaner equipment specifically for the Presumpscot River Watershed, these costs could run from $500 - $5000, depending on the amount and type of equipment desired.)

COST TO: *Minimal*: Maine Stream Team Program

POTENTIAL FUNDING SOURCES:

Intensive: (?) Casco Bay Estuary Project, Portland Trails, Friends of the Presumpscot, Presumpscot River Watch, Maine State Planning Office, Maine Department of Environmental Protection, USEPA, various grant organizations, etc.

Option 2: Restore Riverine Habitat

NEED: Historical accounts and assessments by fisheries agencies have identified the Presumpscot as important habitat for a number of species which either require or do best in riverine vs impounded habitats and habitats where their movements are not impeded by dams. These include both resident and migratory species such as: brook trout, Atlantic salmon, blueback herring. The cumulative impact of dams has been to replace riverine habitat with impoundments and to block free movement of aquatic organisms. This has worked to the detriment of the native species listed above, and in favor of bass and pan fish. At present 22 of the original 27 miles of the Presumpscot River is impounded, and of the 5 miles which remain unimpounded, approximately half is in the estuarine portion of the river. Habitat restoration, which could be accomplished by dam removal, would increase the small proportion of the Presumpscot which is truly riverine from approximately 10% of the river's original non tidal length to something greater. Such efforts would also benefit fisheries restoration efforts for some species (*e.g.,* anadromous species listed earlier), while reducing the potential for species such as American shad (see the companion paper on fisheries for more on this topic).

HOW: Dam removal would be necessary to restore riverine habitat. Friends of the Presumpscot River have proposed removing 3 dams (Saccarappa, Mallison, and Little Falls). This would restore approximately 7 miles of river.

WHEN:

WHERE: Saccarappa, Mallison and Little Falls Dams

WHO: SAPPI, in conjunction with NGOs, State and Federal resource agencies, and other funding sources.

COST: Discussed in fisheries white paper.

POTENTIAL FUNDING SOURCES:
SAPPI, NGO's through grants,
State and Federal funding sources

Option 3: Mitigate for the loss of anadromous and catadromous fish runs , and their contributions to the productivity of Casco Bay

Anadromous fish runs at or near the River's biological potential would result in millions of additional young and adult fish moving through the Presumpscot River estuary and Casco Bay. In addition, improving conditions for passage of American eels would increase their numbers as well. These fish would provide food for a variety of aquatic, avian and mammalian predators and increase the productivity of the Presumpscot River estuary. See the white paper on fisheries for options on what could be done to restore anadromous fish runs and improving conditions for eel passage.

Option 4: Identify Nonpoint Sources of Pollution

NEED: The Presumpscot RiverWatch and the Maine DEP have identified nonpoint sources of pollution as a major contributing factor to the degradation of the Presumpscot River water quality. The Maine Department of Environmental Protection's 1998 Water Quality Assessment reports that continued progress toward cleanup of point sources in Maine has been tempered by the discovery of significant nonpoint sources of pollution such as stormwater runoff.

HOW: Sanitary surveys and watershed surveys need to be conducted within the smaller sub-watersheds of the Presumpscot River. The information from these surveys will help the communities along the river and regional and state entities working on nonpoint source issues further define the problem areas and develop a plan to remove these sources of pollution.

WHEN:

WHERE: Presumpscot River Watershed

WHO: The Department of Environmental Protection, the Cumberland County Soil and Water Conservation District, Presumpscot River Watch, communities and local volunteers can lead and conduct the surveys.

COST: $15,000 to $30,000 per sub-watershed depending on the size of the watershed.

COST TO:

POTENTIAL FUNDING SOURCES:
U.S. Environmental Protection Agency, Maine Department of Environmental Protection.

Option 5: Protect Significant Wetlands through Purchasing, Restoration Efforts, and Protective Buffer Projects

NEED: Priority habitats identified by the CBEP include freshwater wetlands in the watershed. Freshwater wetlands (i.e., vegetated wetlands that often fringe open water but also can be isolated from surface water bodies) range from marshes and wooded swamps to vernal pools (i.e., wetlands that hold standing water for several months in spring and early summer and provide important breeding sites for amphibians). Like coastal salt marshes, freshwater wetlands afford critical habitat, particularly for deer, beavers, muskrats, raccoons, wood ducks, American bitterns, great blue herons, green herons, leopard frogs, painted turtles, and four-toed salamanders. Freshwater wetlands also play an important role in purifying polluted water and reducing flood damage.

Large habitat areas are needed by certain species, such as red-shouldered hawk, which require up to 620 acres of upland and wetland forest for breeding, and the American bittern, which requires a minimum of 6 to 12 acres of shallow freshwater wetlands where abundant vegetation is interspersed with patches of open water.

HOW: The State Planning Office Wetland Protection project staff will meet with each community, local land trusts, and other partners to highlight the significant wetlands in their area and work with them to protect those wetlands.

WHEN: Over the next five years.

WHERE: Presumpscot River Corridor

WHO: State Planning Office, land trusts, community planners and Conservation Commission members, US Fish and Wildlife Service, Inland Fisheries and Wildlife, Presumpscot River Watch, and local landowners.

COST: Varied, depending on the value of the wetland and the conservation option used.

COST TO: Not yet determined.

POTENTIAL FUNDING SOURCES:
Land Trusts, Communities,
Landowners, Foundation and Agency grants.

