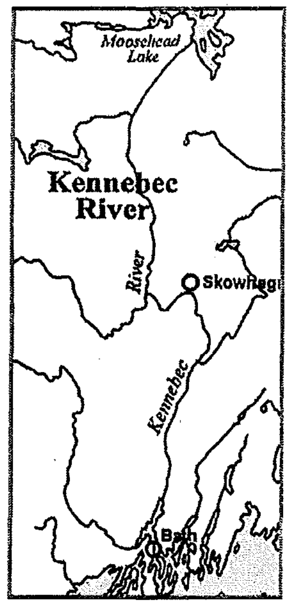
Kennebec River Anadromous Fish Restoration
Annual Progress Report - 2003



Prepared by:
Maine Department of Marine Resources
Stock Enhancement Division
#21 State House Station
Augusta, ME 04333-0021
(207) 624-6340

Maine Atlantic Salmon Commission
270 Lyons Road
Sidney, ME 04330
(207) 547-5326

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EXECUTIVE SUMMARY OF 2003 ACTIVITIES

On May 1, 2003, the temporary fish pump was installed below the Fort Halifax Hydroelectric Project in Winslow, Maine. Trapping of alewives began on May 16 and the pump was used almost daily until June 13. In all, a total of 135,368 river herring were collected with the fish pump; a total of 75,190 alewives were released into Phase I habitat; and 56,751 were released into 23 other ponds and rivers throughout the state. The total mortality rate of adult alewives (1,366 mortalities from combined pump and trucking operations) was 1.0%, an increase from 0.01% in 2002, but less than the 1.6% of 2001. Due to a large number of alewives being attracted to the ledges below Fort Halifax on the south side of the Sebasticook River, dip nets were used to collect and return them to the river below the dam. To prohibit alewives from returning to the ledge area, a series of sandbag and punch plate barriers were constructed along the base of the ledges by FPLE personnel. Overall, the sex ratio of randomly collected samples was essentially equal (1.01 males to 1.0 females). As predicted, fish length/weight decreased over time. The majority of adult alewives collected were Age III males (29.2%) and females (23.6%). Permits were issued to 30 commercial fishermen; however, as of this printing, less than half have reported their landings.

A total of 468 adult American shad broodstock were transferred to the Waldoboro Hatchery from the Merrimack River. No attempts were made to capture broodstock shad in the Kennebec or Sebasticook Rivers in 2003. In addition, no attempt was made to collect broodstock shad from other rivers in Maine.

The year 2003 was a record year for larval shad production. In all, 6.0 million larval shad were released in the Kennebec River and 1.9 million larval shad in the Sebasticook River. Additionally, 1.2 million larval shad were released into the Androscoggin River. In September, 20,600 shad fingerlings were released into the Medomak River.

In June, the pool and chute fishway was completed at the Sebasticook Lake outlet dam, triggering a mid-June 2004 trigger date for installation of permanent upstream fish passage at both the Benton Falls Project and the Burnham Project. The Maine Department of Marine Resources (DMR), with significant funding from the Natural Resource Conservation Service, along with the Town of Newport and other sources of funding, including the US Fish and Wildlife Service, the National Marine Fisheries Service, the National Fish and Wildlife Foundation, and the Maine Corporate Wetland Restoration Partnership, completed this and three other projects in recent years, providing passage for a variety of species in the upper Sebasticook watershed.

DMR personnel checked pond outlet dams from July to November. Water levels were similar to those of 2002, and as a result, downstream passage was available during many of the inspections. Known beaver dam problem areas were also visited throughout the season and were partially breached to provide passage; they were typically reconstructed within days of breaching, however. Particular attention was paid to a large beaver dam located on Seven Mile Stream; DMR personnel partially breached this dam over the course of several days to enable adult alewives to migrate upstream to Webber Pond.

DMR personnel also made unannounced visits to hydroelectric dams from July to November. Bypass facilities were operating at all projects during all visits. DMR personnel discovered fish kills (juvenile alewives) at the Benton Falls Project, while the operators at the Burnham Project reported a kill in the fall of 2003. In addition, a fish kill consisting of American eels was discovered at the American Tissue Project, located on Cobbosseecontee Stream in Gardiner.

DMR personnel conducted biweekly beach seine surveys at nine sites in the Kennebec River between Augusta and Waterville. A total of 1,321 juvenile alewives, 293 juvenile American shad, five American eels, and 57 unidentified alosids were captured throughout the summer.

DMR staff continued to work on upstream and downstream eel passage in 2003. DMR installed and monitored eel upstream passage at the Fort Halifax and Benton Falls Projects. Passage at Benton Falls was not operational for most of the summer, primarily because of repairs at the project. Upstream passage became operational at Shawmut during the summer. Installation of upstream passage was delayed until 2004 at Weston because of dam resurfacing. An experimental design used at Hydro-Kennebec was partially successful, but was subsequently destroyed by ice; DMR staff met with Hydro-Kennebec on February 12, 2004 to develop a replacement design. DMR made several nighttime observations at the Lockwood Project to determine where eels were concentrating. Initiation of the emigrating eel behavior study at Lockwood was delayed until October because of repair work, and by then the migration had ceased. The study will be continued at this site in 2004. DMR will consult with owners of the Burnham Project during 2004.

1.0 Alewife Restoration Methods

Note: The history of the Kennebec River Diadromous Fish Restoration has been included as Appendix A of this report.

1.1 Trap, Transport, and Release

In 2003, DMR continued to utilize only Kennebec River adult alewife returns for release into Phase I restoration lakes. **See Figure 1**. The large number of alewife returns to the Kennebec and Sebasticook Rivers in previous years, coupled with improved capture techniques using the fish pump installed at Fort Halifax, prompted DMR to again trap alewives in the Sebasticook in 2003.

Pump Configuration

As outlined in Exhibit B, Section IV, Part E (1. b.), FPLE, the owners of the Fort Halifax Project were required to:

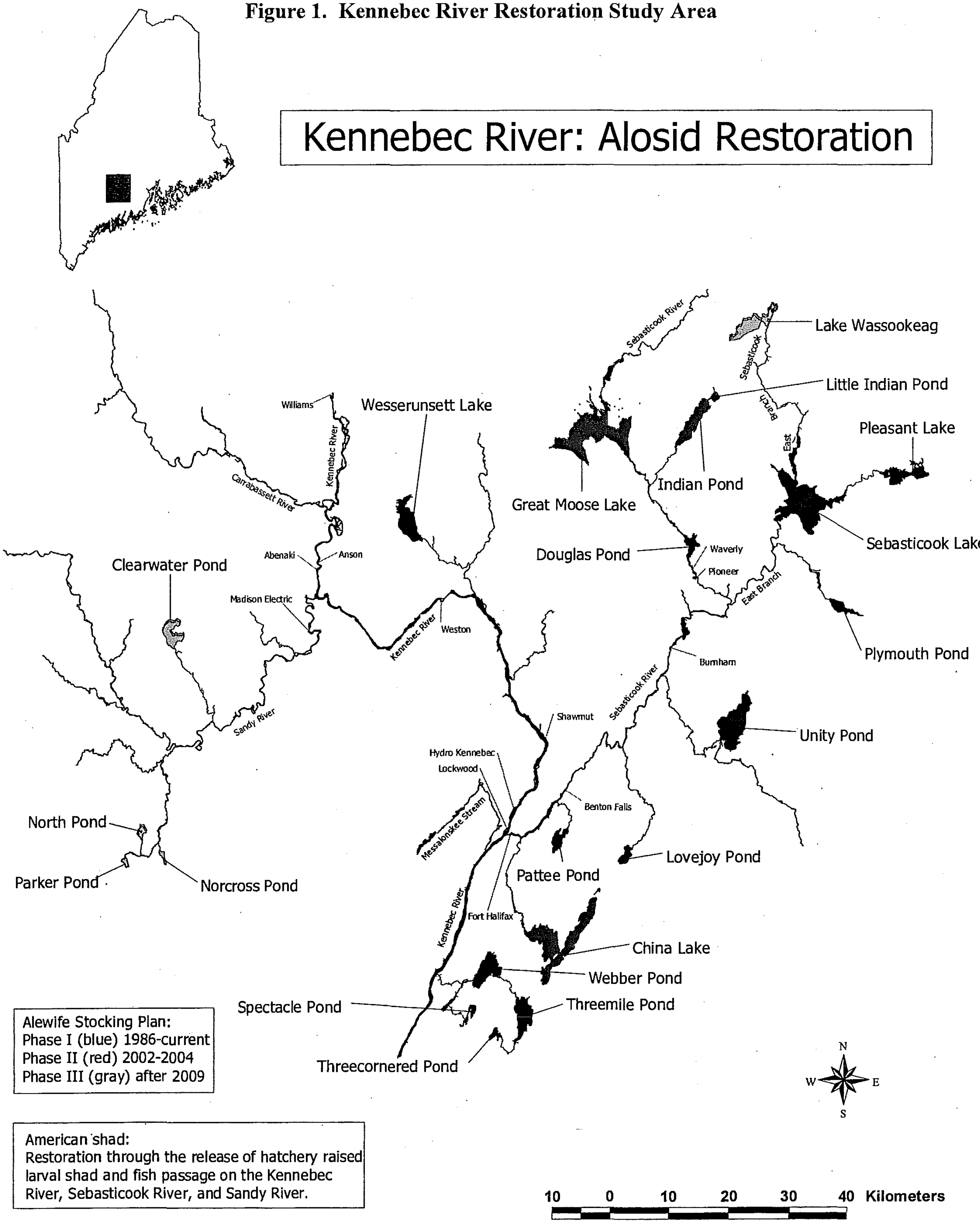
> "By no later than May 1st of the first migration season following the removal of Edwards Dam, anticipated to be removed in 1999, licensee shall install and have fully operational a temporary fish pump and trap and transport facility..."

The pump configuration at Fort Halifax was set up in 2003 in a manner similar as in previous years. For a complete description, refer to the *2001 Kennebec River Diadromous Fish Restoration Annual Progress Report.*

Stocking Truck Configuration

The modifications that were made to the stocking trucks in 2002 were again utilized in 2003. These modifications likely have contributed to the reduced alewife mortality during the transport stage of the program. A complete description of the stocking trucks and their configuration, associated equipment, and standard methods of operation are provided in previous annual reports and are available from DMR upon request.

Figure 1. Kennebec River Restoration Study Area



Alewife Stocking Plan:
Phase I (blue) 1986-current
Phase II (red) 2002-2004
Phase III (gray) after 2009

American shad:
Restoration through the release of hatchery raised larval shad and fish passage on the Kennebec River, Sebasticook River, and Sandy River.

1.2 Overview

On May 8, DMR received reports from FPLE consulting biologist Jason Seiders that small schools of alewives were observed below Fort Halifax in Winslow. However, larger numbers of alewives did not appear for several more days, delaying the onset of pumping until May 16.

Between May 16 and June 12, 2004, a total of 135,368 alewives were collected with the fish pump. Overall, pump efficiency (fish/day) at Fort Halifax was similar to historical pump efficiencies. It operated for a total of 22 days and an average 6,153 adult alewives were collected daily. The variation in the number of fish collected is due to a number of factors, including environmental conditions causing variation in fish densities below the dam (e.g., high water and/or depressed water temperatures), truck loading time, and trip length.

The timing of the alewife run was a little later than average. **See Table 1**. Historically (1994-2003), the mean date by which 50% of alewives have been collected is May 25. In 2003, the 50% date of alewife trapping was May 27 (Day 9 of pump operation). The 25% quartile was only one day later, while the 75% quartile was three days later.

Based on ten years of data (1994-2003), the average peak date of alewife pumping is May 23. **See Table 2**. In 2003, the peak was on May 21 (15,467 alewives collected with the fish pump); however, there were also 13,970 adult alewives collected on May 27.

The number of mortalities due to handling was very low in 2003. In fact, the trucking mortality (mortality=33 fish) rate of 0.02% was the lowest ever. **See Table 3.**

Phase I Habitat

In 2003, a total of 75,190 broodstock alewives were stocked into ten of the 11 upriver Phase I lakes in the Kennebec River watershed. **See Table 4.** In total, 13,400 acres of lake surface area were stocked to a density of approximately six alewives/acre. Due to a concern about the ability

Table 1. Summary of Alewife Trapping by Quartile

Year	25%	50%	75%
1994	May 28	June 1	June 2
1995	May 25	May 27	May 30
1996	May 27	June 3	June 4
1997	May 31	June 3	June 4
1998	May 15	May 18	May 20
1999	May 22	May 28	May 31
2000	May 9	May 15	May 19
2001	May 12	May 14	May 16
2002	May 11	May 20	May 23
2003	**May 21**	**May 27**	**May 30**
Mean=	**May 20**	**May 25**	**May 27**

Table 2. Summary of Peak Alewife Trapping

Year	Peak date	Number pumped
2003	**May 21**	**15,467**
2002	May 20	15,867
2001	May 14	18,896
2000	May 7	13,578
1999	May 23	9,965
1998	May 18	16,311
1997	June 3	21,756
1996	June 4	22,205
1995	May 27	10,634
1994	June 2	13,050
Mean=	**May 23**	**15,773**

Table 3. Alewife Trapping & Distribution from Fort Halifax, Sebasticook River, 2003[1]

Date	Pumped	Pump Mortalities	Biological Sample	Returned to River	Number Loaded Into Truck	Truck Mortalities	Released
May 15	181	16	52	113			
May 16	853	45		1	807	0	807
May 17	5,850	53		0	5,797	4	5,793
May 18	5,987	42	50	0	5,895	1	5,894
May 20	12,280	150		577	11,553	4	11,549
May 21	15,467	67	53	0	15,347	4	15,343
May 22	8,863	54		202	8,607	6	8,601
May 23	9,619	64		217	9,338	0	9,338
May 27	13,970	45	58	0	13,867	2	13,865
May 28	7,765	50		0	7,715	2	7,713
May 29	12,528	60		0	12,468	1	12,467
May 30	9,706	67	55	0	9,584	0	9,584
May 31	5,651	60		220	5,371	0	5,371
June 2	3,406	43		235	3,128	0	3,128
June 3	5,299	48	50	0	5,251	4	5,247
June 4	5,301	78		230	4,993	0	4,993
June 5	4,878	73		0	4,805	1	4,805
June 9	2,617	85	50	0	2,532	0	2,532
June 12	3,167	42	50	0	3,125	2	3,123
June 13	666	45		0	621	0	621
June 16	386	80	50	256	0	---	0
June 17	928	66		0	862	2	860
Totals:	**135,368**	**1,333**	**468**	**2,051**	**131,666**	**33**	**131,634**

[1] Includes all alewives released, not just Phase I ponds

Table 4. Alewife Stocking & Distribution, Phase I and II Lakes, 2003[1]

Ponded Area	Location	Surface Acres	River Section	Stocking Goal[1]	Actual Stocked 2003	No. of Trips	% of Target Number Achieved	Alewives per Acre
Douglas Pond	Pittsfield	525	Sebasticook, W. Branch	3,150	3,174	3	101	6.0
Lovejoy Pond	Albion	324	Sebasticook, mainstem	1,944	2,112	2	109	6.5
Pattee Pond	Winslow	712	Sebasticook, mainstem	4,272	860[3]	1	20[3]	1.2
Pleasant Pond	Stetson	768	Sebasticook, E. Branch	4,608	4,747	3	103	6.2
Plymouth Pond	Plymouth	480	Sebasticook, E. Branch	2,880	2,947	3	102	6.1
Sebasticook Lake	Newport	4,288	Sebasticook, E. Branch	25,728	25,767	10	100	6.0
Unity Pond	Unity	2,528	Sebasticook, mainstem	15,168	15,082	10	99	6.0
Big Indian Pond[2]	St. Albans	990	Sebasticook, W. Branch	5,940	0	---	---	---
Little Indian Pond[2]	St. Albans	145	Sebasticook, W. Branch	870	0	---	---	---
Great Moose Lake[2]	Hartland	3,584	Sebasticook, W. Branch	21,504	0	---	---	---
Threemile Pond	China	1,077	Kennebec River	6,462	6,487	5	100	6.0
Webber Pond	Vassalboro	1,252	Kennebec River	7,512	5,343[4]	3	71[4]	4.3/5.1[4]
Wesserunsett Lake	Madison	1,446	Kennebec River	8,676	8,671	5	100	6.0
Totals:		**18,119**		**108,714**	**75,190**	**45**	**69/94[5]**	**5.6[6]**

[1] Six adult alewives per lake surface acre
[2] Phase II lakes
[3] The stocking site for Pattee Pond was muddy and inaccessible for the 2003 season. These fish were stocked in the outlet stream.
[4] An additional 1,033 alewives were bailed over the Webber Pond dam from Sevenmile Stream on June 11, for a total of 6,376 fish stocked.
[5] First number incorporates the three lakes in which DMR was not permitted to stock; the second number excludes them.
[6] Does not include the three lakes in which DMR was not permitted to stock.

of alewives being able to leave the pond, Three-cornered Pond was not stocked in 2003. The results of surveys conducted during the winter/spring of 2004 will determine whether this waterbody will be stocked in 2004.

In total, 45 alewife-stocking trips were made to the upriver ponds in 2003, averaging 1,671 alewives per trip. Low water temperatures and heavy spring rains contributed significantly to the increased number of trips (i.e., lower pumping capabilities). **See Table 5**. All 45 trips originated from Fort Halifax, as the Kennebec River was once again the sole source of alewife broodstock in 2003. The alewife stocking program in the Phase I lakes required ten days to complete between May 16 and June 17, 2003. The majority of Phase I lakes were stocked by May 28; however, the Pattee Pond stocking was delayed until June 17 due to poor road conditions at the stocking site resulting from rain. As a result, Pattee Pond only obtained 20% of its stocking potential. Additionally, due to poor release site conditions, these fish were not released directly into Pattee Pond; instead, they were released in the outlet stream.

Table 5. Summary of Alewife Releases to Phase I Habitat

Year	No. released	No. of trips	No. Alewives/trip
2003	**75,190**	**45**	**1,671**
2002	81,067	38	2,133
2001	77,168	41	1,882
2000	74,775	43	1,739
1999	71,857	36	1,996
1998	73,148	34	2,151
1997	74,165	41	1,809
1996	67,441	41	1,645
1995	59,080	34	1,738
1994	58,701	36	1,631
1993	36,503	28	1,303
1992	23,579	31	761
Mean=	**64,390**	**37**	**1,705**

The most stocking trips completed to the Phase I ponds in one day was nine, occurring on May 27, which was two more trips than the best day in 2003. The high number of trips per day in 2003 was due to relatively high pump efficiency, loading efficiency, utilization of the Androscoggin River Project trucks, and the proximity of Fort Halifax to the Phase I receiving ponds. **See Table 6.**

Phase II Restoration

The 2003 season was once again scheduled to be the beginning of the Phase II restoration efforts in the watershed. As such, it was DMR's plan to begin stocking Phase II ponds with alewife broodstock at the rate of six alewives/acre. The 2003 Phase II lakes included Big and Little Indian Ponds in St. Albans and Great Moose Lake in Hartland. In order to inform the local residents of the restoration program, DMR held several informational meetings with the Great Moose Lake Association in both 2001 and in the spring of 2002. However, despite the meetings and the endorsement of the stocking plan by MDIFW fishery biologists, MDIFW decided again not to grant DMR permission to stock the Phase II lakes.

Non-Phase I Transfers

In 2003, transfers from Fort Halifax to waters other than the Phase I lakes totaled 56,761 alewives loaded, with ten trucking mortalities, for a total of 56,751 alewives stocked. **See Table 7.** The stocking of non-Phase I habitat with Fort Halifax alewives was substantially less from previous years due to supplemental stocking from alewives trapped at the Brunswick Hydroelectric Project on the Androscoggin River.

The non-Phase I transfers included rivers and ponds within the Kennebec drainage (13), including the Sebasticook system, as well as 24 ponds in 11 other drainages. Non-Phase I transfers began on May 11 to Lower Range Pond in the Androscoggin River watershed and continued until May 24. Alewives transferred to waters other than the Phase I lakes represented 46.1% of the total number trapped at Winslow.

Table 6. Alewife Distribution by Trip, Kennebec River Watershed Phase I Lakes, 2003

Date	Location	No Loaded	No. Mortalities	No. Released
5/16	Unity Pond	807	0	807
5/17	Sebasticook Lake	2,276	1	2,275
5/17	Unity Pond	1,511	0	1,511
5/17	Sebasticook Lake	2,010	3	2,007
5/18	Unity Pond	1,543	0	1,543
5/18	Unity Pond	1,351	0	1,351
5/18	Sebasticook Lake	3,001	1	3,000
5/20	Sebasticook Lake	3,291	0	3,291
5/20	Unity Pond	1,611	0	1,611
5/20	Unity Pond	1,621	0	1,621
5/20	Unity Pond	1,642	0	1,642
5/20	Sebasticook Lake	3,388	4	3,384
5/21	Douglas Pond	1,296	0	1,296
5/21	Sebasticook Lake	2,907	0	2,907
5/21	Sebasticook Lake	3,256	3	3,253
5/21	Sebasticook Lake	2,891	0	2,891
5/21	Unity Pond	1,755	0	1,755
5/21	Unity Pond	1,640	1	1,639
5/21	Unity Pond	1,602	0	1,602
5/22	Plymouth Pond	458	0	458
5/22	Plymouth Pond	1,612	3	1,609
5/22	Douglas Pond	820	0	820
5/22	Douglas Pond	1,058	0	1,058
5/22	Webber Pond - Vassalboro	1,017	0	1,017
5/22	Sebasticook Lake	1,329	2	1,327
5/22	Plymouth Pond	880	0	880
5/22	Sebasticook Lake	1,433	1	1,432
5/23	Three-mile Pond	1,017	0	1,017
5/23	Three-mile Pond	1,003	0	1,003
5/23	Three-mile Pond	986	0	986
5/23	Wesserunsett Lake	3,025	0	3,025
5/23	Three-mile Pond	1,700	0	1,700
5/23	Wesserunsett Lake	1,607	0	
5/27	Webber Pond - Vassalboro	1,170	1	1,169
5/27	Three-mile Pond	1,781	0	1,781
5/27	Lovejoy Pond	1,001	0	1,001
5/27	Lovejoy Pond	1,111	0	1,111
5/27	Wesserunsett Lake	1,367	0	1,367
5/27	Wesserunsett Lake	1,310	0	1,310
5/27	Webber Pond - Vassalboro	1,616	1	1,615
5/27	Wesserunsett Lake	1,362	0	1,362
5/28	Stetson Pond	1,658	0	1,658
5/28	Stetson Pond	1,500	0	1,500
5/28	Stetson Pond	1,589	0	1,589
6/12	Webber Pond - Vassalboro	1,542	0	1,542
6/17	Pattee Pond (outlet stream)	862	2	860
Total Fish:		**75,213**	**23**	**75,190**
Total Days:	**10**			
Total Trips:	**45**			

Table 7. Disposition of Kennebec River Alewives Distributed in Locations Other Than Phase I Lakes, 2003

Drainage	Date	Location		Number Loaded	Number Mortalities	Number Released
Bagaduce	6/2	Pierce Pond		762	0	762
			Total:	**762**	**0**	**762**
Kennebec	5/27	Pleasant Pond (Cobbossee Stream)		1,607	0	1,607
	5/28	Pleasant Pond (Cobbossee Stream)		1,577	1	1,576
	5/28	Pleasant Pond (Cobbossee Stream)		1,391	1	1,390
	5/29	Nehumkeag Pond		666	0	666
	5/29	Nehumkeag Pond		535	1	534
			Total:	**5,776**	**3**	**5,774**
Mill Brook (Taunton Bay)	6/2	Great Pond		1,358	0	1,358
			Total:	**1,358**	**0**	**1,358**
Pemaquid	5/29	Pemaquid Pond		1,503	0	1,503
	5/30	Pemaquid River		2,101	0	2,101
	6/2	Duckpuddle Pond		1,008	0	1,008
			Total:	**4,612**	**0**	**4,612**
Presumpscot	5/29	Highland Lake		3,030	0	3,030
			Total:	**3,030**	**0**	**3,030**
Royal	5/29	Royal-Elm St. HDP		3,009	0	3,009
			Total:	**3,009**	**0**	**3,009**
St. George	5/31	South Pond		1,098	0	1,098
			Total:	**1,098**	**0**	**1,098**
Seal Cove, MDI	5/29	Seal Cove Pond		1,700	0	1,700
Sebasticook	5/29	White's Pond		995	0	995
	5/30	Corundel Lake		1,013	0	1,013
	5/30	Corundel Lake		1,060	0	1,060
	6/3	Martin Stream		679	0	679
	6/4	Burnham Project Headpond		1,627	0	1,627
	6/4	Burnham Project Headpond		1,691	0	1,691
	6/4	Burnham Project Headpond		1,675	0	1,675
	6/5	Burnham Project Headpond		1,470	0	1,470
	6/5	Burnham Project Headpond		1,685	1	1,684
	6/5	Burnham Project Headpond		1,650	0	1,650
	6/9	Burnham Project Headpond		1,326	0	1,326
	6/9	Burnham Project Headpond		1,206	0	1,206
	6/12	Burnham Project Headpond		1,660	0	1,660
	6/12	Burnham Project Headpond		1,465	2	1,463
	6/13	Sebasticook River, Newport		621	0	621
			Total:	**14,449**	**3**	**14,446**

Table 7 (cont.)

