Town Brook (Quincy, MA) specifics Excerpted from:

Massachusetts Division of Marine Fisheries
Technical Report TR-30

Rainbow smelt (Osmerus mordax) spawning habitat on the Gulf of Maine coast of Massachusetts

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The following is a verbatim , albeit reformatted, version of the original document text, data, figures and illustrations.

Excerpted from TR-30 Sec2:85-95 (Town Brook, Quincy MA)
http://www.mass.gov/dfwele/dmf/publications/tr30_smelt_spawning_habitat.pdf

Town Brook (Quincy)

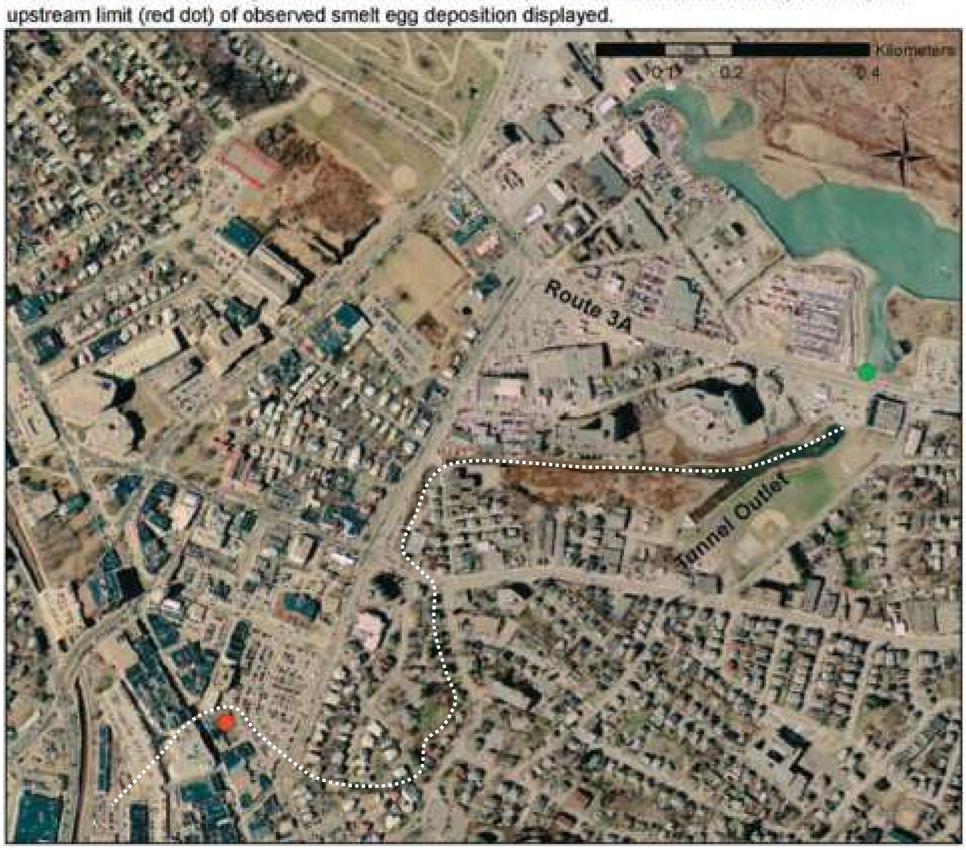
STUDY AREA

Town Brook is located in the Weymouth and Weir River Coastal Drainage Area (Halliwell et al. 1982) on the south side of Boston Harbor. Town Brook originates from freshwater wetlands in the Blue Hill Reservation and flows into the Old Quincy Reservoir in Braintree. From the Old Quincy Reservoir, Town Brook flows for about 4 km to reach the tidal zone, where it is known as Town River. Town River flows into Town River Bay which meets the Fore River close to the confluence with Hingham Bay. The drainage area of Town Brook is approximately 11 km^2 (Wandle 1984) and is highly developed for much of its path. Town Brook crosses Rt. 128 before reaching Old Quincy Reservoir and near the Quincy border crosses under the junction of the Rt. 93 and Rt. 3. Town Brook receives stormwater drainage from a large area of roadways and retail complexes that have proliferated near the highways. In Quincy, Town Brook runs through dense residential areas and the downtown business district before reaching Town River (Figure 4.3). Much of the brook's path in Quincy has been altered in attempts to reduce flooding. Most recently, a large and complex flood control project resulted in major alternations to the streambed and hydrology of Town Brook in the late 1990s. The project sought to reduce Town Brook flooding by increasing storage capacity at the Old Quincy Reservoir, improving drainage by enlarging culverts at key junctions and bypassing flood waters away from downtown and through a deep rock tunnel with an outlet to the Town River marsh (ACOE 1980).

Several references note the presence of a smelt spawning run in Town Brook during the 1970s (Reback and DiCarlo 1972; Iwanowicz et al. 1973; and Dupee and Manhard 1974). Dupee and Manhard (1974) recorded observations of large smelt spawning events occurring in the intertidal zone at the Rt. 3A bridge. A USGS stream flow station (#01105585) was installed in Town Brook in 1972 and has recorded data in most years since. The mean discharge in April at this station for 1973-1986 was 0.32 m^3/s or 11.3 cfs (USGS, http://waterdata.usgs.gov). Four sample stations were selected for monitoring in 1988 and 1989. The Rt. 3A overpass was selected as both a spawning habitat and ichthyoplankton station. In the freshwater zone, the crossings at Washington Street and Revere Road, and the USGS station off Miller Stiles Road were selected as spawning habitat stations. No additional tributaries are found in the Town River basin. The monitoring of smelt spawning habitat preceded construction of the flood control project. This chapter will present findings from 1988 and 1989 and discuss changes that have occurred since then.

