Table 9. Continued.

Stream Segment Description	Sampling Location (RM)	QHEI	Segment Mean QHEI
Oregonia to SR 125, continued (RM 47.5 - 3.5)			
	27.9	80.0	**77.6**
	23.9	82.5	
	22.1	63.5	
	21.5	84.0	
	20.9	80.0	
	18.5	72.5	
	13.3	86.5	
	8.3	73.0	
	8.0	82.0	
	3.5	77.5	
Kellogg Avenue to the Ohio River (RM 1.6 - 0.2)			
	1.6	51.0	**50.5**
	0.2	50.0	
East Fork Little Miami River			
SR 222 to Roundbottom Rd. (RM 15.5 - 6.6)			
	15.5	86.0	**85.9**
	12.7	83.5	
	12.4	87.0	
	9.2	86.0	
	6.6	87.0	
Dst. Clermont Co. Lower E.F. WWTP Trib. to Dst. Milford WWTP (RM 4.7 - 1.4)			
	4.7	68.5	**68.0**
	1.7	70.5	
	1.4	65.0	

Table 10. Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for fish sampling sites in the Little Miami River study area.

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: *No Channelization or Recovered*	*Boulder/Cobble/Gravel Substrates*	*Silt Free Substrates*	*Good/Excellent Substrates*	*Moderate/High Sinuousity*	*Extensive/Moderate Cover*	*Fast Current/ Eddies*	*Low/Normal Embeddedness*	*Max Depth > 40 cm*	*Low/No Riffle Embeddedness*	**Total WWH Attributes**	MWH Attributes — *High Influence*: *Channelized or No Recovery*	*Silt/Muck Substrates*	*Low Sinuousity*	*Sparse/No Cover*	*Max Depth < 40 cm (WD,HW)*	**Total H.I. MWH Attributes**	MWH Attributes — *Moderate Influence*: *Recovering Channel*	*Heavy/Moderate Silt Cover*	*Sand Substrates (Boat)*	*Hardpan Substrate Origin*	*Fair/Poor Development*	*Low/No Sinuosity*	*Only 1-2 Cover Types*	*Intermittent & Poor Pools*	*No Fast Current*	*High/Moderate Embeddedness*	*Ext./Moderate Riffle Embed.*	*No Riffle*	**Total M.I. MWH Attributes**	**MWH H.I./WWH Ratio**	**MWH M.I./WWH Ratio**
(11-001) – Little Miami River																																	
Year: 93																																	
102.1	62.0	6.9	■	■		■	■	■				■	6						0		▲		▲					▲	▲	▲		5	.14	.86
98.3	75.0	8.3	■	■		■	■	■			■	■	8						0			▲	▲					▲				3	.11	.44
92.2	68.5	5.5	■	■	■	■	■	■	■	■	■	■	10						0									▲				1	.09	.18
85.4	87.0	4.9	■	■	■	■	■	■	■	■	■	■	10						0													0	.09	.09
83.1	76.5	25.0	■	■		■	■	■	■	■	■	■	9						0													0	.10	.10
77.3	78.0	5.1	■	■		■	■	■	■	■	■	■	9						0													0	.10	.10
77.0	63.5	5.1	■	■		■	■	■		■	■		7						0			▲	▲	▲				▲		▲		5	.13	.75
76.8	76.0	5.1	■	■		■	■	■	■	■	■	■	9						0						▲							1	.10	.20
74.5	77.5	5.3	■	■		■	■	■	■	■	■	■	9						0													0	.10	.10
71.8	77.5	4.7	■	■		■	■	■	■	■	■	■	9					●	1				▲									1	.20	.30
64.7	73.0	2.6	■	■		■	■	■	■	■	■	■	9						0													0	.10	.10
64.4	62.5	2.6	■	■		■		■	■			■	6					●	1				▲	▲					▲	▲		4	.29	.86
64.2	74.0	2.6	■	■		■	■	■	■			■	7						0										▲	▲		2	.13	.38
63.4	71.0	2.6	■	■		■	■	■	■			■	7						0				▲	▲					▲	▲		4	.13	.63
53.5	65.0	3.2	■			■	■	■	■			■	6		●				1		▲		▲						▲	▲		4	.29	.86
47.5	76.5	5.6	■	■		■	■	■	■			■	8						0		▲								▲			2	.11	.33
44.2	83.5	4.5	■	■		■	■	■	■	■	■	■	9						0		▲											1	.10	.20
38.6	83.5	4.2	■	■		■	■	■	■	■	■	■	9						0													0	.10	.10
35.5	76.5	7.5	■	■		■	■	■	■	■	■	■	9					●	1		▲		▲	▲								3	.20	.50
32.9	74.0	2.7	■	■		■	■	■	■	■	■	■	9		●			●	2		▲		▲						▲			3	.30	.60
32.1	77.0	2.7	■	■		■		■	■	■	■	■	8					●	1		▲			▲								2	.22	.44
31.9	86.5	2.7	■	■		■	■	■	■	■	■	■	9						0													0	.10	.10
28.3	57.5	3.5	■	■				■			■		4		●				1		▲		▲	▲					▲	▲	▲	6	.40	1.60
27.9	80.0	4.9	■	■		■	■	■	■	■	■	■	9						0		▲				▲							2	.10	.30
23.9	82.5	3.9	■	■		■		■	■	■	■	■	8						0					▲									1	.11	.22
22.1	63.5	4.6	■	■				■			■	■	5					●	1		▲		▲	▲					▲		▲		5	.33	1.17
21.5	84.0	3.8	■	■		■		■	■	■	■	■	8						0					▲									1	.11	.22
20.9	80.0	3.8	■	■		■	■	■	■	■	■	■	9						0		▲		▲									2	.10	.30
18.5	72.5	6.5	■	■		■		■	■	■	■	■	8					●	1		▲			▲								2	.22	.44
13.3	86.5	5.5	■	■		■	■	■	■	■			8						0											▲			1	.11	.22
8.3	73.0	3.9	■	■				■	■	■	■	■	7						0		▲		▲	▲					▲	▲			5	.13	.75
8.0	82.0	3.9	■	■		■	■	■	■	■	■		9						0		▲									▲	▲		3	.10	.40
3.5	77.5	.1	■	■		■	■	■	■		■		7						0											▲	▲		2	.13	.38

Table 10. Continued.

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/ Eddies	Low/Normal Embeddedness	Max Depth > 40 cm	Low/No Riffle Embeddedness	Total WWH Attributes	MWH Attributes — High Influence: Channelized or No Recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD,HW)	Total H.I. MWH Attributes	MWH Moderate Influence: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Moderate Embeddedness	Ext./Moderate Riffle Embed.	No Riffle	Total M.I. MWH Attributes	MWH H.I./WWH Ratio	MWH M.I./WWH Ratio
1.6	51.0	.1	■				■	■			■		4	●					1		▲		▲	▲				▲	▲		▲	6	.40	1.60
.2	50.0	.1	■				■	■			■		4	●			●		2		▲		▲	▲				▲	▲		▲	6	.60	1.80
(11-007) – Sycamore Creek																																		
Year: 93																																		
.4	76.0	13.8	■	■		■		■			■	■	■	7					0				▲	▲				▲				3	.13	.50
.2	70.5	13.8	■	■	■	■		■	■		■			7					0				▲	▲	▲				▲	▲		5	.13	.75
.1	75.0	13.8	■	■		■	■	■	■		■			7					0										▲	▲		2	.13	.38
(11-020) – Muddy Creek																																		
Year: 93																																		
1.6	78.0	15.3	■	■		■	■	■	■		■			7					0		▲								▲	▲		3	.13	.50
(11-021) – Turtle Creek																																		
Year: 93																																		
6.3	69.5	10.3	■	■		■	■	■			■			6					0		▲	▲							▲	▲	▲	5	.14	.86
4.7	69.5	7.5	■	■		■	■	■			■			6					0		▲		▲						▲	▲	▲	5	.14	.86
.6	75.5	20.8	■	■		■	■	■			■	■		7					0										▲	▲		2	.13	.38
.5	68.0	20.8	■				■				■	■	■	5					0				▲	▲	▲				▲			4	.17	.83
.4	68.0	20.8	■	■		■		■			■			5					0				▲	▲				▲	▲	▲		5	.17	1.00
.1	68.5	5.2	■	■		■	■	■			■			6					0		▲								▲	▲	▲	4	.14	.71
(11-030) – Newman Run																																		
Year: 93																																		
.3	76.0	41.6	■	■		■	■	■			■	■	■	8					0		▲								▲			2	.11	.33
(11-032) – Glady Run																																		
Year: 93																																		
4.9	54.0	9.5	■				■	■			■			4	●					1		▲		▲				▲	▲	▲	▲	6	.40	1.60
4.7	66.0	40.0	■	■		■	■	■	■		■			7					0										▲	▲		2	.13	.38
.3	69.0	5.6	■	■		■	■	■	■		■			7					0										▲	▲		2	.13	.38

Table 10. Continued.

Key QHEI Components

WWH Attributes | MWH Attributes (*High Influence* | *Moderate Influence*)

River Mile	QHEI	Gradient (ft/mile)	*No Channelization or Recovered*	*Boulder/Cobble/Gravel Substrates*	*Silt Free Substrates*	*Good/Excellent Substrates*	*Moderate/High Sinuousity*	*Extensive/Moderate Cover*	*Fast Current/ Eddies*	*Low/Normal Embeddedness*	*Max Depth > 40 cm*	*Low/No Riffle Embeddedness*	**Total WWH Attributes**	*Channelized or No Recovery*	*Silt/Muck Substrates*	*Low Sinuousity*	*Sparse/No Cover*	*Max Depth < 40 cm (WD,HW)*	**Total H.I. MWH Attributes**	*Recovering Channel*	*Heavy/Moderate Silt Cover*	*Sand Substrates (Boat)*	*Hardpan Substrate Origin*	*Fair/Poor Development*	*Low/No Sinuosity*	*Only 1-2 Cover Types*	*Intermittent & Poor Pools*	*No Fast Current*	*High/Moderate Embeddedness*	*Ext./Moderate Riffle Embed.*	*No Riffle*	**Total M.I. MWH Attributes**	**MWH H.I./WWH Ratio**	**MWH M.I./WWH Ratio**
(11-035) – Beaver Creek																																	
Year: 93																																	
1.6	54.5	5.2	■	■				■			■		4		●		●		2		▲		▲	▲				▲	▲	▲		7	.60	2.00
.5	74.0	15.3	■	■	■	■		■	■		■		7						0					▲				▲	▲			3	.13	.50
.3	64.0	7.2	■	■	■			■	■		■		6				●		1				▲	▲	▲			▲	▲			5	.29	1.00
.3	70.5	7.2	■	■	■	■		■	■		■		7						0				▲	▲				▲	▲			4	.13	.63
(11-036) – Little Beaver Creek																																	
Year: 93																																	
4.7	67.5	16.1	■	■				■	■		■		5		●		●		2		▲			▲	▲				▲	▲			5	.50	1.33
4.5	72.0	10.6	■	■	■			■	■	■	■		7				●		1		▲			▲						▲			3	.25	.63
4.4	48.5	10.6	■								■		2	●		●	●		3		▲			▲	▲				▲	▲	▲		6	1.33	3.33
2.1	76.0	12.3	■	■	■	■	■	■	■		■		8						0		▲			▲						▲	▲		4	.11	.56
.1	70.5	15.3	■					■	■		■		4						0		▲			▲	▲					▲	▲		5	.20	1.20
(11-040) – Yellow Springs Creek																																	
Year: 93																																	
.5	80.0	31.2	■	■			■	■	■		■	■	8						0										▲				1	.11	.22
.4	73.5	31.2	■	■			■	■	■	■	■	■	9				●		1														0	.20	.20
.3	79.0	31.2	■	■			■	■	■	■	■	■	9						0														0	.10	.10
(11-050) – Glady Run WWTP Swale																																	
Year: 93																																	
.3	53.0	24.3	■					■			■		3		●		●		2		▲	▲		▲	▲				▲	▲	▲		7	.75	2.50
.2	49.0	24.3	■	■							■	■	4	●		●	●		3		▲		▲	▲	▲				▲		▲	▲	7	.80	2.20
.1	66.0	24.3	■	■	■			■			■	■	7				●		1		▲		▲	▲	▲				▲				5	.25	.88
(11-100) – East Fork Little Miami River																																	
Year: 93																																	
15.5	86.0	10.9	■	■		■	■	■	■	■	■	■	9						0														0	.10	.10
12.7	83.5	7.5	■			■	■	■	■	■	■	■	8						0														0	.11	.11
12.4	87.0	7.5	■	■		■	■	■	■	■	■	■	9						0														0	.10	.10
9.2	89.0	5.7	■	■		■	■	■	■	■	■	■	9						0					▲									1	.10	.20
6.6	87.0	4.5	■	■		■	■	■	■	■	■	■	9						0		▲			▲									2	.10	.30
4.7	68.5	4.5	■	■				■	■		■		5						0		▲			▲	▲					▲	▲		5	.17	1.00
1.7	70.5	3.5	■	■		■	■	■	■		■		7						0				▲							▲	▲		3	.13	.50
1.4	65.0	3.5	■			■	■	■			■	■	6		●				1		▲		▲	▲					▲	▲			5	.29	1.00

Table 10. Continued.

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuousity	Extensive/Moderate Cover	Fast Current/ Eddies	Low/Normal Embeddedness	Max Depth > 40 cm	Low/No Riffle Embeddedness	Total WWH Attributes	MWH High Influence: Channelized or No Recovery	Silt/Muck Substrates	Low Sinuousity	Sparse/No Cover	Max Depth < 40 cm (WD,HW)	Total H.I. MWH Attributes	MWH Moderate Influence: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Moderate Embeddedness	Ext./Moderate Riffle Embed.	No Riffle	Total M.I. MWH Attributes	MWH H.I./WWH Ratio	MWH M.I./WWH Ratio
(11-300) – Caesar Creek																																	
Year: 93																																	
16.5	76.0	5.2	■	■		■	■	■			■	■	■	8						0								▲				1	.11	.22
.1	81.5	8.2	■	■	■	■	■	■				■	■	8						0								▲	▲			2	.11	.33
(11-301) – Flat Fork																																	
Year: 93																																	
1.7	50.0	31.2	■	■				■			■			4			●	●	●	3			▲	▲			▲				▲	4	.80	1.60
(11-400) – Massies Creek																																	
Year: 93																																	
.3	67.5	18.1	■	■		■		■			■	■	■	7				●		1			▲	▲				▲				3	.25	.63
(11-401) – Oldtown Creek																																	
Year: 93																																	
.1	82.5	17.2	■	■		■	■	■	■	■	■	■	■	9						0												0	.10	.10
(11-404) – South Fork Massies Creek																																	
Year: 93																																	
1.1	66.5	5.5		■		■		■		■	■	■		6			●			1	▲			▲				▲				3	.29	.71
(11-107) – Stonelick Creek																																	
Year: 93																																	
20.0	69.0	18.1	■	■	■	■		■				■		7			●			2				▲				▲	▲			3	.38	.75
16.7	48.0	.1	■				■	■			■			4		●				1	▲		▲	▲				▲	▲		▲	6	.40	1.60
3.1	73.5	18.5	■	■		■		■			■	■		6						0	▲			▲				▲	▲			4	.14	.71
1.2	78.0	7.5	■	■		■	■	■			■	■	■	8						0								▲				1	.11	.22

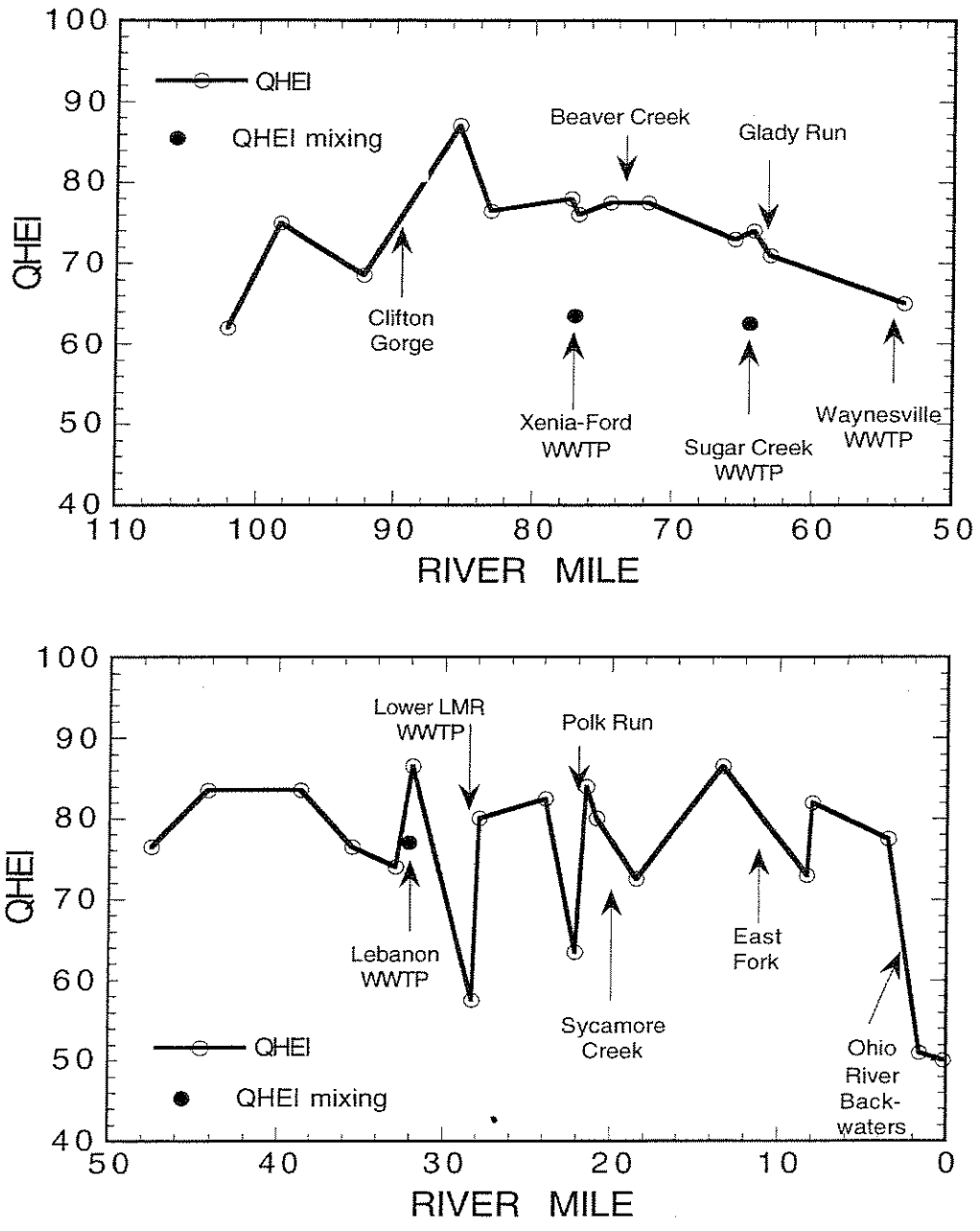


Figure 67. Longitudinal trend of the Qualitative Habitat Evaluation Index (QHEI) in the upper half (Top Graph) and lower half (Bottom Graph) of the Little Miami River mainstem during 1993.

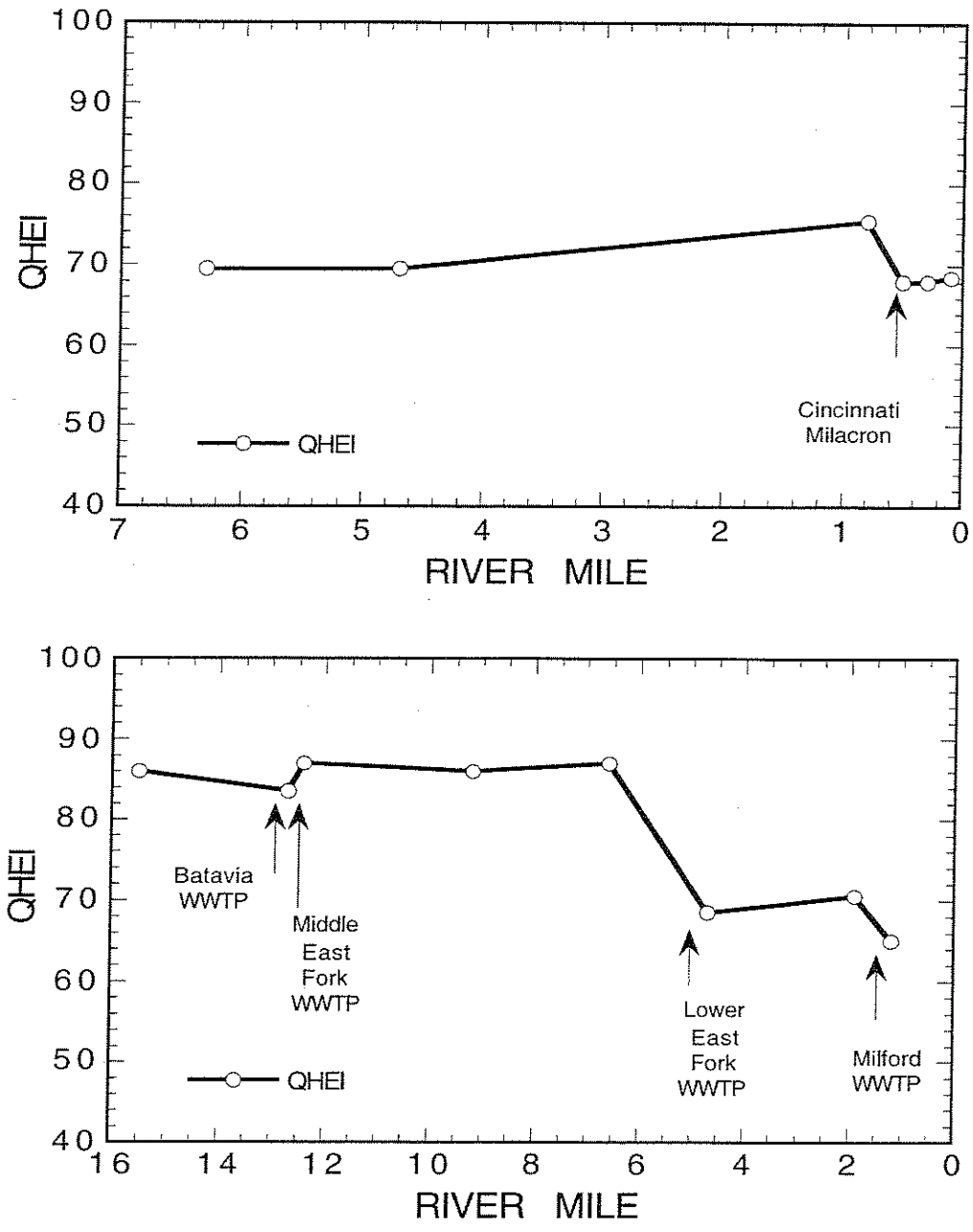


Figure 68. Longitudinal trend of the Qualitative Habitat Evaluation Index (QHEI) in Turtle Creek (Top Graph) and the East Fork of the Little Miami River (Bottom Graph) during 1993.

Macroinvertebrate Assemblages (Plate 6-7,9; Figure 1,69-70; Table 5,11,A-9,A-10)
Little Miami River

- Macroinvertebrate assemblages were sampled and evaluated at 35 sites in the Little Miami River during the 1993 survey. Narrative evaluations of the assemblages ranged from good to exceptional quality in the free flowing section to only fair quality within the Ohio River backwaters (Table 11). Invertebrate Community Index (ICI) scores, excluding mixing zone and slow current affected stations, ranged from a low of 40 (downstream from the Waynesville WWTP, RM 53.2) to a high of 58 (downstream from the I 275 bridge, RM 20.6, Figure 69).

- A total of 236 macroinvertebrate taxa were collected from the Little Miami River by the Ohio EPA in 1993. A cumulative total of 321 taxa were collected throughout the watershed by Ohio EPA (349 total taxa with the additional 28 unionid taxa reported by Hoggarth [1992]). By sampling location, the highest cumulative total number of macroinvertebrates collected in the Little Miami River mainstem (86) occurred at SR 48 (RM 32.9, Figure 1). This location also had the highest cumulative total number (27) of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) taxa (*i.e.,* EPT taxa) in the mainstem. The mainstem at RM 32.9 contained the second most diverse macroinvertebrate assemblage found in the study area. The highest number (90 taxa) occurred in the East Fork at RM 6.7 (Table A-10).

- Macroinvertebrate taxa collected in the Little Miami River that are indicative of high quality streams in Ohio included mayflies from the family Baetidae (species formerly in *Pseudocloeon)* at RMs 101.5 and 72.3; stoneflies of the *Agnetina capitata* complex at 10 stations between RM 47.5 and 8.8, the *Neoperla clymene* complex at 9 locations from RM 43.7 to 18.9, and the genus *Leuctra sp.* at RM 80.6; the caddisfly species *Psychomyia flavida* at 8 stations from RM 76.7 to 29.2 and the genus *Protoptila* at RM 32.0; and the midges of the *Rheotanytarsus distinctissimus* group at 5 sites from RM 85.3 to 35.9 and *Sublettea coffmani* at 7 locations between RMs 83.3 and 64.4. A new macroinvertebrate taxa, the riffle beetle *Microcylloepus pusillus*, was collected for the first time at RMs 53.2, 43.7, and 32.0 (*i.e.,* the first Ohio EPA records for this taxon in an Ohio stream).

- Hoggarth (1992) reports a total of 30 Unionidae (freshwater mussels) species, including two state endangered species (*Quadrula nodulata* , the wartyback mussel at SR 48 [RM 23.9] and Newtown Road [RM 8.2] and *Villosa fabalis*, the rayed bean mussel at SR 123 [RM 38.7]), that inhabit the Little Miami River (Plate 7). The highest numbers of mussel species in the mainstem were collected at RM 23.9 (18 species) and RMs 36.0 and 42.0 (17 species each, Figure 1). Longitudinally within the Little Miami River, the mussel survey found a gradual increase in the number of upper mainstem mussel species from 1 species near South Charleston (RMs 103.0-99.0) to 12 species in the Clifton Gorge (RMs 85.4-80.8) followed by a marked decline of only 3 to 8 species at most locations between Xenia and Waynesville (RMs 80.8-53.8, Hoggarth 1992). Mussel populations within the lower half increased to 12 to 17 species in the segment extending from downstream of Waynesville to South Lebanon (RMs 51.2-33.2), declined to 9 species downstream from Muddy Creek (RM 31.2), increased to 13 to 18 species between Simpson Creek and I-275 (RMs 28.3-20.9), but decrease to only 4 to 12 species between I-275 and Bass Island (RMs 19.3-8.0). No mussel species were collected at Beechmont or Kellogg avenues (RM 3.5-1.6).

- Zebra mussels *(Dreissena polymorpha)* were collected from the Little Miami River at Milford (RM 13.1) for the first time during the 1993 survey. Approximately 125 individuals were attached to a set of artificial substrates retrieved from a calm area in the river with non-detectable current. The introduced species was not found by qualitative sampling at this station, however, or at any other location within the basin. The scarcity of zebra mussels in the basin may be because they have only recently been introduced and have not had time to disperse. Zebra mussels can clog water intake pipes and kill native unionid mussels by physically attaching to their shells and interfering

with their ability to feed, reproduce, and remain anchored in the substrates. The species can be introduced to new waters via transportation on boats and trailers from infested lakes and rivers.

Upper Mainstem: South Charleston to Waynesville

- Macroinvertebrate communities sampled upstream (RM 101.5) and downstream (RM 98.8) from Gilroy Ditch (RM 100.65) were evaluated as exceptional with no apparent impact from the South Charleston WWTP (Gilroy Ditch RM 1.4) or a feedlot near the mouth of Gilroy Ditch that have historically caused impairment (Figure 69). Macroinvertebrate communities remained indicative of exceptional quality downstream to U.S. 68 (RM 80.6). Compared to the results at Dolly Varden Road (RM 98.8), assemblages at Grinnel Rd. (RM 85.3) and U.S. Rt. 68 (RM 80.6) showed some indication of impact due to decreases in the ICIs (50 to 46), fewer total taxa (78 compared to 59 to 64), and higher percentages of tolerant taxa (1.2% compared to 8.2 and 7.1%; Tables A-9 and A-10). The most notable difference upstream and downstream from the confluence of Yellow Springs Creek was a large increase in the density of macroinvertebrates (from 557 individuals per square foot at RM 85.3 to 1081 organisms per square foot at RM 83.1), an indication of nutrient enrichment, most likely from the Yellow Springs Creek WWTP.

- The ICI and total cumulative number of taxa showed further declines downstream from the Xenia Ford Road WWTP (RM 77.05) indicating a change from exceptional to very good quality. Results of qualitative sampling within the mixing zone (RM 77.0) indicated a good quality assemblage (Table 11). The sample contained 12 EPT taxa (compared to 18 EPT taxa at RM 80.6 and 15 at RM 76.7) and the predominant organisms shifted from a diverse mixture of hydropsychid caddisflies, mayflies, and midges (at RM 80.6 and 76.7) to only midges (Table A-10). The total density of macroinvertebrates showed another significant increase from 1488 individuals per square foot at RM 80.6 to 2855 organisms per square foot downstream from the WWTP (RM 76.7). These types of community changes are indicative of increased organic or nutrient loadings as opposed to a more severe impact from acute toxicity. Sampling results from the next two stations downstream (RMs 74.6 and 72.3) remained indicative of exceptional quality. Downstream, sampling results showed an increase in the ICI score and cumulative total number of taxa at RM 72.3, but subsequent declines in both the ICI and taxa richness took place between Bellbrook and Waynesville (RMs 65.6 to 53.2). The highest densities of macroinvertebrates in the mainstem were collected downstream from the Xenia Ford Road WWTP and Beaver Creek which receives effluent from the Montgomery Co. Eastern Regional WWTP and Greene Co. Beavercreek WWTP.

- The ICI increased slightly from the very good range (44 at RM 65.6) upstream from the Greene County Sugar Creek WWTP to the exceptional range (46 at RM 64.2) downstream, however, the cumulative total number of species and number of qualitative EPT taxa showed the opposite trend and decreased (67 to 57 and 16 to 11, respectively). Sampling results from within the WWTP mixing zone were also indicative of an impaired community. Narratively, the ICI was indicative of only a good quality macroinvertebrate assemblage due to a high percentages of tolerant taxa (22.6%) and other dipteran and non-insects and a lower percentage and number of mayflies (Table A-9). Additionally, the majority of hydropsychid caddisflies in the mixing zone sample had severely "burned" gills; this is a condition associated with chlorine pollution (Simpson 1980). The impairment found within the mixing zone was more indicative of enrichment and chlorine impacts as apposed to acute toxicity. Downstream at Spring Valley (RM 63.0), the ICI remained a 46 (exceptional range), but the cumulative total number of taxa declined to 53, the lowest value in the free-flowing mainstem (Table A-10).

- The ICI declined to the good range (40 at RM 53.2) and the total number of taxa remained 53 at the next station located downstream from the Waynesville WWTP. The ICI declined due to a lower number of mayfly taxa and a markedly lower percentage of *Tanytarsini* midges (declined from 40.1 to 4.8% and remained below the expected range for over 17.3 miles). While these

results may have been influenced by suboptimal current velocity over the artificial substrates, water quality impacts are likely because of the abnormally low proportion of *Tanytarsini* midges were also found throughout the next 17.3 miles of the mainstem (RMs 53.2 to 35.9).

Lower Mainstem: Oregonia to the Ohio River

- Narratively, macroinvertebrate communities in the lower free-flowing Little Miami River ranged from very good to exceptional quality, except for one mixing zone station. Communities within the impounded Ohio River backwaters, however, were evaluated as only fair quality (Table 11). Samples affected by slow current speed (RMs 47.5, 35.9, 22.2, 13.1, and 1.6) were evaluated using the qualitative and quantitative results.

- ICI values increased from 48 at Ft. Ancient (RM 43.7) to 56 at South Lebanon (RMs 32.9-32.0), decreased slightly (52-50) between Kings Mill and Loveland (but remained exceptional, RMs 30.7-23.9), increased to the highest mainstem value (58) at I-275, then declined to 52 upstream from Bass Island (RM 8.8) and 42 at Beechmont Avenue (RM 3.5, Figure 69, Table 11). Downstream from Waynesville, densities of macroinvertebrates decreased to values less than 500 organisms per square foot in the mainstem to Morrow, but then increased back to over 1,000 organisms per square foot at most locations from downstream of Turtle Creek to Beechmont Avenue (RMs 32.9-3.4).

- Macroinvertebrate results from the Lebanon WWTP mixing zone (RM 32.1) were indicative of only a good quality assemblage (ICI=34) due partially to very high percentages of tolerant taxa and other dipteran and non-insects. These structural changes and relatively high numbers of qualitative EPT taxa (11), cumulative total taxa (69), and density of organisms (1,161 per foot squared) suggest nutrient enrichment associated impacts as apposed to acute toxicity.

- The ICI significantly declined from 52 at RM 8.8 to 42 at Beechmont Avenue (RM 3.4), one of the largest changes in the study area. The decline was due primarily to an increase in the tolerant taxa Oligochaeta (segmented worms) and an increase in several facultative (pollution intermediate) taxa of midges, possibly caused by CSO discharges and urban runoff from the Cincinnati area.

- The ICI score from the Ohio River backwaters (RMs 1.6) was substantially below the Interior Plateau's warmwater biocriterion (30). Ecologically, the Ohio River backwaters are most similar to the Lake Erie river mouths which are evaluated by an interim biocriterion of 22. The ICI value of 12, however, is even significantly below that value. The communities in the Little Miami River were predominated by the facultative midge taxa *Glyptotendipes (Phytotendipes) sp.* and *Dicrotendipes lucifer*. A cumulative total of only seven (7) mayfly and caddisfly taxa were collected at the two impounded stations compared to 12 to 19 taxa at most free-flowing locations. The primary cause(s) of the depressed community was probably due to lower habitat quality (*i.e.*, slow current speed and fine particle size substrates) combined with CSO and urban runoff impacts from Cincinnati.

Yellow Springs Creek

- Macroinvertebrate samples from upstream (RM 0.5) and downstream (RM 0.3) the Yellow Springs Creek WWTP were evaluated as exceptional (ICI=46) and showed no evidence impact. Two intolerant stonefly taxa, *Leuctra* and *Paragnetina media* , were collected at both stations. Community performance within the mixing zone, however, declined to the good (ICI=36) range due primarily to structural changes. The results did not suggest acutely toxic conditions, but more of an impact associated with nutrients.