Drainage	Date	Location		Number Loaded	Number Mortalities	Number Released
Sheepscot	5/31	Savade Pond		308	0	308
	5/30	Branch Pond		1,007	0	1,007
	5/30	Branch Pond		1,057	0	1,057
	5/31	Travel Pond		636	0	636
	5/29	Sherman Lake		1,030	0	1,030
			Total:	**4,038**	**0**	**4,038**
Union						
	5/30	Lower Patten Pond		3,346	0	3,346
	5/31	Lower Patten Pond		3,329	0	3,329
	6/3	Clary Lake		2,915	0	2,915
			Total:	**9,590**	**9,590**	**9,590**
Webber Pond	6/3	Webber Pond – Bremen		1,657	4	1,653
			Total:	**1,657**	**4**	**1,653**
			Total Fish:	**56,761**	**10**	**56,751**

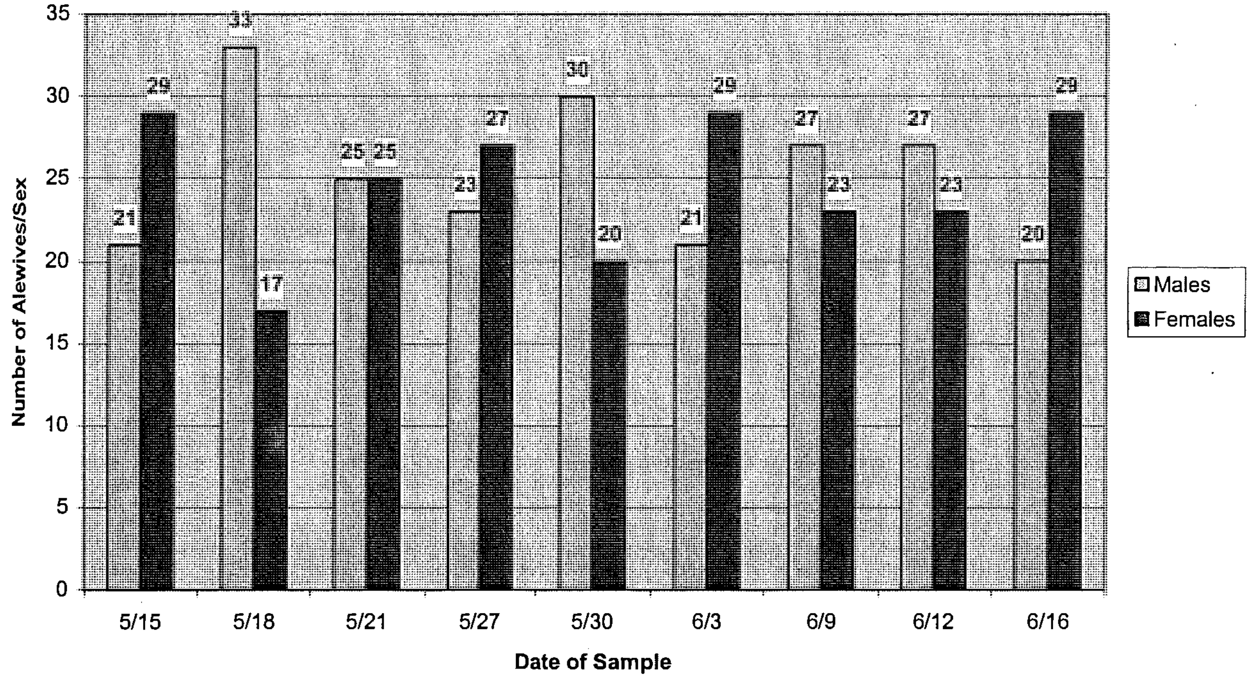
1.3 Adult Alewife Biosamples

On nine different days between May 15 and June 16, DMR personnel sampled approximately 50 adult river herring collected at Fort Halifax. All samples were collected using the fish pump by dipping them out of the pump-receiving tank. Due to the presence of blueback herring in the Kennebec River, all samples were identified using the guidelines of Liem[1], which basically relate to body shape, size and position of the eye, and color of the peritoneum (i.e., lining of the gut cavity: alewives are white/silvery and bluebacks are charcoal). Once the fish were identified, they were measured to the nearest millimeter, weighed to the nearest 0.01 grams, sexed, and scale sampled for later age analysis. Water temperature was measured to the nearest degree Celsius at the time the sample was collected.

Of the 450 fish collected, identified, and measured, only one (0.2%) fish was identified as blueback herring, thereby reducing the number of alewives sampled to 449. Of those 449 alewives, 49% were females and 51% were males. With the exception of one sample on May 11, males were in greater abundance than females. **See Figure 2.**

[1] Liem, A.H. 1924. The life history of the shad [Alosa sapidissima (Wilson)] with special reference to the factors limiting its abundance. Contrib. Can. Biol. 2:161-284.

Figure 2. Adult Alewife Biosamples, Comparison of Male vs. Female Captured at Fort Halifax, 2003



On average, adult female alewives collected in 2003 were shorter and lighter than those collected in 2002. Adult females collected in 2003 (mean = 280mm) were 2mm longer than in 2002 (mean = 282mm). Additionally, those collected in 2003 (mean = 181.5g) were 3.5g lighter than in 2002 (mean = 185.0g). Adult males collected in 2003 (mean = 270mm) were 2mm shorter in length than the 2002 samples (mean = 272mm), and they averaged 2.4g lighter (mean = 162.0g in 2003, 164.4g in 2002).

In 2003, there were significant differences in length and weight, both between sexes and over time. On average, females (280mm) were longer than males (270mm). In addition, females (181.5g) were heavier than males (162.0g). There was a decrease in both length (**Figure 3**) and weight (**Figure 4**) of adult alewife returns to the Sebasticook River over time. Fish collected during the first sample on May 8 (283.02mm and 193.94g) were longer and heavier than fish collected during the last sample on June 13 (263.66mm and 146.5g).

Of the 449 alewives sampled, scales were collected from 144 fish. Most of those sampled were Age III males (29.2%) and Age III females (23.6%). Age IV females (18.1%) and Age IV males (13.9%) were the next most abundant age classes. Within each sex, Age III fish dominated the

Figure 3. Average Lengths of Adult Alewife Biosamples, 2003

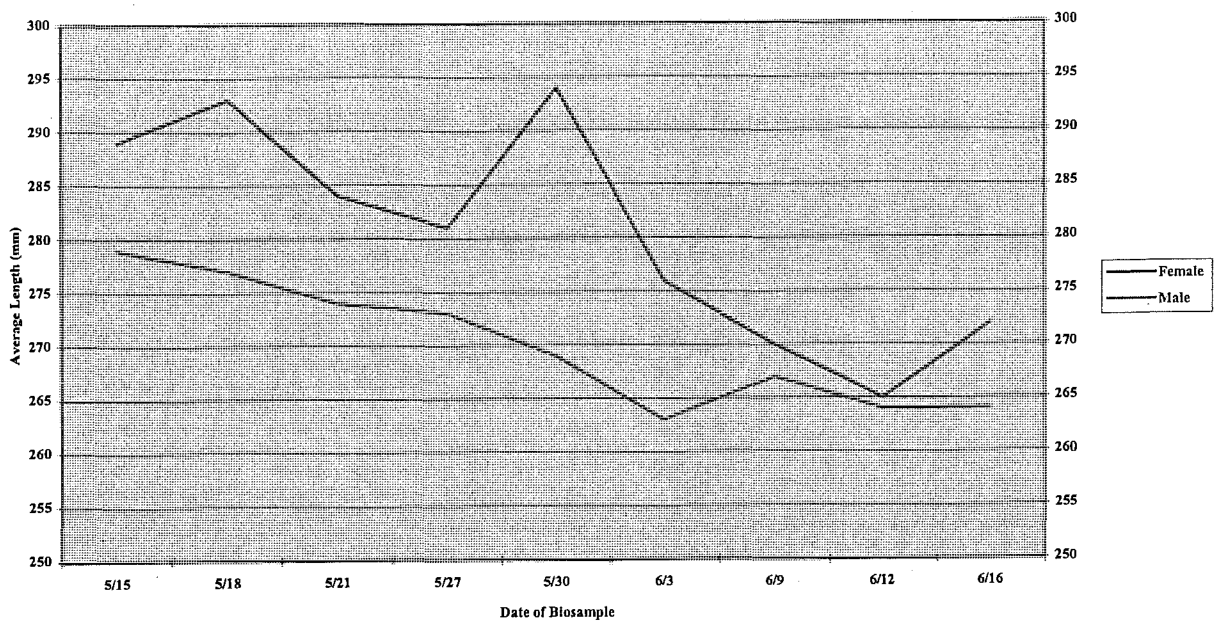
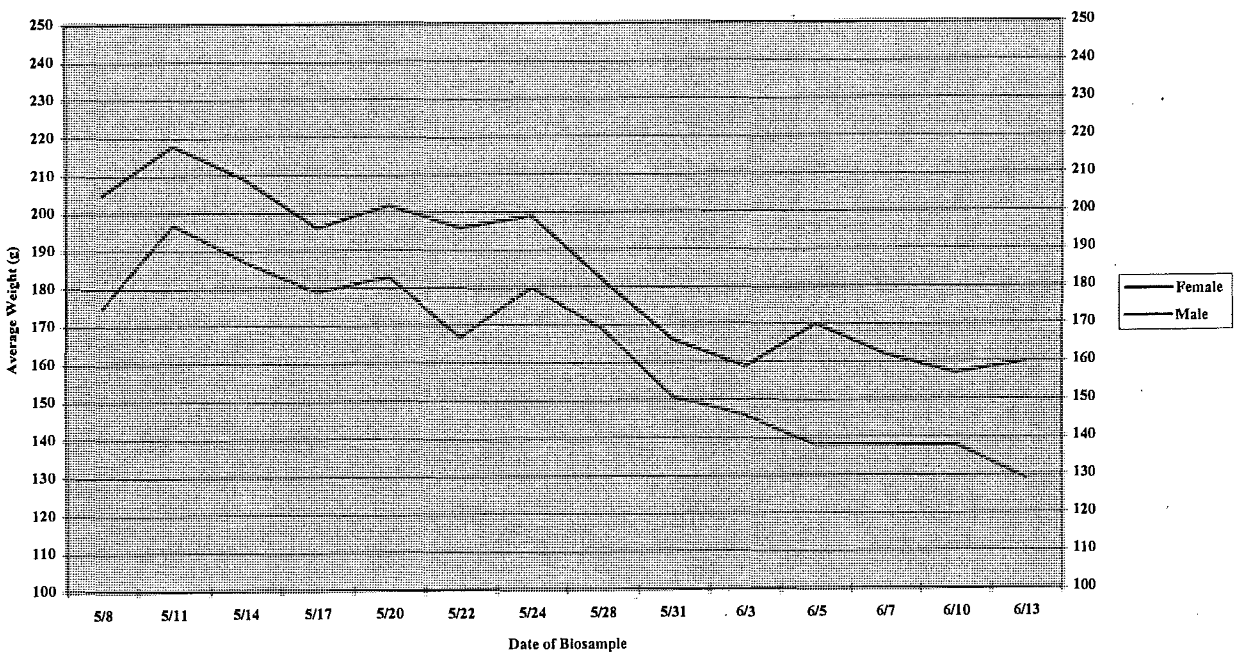


Figure 4. Average Weights of Adult Alewife Biosamples, 2003



samples; 57.5% of males sampled and 47.9% of females sampled were four-year-olds. **See Table 8.**

Table 8. Age Distribution of Adult Alewives Collected at Fort Halifax, 2003

Sample Date	Age II		Age III		Age IV		Age V		Mean Age	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
May 15	0	0	7	4	0	4	0	1	3.0	3.6
May 18	0	0	8	3	2	3	0	0	3.2	3.5
May 21	0	0	6	5	2	1	0	2	3.3	3.6
May 27	1	0	7	2	2	4	0	0	3.1	3.7
May 30	1	0	4	7	3	1	0	0	3.3	3.1
June 3	0	0	3	3	2	4	2	2	3.9	3.9
June 9	0	0	1	6	2	3	2	1	4.2	3.5
June 12	0	0	2	2	6	2	3	1	4.1	3.8
June 16	0	0	4	2	1	4	1	4	3.5	4.2
Σ=	**2**	**0**	**42**	**34**	**20**	**26**	**8**	**11**	**3.5**	**3.7**
% By Sex	**2.7**	**0.0**	**58.3**	**47.9**	**27.8**	**36.6**	**11.1**	**15.5**		
% of Total	**1.4**	**0.0**	**29.4**	**23.8**	**14.0**	**18.2**	**5.6**	**7.7**		

1.4 Commercial Alewife Harvest

In 2003, the Maine Department of Inland Fisheries and Wildlife issued 30 permits to commercial fishermen for the harvest of alewives below Fort Halifax Dam in Winslow. However, unlike previous years, there was no closure period for the commercial harvest in Winslow. It was still unlawful to fish within 150 feet of the fish pump, similar to 2002. The latter condition was added to provide DMR/FPLE personnel space to work in the river below the dam if needed. As of February 13, 2003, only 13 permit holders had reported their landings for a total of 128,880 alewives (compared to a reported 467,640 alewives at the same time last year).

During the week of May 12, Bob Richter (FPLE) informed John Perry of DMR that FPLE would be installing flashboards the following week. However, he was concerned that once the flashboards were installed, flow over the ledges would disappear, stranding an estimated 100,000 - 200, 000 alewives. In order to address the issue, FPLE proposed to slowly draw the headpond down and to rent a boom crane for the day, having commercial harvesters (as well as FPLE staff) dip the alewives from the pools in the ledges into the boom bucket and load their pickup trucks, with the intent being that instead of stranding alewives, many could be harvested and, therefore, not wasted. The slow drawdown would also ensure that no endangered species such as Atlantic salmon or shortnose sturgeon would be stranded.

After inspecting the situation on the ledges, DMR agreed that 100,000 - 200,000 was a reasonable estimate of alewives working their way up the ledges. FPLE also contacted John Boland (MDIFW, the permitting agency for non-tidal waterbodies) and explained the situation; he also agreed that this was a reasonable idea and stated that since the fishermen would still be hand-dipping the alewives, they would be in compliance with their permits.

On May 22, FPLE's contractor set the boom crane up above the ledges, with the bucket in the vicinity of the ledge pools. **See Figure 5**. FPL began to lower the headpond levels at a slow rate. During this time, both fishermen and FPL staff dipped alewives into the bucket. **See Figure 6**. As the spill over the dam subsided, FPL staff was continually building small rock dams to prevent the fish from migrating further up the ledges. The entire operation was completed by late afternoon, when the headpond was completely drawn below the spillway and the vast majority of fish were harvested, returned to the river, or blocked from ascending. The total harvest was estimated to be between 65,000 - 70,000 alewives (120 fish = 1 bushel; ten pick-up loads @ 50 bushels/truck bed = 60,000 fish, plus an additional 20 totes of fish (between 4,800 - 9,600 fish), for a grand total of 65,000 - 70,000 alewives). DMR was on site periodically throughout the day and estimated that the vast majority of alewives were *not* harvested, but remained in the river.

Figure 5. May 22, 2003 Commercial Harvest with Crane Location

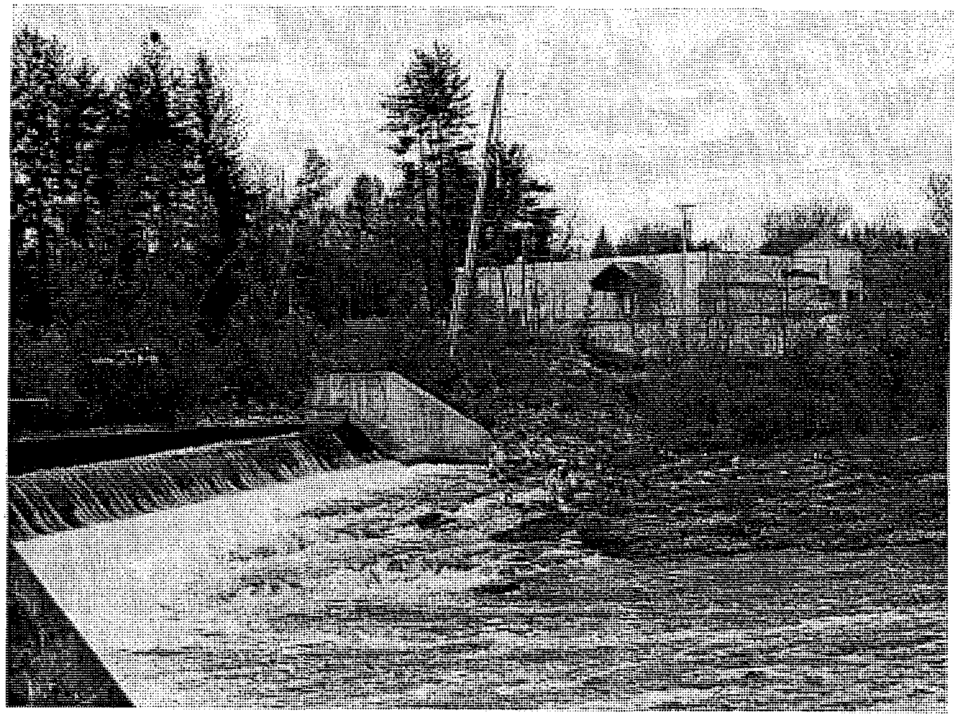


Figure 6. May 22, 2003 Commercial Harvest with Boom Crane

2.0 AMERICAN SHAD RESTORATION METHODS

2.1 Adult Capture and Transport

In 2003, the Merrimack River Technical Advisory Committee granted approval for DMR to transport up to 1,660 adult shad (60 for required fish health workup[2] and the remainder for the hatchery and Androscoggin River) from the Lawrence Hydroelectric Project fish lift operated by CHI Energy, Inc. on the Merrimack River to the Waldoboro Hatchery.

Due to high spring flows and cooler than average water temperatures, the Merrimack River shad run was late in 2003, and as a result, only three trips (May 22, June 4 and 5) were made to obtain broodstock for the hatchery. **See Table 9.** Of the 495 shad loaded at the Essex lift, 468 were released alive into the adult spawning tank, resulting in a hauling mortality of 5.5%.

Table 9. Transfers of American Shad Broodstock to Waldoboro Hatchery, 2003

Source	Trapping Site	Date	Number Loaded	Number Mortalities	Number In
Merrimack River	Essex Lift	5/22/03	161	2	159
		6/4/03	162	2	160
		6/5/03	172	23	149
	Total				**468**

[1] Represents a 5.5% trucking mortality

No American shad were captured with the fish pump in 2003, and no attempt was made by either DMR staff or FPLE to capture broodstock shad from the Kennebec and Sebasticook Rivers.

2.2 Larval Culture and Transport

The shad culture program initiated in 1991 was continued in 2003. The Kennebec River Shad Restoration Program began as a cooperative effort between the DMR, the KHDG, the Town of Waldoboro, and the Time & Tide Mid-Coast Fisheries Development Project, the latter of which was created and administered by the local Time & Tide Resource Conservation and Development Organization. The hatchery is now privately owned and operated by Sam Chapman. It is located in the Town of Waldoboro and consists mainly of two 15-foot diameter

[2] A 60-fish sample of adult American shad was collected at the Essex fish lift in Lawrence, MA. They were packed in ice and transported to the Inland Fisheries & Wildlife Governor Hill Hatchery facility in Augusta, ME. Kidney, spleen, and gill samples were taken in accordance with the AFS Fish Health Blue Book Procedures. Samples were processed for the detection of bacterial and viral fish pathogens, but found to be free of any pathogens of concern to the State of Maine. These procedures are necessary to comply with state law concerning importation of live fish and eggs into Maine waters.

adult spawning tanks, one 12-foot diameter adult spawning tank, and seven six-foot diameter larval rearing tanks. There are also three outdoor settling ponds formerly used for the production of shad fingerlings.

All adult shad transported to the hatchery were placed immediately into either one of two 15-foot diameter spawning tanks. Shad were allowed to spawn "naturally," the eggs collected daily and placed into upwelling incubator jars, and reared to approximately 14-21 days old before being released. While in the hatchery, all larvae are marked with oxytetracycline ("OTC"), an antibiotic that leaves a mark on the otolith, or inner ear bone, when viewed under a microscope equipped with fluorescent light so that DMR can later distinguish adult returns as either hatchery or wild in origin. Prior to releasing larval shad from the hatchery, otoliths from a 20-fish sample from each batch of fish were examined for OTC mark retention. For complete details regarding hatchery operations, please refer to Appendix B, the *Waldoboro Shad Hatchery 2003 Annual Report.*

After OTC mark retention is verified, larval shad are loaded into a stocking tank and released directly into the target river. At the hatchery, larval shad are drained from their rearing tank directly into a four-foot diameter hauling tank that is affixed to the bed of a ¾-ton pickup truck. Approximately 12 liters/minute of oxygen is released into the approximately 150 gallons of hauling water via an air stone. Upon arrival at the stocking site, temperatures of the hauling water and river are assessed. If needed, river water is bucketed into the hauling water to gradually equilibrate the temperatures. Larval shad are then released into the river by draining the hauling tank through a hose attached to the bottom drain of the tank. Several five-gallon buckets of river water are poured through the tank to rinse any remaining larvae into the river. In 2003, no larval shad were intentionally released into the outdoor hatchery ponds for the production of fingerlings.

Between May 22 and July 5, DMR successfully transferred 468 adult American shad broodstock from the Kennebec/Sebasticook and Merrimack Rivers to the Waldoboro Hatchery for tank spawning. **Refer to Table 9 above.** In order to improve egg production at the hatchery, Andy Chapman accompanied DMR staff and hand-selected large healthy females as broodstock, as well as healthy males. All shad were placed in a spawning tank and allowed to spawn over the next several weeks. The fertilized eggs were collected, disinfected, and placed in upwelling incubators. After hatching, the larvae were raised in 575-gallon circular fiberglass tanks and fed brine shrimp. For a complete description of 2003 shad hatchery operations, refer to Appendix B, *Waldoboro Shad Hatchery 2003 Annual Report.*

Between June 18 and July 15, an estimated 7,536,118 shad larvae ranging from 14-23 days old were released at three sites in the Kennebec and Sebasticook Rivers. **See Table 10.** An estimated 2,421,121 shad fry were released just below the Shawmut Project on the Kennebec

Table 10. Larval American Shad Releases, 2003

Receiving Location	No. Stocked
Androscoggin River, Pejepscot Headpond	1,269,842
Kennebec River, Fort Halifax Park	3,257,813
Kennebec River, downstream of Shawmut Project	2,731,545
Sebasticook River, downstream of Burnham Project	1,857,184
TOTAL:	**9,116,384**

River, and 3,257,813 larval shad were released at the Fort Halifax Park in Winslow. An additional 1,857,184 larval shad were released into the Sebasticook River in the tailrace of the Burnham Project. Finally, 1,269,842 larval shad were released into the Androscoggin River, for a total larval shad stocking of 9,116,384. The 2003 total of 7,536,118 larvae released into the Kennebec drainage is by far the largest amount released to date. **See Figure 7**. The record number of larval shad released in 2003 was attributed to hand-selection of quality broodstock from the Essex fish lift (See *Waldoboro Shad Hatchery 2003 Annual Report,* Appendix B).