Option 6: Extend Casco Bay Estuary Project's Toxic Monitoring Program to Include More Sites at the Mouth of the Presumpscot River

NEED: The CBEP monitors toxins in mussels, sediments, and lobsters in Casco Bay. There are no stations in the Presumpscot River for sediment toxic sampling. In 1991, and again in 2000-2001, the CBEP conducted a sediment study that indicated the bay registered potentially toxic levels of PCBs and PAHs and high levels of four heavy metals (Lead, Cadmium, Mercury, Silver) compared to other estuaries nationally. There are three point sources of pollution in the lower Presumpscot River. They include the SAPPI Paper CO. discharge, and the Westbrook and Falmouth Treatment Plants. In addition to those point sources there is a major highway that crosses the Presumpscot River Estuary and other sources of non-point sources of pollution. We need to have further testing in the Presumpscot River Estuary in order to better assess the sources and effects on the estuary.

HOW: The CBEP, Maine DEP, and US EPA work together to find the funding and staff to conduct the increased sampling. A subcommittee of the above-mentioned agencies form to determine the level of increased sites and parameters to monitor.

WHEN: Within the next three years.

WHERE: Presumpscot River Estuary.

WHO: Maine DEP, CBEP, and the US Environmental Protection Agency.

COST: $100,000 for two seasons of increased monitoring.

COST TO: CBEP, US EPA, Maine DEP.

POTENTIAL FUNDING SOURCES:
CBEP, US EPA, Maine DEP.
(list possible grant programs at EPA that we could target and programs within DEP that we could target.)

Option 7: Reclassify the River to Class B from Saccarappa Falls To Tidewater

NEED: The Presumpscot River above Saccarappa is all either Class A or Class B. One of the designated uses for both of these classification is as habitat for indigenous species of fish. Since indigenous species include both anadromous and catadromous species, it is critical that they be able to safely traverse the reach from Saccarappa to Casco Bay. This is also consistent with efforts to provide for fish passage or dam removal in the lower and middle river.

HOW: Removal of Smelt Hill Dam will bring these waters closer to Class B standards. Further efforts will likely be needed, including the protection of riparian buffers, education programs to reduce non-point source pollution, and possibly additional treatment of point source wastewater entering the Presumpscot. Non-attaining tributaries will also need attention.

WHEN:

WHERE: Presumpscot River Corridor

WHO: Friends of the Presumpscot River and Maine Rivers have this reclassification project as a goal to be completed by 2005. These organizations, and other interested parties, need to work with the Department of Environmental Protection to bring this recommendation to the Board of Environmental Protection for approval. This approval need not wait until the waters attain Class B standards because classifications in Maine can be set as goals to be achieved.

COST: No cost to change classifications on paper, but full costs are unknown, as costs for compliance with Class B standards may be significant.

COST TO:

POTENTIAL FUNDING SOURCES:

Option 8: Support Comprehensive Stormwater Management Efforts

NEED: The heavy rainstorm of October 20-22, 1996 resulted in major flood damage to roads and bridges in Cumberland County and caused more than 5.5 million dollars in damage to public, private and business property in our county. A Presidential Disaster was declared.

A series of storms between June 12 and June 21, 1998 resulted in significant damage to roads and crops. Reported damages to road systems totaled $107,270. A Presidential Disaster was declared.

On October 8-11, 1998, heavy rainfall caused numerous small rivers and streams in Cumberland County to flood roadways. Flood warnings were issued for the Presumpscot River, which ran above flood stage for 33 hours. The Presumpscot River finally crested at 20.88 feet, 6 feet above the 15-foot flood stage. Reported damages totaled $866,600 in Cumberland County. A Presidential Disaster was declared.

As communities develop, the amounts of impervious areas increase, causing rainfall runoff to also increase and flooding to occur in areas not previously subject to flooding.

Many local drainage improvements have been and are being installed without any comprehensive study of hydrological and environmental effects. Downstream areas are being impacted by upstream developments.

The lack of real-time precipitation and stream gauges in the watershed make it difficult to accurately determine return frequency for rain events. The lack of real-time gauges does not allow for timely forecasting and adequate warning of the severity of expected flooding. Improved forecasting and warning would reduce damage from future flooding events.

HOW: Develop Interlocal cooperation agreements between County and Municipal Governments for stormwater improvement and management activities in the watershed by establishing a program structure through which the County/District may develop a comprehensive and collaborative approach to stormwater improvement and management and provide financial and technical assistance to municipalities for planning, design and construction activities to ensure an adequate, safe and integrated storm drainage network throughout the watershed and with neighboring communities.

WHEN:

WHERE:

WHO: The Cumberland County Soil and Water Conservation District working in

partnership with Cumberland County Emergency Management, Cumberland County Commissioners, Casco Bay Estuary Project, Greater Portland Council of Governments, Maine Department of Environmental Protection, Maine Department of Transportation, Presumpscot River Watch, and the municipalities of the Presumpscot River Watershed.

COST: $65,000 per year.

COST TO:

POTENTIAL FUNDING SOURCES:

U.S. Environmental Protection Agency,
Maine Department of Environmental Protection,
Federal Emergency Management Agency,
Maine State Planning Office, and
Maine Department of Transportation.

Option 9: Support the CCSWCD's Erosion Control Training for Communities

NEED: The Presumpscot River Watch and the Maine DEP have identified nonpoint sources of pollution as a major contributing factor to the degradation of Presumpscot River water quality. Roadside erosion has been documented as a major contributor of sediment and nutrients in lakes, streams, and rivers throughout the lower Casco Bay Watershed, which includes the Presumpscot River Watershed. The Cumberland County Soil and Water Conservation District (CCSWCD) has identified the following existing needs and opportunities for further work:

- There is significant interest and need for in-house training workshops that are specifically designed to fit the needs of each municipality. For example, some municipalities experience a lot of turnover, while others have crews that have been working for the same municipality for 15-20 years. In order for erosion and sediment control (ESC) training to be effective, it must reflect this.
- There is an ongoing need for technical assistance, which has been identified by both CCSWCD and Androscoggin Valley SWCD as the best vehicle for spreading the word about ESC applications. The feedback we have received to date is that hands-on training is the only way to make these concepts "sink in", and the construction oversight that occurs through the technical assistance program is the best method to provide hands-on training for road crews.

