additional data collections to clarify their status. Identifying specimens to genus/species can help remove some ambiguities in the data, and results in scoring categories of non-impaired, slightly impaired, moderately impaired, and severely impaired. In any event, a result of moderately impaired from family-level identifications indicates a need for some kind of follow-up, such as carrying out the taxonomy beyond family or collection of additional monitoring data.

SAMPLING AND LABORATORY METHODS

Benthic macroinvertebrates were collected by kicking substrates in front of a D-net while slowly moving upstream (traveling kick-sample technique). A total of 2 m^2 of stream bottom was sampled and composited into a single sample from each site. Samples were preserved in the field using 95% ethanol and processed at the OWM facility. Processing involved draining the preservative through a number 30 soil sieve and transferring all sample materials to a gridded pan; a small amount of water was added to aid in distributing the material across the pan. Grids were selected through a randomized process and organisms were extracted from the grids until a count of approximately 100 had been reached. The extracted organisms were preserved in 70% ethanol and later identified to family.

RESULTS

The list of taxa and their relative abundance at each station is shown in Table C1. These data were used to calculate richness (number of different families represented), biotic index, EPT index, EPT/Chironomidae, scrapers/filtering collectors, percent contribution of dominant family, and percent similarity to reference community. These metrics were compared to the values from a reference to obtain an impairment score. Two different "reference" comparisons were made: using the most upstream site available on the Ten Mile River (Table C2); and using upstream/downstream pairs bracketing the North Attleborough and Attleboro wastewater treatment plants (Table C3). For some of the sites--TM01, TM02, and SM00--comparisons were made to 1984 data adapted to the RBP II analysis. The adapted taxa list based on the 1984 species (Johnson, *et al.*, 1986) list is shown in Table C4, while the corresponding RBP II data summary for the 1990 to 1984 comparisons is in Table C5.

Most of the sites sampled had relatively low habitat scores (perfect score is 135). In many cases these scores resulted from, or were at least suggestive of, erosional and NPS pollution problems leading to habitat degradation. While locating and identifying nonpoint sources was not part of the scope of the 1990 assessments, the habitat descriptions often flagged some of these problems or indicated where efforts might be focussed to address them.

For each site a list of upstream influences is provided to lend perspective to benthic invertebrate results. Although the list is identified as intervening "discharges" I have included other influences I feel may be important--most notably, impoundments and tributaries. Since nearly all of the discharges have been removed from the river I have included the discontinued discharges noting in parentheses that they are historical. This information may be useful in trying sort out causes of current ecological conditions, from these and future data.

SM00 Sevenmile River downstream from Draper Avenue, North Attleborough, MA (19 Sept. 1990)

HABITAT

Habitat for fishes and aquatic macroinvertebrates at this station was judged to be very good. The total habitat score for this site was 116, much higher than all but the two most downstream sampling sites in the watershed. About 80% of the bottom substrates were cobble and boulder. No local watershed erosion was noticed, although some potential for nonpoint source (NPS) pollution was identified in conjunction with DPW "dirt" piles. The eastern bank was densely vegetated with shrubs (*Cornus* sp.) while the western bank had extensive stands of *Phragmites* sp.

BENTHOS

SM00 was selected as a reference site for biomonitoring results within the Ten Mile River watershed because there were no NPDES permitted discharges upstream from it and it is included in a reach designated Class A (public drinking water supply) by the Water Quality Standards. Indeed, the expectation was that the attributes of the macroinvertebrate assemblage would set a high "standard" for

comparison of the other sites in the watershed. Yet when TM01 was used as the reference site SM00 was ranked as moderately impaired. This is surprising because TM01 had some obvious habitat problems, resulting in a habitat score only about two-thirds that of SM00. Moderately impaired was also the result when SM00 was compared to itself from 1984 data. This may indicate water quality has been deteriorating in the river. Given the Class A status and high habitat score of SM00, these results suggest a need for a more thorough investigation of the river corridor to try to identify potential nonpoint sources of pollution, better analyze why this site apparently is not measuring up to its potential, and determine if appropriate practices are being employed to protect the Class A status of the Sevenmile River.