No shad larvae were intentionally stocked into the three culture ponds at the hatchery in 2003. However, the runoff from the upwelling incubators drains into these ponds and typically some eggs/larvae are drawn out by the action of the incubators. Since the number of larvae escaping to the ponds is unknown, the ponds are monitored and the larvae/juveniles fed accordingly. On September 26, the first two ponds were beach seined and approximately 20,600 fall fingerlings were loaded into the stocking truck and subsequently released into the Medomak River. The number of fingerlings released in 2003 was slightly higher than average. **See Figure 8.**

Figure 7. American Shad Larvae Released in the Kennebec Drainage, 1992-2003

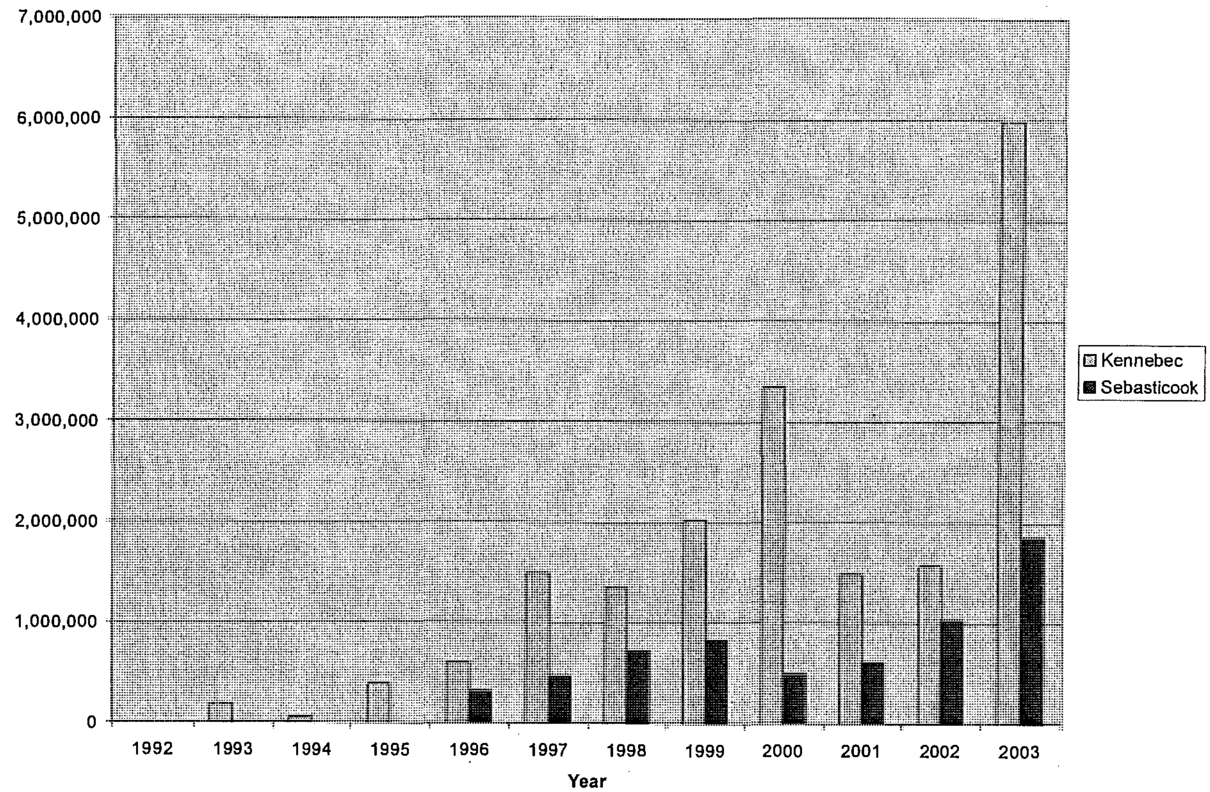
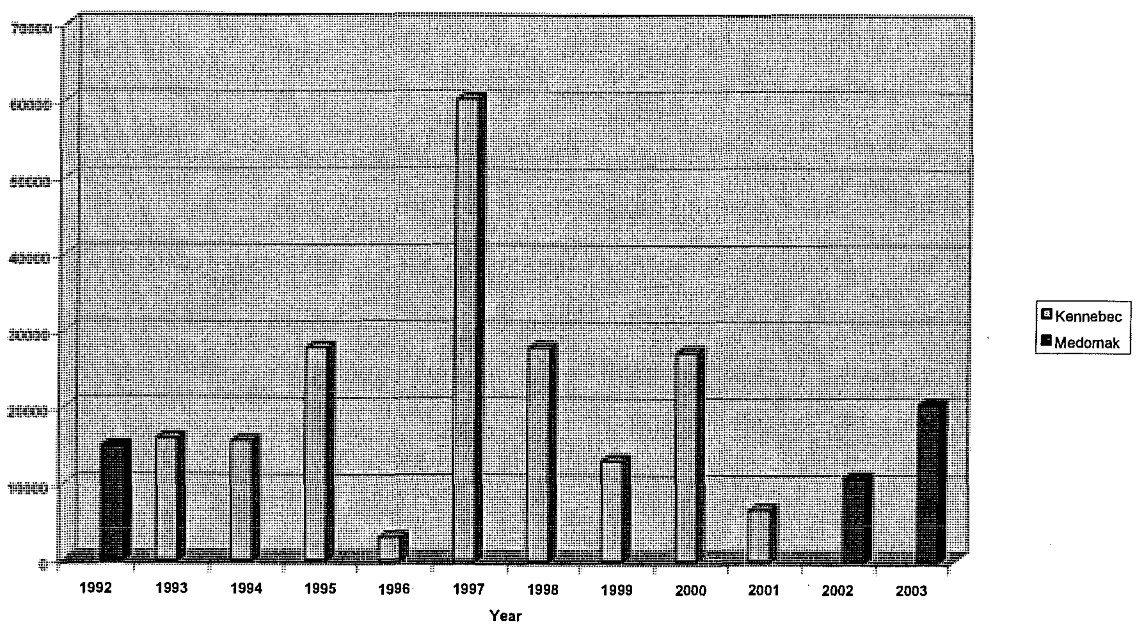


Figure 8. Number of American Shad Fingerlings Released into the Kennebec and/or Medomak Rivers



Based on the results of over a decade of research in the successful American shad restoration of the Connecticut River, DMR biologists have estimated the production potential of shad in the Kennebec watershed. **Table 11** shows the yearly, natural production potential by river segment, adjusted for 10% mortality resulting from passage through each hydroelectric facility in the river reach, within the historical range of American shad. **Table 12** shows the number of adult shad that are estimated to return annually to the Kennebec and Sebasticook Rivers based on previous stocking numbers. These estimates are based on the Susquehanna River adult shad returns of one adult shad returning for every 318 fry stocked.

Table 11. Annual Production Numbers for American Shad for the Kennebec River Watershed above Augusta[1]

River Segment	Habitat Units (100 sq. yd.)	Potential Shad Production[2]	Potential Shad Production With 10% Downstream Mortality[3, 4]
Sandy River above Madison Electric Dam, Madison	36,370	83,650	44,455 (5)
Kennebec River above Weston Dam, Skowhegan	55,869	128,498	75,877 (4)
Kennebec River from Shawmut Dam, Fairfield to Weston Dam	61,252	140,879	92,431 (3)
Kennebec River from Hydro Kennebec Dam, Waterville to Shawmut Dam	25,314	58,221	42,443 (2)
Kennebec River from Augusta to Lockwood Dam, Waterville	63,066	145,053	130,547 (1)
Sebasticook River above Burnham	22,986	52,867	34,686 (3)
Sebasticook River from Benton Falls to Burnham Dam, Burnham	20,847	47,948	34,954 (2)
Sebasticook River from Fort Halifax Dam, Winslow to Benton Falls, Benton	14,199	32,658	26,453 (1)
Total Kennebec	**205,501**	**472,651**	**341,298**
Total Sebasticook	**58,032**	**133,473**	**96,093**
Total, Kennebec watershed above Augusta	**263,533**	**689,774**	**481,846**

[1] Based on 10% downstream mortality at each hydroelectric dam
[2] Based on estimates derived from Susquehanna shad restoration efforts of 2.3 adult shad per Habitat Unit
[3] 10% mortality estimates based on downstream passage efficiencies at hydroelectric facilities along the Susquehanna River
[4] Number in parentheses represents the total dams from that area downstream

Table 12. Projected Shad Returns to the Kennebec & Sebasticook Rivers Based on One Adult Return for 318 Fry Stocked[1, 2]

	Kennebec		Sebasticook	
Stocking Year	Number Fry Stocked[3]	Adult Return From 5-year Stock Date	Number Fry Stocked[3]	Adult Return From 5-year Stock Date
1993	186,000			
1994	56,000			
1995	388,000			
1996	599,990		320,000	0
1997	1,484,908		456,800	0
1998	1,348,937	292	725,000	0
1999	2,020,838	381	839,068	0
2000	3,346,727	698	500,004	0
2001	1,489,913	1,553	618,879	503
2002	1,571,856	3,278	505,902	1,221
2003	5,989,358	5,805	1,857,184	2,038
2004	500,000	8,056	500,000	1,927
2005	500,000	6,599	500,000	2,292
2006	500,000	7,605	500,000	1,759
2007	500,000	4,814	500,000	1,769
2008	500,000	12,181	500,000	3,716
2009	500,000	24,064	500,000	7,671
2010	500,000	16,227	500,000	5,791
2011	500,000	15,776	500,000	5,624
2012	500,000	13,991	500,000	5,100
2013		18,568		7,056
2014		37,818		12,958
2015		41,863		15,034
2016		33,575		12,988
2017		31,339		12,296
2018		33,345		12,943
2019		56,385		20,015
2020		79,681		27,993
2021		75,439		28,022
2022		64,914		25,284
2023		64,684		25,239
2024		89,730		32,957

[1] Based on research from American shad restoration in Susquehanna and Connecticut Rivers of one adult return for every 318 fry stocked

[2] Does not include returns from natural reproduction

[3] Numbers from 2004 and beyond based on a minimum stocking rate of 500,000 fry

In 2003, DMR personnel made frequent observations at the Fort Halifax tailrace for the presence of shad. Due to the shallow depth (approximately two to four feet) of a portion of the tailrace, under appropriate conditions (low water flow and bright sunlight), shad were observed as they darted about in the river. On June 25, a single DMR employee observed 74 shad in a four-hour period, with at least one school of ten documented. However, it should be noted that this is not an accurate means to determine the number of shad in the vicinity as several sightings were most likely repeats; also, the viewing methods were subjective as some observers noticed shad at times when others did not.

Other visual observations, as well as underwater video monitoring and spawning surveys by DMR biologists, indicate that most adult shad near the confluence of the two rivers appear to be utilizing the deeper waters of Ticonic Bay, immediately downstream of the Lockwood Project on the Kennebec. DMR biologists theorize that many shad that are homing to the Sebasticook do not find suitable holding habitat in the river segment below the Fort Halifax dam. As a result, more shad activity is noted in the Kennebec.

In addition to the observations, DMR staff conducted informal angler surveys at Fort Halifax Park in Winslow. During the early evening of July 1, DMR staff interviewed eight anglers at the park. All fishermen stated that they were targeting shad, which were noted by DMR staff to be spawning in the vicinity. While no estimate of success was determined, anglers indicated that they had been successful in their attempts to catch shad in that location. More formal angler surveys will be conducted in 2004.

2.3 Hatchery Evaluation

Since all young-of-year shad released from the hatchery are marked with OTC, DMR is able to assess the relative contribution of hatchery-reared shad to the Kennebec River shad population. Starting in 2000, adult and young-of-year shad collected in the Kennebec were kept for OTC mark analysis. No adult shad were intentionally killed for this study; rather, mortalities from the hatchery were kept and analyzed. Young-of-year shad were collected during biweekly beach seine surveys (see *Community Assessment Methods* in this report for complete details on capture sites and techniques). Otoliths were removed, cleaned in distilled water, and mounted in a thermoplastic resin. Lapping film (9, 3, and 1 micron grit) was used to grind each otolith to mid-saggital plane on one side; otoliths were then flipped over and ground to mid-saggital plane on the opposite side. A drop of Type FF, low fluorescing, immersion oil was placed on each ground otolith and then covered with a glass cover slip. Otoliths were then viewed under a compound microscope equipped with fluorescent light and a FITC filter set. With this microscope configuration, any fish marked with OTC would exhibit a glowing ring for the day that fish was marked.

In 2000, DMR began conducting similar beach seine surveys in the Kennebec River north of Augusta, upstream to Waterville/Winslow. Based on the information gathered during these surveys, DMR has begun to calculate a second JAI for young-of-year shad for this newly reopened stretch of river.

During the 2003 beach seine effort, 702 juvenile shad were captured at four different sites, with the highest number captured at Site 8C. This site, located approximately 500 yards downstream of Site 8A, was added on August 28, 2002, after 8A was compromised due to bridge construction. Of the examined samples of field caught larval shad (about 70% have been evaluated), less than 6% are of hatchery origin.

A Juvenile Abundance Index was calculated for juvenile shad captured in 2003. **See Table 13.** The index for all sites was 17.5 shad/seine haul. Of all the sites sampled in 2003, Site 8C had the highest comparative JAI of 73.8 shad/seine haul, which is the second highest JAI for an individual site in the four years of sampling. Depending on river flows, there is slack water or an eddy at Site 8C. Habitat suitability models indicate that larval shad prefer large eddies[3], which may explain why younger shad are found there.

Table 13. Juvenile Abundance Index (JAI) for American Shad in the Kennebec River above Augusta[1]

Site[2]	2000	2001	2002	2003
1	0.12	0.00	0.88	0.00
2	0.00	0.00	0.63	14.2
3	0.67	0.30	0.50	0.00
4	0.00	0.00	0.00	0.00
5	2.00	56.20	0.25	0.60
7	29.43	87.75	0.13	0.00
8A	0.11	18.67	0.00[3]	---
8B	0.13	0	0.13	51.8
8C	---	---	318.83	73.8
Total	4.06	19.15	0.32/40.17[5]	17.55

[1] Except where noted, JAI was calculated on eight trips, with one haul/trip
[2] Due to bridge construction, Site 8A was abandoned in August 2002. JAI based on three trips.
[3] Site 8C was created as a result of Site 8A being abandoned. JAI based on six trips.
[4] For comparative purposes, the first JAI includes Site 8A; the second JAI includes Site 8C.

[3] Ross, R. M., T. W. H. Backman, and R. M. Bennett. 1993. Evaluation of habitat suitability index models for riverine life stages of American shad, with proposed models for premigratory juveniles. U.S Fish and Wildlife Service Biological Report 14. 26pp.

DMR also sampled the various locations in the Sebasticook and Kennebec Rivers with D-nets to assess the presence of juvenile shad and eggs. While no young-of-year shad were captured in the nets, a total of 290 shad eggs were collected between June 12 and July 2, the majority of which were collected from the Sebasticook River (**see Section 5.0**).

3.0 FISH PASSAGE METHODS

As part of the KHDG Agreement, the State agreed to take the lead in seeking fish passage at four non-hydro dams on the Sebasticook River, which included the outlet dams on Pleasant Lake in Stetson, Plymouth Pond in Plymouth, Sebasticook Lake in Newport, and the Guilford of Maine Dam, also in Newport. In its 1999 annual report, DMR proposed that passage be provided at these dams in 2001. The United States Fish and Wildlife Service (USFWS) prepared conceptual designs and cost estimates for these sites; total estimated cost for passage at all four dams was $510,000 (1997 dollars).

3.1 Fish Passage at Lake Outlets in the Phase I Study Area

Several lake outlet streams were surveyed during the 2003 field season. Due to constraints, only those streams known to be problems in the past were surveyed after the alewife and shad stocking seasons ended. Generally, lake outlets were checked on the same schedule as hydropower facilities. Whenever possible, areas known to be past problems for out-migrant alosids were inspected and debris/blockages removed. While drought conditions were not as severe as the previous year, the lack of water was again the most notable hindrance to downstream passage in 2003. Starting in July, DMR personnel surveyed eight lake outlets regularly through the first of November: Sebasticook Lake in Newport, Pleasant Pond in Stetson, Plymouth Pond in Plymouth, Wesserunsett Lake in Skowhegan, Unity Pond in Unity, Webber Pond in Vassalboro, Pattee Pond in Winslow, and Threemile Pond in China. The results are summarized in **Table 14** and are briefly described below.

While Table 12 states that the **Sebasticook Lake** outlet was checked on ten days to ensure minimum flow requirements were being met, in actuality it was checked almost on a daily basis from July through October while the construction of the fishway was underway. Aside from August 19, when juvenile alewives were observed above the outlet, downstream passage was not available until the lake was drawn down after Labor Day because of construction activities.

Table 14. Downstream Passage Observations at Lake Outlets in Sebasticook and Upper Kennebec Watersheds, 2003

Date	Sebasticook Lake	Plymouth[1] Pond	Unity Pond	Pleasant Pond	Pattee Pond	Webber Pond	Threemile Pond	Wesserunsett Lake
7/8/02					X	O^{B}		
7/10/02	X	O	O	O		O		
7/22/02	X			O^{AB}				O
7/23/02						X		
7/24/02		O^{A}						
7/25/02					X		X	
7/26/02	X					O^{B}		
8/5/02			O		X	O	X	
8/6/02	X	O^{A}		O				O^{B}
8/19/02	O^{A}	X	O	X				X^{B}
8/20/02						O	X	
8/21/02					O^{B}			
9/3/02	X	X^{A}	O	X				X
9/5/02						O	X	
9/16/02						O	X	
9/17/02	O	X^{A}		X^{B}				X
9/19/02		X^{A}			X[2]			
9/30/02	O	X^{A}		O^{A}				X^{A}
10/1/02			O			X	X	
10/15/02	O							X
10/17/02		X^{A}	O	O			X	
10/18/02					O	O		
10/28/02						O		
10/29/02			O				O	
11/1/02	O	O		O			O	O
Total Visits	10	10	7	9	6	11	9	8

[1] The installation of fishways at the Plymouth Pond Dam delayed out-migration in 2002

[2] Beaver dam partially breached to allow alewife passage

O = Downstream passage available at time of survey
X = Downstream passage not available at time of survey
= Not surveyed on this day
^{U} = Juvenile alosids using downstream passage facilities
^{A} = Juvenile alosids above outlet
^{B} = Live alosids present below outlet
^{D} = Dead alosids present below outlet

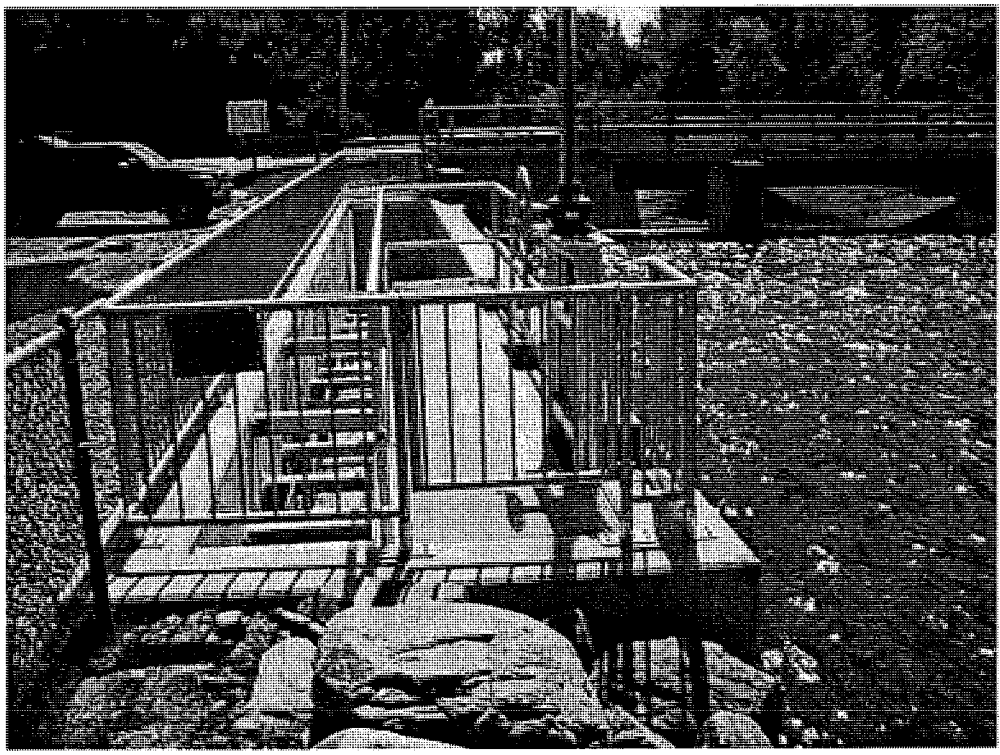
The Sebasticook Lake Outlet Dam, which is owned by the Town of Newport, was constructed in the mid-1980s to maintain lake levels and allow a fall drawdown to flush nutrients from the lake. Upstream passage at this site, which was completed on June 13, 2003, consists of a pool and chute fishway on the eastern side. **See Figure 9**. The fishway was designed to provide accessibility for public viewing, as well as to minimize the amount of water needed for effective upstream and downstream passage. The fishway passed adult alewives, which migrated into the lake to spawn, as well as juvenile alewives in the fall as they migrated to the ocean to mature.

Fishway construction was sponsored by the Town of Newport; the Maine Department of Marine Resources; the Natural Resources Conservation Service (NRCS), a division of the US Department of Agriculture (NRCS also provided daily construction monitoring through completion of the project); the National Fish & Wildlife Foundation's Maine Habitat Restoration Partnership; the US Fish & Wildlife Gulf of Maine Office; the Maine Corporate Wetlands Restoration Partnership; the Conservation Law Foundation/National Oceanic and Atmospheric Administration; and the Environmental Protection Agency's Five Star Challenge Grant. The fishway was designed by URS and constructed by Construction Divers, Inc.; total cost was $392,000.

Pleasant Pond in Stetson was visited nine times from July 10 through November 1. Of those nine visits, downstream passage was available six times. DMR personnel observed juvenile alewives either above or below the dam on July 22, September 17, and September 30.

Plymouth Pond was checked on nine days from July 10 through November 1. As with the Sebasticook Lake Outlet Dam, water was held at Plymouth Pond while the installation of the steeppass fishways was underway. As a result, downstream passage was not available for much of August through October. During this time, thousands of juvenile alewives were observed regularly as they swam along the upstream face of the spillway and gates in search of downstream passage.

Figure 9. Sebasticook Lake Outlet Fishway, August 2003



Wesserunsett Lake in Skowhegan was surveyed eight times from July 22 through November 1. Passage was available during two site visits, with juvenile alewives observed below the outlet during one visit (August 6). Juvenile alewives were also observed below the outlet on August 19 and above the outlet on September 30.

Unity Pond has no outlet dam and has excellent downstream passage into the Twentyfive Mile Stream on all but the driest of years. Unity Pond outlet was checked seven times from July 10 through November 1 and passage was available during all visits.

Webber Pond, like Sebasticook Lake, also uses a fall drawdown for water quality improvement purposes and usually has sufficient water to allow passage over the spillway throughout the season. During 11 visits to Webber Pond, passage was available nine times. Juvenile alewives were observed below the outlet during both the July 8 and July 26 visits.

Pattee Pond has no outlet dam and in the past has demonstrated fair to excellent out-migration of alewives. However, low water levels combined with a beaver dam obstruction during the summer and early fall of 2001 made passage out of Pattee Pond difficult, if not impossible. However, similar to the 2002 season, there was plentiful rainfall in the autumn of 2003 and as a result, downstream passage was readily available to emigrating alewives. As mentioned previously, however, due to muddy conditions at the release site, DMR staff had to release alewives downstream of the pond outlet. Some adult alewives were able to pass over the large beaver dam at the outlet and into Pattee Pond and successfully spawn in 2003, as juvenile alewives were observed migrating downstream on August 21.