HOW: A technical assistance program needs to be available for municipalities of the Presumpscot Watershed for both the design and implementation of erosion and sediment control practices. In order to ensure comprehensive application of erosion and sediment control practices on roadside work, in-house training needs to be provided to municipal road crews in a manner that addresses the specific needs of each municipality.

WHEN:

WHERE:

WHO: The Cumberland County Soil and Water Conservation District working in partnership with the Greater Portland Council of Governments, the Maine Department of Environmental Protection Nonpoint-Source Training Center, Maine Department of Transportation Local Roads Program, the Casco Bay Estuary Project, and the municipalities of the Presumpscot River Watershed.

COST: $40,000 per year.

COST TO:

POTENTIAL FUNDING SOURCES:

U.S. Environmental Protection Agency,
Maine Department of Environmental Protection, and
Maine Department of Transportation.

Option 10: Implement Nonpoint Education for Municipal Officials

NEED: NPS pollution results from the cumulative impacts of individual behaviors and local land use policies. Growth and development generate significant erosion and pollution loads containing phosphorus, nitrogen, heavy metals, hydrocarbons, sediments, and debris that run off into, and threaten, the quality of surface waters.

Changing land use policies is a complex challenge—one that must be met if NPS management is ever to be effectively addressed. Land use decisions are made primarily at the local level by a combination of elected, appointed, and volunteer officials serving on land use commissions such as planning, zoning, conservation and wetlands boards. Educating and assisting those officials involves overcoming a number of barriers, the most prominent of which are:

- The high turnover rate among elected officials and board members;
- The lack of adequate technical training or support services;
- The already full agenda and responsibilities of these boards; and;
- The lack of a means to track and evaluate the cumulative impacts of land use decision.

Due to these obstacles, few programs are working directly and effectively with local officials on this topic. Providing education and technical assistance to targeted local governments speaks to the heart of the new focus on "community-based environmental protection". Educating and assisting these individuals is, in many respects, the "bottom-line" of NPS pollution prevention.

HOW: The NEMO Project will implement a nonpoint source pollution educational program for a targeted audience of local land use officials. The program will help them understand the nature of the problem and its impact on their lives, town, and natural resource base by providing them with information that is specific to their town resources, therefore enabling them to plan for growth while addressing water quality through educated land use decisions.

WHEN:

WHERE:

WHO: Partnership for Environmental Technology Education (PETE) working in partnership with Maine Department of Environmental Protection, State Planning Office, the Casco Bay Estuary Project, Cumberland County Soil and Water Conservation District, Presumpscot River Watch, and the municipalities of the Presumpscot River Watershed.

COST: $60,000 per year.

COST TO:

POTENTIAL FUNDING SOURCES:

U.S. Environmental Protection Agency,
National Oceanic and Atmospheric Administration (NOAA)
Maine Department of Environmental Protection,
State Planning Office, and
The municipalities of the Presumpscot River Watershed.

Option 11: Support Erosion Control Technical Assistance for Landowners

NEED: Maine's Nonpoint Source Awareness Campaign, a collaborative effort between the Maine Department of Environmental Protection (DEP) and the State Planning Office, started in 1995 to raise awareness about nonpoint source pollution prevention. As part of this, a major phone survey was conducted to assess Maine residents' grasp of NPS issues.

After four years of phone surveys that were meant to track the success of complimentary education and mass media campaigns, it has become apparent that a large percentage of Maine's population does not understand the threats to Maine's waters. The conclusion that DEP supplied in its most recent NPS campaign report is that due to these findings, they are left feeling that the only avenue to improve the state's waters is to regulate more heavily.

Unfortunately, regulation does not always yield the results you are aiming for. Therefore, a non-regulatory, educational approach that involves hands-on learning for homeowners would be an inroad to both educate and effect change since education is the key to behavioral change. A subsidized technical assistance program for landowners would provide an excellent avenue for education of MDEP's target audience of 35-55 yr olds who own a home.

HOW: Develop a mechanism where by planning boards and code enforcement officers would require individual landowners to seek technical assistance before granting permits for activities that would disturb soil. This would provide the homeowners with one-on-one education about the natural resource impacts of the activities on their land, something they have a personal connection with.

WHEN:

WHERE:

WHO: The Cumberland County Soil and Water Conservation District working in partnership with the Maine Department of Environmental Protection, the Natural Resources Conservation Service, the Casco Bay Estuary Project, Presumpscot River Watch, and the municipalities of the Presumpscot River Watershed.

COST: $30,000 per year (initially, then more as program grows and demand increases)

COST TO:

POTENTIAL FUNDING SOURCES:

U.S. Environmental Protection Agency,
Maine Department of Environmental Protection,
State Planning Office,
The municipalities and fee for service with homeowners.

Option 12: Support Natural Resources Education for Schools

NEED: A national survey of adults conducted by Lever Brothers and the Nature Conservancy found that people are concerned and somewhat knowledgeable about threats to our natural water resources but lack the time and inclination to get involved personally. Ninety-eight percent, however, said it is necessary to educate our children if we really intend to improve the environment.

Currently school systems in the Presumpscot River Watershed have only limited environmental education in the curricula. This is a factor of both lack of financial resources and lack of time to integrate environmental learning into existing curricula.