Figure 4.3 Smelt spawning habitat in Town Brook, Quincy, with the downstream limit (green dot) and upstream limit (red dot) of observed smelt egg deposition displayed.

White Dashed Line added RJ



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RESULTS

Spawning Habitat

Smelt eggs were readily found at all four sampling stations during 1988 and 1989. Early in the season, smelt eggs were first found in the cobble spillway downstream of Rt. 3A (Figure 4.3). Immediately upstream of Rt. 3A, Town River widened as it passed through salt marsh. This depositional zone received little spawning activity because of low velocities, tidal influence and fine sediments. As the river narrowed a few hundred meters into the salt marsh, intermittent egg deposition was found on patches of gravel. Before reaching Elm Street, the salt marsh ends and the river bank becomes channelized with stone blocks. This stretch was degraded by sedimentation and debris and received minor egg deposition on isolated riffles. Upstream of Elm Street, the channelized river crosses Washington Street and goes into an underground culvert for approximately 125 m before daylighting upstream of Bigelow Street. Egg deposition increased between Elm Street and Washington Street as tidal influence declined and riffle habitat increased. However, the entire tidal zone from Rt. 3A to Washington Street received much less egg deposition than upstream locations and possessed degraded substrate and marginally suitable riffle habitat.

Upstream of Bigelow Street, Town Brook runs through a granite-wall channel that declines in width to 3-4 m, and contains higher water velocity to sustain riffle habitat and attract spawning smelt. The bulk of spawning in Town Brook occurs from Bigelow Street upstream to the Revere Road sampling station. The highest quality riffles were found downstream of Miller Stiles Road within 50 m of the USGS gauge station along the Quincy Chamber of Commerce. The upstream limit of egg deposition in 1988 was the Revere Road downstream culvert opening. Upstream of Revere Road the brook goes underground for about 100 m before briefly opening (10 m length) in a retail parking lot below Cottage Street. A small amount of smelt eggs were found at this opening in 1989. Upstream of this brief opening the brook goes into an underground culvert for over 600 m through downtown Quincy. No eggs were found at the upstream opening and passage was not anticipated; however, a school of 200-300 adult smelt were observed there on one occasion, May 16, 1989 (Abby Childs, DMF, *pers. observation*). Despite underground culverts, long stretches of degraded habitat, and low discharge, the Town Brook provided a large amount of spawning habitat. The brook length where eggs were found in 1988 and 1989 was 800 m and the area of spawning habitat was 3241 m^2. Town Brook has undergone major alterations and a reduction in available spawning habitat since this monitoring. Refer to the Discussion for a description of changes resulting from flood control construction.

USGS gauge station in Town Brook 1998. B. Chase

Spawning Period.
Smelt spawning in 1988 and 1989 began later in Town Brook than other smelt runs monitored in the Boston Harbor region. Smelt spawning began on about March 22nd in 1988 and March 30th in 1989 (Table 4.14). Water temperatures were not particularly cold during early March in these years. For unknown reasons, the run appeared to start late and continue later in May than typical. The end of the spawning period was estimated to be May 25th in 1988. The end date of the spawning period in 1989 was not isolated, although viable smelt eggs and adult smelt were observed on May 25th, indicating that the spawning period likely continued until near the end of May. No eggs were found during several June visits in 1989. The spawning activity and egg deposition in 1989 greatly exceeded that observed in 1988. After observing late and minimal spawning in March, a large spawning event occurred on April 6th, and from this point until the third week in May there was evidence of a strong spawning run in Town Brook. During three station

visits from May 5th to May 18th, thousands of adult smelt were observed crowded in the channel below Revere Road and egg deposition greatly exceeded the habitat capacity at the Revere Road and USGS stations. At several riffles containing very high egg densities, the substrate was covered throughout the channel with white smelt eggs that died from crowding.

Water Chemistry

Spawning Habitat Stations. Water chemistry measurements were made during 1988 and 1989 at the USGS discharge station off Miller Stiles Road (Table 4.15, A.44-A.45) and the downstream culvert openings at Revere Road for both years (A.46-A.47) and at Washington Street for 1988 (Table A.48). For the parameters measured, water quality conditions were adequate to support aquatic life. Dissolved oxygen measurements were at or near saturation and pH measurements slightly exceeded neutral during base flows. Seasonal averages for dissolved oxygen and pH were nearly identical for the Revere Road and USGS stations. Tidal influence was not detected at either station. Tidal influence was routinely observed downstream of the Washington St. culvert, although no traces of salinity were measured. It appeared that the backing up of freshwater observed at Washington St. during high tides dissipates in the underground stretch between Washington and Bigelow Street. Rain events were quickly followed by degraded water quality at these stations, as evident by the presence of trash, oil residues, and high turbidity.