Oldtown Creek

- The macroinvertebrate community sampled downstream from Brush Row Road (RM 0.4) was evaluated as good (ICI=38). This station had a relatively taxa rich caddisfly community, with ten

total taxa, and midge community, with 30 total taxa. Six coolwater taxa were found to inhabit this station which indicates some groundwater recharge in this stream. These six (6) taxa were the caddisfly species *Hydropsyche (H.) slossonae* and midges of the genera *Zavrelimyia*, *Parametriocnemus*, and *Micropsectra* , and the species *Polypedilum (P) aviceps* and *Paratanytarus n. sp. 1.*

South Fork Massies Creek

- Macroinvertebrate communities sampled in South Fork Massies Creek, using qualitative methods, were evaluated as exceptional (RM 2.1) and very good (RM 1.1). The upstream station was channelized with grass banks, agricultural fields on both sides, but contained good riffle development, however, heavy silt covered most substrates. The downstream station had forested banks, good riffle-pool development, and only slight amounts of siltation. The proposed channel deepening in this area would severely degrade the ability of these two sites to support high quality macroinvertebrate communities by turning this area into a big pool.

Massies Creek

- The qualitative macroinvertebrate sample from Massies Creek was indicative of a good quality assemblage, however, the total number of qualitative and EPT taxa were relatively low (33 and 9, respectively). The taxa present were indicative of non-impacted communities, however. The substrates were heavily embedded with marl which may be causing the lower taxa richness by physically reducing suitable attachment sites and microhabitats for macroinvertebrates.

Beaver Creek

- ICI scores in Beaver Creek were exceptional (48) both upstream and downstream from the confluence of Little Beaver Creek, suggesting no far-field impact from the Montgomery Co. E. Regional WWTP. Downstream from the Greene Co. Beavercreek WWTP, however, the mixing zone (RM 0.4) ICI declined to the good range (36) due to a lower number of mayfly taxa, lower percentage of caddisfly taxa, and an increase in other dipteran and non-insect taxa (especially midges of the *Cricotopus tremulus* and *Rheotanytarsus exiguus* groups). Acute toxicity, however, was not indicated. Also suggesting an impact, the qualitative sample further downstream (RM 0.2) was indicative of only a fair quality macroinvertebrate assemblage. A comparison of the qualitative results from upstream of the WWTP (RM 0.5) to downstream (RM 0.2) shows a declines in the total numbers of all taxa and EPT taxa (53 to 35 and 9 to 6, respectively).

Little Beaver Creek

- The macroinvertebrate community in Little Beaver Creek was severely impacted by the Montgomery County Eastern Regional WWTP discharge. The ICI markedly declined from a 40 (good) at RM 4.7 to 4 (poor) within the mixing zone. The mixing zone station was predominated by pollution tolerant Oligochaets (segmented worms), Turbellaria (flatworms), the midge *Polypedilum (P.) illinoense* , and a blackfly *Simulium sp.* The mixing zone sample contained no mayflies or stoneflies and low numbers of only one caddisfly. The degree of impact was indicative of an acutely toxic response by macroinvertebrates to the WWTP effluent. The community sampled at RM 4.4 by qualitative methods was essentially identical to the mixing zone community and was likewise evaluated as poor. The ICI gradually increased to the fair range (20) at North Fairfield Road (RM 2.0) and the good range (38) near the mouth (RM 0.1).

Glady Run

- Macroinvertebrates in Glady Run upstream from the Glady Run Swale (RM 4.9) were indicative of a good quality assemblage (ICI=36). The fauna included 10 cool-water macroinvertebrate taxa indicative of groundwater flow from springs. They were (the stonefly *Amphinemura delosa*, the caddisfly *Diplectrona modesta*, and the midges *Meropelopia sp.*, *Zavrelimyia sp.*, *Prodiamesa olivacea*, *Parametriocnemus sp.*, *Thienemanniella partita*, *Polypedilum (P.) albicorne*,

Micropsectra sp., and *Paratanytarsus n. sp. 1)*.

- The macroinvertebrate community performance downstream (RM 4.7) from Glady Run Swale declined to the fair range (ICI=28) due primarily to compositional and structural changes. The number of coolwater taxa declined to only four midge taxa. The community remained fair (ICI=24) near the mouth (RM 0.3). Isopods (aquatic sow bugs) were one of the most numerous taxa in both the quantitative and qualitative samples.

Glady Run Swale

- A fair quality community was collected from Glady Run Swale upstream from the Xenia-Glady Run WWTP discharge possibly due to channelization. The number of qualitative EPT taxa (3) was below the expectations for a good community, but overall the community supports the conclusion that Glady Run Swale has permanent flow; at least through August.

Newman Run

- A very limited macroinvertebrate community was collected from Newman Run during severe drought (intermittent flow) conditions in late August. Newman Run contained one of the lowest total number of qualitative taxa (11) in the study area. The assemblage was predominated by Isopods, aquatic sow bugs. Based on the fish community results, which were indicative of exceptional quality in early July, the limited macroinvertebrate results were due more to the drought than poor water quality.

Anderson Fork

- The macroinvertebrate community performance in Anderson Fork (RM 5.0) was evaluated as good. The artificial substrate sample was affected by slow current speed, but the number of qualitative sample EPT (11) was indicative of a good benthic community.

Flat Fork

- Qualitative sampling in Flat Fork during intermittent flow yielded a very limited macroinvertebrate community indicative of only marginally fair quality. The assemblage was dominated by water boatmen and snails. An abundance of leeches were also observed by the fish crew while electrofishing.

Caesar Creek

- The macroinvertebrate community performance in Caesar Creek (RM 16.5) upstream from Caesar Creek Reservoir was evaluated as very good. The artificial substrate sample was affected by slow current speed, but the number of qualitative EPT taxa (15) met the expected range for a very good community. The Asiatic clam (*Corbicula fluminea)*, midges, and riffle beetle larvae were the predominant benthic taxa in the stream channel.

- The quality of the macroinvertebrate community declined to only fair downstream from the reservoir. The qualitative EPT declined from 15 to eight (8), which slightly deviates from the expected range for a good quality community.

Dry Run

- A fair quality macroinvertebrate community was collected from Dry Run during intermittent flow in late August. The qualitative number of EPT taxa (4) deviated slightly from the expected range of a good community. The fauna included two intolerant taxa, the stonefly *Acroneuria evoluta* and caddisfly taxa *Helichopsyche borealis*. The quantitative sample was affected by slow current speed, thus was not used as the primary assessment.

Turtle Creek

- ICI values in Turtle Creek ranged from a high of 36 at RM 4.3 to a low of 16 upstream from Dry Run near the mouth (Figure 70). Narratively, the quality of macroinvertebrate communities was marginally good at three locations (RMs 6.3, 0.6, and 0.5), good at one location (RM 4.3), and fair near the mouth (RM 0.1, Table 11). Flows were low throughout most of the sample colonization period; based on an inspection conducted two weeks into colonization. The quantitative sample at RM 0.6 was affected by slow current speed. No significant change was detected between assemblages upstream and immediately downstream from the Cincinnati Milacron discharge, however, the community at RM 0.1 was impacted by enrichment. Sample density increased to 2,583 organisms per square foot compared to a density of 149 organisms at RM 0.5. The most numerous taxa included two pollution tolerant taxa, Oligochaets (segmented worms) and *Dicrotendipes fumidus* (midge).

Muddy Creek

- A macroinvertebrate community indicative of good (ICI=34) quality was collected from Muddy Creek at RM 2.5. The percentage of other dipterans and non-insects, however, strongly deviated from the expected range for a good community suggesting organic or nutrient enrichment from the Mason WWTP which discharges approximately three quarters of a mile upstream. A strong effluent odor and black sludge deposits along the channel margins were present at the sampling site.

Sycamore Creek

- Sycamore Creek contained only fair quality midge dominated communities both upstream and downstream from the Hamilton Co. MSD Sycamore Creek WWTP. The mixing zone supported an improved assemblage indicative of good quality (ICI=32), however, four ICI metrics only scored a "two" and no qualitative EPT taxa were collected. The results also show the continuation of rather severe impacts upstream from the WWTP. Upstream sewer overflows may be the principle source of the impact. Negative attributes of the assemblage downstream from the WWTP included high percentages of other dipteran and non-insects and tolerant taxa which strongly deviated from the expected (*i.e.,* the ICI metric scored a zero).

Stonelick Creek

- Stonelick Creek's macroinvertebrates improved from fair quality (ICI=24) upstream from Stonelick Lake to good quality in the lower three miles (ICI = 32 and 36). The number of qualitative EPT taxa (5) upstream from the Lake (RM 17.7) deviated slightly from the expected range for a good community, possibly impacted by the drought. The stream flow continued to be low downstream from the lake (RMs 2.9 and 1.0), but community performance improved to the good range and the pollution sensitive stonefly, *Agnetina capitata* complex, was collected at both stations. The number of qualitative EPT taxa collected (17) at RM 0.1 is typical of exceptional quality stream communities.

East Fork Little Miami River

- The lower 15.5 miles of the East Fork supports a diverse aquatic macroinvertebrate fauna. Cumulatively, a total of 163 macroinvertebrate taxa were collected from the eight (8) sites downstream from the reservoir (Ohio EPA collections). The total cumulative number of taxa collected by site ranged from a Little Miami River watershed high of 90 taxa collected at Roundbottom Road (RM 6.7) to 50 taxa downstream from the Milford WWTP (RM 0.8, Table 11, A-10). The highest number of qualitative and cumulative EPT taxa (24 and 27, respectively) within the study area was also collected in the East Fork at the ODNR canoe access (RM 12.7), immediately upstream from the Clermont Co. Middle East Fork WWTP. Pollution sensitive taxa collected that are indicative of high quality streams in Ohio included the mayfly Baetidae (formerly in *Pseudocloeon)* at six (6) stations; the stonefly taxa *Acroneuria evoluta* at one (1) station, *Agnetina capitata* complex at all eight (8) stations, and *Neoperla clymene* complex at three (3)

stations; the caddisfly taxa *Psychomyia flava* at four (4) stations, *Leucotrichia pictipes* at three (3) stations, and *Protoptila sp.* at six (6) stations; and the midge taxa *Synorthocladius semivirens* at one (1) station. The combination of high ICI scores and a diverse macroinvertebrate fauna makes the East Fork of the Little Miami River one of Ohio's highest quality streams.

- The macroinvertebrate community samples from the East Fork of the Little Miami River ranged from exceptional to very good quality based on ICI scores (Table 11). The highest ICI value (54) was recorded at three of the four most upstream stations (RMs 15.5, 12.7, and 9.2) and the lowest value (44) occurred downstream from the Clermont County Lower East Fork WWTP (RM 4.7, Figure 70). Longitudinally, the density of macroinvertebrates doubled downstream from the Batavia WWTP (872 to 1649 organisms per square foot), decreased back to background levels (716 -746 organisms per square foot) upstream and downstream from the Clermont Co. Lower East Fork WWTP, but increased again by Milford (1366-1904 organisms per square foot, Table 11).

- The ICI declined 8 units immediately downstream from the Batavia WWTP (RM 13.3) due to structural changes caused by an increase in two filter feeding taxa; the midge *Rheotanytarsus exiguus* group and the caddisfly *Cheumatopsyche* sp., but increased back to 54 one half mile downstream (RM 12.7). The community shift suggests an increase in fine particulate organic matter from the Batavia WWTP, possibly in the form of algae from higher nutrient levels.

- The ICI remained high (54) downstream to Olive Branch Stonelick Road (RM 9.2), but declined to 46 at Perintown (RM 6.7) due to a higher percentage of other dipteran and non-insects and lower percentages of Tanytarsini and caddisflies. The ICI declined further to a 44 (the lowest score) downstream from the Lower East Fork Regional WWTP (RM 4.9) due to a high percentage of tolerant taxa and fewer mayfly taxa. These types of changes were relatively minor and were probably caused by some source of mild organic enrichment.

- Although the ICI increased at the last two downstream stations (upstream and downstream from the Milford WWTP, RMs 1.9 and 0.8), the number of pollution sensitive taxa declined to one (1) taxa (*Agnetina capitata* complex) compared to a minimum of three (3) taxa at the other six (6) upstream stations.

- Hoggarth (1992) reported 22 species of Unionidae (freshwater mussels) as inhabiting the East Fork. The fauna included two state endangered species, *Villosa fabalis* (the rayed bean mussel) and *Villosa lienosa* (the little spectaclecase mussel), upstream from the East Fork Lake.

Table 11. Summary of macroinvertebrate data collected from artificial substrates (quantitative) and natural substrates (qualitative) in the Little Miami River study area from July through September, 1993. Mixing zone samples are denoted by *Italics*.

	Quantitative Evaluation						
Stream River Mile	Density (#/ft²)	Quant. Taxa	Qual. Taxa	Qual. EPT[a]	Total Taxa	ICI	Evaluation
Little Miami River							
101.5	-	-	53	13	-	-	Exceptional
98.8	757	41	62	14	78	50	Exceptional
89.2	-	-	61	19	-	-	Exceptional
85.3	557	40	40	12	59	46	Exceptional
83.1	1081	38	51	18	67	48	Exceptional
80.6	1488	35	48	18	64	46	Exceptional
77.0	-	-	*54*	*12*	-	-	*Good*
76.7	2855	36	32	15	54	44[ns]	Very Good
74.6	-	-	57	18	-	-	Exceptional
72.3	2622	46	54	13	74	52	Exceptional
65.6	1507	33	55	16	67	44[ns]	Very Good
64.4	*1601*	*47*	*44*	*13*	*65*	*38*	*Good*
64.2	1339	37	38	11	57	46	Exceptional
63.0	854	31	42	12	53	46	Exceptional
53.2	293	29	45	14	53	40*	Good
47.5	458	45	46	11	71	[34][c]	Very Good
43.7	406	44	42	12	66	48	Exceptional
38.6	390	45	42	16	61	50	Exceptional
35.9	79	44	55	11	80	[34][c]	Very Good
32.9	1285	50	63	17	86	56	Exceptional
32.1	*1161*	*49*	*39*	*11*	*69*	*34*	*Good*
32.0	1723	44	58	17	78	56	Exceptional
30.7	1916	42	48	15	67	52	Exceptional
29.2	2098	40	68	19	80	52	Exceptional
28.0	-	-	53	18	-	-	Exceptional
23.9	1061	47	64	18	82	50	Exceptional
22.2	292	46	53	13	71	[32][c]	Very Good
21.4	987	51	47	14	73	56	Exceptional
20.6	1068	45	55	19	70	58	Exceptional
18.9	-	-	49	15	-	-	Very Good
13.1	442	38	35	13	55	[32][c]	Very Good
8.8	1347	29	47	16	57	52	Exceptional
3.4	1485	48	61	14	80	42[ns]	Very Good
1.6	626	21	22	4	35	[12][c]	Fair
0.4	-	-	24	5	-	-	Fair
Yellow Springs Creek							
0.5	303	32	45	11	62	46	Exceptional
0.44	*154*	*39*	*37*	*9*	*60*	*36*	*Good*
0.3	253	50	46	12	74	46	Exceptional

Table 11. Continued.

Stream River Mile	Density (#/ft²)	Quant. Taxa	Qual. Taxa	Qual. EPT[a]	Total Taxa	ICI	Evaluation
			Quantitative Evaluation				
Old Town Creek							
0.4	302	35	49	13	69	38	Good
Beaver Creek							
1.6	326	40	35	8	56	48	Exceptional
0.5	1579	40	53	9	69	48	Exceptional
0.4	*1621*	*38*	*29*	*5*	*49*	*36*	*Good*
0.2	-	-	35	6	-	-	Fair
Little Beaver Creek							
4.7	1757	40	37	9	55	40	Good
4.57	*4713*	*11*	*10*	*0*	*14*	*4*	*Poor*
4.4	-	-	18	1	-	-	Poor
2.0	281	28	16	1	34	20*	Fair
0.1	747	33	45	6	58	38	Good
Glady Run							
4.9	229	35	28	6	51	36	Good
4.7	341	39	31	2	56	28*	Fair
0.3	283	37	42	6	66	24*	Fair
Anderson Fork							
5.0	189	37	48	11	72	[30][c]	Good
Caesar Creek							
16.5	122	27	63	15	74	[24][c]	Very Good
0.1	-	-	36	8	-	-	Fair
Dry Run							
1.8	211	15	26	4	29	[8][c]	Fair
Turtle Creek							
6.3	62	33	38	5	55	26[ns]	Marg. Good
4.3	231	41	50	6	70	36	Good
0.6	211	29	39	5	53	[22][c]	Marg. Good
0.5	149	39	41	5	59	26	Marg. Good
0.1	2583	32	42	7	56	16*	Fair
Muddy Creek							
2.5	903	36	36	4	58	34	Good
Sycamore Creek							
0.5	-	-	30	7	-	-	Fair
0.26	*215*	*38*	*24*	*3*	*43*	*32*	*Good*
0.1	406	31	36	7	50	20*	Fair

Table 11. Continued.

Stream River Mile	Density (#/ft²)	Quant. Taxa	Qual. Taxa	Qual. EPT[a]	Total Taxa	ICI	Evaluation
			Quantitative Evaluation				
Stonelick Creek							
17.7	76	29	26	5	45	24*	Fair
2.9	401	29	38	12	56	32	Good
1.0	164	27	46	17	60	36	Good
East Fork Little Miami River							
15.5	872	42	71	21	85	54	Exceptional
13.3	1649	30	65	20	76	46	Exceptional
12.7	1433	51	61	24	81	54	Exceptional
9.2	1381	42	64	19	82	54	Exceptional
6.7	716	62	57	17	90	46	Exceptional
4.7	746	44	64	18	85	44	Very Good
1.9	1366	53	56	14	78	48	Exceptional
0.8	1904	39	61	13	50	50	Exceptional

Stream River Mile	No. Qual. Taxa	QCTV[b]	Qual. EPT[a]	Relative Density	Predominant Organisms	Narrative Evaluation[d]
			Qualitative Evaluation			
Little Miami River						
101.5	53	37.9	13	Low	Hydropsychids, riffle beetles, baetid mayflies	Exceptional
89.2	61	38.1	19	Moderate	Hydropsychids, mayflies	Exceptional
77.0	*54*	*37.9*	*12*	*Moderate*	*Midges*	*Good*
74.6	57	38.9	18	Moderate	Hydropsychids, *Isonychia*, midges	Exceptional
47.5	46	38.8	11	Moderate	Mayflies, hydropsychids, clams & snails	V. Good
35.9	55	38.9	11	Moderate	Hydropsychids, mayflies, snails	V. Good
28.0	53	40.8	18	Moderate	Hydropsychids, baetid mayflies	Exceptional
22.2	53	38.1	13	Low	River snails, mayflies	V. Good
18.9	49	38.9	15	Moderate	Hydropsychids, mayflies	V. Good
13.1	35	38.6	13	High	Hydropsychids, riffle beetles, mayflies	V. Good

Table 11. Continued.

Stream River Mile	No. Qual. Taxa	QCTV[b]	*Qualitative Evaluation* Qual. EPT[a]	Relative Density	Predominant Organisms	Narrative Evaluation[d]
Little Miami River						
0.4	24	35.1	5	Moderate	Midges	Fair
South Fork Massies Creek						
2.1	49	38.9	16	Moderate	Mayflies, hydropsychids, midges	Exceptional
1.1	39	40.6	13	Low-Mod.	Hydropsychids, mayflies	V. Good
Massies Creek						
0.3	33	40.0	9	Low-Mod.	Caddisflies, mayflies, midges	Good
Beaver Creek						
0.2	35	34.9	6	Moderate	Midges	Fair
Little Beaver Creek						
4.4	18	23.2	1	Mod.-High	Midges, flatworms, blackflies	Poor
Glady Run Swale						
0.3	35	35.1	3	Moderate	Blackflies, segmented worms, midges	Fair
Newman Run						
0.3	11	38.9	4	Low	Sow bugs	Fair
Anderson Fork						
5.0	48	38.6	11	High	Caddisflies, *Isonychia*, riffle beetles	Good
Flat Fork						
1.7	19	27.1	2	Moderate	Water boatmen, snails	Low Fair
Ceasar Creek						
16.5	63	37.9	15	Moderate	Asiatic clams, midges, riffle beetles	V. Good
0.1	36	38.6	8	Mod.-High	Damselflies, river snails, riffle beetles	Fair

Table 11. Continued.

Stream River Mile	No. Qual. Taxa	*Qualitative Evaluation* QCTV[b]	Qual. EPT[a]	Relative Density	Predominant Organisms	Narrative Evaluation[d]
Dry Run						
1.8	26	36.1	4	Low	Midges, snails, beetles	Fair
Turtle Creek						
0.6	39	32.5	5	Moderate	Riffle beetles, midges, heptageniids	Marg. Good
Sycamore Creek						
0.5	30	35.1	7	Low	Midges	Fair

Ecoregion Biocriteria: Invertebrate Community Index (ICI)

	WWH	EWH
Eastern Corn Belt Plains (ECBP)	36	46
Interior Plateau (IP)	30	46

a EPT = total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa.
b Qualitative Community Tolerance Value calculated as the median of the weighted ICI for each taxon.
c The quantitative sample was effected by slow current speed, evaluation was based primarily on the qualitative sample.
d A qualitative narrative evaluation based on best professional judgement is used when quantitative data is not available to calculate the Invertebrate Community Index (ICI) scores.
* Significant departure from ecoregion biocriteria (>4 ICI units); poor and very poor results are underlined.
ns Nonsignificant departure from biocriterion (≤4 ICI units).

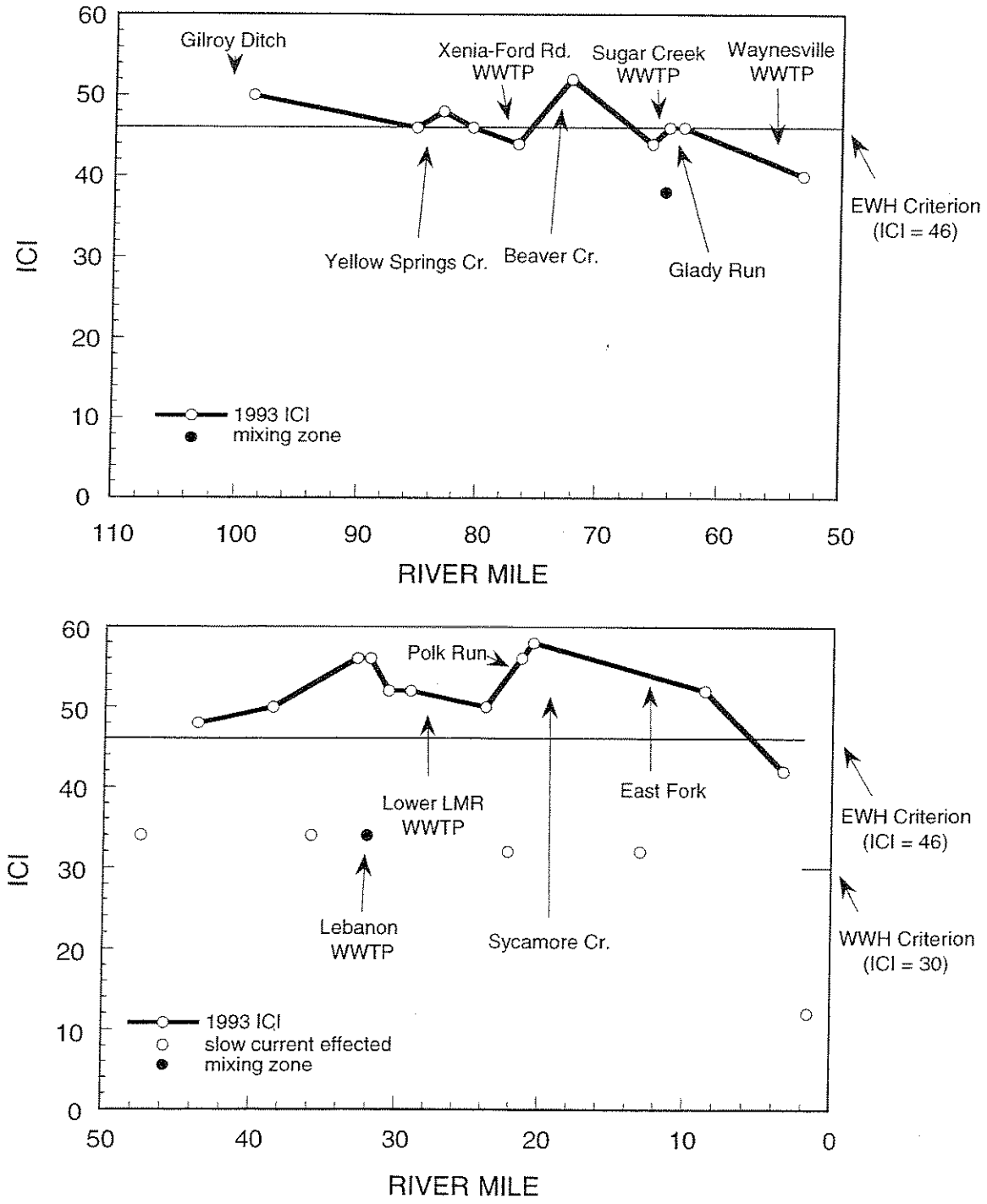


Figure 69. Longitudinal trend of the Invertebrate Community Index (ICI) in the upper half (Top Graph) and lower half (bottom graph) of the Little Miami River during 1993.

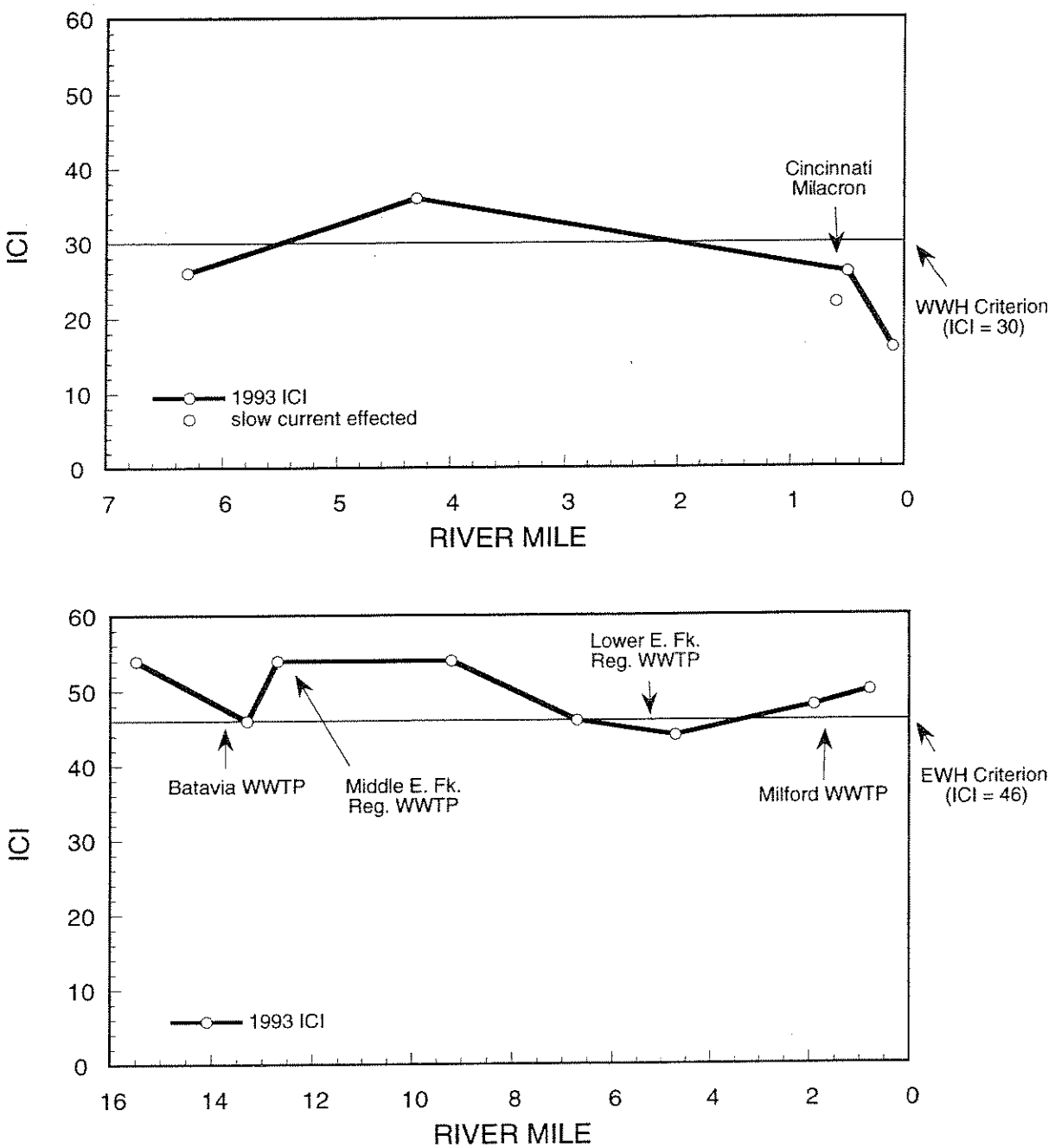


Figure 70. Longitudinal trend of the Invertebrate Community Index (ICI) in Turtle Creek (top graph) and the East Fork Little Miami River (bottom graph) during 1993.

Fish Assemblages (Plates 2, 6-10; Figures 71-81; Tables 1,5,12, A-8b, A-11, A-12)
Little Miami River

- Electrofishing at 35 locations throughout the Little Miami River yielded a total cumulative catch of 33,139 fish comprised of 83 species and 10 hybrids (82 species were collected during the intensive survey and one additional species, the grass carp, was collected during a November blue sucker survey). The mainstem catch included three (3) fish species which are listed as endangered in Ohio (ODNR 1992). A single tonguetied minnow was collected from the Clifton gorge area (RM 85.4), 42 mountain madtoms were captured at Newtown (RM 8.0) and one individual at RM 3.5, and seven blue suckers were captured also at RM 3.5, the first riffle upstream from the Ohio River (Plate 7). The collection of blue suckers is particularly significant because it was the first reported from the watershed and included a variety of sizes from young-of-the-year to large adults. Evidence of the successful reproduction by blue suckers in Ohio has not been documented for approximately 50 years. Despite numerous statewide fish sampling efforts since 1978, only a few large specimens have been collected from one other location in the lower Scioto River. An American eel, a now rare species which was once common in Ohio (Trautman 1981) was also collected in the mainstem at Morrow. The American eel is a long lived catadromus species which is spawned at sea, but which lives most of their adult life in freshwater. Dams on the Ohio and the Mississippi Rivers have impeded migration which has greatly reduced the number of eels observed in Ohio's rivers and streams.

- Mean MIwb values were indicative of very good to exceptional quality fish assemblages at 25 locations (74%), good to marginally good quality at seven locations (21%), and fair quality at two locations (6%). IBI values were indicative of exceptional to very good quality fish assemblages at 17 locations (49%) and good to marginally good assemblages at 10 locations (29%), and fair quality at eight locations (23%). Excluding mixing zone samples, MIwb and IBI values collectively attained (including nonsignificant departures) EWH criteria at 50% of the sampling locations.

Upper Little Miami River: South Charleston to Waynesville

- A total of 16,638 fish comprised of 61 species were collected from the upper half of the LMR located in the Eastern Corn Belt Plains (ECBP) ecoregion. The total cumulative catch was numerically dominated by central stonerollers (19.4%) and white suckers (11.3%). The predominant species by weight were common carp (28.8%), black redhorse (16.9%), white sucker (12.4%), and golden redhorse (12.2%). The total number of fish species collected at sites increased from 14-21 species downstream from South Charleston to 21-38 species between Clifton and Waynesville.

- Between South Charleston and Clifton (RM 102.1-92.2), IBI values were indicative of only fair fish assemblages due to very low numbers of headwater, sensitive, and intolerant species; low percentages of insectivores and top carnivores; and high percentages of tolerant species (Table 12,A-11). MIwb scores were indicative of marginally good quality (i.e., also did not attain EWH biocriterion). The average percent and relative number of fish with deformities, erosion, lesions/ulcers, and tumors (DELT anomalies) remained relatively low throughout the reach (ranged from 0.0-0.6% and 0.0-3.8 fish per 0.3 km, respectively; Figure 75-77b). Fish assemblages throughout the reach may have been impacted by a large fish kill in 1992 caused by manure runoff from a composting industry in South Charleston. The mainstem is also impacted by agricultural activities including unrestricted livestock access, channelization, and intensive row crop cultivation.

- Compositionally, mainstem fish assemblages improved between Clifton and the Narrows (RM 85.4-72.5) to very good to exceptional quality (*i.e.,* IBI and MIwb values attained EWH biocriteria), however, the incidence of DELT anomalies also increased apparently due to effluent quality and the increasing cumulative volume (mean values ranged from 0.3-4.13% and 3.0-51.8 fish per km; Table 12, A-11; Figure 71, 75-77b).

- Downstream from Bellbrook (RM 64.7) and at Spring Valley (RM 63.4), however, both IBI and MIwb values declined to the marginally good to good range downstream (*i.e.,* met only WWH biocriteria), but attained EWH downstream from the Sugar Creek WWTP mixing zone (RM 64.2 also contained the highest total number of fish species within the upper half of the mainstem). The IBI declined further to the fair range downstream from the Waynesville WWTP (RM 53.5), but the MIwb increased to very good. Compositional changes, such as marked increases in the relative abundance of common carp (a highly tolerant fish species) downstream from Bellbrook suggests impacts from pollutant loadings as apposed to lower habitat quality. The relative number and weight of carp increased from 3.3-14.0 fish per km and 4.9-24.7 kg per km between Clifton and the Narrows to 17.3-81.0 fish per km and 35.2-171.2 kg per km between Bellbrook and Waynesville (Table A-12). Higher incidences of DELT anomalies within the segment were also indicative of chemical impacts. The average percent and relative number of fish with DELT anomalies increased to 4.1-9.3% and 18.7-38.0 fish per km (excluding mixing zones) between Bellbrook and Waynesville. The highest incidences of DELT anomalies by sample ranged from 5.3-11.7 % and 22.6-55.5 fish per km between RMs 64.7 and 53.5 (Table A-11, Figure 75).

- The higher than normal incidences of DELT anomalies in the upper half of the mainstem is an indication of stressed fish communities. Elevated DELT levels in Ohio streams typically occur in association with marginal dissolved oxygen concentrations and chemical toxicity. Figures 76a - 77b show a positive relationship between DELT anomalies and the cumulative volume of effluent discharged to the upper half of the mainstem. There is also a direct relationship between anomalies and mean total phosphorus concentrations, a common constituent of municipal WWTP effluent. The types of impacts to fish assemblages throughout the upper half are primarily indicative of excessive nutrient enrichment with an assimilation sag extending from downstream Bellbrook to Oregonia. Although relatively good effluent quality is discharged by most of the WWTPs, the cumulative pollutant load continues to exceed the assimilative capacity of the upper mainstem. The largest mainstem diurnal swings in dissolved oxygen concentrations (4.3-5.0 mg/l difference between maximum and minimum diel values) between RMs 73.2 and 70.5, due to high algal growth, is additional evidence indicative of high nutrient levels (Table A-6).