The **Threemile Pond** outlet was visited seven times between July 25 and October 17. Similar to Pattee Pond, Threemile Pond does not have an outlet dam and the combination of low water conditions and beaver dams appeared to create a barrier to out-migrating juvenile alewives throughout August and September. However, during the fall rains in late October and November, downstream passage became readily available.

3.2 Fish Passage at KHDG Hydropower Projects

Per section III (F) of the Agreement, hydroelectric dam owners are required to conduct passage effectiveness studies. Specifically, the Agreement states:

> "KHDG dam owners will conduct effectiveness studies of all newly constructed interim and permanent upstream and downstream fish passage facilities at project sites. Study plans for these effectiveness studies will be filed with FERC and Maine DEP no later than the date on which passage at a particular project becomes operational, and will be subject to a consultation process with, and written approval from the resource agencies."

DMR has been working with the hydro project owners/operators to develop and evaluate quantitative and qualitative effectiveness studies. As new passage becomes available, DMR will continue to work with hydropower project staff to ensure passage effectiveness.

To date, downstream passage effectiveness studies have been conducted at Benton Falls (1995) and Fort Halifax (1997). In addition, qualitative assessments are being recorded at the interim downstream passage facilities at Lockwood and Shawmut. At Hydro-Kennebec, qualitative observations are being conducted by plant personnel to assess whether or not passing through the turbines has an impact on out-migrant alosid survival. If the owners of Hydro-Kennebec desire to utilize turbine passage once adult shad or salmon begin to inhabit the impoundment, they will be required to conduct site specific quantitative studies, but not before 2006. At the Burnham Project, permanent downstream passage was installed ahead of schedule. However, since CHI is choosing to pass less than the anticipated minimum bypass flow, the downstream bypass is considered an interim facility. As such, CHI is conducting qualitative studies in accordance with the Agreement.

Downstream Passage Monitoring

Downstream passage at hydropower facilities located on the Sebasticook and Kennebec Rivers was monitored through the summer and fall of 2003. Facilities were visited routinely to assess any problems that downstream migrating juveniles might encounter. The condition and operation of downstream bypass facilities, magnitude and location of spilled water, number of turbines in operation, and presence or absence of juvenile alewives were noted at each site. The dams and their locations are presented in **Table 15;** locations were illustrated earlier in **Figure 1**.

Table 15. Downstream Passage Observations at Hydroelectric Facilities, 2003

Date	Fort Halifax	Benton Falls	Burnham	Pioneer	Waverly
7/10/03	O	O	O	O	O
7/28/03				O	O
7/30/03	O	O[H]	O		
8/2/03					
8/6/03					
8/7/03					
8/12/03					
8/15/03	O	O[H]	O	O	O
8/19/03					
8/25/03				O	O
8/28/03	O[H]	O	O		
8/29/03					
8/30/03					
9/3/03					
9/5/03					
9/09/03	O	O			
9/10/03			O	O	O
9/16/03					
9/17/03					
9/24/03				O	O
9/27/03	O				
9/30/03		O[H]	O		
10/01/03					
10/06/03	O	O	O[H]	O	X
10/16/03	O	O	O		
10/17/03	O	O	O		
11/1/03-					
Totals	9	9	9	7	7

O = Downstream passage available at time of survey
X = Downstream passage not available at time of survey
= Not surveyed on this day
[H] = Juvenile alosids in headpond

The **Fort Halifax** Project in Winslow is operated by FPL Energy and is the lowermost dam on the Sebasticook River. FPL Energy installed permanent downstream bypass facilities during the summer and fall of 1993; it uses the same trash sluice opening that was used in past years for the interim facility. The old trash sluice was refitted with a weir gate to control depth of flow at the entrance of the downstream bypass. The downstream side of the opening was fitted with a metal trough with an open top to carry water and fish down close to the tailrace elevation. A 12-foot deep metal punch plate trash rack overlay was installed to aid in excluding alewives from the turbine forebays. This configuration and operational regime was approved by the FERC Order issued on September 30, 1996 and was utilized again during the 2003 season.

DMR made nine visits to the Fort Halifax Dam in 2003. All visits found the downstream bypass open and functioning. During the August 20 site visit, juvenile alewives were observed in the headpond. Observations of the downstream bypass operation were made from the south shore when access to the powerhouse was not available.

The **Benton Falls** Project is equipped with permanent downstream passage facilities that have been on line since 1988. The bypass at Benton Falls consists of two surface weirs, one located above each turbine intake, which interconnect and discharge into the tailrace through a large diameter pipe. Water flow into each weir is regulated by a gate that can be lowered to allow controlled surface spill into the weir. After passing over this gate, fish become committed to the bypass and cannot reenter the headpond. The large turbine weir intake is open throughout the migration period and the small turbine weir intake is typically closed.

DMR personnel made nine visits to make observations of downstream passage capabilities at Benton Falls in 2003. The bypass was open and operating during each of the site visits and there were no problems associated with debris from the headpond plugging the entrance. However, due to past problems of debris blocking downstream passage via the bypass, DMR personnel made a more concerted effort to observe this area in 2003. On October 6, 2003, DMR personnel noted a relatively small entrainment event where a few hundred juvenile alewives were killed by the turbines and by falling over the spillway due to high water. The second downstream bypass was opened to provide additional passage opportunity to numerous alewives still above the project, and no further entrainment was noted.

DMR personnel made nine visits to the **Burnham** Project in 2003. All inspections found the downstream bypass open and operational, and DMR personnel did not observe entrainment of juvenile alosids throughout the season. However, in late September, CHI personnel informed DMR of a small entrainment event involving 100-200 alewives, due to a change in operational activities. These activities were immediately corrected, and no further entrainment was noted in 2003.

Downstream passage through the bypass was available during each of the seven site visits to the **Pioneer Dam** in Pittsfield. No juvenile alewives were observed using the downstream passage facilities on any visit.

DMR visited the **Waverly Avenue Dam** on seven occasions during the 2003 season. Downstream passage was available at the site on all occasions except October 6. Problems encountered during the 2003 season at Waverly Avenue were similar to those of previous seasons. First, gate leakage at the stop log bays on the far side of the spillway remained a problem, causing downstream migrants to be attracted away from the bypass during low flow conditions. Second, the bypass itself frequently collected debris and lost its effectiveness with this fouling. No overlay was installed on the intake racks in 2003.

DMR personnel visited both the **Lockwood** and **Hydro-Kennebec Dams** as often as possible in 2003. Both of these projects are located on the Kennebec River and must pass all downstream migrant alewives from the Wesserunsett Lake alewife restoration effort. Additionally, most of the larval shad released into the Kennebec River are released above both Lockwood and Hydro-Kennebec. During the 2003 season, interim downstream passage at Lockwood was made available through the power canal trash sluice, which is located near the turbine trash racks. Interim downstream passage at Hydro-Kennebec is achieved by passing out-migrants through the project turbines. FPLE consultants observed juvenile alosids in both the Hydro-Kennebec and Lockwood Project forebays on several occasions (personal communication with Jason Seiders, Normandeau Consultants, 2003) and submitted several samples of both juvenile shad and alewives for DMR analysis.

Upstream Passage Monitoring

Per the KHDG Agreement and the project license, FPLE was required to install a permanent upstream fish lift at the **Fort Halifax** Project by May 1, 2003, or breach the dam in 2003. In 2002, FPLE proposed to decommission and partially breach the dam in order to provide upstream passage. However, FERC did not approve FPLE's Application to Surrender its license and partially breach the dam until January 23, 2004. Therefore, the trap-and-truck program will continue in 2004: alewives are collected at the facility with a pump and transferred into upstream spawning habitat in stocking trucks. FPLE still needs to obtain permits from the Maine Department of Environmental Protection, the US Army Corps of Engineers, and the Winslow Planning Board before it begins removal of an 87-foot section of the dam.

Upstream passages at the **Benton Falls** and **Burnham Dams** are required to be operational one year following the installation of permanent or temporary upstream fish passage at Fort Halifax and installation of permanent upstream fish passage at four upriver non-hydro dams. These projects included the construction of fishways at the Pleasant Pond dam in Stetson, the Plymouth Pond dam in Plymouth, the Sebasticook Lake outlet dam in Newport, and the removal of the Guilford Dam in Newport. These projects were completed on June 13, 2003, triggering a June 14, 2004 date for fish passage to be operational.

In regards to passage at Benton Falls, the Licensee has recently submitted conceptual plans for a fish lift at the facility. On March 10, 2004, the owner of the project, The Arcadia Companies, and its consultant, Kleinschmidt Associates, met with the fisheries agencies to discuss the conceptual plans and a proposed timeline for completion. The review process is currently ongoing at the time of this printing and it is questionable whether the Benton Falls fish lift will be operational in 2004. More likely, permanent fish passage installation will begin in 2004 and be operational by May 1, 2005. DMR, MDIFW, and the USFWS will work with the Licensee to incorporate a sorting facility in the Benton Falls fish passage facility.

In regards to the Burnham Project, at the time of this printing, the Licensee has not formally submitted conceptual plans for permanent fish passage to the appropriate agencies for review. However, the Licensee has indicated to both DMR and USFWS that it will install a fish lift at the facility. Similar to Benton Falls, permanent fish passage installation will likely begin in 2004 and be operational by May 1, 2005.

3.3 Cobbosseecontee Stream Fish Passage

The Department of Marine Resources is in the process of developing a Diadromous Fish Restoration Plan for the Cobbosseecontee Stream watershed. Presently, the draft is being reviewed within the Department, after which it will be forwarded to MDIFW and MASC for their review. Several consecutive years of fish kills involving out-migrating alewives and American eels have prompted the DMR to begin to focus on this important fishery. Both DMR and the USFWS have approved interim plans for downstream fish passage in the form of a flashboard notch and plunge pool. At the present stocking density in Pleasant Pond (the only waterbody in the watershed presently stocked with adult alewives) and resulting alewife offspring production, this bypass method has been successful the past two seasons.

However, the method for passing American eels (installation of a blinding plate along the base of the trash racks and opening the deep gate at least 8") has proven ineffective the past two seasons and nighttime generation was ceased to prevent further entrainment of eels during their migration period. CHI, the operator of the American Tissue Project, has indicated that it would develop permanent fish passage pending DMR's restoration plan. DMR will continue to work with CHI in 2004 to ensure that entrainment of American eels will not continue at the project.

4.0 FISH COMMUNITY ASSESSMENT

With the removal of the Edwards Dam in 1999, approximately 17 miles of Kennebec River habitat was reopened for the first time since the dam was built in the mid-1800s. The benefits of dam removal are already being realized with anecdotal reports of enhanced recreational angling opportunities and results, as well as an increase in available spawning and nursery habitat for native anadromous fish species. For example, evidence of American shad spawning has occurred as far upriver as Winslow. In addition, both striped bass and sturgeon are now observed in Winslow. There are also increased observations of wildlife species benefiting from this newly opened river stretch. DMR staff have observed bald eagles, osprey, great blue heron, several species of ducks and Canada geese, as well as various species of aquatic furbearers, including mink and river otter, and even a harbor seal, utilizing this free-flowing segment of the Kennebec.

The intent of this investigation is to document the presence and spawning activity of anadromous fish species (e.g., American shad, blueback herring, and rainbow smelt) in this newly reopened stretch of river. This data will be useful to examine the impact current restoration programs are having on Kennebec River stocks of anadromous fish. Additionally, habitat information will be collected at each fish sample site. Data will be used to document changes in habitat types over time and determine how these changes will benefit anadromous fish.

Sampling Sites

In June 2000, Kennebec River Project personnel surveyed the 17-mile stretch of the Kennebec River from the Fort Halifax and Lockwood Dams downstream to the former Edwards Dam site. The objective of the survey was to locate potential sampling sites for the deployment of beach seines and other sampling gear for fish community assessment purposes. Several factors led to the selection (or non-selection) of the sampling sites, including depth; areas of strong currents; and obstructions such as ledges, logs, and boulders, which render potential sites unsuitable for seining and fyke net deployment. Generally, sites with even, regular bottoms were chosen. Originally, a total of eight sites were sampled biweekly between Waterville and Augusta from June/July (immediately following alewife/shad stocking) until November.

Biological Sampling Procedures

Depending on river flow, either a 17-foot or 19-foot johnboat equipped with a jet drive was used to access all of the sampling sites. At sites where water depth exceeded the ability to wade, the johnboat was used to deploy an 8' x 150' x 3/8" delta mesh net with an 8' x 8' x 8' x ¼" delta mesh bag seine. The bag was used to better capture and, more importantly, retain the items sampled by eliminating the gap between the net and river bottom at the vertex of the seine as it was hauled. The beach seine was flaked onto the bow of the boat. After landing at the survey site, a crewmember would debark and hold one end of the beach seine. The boat would then be backed out into the river and continue until approximately 2/3 of the net had been deployed. At this point, the boat would back towards shore. As the boat reached wading depth, a crewmember would debark, taking the other end of the net to shore where the haul would be completed.

In order to best understand the structure of the fish community present, every species of fish - diadromous and resident - was examined. Total number of fish caught was assessed, as was number per species. Total length was assessed to the nearest millimeter for up to 100 diadromous fish per species and up to 50 per resident species. If American shad were captured, a random sample of 20 was placed on ice and brought back to the DMR office in Hallowell for otolith work (see **Section 3.0** of this report).

Data Analysis

Seining surveys for the 2003 season commenced on July 21. The sampling sites consisted of the same sites as those of late 2002.

Between June 12 and July 2, D-nets were set at various sites in the upper (above Augusta) Kennebec and Sebasticook Rivers to capture any eggs that shad may have released during natural spawning events. The eggs of anadromous herring are fertilized in the water column and drift in the currents until finally settling upon the substrate or aquatic vegetation. The use of D-nets is helpful in locating spawning areas by collecting the drifting fish eggs. These types of nets have a D-shaped frame, with the 40" long straight edge resting flat on the bottom substrate and the 22" high curved edge perpendicular to the bottom. Anchors were used to hold the frame upright and facing into the current. The river currents carried fish eggs into the net where they were collected in a cup located at the end of fine mesh netting. Most nets were set for an average of three hours during daylight hours; however, four nets were set overnight. The water depth where the nets were set ranged from 3-18 feet. All eggs collected were placed in preservative for later identification and enumeration. The locations of the sampling sites upstream of the former Edwards Dam are shown in **Figures 10 and 11.** See **Table 16** for their respective descriptions.

A total of 290 shad eggs were collected during this period, with the greatest majority (163 eggs) captured in the Sebasticook River at the south shore, lower site. The majority of American shad eggs were collected in two areas: the confluence of the Sebasticook and Kennebec Rivers and in a stretch of the Kennebec River in Sidney. At one D-net site in Sidney, several hundred shad eggs were observed in the water column with an underwater camera in the course of a minute or so. Alewife and blueback herring eggs were collected from Augusta to Winslow.

A total of 48 seine hauls were made during the community assessment survey on the Kennebec River upstream of the site of the former Edwards Dam. A total of 3,662 fish representing 19 species were captured and identified. Of those, total length was assessed for 1,171 fish. Fish of questionable identity were placed on ice for later identification. For a breakdown of diadromous fish captured by site, refer to **Table 17**.

In conjunction with the sampling sites upstream, DMR personnel also beach seined at several locations downriver of the Edwards Dam site. See **Table 18** for results of these sampling events.

Figure 10. Locations of D-nets in Kennebec River, 2003

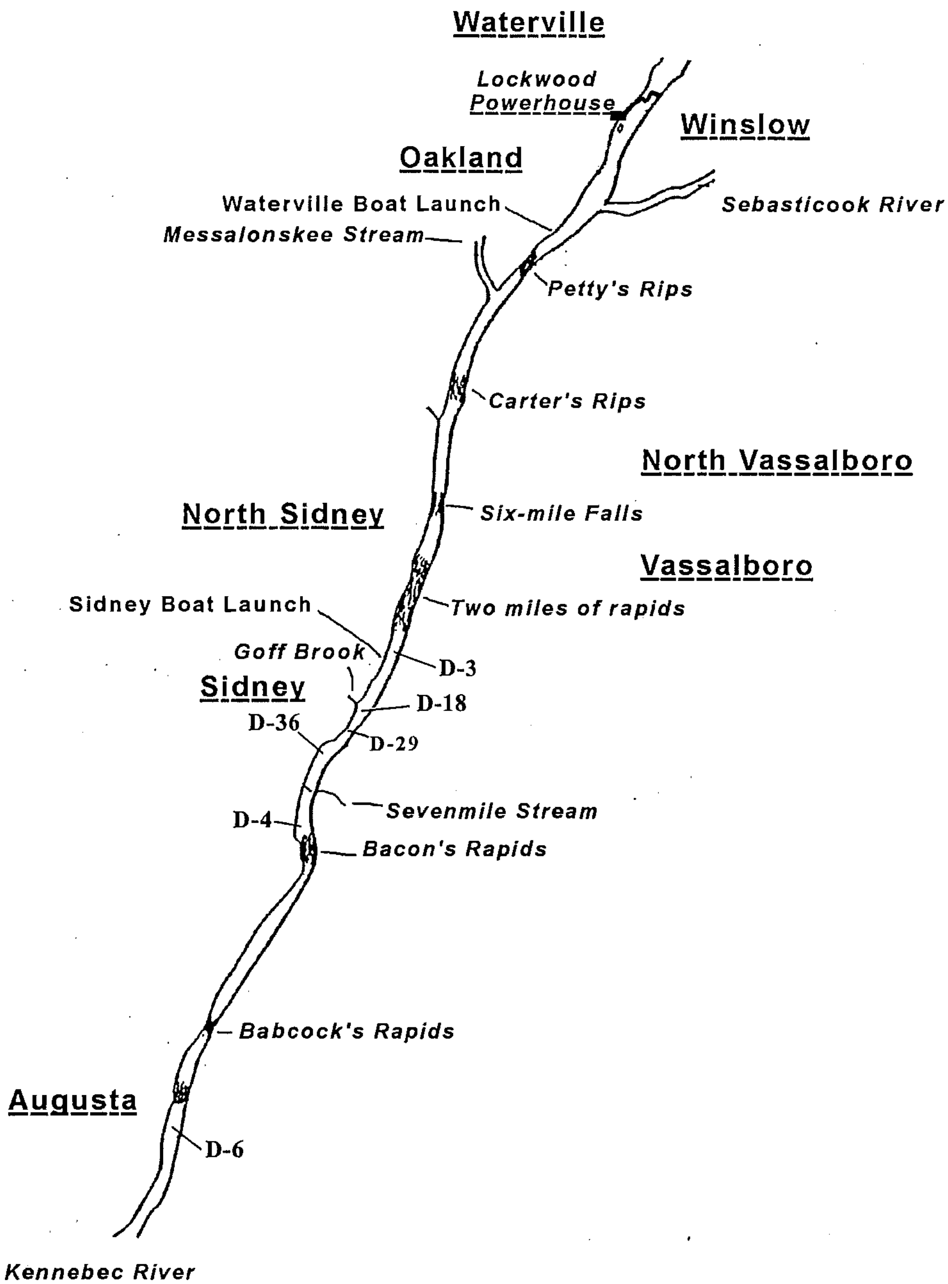


Figure 11. Locations of D-nets near Kennebec/Sebasticook Confluence, 2003

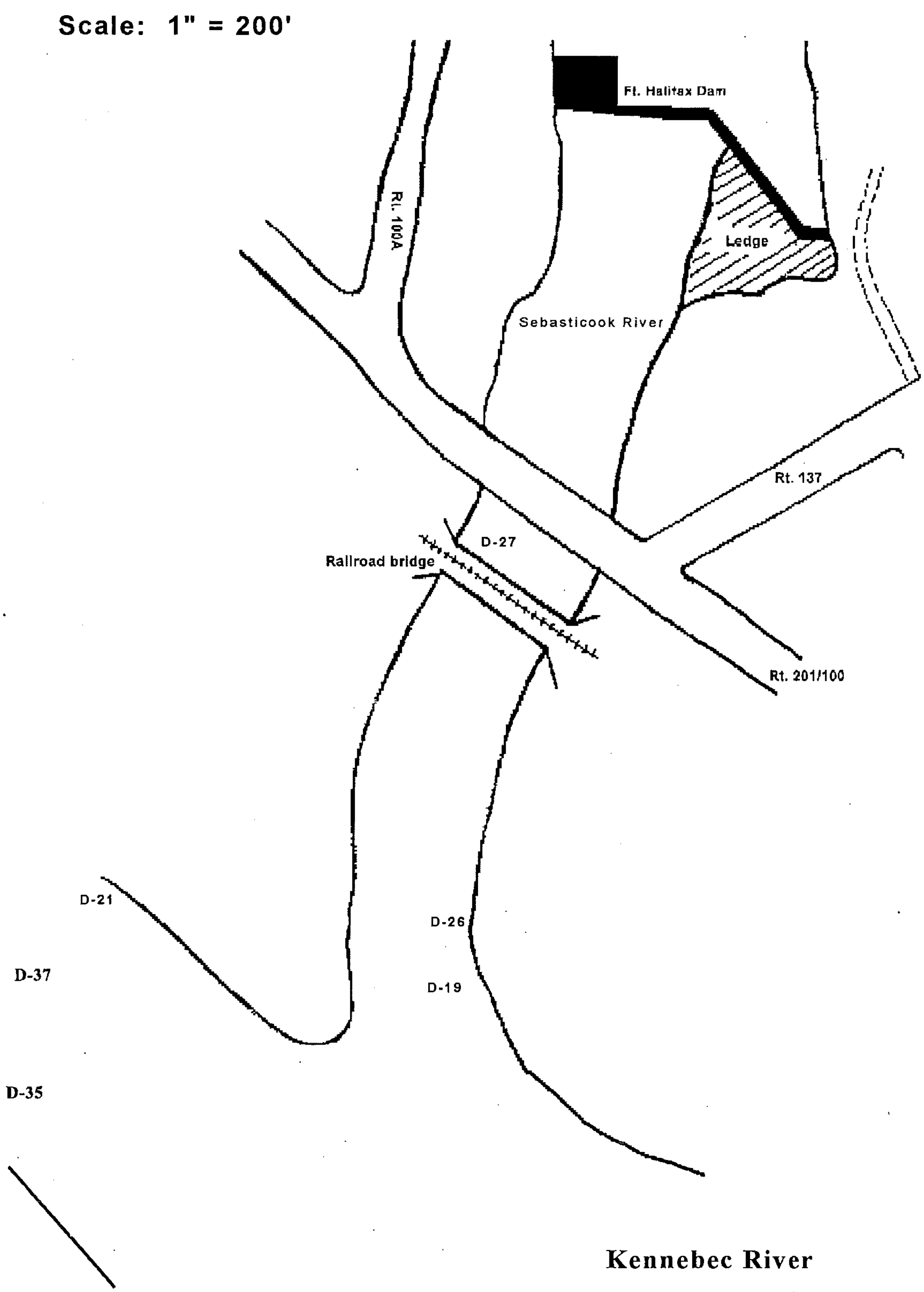


Table 16. Locations & Results of D-Net Sets, 2003

Site	Site	Water Temp	Air Temp	Date Set	Date Hauled	Depth (ft.)	No. of Eggs	No. of Larvae	ID
Rolling Dam Brook	D-12	16.5		6/12/2003	6/12/2003	12			
Brown's Island	D-11	16	20	6/12/2003	6/12/2003	10			
Hallowell Cement Pier	D-8	16	20	6/12/2003	6/12/2003	10			
Augusta	D-6	16	22	6/12/2003	6/12/2003	8			
Sebasticook R Between Bridges	D-27	17.5	19	6/17/2003	6/17/2003	10			
Sebasticook R South Shore Lower Site	D-26	17.5	19	6/17/2003	6/17/2003	6	15		American Shad
Sebasticook R South Shore Lower Site	D-26	15.5	20	6/17/2003	6/17/2003	6	53		alewife/blueback
Lower end Ticonic Bay, middle	D-37*	15.5	20	6/17/2003	6/17/2003	12	10		alewife/blueback
Lower end Ticonic Bay, east side	D-21			6/17/2003	6/17/2003		2		alewife/blueback
Sebasticook R Between Bridges	D-27			6/17/2003	6/18/2003				
Sebasticook R South Shore Lower Site	D-26			6/17/2003	6/18/2003		163		American shad
Sebasticook R South Shore Lower Site	D-26			6/17/2003	6/18/2003			7	white sucker
Lower end Ticonic Bay, middle	D-37*			6/17/2003	6/18/2003		19		alewife/blueback
Lower end Ticonic Bay, east side	D-21			6/17/2003	6/18/2003		5		alewife/blueback
Sebasticook R Between Bridges	D-27			6/18/2003	6/18/2003		9		alewife/blueback
Sebasticook R South Shore Lower Site	D-26			6/18/2003	6/18/2003		61		American shad
Sebasticook R South Shore Lower Site	D-26			6/18/2003	6/18/2003		13		alewife/blueback
Lower end Ticonic Bay, middle	D-37*			6/18/2003	6/18/2003	14			
Lower end Ticonic Bay, east side	D-21	17	20	6/18/2003	6/18/2003	10			
Opposite Sidney Boat Launch	D-3[1]	17	20	6/19/2003	6/19/2003	11	13		American shad
Opposite Sidney Boat Launch	D-3			6/19/2003	6/19/2003		3		alewife/blueback
Below Goff Brook	D-18			6/19/2003	6/19/2003	10	43		alewife/blueback
Opposite Twin Culverts	D-29			6/19/2003	6/19/2003	8	16		alewife/blueback
Above Bacon Rapids, west Shore	D-4	19.5	23	6/19/2003	6/19/2003	17	5		alewife/blueback

Table 16 (cont.)