Route 3A. Water chemistry measurements were made at the downstream opening of the culvert under Rt. 3A (Tables A.49-A.50). Water chemistry at this station was driven by tide stage. Near low tide, water depth was less than 0.5 m and no salinity was detected. Near high tide, water depth exceeded 2 m and the bottom water was highly saline. Within two hours of high tide, all bottom salinity measurements were in the range of 26-34 ppt. Surface waters near high tide were slightly saline, but variable and dependent on freshwater discharge and tidal amplitude. The elevation rise and constriction of the Rt. 3A bridge apparently induce some smelt to spawn during ebb tide. Few locations in Massachusetts have smelt spawning and egg survival occurring with exposure to such high salinity.

Discharge Measurements. Stream discharge measurements have been made at the USGS gauge station during most years since 1973. Provisional data are available for 1988, but unfortunately, no data were recorded in 1989. For the period of March-May 1988, the minimum flow was 0.20 m3/s (7.2 cfs) and the maximum discharge was 1.56 m3/s (55.0 cfs). The monthly mean discharge for March-May 1988 were slightly higher than the series averages for this station (Table 4.16). Five discharge measurements were made at the Revere Road station during 1992 and 1993 (Table 4.17). These measurements at a shallow spawning riffle below Revere Road had a mean depth of 24 cm and mean water velocity of 0.464 m/s.

Ichthyoplankton

Ichthyoplankton samples were collected from surface flow during ebb tide on seven dates at the Rt. 3A overpass of Town River. Relative to other sample stations, very few ichthyoplankton were caught. Only four samples contained fish eggs or larvae (Table B.4). Smelt larvae were caught on two dates, a large catch on April 28, 1988, and a single larva on May 26, 1988. A high density of yolk-sac smelt larvae were caught on April 28th (371/100 m^3, mean length = 6.1 mm TL). The only other identified ichthyoplankton caught were smelt eggs (dead or detrital) on two dates in April (120 and 150/100 m^3), and a single Atlantic tomcod larva caught on March 24, 1989.

Table 4.14 Smelt spawning period in Town Brook, Quincy, 1988-1989. Viable eggs were observed on May 25th, 1989; however, the end date was not accurately delineated. The spawning period is an estimation based on observations of viable smelt eggs.

			Water Temperature (°C)			
Year	**Spawning Period**	**Days**	**Start**	**End**	**Range**	**Mean**
1988	March 22nd - May 25th	65	8.0	13.0	7.0 - 13.5	10.6
1989	March 30th - (not delineated)		7.0	-		-

Table 4.15 Water chemistry and weather summary for the Town Brook spawning habitat station at Miller Stiles Road, 1988-1989. Data are averages (Tables A.44-A.45) except station visits and and NOAA rainfall are total values. Air temperature and rainfall data were recorded at Hingham, Massachusetts (NOAA 1988 and 1989).

Sample Period	**Station Visits** (No.)	**NOAA Air Temp** (°C)	**NOAA Rainfall** (cm)	**Water Temp.** (°C)	**Water Salinity** (ppt)	**Water pH**	**Water D.O.** (mg/l)
1988							
March	6	3.8	10.4	8.0	0.0	7.0	-
April	8	7.6	4.8	10.0	0.0	7.1	-
May	7	13.7	9.4	12.5	0.0	7.2	-
Season	21	8.4	24.6	10.0	0.0	7.1	-
1989							
March	10	2.3	9.7	5.5	0.0	7.5	12.4
April	6	7.1	11.2	10.0	0.0	7.1	11.3
May	4	13.5	13.2	14.0	0.0	7.1	9.9
Season	20	7.6	34.1	8.5	0.0	7.3	11.5

Table 4.17 River discharge measurements made at Town Brook, Quincy, 1992-1993. Five depth/velocity cells were measured at a transect 10 m downstream of Revere Road. Rainfall data are five day precipitation totals at the Hingham weather station (NOAA 1992 and 1993).

Date	**Width** (m)Ave.	**Depth** (m)Ave.	**Velocity** m/sec	**Discharge** (m^3/sec)	**Rainfall** (cm)	**Habitat Coverage**
3/24/1992	2.5	0.22	0.374	0.206	1.02	adequate coverage
5/12/1992	2.5	0.22	0.420	0.231	0.74	adequate coverage
4/8/1993	2.5	0.27	0.609	0.411	0.05	good flow over substrate
5/4/1993	2.5	0.26	0.494	0.321	0.03	adequate coverage
5/28/1993	2.5	0.21	0.424	0.223	0.00	adequate coverage

Table 4.16 Town Brook discharge records for 1973-2004 from the US Geological Survey gauge station (#01105585), Miller Stiles Road, Quincy. Discharge data are cubic feet per second (cfs) provided by the USGS Water Resources Division, Marlboro, Massachusetts. Data from 1973-1986 are final data and 1987 to 2004 are provisional data. Rain data are departure from normal monthly total precipitation (inches) at Logan Airport, Boston. The flood control tunnel was constructed in1997 and operating in 1998.