However, the Cumberland County Soil and Water Conservation District has found a cost-effective tool to encourage the development of environmental education in schools. The staff of the Vermont Institute of Natural Science developed Environmental Learning for the Future, ELF. It is an award-winning program designed for elementary-aged children and taught by parents and other community volunteers. This unique approach promotes understanding and appreciation of the natural world and increases environmental literacy in both the students and the adult volunteers.

HOW: CCSWCD trains volunteer educators during monthly workshops. The two-hour workshops help volunteers learn the activities, develop teaching skills and adapt the lessons to various grade levels. Most workshops include an outdoor component that allows participants to experience the natural world first-hand and apply their learning. ELF explores nature in and around the school grounds, teaching children that nature study need not take place at the end of a long bus ride.

WHEN:

WHERE:

WHO: The Cumberland County Soil and Water Conservation District working in partnership with the Casco Bay Estuary Project, Presumpscot River Watch, and the school districts of the Presumpscot River Watershed.

COST: $50,000/yr

COST TO:

POTENTIAL FUNDING SOURCES:

U.S. Environmental Protection Agency,
Maine Department of Environmental Protection,
State Planning Office,
The municipalities/schools and foundations.

Option 13: Continue efforts of the U.S. Fish and Wildlife Service's Gulf of Maine Program and the State of Maine to provide information to communities in the Presumpscot River Watershed and work with the communities and land trusts to develop protected wildlife corridors

NEED: The U.S. Fish and Wildlife Service, Maine Dept. of Inland Fisheries and Wildlife, Maine Natural Areas Program and Maine State Planning Office have been working together for more than a year to develop **"Habitat-Based Approach for Conservation,"** a coordinated pilot effort to provide towns and local land trusts with current information on important habitats in their community. Maps identifying important habitat, as defined by each agency have been prepared as hard copy overlays and in an ArcView digital format, and written materials describing how to interpret and use the data for habitat protection have been produced and distributed to several communities in Maine. Presenting this information requires a biologist with outreach skills to provide and explain the information to each community, and for this pilot effort, the work has been conducted by a staff person supported by a Maine Outdoor Heritage Fund grant. Town officials, land trust representatives and agency staff recognize the value of this effort and envision expanding the project statewide.

HOW: Now that the pilot **"Habitat-Based Approach for Conservation,"** has been successfully completed, it is a relatively simple task for agency staff to produce new maps for other towns. However, in order to provide the habitat information to additional communities around the state, it is vital that the staff position needed to deliver and interpret the data remains in place. Currently, the position is only funded with one-year of funds. The Casco Bay Estuary Project and other partners could help continue this habitat initiative next year and target communities in the Presumpscot River Watershed by providing matching funds to support a renewed Maine Outdoor Heritage Grant.

WHEN:

WHERE:

WHO: Casco Bay Estuary Project, U.S. Fish and Wildlife Service, Maine State Planning Office, Maine Dept. of Inland Fisheries and Wildlife and Maine Natural Areas Program will work together to deliver the habitat information to targeted towns in the Presumpscot River Watershed. Casco Bay Estuary Project, Presumpscot River Watch, and other partners will provide oversight to ensure that the Presumpscot River Watershed communities receive the information and support they need.

COST: $30,000 to provide outreach services to all towns in the Presumpscot River Watershed.

COST TO:

POTENTIAL FUNDING SOURCES:

Casco Bay Estuary Project and other partners could provide matching funds to request a second year of Maine Outdoor Heritage Grant funding to support the outreach staff position. U.S. Fish and Wildlife Service Gulf of Maine Program will commit to providing $5,000 in support of this partnership. Maine State Planning Office, Maine Dept. of Inland Fisheries and Wildlife, Maine Natural Areas Program, Maine Dept. of Environmental Protection and Cumberland County Soil and Water Conservation District are other potential matching grant funders. In addition, U.S. Fish and Wildlife Service Gulf of Maine Program, Maine State Planning Office, Maine Dept. of Inland Fisheries and Wildlife and Maine Natural Areas Program will continue to provide staff support as match in order to produce maps and coordinate the work of the outreach staff.

Option 14: Protect and enhance the riparian corridor by re-establishing forested buffers and siting development appropriately

NEED: Because the Presumpscot River was severely polluted, the riparian corridor along the river's edge was not conducive to development and has been left relatively undisturbed. Now, as the water quality in the river is improving, residents are re-discovering the values of the Presumpscot River's (and its tributaries') beautiful riparian buffer(s) as:

1. a community recreational asset for paddling, walking, biking and cross-country skiing,
2. a floodwater control mechanism,
3. a source of shade to optimize light and temperature conditions and a source of organic foods needed for a diverse assemblage of aquatic plants and animals, and a source of large woody debris structures which increase the amount of aquatic habitat diversity by providing cover for fish, creating pools (by deflecting flows), and providing attachments sites for aquatic insects (a source of food for fish)
4. a wildlife corridor for birds, fish, furbearers and deer,
5. a tool to minimize non-point source pollution by limiting erosion and cleaning polluted runoff (i.e. oil, fertilizers, pesticides) and
6. a way to reduce contamination in the downstream clam flats of the Presumpscot estuary.

However, as the water quality improves, development pressures along the Presumpscot River are intensifying. In order to ensure that the multiple community values of the existing riparian buffers are retained, concerted pro-active, as well as reactive initiatives must be energized, funded and implemented. If we act now, we will be able to avert the losses already demonstrated and experienced in nearby watersheds.