- Fish sampling results from the mixing zones (first 100 meters downstream from the 001 outfalls) of the Xenia-Ford Road and Greene County Sugar Creek WWTPs showed no evidence of acute toxicity or avoidance and were indicative (respectively) of good to exceptional and fair to very good quality fish assemblages. Twenty one (21) and 29 species, respectively, were collected within 100 m of the outfalls. High levels of DELT anomalies, however, were found on fish captured in the Xenia-Ford Road WWTP mixing zone (4.0-4.2% and 40.0-61.7 per km).

- Fish assemblages throughout the upper mainstem contained a relatively low percentage of top carnivore fish such as smallmouth bass and rock bass (Table A-11). The highest value (11%) was recorded upstream from Xenia at Jacoby Road (RM 83.1) during the early August sample. This sample was the only one where the IBI metric scored a "5" which is indicative of expected values for reference sites. Although not markedly higher, percentages decreased downstream from the Xenia-Ford Road WWTP enough to score a "1" (value strongly deviates from the expected) in all but one sample (RM 64.2) at the next eight sites (RM 76.8-53.5).

Lower Little Miami River: Oregonia to the Ohio River

- A total of 16,500 fish comprised of 69 species and seven (7) hybrids were collected from the Little Miami River between Oregonia and the Ohio River within the Interior Plateau ecoregion. The total cumulative catch from 20 locations was numerically dominated by gizzard shad (27.7%), golden redhorse (11.3%), and emerald shiner (10.2%). By weight, the predominate species were common carp (24.5%), golden redhorse (17.1%), and shorthead redhorse (12.0%). The highest total number of fish species collected 41 fish species (50 % of the total number collected from the 102 mile mainstem) adjacent to Bass Island RM 8.0) downstream from Newtown Road

- Longitudinally, mean IBI and MIwb values exhibited slight recovery from upstream impacts by Oregonia and FULL attainment of EWH biocriteria at nine (9) of the next 11 locations sampled between Fort Ancient and I-275 (RMs 44.2-20.9, Figure 72, Table 12). The two sampling locations where one or both fish indices did not attain EWH (upstream from Simpson Creek [RM 28.3] and downstream of Tote's [RM 22.1]) contained only large pool habitat. The lack of swift flowing habitat which is preferred by shorthead redhorse and other pollution sensitive species may have been responsible for the lower than expected values, however, thick sediment deposits from excessive soil erosion may also be responsible. The mean percent and relative number of DELT anomalies between Oregonia and I-275 (excluding the Lebanon WWTP mixing zone sample) ranged from 1.0-4.8% and 2.7-27.2 fish per km (Table A-11, Figure 75, 78-80b). Longitudinally, the highest incidences were recorded at Oregonia (RM 47.5) and downstream from the Lebanon WWTP and Muddy Creek (RM 31.9-28.2). Overall, the incidences of DELT anomalies on fish in the lower half of the mainstem also appear to show positive relationships to the amount of effluent and total phosphorus concentrations (Figure 78-80b).

- The only mixing zone sample in the lower mainstem was conducted immediately downstream from the Lebanon WWTP (RM 32.1). Sampling results at RM 32.1 yielded 21 cumulative species (including several large sport fish) and there was no evidence of acute toxicity through avoidance. Fish assemblages within the mixing zone did, however, have a high number of DELT anomalies (mean values = 6.1% and 40.3 fish per km).

- The IBI decreased downstream from Sycamore Creek and failed to meet the EHW biocriterion at all seven sampling locations in the lower 18.5 miles of the mainstem. IBI scores were indicative of fair to good fish assemblages. IBI metrics which showed the greatest departure from background reference conditions included lower than normal numbers of sunfish and intolerant species combined with low percentages of top carnivores, and generally higher than expected percentages of omnivorous species and DELT anomalies. The MIwb also decreased downstream from Sycamore Creek and did not meet EWH biocriterion at Milford (RM 13.3, despite excellent habitat) or upstream from Bass Island (RM 8.3), but increased back to the exceptional range at Bass Island and Beechmont Avenue (RMs 8.0 and 3.5). The mean percent and relative number of DELT anomalies on fish captured downstream from Sycamore Creek to Beechmont Avenue (RMs 18.5-3.5) ranged from 1.9-5.0% and 8.7-20.7 fish per km. The highest incidences occurred downstream from Sycamore Creek (RM 18.5). The impairment to fish assemblages within the segment is likely due to a combination of causes and sources. Longitudinally, changes include lower dissolved oxygen levels (due to the assimilation of upstream discharges of organic and nutrients) and higher concentrations of total suspended solids. Fecal bacteria counts also increased within the segment. Possible sources of nutrients and other pollutants include the cumulative WWTP discharges between Lebanon and I-275, pollutant loads from Sycamore Creek, CSO discharges in Milford, WWTP loads from the East Fork, and additional CSO and landfill leachate from Duck Creek. Urban runoff also contributes pollutants to the river throughout the segment.

- IBI and MIwb values from the lower two impounded miles of the river were indicative of only fair quality fish assemblages. These two sites, however, were sampled only during the day and may have scored higher if sampled during the night.

Yellow Springs Creek

- A total of 2,428 fish comprised of 23 species were collected from the three adjacent sampling locations in Yellow Springs Creek which bracketed the Yellow Springs WWTP (RM 0.5 - 0.3). Fish assemblages showed no impact from the 001 effluent, IBI scores attained EWH criterion both upstream and downstream from the discharge and in the mixing zone. The most numerically abundant species were creek chubs (18.5%), greenside darters (13.4%), rainbow darters (12.7%), white suckers (12.4%), and central stonerollers (11.9%). No DELT anomalies were observed on fish during the six samples.

Oldtown Creek

- A total of 1,370 fish comprised of 21 species were collected from Oldtown Creek near the mouth (RM 0.1) during early July (a second sample was not collected due to the extreme drought conditions). The IBI score of 56 (the highest value in the 1993 study area) was indicative of an exceptional quality headwater fish community. Numerically dominant species were central stonerollers (41%), followed by creek chubs (12.3%), and mottled sculpins (12.0%). River chubs (7.4%) were also common. The reference site sampled, however, was not representative of the long channelized stretch upstream and adjacent to the old railroad grade. No DELT anomalies were observed during the July sample.

South Fork Massies Creek

- A total of 331 fish comprised of 15 species were collected from a wooded segment of the South Fork of Massies Creek adjacent to the quarry (RM 1.1). Despite relatively good physical habitat (pool-riffle-run sequences) the fish assemblage was indicative of only fair quality. The IBI scored a 30, considerably lower than the WWH biocriterion for headwater streams within the ECBP (40). Two highly tolerant species, creek chubs and bluntnose minnows, were numerically dominant and represented over half of the fish caught. The catch did include, however, several creek chubsuckers and a brook stickleback which are uncommon Ohio fish species. Downstream effects of upstream channel modifications may be impacting this site. A local land owner reported that even the wooded section had been historically modified.

Massies Creek

- The two samples from Massies Creek at the confluence of Oldtown Creek (RM 0.3) yielded a total catch of 1,379 fish comprised of 25 species. The catch was representative of a very good fish assemblage, MIwb and IBI scores exceeded the WWH biocriteria and were in the nonsignificant departure ranges of EWH criteria. Numerically dominant species were central stonerollers (29.4%), northern hog suckers (17.9%), and greenside darters (13.7%). By weight, the catch was predominantly composed of northern hog suckers (40.9%), black redhorse (18.3%), and central stonerollers (12.6%). Only two fish were collected with a DELT anomaly (mean = 0.15% DELT) (Table A-11).

Beaver Creek

- A total of 3,054 fish comprised of 28 species were collected from the four sampling locations in Beaver Creek (RMs 1.6-0.3). IBI scores were indicative of only fair quality fish assemblages at the three full length sampling locations, but a marginally good quality assemblage was present in the mixing zone of the Beaver Creek WWTP. MIwb scores increased from the fair range at the upstream control site to the good range downstream from Little Beaver Creek and upstream from the Greene Co. Beaver Creek WWTP (RM 0.5). MIwb values decreased to the marginally good range at both locations downstream from the WWTP. Downstream from Little Beaver Creek, dominant fish species shifted from creek chubs and white suckers to central stonerollers, white suckers, green sunfish, common carp, northern hog suckers, and black redhorse. Fish assemblages captured in the Beaver Creek WWTP mixing zone showed no evidence of acute toxicity. The most common species in the mixing zone species were northern hog suckers, central stonerollers, blacknose dace, and greenside darters. Immediately downstream from the WWTP, however, no black redhorse were collected and the relative weight of fish declined from 47.2 kg/km (RM 0.5) to 15.7 kg/km (0.3). The catch did include five (5) pollution sensitive species, the rainbow darter, mottled sculpin, greenside darter, longear sunfish, and northern hog sucker. Dominant species downstream from the mixing zone included creek chubs, green sunfish, blacknose dace, white suckers, common carp, and northern hog suckers. A total of 29 fish with a DELT anomaly were collected in the stream, three upstream from Little Beaver Creek, 16 downstream from Little Beaver Creek, and 10 downstream from the Beaver Creek WWTP. The mean percent of DELT anomalies increased from 0.5% (RM 1.6) to 2.2% downstream from Little Beaver Creek (RM 0.5), but decreased to 0.6 - 1.0% downstream from the WWTP.

Little Beaver Creek

- A total of 2,841 fish comprised of 24 species and three hybrids were collected from the five sampling locations in Little Beaver Creek (RMs 4.7-0.1). Narratively, fish assemblages exhibited slight recovery from poor quality upstream and downstream from the Montgomery Co. East WWTP (RMs 4.7-4.4) to fair quality in the lower two miles (RMs 2.1-0.1, Table 12). The highest relative number of fish in the tributary was recorded in the mixing zone, suggesting no acute toxicity or avoidance. The relative abundance of predominant species numerically shifted from green sunfish, central stonerollers, creek chubs, and bluntnose minnows at RM 4.7 to northern hog suckers, green sunfish, white suckers, and creek chubs at RM 0.1. A total of 46 fish with a DELT anomaly were collected throughout the tributary, however, with 44 of them occurring downstream from the Montgomery Co. East Regional WWTP (cumulative total from the four sites). The highest number (24) and most severe anomalies (*i.e.*, heavy vs. light) were recorded at North Fairfield Road (RM 2.1).

Glady Run

- A total of the 3,506 fish comprised of 22 species (including brook stickleback and southern redbelly dace) were captured in Glady Run. The headwater tributary supported only fair quality fish assemblages upstream and immediately downstream from the WWTP swale, but a good assemblage near the mouth. The total cumulative number of fish species markedly increased from five to eight (5-8) species near the swale (RM 4.9-4.7) to 20 species downstream from SR 725 (RM 0.3). The relative number of fish collected markedly increased downstream from the WWTP due partially to improved habitat from additional flow. Only one fish captured in Glady Run had a DELT anomaly. Southern redbelly dace, one of Ohio's declining fish species, was very abundant downstream from the WWTP swale (229 were collected at RM 4.7).

Glady Run Swale

- Fish sampling (single pass) at the three sites in Glady Run Swale yielded 1,942 fish comprised of 12 species. Fish assemblages in small tributary improved from poor to good quality downstream from the Xenia-Glady Run WWTP. The mixing zone contained a fair quality fish community with no evidence of avoidance or acute toxicity. Similar to Glady Run, only one fish with a DELT anomaly was observed. Although QHEI values were relatively low at all three sites (53.0-48.5) due to previous channelization, the lower section downstream from the railroad grade appeared to have recovered the most.

Newman Run

- A total of 559 fish comprised of 15 species were collected in Newman Run in early July, before the drought. The July sample had an IBI score of 54 (the second highest value in the study area) which is indicative of an exceptional quality headwater fish community. The community was well balanced and numerically dominated by mottled sculpins (31.5%), rainbow darters (19.3%), central stonerollers (12.9%), creek chubs (11.5%), and small white suckers (10.2%). No DELT anomalies were observed in the catch.

Anderson Fork

- During the August sample, a total of 956 fish comprised of 26 species were collected from the Caesar Creek tributary upstream from the Old Winchester Trail bridge. Similar to Newman Run, the IBI also scored a 54 in Anderson Fork (RM 5.0). The MIwb (10.0) was also indicative of an exceptional quality fish assemblage. Both IBI and the MIwb scores exceeded EWH biocriteria. The most abundant fish species in the stream were central stonerollers (33.6%) and northern hog suckers (9.1%). By weight, the catch was dominated by northern hog suckers (35.2%), black redhorse (18.3%), central stonerollers (10.1%), an common carp (10.0%). The incidence of DELT anomalies was low at 0.1%.

Flat Fork

- Flat Fork had intermittent flow regime and was mostly dry when sampled in August. The isolated pools contained only 6 fish species, dominated numerically by green sunfish (84.9%). Although the QHEI (50) reflected sub-optimal physical habitat, such conditions typically occur in small southwestern streams with limestone bedrock. The IBI scored in the poor range (24), considerably lower than expected and indicative of a rather severe impact. Algae was present suggesting nutrient enriched conditions and low D.O. levels. The source of pollutants is unknown, but may be agriculturally related. The abundance of leeches further suggests possible organic enrichment.

Caesar Creek

- A total of 1,361 fish comprised of 36 species were collected from the two sampling locations. Upstream from the reservoir (RM 16.5), the fish assemblage in Caesar Creek was indicative of very good (IBI) to exceptional (MIwb) quality. Downstream from the lake (RM 0.1), the IBI increased to the exceptional range, but the MIwb decreased to the good range. A predominance of shallow water habitat may have been the reason for considerably lower relative number and weight of fish captured near the mouth. Compositionally, the downstream assemblage (dominated by longear sunfish, northern hog suckers, and golden redhorse) by was more indicative of a high quality stream than the upstream assemblage (gizzard shad, common carp, and northern hog suckers) possibly due to lake influences. The total number of fish species , however, declined from 30 at RM 16.5 to 23 at RM 0.1. The incidence of DELT anomalies was slightly higher at RM 16.5 (0.5%) than at RM 0.1 (0.0%).

Dry Run

- Only 450 fish comprised of 8 species were collected from Dry Run (RM 1.8). The IBI scored a 34 and did not meet the ecoregional expectation for a headwater stream. The percent DELT anomalies was the only metric to score a "5". Suggesting rather severe impairment, a low number of sensitive species and high percentages of tolerant fishes and omnivores caused these three metrics to score a "1". Other fair habitat quality, the cause of impairment is unknown.

Turtle Creek

- A total of 10,603 fish of 40 species were collected from the six sampling locations in Turtle Creek (RMs 6.3-0.1). IBI scores were indicative of marginally good to exceptional fish assemblages and exceeded the WWH criterion of 40 at all locations (except for a 39 at RM 4.7 which is a nonsignificant departure, Table 12, Figure 73). MIwb scores exceeded the 8.1 WWH criterion at five (5) locations, but were significantly lower (6.7) in the shallow segment downstream from Cincinnati Milacron (RM 0.4). The low score may have been caused entirely by the lack of a deep pool. The mean percent DELT anomalies was lower downstream (0.0-0.1%) from the industrial discharger than upstream (0.3-0.7%). The highest percentages of tolerant fish species also occurred in the upper reach downstream from Lebanon.

Muddy Creek

- A total of 1,468 fish of 21 species were collected at RM 1.6 during August. Despite the abundance of common carp (82.2% of the total relative weight of 111 kg/.3 km), the IBI (46) exceeded the WWH criterion (40) for a headwater stream and was indicative of very good quality. Central stonerollers were numerically dominant and represented 74.4% of the catch. The percent of fish with DELT anomalies was slightly elevated (0.5%). Black sludge deposits were observed in the deep pools.

Sycamore Creek

- A total of 2,864 fish comprised of 27 species were collected from the three adjacent locations sampled during the survey. Central stonerollers, creek chubs, and juvenile white suckers were the dominant species. IBI and MIwb scores did not meet WWH criteria upstream from the Sycamore Creek WWTP, but were within the area of nonsignificant departure downstream from the facility. The number of fish species captured increased from 18 at RM 0.4 to 25 at RM 0.2). A total 832

fish comprised of 11 species, including fantail darters, were collected from the shallow WWTP mixing zone suggesting no acute toxicity. Zero to one intolerant species caused the metric to score a "1" at all three sites during both samples. The mean percentage of fish with DELT anomalies increased from 0.1% upstream from the WWTP to 0.8% downstream. Thick black sludge deposits were observed in the large pool downstream from the WWTP. Despite good cover, longear sunfish and other pool dwelling species were noticeably lacking in the large pool upstream from the WWTP.

Stonelick Creek

- A total of 2,662 fish comprised of 42 species and two (2) hybrids were collected from four locations. Fish assemblages were sampled at three free-flowing locations and one impounded location within the upper section of Stonelick Lake. The quality of fish assemblages improved from fair upstream from the lake to good to exceptional downstream (Table 12). IBI and MIwb scores did not attain in Stonelick Lake or its headwaters, but met or exceeded WWH criteria at both locations in the lower 3 miles. The mean number of fish species was only 8.0-11.0 at the two upstream sites, but increased to 27.5-36.0 at the downstream two sites. The assemblage at RM 1.2 was very diverse with a cumulative total of 39 fish species. The mean percentage of fish with DELT anomalies was 0.0% in the headwaters (RM 20.0), 0.7% in the upper end of the lake (RM 16.7), 0.5% downstream at RM 3.1, and 1.0% at U.S. 50 (RM 1.2).

East Fork Little Miami River

- A total of 4,357 fish comprised of 55 species and five (5) hybrids were collected from eight sites in the lower 16 miles downstream from the East Fork Lake (RMs 15.5-1.4). Numerically, the total catch was well balanced and dominated by central stonerollers (10.0%), longear sunfish (8.6%), emerald shiners (7.7%), and gizzard shad (7.6%). Distribution by weight, however, was more typically skewed and dominated by common carp (37.0%) and golden redhorse (9.1%). Mean MIwb scores were indicative of very good to exceptional fish assemblages (mean = 10.1, range 9.4-11.1) due to high numbers, biomass, and diversity of fish at all eight locations.

- Mean IBI values were representative of only marginally good to very good quality fish assemblages, suggesting more significant changes between the sampling locations. All eight (8) The five IBI values that did meet EWH below 50 and further suggest only marginal attainment. Longitudinally, both fish indices met EWH expectations (or nonsignificant departure) from upstream of Batavia (RM 15.5) downstream to Olive Branch Stonelick Creek Road (RM 9.2), but dropped into partial attainment at Perintown (RM 6.6) due to a slight decrease in the IBI.

- The percentages of top carnivores in the East Fork markedly declined from 26 - 27% upstream from Batavia (RM 15.5) to only 2-13% (mean = 6.6%) at all seven locations from one or more WWTPs. The total relative number (density) of rock bass, smallmouth bass, and spotted bass combined (the three most abundant game species) declined from 167 per km at RM 15.5 to 26 per km at RM 12.7. Downstream densities remained low (6-61/km) to the mouth. The cause of decline is unknown, but may be related to the quality of WWTP discharges. The decline is indicative of an impact to fish assemblages in the mainstem.

- A higher than normal incidence of external DELT anomalies was found at all eight sampling locations (Table A-11, Figure 81). The percent occurrence of DELT anomalies increased downstream from Batavia. The actual number of fish weighed with an anomaly increased from 4-5 fish at the two sampling locations upstream from the Middle Fork WWTP to 13-16 fish downstream to Round Bottom Road to 7-16 fish downstream from the Lower East Fork WWTP.

- Some of the declines in the lower five miles of the mainstem may have been due to changes in physical habitat as reflected by lower QHEI scores.

Table 12. Fish community summaries for 84 locations in the Little Miami River study area based on pulsed D.C. electrofishing catches during June through October, 1993. The number of samples collected at each location is listed with the sampling method. Relative number and weight are per km for boat sites and 0.3 km for wading sites. Mixing zone samples are denoted by italics.

Stream RM	Sampling Method*	Mean # Species	Total # Species	Mean Relative Number	Mean Relative Weight(kg)	QHEI	Mean Index of Biotic Integrity	Mean Modified Index of Well-Being	Narrative Evaluation
Little Miami River									
102.1	Wading-2	13.0	14	2,494	NA	62.0	33*	NA	Fair
98.3	Wading-2	19.5	21	1,696	35.3	75.0	35*	7.8ns	Fair-M.Good
92.2	Wading-2	17.5	19	689	17.0	68.5	35*	7.9ns	Fair-M.Good
85.4	Wading-2	27.0	30	1,027	27.5	87.0	47ns	9.0ns	Very Good
83.1	Boat-3	22.3	24	1,180	106.2	76.5	45ns	10.1	V.G.-Except.
77.3	Boat-2	27.0	30	1,452	129.1	78.0	48	10.3	Exceptional
77.0	*Boat-3*	*16.0*	*21*	*1,260*	*368.8*	*63.5*	*42*	*10.1*	*Good-Except.*
76.8	Boat-3	26.3	32	979	114.1	76.0	49	10.1	Exceptional
74.5	Boat-2	30.5	35	1,262	141.2	77.5	48	10.5	Exceptional
71.8	Boat-2	27.0	30	624	85.6	77.5	52	9.9	Exceptional
64.7	Boat-3	23.3	31	553	160.9	73.0	41*	9.0*	M.G.-Good
64.4	*Boat-3*	*20.0*	*29*	*1,513*	*62.8*	*62.5*	*33*	*9.2*	*Fair-V.Good*
64.2	Boat-3	29.7	38	684	175.3	74.0	46ns	9.6	V.G.-Except.
63.4	Boat-2	24.0	26	452	235.7	71.0	39*	8.5*	M.G.-Good
53.5	Boat-3	22.0	32	211	96.4	65.0	33*	9.3ns	Fair-V.Good
47.5	Boat-3	24.3	35	331	116.7	76.5	39*	9.3ns	Good-V.G.
44.2	Boat-3	28.0	37	454	104.2	83.5	49	9.8	Exceptional
38.6	Boat-3	23.7	37	537	223.5	83.5	47ns	10.0	V.G.-Except.
35.5	Boat-3	26.0	36	536	179.4	76.5	49	10.2	Exceptional
32.9	Boat-3	24.3	39	378	128.7	74.0	47ns	9.3ns	Very Good
32.1	*Boat-3*	*14.3*	*21*	*670*	*360.4*	*77.0*	*37*	*9.6*	*M.G.-Except.*
31.9	Boat-3	31.3	38	828	248.4	86.5	48	11.0	Exceptional
28.3	Boat-3	17.7	25	328	163.7	57.5	34*	9.0*	M.G.-Good
27.9	Boat-3	27.7	35	814	263.2	80.0	50	10.7	Exceptional
23.9	Boat-3	23.3	33	652	201.5	82.5	47ns	10.2	V.G.-Except.
22.1	Boat-3	19.0	29	444	76.9	63.5	46ns	8.7*	V.G.-Good
21.5	Boat-3	26.0	36	719	173.6	84.0	49	10.4	Exceptional
20.9	Boat-3	22.0	34	360	142.6	80.0	45ns	9.6	V.G.-Except.
18.5	Boat-3	21.7	36	431	129.9	72.5	40*	9.3ns	Good-V.G.
13.3	Boat-3	23.3	36	1,119	170.7	86.5	35*	8.8*	M.G.-Good
8.3	Boat-3	21.0	34	431	114.2	73.0	33*	8.9*	Fair-Good
8.0	Boat-2	33.0	41	714	150.0	82.0	43*	10.1	Good-Except.
3.5	Boat-3	26.7	37	853	222.0	77.5	40*	9.9	Good-Except.
1.6	Boat-3	12.7	20	605	35.8	51.0	33*	7.4*	Fair
0.2	Boat-3	13.3	21	529	26.4	50.0	29*	7.3*	Fair
Yellow Springs Creek									
0.5	Wading-2	18.0	20	870	NA	80.0	48	NA	Very Good
0.43	*Wading-2*	*14.0*	*16*	*1,358*	*NA*	*73.5*	*51*	*NA*	*Exceptional*
0.3	Wading-2	18.0	21	1,305	NA	79.0	50	NA	Exceptional

Table 12. Continued.

Stream RM	Sampling Method	Mean # Species	Total # Species	Mean Relative Number	Mean Relative Weight(kg)	QHEI	Biotic Integrity	Mean Index of Index of Well-Being	Mean Modified Narrative Evaluation
Oldtown Creek									
0.1	Wading-1	21.0	21	2,055	15.3	82.5	56	8.8	Exceptional
South Fork Massies Creek									
1.1	Wading-1	15	15	662	NA	66.5	30*	NA	Fair
Massies Creek									
0.3	Wading-2	23.0	25	1,034	17.3	67.5	46	9.0	Very Good
Beaver Creek									
1.6	Wading-2	15.5	18	885	17.6	54.5	28*	6.8*	Fair
0.5	Wading-2	20.5	22	860	47.2	74.0	32*	8.7	Fair-Good
0.39	*Wading-2*	*12.0*	*14*	*1,089*	*13.7*	*64.0*	*37*	*8.0*	*Marg. Good*
0.3	Wading-2	16.5	19	832	15.7	70.5	32*	7.9ns	Fair-M.G.
Little Beaver Creek									
4.7	Wading-2	8.5	10	563	NA	67.5	26*	NA	Poor
4.57	*Wading-2*	*7.0*	*9*	*958*	*NA*	*72.0*	*23*	*NA*	*Poor*
4.4	Wading-2	10.0	13	530	NA	48.5	24*	NA	Poor
2.1	Wading-2	15.0	18	532	16.0	76.0	31*	NA	Fair
0.1	Wading-2	15.0	20	303	15.9	70.5	33*	7.0*	Fair
Glady Run									
4.9	Wading-1	5.0	5	180	NA	54.0	34*	NA	Fair
4.7	Wading-2	7.0	8	1,511	NA	66.0	33*	NA	Fair
0.3	Wading-2	16.0	20	1,692	NA		40	NA	Good
Glady Run Swale									
0.3	Wading-1	6.0	6	534	NA	53.0	24*	NA	Poor
0.2	*Wading-1*	*3.0*	*3*	*750*	*NA*	*49.0*	*28*	*NA*	*Fair*
0.1	Wading-1	10.0	10	3,278	NA	48.5	40	NA	Good
Newman Run									
0.3	Wading-1	15.0	15	1,118	NA	76.0	54	NA	Exceptional
Anderson Fork									
5.0	Wading-1	26.0	26	1,434	40.8	75.0	54	10.0	Exceptional
Flat Fork									
1.7	Wading-1	6.0	6	358	NA	50.0	24*	NA	Poor
Caesar Creek									
16.5	Wading-1	30.0	30	1,598	81.3	76.0	46ns	9.5	V.G.-Except.
0.1	Wading-1	23.0	23	476	16.1	81.5	50	8.7	Except.-Good

Table 12. Continued.

Stream RM	Sampling Method	Mean # Species	Total # Species	Mean Relative Number	Mean Relative Weight(kg)	QHEI	Mean Index of Biotic Integrity	Mean Modified Index of Well-Being	Narrative Evaluation
Dry Run									
1.8	Wading-1	8.0	8	900	NA	54.5	34*	NA	Fair
Turtle Creek									
6.3	Wading-2	19.5	21	2,358	14.0	69.5	43	NA	Good
4.7	Wading-2	24.5	27	2,492	45.0	69.5	39ns	8.5	M.G.-Good
0.6	Wading-2	25.5	28	1,156	45.6	75.5	50	10.1	Exceptional
0.5	Wading-2	17.0	21	1,245	5.8	68.0	41	8.3	Good
0.4	Wading-2	18.5	24	1,138	2.2	68.0	41	6.7*	Good-Fair
0.1	Wading-2	27.5	33	1,122	21.5	68.5	46	8.9	Very Good
Muddy Creek									
1.6	Wading-1	21.0	21	2,936	111.3	78.0	46	NA	Very Good
Stonelick Creek									
20.0	Wading-1	11.0	11	570	NA	69.0	30*	NA	Fair
16.7	Boat-1	8.0	8	562	97.2	48.0	30*	7.5*	Fair
3.1	Wading-2	27.5	31	769	33.6	73.5	45	8.8	Good
1.2	Wading-2	36.0	39	832	95.4	78.0	49	10.4	V.G.-Except.
Sycamore Creek									
0.4	Wading-2	14.5	18	1,546	4.4	76.0	34*	6.6*	Fair
0.26	*Wading-2*	*8.0*	*11*	*2,080*	*3.5*	*70.5*	*29*	*6.6*	*Fair*
0.2	Wading-2	19.5	25	365	11.2	75.0	38ns	7.7ns	Marg. Good
East Fork Little Miami River									
15.5	Boat-2	21.5	26	638	137.5	86.0	45ns	9.4ns	Very Good
12.7	Boat-2	31.5	35	583	170.7	83.5	47ns	10.5	V.G.-Except.
12.4	Boat-2	33.5	41	731	221.1	87.0	47ns	11.1	V.G.-Except.
9.2	Boat-2	32.0	39	617	162.4	86.0	44ns	10.4	V.G.-Except.
6.6	Boat-2	28.0	35	429	108.6	87.0	42*	9.4ns	Good-V.G.
4.7	Boat-2	30.0	37	515	58.5	68.5	44ns	10.1	V.G.-Except.
1.7	Boat-2	30.0	34	556	101.8	70.5	36*	10.2	M.G.-Except.
1.4	Boat-2	27.5	33	288	133.5	65.0	39*	10.0	Good-Except.

	Eastern Corn Belt Plains (ECBP)			*Interior Plateau (IP)*		
INDEX - Site Type	**WWH**	**EWH**	**MWH**	**WWH**	**EWH**	**MWH**
IBI - Headwaters	**40**	**50**	**24**	**40**	**50**	**24**
IBI - Wading	**40**	**50**	**24**	**40**	**50**	**24**
IBI - Boat	**42**	**48**	**24**	**38**	**48**	**24**
Mod. Iwb - Wading	**8.3**	**9.4**	**6.2**	**8.1**	**9.4**	**6.2**
Mod. Iwb - Boat	**8.5**	**9.6**	**5.8**	**8.7**	**9.6**	**5.8**

* Significant departure from ecoregional biological criterion (>4 IBI or >0.5 Iwb units); underlined values are in the poor and very poor range.

ns Nonsignificant departure from biocriterion (≤4 IBI units or ≤ 0.5 MIwb units)

a Narrative evaluation is based on both MIwb and IBI scores.

NA Headwater site; MIwb is not applicable.

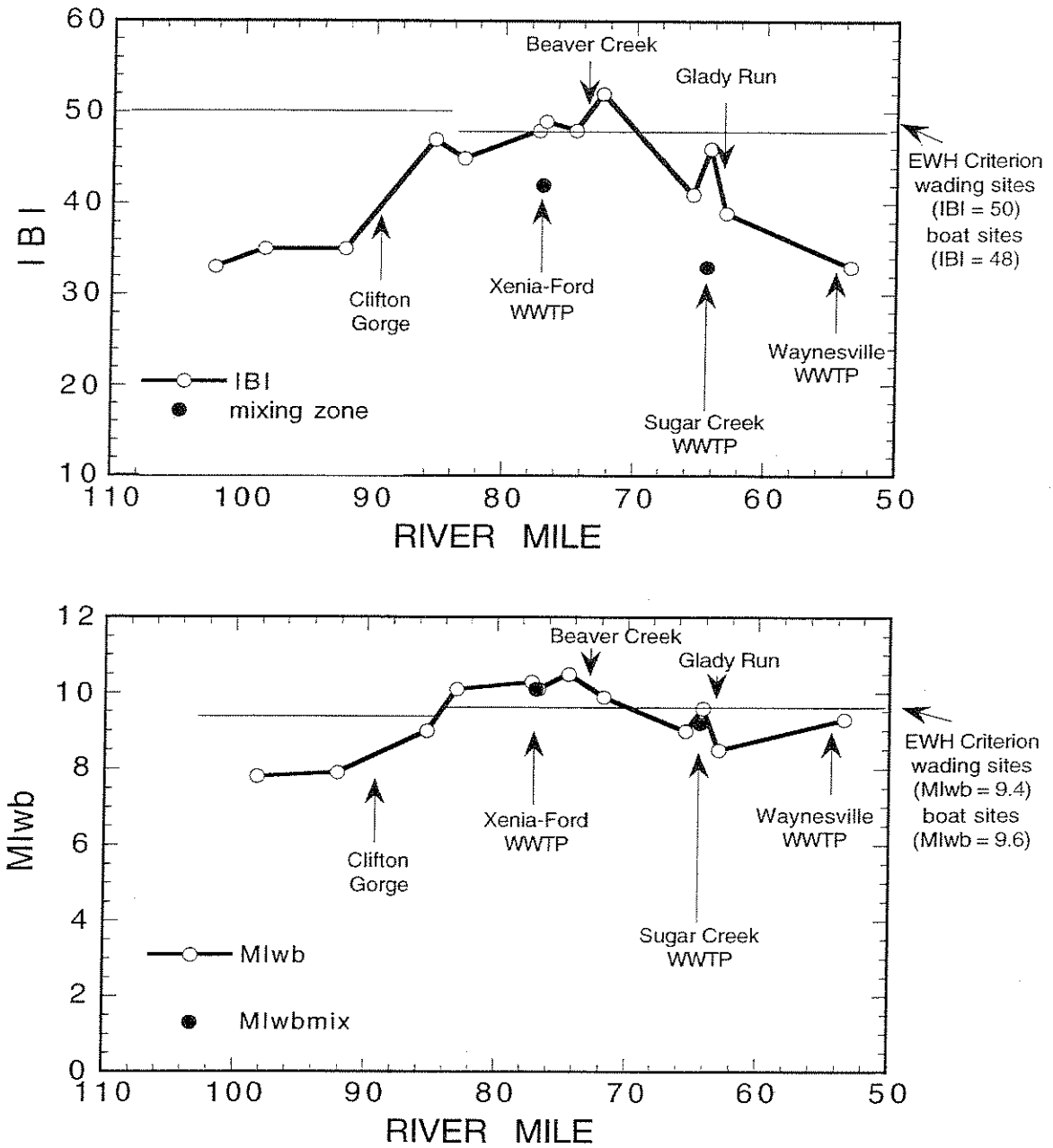


Figure 71. Longitudinal trend of the Index of Biotic Integrity (IBI; Top Graph) and the Modified Index of Well-Being (MIwb; Bottom Graph) in the upper half of the Little Miami River during 1993.