	March				April				May			
Year	**Min.**	**Max.**	**Mean**	**Rain**	**Min.**	**Max.**	**Mean**	**Rain**	**Min.**	**Max.**	**Mean**	**Rain**
1973	4.2	13.0	6.1	-1.70	2.9	37.0	12.5	2.09	2.8	27.0	9.2	0.53
1974	4.4	77.0	14.5	0.11	7.4	45.0	15.0	0.40	4.9	16.0	7.0	-0.36
1975	6.0	32.0	9.8	-1.16	3.6	58.0	9.4	-1.16	3.6	43.0	9.1	-1.45
1976	4.7	16.0	8.3	-1.48	1.7	20.0	5.5	-1.56	3.4	24.0	5.3	-1.25
1977	12.0	57.0	19.0	0.86	1.3	40.0	8.1	0.51	1.1	52.0	7.5	0.29
1978	2.2	55.0	16.5	-1.44	3.2	23.0	7.5	-1.77	2.8	55.0	11.5	1.27
1979	8.7	60.0	18.6	-0.87	2.4	32.0	6.7	-0.37	1.3	31.0	7.6	1.01
1980	1.5	37.0	8.2	1.47	4.5	66.0	11.6	0.80	1.6	9.4	4.3	-0.93
1981	2.4	20.0	9.4	-3.28	2.4	15.0	5.6	-0.42	2.0	13.0	5.1	-2.06
1982	5.5	12.0	7.7	-1.73	5.4	30.0	14.0	-0.14	2.6	11.0	5.9	-0.65
1983	15.0	124.0	33.8	5.82	13.0	87.0	26.5	3.30	2.1	24.0	11.2	-0.29
1984	10.0	120.0	27.4	2.92	14.0	61.0	24.9	0.87	8.6	120.0	18.9	5.54
1985	2.9	24.0	8.1	-1.63	2.9	15.0	4.9	-1.94	2.4	31.0	5.6	0.13
1986	3.9	28.0	8.5	-0.48	3.6	12.0	6.4	-1.97	2.0	9.1	4.7	-1.92
1987												
1988	10.0	55.0	21.8	-0.38	8.5	31.0	15.7	-2.09	7.2	39.0	12.7	-0.37
1989												
1990	13.0	32.0	16.7	-2.19	12.0	81.0	24.6	2.38	16.0	56.0	26.1	3.30
1991	13.0	24.0	15.7	-2.31								
1992	9.4	40.0	17.4	-0.31	15.0	36.0	18.6	-1.22	14.0	25.0	15.6	-1.83
1993	6.5	71.0	18.4	3.77	12.0	81.0	24.4	1.30	5.6	21.0	14.1	-2.19
1994	8.2	107.0	23.1	3.59	10.0	20.0	12.6	-1.31	8.6	37.0	12.2	2.12
1995	9.3	31.0	13.1	-1.70	3.7	19.0	7.9	-2.16	2.3	12.0	4.0	-1.41
1996	4.3	19.0	10.0	-1.54	3.8	60.0	14.7	0.81	9.0	23.0	13.1	-0.50
1997	4.6	30.0	8.6	0.78	0.8	35.0	15.6	-0.10	2.9	15.0	6.8	-0.60
1998	0.9	51.0	5.6	0.25	1.2	14.0	7.0	0.02	4.6	58.0	12.6	3.61
1999	7.6	17.0	10.3	0.67	2.4	7.7	5.1	-2.73	2.2	21.0	5.3	-0.53
2000	4.5	26.0	8.9	-0.31	4.1	25.0	7.7	1.46	3.6	17.0	6.3	-0.35
2001	2.7	63.0	13.7	3.67	1.9	13.0	6.1	-2.68	1.8	10.0	3.1	-2.00
2002	2.8	19.0	7.3	-0.38	3.2	24.0	6.7	-0.92	2.7	30.0	8.8	1.25
2003	4.4	35.0	8.2	0.15	5.1	31.0	9.2	0.40	3.3	27.0	6.4	0.88
2004	2.4	16.0	4.4	-0.65	4.5	52.0	10.3	5.75	2.5	12.0	4.5	-0.28
Mean												
1973-1997	6.8	48.2	14.8	-0.03	6.1	41.1	13.3	-0.17	5.2	31.2	10.1	-0.17
1998-2004	3.6	32.4	8.3	0.49	3.2	23.8	7.4	0.19	3.0	25.0	6.7	0.37

Other Diadromous Species

No other anadromous fish were observed in Town Brook during 1988 and 1989 and there are no previous records of anadromous fish other than smelt. The catadromous American eel was observed on several occasion in Town Brook. Elvers were observed swimming upstream at the Rt. 3A culvert and two dead adult eels were observed at upstream spawning stations.

DISCUSSION

Monitoring of Town Brook smelt spawning habitat in 1988 and 1989 portrayed a viable smelt run existing in a small, highly altered brook. The density of egg deposition observed in 1989 exceeded the capacity of the prime riffle habitat and indicated the presence of a large run relative to other smelt runs of similar size (available habitat and discharge) in the study area. Previous references of Town Brook smelt spawning habitat identified only the tidal zone near Rt. 3A as spawning habitat (Reback and DiCarlo 1972; and Dupee and Manhard 1974). Presumably, these studies observed the upstream culverts and degraded habitats and expected that smelt would not pass further upstream. The late 1980s monitoring and subsequent visits to Town Brook in the 1990s have provided some insight on the continued viability of the smelt run in a degraded urban river system. I suspect the combination of recruitment from the Fore River spawning habitat and stretches of suitable spawning habitat in the Town Brook are sustaining the smelt run. The proximity of the main stem Fore River may allow schools of smelt that hatched in the Fore River to detect the attraction of Town Brook flows. And despite the lengthy stretches of poor spawning habitat, the brook from Bigelow Street to Revere Road has physical characteristics (width, depth, velocity and substrate) that create a raceway effect that is well suited for spawning smelt. Six visits were made to Town Brook during 1992 and 1993 to observe egg deposition during the peak spawning season and to measure discharge at the Revere Road station. The stream bed below the Revere Road culvert has been modified, resulting in a rise in the stream bed slope and a cement-lined substrate. This location can attract large numbers of spawning smelt, mostly during years of an above average spawning run. The water chemistry measurements found higher than average specific conductivity for smelt runs in the study area (N =5; range = 0.62-0.88 mmho/cm; and mean = 0.72 mmho/cm). Also noted during these site visits was the growth of algae on the substrate and poor egg survival of eggs deposited on the algae. Brown periphyton were observed throughout the spawning habitat and growths of green algae were observed at Revere Road.