TM01 Ten Mile River downstream from Fuller Pond and Fuller Street, Plainville, MA (17 Sept. 1990)

HABITAT
The habitat at this site scored 76, lower than nearly every other site sampled in this watershed. The biggest habitat problems appeared to be associated with scour and deposition of fine sediment materials (15 to 20 cm deep in spots). Field notes indicated that this problem was probably connected to a gravel company upstream from Fuller Pond. Evidently a heavy rainfall (approx. 18 cm, or seven inches) caused the company's siltation lagoon to overflow and carry a heavy silt load into Fuller Pond--and, presumably, the Ten Mile River.

BENTHOS
In spite of the habitat problems at TM01, the assemblage of macroinvertebrates indicated better health than at any of the other sampling locations. Had there been a reference site available in this watershed that was unimpacted by human activities TM01 likely would not have scored well. Indeed, when compared against data from this same site in 1984 the RBP II analysis of the 1990 data indicated a status of moderately impaired (Table C5).

Upstream "discharges": Lorusso Corp.; Fuller Pond.

TM02 Ten Mile River upstream from Bacon Street, Plainville, MA (17 Sept. 1990)

HABITAT
The land use along this stretch of the river was characterized as industrial. Even so, the habitat score was 92, slightly better than at TM01. The major mark-downs appeared to be related to substrate and flow inadequacies. No obvious NPS problems were recorded but a parking lot adjacent to the stream bank was identified as a potential source.

BENTHOS
This site scored as moderately impaired compared against both TM01 in 1990 and TM02 in 1984. The extreme imbalance in the assemblage and the paucity of, in particular, mayflies and caddisflies make this community appear more unhealthy than its ranking might suggest (i.e., I'm surprised it didn't score in the severely impaired range). It is probably a good idea to look carefully at any instream chemistry data, discharge monitoring reports, and sediment data that may be available. It may also be worthwhile to complete the taxonomy to genus/species on this sample.

Intervening discharges: Whiting and Davis (historical).

TM04A Ten Mile River upstream from East Washington Street (Rte. 1) North Attleborough, MA (18 Sept. 1990)

HABITAT
The habitat score at this site was 69, the lowest score among the sites sampled (still 91% of the reference station habitat score). The major habitat deficiencies appeared to be related to channelization and flow status. Some potential for NPS-related problems was noted. Some oiliness of the sediments was detected, and there was siltation along the stream margins and even around the cobble/gravel substrates.

BENTHOS
The score for TM04A ranked the site as moderately impaired. The difference in the habitat score as compared to the reference is not sufficient to account for the impairment ranking.

Intervening "discharges": Hilsinger Corp. (historical); Cook-Horton (historical); L.S. Peterson Co. (historical); N. Attleborough Taps (historical); Handy & Harmon (historical); L.G. Balfour (historical); Wetherells Pond; Whiting Pond.

TM06 and TM06A Ten Mile River upstream (TM06) and downstream (TM06A) from Cedar Street and the wastewater treatment plant, North Attleborough, MA (18 Sept. 1990)

HABITAT

These two sites were only about 300 m apart and were selected to bracket the discharge from the North Attleborough wastewater treatment plant. There was no evidence of local watershed erosion and no potential nonpoint sources of pollution were identified. The habitat score at TM06 was 82 and at TM06A was 91.

BENTHOS

TM06 ranked as moderately impaired relative to TM01. TM06A was ranked as moderately impaired against both TM01 and TM06. Because the habitat score at TM06 was lower than the score downstream at TM06A, and because of how tightly these locations bracketed the wastewater discharge, the degradation in community health evident from the benthos data is likely due to the intervention of the wastewater discharge, and not habitat quality differences.

Intervening "discharges": between TM04 and TM06--C. Ray Randall (historical), B&J Manufacturing (historical), and Falls Pond; between TM06 and TM06A--North Attleborough wastewater treatment plant.

TM08A Ten Mile River downstream from Olive Street, Attleboro, MA (17 Sept. 1990)

HABITAT

The habitat score here was 94. The surrounding land use was characterized as predominantly forest, but with some commercial uses present. Field notes indicated local watershed erosion was moderate and that some potential for NPS pollution existed in conjunction with a coal or asphalt pile downstream from Olive Street. Sand deposits were observed instream and filling catch basins. Chlorine odors wafted through periodically, and the water was slightly turbid and gray (often an indicator of untreated or insufficiently treated sewage).