HOW: In order to protect the multiple community assets that an intact riparian buffer provides, the Casco Bay Estuary Project and other partners will work with communities, land trusts and developers to protect the Presumpscot River's (and its tributaries') riparian buffer. Riparian buffers may be donated or purchased, and may be protected by regulatory requirements, zoning, fee acquisition, conservation easement and/or management agreements. Considerable professional outreach work directed to riverside communities, town officials, developers, landowners and nearby residents will be essential in order to explain the importance of riparian buffers, to build supportive and effective regulatory controls, encourage voluntary participation, and craft landowner agreements. This

outreach effort could be initiated by providing grants to existing land trusts to hire staff focused on the Presumpscot River corridor. Staff responsibilities would include:

1. coordinating with the federal-state "Habitat-Based Approach for Conservation" effort designed to provide information on important habitats to Maine communities,

2. developing current land ownership maps of the riparian corridor,

3. working with targeted groups to identify opportunities to protect the riparian buffer,

4. reaching consensus with stakeholders,

5. fundraising, and

6. implementing priority riparian buffer initiatives along the Presumpscot River (and its tributaries).

WHEN:

WHERE: Presumpscot River (and its tributaries') Corridor

WHO: Casco Bay Estuary Project, Portland Trails, Friends of the Presumpscot, Presumpscot River Watch, local community officials, developers, Gorham-Sebago Lake Regional Land Trust, Maine State Planning Office, Maine Dept. of Inland Fisheries and Wildlife, Maine Natural Areas Program, U.S. Fish and Wildlife Service -- Gulf of Maine Program, The Nature Conservancy, Maine Coast Heritage Trust, and Presumpscot River Watch.

COST: $45,000 to initiate the outreach effort through an existing land trust along the Presumpscot River (and its tributaries') corridor. Estimating the total cost for implementing a comprehensive riparian buffer protection program along the Presumpscot River (and its tributaries') corridor is beyond the scope of this proposal.

COST TO:

POTENTIAL FUNDING SOURCES:

Land for Maine's Future Program,
Casco Bay Land Opportunity Fund,
Maine Outdoor Heritage Grant,
Private foundations, community bond funds for land protection,
Land trust fundraising initiatives, bargain sales or donations from developers.

Option 15: Identify potential inadequate treatment of point sources of pollution where they exist.

NEED: From the mid 19th century to the latter part of the 20th century, the Presumpscot River was significantly impacted by direct discharges of industrial, commercial, and residential waste. The discharges from these point sources of pollution deteriorated the water quality to such an extent that some stretches of the river were considered 'dead'. In the 1970's, interceptor sewers and wastewater treatment plants were built to collect and treat the waste before discharging to the river. The wastewater treatment plants, including the Maine Correctional Center Facility, the South Windham WWTP, the Westbrook WWTP, the SAPPI WWTP, and the Windham School Department WWTP, which discharges to the Pleasant River, are all closely regulated and must meet very stringent discharge requirements. All the existing facilities are presently operating within their design capacities, except for the Maine Correctional Center Facility, which is reaching its treatment capacity. A study of that facility has been undertaken by Woodard & Curran Associates to identify future capacity needs. The Little Falls WWTP is operating within design capacity and averages 90-95% BOD and TSS removals, but has at times experienced upsets because of stormwater flow. Both of these treatment plants are discharging a combined flow of 100,000 gallons per day to the class B section of the river. Water quality improvements to this section of the river could be realized if these discharges were relocated.

HOW : Connect the raw wastewater piping from the Maine Correctional Facility to the Little Falls sewer system and then pump the combined wastewater to the Westbrook Wastewater Treatment Facility for treatment and discharge to the Class C section of the river.

WHO: Maine Department of Corrections, Maine Department of Environmental Protection, Town of Windham, Town of Gorham, and Portland Water District.

COST:

COST TO:

POTENTIAL FUNDING SOURCES: (NOTE: INFORMATION ON POTENTIAL FUNDING WILL BE REQUESTED FROM DEP)

DEP, Portland Office

Option 16: Develop a Flood Mitigation Program for the Presumpscot River Watershed

NEED: The flood of October 1996 caused extensive damage to private property, land and buildings, public property roads, and infrastructure. Flooding not only causes damage to public and private property, the disruption in our road-highway transportation systems, but also results in pollution and erosion.

If the removal of the existing dam(s) is contemplated, it is necessary to model the River and its tributaries to insure that this action does not increase flooding and flood damage(s), and provides sufficient information to identify the flood zone(s) to update the F.E.M.A. (Federal Emergency Management Agencies) National Flood Insurance Maps.

The Eel Weir dam at the outlet of Sebago Lake, the headwaters of the Presumpscot River, is used to control the river flow by SAPPI.-Westbrook. A lake level management plan approved by the Federal Energy Regulatory Commission in 1997 establishes lake level targets, ranges, and flow requirements which SAPPI must comply with. When there is a weather event predicted for Cumberland County and the Sebago Lake-Presumpscot River Watershed, SAPPI shuts off the flow of water from the Lake into the Presumpscot River.

There are eight major brook systems that flow into the Presumpscot River between Sebago Lake and the Casco Bay Estuary. In order to fully understand the flooding impacts of the Presumpscot River, one must also understand the impact of the tributaries to the Presumpscot River. Development in the towns where these tributaries are located changes the flow characteristics, not only of the tributaries, but the Presumpscot River as well.

HOW: A good model will give good engineering information to understand and manage this river system. What is needed, more specifically, is: to develop a comprehensive hydraulic model of the Presumpscot River and its tributaries to identify flood hazard areas of the River and tributaries, and to identify how or if the dams reduce or increase the flood hazard; and install flow gauges on the Presumpscot River and its tributaries.

The model would enable FEMA and other public official planners to

- Provide flood warnings to public safety officials and affected citizens.
- Provide in-place monitoring equipment to insure adequate warning.
- Identify flood hazard areas.
- Insure that F.E.M.A.'s National Flood Insurance Maps are adequate.

- Provide information on how development will impact the Presumpscot River System.

- Provide information that will allow the development of a comprehensive flood mitigation program.