Town Brook Flood Control Projects

Since the 1988/1989 monitoring, alterations to Town Brook smelt spawning habitat have occurred as a result of the completion of several components of a large and complex flood control project. The project was designed by the US ACOE with participation from the MDC in the 1970s to address flooding problems in the downtown Quincy district, and received interagency review in the 1980s to avoid impacting natural resources, including the smelt run. Most components of the project were constructed in the 1990s. The following paragraphs summarize major components of this project and describe impacts to smelt spawning habitat that have been identified since 1997. Specific details on the project design are not located in one document. An Environmental Impact Review was not required for this project. Refer to the ACOE's feasibility report (1980), the Notice of Intent (DEQE 1987) and Water Quality Certificate (DEQE 1989) for more details on the project.

Route 3A Culverts. Three large box culverts (16 ft. x 7 ft.) replaced a smaller culvert that ran under the Rt. 3A bridge. The larger culverts enhanced the movement of the salt wedge into the basin upstream of Rt. 3A. The improved flushing may benefit the ecology of the basin; however, by removing the constriction at the Rt. 3A bridge the attraction for smelt spawning has been minimized. A few dead smelt eggs have been found since construction of the new culverts downstream of Rt. 3A. Presumably, the wider opening and grade reduction eliminates spawning riffles during ebb tides and encourages upstream passage. This relatively small loss of spawning habitat (about 171 m2) was not anticipated by the flood control project design.

Town River marsh upstream of Rt. 3A. The Town River channel upstream of Rt. 3A was widened to accommodate releases of flood waters from the deep rock tunnel, and portions of the stream bed and bank were lined with gabion mattress to stabilize underlying sediments. This construction removed salt marsh vegetation and resulted in losses of smelt spawning habitat. Prior to the widening, there were small patches of gravel riffles where spawning occurred. Since construction, a few dead eggs have been found on gabion wire near the deep rock tunnel outlet where the basin width decreases. The widening has decreased water velocity and lowered water depth (<10 cm at low tide) causing poor spawning attraction and egg survival. Habitat losses here were similar in area to Rt. 3A and not anticipated by the flood control project design.

Deep Rock Tunnel. A principal component of the overall flood control project was the construction of a 4,100 ft. tunnel (12 ft. diameter) that would travel to depths exceeding 100 ft. under the downtown district of Quincy for bypassing stormwater flows. The tunnel was constructed primarily during 1996 and 1997 and began operation in early 1998. The tunnel inlet is located off School Street and includes a sediment trap and weir to divert Town Brook flows. If properly maintained, the trap and weir can reduce sedimentation at downstream spawning habitat.

The inlet is designed to divert flows in excess of 100 cfsinto the tunnel. The outlet is located downstream of Elm Street in the former salt marsh. The construction of the tunnel resulted in direct mortality to smelt eggs during the 1997 spawning run (Chase 1998). Discharge records and observations since 1998 indicate that the tunnel is diverting Town Brook water at much lower levels than 100 cfs and this condition is chronically degrading the smelt spawning habitat upstream of the tunnel outlet.

Old Quincy Reservoir. The Old Quincy Reservoir in Braintree was reconstructed to improve the storage capacity of the reservoir. This project was recently completely in 2002. The installation of a regulated discharge gate at the reservoir provides to mechanism to assist the smelt run, by augmenting Town Brook flows during the smelt spawning period. This operational feature has potential to be a valuable safeguard for the Town Brook smelt run.

Urban Drainage Improvement. Included in this large flood control project were several smaller projects designed to improve local drainage, primarily through the construction of new culverts and relief conduits along the urban path of Town Brook. Culverts were completed in Braintree and Quincy near Rt. 93 and a major relief conduit was constructed from Centre Street to School Street along the existing Burgin Parkway. A Town Brook channel improvement project (Bigelow Street component) further downstream in Quincy has not been constructed as of 2005. The junction structure at Centre Street was designed to divert Town Brook flood flows into the Burgin Parkway relief conduit which empties to the inlet for the deep rock tunnel. This critical junction is diverting brook flows well below the design specifications. Furthermore, the diversion of dry weather flows is also occurring at Centre Street due to the periodic backwater influence from sediment, debris, and plant growth. Finally, flows from a tributary at Crown Colony that once contributed to Town Brook now run directly to the Burgin Parkway conduit. These routine diversions are having a negative impact on the smelt run by reducing the supply of Town Brook water to downstream spawning habitat. The negative impacts have been seen since the tunnel was constructed in 1997 both in the form of acute affects on egg mortality from low water and the affects of sedimentation and periphyton growth on spawning substrate from chronic lower flows.