BENTHOS

The RBP II score for TM08A placed it in the moderately impaired category. This situation should be investigated further to see if it is attributable to erosion/NPS problems or residual effects of discharges (past and present). One potentially important influence between TM06A and TM08A is the confluence with the Bungay River.

Intervening "discharges": Walton and Lonsbury (historical), Mt. Vernon Silver (historical); L.G. Balfour (historical); Foster Metal Products (historical); Lambert Anodizing (historical); Montrose-Heuser (historical); Farmers Pond; Mechanics Pond; Bungay River.

TM11 Ten Mile River downstream from Tiffany Street, Attleboro, MA (19 Sept. 1990)

HABITAT

This habitat score was 90. Predominant surrounding land use was forest, with some residential. No local watershed erosion or NPS pollution was evident at the time of sampling. The water column was clear and colorless and no odors were detected.

BENTHOS

This site fell into the moderately impaired category. Given the habitat score and the lack of obvious indications of erosion or NPS problems, a better result was expected here. It is difficult to tell if this result is because of polluting influences downstream from TM08A, or if improvements in water quality between the two locations are simply too slight to detect with this analysis.

Intervening "discharges": Leavens Corp. (historical); Speedway Brook; Dodgeville Pond.

TM12 Ten Mile River downstream from Hebronville Dam (off Read Street), Attleboro, MA (20 Sept. 1990)

HABITAT
The habitat score was 108, one of the highest among the sampled sites. The surrounding land uses were a mix of industrial and residential upstream and field and forest downstream. No evidence of local watershed erosion or NPS problems was detected at the time of sampling. The water column was clear and colorless.

BENTHOS
This site scored in the moderately impaired category, in spite of a good habitat score and no obvious erosion or NPS problems.

Intervening "discharges": Handy and Harmon (historical) and Hebronville Impoundment.

TM14 Ten Mile River downstream from Central Avenue, Pawtucket, RI (20 Sept. 1990)

HABITAT
The habitat score was 113, one of the two highest scores among the sites sampled. The predominant surrounding land use was commercial. Slight areas of erosion were noticed along the river banks and potential sources of NPS contamination were present. The water column was clear and colorless at the time of sampling.

BENTHOS
The data from this site produced a rating of moderately impaired when compared against TM01, but non-impaired against TM12. It appears, then, that the wastewater treatment plant does not cause further degradation in water quality at this point in the river.

Intervening "discharges": Attleboro wastewater treatment plant; Sevenmile River; unnamed impoundment (upstream from the treatment plant).

SW01 Speedway Brook downstream from route 152, Attleboro, MA (19 Sept. 1990)

HABITAT
The habitat score was 76. The surrounding land uses were predominantly a mix of forest and field. There were no indications of erosion or potential NPS problems in the immediate drainage area. The riffle habitat in this reach was restricted to a small area close to the bridge. The water column appeared to be clear and colorless--a decided improvement over its appearance during the 1984 survey.

BENTHOS
This site was rated moderately impaired. In spite of the visual indications of improvements in the water quality of Speedway Brook it may be that more time is required to see significant improvements reflected in instream communities. A more sensitive analysis (e.g., RBP III) may be able to reveal slight improvements here.

Upstream discharges: Leach and Garner (historical), Swank Inc. (historical), and Robbins Co. (historical).

SUMMARY AND RECOMMENDATIONS

The RBP II analysis showed all sites sampled in this watershed to be moderately impaired when compared against the most upstream site on the Ten Mile River. Habitat scores at all sites were at least 90% of the reference site habitat score (all but two were higher) suggesting that habitat factors alone are not limiting benthic communities at these sites. Inasmuch as most of the direct discharges have been eliminated from the river the question arises as to whether there are residual effects from them. It is also possible that nonpoint source pollution or illegal discharges are causes of the detected impairment, or that they are slowing the recovery of the river since the discharges have been eliminated.

A few sites stand out as particularly high priority in spite of the fact all sites scored the same. The most obvious of these is the Sevenmile River at SM00. Its habitat score and Class A status mean that it should

have exhibited the healthiest RBP II score in the watershed. More intensive investigation of this river should be done to corroborate this finding and to scrutinize measures being taken to protect its Class A status.