Site	Site	Water Temp	Air Temp	Date Set	Date Hauled	Depth (ft.)	No. of Eggs	No. of Larvae	ID
Rolling Dam Brook	D-12	19.5	25	6/23/2003	6/23/2003	18			
Brown's Island	D-11	19.5	25.5	6/23/2003	6/23/2003	12			
Hallowell Cement Pier	D-8	19.5	25.5	6/23/2003	6/23/2003	13			
Augusta	D-6	19.5	29	6/23/2003	6/23/2003	9			
Mouth of Sebasticook River	D-19	19.5	29	6/24/2003	6/24/2003	3	8		American shad
Lower end Ticonic Bay, middle	D-37*	19.5	29	6/24/2003	6/24/2003	9	6		alewife/blueback
Lower end Ticonic Bay, east side	D-21			6/24/2003	6/24/2003	6			
Opposite Sidney Boat Launch	D-3			6/26/2003	6/26/2003	5			
Below Goff Brook	D-18			6/26/2003	6/26/2003	6	7		American shad
Opposite Twin Culverts	D-29			6/26/2003	6/26/2003	6	9		American shad
Sidney, below River Bend at ledges, above house	D-36*	24	23	6/26/2003	6/26/2003	10	10		American shad
Rolling Dam Brook	D-12	24	23	6/30/2003	6/30/2003	13			
Brown's Island	D-11	24	23	6/30/2003	6/30/2003	6			
Hallowell Cement Pier	D-8	24	23	6/30/2003	6/30/2003	9	2		alewife/blueback
Augusta	D-6		26.5	6/30/2003	6/30/2003	9			
Mouth of Sebasticook River	D-19			7/1/2003	7/1/2003	3			
Lower end Ticonic Bay, middle	D-37*			7/1/2003	7/1/2003	15			
Lower end Ticonic Bay, west shore	D-35	22.5		7/1/2003	7/1/2003	13			
Opposite Sidney Boat Launch	D-3	22.5		7/2/2003	7/2/2003	8			
Opposite Twin Culverts	D-29*	22.5		7/2/2003	7/2/2003	8	4		American shad
Sidney, below River Bend at ledges, above house	D-36	16.5		7/2/2003	7/2/2003	13			

* New sampling locations for 2003

[1] Observed numerous eggs (likely shad) in water column with underwater video camera

Table 17. Diadromous Fish Captured in the Kennebec River above the Edwards Dam Site, 2003

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 7	Site 8B	Site 8C
Alewife				1,321				
Alosid sp.[1]						57		
American Eel	4						1	
American Shad		71			3		259	369
Blueback Herring								
Striped Bass								
Site Totals	**4**	**71**		**1,321**	**3**	**57**	**260**	**369**
Grand Total All Sites								
Total By Species								
Alewife	**1,321**							
Alosid sp.[1]	**57**							
American Eel	**5**							
American Shad	**702**							
Blueback Herring	**0**							
Striped Bass	**0**							

[1] Further laboratory analysis needed to determine species of larval samples

Table 18. Locations & Results of Seine Hauls in Lower Kennebec River, 2003

Date	Sampling Location	Species Captured	Number Captured
7/15	Sand Island (South Gardiner)	Alewife	2
7/15	Richmond (downriver of Swan Island)	Alewife	36
7/15	Hallowell (near boat launch)	Unidentified alosid	7
7/15	Richmond (downriver of Swan Island)	Unidentified alosid	8
7/29	Hallowell (near boat launch)	American shad	1
7/29	Sand Island (South Gardiner)	American shad	159
7/29	Richmond (downriver of Swan Island)	American shad	4
7/29	Richmond (downriver of Swan Island)	Alewife	14
8/13	Augusta (near boat launch)	American shad	275
8/13	Sand Island (South Gardiner)	American shad	676
8/13	Richmond (downriver of Swan Island)	American shad	1
8/27	Sand Island (South Gardiner)	American shad	71
8/27	Sand Island (South Gardiner)	Alewife	1
8/27	Richmond (downriver of Swan Island)	Alewife	4
9/9	Augusta (near boat launch)	American shad	498
9/9	Sand Island (South Gardiner)	American shad	83
9/9	Augusta (near boat launch)	Alewife	261
9/9	Richmond (downriver of Swan Island)	Alewife	2
9/29	Sand Island (South Gardiner)	American shad	16
9/29	Sand Island (South Gardiner)	Blueback herring	1

5.0 AMERICAN EEL

The *Lower Kennebec River Comprehensive Hydropower Settlement Accord* requires that KHDG dam owners and DMR, in consultation with NMFS and USFWS and subject to approval by FERC, undertake a three-year research project to determine 1) the appropriate placement of upstream passage for American eel at each of the seven KHDG facilities based upon field observations of where eel are passing or attempting to pass upstream at each facility, and 2) appropriate permanent downstream fish passage measures, based on radio telemetry and other tracking mechanisms and field observations.

5.1 Upstream Passage

Introduction

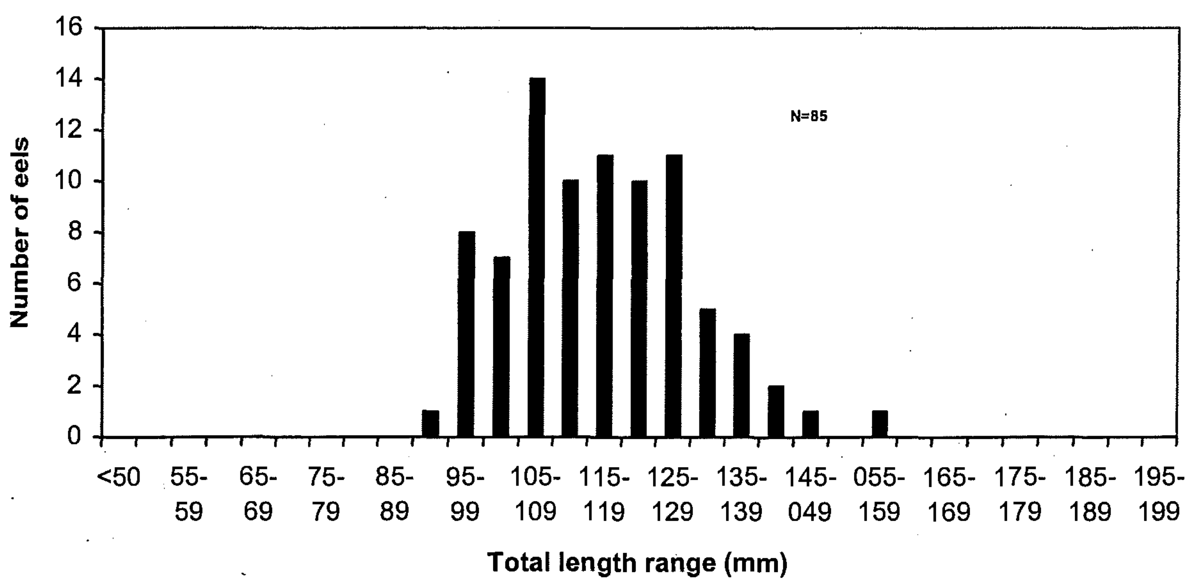
The primary objective of this study was to determine where juvenile eels pass or attempt to pass upstream at each of the seven KHDG facilities. Secondary objectives were to determine the timing of the upstream migration, the magnitude of the migration, and the size distribution of the migrants. After three years of study, DMR staff made recommendations in 2001 on the appropriate locations for placement of upstream eel passage at five of the seven KHDG facilities (Fort Halifax, Benton Falls, Burnham, Hydro-Kennebec, and Shawmut). In 2003, DMR staff made additional nighttime observations at Lockwood and Weston, assisted with the startup and evaluation of passages at Hydro-Kennebec and Shawmut, and deployed passages at Fort Halifax and Benton Falls to monitor recruitment and pass eels upstream.

Methods, Results and Discussion

Observations were made on five occasions at the **Lockwood** Project (July 8, 10, 16, 22, and 29) in 2003. DMR staff observed small numbers of eels ranging from approximately 20 to several hundred at various locations at the base of the dam or climbing the dam. These observations confirm previous observations that there is no single place where eels tend to concentrate because of widespread and variable leakage.

Personnel at the **Hydro-Kennebec** Project installed an experimental upstream eel passage made of flexible exhaust hose with Enkamat lining the invert on the west side of the spillway at the end of June. DMR staff installed a catch box at the top of the passage on July 8, and that night observed eels being attracted to various locations along the dam by leakage from the flashboards and ram-pump. No eels were found in the catch box the next day. When sections of the hose were dismantled, eels were found to have climbed as far as the penultimate section. To eliminate these problems, Hydro-Kennebec staff reworked the connection between the last two sections of exhaust hose, reduced flashboard leakage with bark, and attempted to consolidate flow from the ram-pump. Approximately 4,747 eels climbed the passage over the next 11 days (July 11- 21). The size distribution (**Figure 12**) was similar to previous years. On the evenings of July 16 and 23, DMR staff observed that eels continued to be attracted to various locations by leakage from

Figure 12. Hydro-Kennebec 2003



the flashboards and ram-pump. In addition, the entrance seemed to be incorrectly oriented. At DMR's request, additional steps were taken to reduce leakage and the lower three sections of exhaust hose were replaced with an Enkamat-covered ramp. By the end of July, the number of migrating eels had started to decline and the ramp was not properly tested. We recommend that installation begin as early as possible in 2004 and that the exhaust hose be replaced with an Enkamat-covered ramp. Problems that arise with the climbing substrate are more visible and easily repaired with the ramp design.

FPL Energy (FPLE) installed an upstream eel passage at the **Shawmut** Project during the week of June 9. Modifications to the passage entrance were made on July 18 following site visits by DMR, FPLE, and Normandeau staff to assess whether eels were successfully using the passage. We recommend that the passage be installed earlier in 2004 (i.e., the end of May or beginning of June).

Maintenance and repair work were conducted on the south channel dam of the **Weston** Project during the summer and fall of 2003. The repair work on the dam caused changes in leakage flow patterns. DMR recommended that installation of the upstream eel passage be delayed until 2004.

The passage at the **Fort Halifax** Project, which was installed on June 9 and modified on July 18, was operated for a total of 60 days between June 11 and September 17 in 2003, passing an estimated 155,012 eels, the third highest number since 1999 (**Table 19**). The upstream migration was more protracted than in previous years. Approximately 90% of the eels moved upstream within a two-month period (**Figure 13**), as opposed to a one-month period in the previous four years. Eels started migrating when the water temperature in the headpond was 18.2° C and flow measured at Pittston was 946 cfs. Peaks of migration did not appear to be related to temperature or river flow (**Figure 13**). Two peaks in August followed periods when the passage was not checked daily (August 9-12) or was shut down (August 14-25). The size distribution of eels passing in 2003 (**Figure 14**) was similar to previous years.

The passage at **Benton Falls** Project was operated for just 16 days in 2003, and passed approximately 6,434 eels, the lowest number passed since 1999 (**Table 19**). Nearly 90% of the eels passed on a single date (July 1). The passage was not operated for most of the summer, primarily because one turbine was being repaired. As a consequence, the entrance to the passage was flooded by inflow being passed over the spillway from July 10-29 and August13-September 23. In addition, the attraction water hose had to be repaired at the beginning of the season. The size distribution of eels changed dramatically in 2002 and this trend continued in 2003. From 1999-2001, the length distribution was unimodal with the most common length being 105-109 or 110-114 mm. In 2002, the distribution became multimodal with 37% of the eels > 150 mm. In 2003, the distribution was again multimodal with 41% of the eels >150mm (**Figure 15**).

Table 19. Summary of Upstream Eel Migration at Fort Halifax & Benton Falls, 1999-2003

	Fort Halifax		Benton Falls	
Year	Passage operating	Eels passed	Passage operating	Eels passed
2003	6/11-9/17	155,012	16 days	6,434
2002	6/10-9/13	56,292	6/18-9/13	22,502
2001	5/26-8/24	224,373	6/6-8/24	231,859
2000	6/21-7/28; 8/15-8/22	81,628	6/29-7/28; 8/14-8/24	37,207
1999	6/4-9/15	551,262	6/22-9/16	14,335

Figure 13. Fort Halifax, 2003

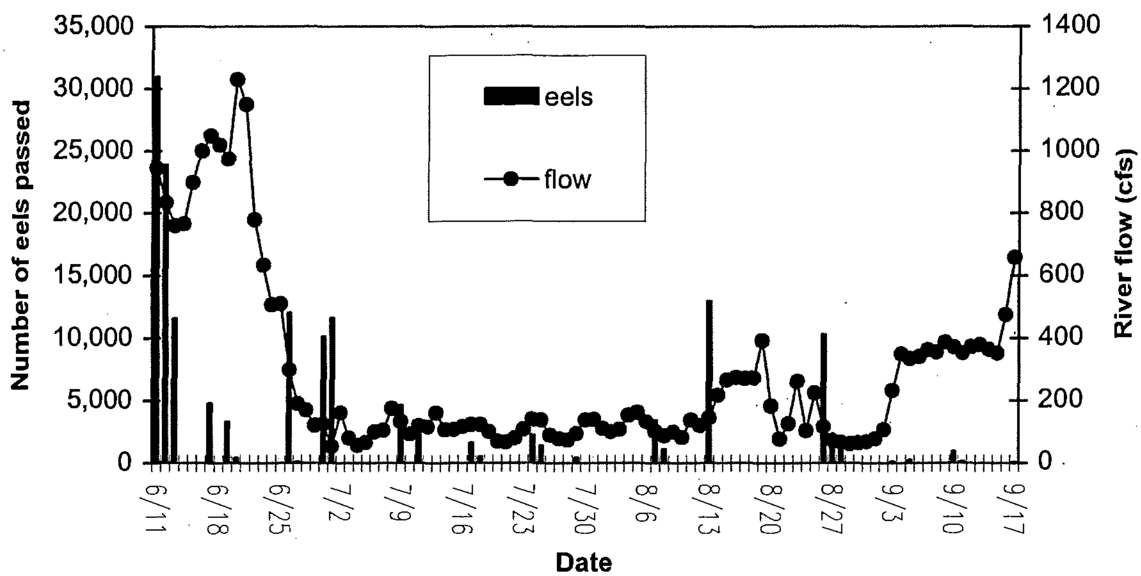


Figure 14. Fort Halifax, 2003

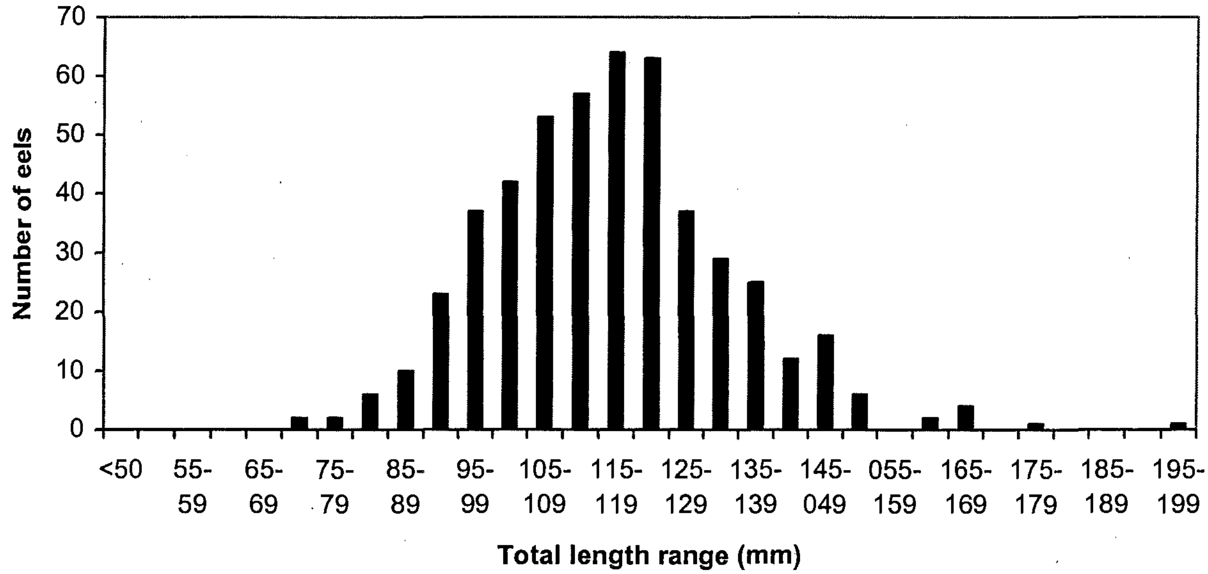
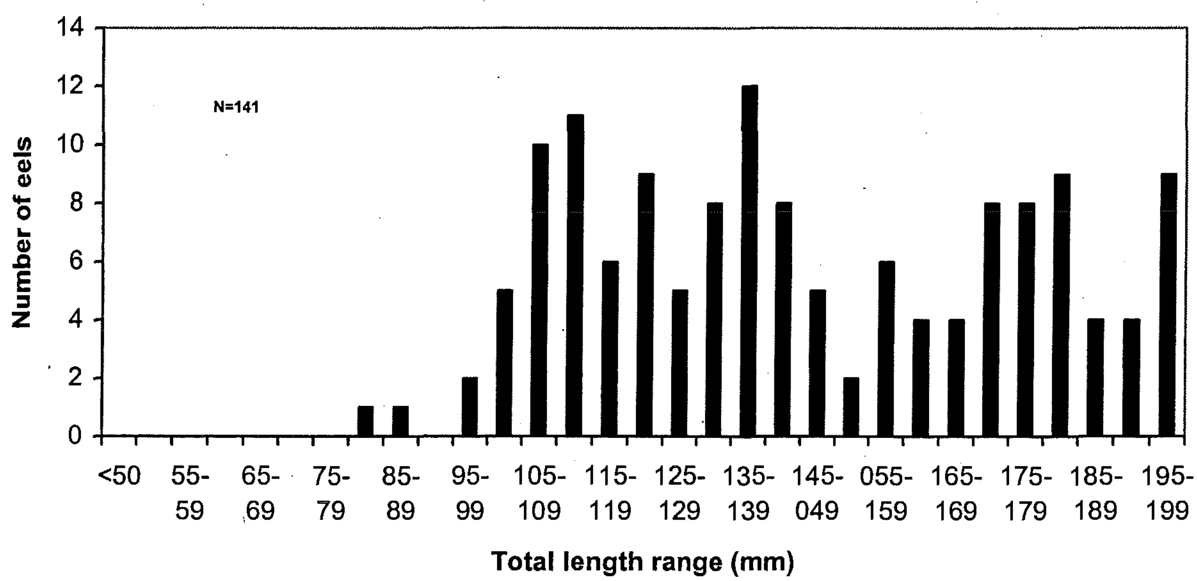


Figure 15. Benton Falls, 2003



5.2 Downstream Migration

Introduction

The primary objectives of this study were to determine the seasonal and diel timing of the downstream migration of adult eels, the behavior of migrating adult eels at hydropower facilities, and the efficiency of various downstream passage measures for adult eels.

Methods and discussion

DMR intended to continue its study of eel behavior at the Lockwood Project, which is located on the Kennebec River approximately 0.5 mile above the confluence of the Sebasticook and the Kennebec Rivers. However, the 2003 study was not completed because the eel migration occurred early and calibration of radio telemetry equipment was delayed by annual turbine maintenance (September 6-20). The telemetry equipment was installed from August 7-September 9, but a final calibration was not conducted until October 14. A fyke net was set in Carrabassett Stream and fished for ten nights from October 14-November 14, but no downstream migrating eels were caught. High flow often made it impossible to set the net and it was damaged on several occasions by debris. A number of resident fishes were caught in the net, indicating that it was fishing correctly. We learned from an eel weir fisherman that most eels migrated with the first heavy rains in early October. The study will be continued in 2004.

6.0 ATLANTIC SALMON RESTORATION

In 1984, the Maine Atlantic Sea Run Salmon Commission (MASRSC) adopted *Management of Atlantic Salmon in the State of Maine: a Strategic Plan.* In the plan, the MASRSC partitioned existing and historical salmon rivers into four categories (A, B, C, and D). The Kennebec River was one of five historical Atlantic salmon rivers assigned to category "C" primarily because Atlantic salmon habitat was inaccessible due to impassable dams and lack of resources to initiate restoration of Atlantic salmon.

In 1995, the MASRSC further delineated its proposed activities within the Kennebec River watershed in its *Maine Atlantic Salmon Restoration and Management Plan, 1995 – 2000.* The status of the Kennebec River Atlantic salmon resource was denoted as "unknown," but recognized it included hatchery and wild origin strays with some limited natural production. Restoration was deemed to be passive, with limited activities as resources allowed. The 1995 - 2000 goal for the Kennebec was to maintain current numbers of Atlantic salmon and to increase those numbers in the future.

The Maine Atlantic Salmon Authority (MASA, formerly the MASRSC) adopted the *Maine Atlantic Salmon Management Plan with Recommendations Pertaining to Staffing and Budget Matters* in 1997. In this document, the MASA identified a ten-year restoration goal to be undertaken in two phases. Under Phase I (1997 - 2001), the MASA would focus upon improving Atlantic salmon habitat and fish passage in the Kennebec River and tributaries below the Edwards Dam (now removed). The MASA supported ongoing efforts for removal of the Edwards Dam. Phase II (2002 - 2006) objectives are to focus on developing a multi-agency fisheries management plan for the river above the Lockwood Dam and initiating an Atlantic salmon stocking program.

Atlantic Salmon Restoration

In 2003, field activities conducted by the Maine Atlantic Salmon Commission (MASC) staff consisted of the following: juvenile salmon population assessments, spawning surveys, habitat assessments, temperature monitoring, and streamside incubation.

Atlantic Salmon Population Monitoring

The removal of the Edwards Dam in 1999 opened approximately 17 miles of the mainstem Kennebec River from Augusta to Waterville/Winslow as a migratory corridor for the small numbers of mature Atlantic salmon returning to the Kennebec. It is also now possible for Atlantic salmon to spawn in the mainstem between Augusta and Waterville/Winslow and in tributaries entering this mainstem reach downstream of impassable barriers. Methods utilized to monitor spawning activity and successes were redd counts and electrofishing.