- Establish a database for a comprehensive land-use management program in the Presumpscot River Watershed to manage sprawl.

WHEN:

WHERE: Presumpscot River Watershed

WHO:

COST:

COST TO:

POTENTIAL FUNDING SOURCES:
Provided to CBEP by George Flaherty, Cumberland County Emergency Management Agency.

Option 17: A Field Survey for Eel Grass in the Estuary

NEED: Biological indicators of the health of the estuary can be used to monitor potential improvements due to pollution abatement and dam removals.

HOW: A field survey of eel grass in the estuary is need to determine if the estuary is recovering from past impacts.

WHEN:

WHERE: Presumpscot River Estuary

WHO: Partner with FOCB?

COST:

COST TO:

POTENTIAL FUNDING SOURCES:

Option 18: Inform Public of Fish Advisories.

NEED: The Environmental toxicology Program under the Maine Bureau of Health has issued Statewide fish consumption advisories for fresh water fish. This advisory includes the Presumpscot River, and a need exists to inform the public of the fish advisories.

HOW: A collaborative effort by agencies and NGO's to distribute the new fish advisory pamphlets developed by Environmental Toxicology Program to all locations in the Presumpscot River Watershed that issue fishing licenses so they can be available to area fishermen; distribute pamphlets to local Rod and Gun Clubs; post advisories on watershed NGO web sites with links to state agencies' web sites for further information; post fish advisory posters in public access areas on the Presumpscot; and PSA's issued by agencies and watershed NGO's to area daily, weekly newspapers and local radio stations.

WHEN:

WHERE: Presumpscot River Watershed

WHO:

COST:

COST TO:

POTENTIAL FUNDING SOURCES:

Option 19: Educate Property Owners of Negative Effects of Pesticides

NEED: Educate property owners in the watershed on negative impacts of pesticides reaching the Presumpscot River, and offer ways to limit their use and impact

HOW: Develop informational material that local watershed NGO's can add to their web sites with links to agencies and other sources to help property owners to practice low impact gardening and lawn care. A collaborative (agencies and NOG's sponsorship of several information seminars featuring low impact garden and lawn care, Best Management Practices, buffering, etc. A collaborative development of Public Service Announcements by agencies and NGO's featuring public educational information on low impact lawn care and gardening, distributed to local weekly and daily papers. Radio talk show information presentations such as WMPG and Maine Public Broadcasting by local NGO's.

WHEN:

WHERE: Presumpscot River Watershed

WHO Presumpscot River Watch.

COST:

COST TO:

POTENTIAL FUNDING SOURCES:

XIV. REFERENCE LIST

Atkins, Charles G. 1867. *Fish Commissioner's Report, 1st* (State of Maine)

Atkins, Charles G. 1887. "The River fisheries of Maine," in The Fisheries and Fishery Industries of the United States, Section V, History and Methods of the Fisheries, Vol. 1. Report to the US 4th Congress, 1st Session. United States Commission of Fish an fisheries. Prepared by George Brown Goode in cooperation with the Commissioner of Fisheries and the Superintendent of the 10th Census. Government Printing Office, Washington, DC.

Azous, A. and R. Horner. 1997. *Wetlands and Urbanization: Implications for the Future.* Final report of the Puget Sound Wetlands and Stormwater Management Research Program. Washington State Department of Ecology, Olympia, WA.

Bi-centennial Commemoration of the Incorporation of the Town of Gorham, Maine. 1964.

Bloom, A. L. 1959. *The Geology of Sebago Lake State Park*, Maine Geological Survey, Augusta, cited in Yesner *et al*., 1983.

Boyle and Teisl. 1998. *The Economic Impacts of Hunting, Inland Fishing and Wildlife-Associated Recreation in Maine.*

Brautigam, Francis. May 1997. *Presumpscot River Eel Weir Bypass Fishery Report.* Maine Department of Inland Fisheries and Wildlife. Interim Summary Report Series 97-4

Brinson, M. M. 1988. "Strategies for assessing the cumulative effects of wetland alteration on water quality." *Environmental Management* 12(5): 655-662.

Dadswell, Michael J. 2001. *Fisheries Resources: Past, Present and Potential: The Presumpscot River, Maine* in *Comments, Recommendations, Terms and Conditions by American Rivers and Friends of the Presumpscot River*, in USA Before the FERC, S. D. Warren Company, February 2, 2001, Project Nos. 2942-005, 2931-002, 2941-002, 2932-003, and 2897-003.

DeRoche, S. E. 1967. *The Presumpscot River*, A Biological Survey Report, Maine Department of Inland Fisheries and Game, cited in Dadswell, 2001.

Devin, Stevin C. and Thomas C. Sanford. 1990. Open File Report No 90-24, *"Stability of Natural Slopes in the Presumpscot Formation*.

Dole, Samuel. Thomas. 1916. *Windham in the Past*, Windham Historical Society cited in Dadswell, 2001.

Dube, N. R., 1983, *The Potential for Atlantic Salmon Restoration in Five Coastal Drainages West of the Kennebec River, Maine*, MS State of Maine Atlantic Sea Run Commission cited in Dadswell, 2001.

FERC, 1993 and FERC, 1996, FERC Nos. 2375, 8277), FERC, 19951 (All cited in wetlands).

FERC, 2001 Draft Environmental Impact Statement, Presumpscot River Projects – Dundee Project FERC No. 2942, Gambo Project FERC No. 2931, Little Falls Project FERC No. 2941, Mallison Falls Project GERC No. 2932, and Saccarappa Project FERC No. 2897. *FERC, Washington, DC.*

Fobes, Charles S. 1894. *The Story of the Presumpscot.* In Maine Historical Society Collections, Second Series, Vol. 5, pp. 361-386. Maine Historical Society, Portland, Maine.