The field descriptions and resultant habitat score at TM01 document habitat damage caused by deposition of fine sediment materials. The causes of this problem need to be investigated. The sand and gravel company should be scrutinized to see if they are taking adequate steps to prevent fine materials from migrating into Fuller Pond, and eventually into the Ten Mile River. At the same time, however, other land uses upstream from TM01 should also be examined as possible sources of sediment loading.

While TM02 ranked the same as all the remaining sites (moderately impaired) I would place it at a higher priority for follow-up than the others for two reasons. One is that its habitat score is slightly better than TM01's and the other is that it is only a short distance downstream from TM01. In this context it should have been the most similar to the reference community and yet it was the least. Additional biomonitoring work should probably be done here along with sediment sampling and a thorough reconnaissance of the reach upstream to TM01 to identify possible nonpoint sources of pollution.

Depending on resources and other priorities of the team, probably all of the sites used in 1990 should be sampled again for macroinvertebrates, sediment, and water quality. A more intensive effort should be made to investigate possible problem spots in each reach and identifying the probable causes of ecological impairment based on the data presented here. Together, past and present data can help sort out to what extent the Ten Mile River is still suffering from past damage and to what extent existing pressures are causing harm.

cc: A. Johnson
R. McVoy

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LIST OF TABLES

Table C1. List of macroinvertebrate taxa collected by DEP DWM from stream sites in the Ten Mile River watershed between 17 and 19 September 1990. Sampling sites were in: Ten Mile River (TM01, TM02, TM04A, TM06, TM06A, TM08A, TM11, TM12, TM14); Sevenmile River (SM00); and Speedway Brook (SW01). All were in Massachusetts except TM14 (Pawtucket, RI).

TAXA	FFG	TV	TM01	TM02	TM04A	TM06	TM06A	TM08A	TM11	TM12	TM14	SW01	SM00
Physidae	GC	8						2					
Ancylidae	SC	7			1								
Pisidiidae	FC	6	1					8	2	4			5
Tubificidae	GC	10			6			5					
Naididae	GC	9	1										10
Lumbriculidae	GC	7	2			4							11
Glossophoniidae	PR	7			1								
Erpobdellidae	PR	8								2			
Asellidae	GC	8			8			4	1	8			
Crangonyctidae	GC	8			1								
Gammaridae	GC	6		95									10
Baetidae	GC	4					3						
Heptageniidae	SC	4	9	1		4				1	3		1
Aeschnidae	PR	3				2					1		2
Corydalidae	PR	5				3	1				2	6	
Philopotamidae	FC	3	1										
Hydropsychidae	FC	4	44	2	25	55	21	13	15	19	41	78	12
Hydroptilidae	GC	4	1										2
Limnephilidae	SH	4				1							1
Elmidae	SC	4	6		1	5	3	11	90	62	9	3	2
Tipulidae	SH	5		2									
Simuliidae	FC	6	30	2	10	5	48	28	3	2	16	2	8
Chironomidae	GC	6	4	1	37	29	11	38	3	16	35	19	30
Empididae	PR	6			2	1	3					5	1
TOTAL			99	103	92	109	90	109	114	114	107	113	95

Table C2. Summary of RBP II data analysis for macroinvertebrate communities sampled by DEP DWM at eleven stream sites in the Ten Mile River watershed. Seven biological metrics were calculated for taxa collected at each station, and scored (in parentheses). Scores were totaled and compared to station TM01 for reference. The percent comparability to the reference station yields a final impairment score for each station.