Smelt Egg Mortality, 1997

During April, 1997, while working instream related to the deep rock tunnel construction, contractors for ACOE diverted water from Town Brook into the tunnel inlet. Town Brook discharge records indicate the diversion began on April 23rd. The USGS gauge recorded stream discharges of 0.8-0.9 cfs for April 24th-27th, representing a 90-95% reduction in stream flow from April 22nd. On April 26th, DMF staff inspected Town Brook spawning habitat and found a large majority of the streambed exposed to air a ndthat a major smelt egg mortality event had occurred. Upon notification of the egg mortality, the contractors began to disassemble the diversion on April 28th and by April 30th, stream flow had been restored to the spawning habitat (Figure 4.4).

A smelt egg mortality assessment was conducted by DMF following the egg mortality event (Chase 1998). Estimates of smelt egg densities were applied to the Equivalent Adult Method (Boreman 1997) to forecast the losses of age-2 smelt due to the egg mortality event. The estimated losses for age-2 adult smelt were approximately 14,000 – 21,000 for the medium egg density estimate (15.5 eggs/cm^2). The diversion of water from Town Brook and resulting smelt egg mortality was determined by the Commonwealth's Attorney General to be an impact from tunnel construction that violated the project's order of conditions under the Wetlands Protection Act (G.L. c. 131, section 40). The smelt egg mortality was also determined to be a violation of the Massachusetts Inland Fish Kill statute (G.L. c. 131, section 42). A settlement was reached with the ACOE contractors to pay a civil penalty of $50,000 to the Commonwealth and pay $75,000 to the Natural Resources Damages Trust Fund for future smelt restoration efforts in Town Brook.

Smelt Egg Mortality, 1998

On March 25th, 1998, a second smelt egg mortality event was observed by DMF staff at Town Brook. Similar to 1997, a majority of the stream bed was exposed and a high percentage of deposited smelt eggs were dead. An evaluation of the USGS stream discharge records indicated that flows had been depressed since the deep rock tunnel became operational in January, 1998. During January-March, the discharge at the USGS station increased with rain, followed by steady decline to a range of 1-2 cfs. The cause of the diversion was not apparent at first. By early April it was discovered that debris and sediment build-up downstream of the Centre Street junction box was causing brook water to back up and spill into the Burgin Parkway conduit which fed directly to the tunnel inlet. This was corrected on April 3rd and discharge responded by rising to about 8 cfs. Apparently, smelt had entered the spawning habitat while flows were elevated by rain around the third week in March. Their deposited eggs were then exposed as discharge declined during the last week of March to a low of 0.9 cfs (Figure 4.4).

The project's environmental permits did not contain operational requirements for providing minimum flows in Town Brook, and therefore, DEP determined no violations had occurred during the 1998 smelt egg mortality. The timing of smelt spawning was unfortunately matched with the flow blockage at the Centre Street junction box. The egg mortality did raise important questions on the loss of Town Brook flows through the Burgin Parkway conduit and over the maintenance of the flood control project.

No assessment was conducted on smelt egg mortality and storm flows over 100 cfs (Table 4.16). This variability reflects the influence of the flood control structures and precipitation on a small, channelized stream in an urban setting. Rainfall results in sharp pulses in discharge and during dry periods the flow steadily decline to very low levels (Figure 4.4).

The discharge records can be associated with field observations to develop a range of flows needed for smelt spawning and egg survival requirements in Town Brook. In 30 years of records, the two lowest monthly minimum flows in the spawning period resulted in substantial smelt egg mortality (April-1997 and March-1998). These data indicate that discharges less than 1.0 cfs will expose large resulting losses of equivalent adult smelt. The egg mortality was judged to have occurred prior to peak smelt spawning season and to have involved lower egg densities than the 1997 event.