Goold, William. 1886. *Portland in the Past.*

Hartman, Kyle J. and Kitchell, James F. *Bioenergetics Modeling of Sites Where Fish Ladders Have Been Installed, PSE&G Renewal Application – Salem Generating Station.* March 4, 1999.

Harvey, K. A. and K. Warner. 1970. *The Landlocked Salmon (Salmo salar) Its Life History and Management in Maine*. Sports Fishing Institute and the Maine Department of Inland Fisheries and Game cited in Dadswell, 2001.

Hull, John T. 1888. *Handbook: Portland, Old Orchard, Cape Elizabeth and Casco Bay.*

Jones, Herbert G. 1946. *Sebago Lake Land.*

Kendall, W. C. 1935. "The Fishes of New England, The Salmon Family." II The Salmons, *Memoirs of the Boston Society of Natural History*, 9:1-166 cited in Dadswell, 2001.

Kennicutt, M. C. II, T. Wade, B. J. Presley, A. G. Requejo, J. M. Brooks, and G. J. Denoux. 1994. "Sediment contaminants in Casco Bay, Maine: Inventories, Sources, and Potential for Biological Impact," *Environ, Sic. Techno*., 28: 1, 1-15 1994.

Knight, E. H. 1976. *A Guide to the Cumberland and Oxford Canal*, Cumberland and Oxford Canal Association.

Loucks, O. L. 1990. *Restoration of the Pulse Control Function of Wetlands and Its Relationship to Water Quality Objectives,* in Jon A. Kaiser & Mary E. Kentia (eds). Wetland Creation and Restoration: The Status of the Science (1990).

MacDonald, Amy. *et al*.1994. *Guide to the Presumpscot River: Its History, Ecology, and Recreational Uses.* Presumpscot River Watch.

Maine Board of Agriculture. 1867. *Twelfth Annual Report of the Maine Board of Agriculture*.

Maine DEC (Department of Conservation), Natural Areas Division. 1999. Letter to Army Corps of Engineers.

Maine DEP (Department of Environmental Protection). November 1995. *Presumpscot River Waste: Load Allocation Final Report*.

Maine DEP. 1998. *1997 - 1998 Dioxin Monitoring Program Report*.

Maine DEP. March 1998. *Presumpscot River Supplemental Report to Waste Load Allocation.*

Maine DEP. 1999. *Biomonitoring Retrospective: A Fifteen Year Summary of Maine Rivers and Streams.*

Maine Department of Inland Fisheries and Wildlife, Wildlife Division. 2001. Research and Management Report.

Maine Historical Society, *Collection and Proceedings of the Maine Historical Society*, Second Series, Vol. V 1894 B The Story of the Presumpscot.

Maine Statutes, Title 38, Section 465, 465A.

McLellan, Hugh. D. 1903. *The History of Gorham, Maine*, Smith and Sale, Portland, Maine.

Milius, S. 1998. *Mountain Streams: Still Living in the '50's*. In Science News Vol. 154. December 12, 1998, p. 375.

Moulton, Augustus F. 1926. *Portland by the Sea.*

Murray, P. E. 1989. "Drained Dundee Pond is a Big Attraction." *American Journal*. Nov. 8, 1989.

Northern Ecological Associates, 2000 cited in Dadswell, 2001.

NRCS. 1995. *Casco Bay Watershed Land Use Inventory: In Support of the Casco Bay Estuary Project*, Gorham, ME.

Peek, James M. 1986. *A Review of Wildlife Management*. Prentice-Hall. Englewood Cliffs, New Jersey, 486 pp.

Pennuto, *et al*.. 2001. *Deciphering Rainfall Dependent Effects on Surface Water Bacteria Counts*.

Poff, N. L., *et al*.. 1997. "The Natural Flow Regime", *BioScience*, 47: 11.

Presumpscot River Watch. Annual. Monitoring data reports. PRW, Westbrook, Maine. Available at http://www.prw-maine.org.

Reiche, Ford S. 1978. *Past Activities in the Mouth of the Presumpscot River [map]*, in McDonald, *et al.*, 1994, *Guide to the Presumpscot River.*

Rowe, William H. 1929. *Shipbuilding Days in Casco Bay.*

S. D. Warren. 1998. *A baseline investigation of the fisheries resources in the vicinity of the Dundee, Gambo, Little Falls, Mallison, and Saccarappa hydroelectric projects, FERC Project Nos. 2942, 2931, 2932, and 2897, on the Presumpscot River, Cumberland County, Maine*. Prepared by Ichthyological Assoc. Inc., and Duke Engineering and Services.

S. D. Warren. 1999. *application for a New License for a Major Water Power Project Under 5MW (Dundee Project FERC No. 2942; Gambo Project FERC No. 2931; Little Falls Project FERC No. 2941; Mallison Falls Project FERC No. 2932; Saccarappa Project FERC No. 2897.* Prepared by Kleinschmidt and Associates for S. D. Warren Co., January, 1999.

S. D. Warren, FERC submittal A *Responses to FERC March 16, 2000 Schedule A Additional Information Requests, July 2000*.

Smith, Thomas. 1849. *Journals of the Rev. Thomas Smith.*

Stillwell, E. M. and H. O. Stanley. 1891. *Landlocked Salmon*, *Report Comm. Fish and Fisheries, Maine (1889-90)*, 11-12 cited in Dadswell, 2001.

USCFF (United States Commission of Fish and Fisheries). 1887. *The Fisheries and Fishery Industries of the United States*.

US Army Corps of Engineers. 2000. *Smelt Hill Environmental Restoration Study*, *Falmouth, Maine*, September 2000.