RBP DATA SUMMARY FOR: **TEN MILE RIVER WATERSHED** DATE: **1990**

Station #	TM01*		TM02		TM04A		TM06		TM06A		TM08A		TM11		TM12		TM14		SW01		SM00	
Stream	Ten Mile River		Ten Mile River		Ten Mile River		Ten Mile River		Ten Mile River		Ten Mile River		Ten Mile River		Ten Mile River		Ten Mile River		Speedway Brook		Sevenmile River	
Habitat Score	76		92		69		82		91		94		90		108		113		76		116	
Taxa Richness	10	*(6)*	6	*(3)*	10	*(6)*	10	*(6)*	7	*(3)*	8	*(3)*	6	*(3)*	8	*(3)*	7	*(3)*	6	*(3)*	13	*(6)*
Biotic Index	4.81	*(6)*	5.92	*(3)*	5.91	*(3)*	4.76	*(6)*	5.39	*(6)*	5.85	*(3)*	4.18	*(6)*	4.74	*(6)*	4.96	*(6)*	4.51	*(6)*	5.99	*(3)*
EPT Index	4	*(6)*	2	*(0)*	1	*(0)*	3	*(3)*	2	*(0)*	1	*(0)*	1	*(0)*	2	*(0)*	2	*(0)*	1	*(0)*	4	*(6)*
EPT/Chironomidae	13.75	*(6)*	3	*(0)*	0.68	*(0)*	2.07	*(0)*	2.18	*(0)*	0.34	*(0)*	5	*(3)*	1.25	*(0)*	1.26	*(0)*	4.11	*(3)*	0.53	*(0)*
Riffle Community: Scrapers/Filt. Coll.	0.20	*(6)*	0.25	*(6)*	0.057	*(3)*	0.14	*(6)*	0.043	*(0)*	0.22	*(6)*	4.5	*(6)*	2.5	*(6)*	0.21	*(6)*	0.038	*(0)*	0.12	*(6)*
% Contribution (Dominant Family)	44%	*(3)*	92	*(0)*	40%	*(3)*	50%	*(3)*	53%	*(0)*	35%	*(3)*	79%	*(0)*	54%	*(0)*	38%	*(3)*	69%	*(0)*	32%	*(3)*
Community Similarity	100%	*(6)*	6%	*(0)*	43%	*(3)*	64%	*(3)*	60%	*(3)*	49%	*(3)*	26%	*(0)*	31%	*(3)*	66%	*(3)*	53%	*(3)*	33%	*(3)*
Total Metric Score	*39*		*12*		*18*		*27*		*12*		*18*		*18*		*18*		*21*		*15*		*27*	
% Comparability To Reference Station	100%		31%		46%		69%		31%		46%		46%		46%		54%		38%		69%	
Biological Status-Degree Impairment	Reference		Moderately Impaired		Moderately Impaired		Moderately Impaired		Moderately Impaired		Moderately Impaired		Moderately Impaired		Moderately Impaired		Moderately Impaired		Moderately Impaired		Moderately Impaired	

*Watershed reference station for all.

Table C3. Summary of RBP II data analysis for macroinvertebrate communities sampled by DEP DWM at stream sites bracketing the N. Attleboro (TM06 and TM06A) and Attleboro (TM12 and TM14) wastewater treatment plants in the Ten Mile River watershed. Seven biological metrics were calculated for taxa collected at each station, and scored (in parentheses). Scores were totaled and compared to the upstream station in each pair. The percent comparability to the reference station yields a final impairment score for the downstream station.

RBP DATA SUMMARY FOR: **TEN MILE RIVER WATERSHED** DATE: **1990**

Station #	TM06[1]		TM06A		TM12[2]		TM14	
Stream	Ten Mile River		Ten Mile River		Ten Mile River		Ten Mile River	
Habitat Score	82		91		108		113	
Taxa Richness	10	(6)	7	(3)	8	(6)	7	(6)
Biotic Index	4.76	(6)	5.39	(6)	4.74	(6)	4.96	(6)
EPT Index	3	(6)	2	(0)	2	(6)	2	(6)
EPT/Chironomidae	2.07	(6)	2.18	(6)	1.3	(6)	1.3	(6)
Riffle Community: Scrapers/Filt. Coll.	0.14	(6)	0.043	(3)	2.5	(6)	0.21	(6)
% Contribution (Dominant Family)	50%	(3)	53%	(0)	54%	(0)	38%	(3)
Community Similarity	100%	(6)	45%	(3)	100%	(6)	42%	(3)
Total Metric Score		*39*		*21*		*36*		*36*
% Comparability To Reference Station	100%		54%		100%		100%	
Biological Status- Degree Impairment	Reference		Moderately Impaired		Reference		Non-Impaired	

[1] Upstream reference station for TM06A.
[2] Upstream reference station for TM14.

Table C4. List of macroinvertebrate families collected by DEP DWM from stream sites in the Ten Mile River watershed between 17 and 20 September 1984. Sampling sites were in: Ten Mile River (TM01, TM02, TM04, TM06, TM06A, TM08A, TM11, TM12, TM14); Sevenmile River (SM00); and Speedway Brook (SW01). All were in Massachusetts except TM14 (Pawtucket, RI). This list was adapted for RBP II analysis from the 1984 species list (Johnson, *et al.* 1986).