Juvenile Atlantic Salmon Assessments

Methods

The MASC staff from the Sidney Regional Office sampled three sites in two tributaries below Waterville/Winslow (Bond Brook and Togus Stream) to determine the presence or absence of juvenile Atlantic salmon (**Table 20**). Additionally, one site was sampled on the Sandy River in Madrid to assess survival of fry released from streamside incubators (see **Appendix C**). All sites were evaluated using a single pass electrofishing assessment method except the Sandy River site where a four-run removal method was used. All age 0+ Atlantic salmon parr captured were sampled for length and weight. All salmon were released alive.

Results and Discussion

No Atlantic salmon were found in Togus Stream or Bond Brook. However, densities found in the Sandy River were between 50-100 salmon per unit (one unit = 100 m^2).

Spawning Surveys

Methods

Redd counts were undertaken by foot on tributaries of the Kennebec River on November 3 and 18. Tributaries surveyed during this period included Bond Brook and Togus Stream. Surveys of the mainstem Kennebec River, as well as other tributaries, were not possible due to high flows and ice cover.

Results and Discussion

In general, two surveys - one early and one late in the spawning season - are conducted to generate a final redd count. This is primarily due to the distortion of redds over time by high flows and the potential for late spawning. In 2003, due to ice formation and high flows, only a single survey on each tributary was completed. Consequently, it is possible to have had spawning occur after our survey even though we initially didn't document any redds. In addition, no redd counts were conducted on the mainstem of the Kennebec River because of the unseasonably high flows and poor visibility.

Atlantic Salmon Habitat Assessment

Habitat Surveys

Methods

The MASC continued ongoing habitat surveys on tributaries of the Kennebec River to quantify adult salmon spawning and juvenile salmon-rearing habitat in the basin. Surveys were conducted on the mainstem Sebasticook River from Pittsfield to the Burnham Dam and the Sandy River from Phillips to Farmington.

Results and Discussion

The quantities of juvenile salmon habitat surveyed in 2003 included 24 units on the Sebasticook River and 3,714 units on the Sandy River. One habitat unit equals 100 m^2 of juvenile Atlantic salmon habitat of riffles and runs combined **(Table 21)**.

Temperature Monitoring

Methods

Data loggers were deployed and set to record once every hour in the Sebasticook River (Pittsfield), Togus Stream (Randolph), Sandy River (Madrid), Valley Brook (Strong) South Branch Sandy River (Phillips), Saddleback Stream (Madrid), Orbeton Stream (Phillips), and Mt. Blue Steam (Avon) to document summer river temperatures to gain insight into the thermal regimes that exist in streams with the potential for Atlantic salmon restoration. At the end of summer, the data were downloaded and filtered to generate a table and graph for presentation purposes. The monthly maximum, minimum, and average temperatures over the summer months are presented in Table 22 and monthly maximums and minimums for July and August are graphically presented in Figure 16.

Table 20. Juvenile Atlantic Salmon Assessments - Kennebec River Tributaries, 2003

Date	Tributary	Sampling Location	No. of Salmon Parr	Ave. Fork Length (mm)	Ave. Weight (g)	Other Species Observed
8/21	Sandy River	Site 1: Madrid	300	54.2	2.3	blacknose dace, slimy sculpin, American eel, brook trout, white sucker
9/3	Bond Brook	Site 1: Bond Bk Rd. index site	0	0	0	blacknose dace, brown trout, American eel, white sucker, fall fish
9/3	Togus Stream	Site 1: Above Rt. 27	0	0	0	blacknose dace, smallmouth bass, American eel, white sucker
9/3	Togus Stream	Site 2: Upper Barber Rd.	0	0	0	blacknose dace, smallmouth bass, American eel, golden shiner, white sucker, fall fish

Results and Discussion

The temperature data collected indicates most sites in 2003 would not have been thermally stressful to Atlantic salmon. The only exception was the lower site on Togus Stream where temperatures approached 27 ^{0}C. Even though maximum temperatures recorded in Togus Steam were high, it maintained enough diurnal variation by dropping below 23^{0}C to allow some daily thermal relief. A copy of the entire temperature dataset can be obtained by contacting the MASC.

Research

During the winter of 2002-03, the MASC conducted a research project to test the feasibility of streamside incubation as a method for Atlantic salmon restoration. The report submitted to the Maine Atlantic Salmon Technical Advisory Committee (TAC) for this project is presented in Appendix C.

Table 21. Atlantic Salmon Habitat Assessment on Selected Tributaries in the Kennebec River Drainage, 2003

	Habitat Type and Units (unit=100m2)						
Section Surveyed	Dead Water	Glide	Pool	Falls	Riffle	Run	Riffle+Run
Sebasticook River*	N/A	188	-	-	10	14	24
Sandy River**	N/A	3,975	-	-	982	2,732	3,714
Totals:	-	4,163	-	-	992	2,746	3,738

*Partial survey, Sebasticook River between Pittsfield and Burnham Dam

**Partial survey, Sandy River in Farmington.

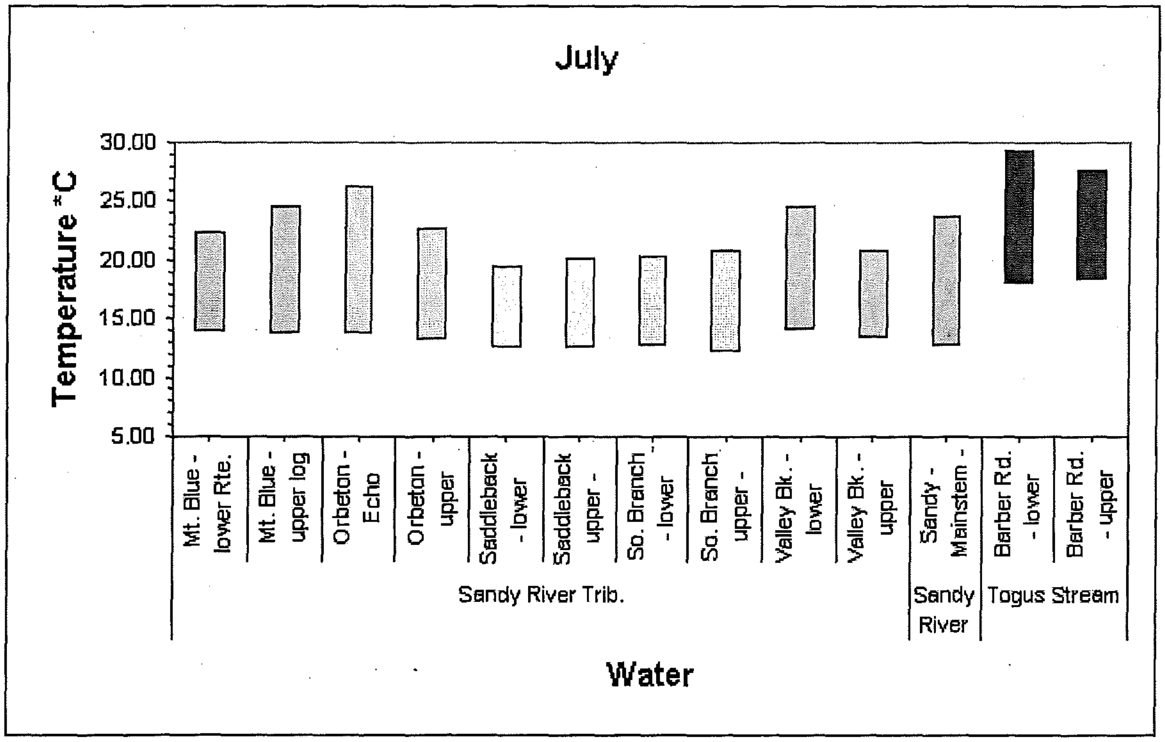
Table 22. Monthly Maximum, Minimum, & Average Temperatures (°C) for Selected Waters in the Kennebec River Drainage, 2003

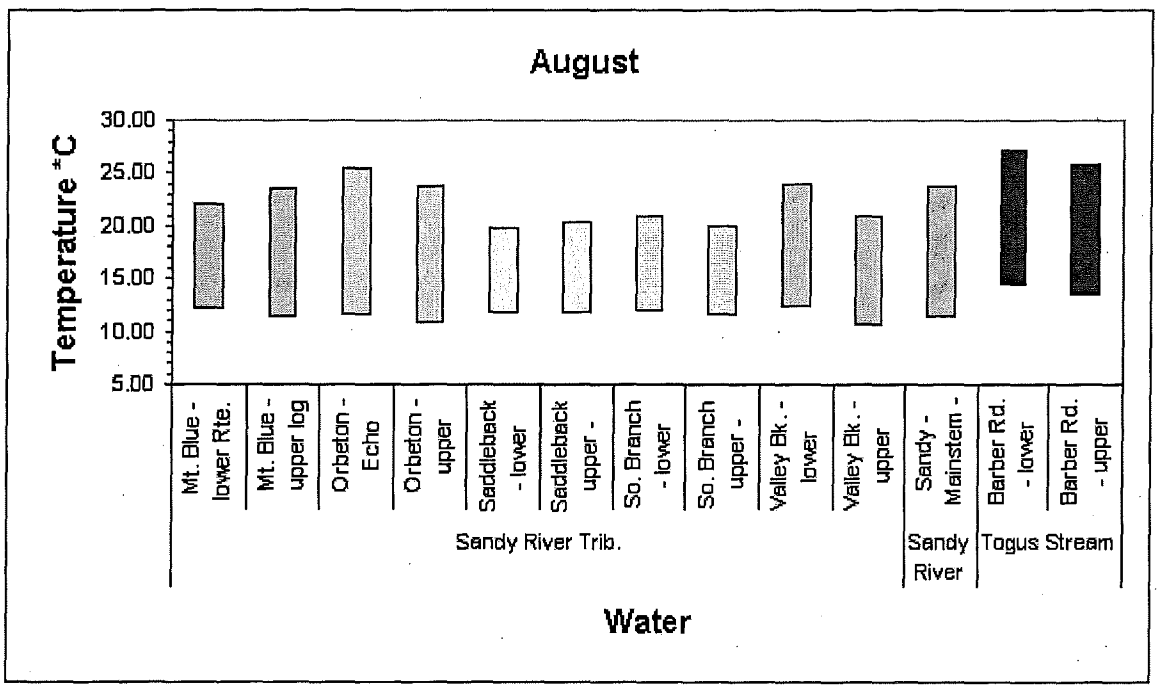
Water	Summer Town/Site	June			July			August			Comments
		Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	
Mt. Blue Stream	Avon lower	23.6	11.8	16.8	22.3	13.8	18.3	22.0	12.1	18.3	Deployed 6/9
Mt. Blue Stream	Avon upper	25.6	11.8	17.1	24.5	13.6	18.6	23.5	11.3	18.5	Deployed 6/9
Orbeton Stream.	Phillips Echo Valley Rd	28.0	10.1	17.2	26.2	13.7	19.4	25.5	11.4	19.2	Deployed 6/9
Orbeton Stream	Madrid upper	25.9	9.5	15.9	22.7	13.2	17.9	23.7	10.7	18.0	Deployed 6/9
Saddleback Stream	Madrid lower	20.0	9.6	14.2	19.5	12.5	15.9	19.8	11.6	16.5	Deployed 6/10
Saddleback Stream.	Madrid upper	20.2	9.5	14.3	20.1	12.5	16.2	20.4	11.5	16.8	Deployed 6/10
So. Branch	Phillips lower	20.6	9.4	14.8	20.3	12.7	15.5	21.0	11.9	16.3	Deployed 6/10
So. Branch	Phillips upper	21.3	8.9	13.9	20.8	12.1	16.3	20.0	11.5	16.2	Deployed 6/10
Valley Bk.	Strong lower	25.9	12.3	17.5	24.5	14.0	19.1	24.0	12.3	18.9	Deployed 6/10
Valley Bk.	Strong upper	21.8	10.5	15.8	20.8	13.3	17.0	21.0	10.5	17.3	Deployed 6/10
Sandy River	Madrid Rte. 4	24.0	10.2	15.7	23.7	12.7	17.9	23.7	11.3	18.1	Deployed 6/10
Togus Stream	Randolph lower	28.4	16.9	22.8	29.3	17.9	22.5	27.1	14.4	21.5	Deployed 6/17
Togus Stream	Randolph upper	28.9	16.9	23.2	27.6	18.3	22.7	25.9	13.3	21.3	Deployed 6/17

Table 22 (Cont.) Fall

Water	Town/Site	Sept			Oct			Nov			Comments
		Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	
Mt. Blue Stream	Avon lower	19.0	9.9	14.5							Retrieved 9/18
Mt. Blue Stream	Avon upper	19.4	9.5	15.1							Retrieved 9/18
Orbeton Stream.	Phillips Echo Valley Rd	22.4	9.8	16.4							Retrieved 9/18
Orbeton Stream	Madrid upper	20.0	9.6	15.4							Retrieved 9/18
Saddleback Stream	Madrid lower	16.1	9.9	14.2							Retrieved 9/18
Saddleback Stream.	Madrid upper	17.5	9.8	14.6							Retrieved 9/18
So. Branch	Phillips lower	16.9	10.5	14.5							Retrieved 9/18
So. Branch	Phillips upper	18.4	9.8	14.3							Retrieved 9/18
Valley Bk.	Strong lower	23.0	10.1	15.9							Retrieved 9/18
Valley Bk.	Strong upper	17.6	8.7	14.3							Retrieved 9/18
Sandy River	Madrid Rte. 4	20.7	9.8	15.6							Retrieved 9/18
Togus Stream	Randolph lower	22.1	11.6	17.2							Retrieved 9/18
Togus Stream	Randolph upper	22.9	10.8	16.8							Retrieved 9/18

Figure 16. Maximum & Minimum Temperatures for July/August in Selected Waters, Kennebec River Drainage, 2003





APPENDIX A - History of Management Plan

Diadromous Fish Restoration on the Kennebec River
(The information contained in the following sections is intended as an overview of the history of diadromous fish restoration in the Kennebec River watershed.)

1.1 History of the Management Plan

As documented in the *State of Maine Statewide River Fisheries Management Plan* (June 1982), the State's goal related to anadromous fish resources is:

> "To restore, maintain, and enhance anadromous fish resources for the benefit of the people of Maine."

With the following objectives:

1. Determine the status of anadromous fish stocks and their potential for expansion;

2. Identify, maintain, and enhance anadromous fish habitat essential to the viability of the resource; and

3. Provide, maintain, and enhance access of anadromous fish to and from suitable spawning areas

With respect to the Kennebec River, the State's goal is to:

> "Restore striped bass, rainbow smelt, Atlantic sturgeon, shortnose sturgeon, American shad and alewives to their historic range in the mainstem of the Kennebec River."

In 1986, the Maine Department of Marine Resources (DMR) developed *"The Strategic and Operational Plan for the Restoration of Shad and Alewives to the Kennebec River Above Augusta."* The goal of this plan was:

> "To restore the alewife and shad resources to their historical range in the Kennebec River System."

To meet this goal, the following objectives were developed:

1. To achieve an annual production of six million alewives above Augusta; and

2. To achieve an annual production of 725,000 American shad above Augusta

Coincidentally with the creation of this plan, the Kennebec Hydro Developers Group (KHDG) was created and a new *Operational Plan for the Restoration of Shad and Alewives to the Kennebec River* was implemented in 1986. This plan became the first "Agreement" between the KHDG and DMR. While its goals and objectives were the same as those of 1985, it allowed dam owners upstream of Edwards Dam to delay the installation of fish passage in exchange for funding a trap, truck, and release program to move adult alewives and shad into upstream habitat.

In 1993, the Natural Resources Policy Division of the Maine State Planning Office drafted the *Kennebec River Resource Management Plan: Balancing Hydropower Generation and Other Uses*. Its goal for anadromous fish restoration in the Kennebec River remained the same as that established in 1982:

> "To restore striped bass, rainbow smelt, Atlantic sturgeon, shortnose sturgeon, American shad, and alewives to their historical range in the mainstem of the Kennebec River."

The objectives for striped bass, rainbow smelt, Atlantic sturgeon, and shortnose sturgeon were to restore or enhance populations in the segment of the Kennebec River from Edwards Dam in Augusta to the Milstar Dam in Waterville. At the time of the 1993 Agreement, there was an ongoing DMR enhancement program for striped bass that consisted of fall fingerling releases. Since mature striped bass, rainbow smelt, and Atlantic and shortnose sturgeon will not utilize fish passage facilities, the strategy for the restoration of these species was to remove the Edwards Dam. Its removal would also enhance the ongoing shad and alewife restoration program by reducing the cumulative impacts of dams on out-migrating juvenile alosids.

With the end of the KHDG Agreement and the removal of the Edwards Dam, a second agreement, *The Agreement Between Members of the Kennebec Hydro Developers Group (KHDG), The Kennebec Coalition, The National Marine Fisheries Service, The State of Maine, and The US Fish and Wildlife Service,* was implemented on May 26, 1998. Under this Agreement, the DMR continues to be responsible for implementing a trap, truck, and release program for anadromous alewives and American shad. DMR is also responsible for ensuring that the goals and objectives identified for the Kennebec River in the 1982 plan are met through monitoring and assessment of other anadromous fish species. DMR, the KHDG, and the US Fish and Wildlife Service provide funds for the continued implementation of the state fishery agencies' fishery management plan.

In 1984, the Maine Atlantic Sea-Run Salmon Commission (MASRSC) adopted the *Management of Atlantic Salmon in the State of Maine: a Strategic Plan.* In the plan, the MASRSC partitioned existing and historical salmon rivers into four categories (A, B, C, and D). The Kennebec River was one of five historical Atlantic salmon rivers assigned to category "C" primarily because salmon habitat was inaccessible due to impassable dams and lack of resources to initiate restoration.

In 1995, the MASRSC further delineated its proposed activities within the Kennebec River watershed in its *Maine Atlantic Salmon Restoration and Management Plan, 1995-2000.* The status of the Kennebec River Atlantic salmon resource was denoted as "unknown," but recognized that it included hatchery and wild origin strays with limited natural production. Restoration was deemed passive, with limited activities as resources allowed. The 1995-2000 goal for the Kennebec was to maintain current numbers of Atlantic salmon and increase those numbers in the future.

In 1997, the Maine Atlantic Salmon Authority (MASA, formerly the MASRSC) adopted the *Maine Atlantic Salmon Management Plan with Recommendations Pertaining to Staffing and Budget Matters.* In this document, the MASA identified a ten-year restoration goal to be undertaken in two phases. Under Phase I (1997-2001), the MASA would focus upon improving Atlantic salmon habitat and fish passage in the Kennebec River and tributaries below the Edwards Dam site. The MASA supported ongoing efforts for removal of the Edwards Dam. Phase II (2002-2006) objectives are to focus on developing a multi-agency fisheries management plan for the river above Lockwood, as well as initiating an Atlantic salmon stocking program.

1.2 Implementation of the Management Plan (1986-2001)

The strategy developed to meet the objectives of alosid restoration was planned in two phases. Phase I (January 1, 1986 through December 31, 2001) involved restoration by means of trap and truck of alewives and shad for release into spawning and nursery habitat. Phase II (January 1, 2002 through December 31, 2010), which is currently ongoing, involves providing upstream and downstream fish passage at Phase I release sites, as well as trap and truck operations to Phase II lakes. As originally planned, the Edwards Dam (whose owner chose not to participate in the KHDG/State Agreement) was to be the primary site for capturing returning adults for the restoration program. However, for several reasons, fish for the restoration were not obtained at Edwards until 1993. No capture facilities were available during 1987 and 1988; in 1989, an experimental fish pump was installed by the owner, but proved to be ineffective in capturing sufficient numbers for release in upriver spawning habitat. As a result, from 1987 through 1992, all the alewife broodstock stocked in Phase I lakes (see Table 1 for a list of these lakes) came primarily from the Androscoggin River.

A shift in the source of alewife broodstock occurred in 1993, due to an increased number of returns in the Kennebec below Edwards and the simultaneous decline in the run of the Androscoggin donor stock. In 1993, all adult alewives transferred to upstream habitat were Kennebec River returns and were predominantly trapped by netting. The broodstock source was split between the two rivers in 1994, but the bulk of the fish (93%) were Kennebec River returns, with most collected by the fish pump. Since 1995, DMR has obtained alewife broodstock exclusively from the Kennebec River. Between 1996 and 1999, the majority of alewives transported were collected using the fish pump at the Edwards Dam. In 2000 and 2001, all of the fish transported were again collected with the fish pump; however, following the removal of Edwards Dam, the operation was moved upstream to Fort Halifax in Winslow.

Due to the increased number of adult alewife returns to the Kennebec River since 1994, DMR typically not only meets Phase I stocking goals, but also has additional alewives available for other restoration sites in Maine. In 1998, alewives from the Kennebec were released into four additional ponds within its drainage and 14 ponds in eight other drainages. In 1999, due to a smaller run, this stocking practice was limited to three ponds in the Androscoggin River. In 2003, a record number of alewives were captured at Fort Halifax and released into 44 ponds throughout Maine, including all Phase I ponds that DMR was permitted and chose to stock.

The Edwards Dam issue was settled in 1998. The State of Maine took possession of the dam on January 1, 1999 as part of an agreement reached with the dam's previous owner, Edwards Manufacturing Company. The relicensing process of Edwards Dam included several landmarks that contributed to the company's decision to turn the dam over to the state. In the fall of 1997, the Federal Energy Regulatory Commission (FERC) released a basin-wide Environmental Impact Statement, which recommended removal of the Edwards Dam. The FERC voted on this removal recommendation and ordered it in December 1997. In addition, Edwards' power contract with FPL Energy expired December 31, 1998. Rather than participate in a protracted legal battle, Edwards Manufacturing chose to negotiate with and turn the dam over to the State of Maine, allowing its ultimate removal by the state.

Physical removal of the dam began in early June 1999 and was completed by the end of October 1999. The breaching on July 1 and resultant fish passage, coupled with the dewatering of the impoundment previously created by the dam, allows restoration of the Kennebec and Sebasticook Rivers above Augusta. An important component of this restoration is the access to spawning and nursery areas for all anadromous fish species, including striped bass, rainbow smelt, shortnose sturgeon, and Atlantic sturgeon, none of which utilize conventional fish passage facilities. Since dam removal was not completed in time for the 1999 spring spawning runs of alewife and American shad, trap and truck operations continued at Edwards to ensure that those fish trapped below were able to spawn upstream.

On June 25, 1999, DMR, in cooperation with the Maine Department of Inland Fisheries & Wildlife (MDIFW), installed a barrier on Sevenmile Brook to exclude undesirable, non-indigenous species. European carp, previously excluded by the Edwards Dam, have been shown to be detrimental to pond ecosystems. At this time, not enough is known about the potential impacts of this species to risk NOT having a strategic barrier on the Sevenmile drainage. The barrier was installed May 3, 2003 and MDIFW was responsible for its cleaning and maintenance.

Under the Agreement with the Edwards Dam removal, an interim trapping facility was constructed at the Fort Halifax Dam on the Sebasticook River to collect returning adult alewives and American shad in the spring of 2000. This interim facility is slated to be used for the trapping and trucking of adults for release upstream through 2004.

Under Phase I of the restoration plan, only those lakes approved by MDIFW were to be stocked with six alewives per surface acre. Of the 11 impoundments listed under Phase I, only eight were stocked at the beginning of the program in 1987; Wesserunsett Lake was stocked beginning in 1996. Restoration at the remaining two Phase I impoundments, Threemile Pond and Three-cornered Pond, both in the Sevenmile Brook drainage, was delayed due to their marginal to poor water quality. In 2001, alewives were released into Threemile at a reduced rate of two alewives $acre^{-1}$; however, this was increased in 2002 to six $acre^{-1}$. Restoration at the ten remaining impoundments was contingent upon the outcome of a cooperative research project sponsored by DMR, the Maine Department of Environmental Protection (DEP), and MDIFW to assess the interactions of alewives with resident smelt and salmonids. In June 1997, MDIFW confirmed that the Lake George Study indicated no negative impacts of alewife reintroduction on resident fish populations and outlined a schedule for stocking alewives into Phase II and Phase III habitat.