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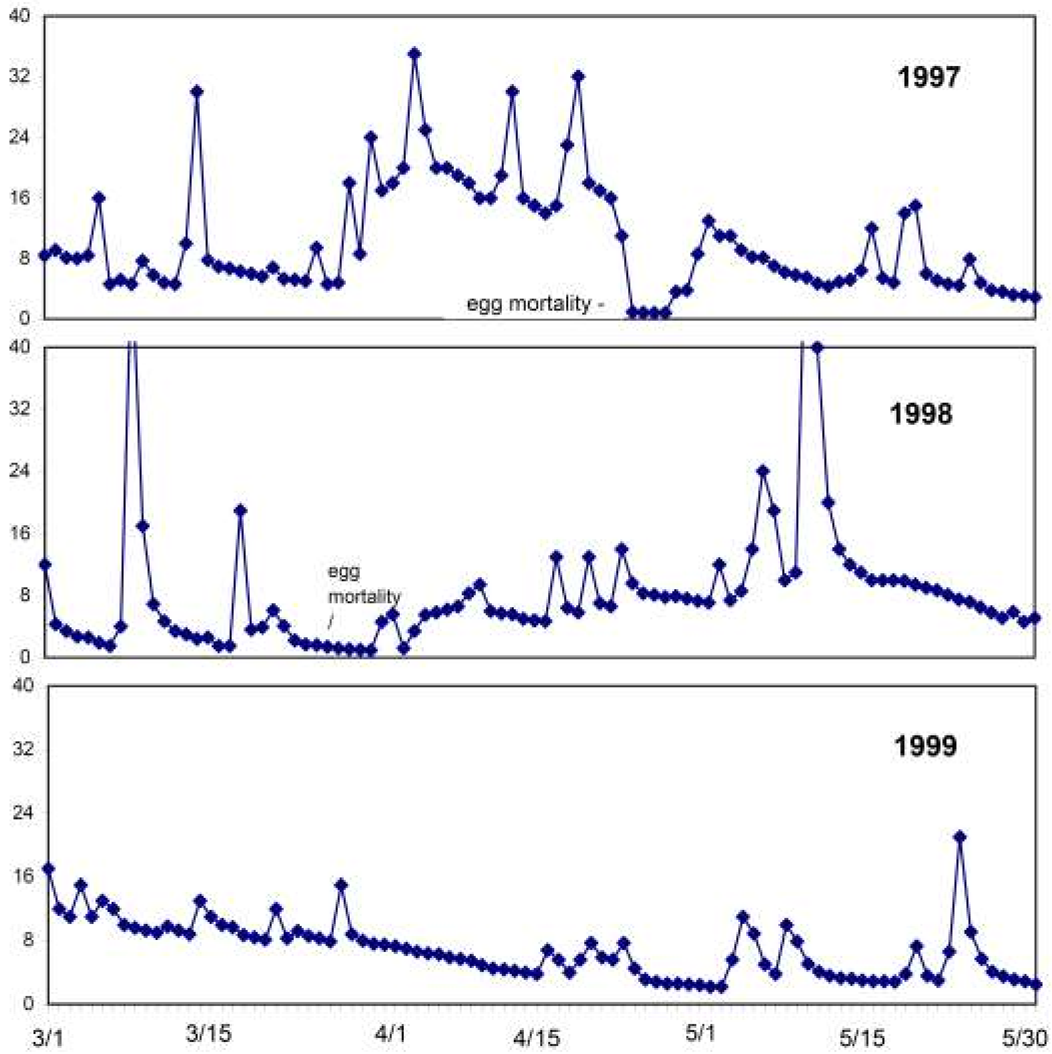
http://www.mass.gov/dfwele/dmf/publications/tr30_smelt_spawning_habitat.pdf

Town Brook Discharge Measurements

The USGS gauge station on Town Brook has provided a valuable time series of discharge measurements that has improved the understanding of smelt spawning habitat requirements and the performance of flood control structures. A summary of discharge records from 1973-2003 during the spring spawning season display a wide range of discharge with periodic lows near one cfs and occasional amounts of spawning substrate. Additional observations at discharges below 2.0 cfs indicate that reduced egg survival will result by exposing parts of spawning riffles to air and lower water velocity. Comparisons of discharge records before and after the deep rock tunnel was opened (1998) indicate that the operation of the flood control structures is depressing Town Brook discharge flowing over spawning habitat. The mean April discharge during 1998-2004 was 7.4 cfs, compared to 13.3 for 1972-1997. The lowest monthly mean discharges on record for March and May, and second lowest for April, have occurred since the tunnel opened. More annual observations and analyses that include precipitation data are needed to define Town Brook discharge relationships. However, observations of the spawning habitat before and after the tunnel construction are clearly demonstrating an impact is occurring. In addition to egg mortality events, lower water velocity, sediment accumulation, and periphyton growth are related to chronic low base flow and degrading spawning riffles.

Figure 4.4 Spring discharge (daily mean cfs) at Town Brook USGS gauge station, 1997-1999. The discharges associated with 1997 and 1998 smelt egg mortality events are noted on graphs.



Smelt egg mortality following 1998 low flows. B.Chase

Town Brook Smelt Conservation Team

The ACOE Section 10/404 permit for the Bigelow Street component of this flood control project contained a requirement for MDC to establish and coordinate a multi-jurisdiction "Town Brook Smelt Conservation Team" for the purpose of resolving project impacts to smelt (ACOE 1998). The team met once or twice a year during 1998-2002, and was typically comprised of staff from MDC, DMF, ACOE, NMFS, City of Quincy, and local participants. Recommendations from the Team were required to be incorporated into the Operation and Maintenance manual for the Bigelow Street project; however, the project has been permitted but not constructed to date. Therefore the team's work is ongoing and final recommendations have not been reported. The team has been successful in linking components of this complex project to smelt impacts and have developed proposals for solving specific problems. The team has identified key brook junctions that need to be inspected and routinely cleaned of sediment (Rt. 93 culvert, Centre St. culvert, and tunnel inlet sediment basin). The team developed a process to use outlet flows at the Quincy Reservoir to augment Town Brook flows when gauge station discharges fall below a 2 cfs threshold. The process includes a low-flow alarm at the gauge station to prompt inspections by Quincy's Department of Public Works. The low-flow augmentation process will be included in the Old Quincy Reservoir O&M plan, and should be a valuable mechanism to protect the smelt run. The low-flow augmentation provides a process to respond to low water levels during the smelt spawning season. A long-term goal of the team is to avoid water level problems at the spawning habitat by recapturing Town Brook flow losses into the Burgin Parkway conduit at the Centre Street junction. These flows bypass the spawning habitat by going into the deep rock tunnel and contribute to chronically depressed spring flows over the smelt spawning habitat. This issue has not been resolved to date. The source of the diversion involves a combination of maintenance and design concerns at the Centre Street junction, and direct losses of stream flow from Crown Colony to the Burgin Parkway conduit. Further evaluations are needed on the design of Centre Street junction structures and on retrieving dry weather flow losses.