TAXON	FFG	TOL. VAL.	SM00	TM01	TM02	TM04	TM06	TM06A	TM08A	TM11	TM12	TM14	SW01
Physidae	GC	8	5										
Planorbidae	SC	6		1	1								
Tubificidae	GC	10			4	8			12		8		4
Naididae	GC	9	1										
Lumbriculidae	GC	7		6									
Erpobdellidae	PR	8		1					1				
Asellidae	GC	8		1	5	1			16		4	1	
Gammaridae	GC	6	6		1								
Hyalellidae	GC	8		1	2								
Hydracarina	PR	6			2				1				
Baetidae	GC	4	1				6	1		1			
Heptageniidae	SC	4	1	29	1								
Ephemerellidae	GC	1			1								
Caenidae	GC	7									2		
Leptophlebiidae	GC	2		13									
Aeschnidae	PR	3	3										
Libellulidae	PR	9									2		
Calopterygidae	PR	5	5					1					
Coenagrionidae	PR	9				3					3		
Sialidae	PR	8	1		2	7							
Corydalidae	PR	5		3	5			38					
Philopotamidae	FC	3		1									
Polycentropodidae	FC	6	4										
Hydropsychidae	FC	4	26	26	3	1	65	9	14	69	3	86	1
Hydroptilidae	GC	4	1									1	
Phryganeidae	SH	4									2		
Leptoceridae	PR	4					1	6	1		7		
Halipildae	SH	5	1										
Hydrophilidae	PR	5					1				2		
Elmidae	SC	4		1							7		
Tipulidae	SH	5	3	1	2								
Ceratopogonidae	PR	6			2	1							
Simuliidae	FC	6					6	1	1	8		6	
Chironomidae	GC	6	41	15	65	79	20	23	20	28	57	2	81
Empididae	PR	6					3	22	34			3	11
TOTAL			99	99	97	100	102	101	100	106	97	99	97

Table C5. Summary of RBP II data comparisons for macroinvertebrate communities sampled by DEP DWM at selected stream sites in the Ten Mile River watershed. Seven biological metrics were calculated for taxa collected at each station, and scored (in parentheses). Scores were totaled and the 1990 data set for each station was compared to its 1984 data set for reference. The percent comparability to the reference station yields a final impairment score for each station.

Station #	84-TM01		90-TM01[1]		84-SM00		90-SM00[2]		84-TM02		90-TM02[3]	
Stream	Ten Mile River		Ten Mile River		Sevenmile River		Sevenmile River		Ten Mile River		Ten Mile River	
Habitat Score			76				116				92	
Taxa Richness	13	*(6)*	10	*(3)*	14	*(6)*	13	*(6)*	14	*(6)*	6	*(3)*
Biotic Index	4.4	*(6)*	4.8	*(6)*	5.4	*(6)*	6.0	*(6)*	6.1	*(6)*	5.9	*(6)*
EPT Index	4	*(6)*	4	*(6)*	5	*(6)*	4	*(3)*	3	*(6)*	2	*(0)*
EPT/Chironomidae	4.6	*(6)*	14	*(6)*	0.80	*(6)*	0.53	*(3)*	0.076	*(6)*	3.0	*(6)*
Riffle Community: Scrapers/Filt. Coll.	1.1	*(6)*	0.20	*(0)*	0.033	*(6)*	0.12	*(6)*	0.67	*(6)*	0.25	*(3)*
% Contribution (Dom. Fam.)	29	*(6)*	44	*(3)*	41	*(3)*	32	*(3)*	68	*(0)*	92	*(0)*
Community Similarity	100%	*(6)*	42%	*(3)*	100%	*(6)*	23%	*(0)*	100%	*(6)*	7%	*(0)*
Total Metric Score		*42*		*27*		*39*		*27*		*36*		*18*
% Compararbility To Reference Station	Reference		(27/42) 64		Reference		(27/39) 69		Reference		(18/36) 50	
Biological Status-- Degree Impairment			moderately impaired				moderately impaired				moderately impaired	

[1] Ref.: 84-TM01
[2] Ref.: 84-SM00
[3] Ref.: 84-TM02