The initial restoration of alewives to Webber Pond had been postponed for several years to allow DEP time to establish a better long-term water quality database on this pond. In fact, DMR deferred stocking alewives into the whole Sevenmile Brook drainage (Webber, Threemile, and Three-cornered Ponds) for a number of years due to the ongoing work in water quality improvement by DEP, local residents, lake associations, and the China Region Lake Alliance. In early 1995, DMR, DEP, and MDIFW agreed that alewife restoration at six alewives $acre^{-1}$ would have no negative impact on water quality and may, in fact, have a positive long-term impact through phosphorus export from the lakes. However, a conservative plan was agreed upon which called for stocking only Webber Pond initially. Webber was stocked in 1997 with two alewives per acre, followed by four alewives per acre in 1998, and starting in 1999, six per acre annually. As previously mentioned, DMR implemented a conservative stocking plan at Threemile Pond in 2001 when alewives were released at a density of two alewives $acre^{-1}$.

In 2003, DMR continued to transfer American shad from out-of-basin to the Waldoboro Shad Hatchery for use as captive broodstock in the tank-spawning program. However, beginning in 2001, DMR collected broodstock from the Merrimack River rather than the Connecticut River because of its increased run size over the past few years and its closer proximity to Maine[4].

In both 2000 and 2001, DMR transferred broodstock from the Kennebec River to the shad hatchery. In 2002, a total of 50 shad were captured near the confluence of the Kennebec and Sebasticook Rivers, although only four females were transported to the hatchery (at the time of the shad capture, the hatchery was already near capacity with shad).

American shad fry production increased in 1997 with the Maine Outdoor Heritage and KHDG-funded expansion of the hatchery facility. The 2000 shad culture operational budget was funded by the DMR and Kennebec River Restoration Fund. DMR released more larval shad (2.6 million into the Kennebec watershed) in 2003 than in previous years. All larval shad raised at the hatchery were marked with oxytetracycline prior to release.

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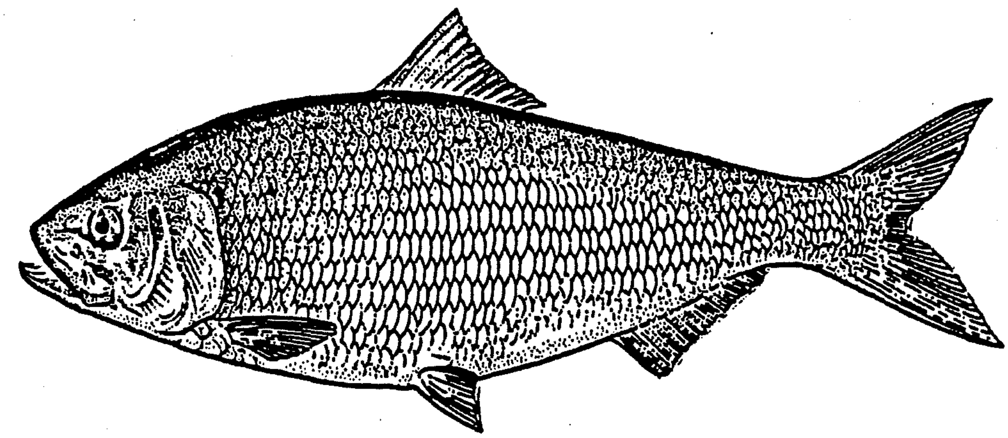
[4] Shad restoration efforts in other rivers, such as the Susquehanna, have shown fry releases to be more successful than fingerling or adult releases. Therefore, no broodstock American shad have been transferred from out-of-basin (the Connecticut River was the primary source in past years) directly to the Kennebec River since 1997. Rather, DMR has concentrated on providing broodstock for the hatchery's tank spawning effort.

APPENDIX B—2003 Shad Hatchery Report

WALDOBORO SHAD HATCHERY



2003

ANNUAL REPORT

Carolyn, Samuel and Andrew Chapman

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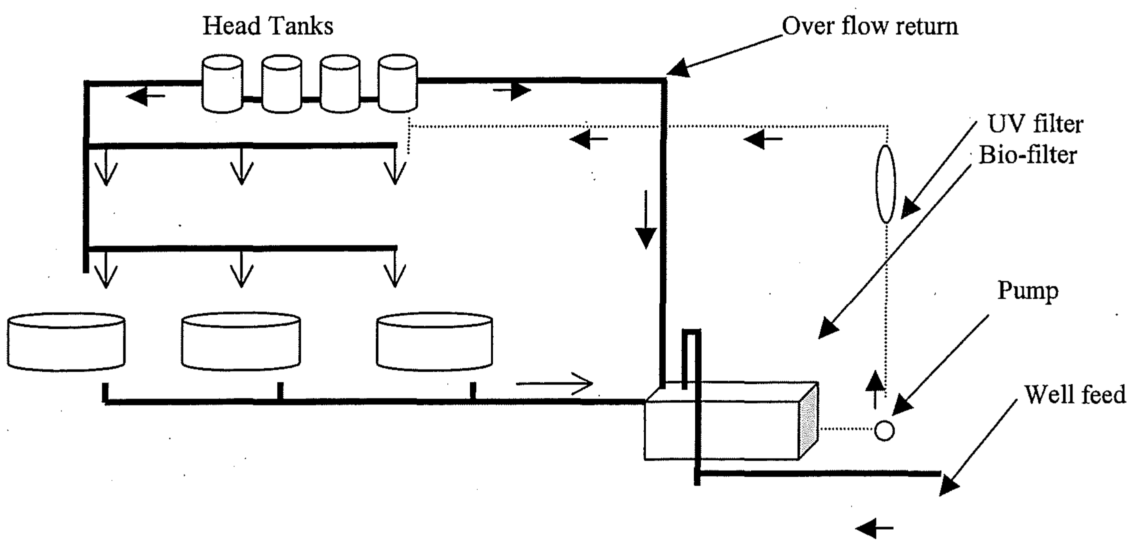
INTRODUCTION

In 1992, the Time & Tide Resource Conservation & Development Area Council, in cooperation with and financed by the Maine Department of Marine Resources, established a pilot shad hatchery in the town of Waldoboro, Maine. This operation was run in an 18' x 19' aluminum shed that had no running water or sanitary facilities. Water for the hatchery's operation was piped in from an artesian well overflow 325' from the site. Technology developed at the Susquehanna River Van Dyke Shad Hatchery proved to be very sound and reliable and was adopted for use at the Waldoboro Shad Hatchery. The Waldoboro Hatchery has successfully operated from 1992 to 2003, and during that period provided 28,551,156 fry for distribution by the DMR.

BASIC HATCHERY CULTURE SYSTEM

Well water to the culture area comes through a raised head tank, a bank of four separate tanks, which provides constant low-pressure gravity fed water through a 2" PVC pipe system.



DETAILED SYSTEM INFORMATION

Water coming into the building goes through a 50-micron filter and UV sterilizer before entering the head tank. The tank is built on a shelf close to the ceiling to provide water pressure and some height for the pipes above the culture tanks. Excess flow to the head tanks is allowed to return to a bio-filter recirculation tank where it is mixed with new water coming into the building, heated, aerated, and pumped back up into the head tanks. Seven 6' diameter x 3' deep fiberglass tanks were constructed locally and are positioned under the pipe system in a floor plan that allows easy access for culture and cleaning. Plastic upwelling incubators sit on tables beside the tanks. Newly hatched fry swim up to the top of the incubators and are automatically drained into the fry culture tanks; they are held in the tanks 5-7 days after hatching. Brine shrimp are the primary fry diet and a system to conveniently provide feed to all the tanks is required. Four fiberglass 125-gallon, conical bottom tanks were set up to supply the hatched brine shrimp for the fry.

Two 250-gallon fiberglass tank holds a day's supply of brine shrimp and is connected to two systems of pipes, valves, and timers that automatically feed a plentiful diet of newly hatched shrimp over a 22-hour period to all the culture tanks at once. The fiberglass tanks used to culture the fry are 6' in diameter and 3' deep, with a slight slope to the center drain. This drain is a threaded 2" fitting that is designed to accept a 2" standpipe, which in turn maintains the tank water level. All water flow out of the fry culture tanks is filtered and piped into the outflow end of the head tank bio-filter recirculation system. If a water crisis should develop, the larval culture tanks can be put into a temporary recirculation loop through the bio-filter tank with no stress to the fish in the tanks.

Tank effluent normally drains to a nearby pond, but the drain arrangement may be changed by opening and closing a series of valves in order to allow fry ready to be stocked to drain directly into the stocking tank on the bed of a ¾ -ton pickup.

TANK SPAWNING SETUP

The system consists of one 12' and two 15' diameter x 4' deep adult shad holding tanks that gravity drain into separate 3'x 3' x 8' bio-filter tanks from which treated water is pumped back into the spawning tanks at a rate of approximately 30 gallons per minute. Depending upon its size, each round spawning tank receives 5-7.5 gallons of new water per minute. Each bio-filter tank is now fitted with three 3000-watt stainless steel immersion heaters, each set of which provides as much heating capacity as a standard 30,000 BTU, 40-gallon home hot water heater. The previous use of 4000-watt immersion heaters was an undersized heating capacity for maintaining optimal tank spawning temperatures early in the season. Each bio-filter tank has had its degassing capabilities augmented with the addition of aeration towers with extra surface-to-water enhancing media.

Because shad eggs sink, the spawning tank has to drain from the center bottom. To accomplish this, an 8" plastic collar is placed around the 4" overflow. This collar causes the water to drain from the center bottom of the tank, carrying along with it any eggs that naturally drift to the center. Water coming from the spawning tank enters the bio-filter tank through a 3" pipe tee that is drilled with ¾" holes and acts as a muffler in slowing down the water velocity and evenly diffusing water currents. Knitted polyethylene bags of 0.5mm mesh are tied onto both legs of the water muffler to collect eggs released by adult shad; the bags are changed each morning and the collected eggs placed in incubators.

TANK SPAWNING SYSTEM - 2003 OPERATION

The system was operated in the same manner as that described in the 1999 report. The eggs from the tank spawning systems were produced without the use of hormones.

QUALITY OF BROODSTOCK:

Broodstock adult shad transported to the hatchery by truck can exhibit obvious bruising about the head and inside the eyes, as well as severe scale loss. Any incoming shad that exhibit bruising about the head are either DOA or die soon after being transferred to the spawning tank. In addition to the bruised and traumatized shad, there is a significant percentage that are lightly battered and de-scaled. These shad soon become festooned with heavy patches of fungus and eventually die. Careful selection by the transport crew of only vigorous and blemish-free fish has shown to have a dramatic positive effect on the overall survival of the transported shad.

For the 2003 season, the hatchery maintained the theory that more fish would produce more eggs. Supposedly, three times as many fish would produce three times as many eggs. This only works if the proportion of female fish to male fish is properly balanced. During the 2003 season, extra effort was made to select quality female shad from the fish lift holding pen, located in Lawrence, MA on the Merrimack River. This activity resulted in broodstock that were in very good condition, and produced the largest number of eggs, to date, of all broodstock batches. Mortalities collected from the spawning systems were 56% female and 44% male.

EGG VIABILITY

It has been noticed that some batches of eggs exhibit low viability due to the presence of small, immature eggs. These eggs contribute to nutrient loading and the promotion of fungal growth in the egg incubators that would be lessened if the small eggs were removed. Since 1998, all eggs delivered to or produced at the hatchery are sieved on a variety of mesh sizes. Past investigation has revealed that most eggs <2mm are not viable. Generally, only the eggs that are retained on a 2mm screen are selected for incubation.

ENUMERATION OF CULTURE TANK MORTALITY

During the hatchery season, waste that is routinely siphoned from the bottom of the culture tanks is sampled to determine larval mortality after hatching and up to the time of stocking. Individual tanks are not cleaned daily. It takes several days for detritus to develop and show on a tank bottom; therefore, the cleaning time interval varies from one batch of larvae to the next. When a tank is cleaned, the bottom waste is siphoned into several plastic buckets and diluted to 15 liters per bucket; the contents are suspended by mixing with an open hand. While a bucket is being mixed, three 10-ml samples are removed and emptied into three individual petri dishes. The live and dead larvae are counted separately, but both are counted as mortality. An average of the three samples, including live and dead larvae, are determined as larvae mortality per milliliter. The number of mortalities per bucket is estimated by multiplying the average of the three samples by 15,000. Finally, total mortality is estimated as the sum of the means of all the buckets. Mortalities were determined for all batches of cultured shad and are listed as "Fry discarded" in the data Table 1. The number of fry discarded increases with amount of time they are maintained in the hatchery system.

HATCHERY PRODUCTION SUMMARY FOR 2003

Waldoboro Hatchery Tank Spawning System - Merrimack River Shad

A total of 638 Merrimack River shad were delivered to the Waldoboro Shad Hatchery between May 22 and June 23. While in the hatchery system, the Merrimack fish produced a total of 231.87 liters of eggs >2mm, equaling 12,267,352 eggs with an average viability of 81%. During culture, 597,036 dead and alive shad fry were siphoned with waste from the bottom of the tanks and discarded into waste treatment ponds. On July 2, 369 (58%) .

of the 638-broodstock shad held in the tank spawning system were released back into the wild (Table 2). A total of 9,629,587 fry were stocked in the Kennebec, Sebasticook, and Androscoggin Rivers between June 21 and August 12. Twenty thousand six hundred fingerlings were seined from the waste treatment ponds and released into the Medomak River on September 26.

Waldoboro Hatchery Tank Spawning System - Kennebec River Shad
There were no Kennebec River shad captured this year.

FRY STOCKING SUMMARY
The following list of dates, names, locations, and numbers of fry are the American shad fry released back into Maine waters during the 2003 season:

Date	Egg location	Stocking location	# Fry stocked
06/18/03	Merrimack	Shawmut - Kennebec	305,624
06/19/03	Merrimack	Shawmut - Kennebec	385,552
06/20/03	Merrimack	Burnham - Sebasticook	579,248
06/21/03	Merrimack	Burnham - Sebasticook	665,164
06/23/03	Merrimack	Shawmut - Kennebec	571,009
06/24/03	Merrimack	Shawmut - Kennebec	689,358
06/25/03	Merrimack	Shawmut - Kennebec	460,578
06/26/03	Merrimack	Burnham - Sebasticook	519,486
06/27/03	Merrimack	Fort Halifax - Kennebec	614,814
06/27/03	Merrimack	Fort Halifax - Kennebec	730,336
06/30/03	Merrimack	Fort Halifax - Kennebec	556,301
06/30/03	Merrimack	Pejepscot - Androscoggin	748,586
07/01/03	Merrimack	Fort Halifax - Kennebec	521,256
07/03/03	Merrimack	Fort Halifax -Kennebec	759,161
07/05/03	Merrimack	Pejepscot - Androscoggin	806,527
07/07/03	Merrimack	Fort Halifax - Kennebec	364,716
07/15/03	Merrimack	Burnham - Sebasticook	93,286
07/16/03	Merrimack	Fort Halifax - Kennebec	232,485
07/16/03	Merrimack	Pond/Tank DMR OTC mark samples	5,500
08/26/03	Merrimack	Pond - Medomak	20,600
		Total Fry Stocked:	**9,629,587**

POND CULTURE
No shad fry were intentionally stocked into the ponds for rearing; however, fall fingerlings were produced as a result of fry either escaping from the hatchery culture tanks or caught when waste was removed from the bottom of the tanks. The culture tanks have a 500-micron nylon screen that fits tightly over the tank standpipe to prevent fry from escaping down the drains. Even so, when the standpipe screens are changed, a few larvae escape into the drains. On September 26, 2003, approximately 20,600 three-inch fall fingerlings were seined and released into the Medomak River by DMR personnel from the hatchery pond system.

Fry started	Fry discarded	Fry stocked	Date stocked	Stocking location
6/8				
6/9	2,280			
N/A				
6/11				
6/12				
6/13	4,800			
6/13	128,600	305,624	6/18	Shawmut
6/14	2,800			
6/14	1,710			
6/14	3,880			
6/14	3,733	385,552	6/19	Shawmut
6/14				
6/14				
6/14				
6/14				
6/14	3,733	579,248	6/20	Burnham
6/16	9,200			
6/16	12,360			
6/16		665,164	6/21	Burnham
6/16				
6/17				
6/17	63,600	571,009	6/23	Shawmut
6/18	200			
6/18	8,800	698,358	6/24	Shawmut
6/20				
6/20	64,680	460,578	6/25	Shawmut
6/20	15,200			
6/21	11,320	519,486	6/26	Burnham
6/21				
6/21				
6/21				
6/21	3,600			
6/21	4,280	614,814	6/27	Ft. Halifax
6/21				
6/21	3,720	730,336	6/27	Ft. Halifax
6/21	18,120			
6/21	3,300			
6/23	13,930			
6/23		556,301	6/30	Ft. Halifax
6/25	300			
6/25	18,960			
6/25				
6/25		748,586	6/30	Pejepscot
6/26	1,000			
6/26	5,200			
6/27		521,256	7/1	Ft. Halifax
6/28	520			
6/28				
6/28	56,400	759,161	7/3	Ft. Halifax
6/30	10,640			
6/30	13,200			
6/30		806,527	7/5	Pejepscot
6/30				
7/2	10,410	364,716	7/7	Ft. Halifax

Fry started	Fry discarded	Fry stocked	Date stocked	Stocking location
7/2	11,300			
7/3	3,920	93,286	7/15	Burnham
7/4	1,300			
7/5	80,040	232,485	7/16	Ft. Halifax
		5,500	7/16	Stock to Pond

APPENDIX C - 2003 Atlantic Salmon Streamside Incubation Report

Report to the Maine Atlantic Salmon Technical Advisory Committee - October 2003

STREAMSIDE INCUBATION: A Low Tech, Low Cost Approach
to Atlantic Salmon Restoration
(by Paul Christman, Kevin Dunham and Dan McCaw)

Introduction

In September 2002, the Sidney Regional Office staff of the Maine Atlantic Salmon Commission (MASC) proposed a pilot study to examine streamside incubation of Atlantic salmon eggs in the Kennebec River drainage. The pilot study was designed to determine the feasibility of a low-tech, low-cost method of incubating eggs for Atlantic salmon restoration. The Kennebec River was chosen because Atlantic salmon historically were present and currently do not have dedicated governmental resources.

In 1997, the Maine Atlantic Salmon Authority (MASA, now the MASC) adopted the *Maine Atlantic Salmon Management Plan with Recommendations Pertaining to Staffing and Budget Matters*. In this document, the MASA identified a ten-year Kennebec River restoration goal to be undertaken in two phases. Under Phase I (1997-2001), the MASA would focus upon improving Atlantic salmon habitat and fish passage in the Kennebec River and tributaries below the Edwards Dam (now removed). The Phase II (2002-2006) objectives are to develop a multi-agency fisheries management plan for the river above the Lockwood Dam and to initiate an Atlantic salmon stocking program.

The Kennebec River had once supported large runs of Atlantic salmon. The MASC has initiated restoration efforts on the Kennebec River by conducting habitat surveys and monitoring existing populations and water temperatures. The MASC has worked with state and federal resource agencies, NGOs, and hydroelectric dam owners to establish a schedule for the construction and operation of upstream and downstream fish passage facilities. The second phase will be to initiate active stocking of salmon. Salmon fry, parr, and smolt production facilities cannot meet existing demand. Therefore, it is imperative that methods that are less dependent upon hatcheries need to be evaluated as a way of producing juvenile salmon until such time as hatchery resources become available. In pursuit of this objective, the staff of the Sidney Regional Office of the MASC proposed to test streamside incubator technology currently being used by volunteer groups in various restoration projects in the Western United States and the Canadian Maritimes.

We initially proposed to test three 10,000-egg capacity streamside incubators in the Sandy River. It became evident through the scientific literature and discussions with scientists and volunteers operating streamside incubators, that gathering performance information on different types of incubators would be beneficial. Therefore, we decided to set up two 5,000-egg capacity incubators at three sites. The styles of incubators chosen for this project were Whitlock Vibert box (WV) and upweller (UPW) type incubators.

The Sandy River, a large mid-drainage tributary to the Kennebec River, was selected for the study site. Incubating Atlantic salmon eggs at remote sites in the Sandy River subdrainage will answer the following questions: 1) Can we successfully hatch fry using water sources in the Sandy River drainage? 2) In concert with recently collected Atlantic salmon habitat information, are growth and survival of juvenile salmon in barren areas of the Sandy River comparable to growth and survival in other Maine salmon streams? 3) Is it cost-effective to establish a volunteer group streamside incubator program? The pilot study will also serve to provide us with practical experience building and operating streamside incubators.

This preliminary report of our findings answers Questions 1 and 3. Growth and survival information will be collected during the 2003 field season and will be reported in 2004, as described in the initial research proposal.

Methods

Discarded refrigerators were selected for the structure of the incubators. Six coolant-free discarded old refrigerators were obtained from local transfer stations. The mechanical components of the refrigerators were removed and the interiors were sealed to create flow through incubation chambers. We left the interior liner with insulation intact. In general, the interior dimensions of the refrigerators were approximately 121 cm long x 66 cm wide x 46 cm deep.

Three incubators were configured according to specifications for WV incubators provided to us by Don Duff, Senior Aquatic Ecologist, United States Fish and Wildlife Service (personal communication). Each WV incubator consisted of a settling chamber at the head end of the box, a set of baffles to direct flow through WV boxes in a meandering channel and a stand pipe as an outlet (Figure 1). To create the settling chamber, Plexiglas panels were held in place with silicone sealant as a partition at the head end of the incubator and reinforced with aluminum angle bar. This created a water settling chamber 46 cm long x 66 cm wide x 25 cm deep. Plexiglas was also used to create baffles 17.8 cm high which were secured to the bottom and one side of the chamber with silicone sealant. The side on which baffles were attached alternated causing the water to flow in a meandering fashion from the settling chamber to the outlet. The channel was large enough to accommodate WV boxes perpendicular to the flow with a 2.5 cm layer of gravel on the bottom of the incubator. Individual WV boxes measured 14.5 cm long x 5.5 cm wide x 9.0 cm deep. A standpipe in the incubator outlet was constructed from a short piece of PVC pipe cut to maintain water levels sufficient to cover the WV boxes.

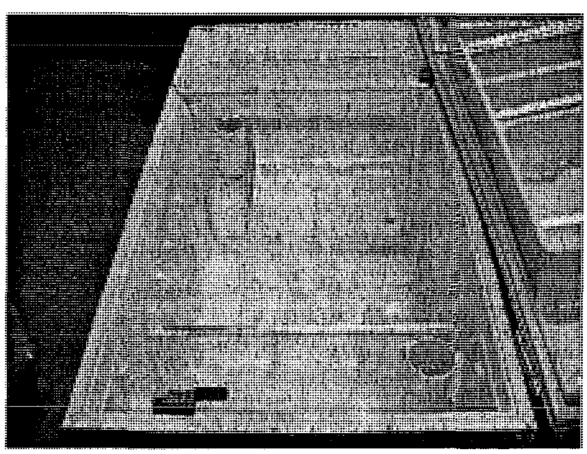


Figure 1. Photo of Whitlock Vibert (WV) box incubator with WV boxes

Each UPW incubator contained a settling chamber similar to the WV style. Instead of forcing the flow as it leaves the settling chamber into a meandering channel as in the WV incubators, the flow is forced under the false floor of an upwelling chamber (Figure 2). To create an upwelling chamber, silicone sealant was used to secure two Plexiglas panels together up against the incubator wall and the settling chamber. An aluminum perforated sheet covered by fiberglass screen was installed as a false floor. The panel adjacent to the settling chamber wall did not extend to the floor of the incubator, which allowed water to flow under the chamber floor and up through the perforated sheet. The dimensions for the upweller chambers were 50.8 cm long x 45.7 cm wide x 38.1 cm deep. This design accommodated four layers of poultry nesting material and 2.5 cm of stone spacers on the bottom and between layers. The standpipes were constructed similarly to the outlets in the WV incubators.