Excerpted from TR-30 Sec2:85-95 (Town Brook, Quincy MA)
http://www.mass.gov/dfwele/dmf/publications/tr30_smelt_spawning_habitat.pdf

Minimum Flow Requirements

An important component of the effort to sustain a smelt spawning run in Town Brook is the determination and maintenance of water flow levels that meet minimum requirements for adult smelt attraction and smelt egg survival. When this project was under review in the 1980s, the project was designed to not release dry weather flows into the deep rock tunnel and maintain flows less than 100 cfs in Town Brook (ACOE 1980; and DEQE 1989). These conditions have not been met, and consequently the smelt run has suffered acute impacts (egg mortality) and chronic impacts (reduced spawning habitat; and sedimentation and periphyton accumulation in the presence of lower flows) since tunnel construction. The interagency evaluation of the project design for the deep rock tunnel accepted the 100 cfs diversion target as adequate for smelt requirements. By the time that the Bigelow Street component was under review in the late 1990s concerns over minimum flow inTown Brook were apparent. As a result, the Bigelow Streetcomponent permits (ACOE Section 10/404 and DEPWater Quality Certificate) contain a monthly mean streamflow of 8 cfs and daily minimum stream flow of 4 cfs forthe months of March, April and May (ACOE 1998; and MDEP 1998). Unfortunately, the depressed flows in Town Brook have resulted in these specifications being exceeded in most years since the tunnel became operational (Table 4.16). However, these criteria are only requirements for the Bigelow Street component, which has not been constructed.

The Smelt Brook Conservation Team developed the low-flow augmentation protocol to use Quincy Reservoir outflow to enhance discharge over the spawning habitat when measurements drop below 2 cfs. This is a positive safeguard against major resource losses, but the action level is approaching a discharge where acute impacts may occur and chronic impacts are probably already occurring. It is likely that the 4-8 cfs range that was adopted during the Bigelow Street permit review is better suited for smelt spawning requirements in Smelt Brook. Additional work is needed to both retrieve dry weather losses in the deep rock tunnel and relate the function of flood control structures to smelt spawning habitat requirements.

RECOMMENDATIONS

1. Remediation Work Plan. Following the 1998 egg mortality event, Secretary of EOEA requested that the ACOE's Lt. Colonel for the New England District develop a work plan with other agencies to remediate the flood control project impacts on the Town Brook smelt run. This effort has not been completed. It is recommended that the remediation plan be developed.

2. Sedimentation Maintenance. The accumulation of debris and sediment at the Centre Street junction structure had a major role in the smelt egg mortality event in 1998. Responsibility for maintaining sediment basins has been passed from the ACOE to MDC to the city of Quincy and is documented in the O&M plan. It is essential that sediment and debris are removed from Centre Street junction structures, the Rt. 93 sediment basin and the tunnel inlet basin each year prior to the spring smelt spawning season. Consideration should also be given to an in-stream sump downstream of the Centre Street Junction Box to capture sediment loads and facilitate cleaning.

3. Chronic Low Discharge. The USGS gauge statio has documented depressed Town Brook discharges during the smelt spawning season since the deep rock tunnel became operational in 1998. This chronic condition is having a negative impact on the quality of smelt spawning habitat and the survival of smelt eggs. Two identified sources of lower flows were the reconstruction of Quincy Reservoir and diversions at the Centre Street junction structure. With the completion of the Quincy Reservoir in 2002, there may be more stability to spring flows and augmentation is now possible. However, the long-term solution is to recapture flow losses that are diverted at the Centre Street junction and run through the Burgin Parkway conduit into the tunnel. Routine annual maintenance of this structure is part of the solution. It is also recommended that the ACOE evaluate and correct dry weather diversions by using their program authorities for project modifications.

4. Stream Discharge Data. The USGS stream discharge station has provided useful data that improved our understanding of hydrological dynamics between Town Brook and the flood control project. It is recommended that this valuable data series (1973 to present) be continued. It is also recommended that analyses are conducted relating the operation of the flood control project to Town Brook discharges with consideration for precipitation.

5. Minimum Flow Requirements. The original flood control project did not contain requirements for sustaining minimum stream flows during the smelt spawning season. The Bigelow Street channel modification component (permitted but not constructed) does include requirements for maintaining stream flows during the spawning period. Project permits (ACOE 1998; and MDEP 1998) r**equires a monthly mean flow of 8 cfs, and a daily minimum of 4 cfs during March-May**. It is recommended that future efforts to remediate the present impacts in Town Brook revisit the issue of minimum flows and provide updated criteria. The evaluation of existing DEP requirements, USGS stream gauge data and discharge records for the Old Quincy Reservoir can assist this process.

6. Revere Road Brook Substrate Modification. It is recommended that a spawning habitat restoration project be conducted along the Revere Road streambed. The flow regime at this location is suitable for smelt attraction but the elevation rise and smooth cement channel floor are not optimal for egg survival. Better egg survival could be achieved by removing the cement floor and replacing it with large cracked stone and reducing the stream elevation to prevent egg crowding.