USEPA. 1996. *Protecting Natural Wetlands A Guide to Stormwater Best Management Practices.* EPA-843-B-96-001. US Environmental Protection Agency, Office of Water, Washington, DC [Brinson, 1988 qtd in Protecting Natural Wetlands -fix in wetlands]

USEPA 1997 Cluster Rule, Maine 1997 Act LD1633.

Wade, T. L., T. J. Jackson, L. Chambers, and P. Gardinali. 1995. Texas A&M University. *Assessment of Contaminants in Sediments from Casco Bay*. Casco Bay Estuary Project.

Wallace, Charlotte. 1976. *E Pluribus Unum: A Story of Falmouth, Maine.*

Westbrook, *Annual CSO Progress Report for 2000*, submitted to Maine DEP.

Westbrook History 2000 Committee and Dianne LeConte. 2000. *Images of America: Westbrook on the Presumpscot*.

Wheeler, R. 1996. *The Great Basin Dam War*, Friends of Sebago Lake, Sebago Lake, Maine.

Windham 1976: Bi-centennial Issue. 1976.

Woodward and Curran, Inc. 1997. *1997 Ambient Water Quality Monitoring Final Report*. S. D. Warren Company.

Yesner, D. R., N. D. Hamilton, and R. A. Doyle. 1983. *Landlocked Salmon and Early Holocene Lacustrine Adaptation in Southwestern Maine*. North Amer. Archie. 4: 307-333.

MDEP 1993, Woodard and Curran 1997 and by Presumpscot River Watch, 1999.

The Old Maps of Rural Cumberland County, Maine, *1871.*

APPENDICES

Appendix 1: Maine Water Quality Standards

Appendix 2: Chapter 21 Province Laws 1735-36
An Act to Prevent the Destruction of the Fish Called Alewives

Appendix 3: Chapter 16 Province Laws 1741-42
An Act in Addition to
An Act to Prevent the Destruction of the Fish Called Alewives, and Other Fish

APPENDIX 1: Maine Water Quality Standards

A. Class GPA water quality standards (Maine Statutes, Title 38, section 465A): A. Class GPA waters shall be of such quality that they are suitable for the designated uses of drinking water after disinfection, recreation in and on the water, fishing, industrial process and cooling water supply, hydroelectric power generation and navigation and as habitat for fish and other aquatic life. The habitat shall be characterized as natural.

B. Class GPA waters shall be described by their trophic state based on measures of *chlorophyll a* content, Secchi disk transparency, total phosphorus content and other appropriate criteria. Class GPA waters shall have a stable or decreasing trophic state, subject only to natural fluctuations and shall be free of culturally induced algal blooms which impair their use and enjoyment. The number of *Escherichia coli* bacteria of human origin in these waters may not exceed a geometric mean of 29 per 100 milliliters or an instantaneous level of 194 per 100 ml.

C. There may be no new direct discharges of pollutants into Class GPA waters... No materials may be placed on or removed from the shores or banks of a Class GPA water body in such a manner that the materials may fall or be washed into those waters or that contaminated drainage therefrom may flow or leach into those waters,... No change of land use in the watershed of a Class GPA water body may, by itself or in combination with other activities, cause water quality degradation that would impair the characteristics and designated uses of downstream GPA waters or cause an increase in the trophic state of those GPA waters.

Riverine Class A waters

A. Class A waters shall be of such quality that they are suitable for the designated uses of drinking water after disinfection; fishing; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; and navigation; and as habitat for fish and other aquatic life. The habitat shall be characterized as natural.

B. The dissolved oxygen content of Class A waters shall be not less than 7 parts per million or 75% of saturation, whichever is higher. The aquatic life and bacteria content of Class A waters shall be as naturally occurs.

C. Direct discharges to these waters licensed after January 1, 1986, are permitted only if, in addition to satisfying all the requirements of this article, the discharged effluent will be equal to or better than the existing water quality of the receiving waters... Discharges into waters of this classification licensed prior to January 1, 1986, are allowed to continue only until practical alternatives exist. There may be no deposits of any material on the banks of these waters in any manner so that transfer of pollutants into the waters is likely.

Riverine Class B waters (Maine Statutes, Title 38, section 465).

A. Class B waters shall be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; and navigation; and as habitat for fish and other aquatic life. The habitat shall be characterized as unimpaired.

B. The dissolved oxygen content of Class B waters shall be not less than 7 parts per million or 75% of saturation, whichever is higher, except that for the period from October 1st to May 14th, in order to ensure spawning and egg incubation of indigenous fish species, the 7-day mean dissolved oxygen concentration shall not be less than 9.5 parts per million and the 1-day minimum dissolved oxygen concentration shall not be less than 8.0 parts per million in identified fish spawning areas. Between May 15th and September 30th, the number of *Escherichia coli* bacteria of human origin in these waters may not exceed a geometric mean of 64 per 100 milliliters or an instantaneous level of 427 per 100 milliliters.

C. Discharges to Class B waters shall not cause adverse impact to aquatic life in that the receiving waters shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.

Riverine Class C Waters

A. Class C waters shall be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; and navigation; and as a habitat for fish and other aquatic life.

B. The dissolved oxygen content of Class C water may be not less than 5 parts per million or 60% of saturation, whichever is higher, except that in identified salmonid spawning areas where water quality is sufficient to ensure spawning, egg incubation and survival of early life stages, that water quality sufficient for these purposes must be maintained. Between May 15th and September 30th, the number of *Escherichia coli* bacteria of human origin in these waters may not exceed a geometric mean of 142 cfu per 100 milliliters or an instantaneous level of 949 cfu per 100 milliliters.

C. Discharges to Class C waters may cause some changes to aquatic life, provided that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.