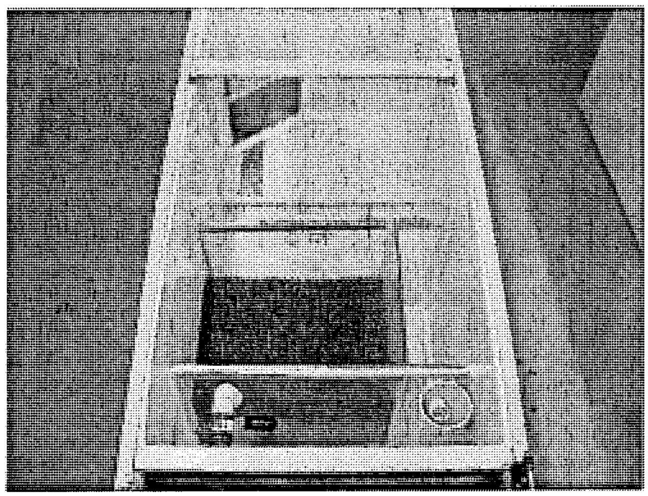


Figure 2. Photo of streamside UPW incubator with poultry nesting material.

To ensure that clean water circulated throughout the incubators, two filters were installed in each settling chamber. Stock fiberglass furnace filters between the inflowing water and the settling chamber were the primary filter. The second filter was made of 5 cm PVC pipe perforated with 1.27 cm holes and wrapped in polar fleece. This second filter was secured in the settling chamber and filtered water before it entered into the incubation chamber.

Stream water was supplied to the incubators by gravity feed through a 3.8 cm polyethylene pipe. The feed pipe was laid in the stream and connected to a three-way connector to divide the flow between the two incubators and one overflow to return unneeded water back to the stream. Each incubator was fitted with a valve in the settling chamber to adjust flows entering into the incubator. A 3.8 cm polyethylene pipe was connected to each out-flowing incubator standpipe to discharge water back into the stream. To minimize freezing, all pipes were wrapped with R-19 household fiberglass insulation and covered with plastic sheeting. To provide additional insulation, we covered all water lines and incubators with snow.

We identified seven potential sites on tributaries to the Sandy River that possessed the necessary site characteristics. Important site characteristics included high gradient to allow for short feeder pipes; sufficient wintertime stream flows; ease of access; and varied water sources such as springs, ponds and streams. Seven possible sites were Perry Pond Brook, Warm Brook, Warm Brook Spring, Fox-Carlton Pond outlet, Mill Brook, Dickey Brook, and an unnamed brook on the Thorndike property in Strong.

Warm Brook and Mill Brook were selected as our primary sites and we deployed incubators in January and February 2003 (Figure 3). Four incubators, two WV and two UPW, were installed on Warm Brook and two incubators, one WV and one UPW, were installed on Mill Brook. The catchments for each of these brooks are 8.9 km^2 for Warm Brook and 4.9 km^2 for Mill Brook. The gradient at the incubation site on Warm Brook was 2% and for Mill Brook, 11%.

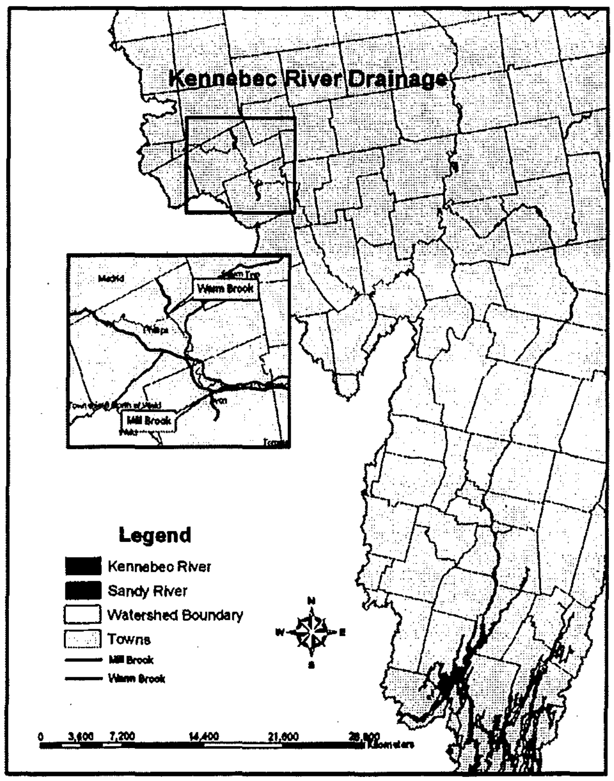


Figure 3. Map of Kennebec River drainage showing incubation sites

The boxes are referred to numerically and according to type of incubator. Incubators 1-4 were located on Warm Brook and incubators 5-6 on Mill Brook. Incubators 1, 2, and 6 were WV and 3, 4, and 5 were UPW (Table 1). We initially set up two incubators on Dickey Brook, but due to freezing problems, both incubators were moved to Warm Brook just prior to receiving eggs. One of the moved incubators, 4 UPW, was installed adjacent to the two Warm Brook (2 WV and 3 UPW) incubators and shared their water supply line. The second moved incubator (1 WV) was installed on its own site with a separate water supply line approximately 150 meters upstream of the other three incubators.

Table 1. Locations & Incubator Types Utilized in 2003

	Incubator Number and Type					
Tributary	1	2	3	4	5	6
Warm Bk	WV	WV	UPW	UPW		
Mill Bk					UPW	WV

Prior to receiving eggs, the water flow to each incubator was adjusted to yield between 2.2 - 3.8 L/min per 1,000 eggs.

On February 24 and 25, we took delivery of approximately 43,496-eyed Penobscot F_2 eggs from the Green Lake National Fish Hatchery (GLNFH), Ellsworth Falls, Maine. The F_2 eggs are two generations removed from sea-run adults. The eggs were from 13 matings, fully mixed, to control for variable survival in any single family and from a single egg take. According to the egg developmental index provided to us by GLNFH staff, the eggs were determined to be 39% developed at the start of incubation in the field. The estimated egg quantities were derived at time of deposition in the incubators through volumetric displacement. Eggs were spread equally on three layers of poultry nesting material in each UPW incubator and each individual WV box received 380 eggs. A stone was placed on top of each WV box to keep them submerged. The approximate number of eggs deposited in each incubator was as follows:

Incubator	No. Eggs
1 WV	5,570
2 WV	7,600
3 UPW	9,300
4 UPW	5,866
5 UPW	7,560
6 WV	7,600

After deposition of eggs, incubators were inspected two to three times weekly to make observations, to clean filters, and to adjust flows. On two occasions, extremely cold weather caused icing in the main water supply line at both Warm and Mill Brooks. The pipes were disconnected, cleared, and flowing water restored to the incubation boxes. Another interruption in flow occurred at 5 UPW. Inexplicably, flow stopped during the weekend of May 3-4. To compound the lack of flow, the incubator also developed a leak that allowed water levels to drop within the incubator upon cessation of flow. However, the alevin were not completely dewatered. Visual inspections of the alevin indicated some mortality had occurred. Temperature recorders were also placed at each site for tracking egg development through a temperature based development index.

Just prior to release of fry into the wild, an attempt was made to install containers in the outflow to capture fry at volitional swim-up. However, fry developed faster than anticipated due to rapidly increasing water temperatures during the spring season. Initiation of volitional swim-up had been missed and it was decided that fry should be released. All alevin were removed from the incubators on May 27 and 28 and released in a pre-chosen stretch of the mainstem Sandy River in Madrid.

Weights from four 100-fry samples were used to estimate total fry counts from each incubator. A 100-fry sample weight was obtained from each of the Warm Brook incubators and the four sample weights were averaged prior to estimating total fry numbers. Two additional 100-fry sample weights were taken from the Mill Brook incubators, but not used. Both samples were miscounted and were excluded.

All time and costs expended were recorded to establish the feasibility of a streamside incubation program for volunteer groups. We also projected what a second year would cost, given that some items would not need to be purchased again and time spent at certain activities the first year would not be necessary for the second year.

Results

The total estimated fry counts per incubator were as follows:

Incubator	No. Fry
1 WV	5,466
2 WV	6,922
3 UPW	8,283
4 UPW	5,311
5 UPW	6,404
6 WV	7,082

The estimated number of eggs incubated and the estimated number of fry removed from each incubator is graphically represented in Figure 4. Hatching success ranged from a low of 85% to as high as 98% (Figure 5). Average daily temperatures taken from temperature loggers at each site and used to track fry development indicated that at the time of fry removal, Warm Brook fry were at 94% development and Mill Brook fry were at 96% development.

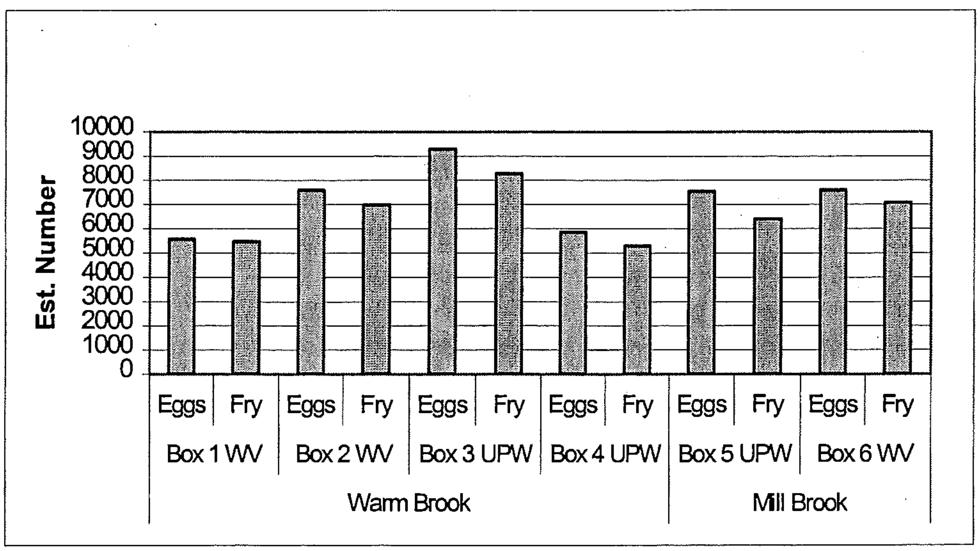


Figure 4. Estimated number of eggs deposited and fry removed from each incubator at two sites.

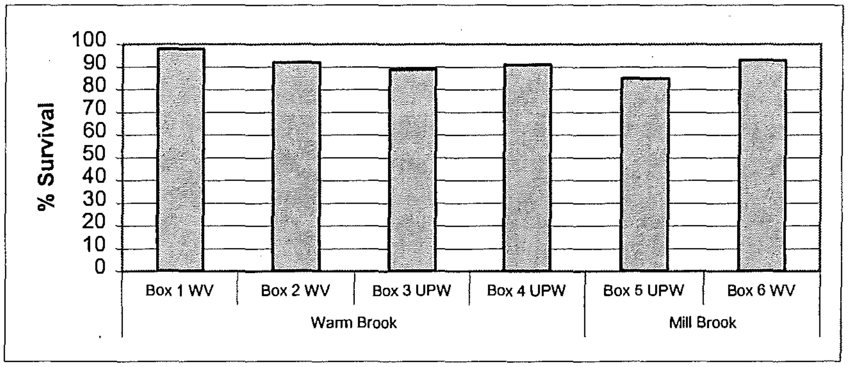


Figure 5. Survival from estimated number of eggs to fry from each incubator at two sites.

Monetary expenditures, including ancillary equipment, for this project were recorded and broken down by incubator. Costs for the six incubators averaged $247.00 each, totally assembled and placed in operation. We also purchased water quality testing equipment at a cost of $265.00 and expended an additional $604.00 on miscellaneous items including shovels, propane torches, and gloves. Total expenditures for the entire project were $2,352.24. If the project was to continue for a second year, the operational cost is estimated at approximately 30% of the initial investment ($660.00) because some items are reusable. Expenditures of time and money on travel are not included. The time and money spent traveling is project specific and any volunteer group planning on duplicating the project could expect different travel expenses than we experienced.

Each person recorded his/her time at each task and the entire time was added together to generate total project hours. We spent approximately 137 hours conducting research, attending meetings, and giving presentations regarding this project. Water quality sampling and site reconnaissance took approximately 81 hours. Incubator construction (including design modification and procurement of supplies) added up to 287 hours and field deployment amounted to 228 hours. The greatest time consumers were incubator maintenance (314 hours) and tending (308 hours). Total time spent on this project, not including traveling time, was 1,355 hours.

If this project were to continue for a second year, far less time would be needed. Less time would be spent on construction, reconnaissance, water quality sampling, and research, as well as time spent on learning how to construct incubators and testing equipment. The total time for a second year is estimated at 468 hours, excluding travel time.

Discussion

Streamside incubation was successful in this preliminary attempt. We were able to operate six large incubators and achieve an overall eyed egg to fry survival rate of 90%. It should be noted that average hatching success would have been higher were it not for incubator 5 UPW, which experienced a flow stoppage and a water leak that resulted in some alevin mortality.

The only substantial difference found between the two types of incubators was egg capacity. To incubate 6,000 to 7,600 eggs required about 20 WV boxes, which took up the majority of space in the meandering channel. Even if WV boxes were stacked, it would be unlikely that we could fit more than 30,000 eggs in a single WV incubator. In comparison, the upwellers could hold a far greater number of eggs. A single upweller incubator loaded to capacity, using suggested densities found in the literature, could have incubated approximately 112,000 eggs on eight layers of nesting material with a maximum potential of 672,000 eggs in the six incubators. If the hatching rate were consistent to the rate observed in this project, the maximum number of 672,000 eggs would have produced 604,000 fry to release to the wild. It would be worthwhile to test the capacity of these units to see if a similar hatch rate could be achieved. The ability to fully utilize incubators to capacity, coupled with high hatch rates, would support the utility of incubators as a restoration tool.

The materials used to construct incubators were relatively inexpensive and easy to find. Most items were purchased at local hardware stores. The only item we had difficulty obtaining was the poultry nesting material, which was generously donated to us by the Dug Brook Hatchery, Ashland, Maine, as we were unable to find a supplier at the time.

The greatest difficulty facing any group initiating a project such as this one is the constant attention needed to incubate eggs streamside. We found two problems that necessitated regular inspections. The first problem we encountered was icing of inflow and outflow lines and, to a lesser extent, freezing within the incubator itself. We found that we could keep water flowing in the main pipes at air temperatures of -23°C, but when temperatures dropped below this, we experienced considerable icing. Fortunately, we received our eggs after most of the cold weather had passed, so icing was not as much of a problem as it could have been if we had received our eggs in early February. The second problem we experienced was silting within the incubators. Even though we purchased and constructed filters that worked adequately, we needed to clean them at least every other day to keep water flowing properly through the incubators. It is possible with some design modifications or better site location, freezing and silting could be minimized. We recommend that more testing take place regarding these concerns and that this project continue for at least two more years to encompass all weather and stream conditions that might be expected for any restoration project using streamside incubators in this locale.

APPENDIX D - Proposed 2004 Trap & Truck Budget

Job 1. Trap and Truck Alewives

Transfer of broodstock alewives via tank truck will begin in May and conclude in June. About 90% of the alewife habitat that has been stocked in past years is in the Sebasticook drainage, which means that the majority of returning adult alewives will home to the Sebasticook River.

Alewives will be trapped using the Transvac fish pump and storage tank that were employed last year at Fort Halifax. DMR personnel will remove trapped fish from the tank, sort all fish collected, remove undesirable species, pass other target species, and count and load alewives in the tank trucks. DMR personnel will transport the alewives and release them in the designated lake spawning habitat.

If blueback herring are captured, they may be stocked into riverine habitat above the Fort Halifax Dam. Alewife stocking goals for 2004 are summarized in Table 1.

Table 1.
Phase I and II Stocking Locations with Alewives (6/acre) in 2004

Ponded Area	Surface Acreage	Stocking Target
Sebasticook Lake	4,288	25,728
Lovejoy Pond	324	1,944
Plymouth Pond	480	2,880
Pleasant Pond (Stetson)	768	4,608
Douglas Pond	525	3,150
Pattee Pond	712	4,272
Threemile Pond	1,077	6,462
Unity Pond	2,528	15,168
Webber Pond	1,252	7,512
Wesserunsett Lake	1,446	8,676
Big Indian Pond	990	5,940
Great Moose Lake	3,584	21,504

Job 2. Trap and Truck of American Shad

Transfer of broodstock American shad via tank truck will begin in May and conclude in July. DMR expects to transfer about 1,000 shad broodstock to the shad hatchery. Due to the efficient and highly successful 2003 season, the majority of broodstock will be transferred from the

Merrimack River. However, Florida Power Light and Energy (FPLE) is required by the *Kennebec River Settlement Accord* to install, operate, and maintain all measures necessary for the capture of adult shad broodstock. DMR will transport any adult shad captured at Fort Halifax to the shad hatchery where they will be placed into a tank spawning system. Lengths, scales, and otoliths will be collected from all adult mortalities occurring at Fort Halifax during transport and at the hatchery.

Job 3. Transportation of American Shad Larvae

DMR will load, transport, and release shad larvae produced at the hatchery. As the larvae reach 7 to 21 days old, they will be loaded into a transportation tank, trucked to the appropriate habitat, and released. This operation begins in mid-June and may continue through mid-August.

Job 4. Assessment of Young-of-Year American Shad and Alewives

DMR will continue to sample young-of-year American shad in the segments of the Sebasticook and Kennebec Rivers that were stocked with shad fry, fall fingerlings, and adult broodstock. Sampling will occur between July and October and may include seining, fyke netting, trawling, electrofishing, or sampling downstream migrants at hydroelectric sites. Representative numbers of juvenile shad will be retained for otolith extraction and checked for tetracycline marks applied at the hatchery.

DMR will sample young-of-year alewives in both Great Moose Pond and Big Indian Lake, which are being stocked with broodstock alewives for the first time. Sampling will occur between July and October and may include seining, fyke netting, trawling, electrofishing, dip or cast netting, in addition to sampling downstream migrants at hydroelectric sites or lake outlet dams.

Job 5. Assessment of Downstream Passage of American Shad and Alewives

DMR will survey the outlet streams of lakes or ponds stocked with broodstock alewives to determine the feasibility of downstream migration of the postspawner adult and young-of-year alewives. Potential obstacles to passage will be recorded and revisited as the emigration of alewives is observed in the river system. Much of the stream survey work will take place in late June through August, with the follow up visits occurring as needed throughout the fall.

DMR will visit hydroelectric dams, as well as non-hydro dams, located below shad and alewife stocking sites and record observations regarding the availability, quality, and effectiveness of downstream passage at these sites. The proper authorities will be notified if problems are observed. Dam surveys may begin as early as June and will take place through November and the termination of alosid emigration.

Job 6. Studies of the Fish Assemblage of the Kennebec River

DMR will continue to collect data on the fish community at several locations in the Kennebec River between Merrymeeting Bay and Winslow. In addition, habitat data including DO, substrate type, water temperature and depth, flow, and measurements of bank stability and vegetation will be collected. This effort will continue in 2004.

Sampling methods will include fyke netting, electrofishing, minnow trapping, trawling, angling, and beach seining. Beach seines will be used as the primary means of capturing YOY fish. However, other means may need to be employed to capture adults. Samples will be collected biweekly from all sites and otoliths will be extracted from samples of American shad captured to determine the presence of an OTC mark.

2004 Budget

	Q1	Q2	Q3	Q4	TOTAL
Personal Services	$27,750	$41,250	$48,000	$34,500	**$151,500.00**
Materials/Supplies	$2,333.00	$3,500.00	$583.00	$583.00	**$7,000.00**
Operations/Maintenance	$1,857.00	$5,571.00	$3,714.00	$1,857.00	**$13,000.00**
State Indirect Cost (2%)	$638.80	$1,006.42	$1,045.94	$738.804	**$3,429.96**
Capital					
TOTALS	**$30,025.58**	**$50,258.19**	**$46,227.84**	**$30,961.79**	**$174,929.96**

APPENDIX E - Proposed 2004 Kennebec River Atlantic Salmon Restoration

Work Plan & Budget

Proposed 2004 Kennebec River Atlantic Salmon Restoration Work Plan and Budget

Job 1. Perform Habitat Surveys on Tributaries of the Kennebec River.
A standard habitat survey will be conducted on selected tributaries and mainstem of the Kennebec River. Maine Atlantic Salmon Commission (MASC) staff from the Sidney office will record quantitative measurements (length, width, depth, etc.), substrate composition, suitability for juvenile rearing, spawning, and holding habitat for salmon and provide Global Positioning System (GPS) points for habitat breaks. Work will continue within the Sebasticook River drainage, the Sandy River drainage, and mainstem of the Kennebec River below Skowhegan.

Job 2. Produce Geographic Information System Coverages.
Using the habitat information collected above, MASC staff will produce Geographic Information System (GIS) coverages to display the location and estimate the amount of salmon habitat types available in the surveyed streams. Coverages produced from the 2001- 2004 habitat surveys will also give us the ability to display redd locations and areas of critical importance to salmon in the lower mainstem and tributaries.

Job 3. Assess Current Atlantic Salmon Populations in the Kennebec River & Tributaries.
The MASC staff will continue to electrofish Messalonskee, Sevenmile, and Togus Streams and Bond Brook to 1) add to the historical database for Togus Stream and Bond Brook, and 2) establish presence/absence and/or densities of salmon in lower mainstem Kennebec River tributaries. In addition, other tributaries identified as having salmon habitat will be electrofished for presence/absence of salmon or to establish baseline fish species composition information.

In a further effort to assess adult returns to the lower Kennebec River and its tributaries, complete redd counts will be conducted on all spawning habitat identified by the habitat surveys. This will entail surveying for evidence of spawning salmon in the mainstem Kennebec from Waterville/Winslow to Augusta and all lower mainstem tributaries to their first upstream obstruction.

Job 4. Obtain Temperature Profiles of Selected Kennebec River Tributaries
The MASC will monitor water temperature throughout the summer months in the Kennebec River and selected tributaries. Data loggers will be deployed in lower tributaries (e.g., Togus Stream and Sebasticook River) and in the mid-Kennebec River portion of the drainage (e.g., Sandy River, Carrabassett River) and the mainstem of the Kennebec River below Madison to record summer river temperatures and to gain a better understanding of thermal regimes that may exist in streams with the potential for Atlantic salmon restoration.

Job 5. Streamside Incubation
MASC staff will continue testing streamside egg incubators in the Sandy River drainage. Incubating Atlantic salmon eggs remotely in the Sandy River will provide MASC with the following information and benefits: 1) fry hatching success using water sources in the Sandy River drainage; 2) growth and survival of juvenile salmon in the Sandy River in concert with recently collected habitat information; 3) cost effectiveness for establishing a volunteer group streamside incubator program; and 4) experience building and operating streamside incubators.

A streamside incubator program operated successfully in remote locations within the Kennebec could be a viable option for restoration start-up until federal and/or state hatchery resources can be made available, until privately funded hatcheries are constructed, or until private hatcheries are contracted to provide eggs and/or juvenile salmon of suitable stock.

Job 6. Annual Report and Recommendations

The MASC staff will produce an annual report with recommendations for future salmon efforts in the Kennebec River and its tributaries. These recommendations will be based on available habitat, current populations status, and estimated salmon production potential in the waters currently accessible to salmon.

Job 7. Development, Updating, & Implementation of a Long-Range Restoration & Management Plan

The MASC staff will participate in joint planning and development of a comprehensive basin wide fish management plan with the Department of Marine Resources and Department of Inland Fisheries and Wildlife. Long-term planning is necessary for the proper management of the existing Atlantic salmon resource and potential future expansion of a restoration program in the Kennebec River.

Job 8. Public Outreach

The MASC staff will participate in meetings, forums, round-tables, etc. as necessary to appraise public and private groups of MASC activities within the Kennebec River drainage. This will include interpretation, explanation, and promotion of MASC programs, policies, and concerns to the public, private organizations, stakeholders, and the media in the Kennebec River watershed.

	Q1	Q2	Q3	Q4	Totals
Personal Services	$2,464.00	$3,080.00	$8,008.00	$8,008.00	$21,560.00
Materials/Supplies	$ 750.00	$1,000.00	$1,000.00	$ 750.00	$ 3,500.00
Operations/Maintenance	$1,500.00	$1,500.00	$2,000.00	$1,000.00	$ 6,000.00
Capital	$ -	$ -	$ -	$ -	$ 0.00
Totals:	**$4,714.00**	**$5,580.00**	**$11,008.00**	**$ 9,758.00**	**$31,060.00**