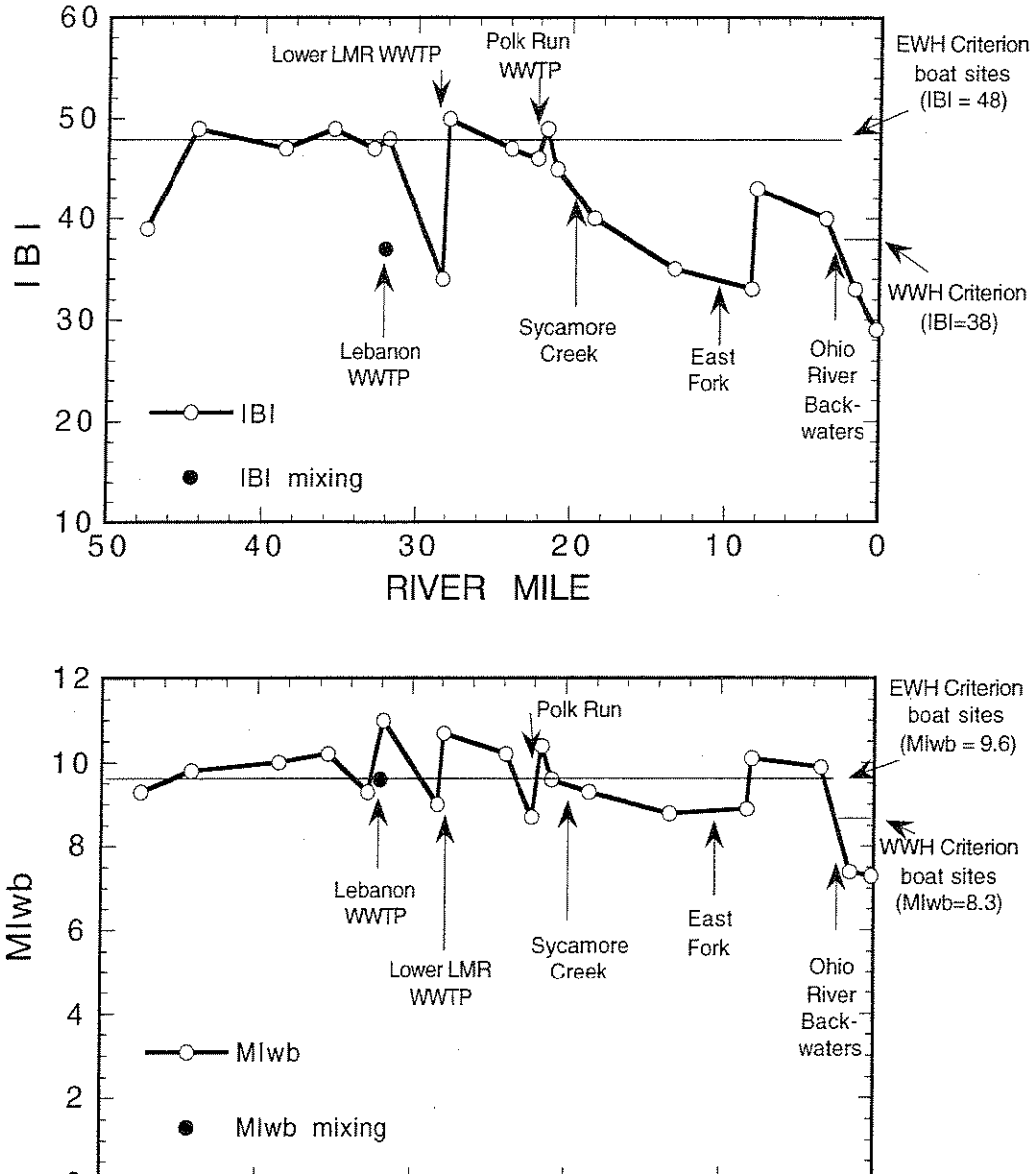


Figure 72. Longitudinal trend of the Index of Biotic Integrity (IBI; upper graph) and the Modified Index of Well-Being (MIwb; lower graph) in the lower half of the Little Miami River during 1993.

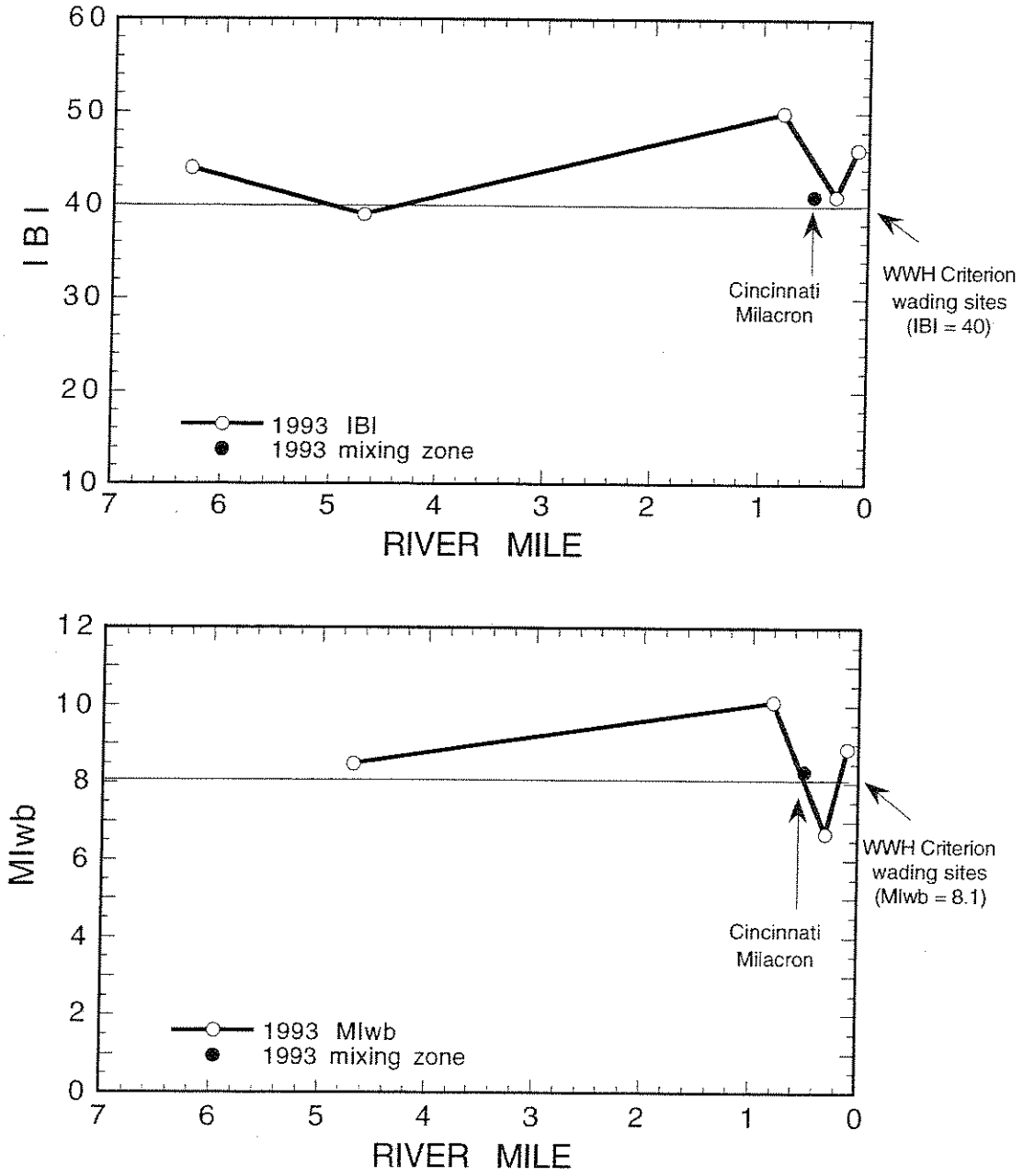


Figure 73. Longitudinal trend of the Index of Biotic Integrity (IBI; Top Graph) and the Modified Index of Well-Being (MIwb; Bottom Graph) in Turtle Creek during 1993.

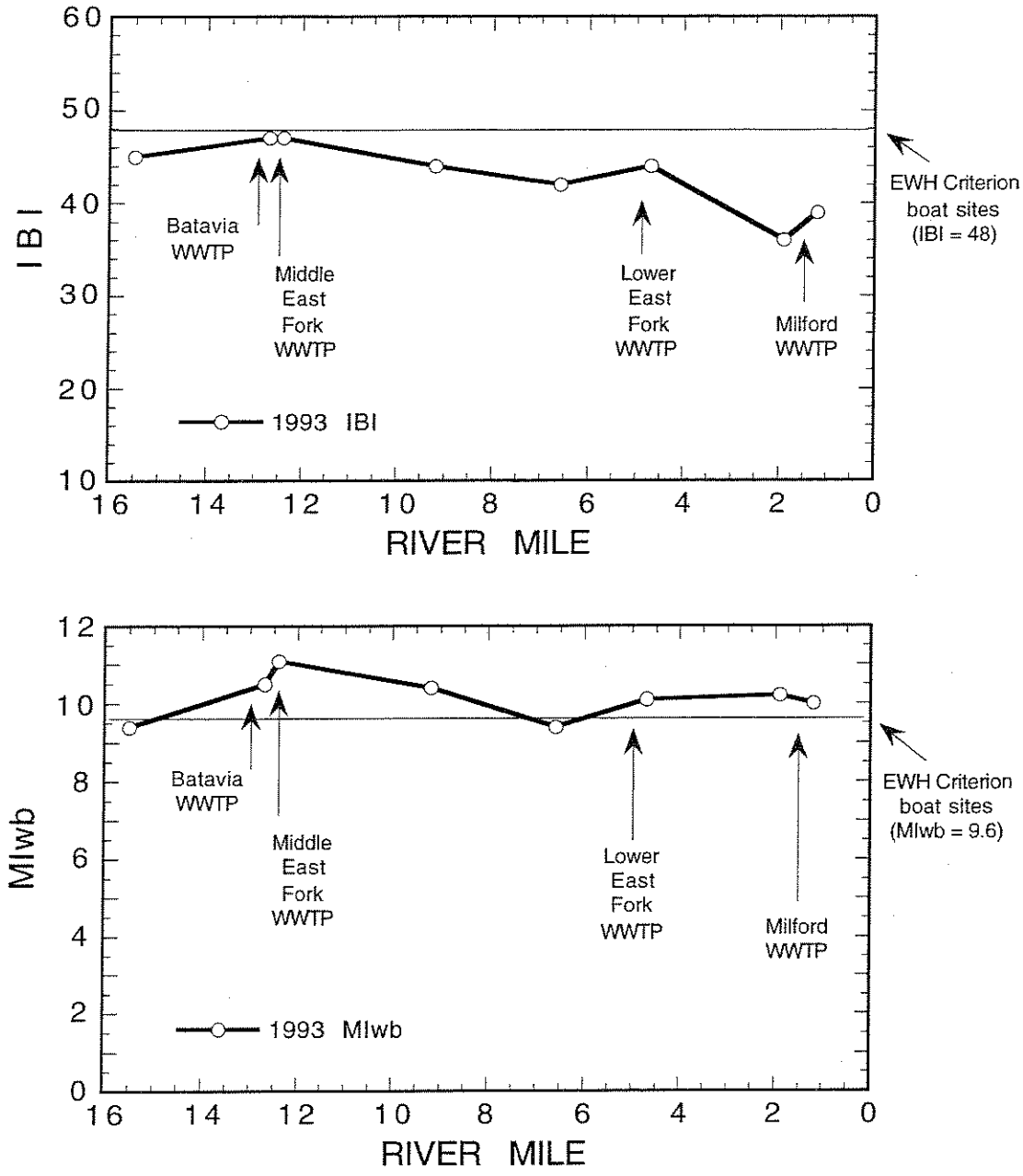


Figure 74. Longitudinal trend of the Index of Biotic Integrity (IBI; Top Graph) and the Modified Index of Well-Being (MIwb; Bottom Graph) in the East Fork of the Little Miami River during 1993.

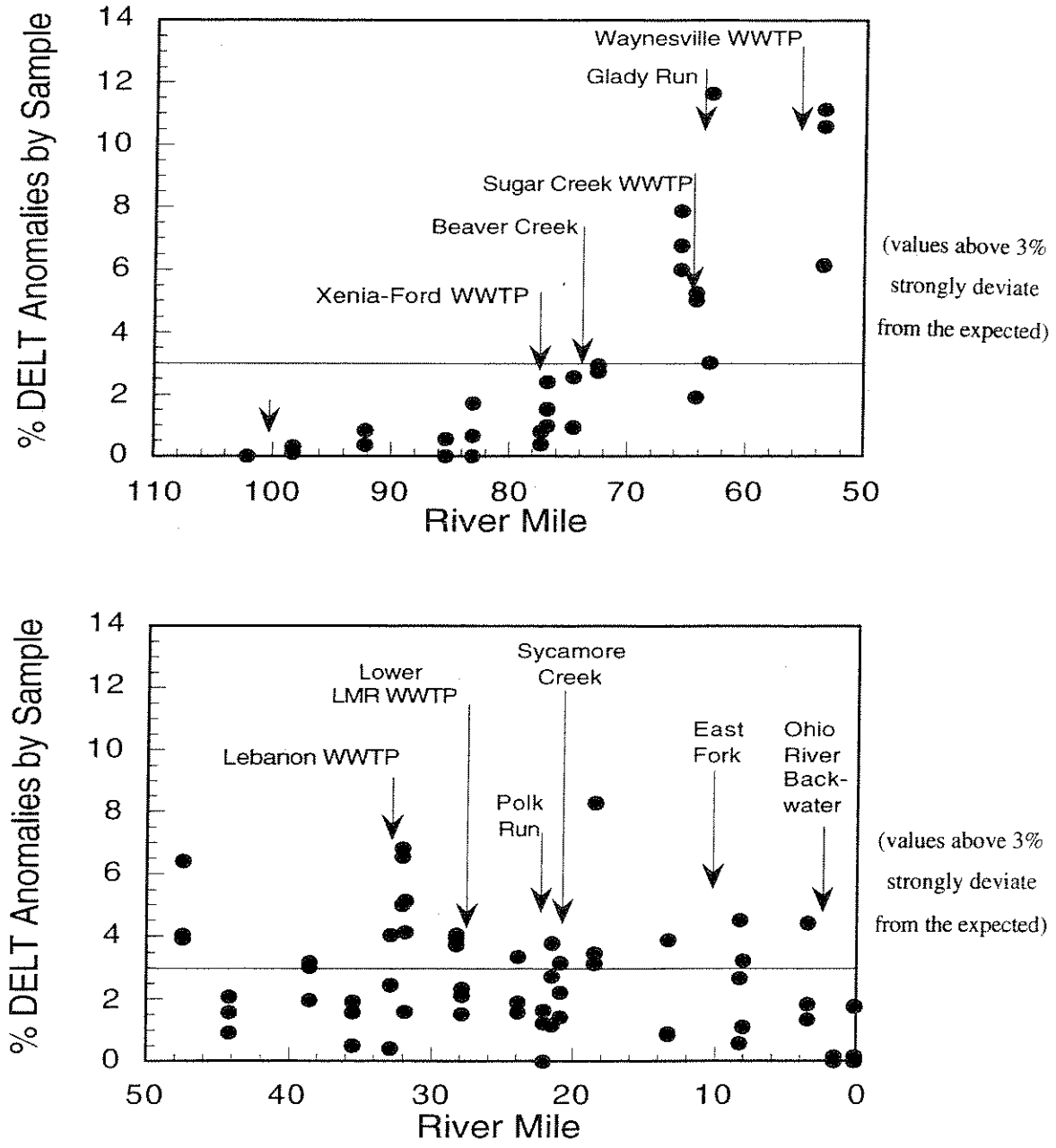


Figure 75. Longitudinal scatter plots of the percentages of fish with DELT (deformities, eroded fins, lesions, and tumors) external anomalies by sample in the upper half (Top Graph) and lower half (Bottom Graph) of the Little Miami River during 1993.

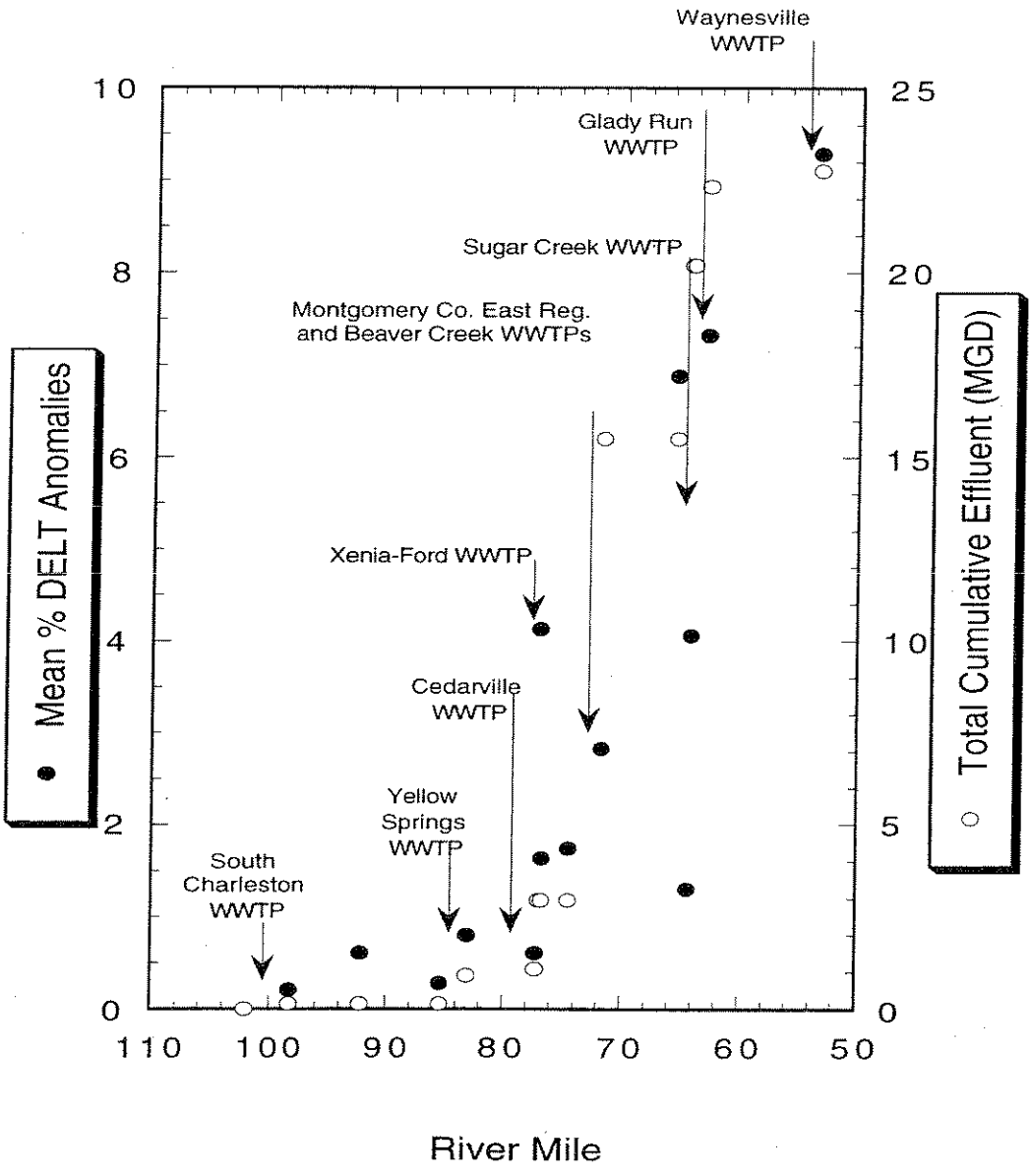


Figure 76a. Longitudinal scatter plots of the mean percentage of fish with DELT (deformities, eroded fins, lesions, and tumors) external anomalies and total cumulative effluent (3rd quarter mean million gallons per day) in the upper half of the Little Miami River during 1993.

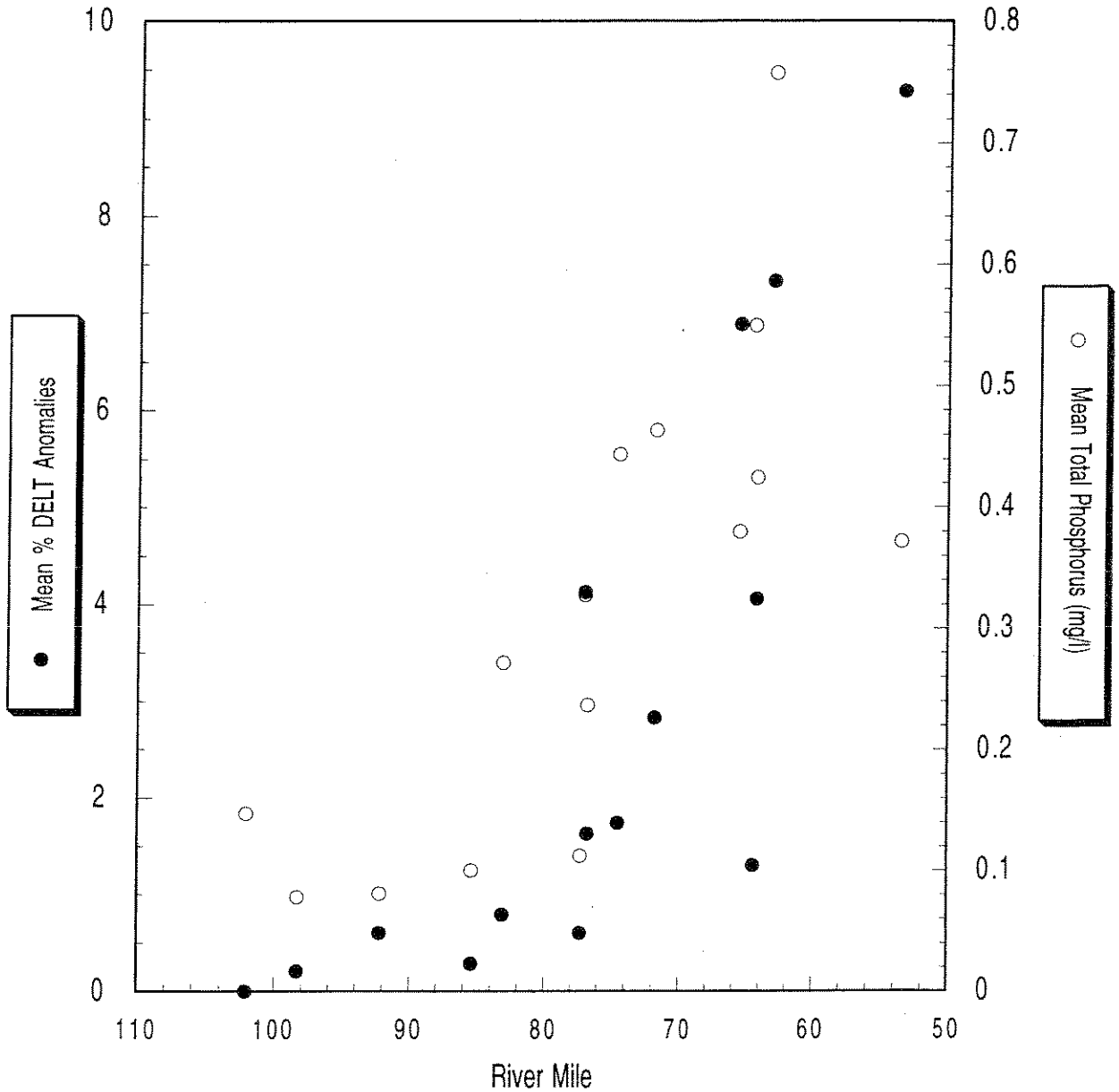


Figure 76b. Longitudinal scatter plots of the mean percentage of fish with DELT (deformities, eroded fins, lesions, and tumors) external anomalies and average total phosphorus concentrations (mg/l) in the upper half of the Little Miami River during 1993.

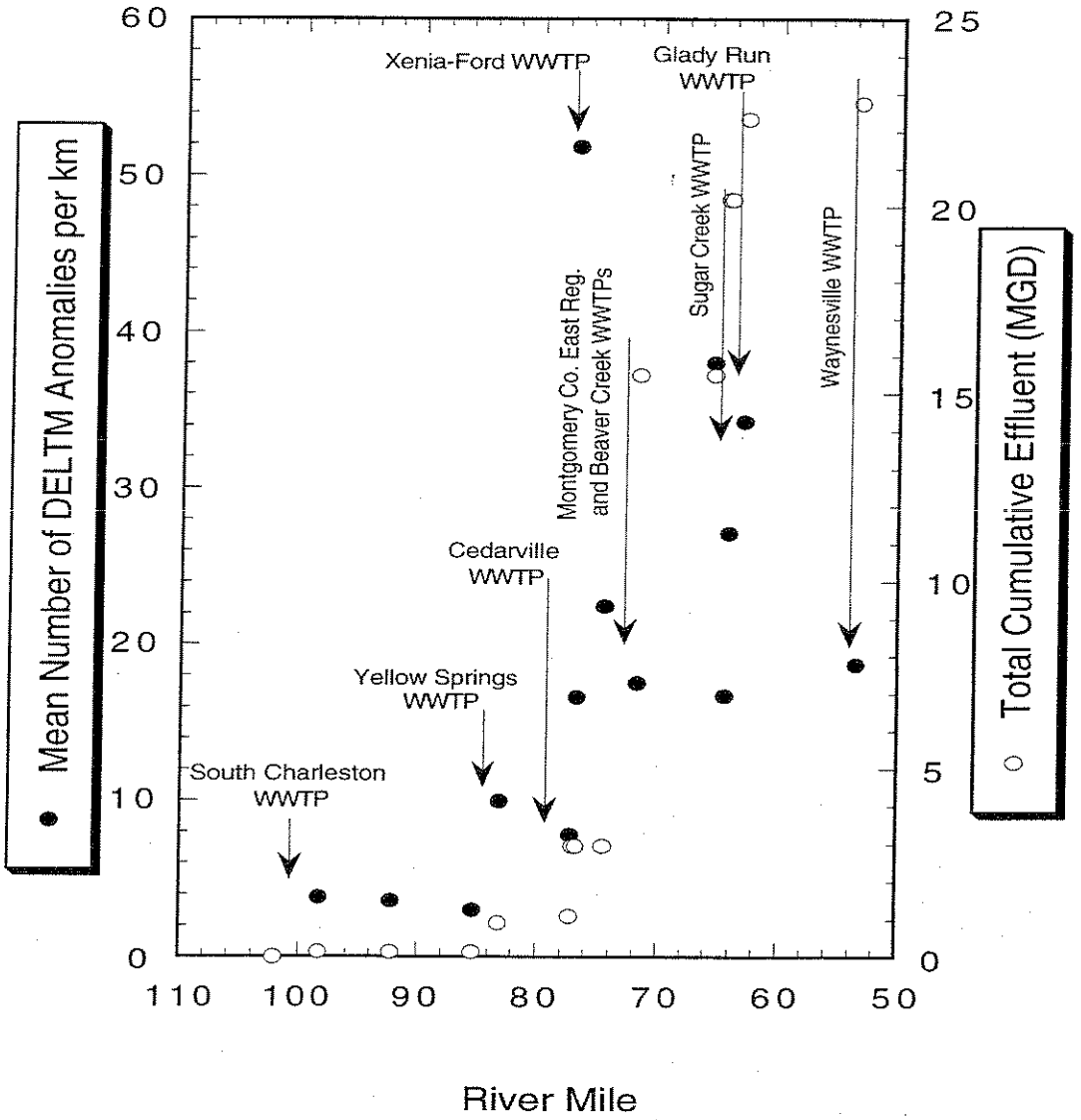


Figure 77a. Longitudinal scatter plots of the mean number of fish with DELT (deformities, eroded fins, lesions, and tumors) external anomalies and total cumulative effluent (3rd quarter mean million gallons per day) in the upper half of the Little Miami River during 1993.

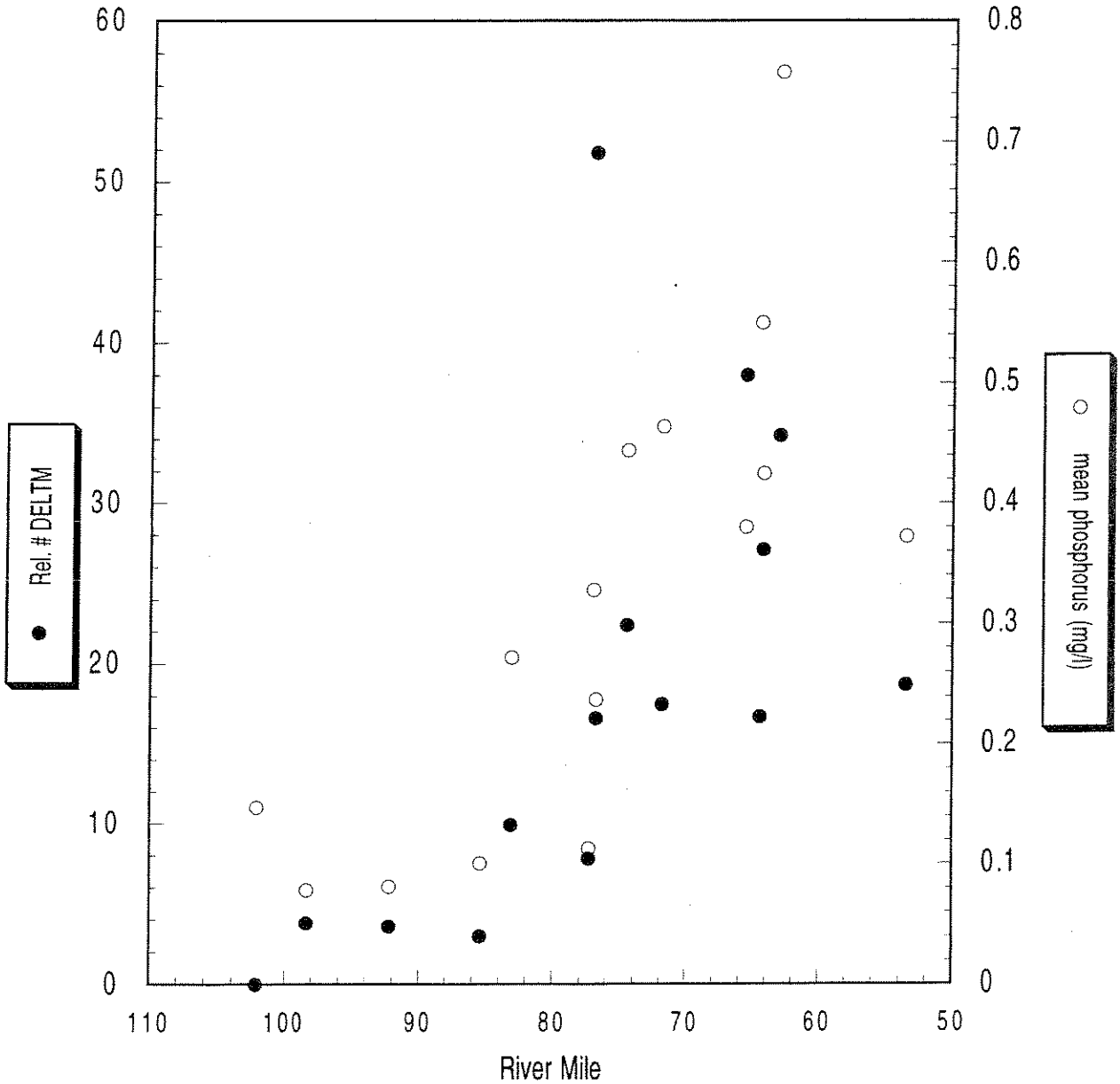
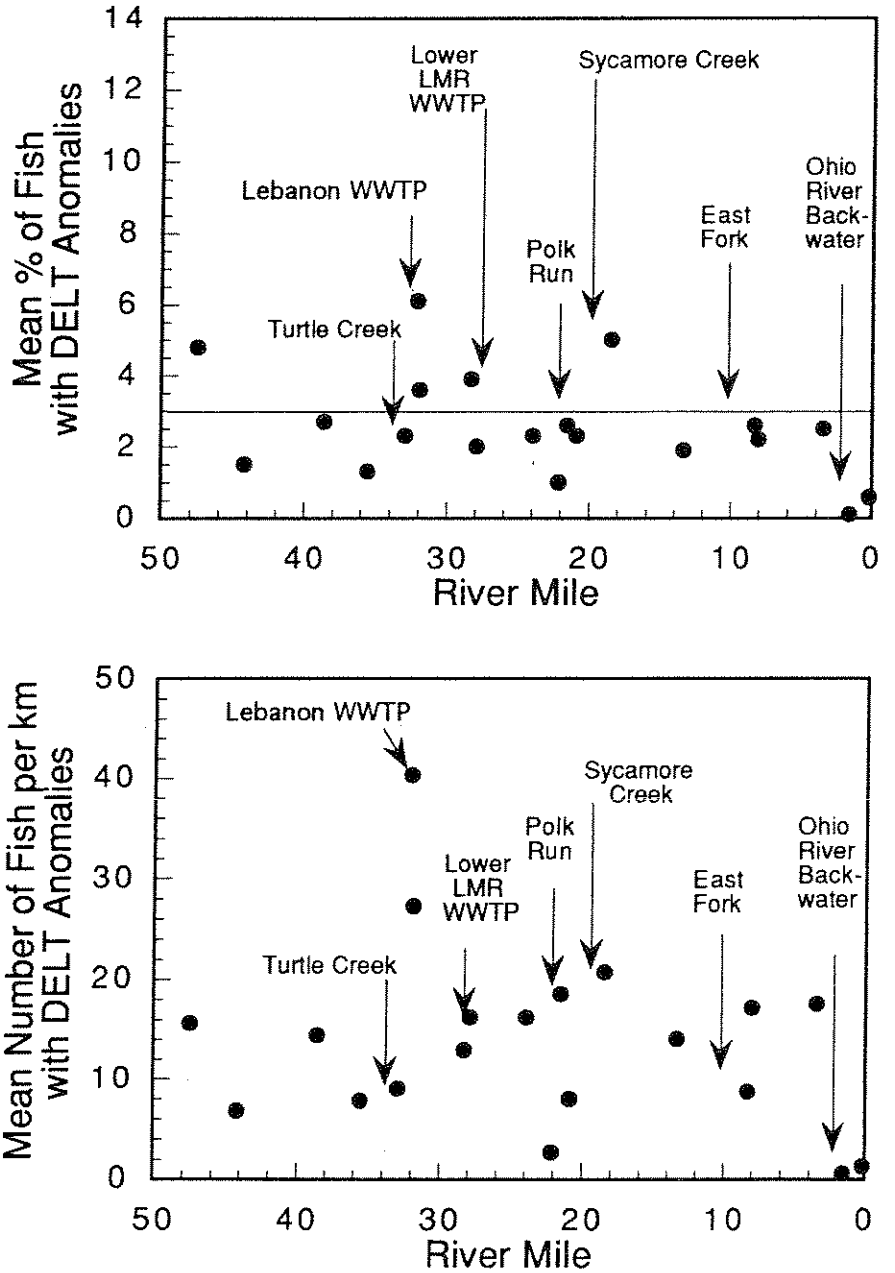


Figure 77b. Longitudinal scatter plots of the mean number of fish with DELT (deformities, eroded fins, lesions, and tumors) external anomalies and average total phosphorus concentrations (mg/l) in the upper half of the Little Miami River during 1993.



(values above 3% strongly deviate from the expected)

Figure 78 Longitudinal scatter plot of the mean percent occurrence of DELT anomalies (upper graph) and the mean relative number of fish (#/km) with DELT (deformities, eroded fins, lesions, and tumors) external anomalies (lower graph) by location in the lower half of the Little Miami River during 1993.

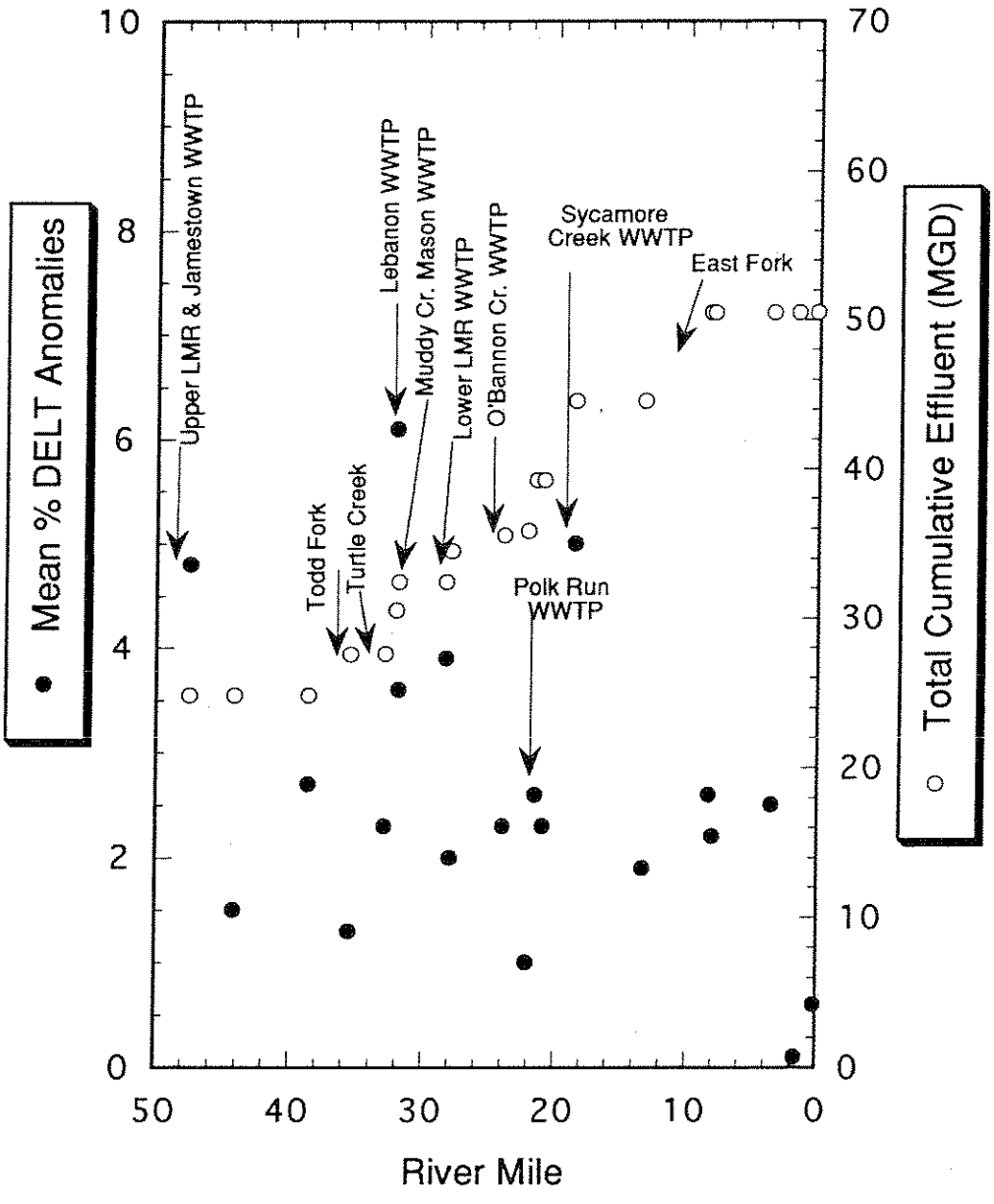


Figure 79a. Longitudinal scatter plots of the mean percentages of fish with DELT (deformities, eroded fins, lesions, and tumors) external anomalies and total cumulative effluent (3rd quarter mean million gallons per day) in the lower half of the Little Miami River during 1993.

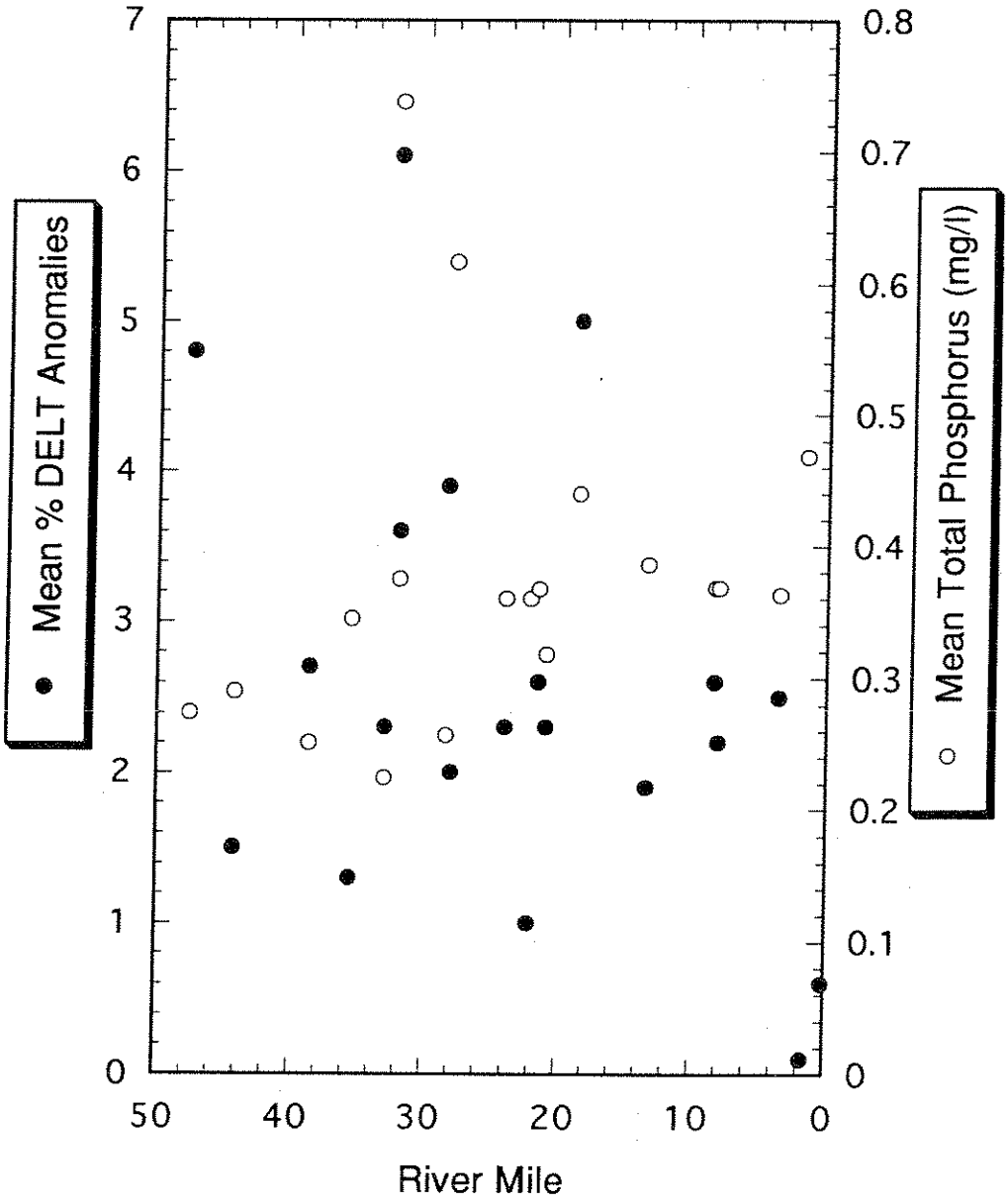


Figure 79b. Longitudinal scatter plots of the mean percentage of fish with DELT (deformities, eroded fins, lesions, and tumors) external anomalies and average total phosphorus concentrations (mg/l) in the lower half of the Little Miami River during 1993.

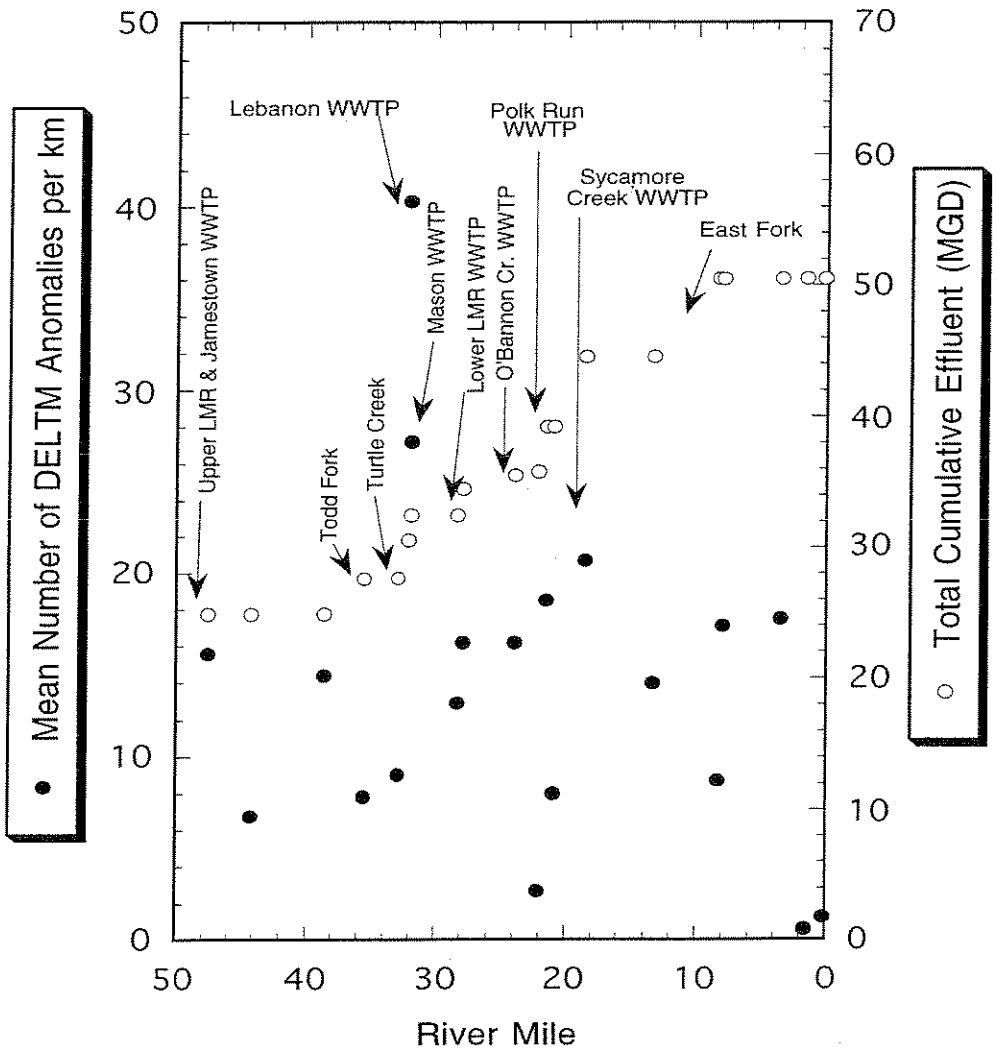


Figure 80a. Longitudinal scatter plots of the mean number of fish with DELT (deformities, eroded fins, lesions, and tumors) external anomalies and total cumulative effluent (3rd quarter mean million gallons per day) in the lower half of the Little Miami River during 1993.

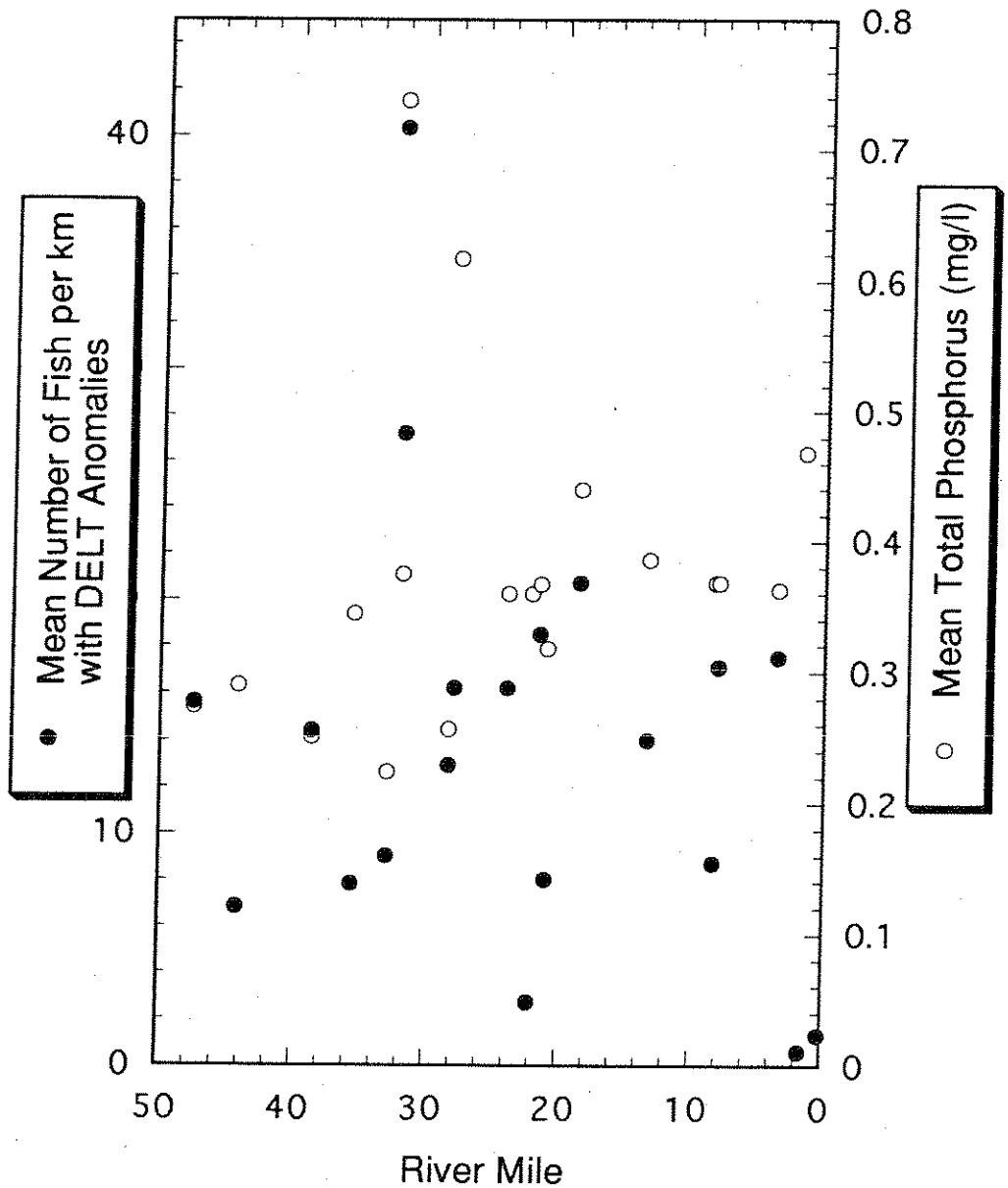


Figure 80b. Longitudinal scatter plots of the mean number of fish with DELT (deformities, eroded fins, lesions, and tumors) external anomalies and average total phosphorus concentrations (mg/l) in the lower half of the Little Miami River during 1993.

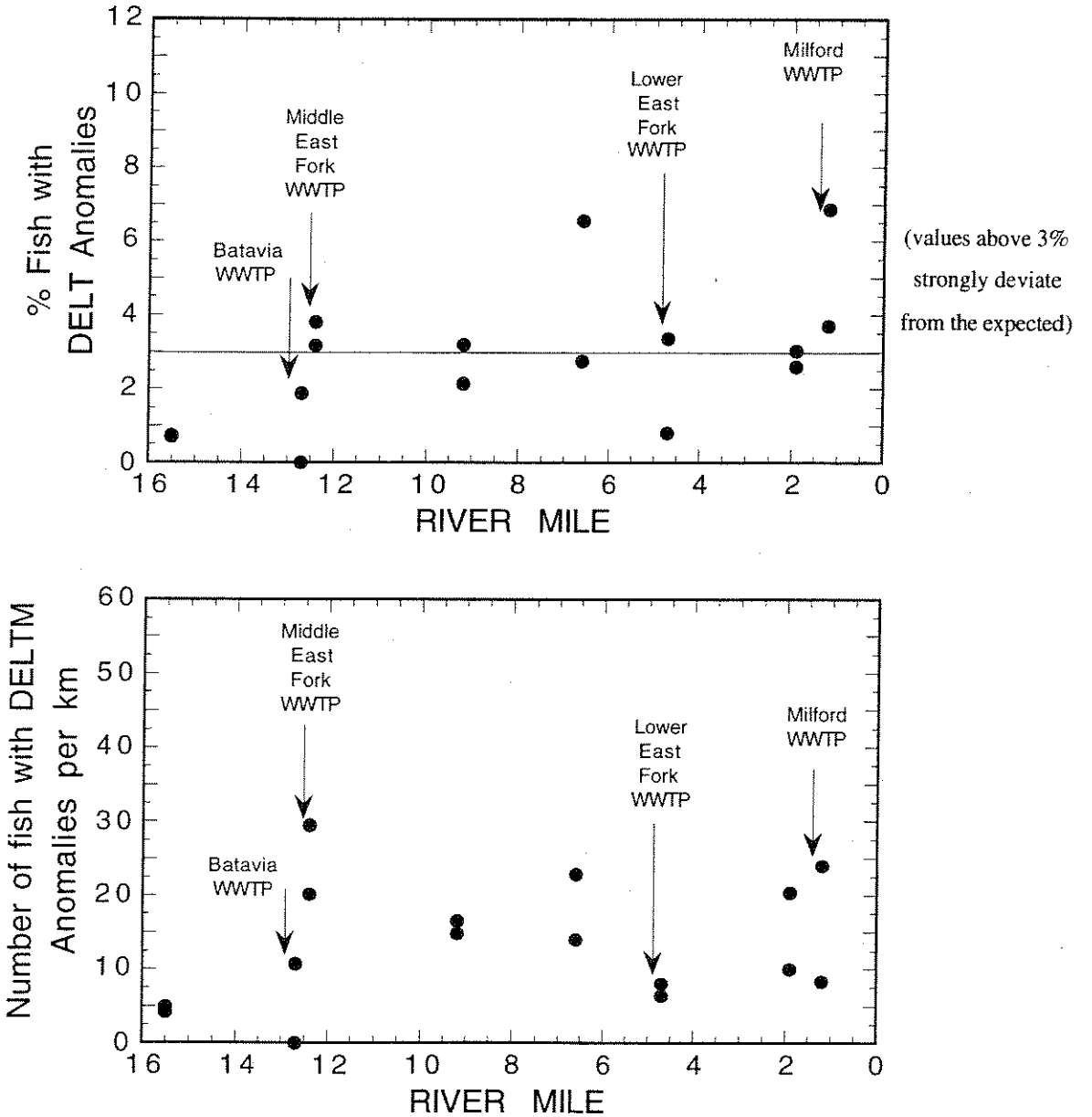


Figure 81. Longitudinal scatter plot of the percentage of DELT anomalies by sample (Upper Graph) and the relative number of fish (#/km) with DELT (deformities, eroded fins, lesions, and tumors) external anomalies (Lower Graph) in the East Fork of the Little Miami River during 1993.

TREND ASSESSMENT: 1983 - 1993

Chemical Water Quality Changes (Figures 82-96)

Little Miami River

- Since 1975, ambient chemical monitoring has been conducted in the Little Miami River near Xenia (RM 80.63) as part of the National Ambient Water Quality Monitoring Network (NAWQMN). Box plots of monthly data for six parameters are summarized in Figures 82 and 83. Throughout the nineteen year period, only one recorded dissolved oxygen concentration (daytime grab in July 1977) was below the EWH minimum criterion of 6 mg/l. Ammonia-N concentrations in earlier years (1975-1982) were elevated, but generally decreased to below the minimum detection limit in later years (1983-1993). Moderate to high levels of nitrate+nitrite-N have been recorded at the site throughout the period reflecting the predominantly agricultural land use within the upper basin. However, nitrate+nitrite-N values generally increased as ammonia-N levels decreased in the mid to late 1970s, possibly due to increased nitrification at the South Charleston WWTP. Most phosphorus concentrations recorded at the site have remained below the WQS guideline of 1.0 mg/l. High concentrations of total suspended solids (TSS) and high fecal coliform counts have tended to coincide with high flow events due to increased nonpoint source runoff from the agricultural land use.

- Ohio EPA conducted an intensive biological and water quality study of the Little Miami River mainstem in 1983 and a comparison of 1983 and 1993 mean chemical results are presented in Figures 84-88. Daytime grab dissolved oxygen concentrations have remained similar throughout the mainstem with the exception of lower values recorded downstream of Gilroy Ditch in 1993 (Figure 84). D.O. values in the headwater region (RM 101.30) were below the EWH minimum criterion in 1983 and 1993.

- Mean ammonia-N concentrations recorded in 1993 were consistently low throughout most of the mainstem (Figure 85). In the upper half of the Little Miami River, lower concentrations were evident downstream of Gilroy Ditch (South Charleston WWTP, RM 98.98) and downstream from Beaver Creek (RMs 72.30 and 66.56). In the lower half, mean concentrations downstream from Sycamore Creek (RM 18.14) have also decreased since 1983. However, concentrations downstream from the Lebanon and Mason WWTPs have increased slightly.

- Mean nitrate+nitrite-N concentrations have increased since 1983 at most locations in the upper half with the largest increase recorded downstream from Gilroy Ditch (Figure 86). Concentrations in the lower half have remained more similar at most locations.

- Mean phosphorus concentrations in the upper half have decreased downstream from Gilroy Ditch, but increased slightly downstream from Yellow Springs Creek (Figure 87). Values also decreased downstream from the Xenia Ford Road WWTP and the confluence of Beaver Creek, but remain higher in 1993 than background levels upstream from Clifton. Total phosphorus concentrations decreased at most locations in the lower mainstem except for downstream from the Warren Co. Lower LMR WWTP (Simpson Creek).

- Mean fecal coliform counts were generally below the Primary Contact Recreation (PCR) criterion in both 1983 and 1993. Mean concentrations downstream from Sycamore Creek (RM 18.14) exceeded the primary contact criterion both years (Figure 88).

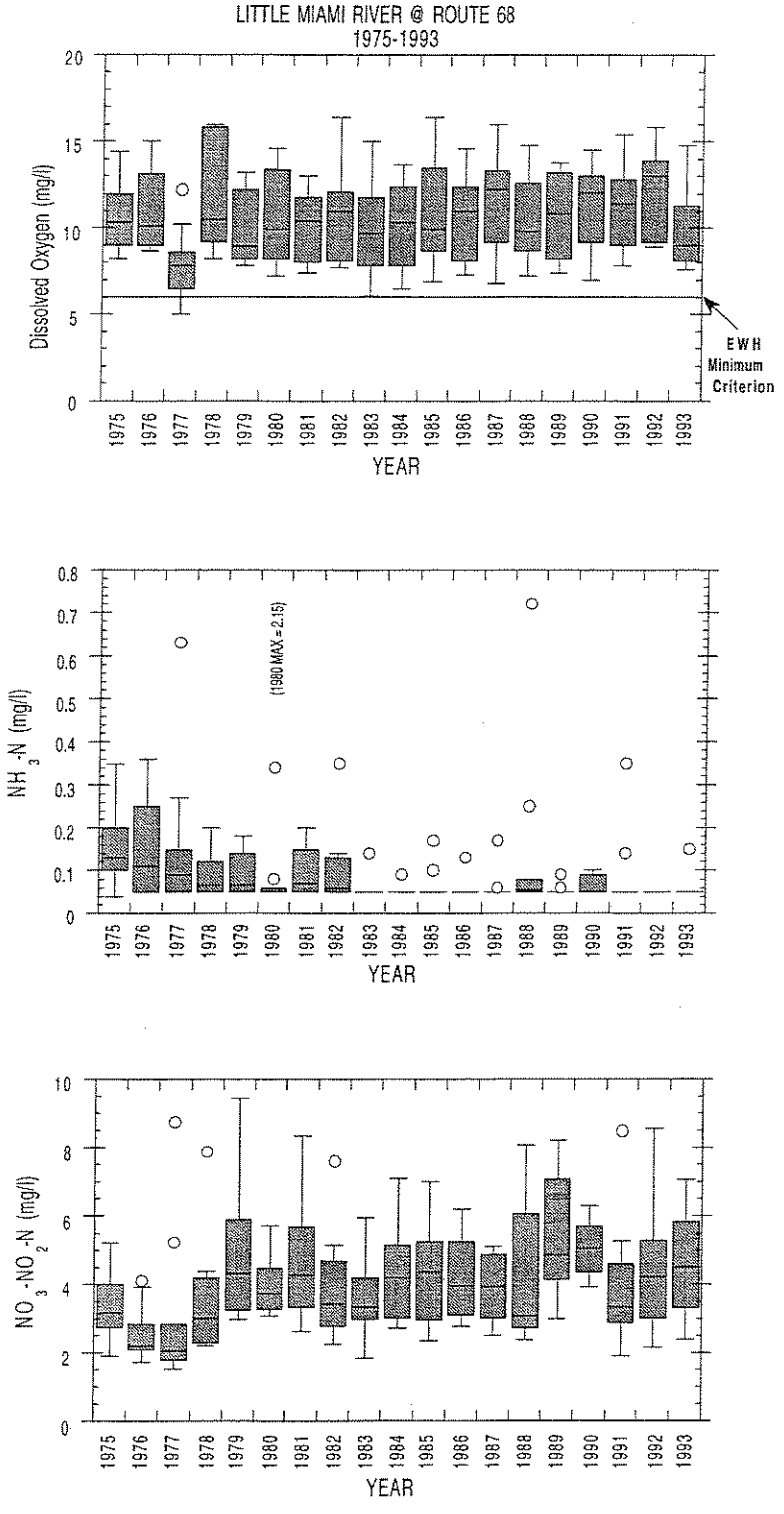


Figure 82. Longitudinal trends of dissolved oxygen (daytime grabs), ammonia-N, and nitrate+nitrite-N in the upper Little Miami River at SR 68 (RM 80.63) from 1975-1993.

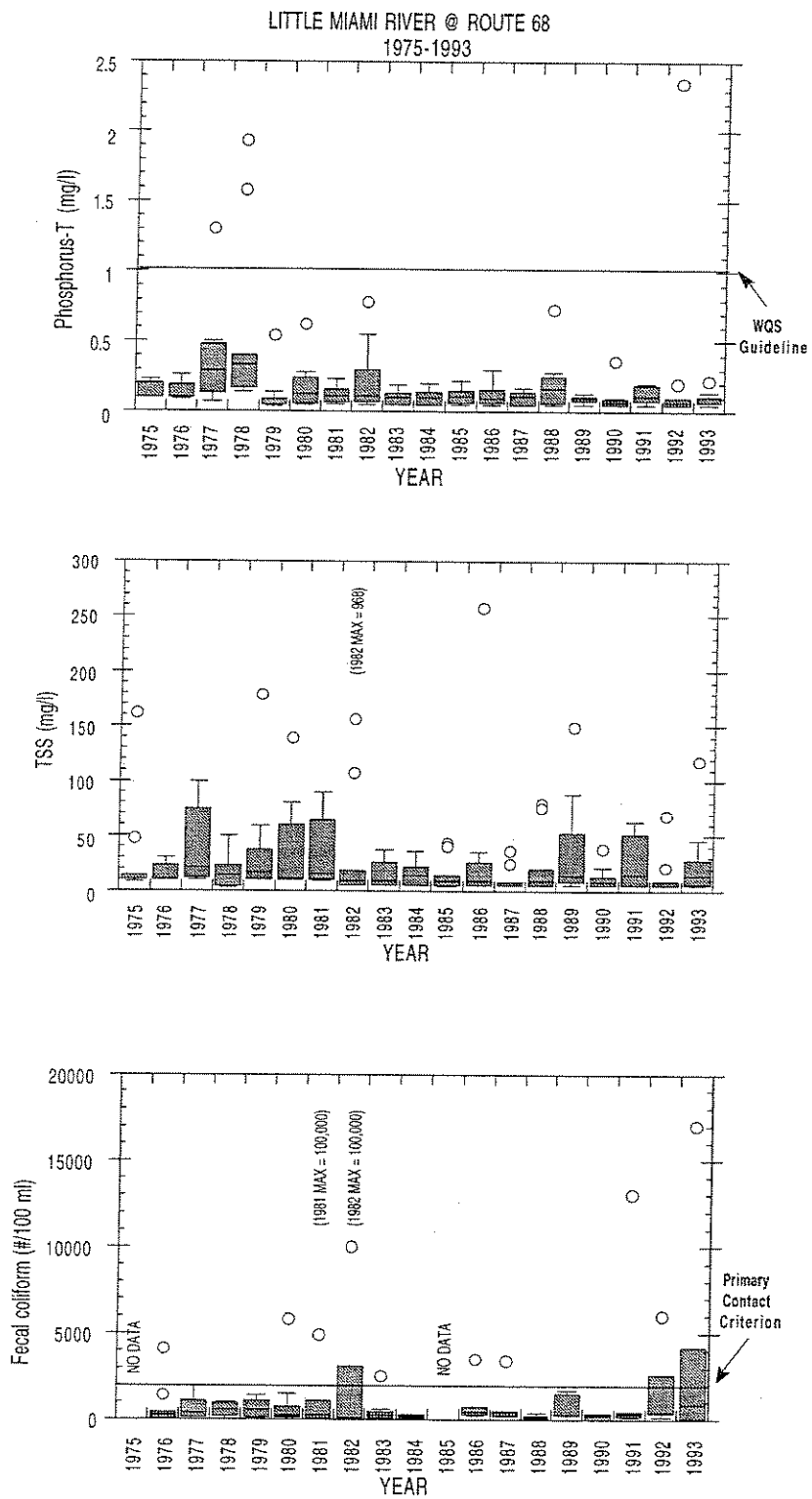


Figure 83. Longitudinal trend of total phosphorus, total suspended solids (TSS) and fecal coliform in the Little Miami River at State Route 68 (river mile 80.63) from 1975-1993.

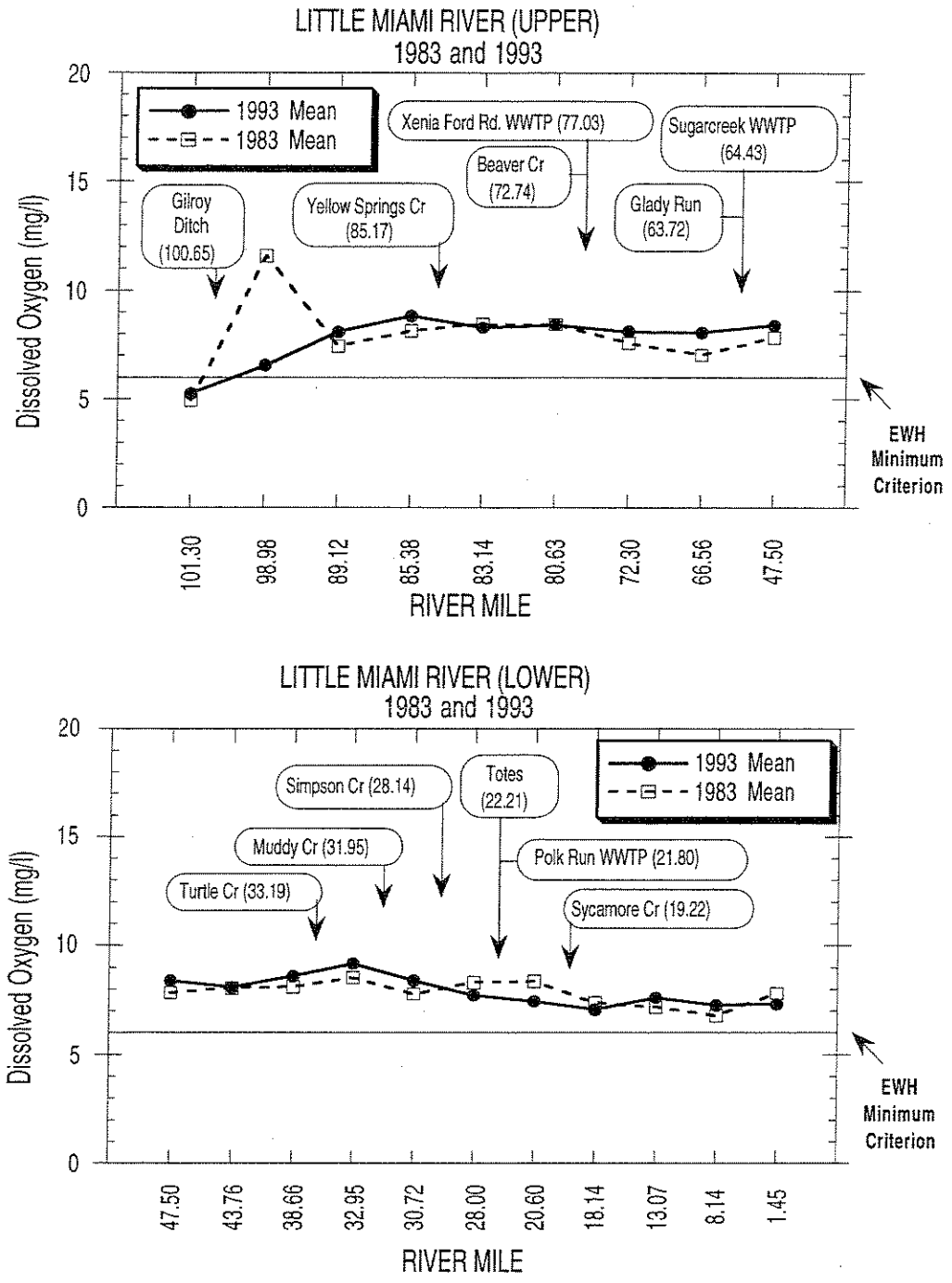


Figure 84. Longitudinal trend of mean dissolved oxygen (daytime grabs) in the upper and lower Little Miami River in 1983 and 1993.

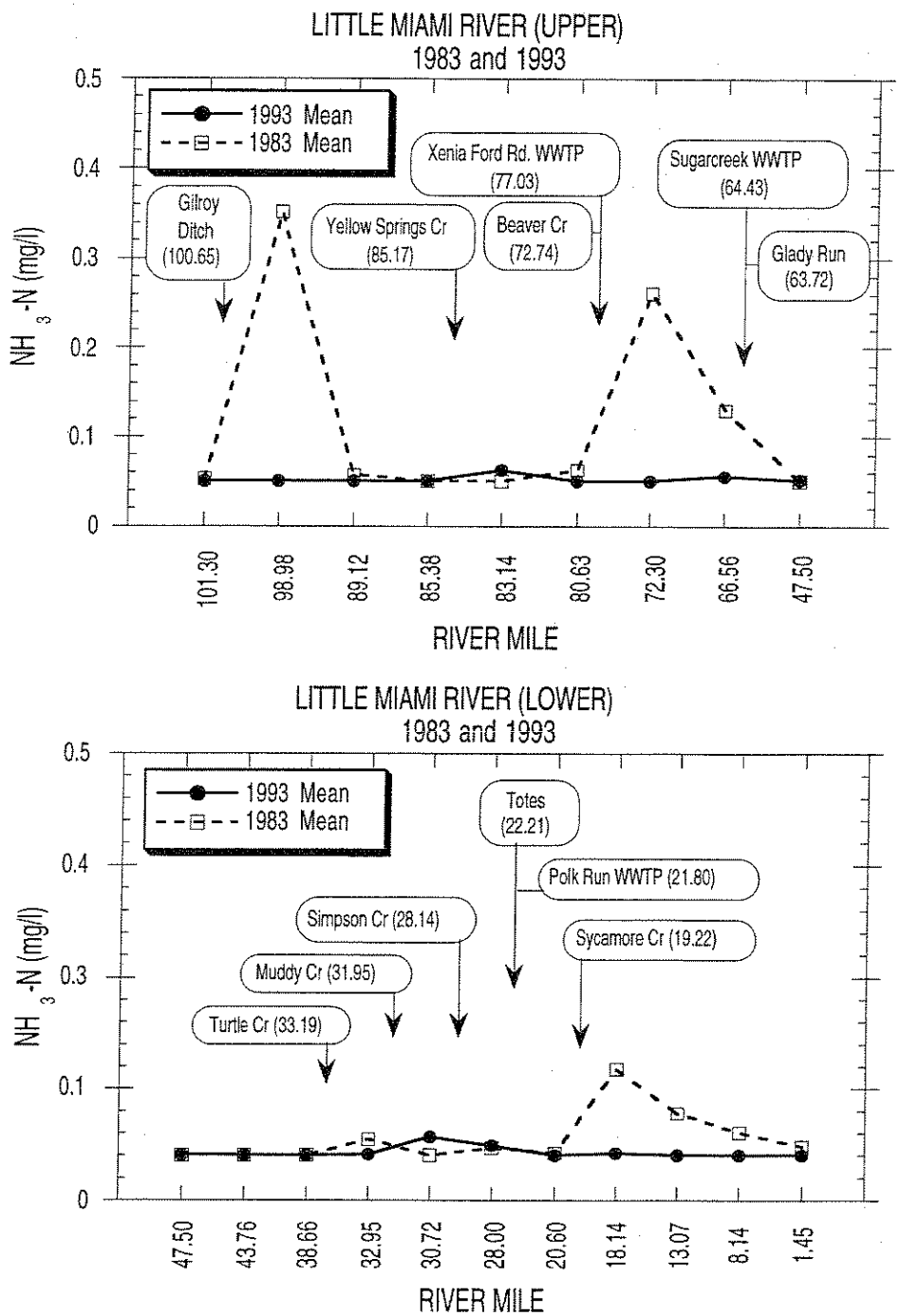


Figure 85. Longitudinal trend of mean ammonia-N in the upper and lower Little Miami River in 1983 and 1993.

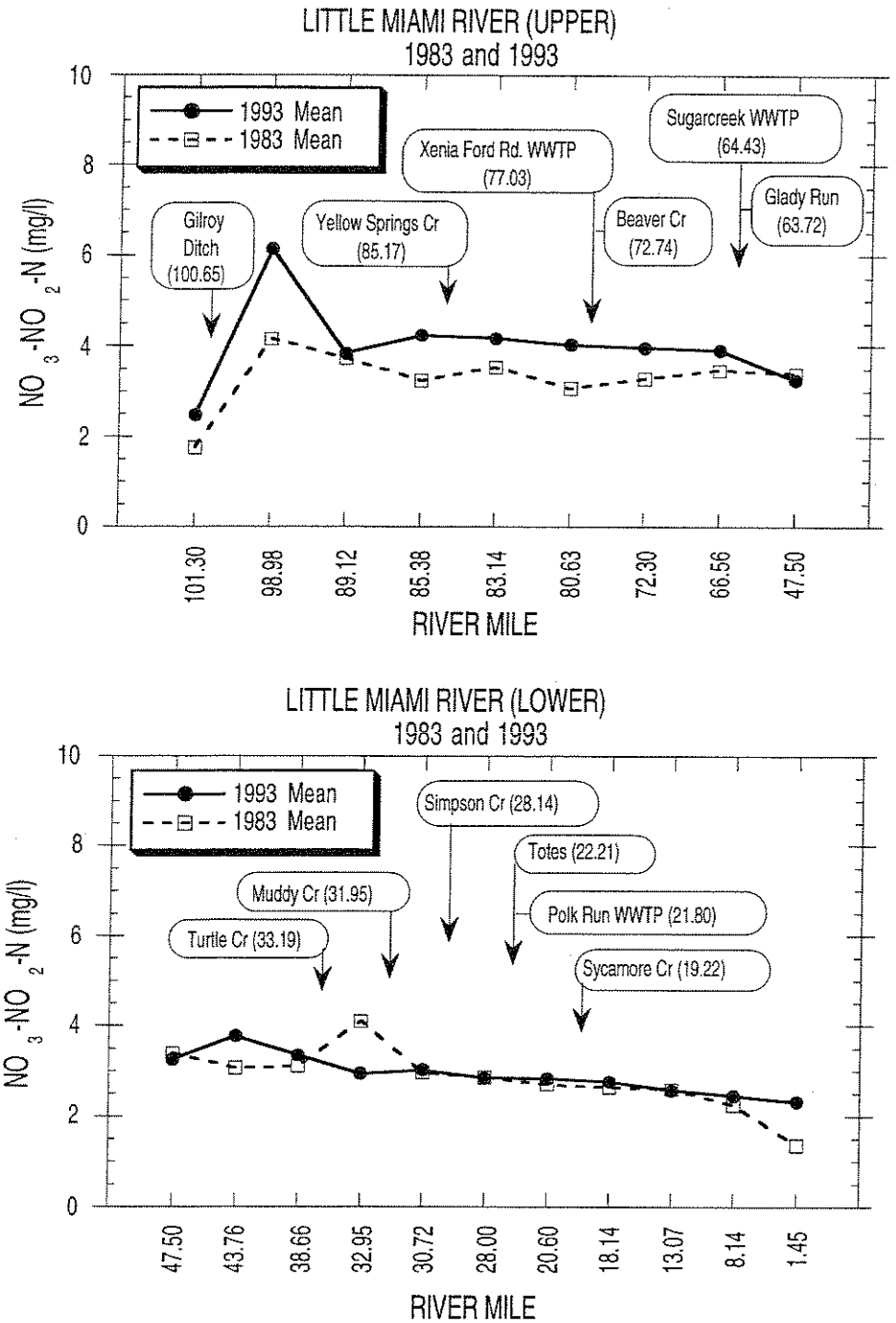


Figure 86. Longitudinal trend of mean nitrate+nitrite-N in the upper and lower Little Miami River in 1983 and 1993.

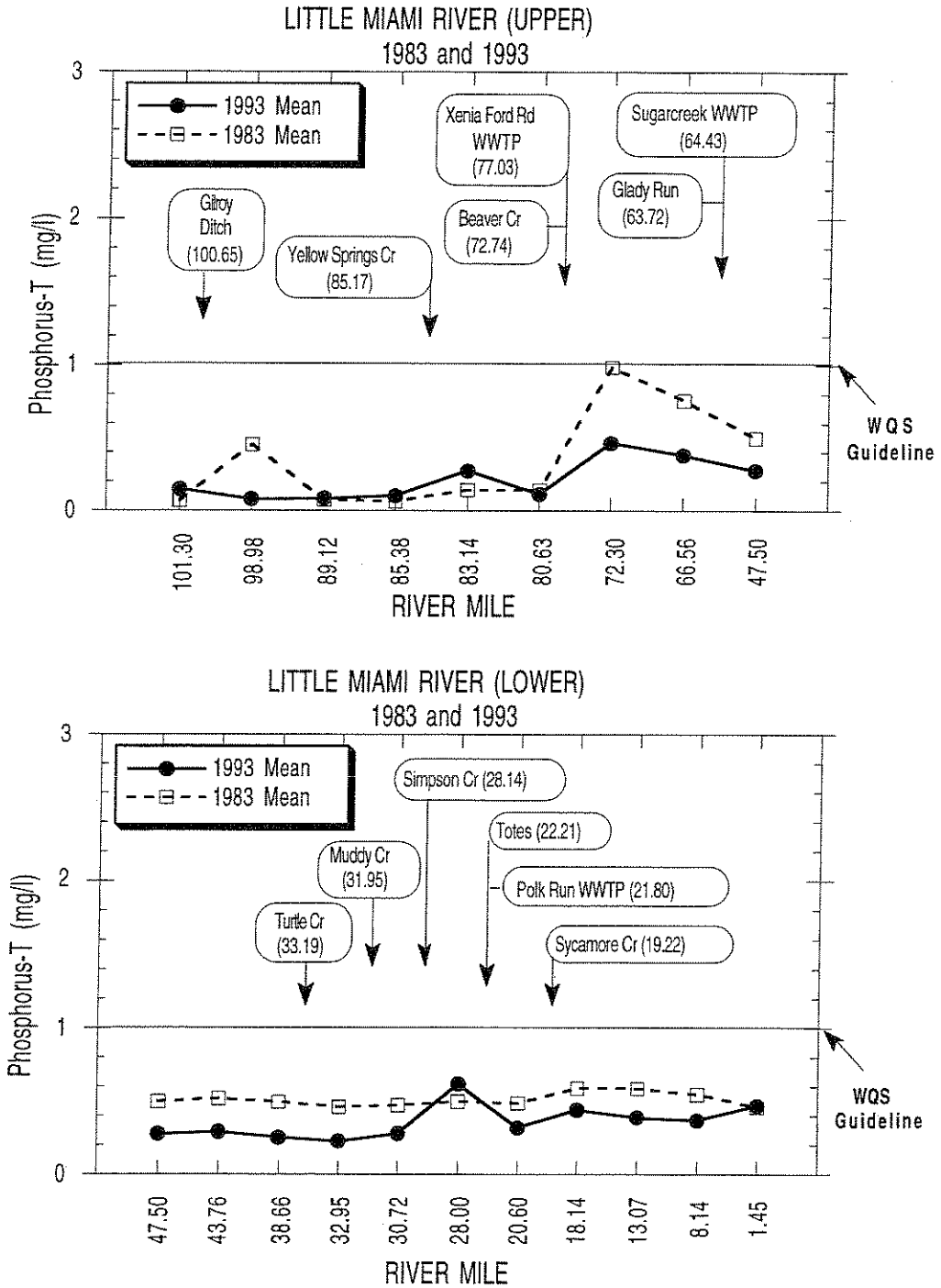


Figure 87. Longitudinal trend of mean total phosphorus in the upper and lower Little Miami River in 1983 and 1993.

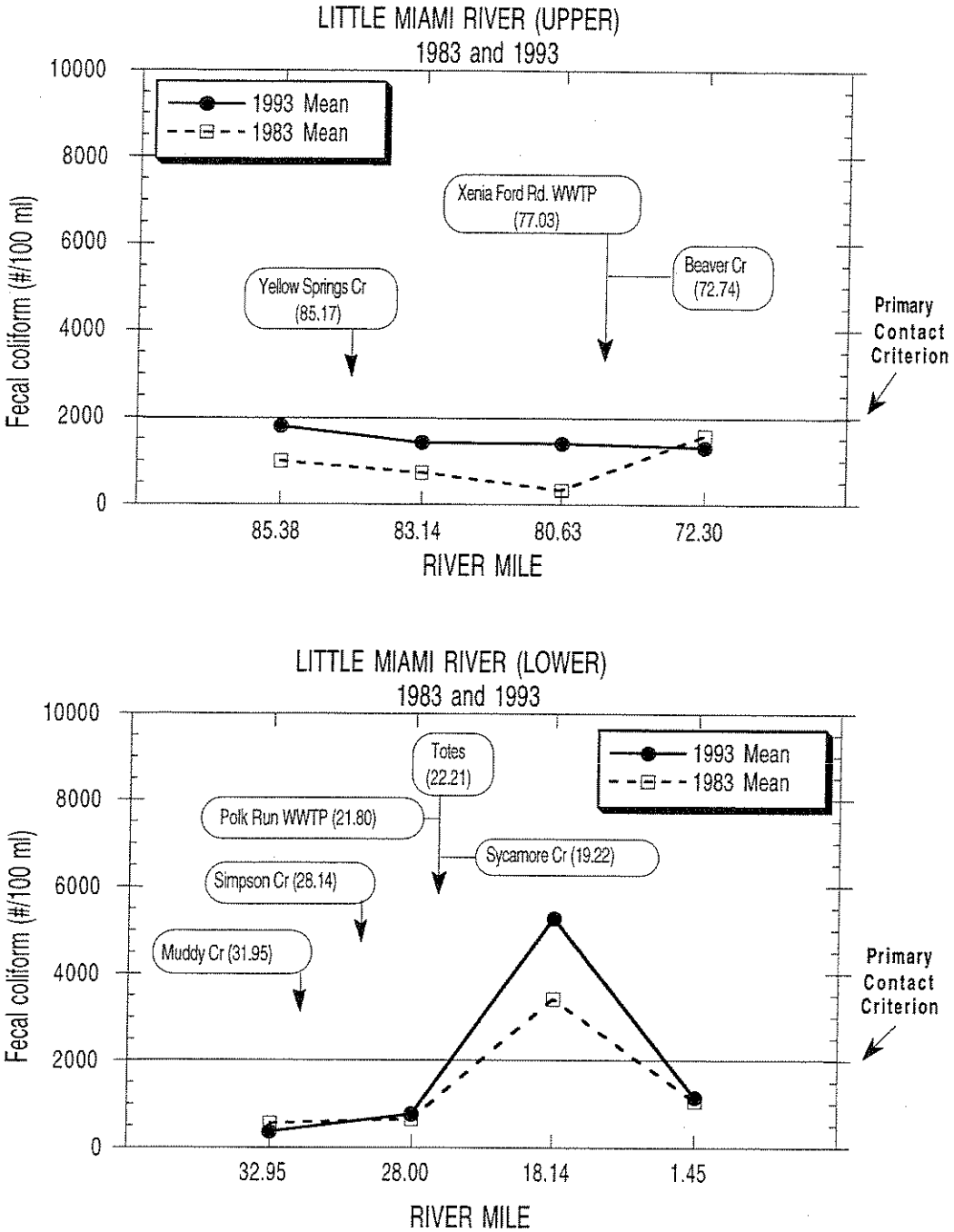


Figure 88. Longitudinal trend of mean fecal coliform in the upper and lower Little Miami River in 1983 and 1993.

Little Beaver Creek

- A comparison of 1982 and 1993 mean water chemistry results for five parameters from two locations (RMs 1.95 and 0.05) are shown in Figures 89 and 90. Due likely to improved treatment at Montgomery County Eastern Regional WWTP, the 1993 data shows increased dissolved oxygen and nitrate+nitrite-N levels and decreased ammonia-N concentrations. Mean phosphorus concentrations also markedly decreased in 1993, but remained above the WQS guideline (1.0 mg/l) demonstrating the continued nutrient loading from the Montgomery County Eastern Regional WWTP. Although now measured as CBOD5, BOD5 levels have markedly declined since 1982. The conversion of the 1993 $CBOD_5$ values near 1.0 mg/l would yield a very similar trend in BOD_5 (Figure 89).

Turtle Creek

- Mean results from comparable sites (RMs 6.23, 0.70, and 0.52) in the 1983 and 1993 surveys of Turtle Creek are given in Figures 91 through 93. Turtle Creek in the vicinity of Cincinnati Milacron was also sampled extensively for metals in 1989. Mean copper and lead results from 1989 are presented in Figure 93.

- The 1993 results show slightly lower mean dissolved oxygen concentrations at RMs 6.23 and 0.52, but a markedly lower level at RM 0.70, the area upstream from the industrial discharge where dewatering was suspected in 1993. Values did, however, remained above the WWH average criterion (5.0 mg/l) at all three sites (Figure 91).

- Mean ammonia-N levels in 1993 remained similar to the 1983 concentrations between RMs 6.23 and 0.70, but markedly increased to critically high values downstream from Cincinnati Milacron (RM 0.52, Figure 91). The 1993 mean concentration of nitrate+nitrite-N was similar at the upstream site and markedly lower between RMs 0.70 and 0.52 (Figure 92). Total phosphorus was similar to slightly higher between RMs 6.23 and 0.70 and markedly lower downstream from Cincinnati Milacron. The 1993 mean phosphorus levels at RMs 0.70 and 0.52 approached the WQS guideline (Figure 92).

- The mean concentrations of copper has remained highly elevated immediately downstream from Cincinnati Milacron since 1983 (Figure 93). While mean concentrations recorded in the mixing zone (RM 0.58) in 1993 were lower than 1989, 1993 levels were more highly elevated than the 1989 value at RM 0.52. Mean lead concentrations recorded in 1989 and 1993 in the mixing zone were comparable, but the 1993 value again exceeded 1989 concentration at RM 0.52 (Figure 93).

East Fork Little Miami River

- The 1993 mean dissolved oxygen values were similar to the 1982 values between RMs 9.10 and 0.77, but were considerably lower downstream from the reservoir at RM 15.60 (Figure 94). The 1993 trend remained fairly constant and above the EWH minimum water quality criterion throughout the lower mainstem. Although now measured as CBOD5, BOD5 levels have apparently declined since 1982. The conversion of the 1993 $CBOD_5$ values near 1.0 mg/l would yield a very similar trend in BOD_5 (Figure 94).

- The 1993 mean ammonia-N concentrations were below the minimum detection limit (0.05 mg/l) at all four sites. In 1982, concentrations were detected at most locations. Mean nitrate+nitrite-N levels were relatively constant throughout the mainstem in 1982, but demonstrated an increasing trend downstream from the WWTPs in 1993 (Figure 95). Mean phosphorus concentrations in 1982 and 1993 were very similar. Values in both years peaked at RM 0.77, but remained below 1.0 mg/l (Figure 96). Mean total suspended solids concentrations were somewhat more elevated in 1993 and increased longitudinally during both years (Figure 96). Fecal coliform counts in 1982 and 1993 also showed higher values near the mouth than upstream from Batavia, but the 1993 value at RM 0.77 was markedly lower in 1993. Mean 1993 concentrations remained below the primary contact recreation criterion at both locations (Figure 96).

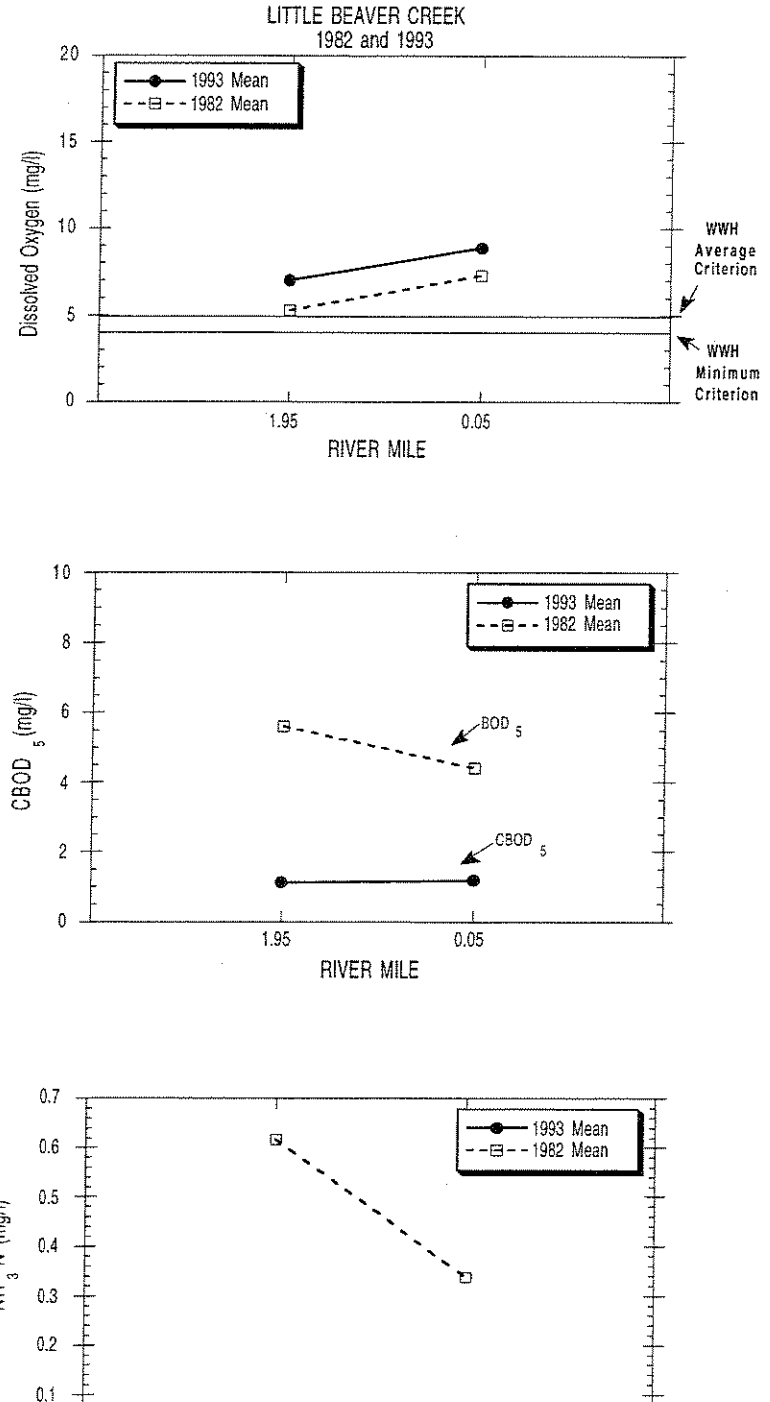


Figure 89. Longitudinal trend of mean dissolved oxygen (daytime grabs), (C)BOD_5, and ammonia-N in Little Beaver Creek in 1982 and 1993.

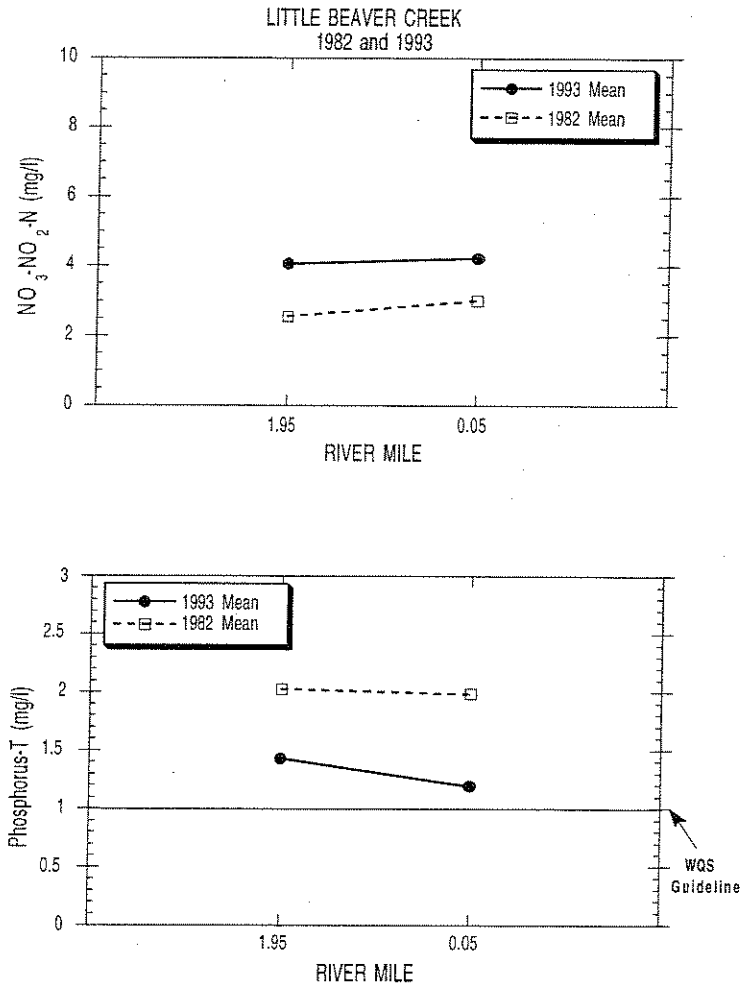


Figure 90. Longitudinal trend of mean nitrate+nitrite-N and total phosphorus in Little Beaver Creek in 1982 and 1993.

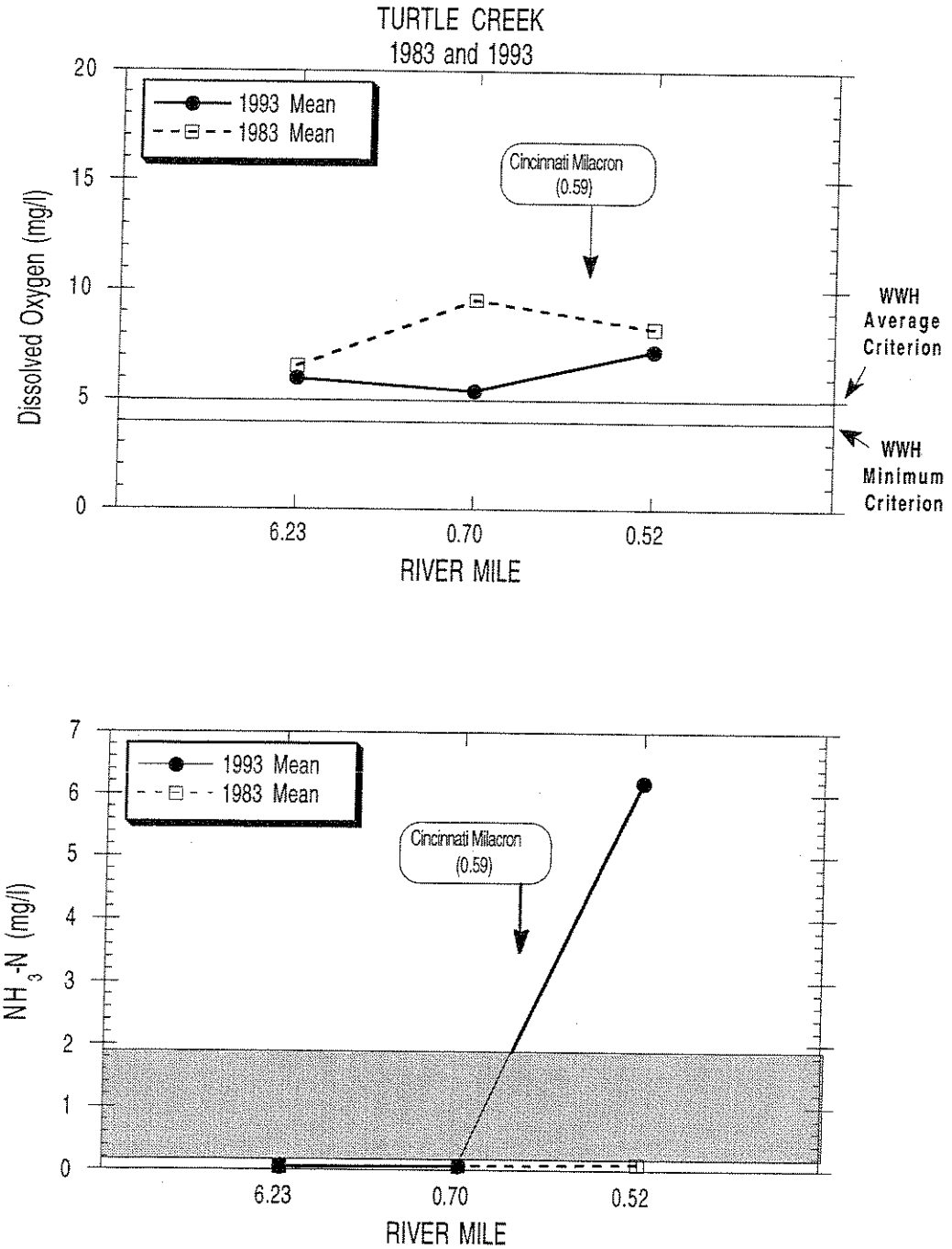


Figure 91. Longitudinal trends of mean dissolved oxygen (daytime grabs) and ammonia-N in Turtle Creek in 1983 and 1993 (*shaded area is the ammonia-N water quality criteria range between the 25th and 90th percentile hardness recorded during sample collection*).

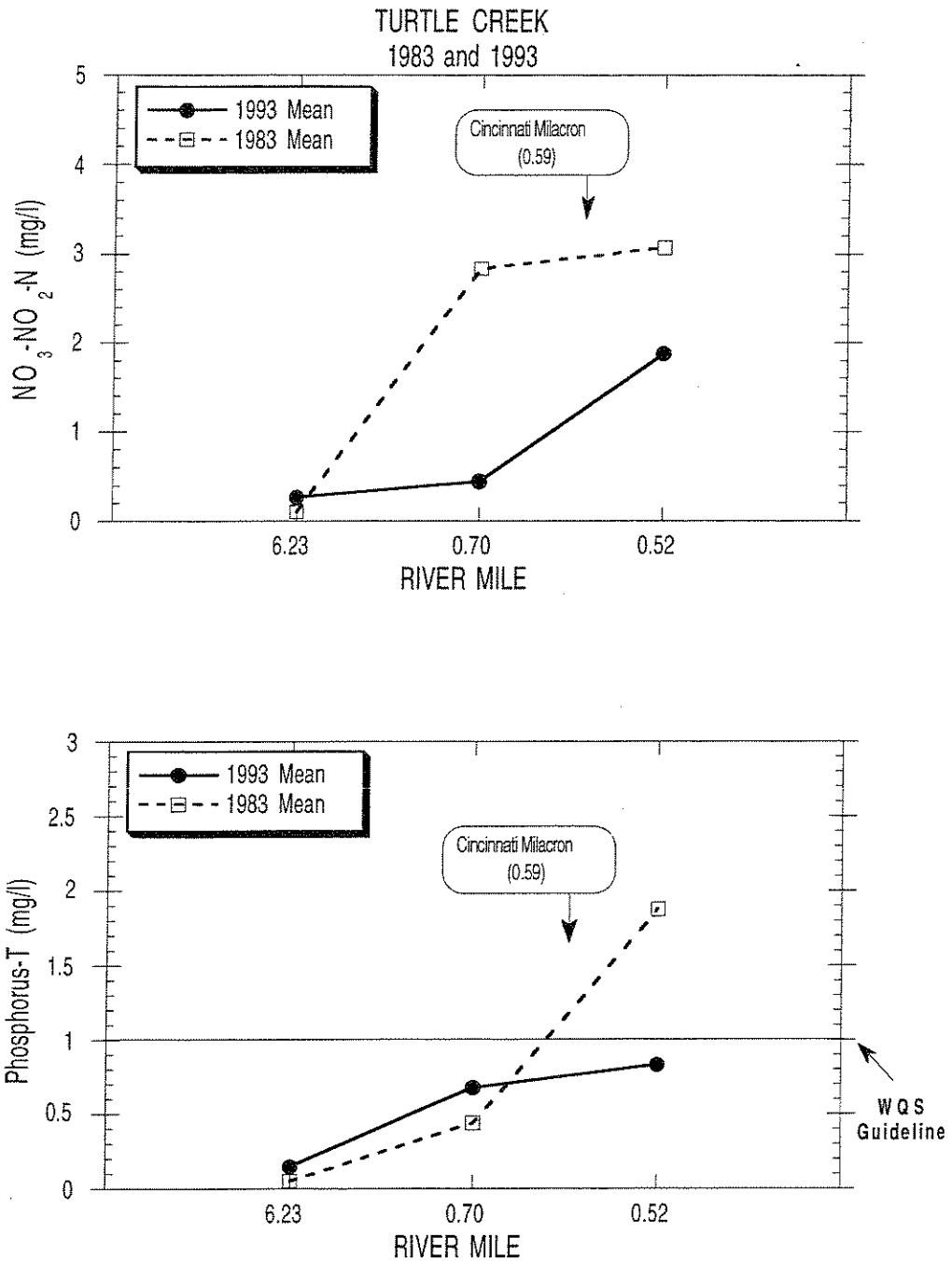


Figure 92. Longitudinal trend of mean nitrate+nitrite-N and total phosphorus in Turtle Creek in 1983 and 1993.

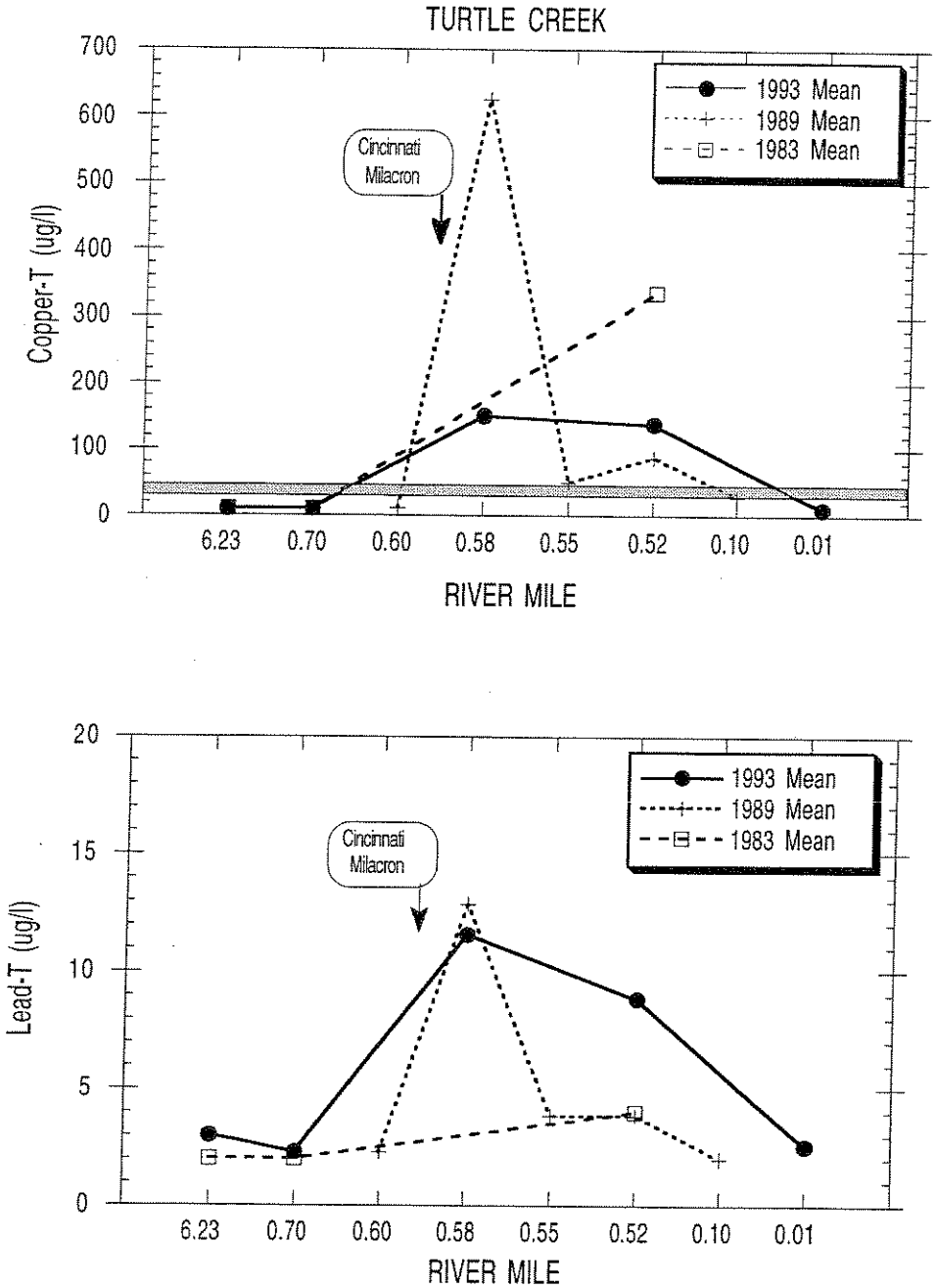


Figure 93. Longitudinal trend of mean copper and lead concentrations in Turtle Creek in 1983, 1989 and 1993 (*shaded area is the water quality criteria range between the 25th and 90th percentile hardness recorded during sample collection*).

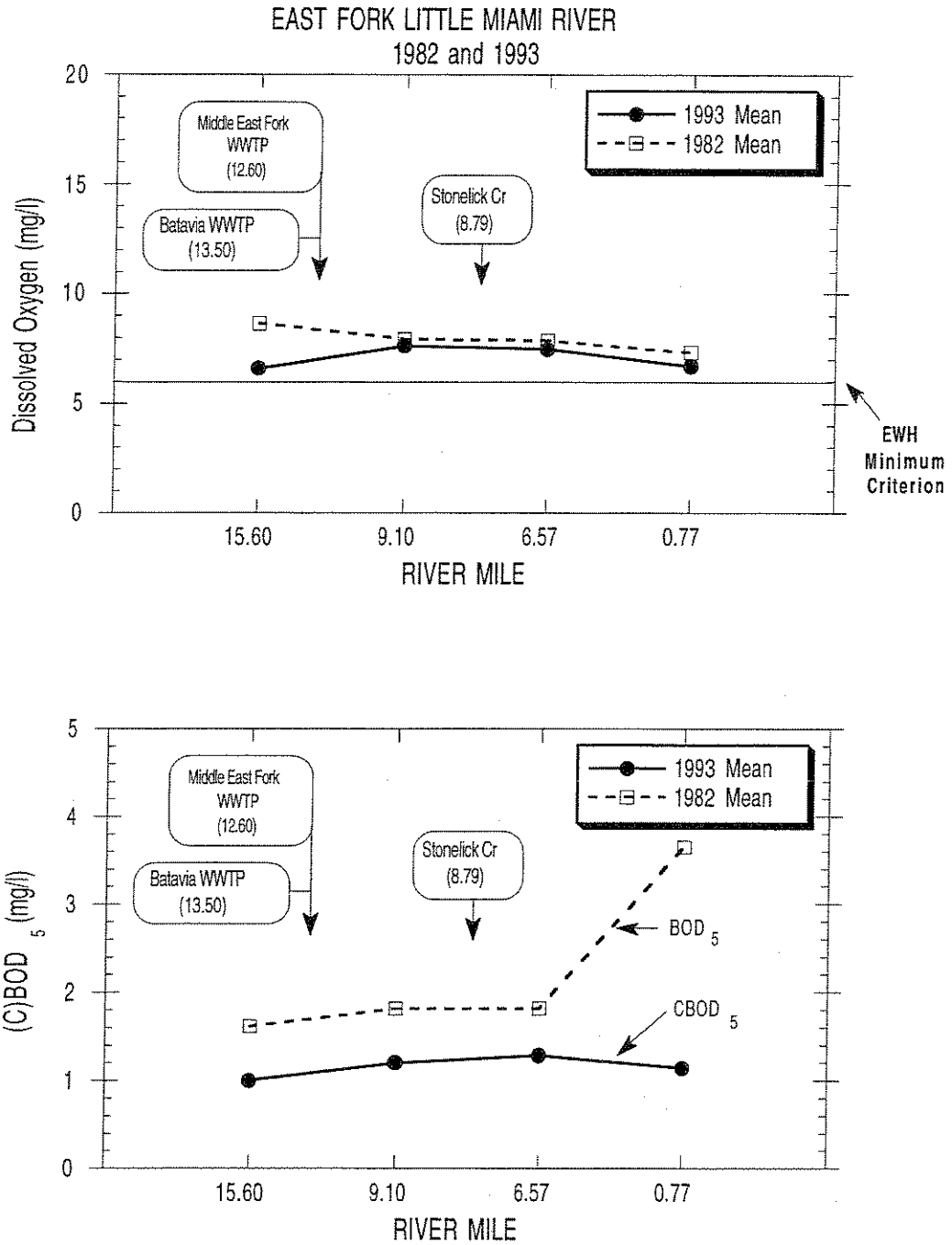


Figure 94. Longitudinal trend of mean dissolved oxygen (daytime grabs) and (C)BOD_5 in the East Fork Little Miami River in 1982 and 1993.

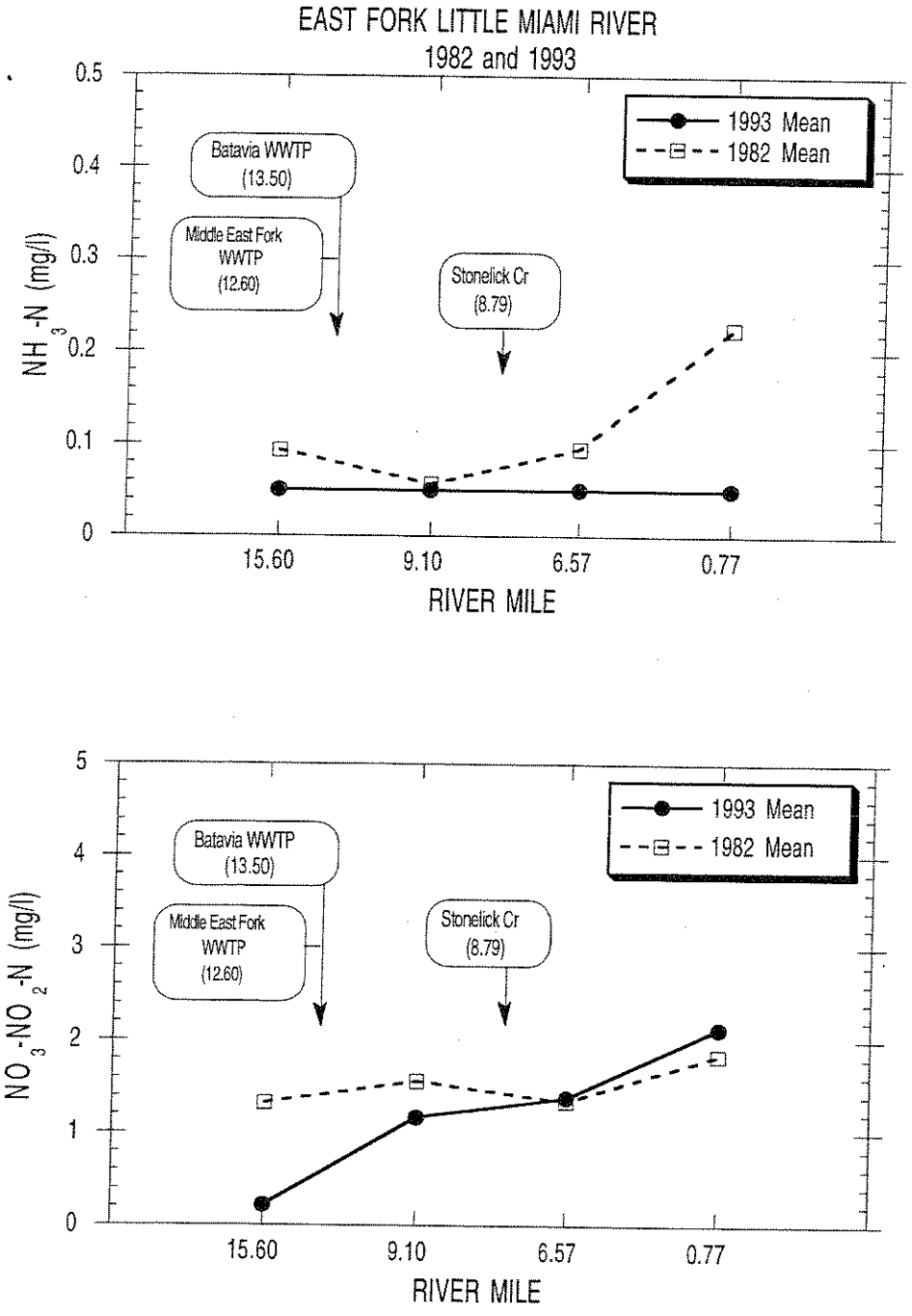


Figure 95. Longitudinal trend of mean concentrations of ammonia-N and nitrate-nitrite-N in the East Fork Little Miami River in 1982 and 1993.

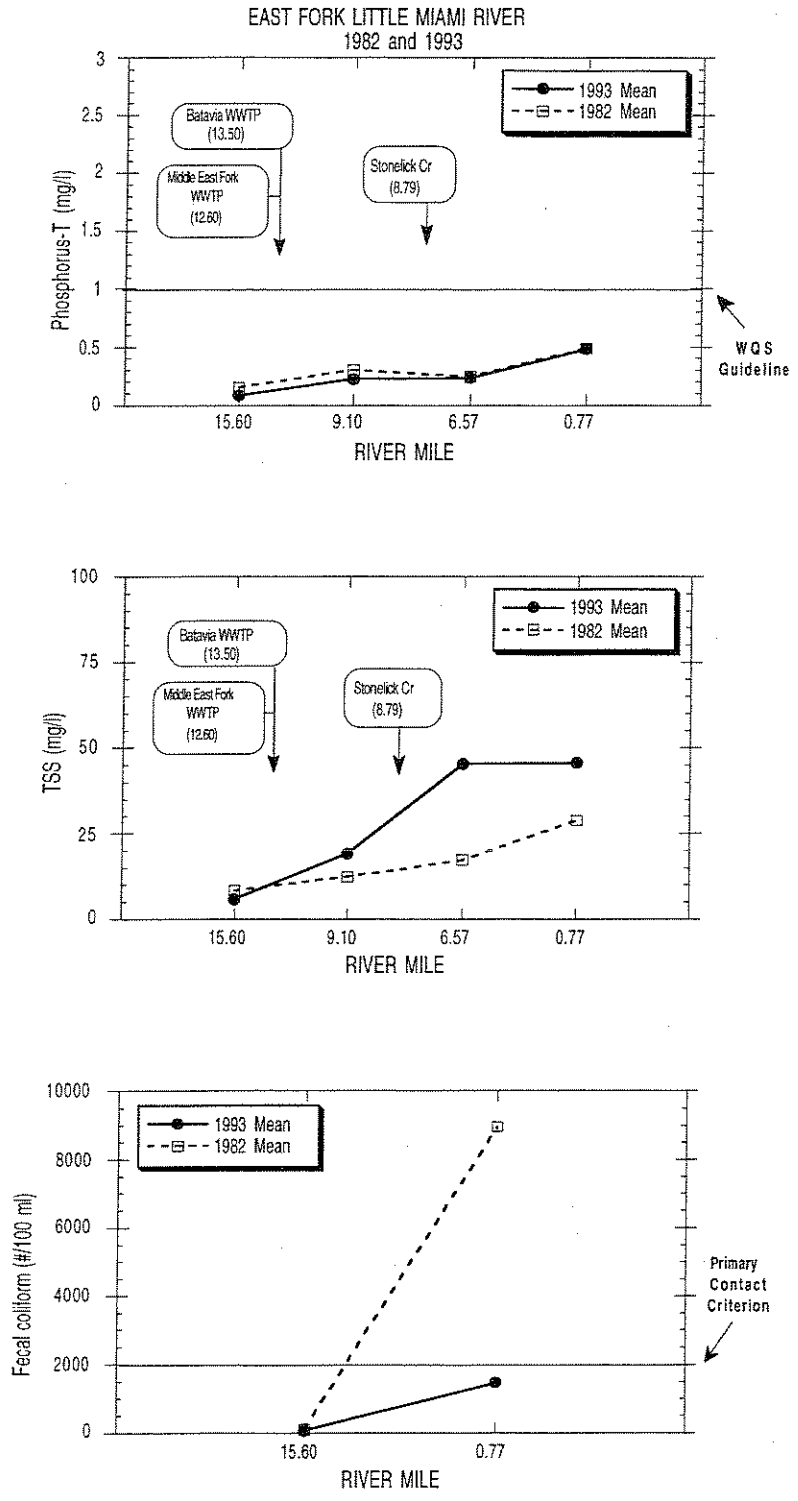


Figure 96. Longitudinal average concentrations of total phosphorus, total suspended solids (TSS), and fecal coliform in the East Fork Little Miami River in 1982 and 1993.

Biological and Aquatic Life Use Attainment Changes (Figures 97-107; Tables 3, 13)

Little Miami River

- Over the last decade, significant improvements have been made in restoring the chemical and biological integrity of the Little Miami River mainstem. From 1983 to 1993, the number of miles in FULL EWH attainment has increased from 1.5 to 40.9 while the number of miles in NON attainment decreased from 45.4 to 3.0 in 1993 (Table 13). Complete recovery had not occurred by 1993, however, because 58.2 miles were in only PARTIAL attainment due primarily to impacted fish assemblages.

- The most significant improvements (*i.e.*, FULL EWH attainment) have occurred in Greene, southern Warren, and northern Hamilton/Clermont Counties due to the improved treatment of sewage by county and municipal wastewater treatment plants (WWTPs). Since 1983, the aquatic life attainment status has improved (*e.g.*, **NON** to Partial, Partial to FULL) at all 11 of the similarly sampled segments within the upper half of the mainstem, but only six of the 13 previously PARTIAL or **NON** attaining segments within the lower half (Table 3). Comparisons of the biological indices (ICI, MIwb, and IBI) and Area of Degradation (ADV) values from 1983 to 1993 for similarly sampled segments also show the greatest improvements have occurred within the upper half of the Little Miami River mainstem (Tables 3 and 13). The mean difference between 1983 and 1993 ICI scores was significantly (> 4 units) higher in the upper half (13.8 units; range 2 to 32) than in the lower half (5.8 units; range -2 to 18). Also indicating considerable improvement in macroinvertebrate assemblages, ADV values for the ICI markedly declined 5,637 units in the upper half. and in the lower half. The ICI's ADV value declined less (326 units) in the lower half. During 1993, the ICI's ADV value in the lower mainstem was also significantly higher (*i.e.*, more impacted) than in the upper half (743 vs. 44 ADV units, respectively). The mean difference between MIwb scores was also higher in the upper half (1.0 units; range -0.3 to 2.1) than in the lower half (0.5 units; range -0.7 to 1.7 [> 0.5 MIwb units is considered a significant difference]). ADV values for the MIwb declined 1,765 units in the upper half and 370 units in the lower half. The MIwb's ADV value during 1993 was only slightly higher in the upper half (320) than the lower half (255). The mean difference between 1983 and 1993 IBI scores was only slightly higher in the upper half (2.8 units; range -4 to 13) than in the lower half (1.6 units; range -8 to 9 [> 4 IBI units is considered a significant difference]). ADV values for the IBI declined 1,671 units in the upper half and 317 units in the lower half. The 1993 ADV values remain high in the mainstem in both the upper half (2,412) and in the lower half (1,632) indicating fish assemblages are still impacted in portions of both 50 mile segments. Overall, the 1993 ADV values per mile in both the upper and lower mainstem remained relatively high (46.3 and 32.6, respectively). Also indicating improvement, the number of fish species collected in the Little Miami River increased from 71 in 1983 to 83 in 1993.

LMR: Upstream from Clifton (RM 102.1 - 89.2)

- Since 1983, the EWH attainment status in the three commonly sampled segments have improved from **NON** to PARTIAL attainment (Table 3). Macroinvertebrate assemblages have significantly improved upstream from Clifton. ICI values at all three locations improved from the fair to good range in 1983 to the exceptional range in 1993 (Table 11, Figure 97). Fish assemblages, however, have improved less with IBI scores remaining in the fair range and MIwb values indicative of only marginally good assemblages (Table 12, Figure 101). The 1993 PARTIAL attainment of EWH appeared due to a combination causes and sources including low dissolved oxygen levels; extremely high fecal bacteria counts; manure runoff from a commercial composting operation (Paygro was the source of a large fish kill in 1992); high nitrate-nitrite concentrations downstream from Gilroy Ditch; NPDES exceedences at the South Charleston WWTP; and physical habitat degradation from agricultural runoff, riparian encroachment, channelization, and uncontrolled livestock access (Table 2, A-3). The improvements in biological performance are primarily attributed to the improvements completed at the South Charleston WWTP in 1990. Incidences of DELT anomalies have decreased slightly in this upper reach since 1983 (Figure 102).

LMR: Clifton to the Narrows (RM 85.4 - 71.8)

- Since 1983, the EWH attainment status in the five commonly sampled segments have improved from PARTIAL to FULL attainment (Table 3). Macroinvertebrate and fish communities throughout the segment were indicative of exceptional quality with the exception of several locations with very good index scores (Tables 11-12, Figure 97, 101). The incidences of DELT anomalies, however, have also increased and appears to be positively correlated to the cumulative quantity and/or quality of effluent discharged by the series of municipal and county WWTPs (Figure 102). Ongoing sewage and chemical spills in Shawnee Creek and other areas also contribute pollutants and have caused fish kills. Similar to the chemical sampling, macroinvertebrate assemblages were also annually sampled in the Little Miami River at RM 80.0 from 1977 to 1979 and at RM 80.6 from 1983 to 1993. Results show the quality of macroinvertebrate assemblages has improved from high fair to low good from 1977 to 1983, to very good in 1984, and exceptional quality from 1989 to 1993 (Figure 98).

LMR: Bellbrook to Oregonia (RM 65.6 - 47.5)

- Since 1983, three similarly sampled segments have improved from **NON** to PARTIAL attainment and one site has remained PARTIAL (Table 3). The incidence of fish with external DELT anomalies within this segment has increased since 1983. This segment had some of the highest percentages and relative numbers of DELTs recorded during the 1993 survey. The primary cause and sources of impacts appears to be from a high volume of effluent and excessive nutrient loads cumulatively discharged by WWTPs. Urban and agricultural runoff, spills, and NPDES exceedences may also be contributing to the total pollutant loadings (Table 2, A-1, A-3).

LMR: Fort Ancient to I-275 (RM 44.2 - 20.6)

- Eight of the nine commonly sampled segments within this reach improved to FULL attainment in 1993. Only two of the sites attained EWH criteria during the 1983 survey. The one segment that did not improve, remained PARTIAL in 1993 possibly due to the lack of swift-water habitat within the fish sampling location. The segment receives WWTP effluent from a number of municipalities and small industries. Ambient chemical and bacterial exceedences were detected along with a number of NPDES exceedences (Table 6, A-3). Spills were also reported in several tributaries, particularly within the Todd Fork basin. Similar to the Bellbrook to Oregonia reach, cumulative pollutant loadings from dischargers within this reach may contribute to the PARTIAL attainment recorded downstream. Similar to areas within the upper half, tremendous residential and commercial growth has occurred locally within this portion of the watershed (e.g., Mason area).

LMR: Sycamore Creek to the Ohio River (RM 18.9 - 0.2)

- In contrast to most of the mainstem, the attainment status in five similarly sampled segments downstream from Sycamore Creek have not improved (remained PARTIAL) since 1983 (Table 3). ICI and MIwb scores have not significantly changed at the three similarly sampled locations. The IBI, however, remained similar between Remington and Milford, but decreased (8 units) downstream from the confluence of the East Fork near Newtown. MIwb and IBI have declined slightly at the two similarly sampled sites in the Ohio River backwaters since 1983. In addition to upstream point source discharges, this segment receives additional pollutant loadings from point source discharger(s) in Sycamore Creek and the East Fork; CSO and SSO discharges, landfill leechate, and urban runoff. Contaminated sediments were detected near the mouth of Sycamore Creek and in the mainstem at Beechmont Avenue (RM 3.5).

Yellow Springs Creek

- Since 1983, macroinvertebrate assemblages have remained exceptional quality both upstream and downstream from the Yellow Springs WWTP. A mild and relatively minor enrichment effect was detected, however, downstream from the facility in 1993. Fish assemblages in Yellow Springs Creek have significantly improved since 1983. During the 10 year period, fish assemblages have improved from fair to exceptional quality downstream from the WWTP.

Oldtown Creek

- Biological sampling in the lower reach of Oldtown Creek during 1993 showed improved macroinvertebrate and fish assemblages. Macroinvertebrate sampling yielded 13 qualitative EPT taxa in 1993 compared to seven in 1983. The IBI value increased from 45 to 56 (*i.e.,* good to exceptional quality) near the mouth (RM 0.1).

Massies Creek

- The 1993 biological results from Massies Creek were similar to the 1983 results. Ten qualitative EPT taxa were collected in 1983 compared to nine in 1993. The 1993 MIwb and IBI scores were slightly higher than in 1983 (8.8 increased to 9.0 and 45 increased to 46, respectively).

Beaver Creek

- Since 1983, the aquatic life use attainment status in Beaver Creek has shown no significant change downstream from Little Beaver Creek or the Greene County Beaver Creek WWTP. The length of stream in PARTIAL attainment of WWH has remained at 0.4 miles. The number of qualitative EPT taxa upstream and downstream from the Greene County Beaver Creek WWTP has remained similar since 1983 with a decline from very good (EPT=13) upstream to fair (EPT=4) downstream. The IBI has also shown little change at RMs 0.5 or 0.3 since 1983. The MIwb has increased upstream from the Beaver Creek WWTP (7.7 to 8.7 at RM 0.5), but decreased downstream from the facility (from 8.6 to 7.9 at RM 0.2 - 0.3). The mean number of fish species collected, however, has increased at both locations (15.5 to 20.5 species at RM 0.5 and 15.0 to 16.5 species at RMs 0.2 -0.3).

Little Beaver Creek

- The WWH aquatic life use attainment status in Little Beaver Creek has slightly improved since 1982. The number of miles in NON attainment has decreased from 4.2 to 2.1 while the number of miles in PARTIAL attainment has increased from 0.0 to 0.7 in 1993. Macroinvertebrate communities in Little Beaver Creek have improved since 1982, but remain severely to moderately degraded between the Montgomery County Eastern Regional WWTP discharge and the mouth. The number of fish species collected in 1993 was only slightly higher upstream from the WWTP (6.0 species at RM 5.0 in 1982, 8.5 species at RM 4.7 in 1993), but markedly higher near the mouth (1.0 species at RM 0.2 in 1982, 15.0 species at RM 0.1 in 1993). The 1993 IBI values, however, improved only slightly from 28 at RM 4.7 to 33 at RMs 2.1 and 0.1. Narratively, fish assemblages were only fair quality at the mouth. Little Beaver Creek has also been recently affected by spills and fish kills.

Glady Run

- Since 1983, the macroinvertebrate communities in Glady Run have remained similar with a fair community present downstream from the Xenia-Glady Run WWTP (RM 4.1) and a slightly better assemblage farther downstream (RM 0.6). Macroinvertebrates remained impacted near the mouth in 1993. The sampling location near the mouth of Glady Run (RM 0.3), however, was the only location in the tributary with a good fish community. Fish assemblages have also remained similar upstream from the Glady Run WWTP, but have improved downstream from the WWTP near the mouth. The mean number of fish species collected at RM 0.3 has increased from 7.3 in 1983 to 16.0 in 1993.

Newman Run

- The macroinvertebrate community in Newman Run was limited by intermittent flow conditions in 1983 and 1993. A total of five (5) qualitative EPT which slightly deviates from the expected range for a good community was collected both years. The fish community was sampled only once in 1993 due to severe drought conditions. The IBI scored a 54 (exceptional) in 1993 compared to a 47 (very good) in 1983 using a backpack shocker. The mean number of fish species collected in 1993 (15), however, was slightly lower than in 1983 (18).

Anderson Fork

- Since 1984, the fish community in Anderson Fork has remained exceptional. MIwb and IBI scores, respectively, were 10.0 and 51 in 1984 and a 10.0 and 54 in 1993.

Caesar Creek

- Since 1983, the number of EPT taxa (8) collected in Caesar Creek near the mouth (RM 0.1) has remained similar. This lower than expected number may be due to fluctuating flow releases from the reservoir. MIwb and IBI scores near the mouth, however, were higher in 1993 than in 1983 (respectively, a 7.9 and 46 in 1983 and a 8.7 and 50 in 1993), suggesting an improved fish community. Although Caesar Creek was not sampled upstream from the reservoir prior to 1993, the 1993 quality of macroinvertebrate and fish assemblages in Caesar Creek from upstream to downstream from the reservoir, respectively, declined from very good to fair and very good/exceptional to exceptional/good (Table 11-12).

Dry Run

- Similar to 1983, the macroinvertebrate community in Dry Run (RM 1.8) in 1993 was also limited by intermittent flow conditions. The 1993 community contained a slightly lower than expected number of qualitative EPT taxa (4). A decrease in IBI values from a 40 in 1983 to a 34 in 1993 is indicative of a moderately severe impact to the headwater fish community at the reference location (RM 1.8). The quality of physical habitat appears to have been impacted possibly by excessive sedimentation. The QHEI score decreased from 67.0 in 1983 to 54.5 in 1993. Drought conditions may have also impacted aquatic communities in 1993.

Turtle Creek

- From 1983 to 1993, the number of miles in FULL attainment of the WWH aquatic life use designation has increased from 1.6 to 5.9 miles (Table 13). The number of miles in **NON** attainment has decreased from 4.0 in 1983 to 0.0 in 1993. More recent monitoring, however, shows that the current attainment status downstream from Cincinnati Milacron has decreased from FULL in 1992 to PARTIAL in 1993.

- Macroinvertebrate communities in the upper reach of Turtle Creek have significantly improved since the Lebanon WWTP relocated to the Little Miami River in 1987 (Figure 99). Sampling stations upstream (RM 0.6) and downstream (RM 0.5) from Cincinnati Milacron have been sampled six (6) times from 1983 to 1993 (Figure 100). Communities have generally improved from 1983 to 1989, but subsequently declined to the fair range. This declining trend has occurred both upstream and downstream from the industrial discharge and may be due to a reduction in flow caused by some unknown source. There may also be an unknown intermittent source of turbid water discharged into the stream between Glosser Road (RM 6.3) and the next upstream bridge (West Road).

- MIwb and IBI values have also improved throughout Turtle Creek since 1983 (Figure 105-106). Both fish community indices longitudinally increase to their highest values at RM 0.6 then decline downstream from Cincinnati Milacron (RM 0.4). MIwb and IBI values increased the most between 1982 and 1989, but have subsequently shown a general declining trend. Since 1983, the mean incidence of DELT anomalies has decreased from 4.8 to 0.1% near the mouth (RM 0.1) and from 0.9 to 0.2% at McClure Road (RM 4.7), but increased slightly at Glosser Road (RM 6.3, 0.1 to 0.4%) and at Mason Road (RM 0.6, 0.4 to 0.7%). No DELT anomalies were observed immediately downstream from Cincinnati Milacron (RM 0.5 - 0.4) during the 1983 or 1993 surveys.

Muddy Creek

- Macroinvertebrate communities in Muddy Creek downstream from the Mason WWTP (RM 2.5) have improved since 1981-1983 when they were evaluated as fair (EPT=5) due to organic loadings from the WWTP. Since 1989, the macroinvertebrate assemblage at RM 2.5 has been in the marginally good to good range (ICI=28, EPT=8 in 1989; ICI=32, EPT=12 in 1991). The communities, however, were stressed by organic enrichment (*i.e.*, ICI metrics for other diptera/non-insects and for tolerant taxa strongly deviated from the expected range for a good community in 1989 and 1991). The ICI in 1993 continued to increase due to a reduction in the percentage of tolerant taxa (9.1% compared to 40.0% in 1991), but a decrease in the number of qualitative EPT from 12 in 1991 to four (4) suggests a decline in water quality. The fish community in Muddy Creek at RM 1.6 has shown considerable improvement since 1981. The IBI has increased from 15 to 46.

Sycamore Creek

- Since 1983, the aquatic life use attainment status in the lower half mile of Sycamore Creek has shown only a slight improvement downstream from Hamilton Co. MSD Sycamore Creek WWTP. The number of miles in PARTIAL attainment of WWH has increased from 0.0 to 0.3 while the number of poor to very poor miles have decreased from 0.6 to 0.1 miles.

- The macroinvertebrate community downstream from the Hamilton County Sycamore Creek WWTP (RM 0.1) has improved from poor quality in 1983 to fair to good quality in 1993. The community upstream (RM 0.6) from the WWTP was evaluated as fair (EPT=4) in 1983 and in 1993. The number of qualitative EPT taxa, however, increased slightly to seven in 1993, suggesting a slight improvement. Community degradation from sewage overflows and sewer line construction (Ohio EPA 1992) remain the primary factors for not attaining the biocriterion for WWH upstream from the WWTP. The fish assemblage downstream from the Sycamore Creek WWTP has shown considerable improvement since 1983. MIwb and IBI scores, respectively, at RM 0.2 increased from a 5.2 and 26 in 1983 to 7.7 and 38 in 1993. MIwb and IBI values upstream from the WWTP (RM 0.4), however, have shown little change scoring a 6.9 and 27 in 1983 and 6.6 and 34 in 1993. Streams within the Sycamore Creek basin contain gravity fed sewer lines and have been impacted by instream channel modifications, urban runoff, and sewer overflows (OEPA 1992b). Sewerline improvements have been recently made by the Hamilton Co. MSD to reduce infiltration into the sewers during high flows which caused frequent overflows.

Stonelick Creek

- Since 1984, the macroinvertebrate community at RM 1.0 has remained good quality with an ICI score of 36. Fish communities in the headwaters of Stonelick Creek (RM 20.0) have remained impacted (*i.e.*, fair quality and [NON] attainment) since 1982 due presumably to nonpoint sources. The IBI scored a 28 at RM 19.0 in 1982 and a 30 at RM 20.0 in 1993. MIwb and IBI scores downstream from the lake have decreased at RM 3.1 which scored a 10.4 and 54, respectively, in 1987 and a 8.8 and a 45 in 1993, but increased at RM 1.2 from a 8.4 and 43 in 1982 and a 7.9 and 41 in 1984 to a 10.4 and 49 in 1993.

East Fork Little Miami River

- The 1993 results show the aquatic life attainment status within the East Fork has deteriorated since 1982 due primarily to lower IBI scores (Table 3). The number of miles in FULL attainment of EWH has decreased from 10.0 in 1982 to 7.1 in 1993, while the number of miles in PARTIAL attainment increased from 4.8 to 7.8 (Table 13). Since 1982, the use attainment status in commonly sampled segments upstream and downstream from Batavia have improved from PARTIAL to FULL (RM 15.5 - 12.7); the reach downstream from the Clermont County Middle East Fork WWTP to Stonelick Creek has remained FULL (RM 12.4-9.1); the site at Perintown has decreased from FULL to PARTIAL (RM 6.7-6.6); downstream from the Clermont Co. Lower E.F. WWTP has improved from PARTIAL to FULL, but also shown evidence of more impact (RM 4.7-4.1); the segment upstream from the Milford WWTP has remained PARTIAL (RM 2.4-

1.7); and the segment downstream from the Milford WWTP has decreased from FULL to PARTIAL (RM 1.4-0.8).

- Macroinvertebrate communities in the East Fork Little Miami River downstream from East Fork Lake have remained very good to exceptional quality since 1982, but exhibited signs of both improvement and impact (Figure 99). Compared to the 1982 values, the 1993 ICI scores have increased in four segments, but decreased in three segments (mean increase of +1.8 units; range -6 to +8, Table 3). The largest ICI decreases occurred from Perintown to downstream from the Lower East Fork WWTP (RMs 6.7-4.7).

- Compared to the 1982 values, the 1993 IBI values have declined in four segments and increased in three segments (mean decrease of -1.4 units; range -5 to +7, Table 3). IBI values were slightly lower at RM 15.5, higher downstream from the Batavia WWTP, similar downstream from the Middle and Lower East Fork WWTPs, but lower than in 1982 at the other four locations. Since 1982, the MIwb values have increased in six segments and decreased in only one segment (mean increase of +0.7 units; range -0.2 to +1.9, Table 3). MIwb scores were slightly higher upstream from Batavia, considerably higher downstream from the Batavia and Middle East Fork WWTPs, similar in Perintown and downstream from the Lower East Fork WWTP, and slightly higher upstream and downstream from the Milford WWTP. The mean relative number of the three most common game fish in the lower 13 miles of the East Fork declined from 59 per km in 1982 to 26 per km in 1993.

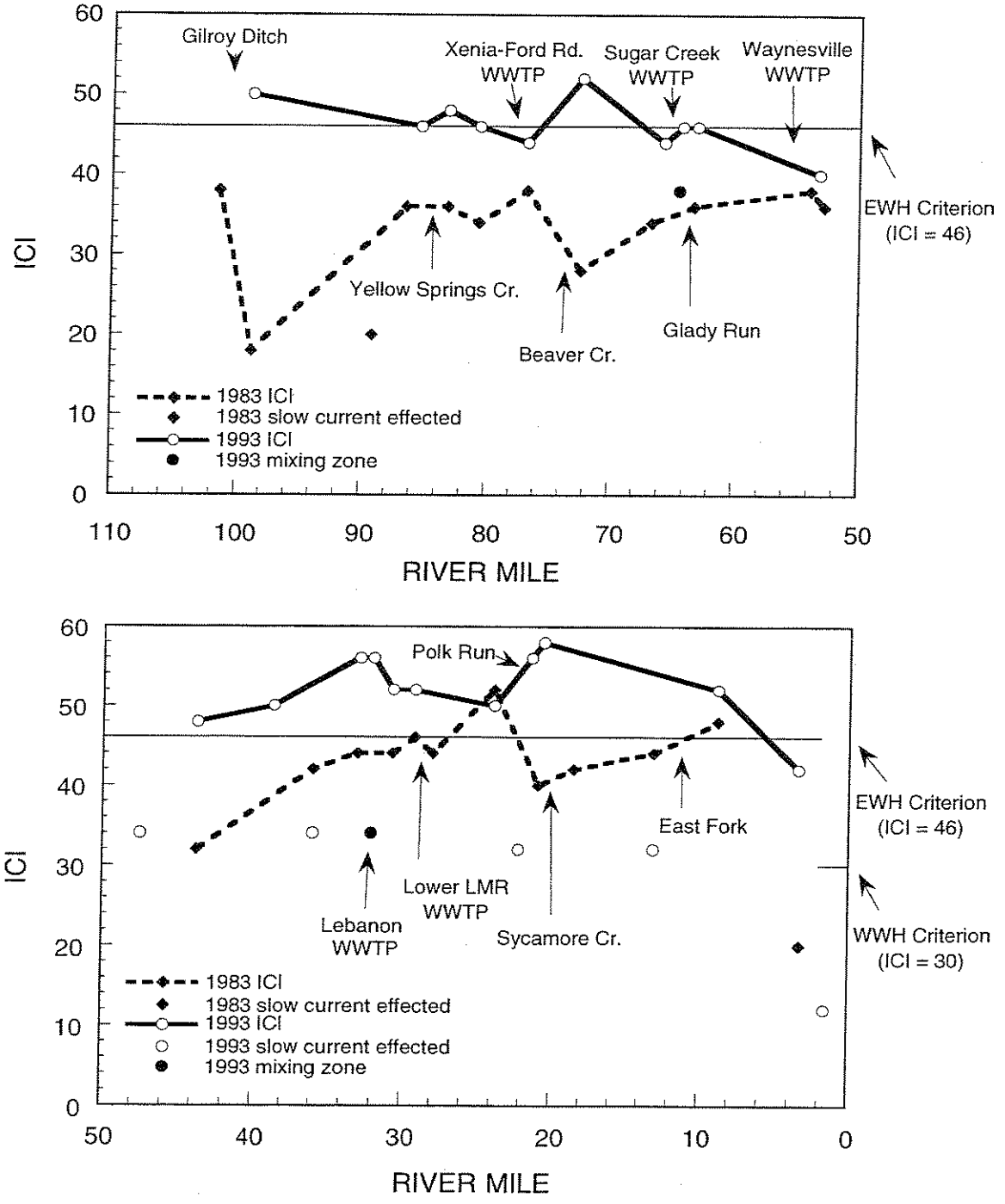


Figure 97. Longitudinal trend of the Invertebrate Community Index (ICI) from 1983 to 1993 in the upper half (Top Graph) and lower half (Bottom Graph) of the Little Miami River.

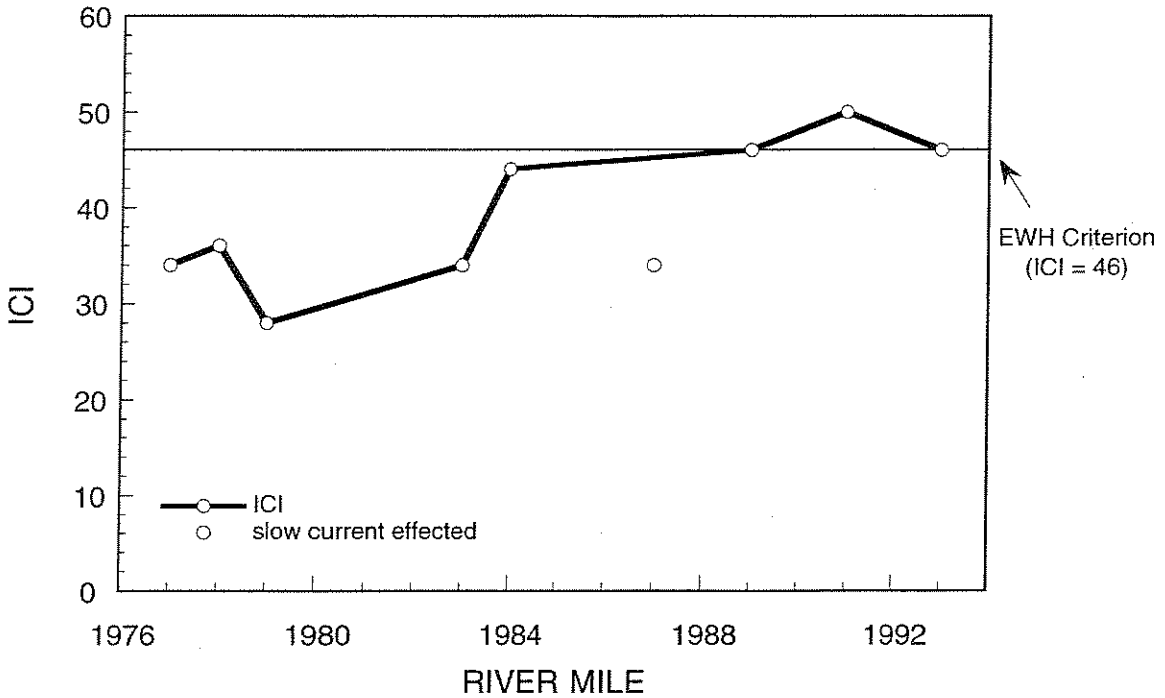


Figure 98. Historical trend of the Invertebrate Community Index (ICI) from 1977 to 1993 in the upper Little Miami River at Oldtown (RM 80.0, 80.6).

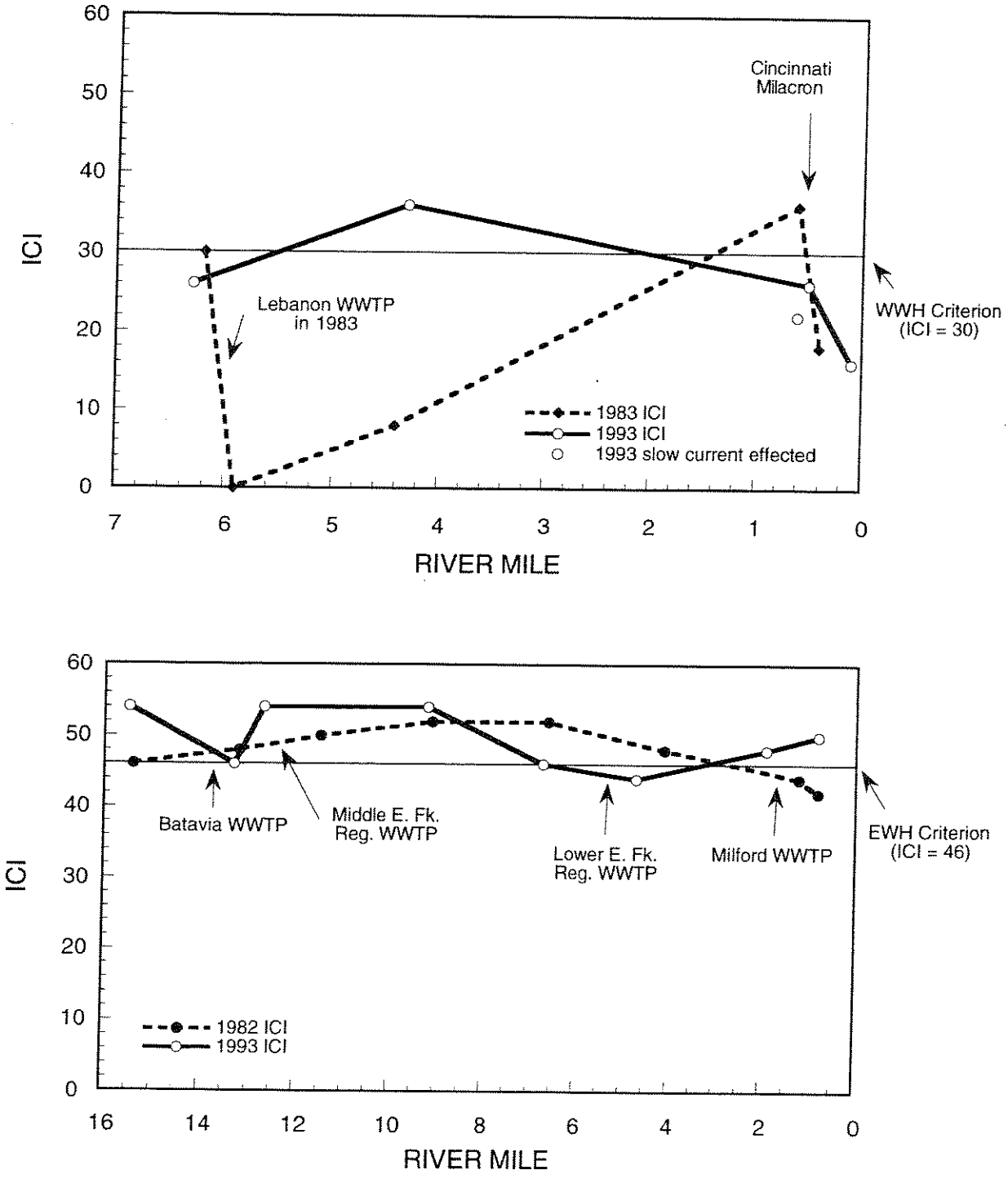


Figure 99. Longitudinal trend of the Invertebrate Community Index (ICI) from 1983 to 1993 in Turtle Creek (Upper Graph) and from 1982 to 1993 in the East Fork Little Miami River (Bottom Graph).

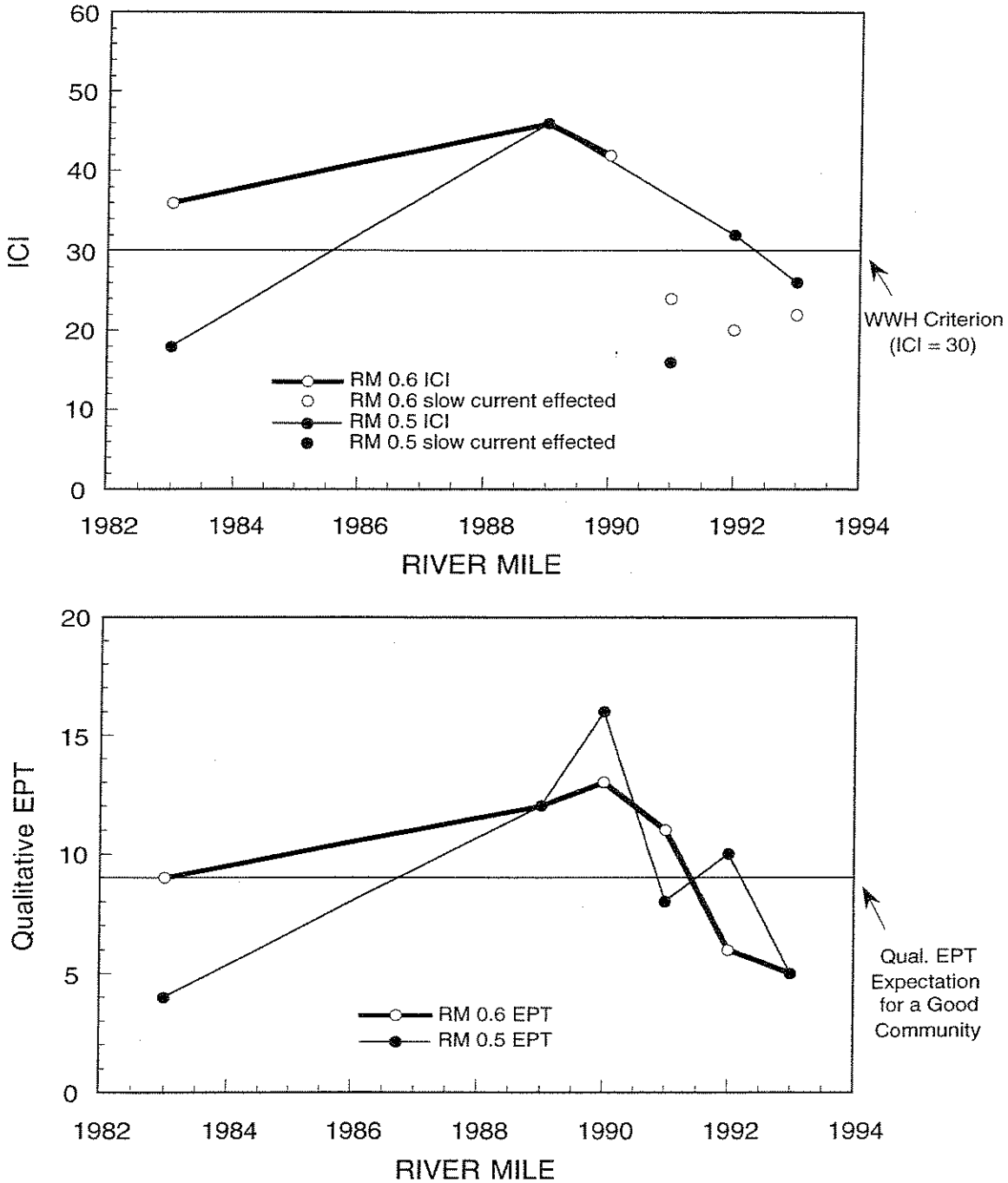


Figure 100. Historical trend of the Invertebrate Community Index (ICI; Top Graph) and qualitative number of mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa (EPT; Bottom Graph) from 1983 to 1993 in Turtle Creek upstream (RM 0.6) and downstream (RM 0.5) from Cincinnati Milacron.

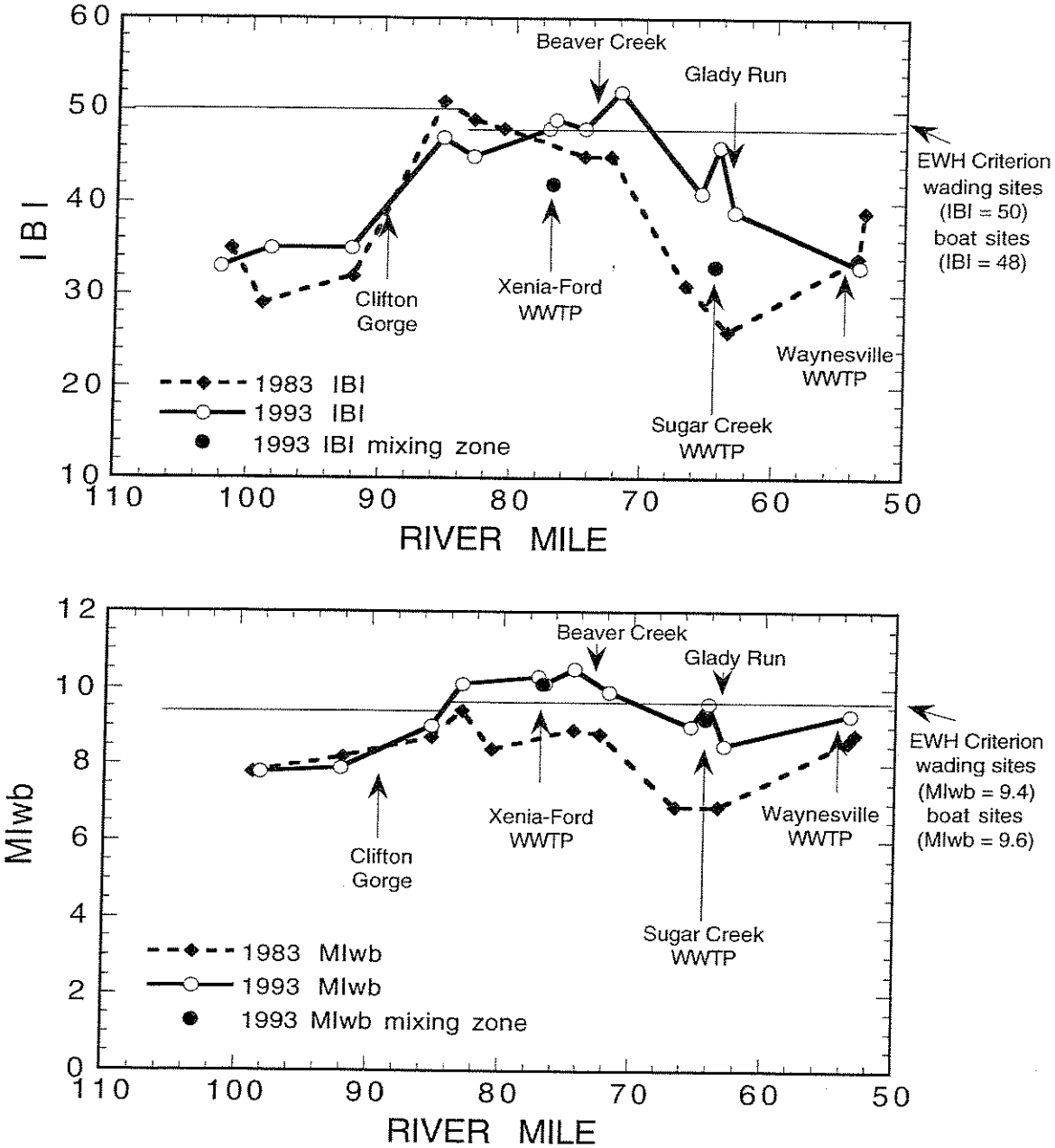


Figure 101. Longitudinal trends of the Index of Biotic Integrity (IBI; Top Graph) and the Modified Index of Well-Being (MIwb; Bottom Graph) in the upper half of the Little Miami River during 1983 and 1993.

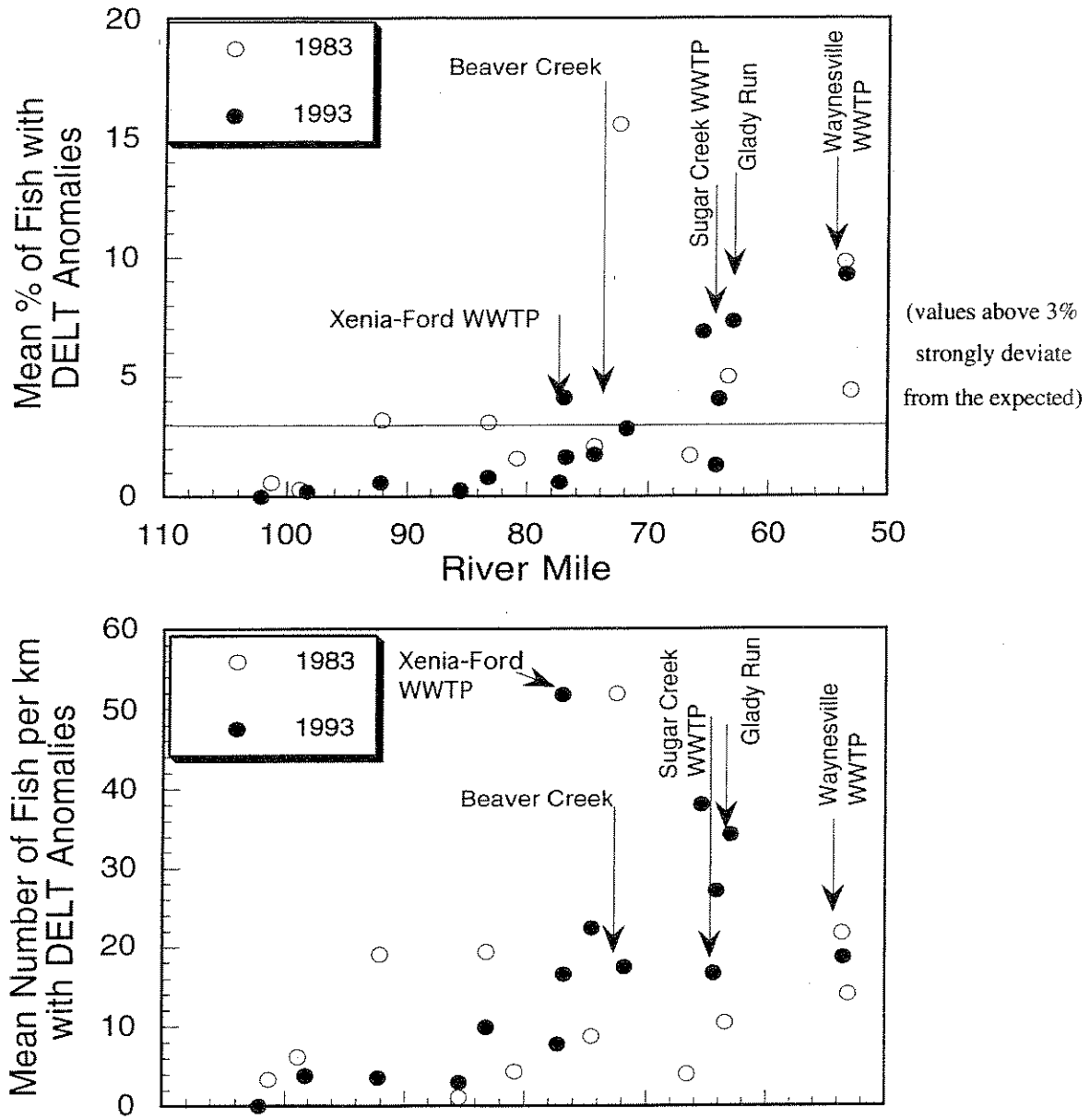


Figure 102. Longitudinal scatter plots of the mean percent (Top Graph) and number per kilometer (Bottom Graph) of fish with external DELT anomalies in the upper half of the Little Miami River during 1983 and 1993.

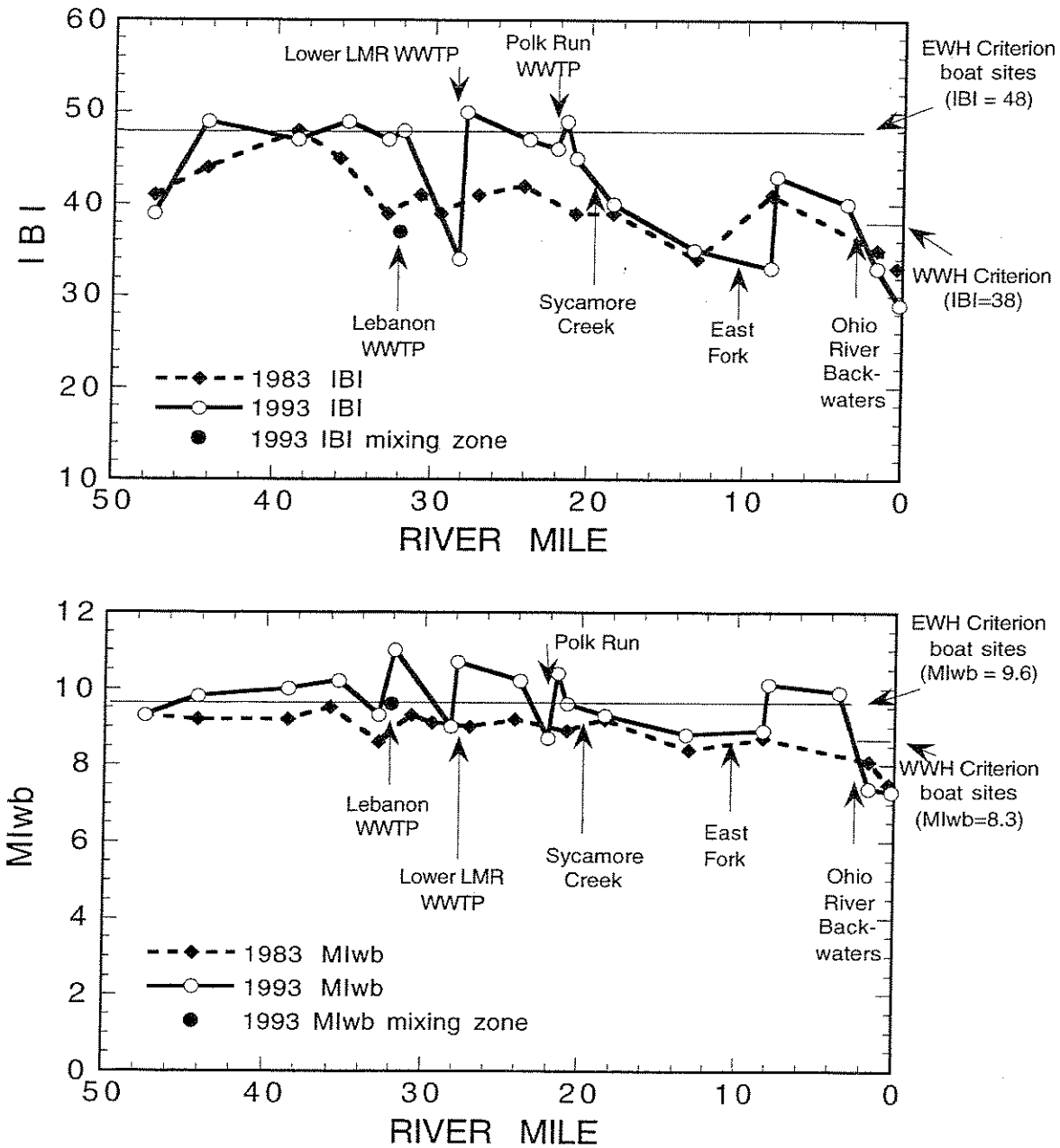


Figure 103. Longitudinal trends of the Index of Biotic Integrity (IBI; Top Graph) and the Modified Index of Well-Being (MIwb;Bottom Graph) in the lower half of the Little Miami River during 1983 and 1993.

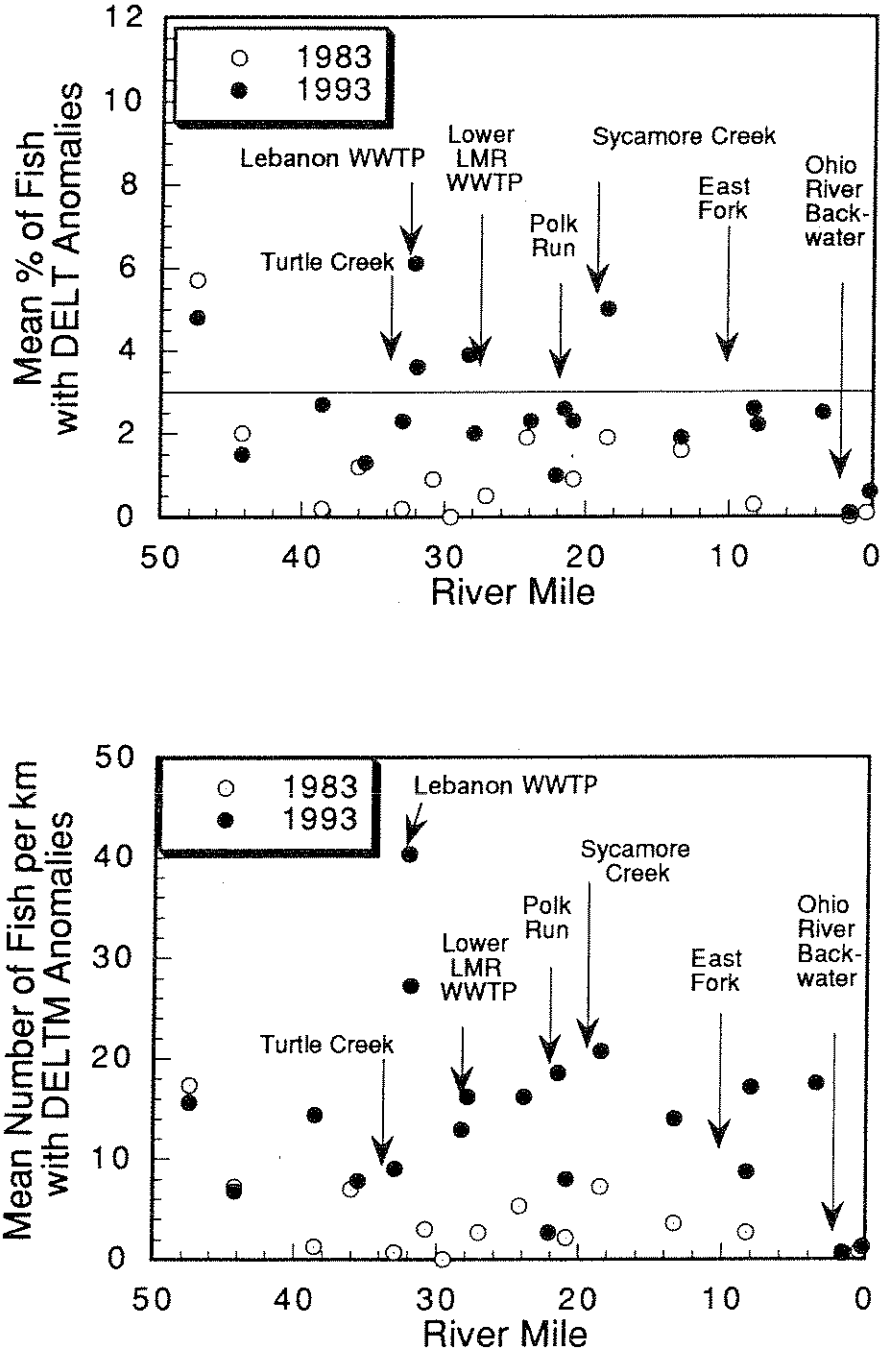


Figure 104. Longitudinal scatter plots of the mean percentage (Top Graph) and number per km (Bottom Graph) of fish with external DELT anomalies in the lower half of the Little Miami River during 1983 and 1993.

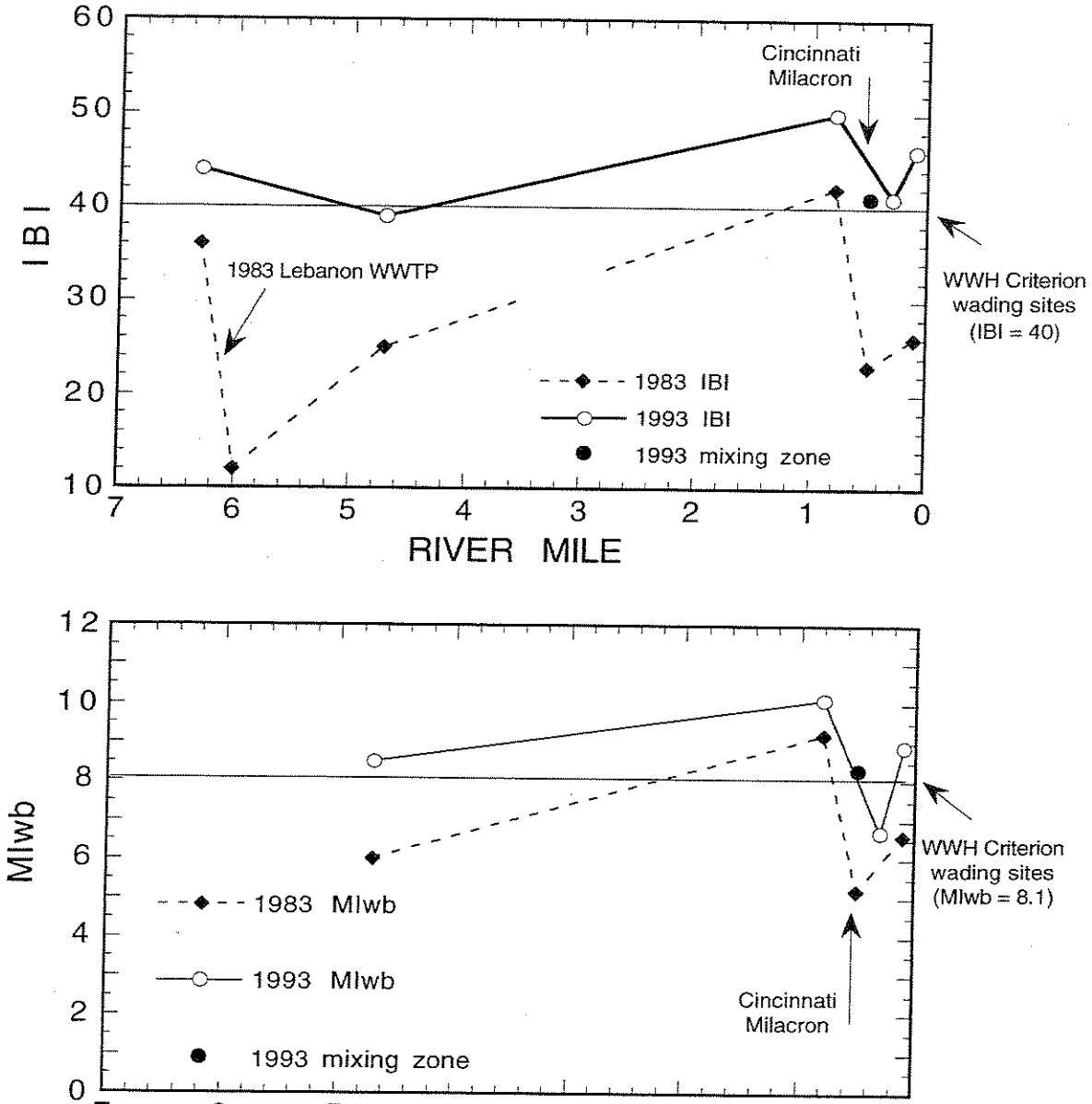


Figure 105. Longitudinal trends of the Index of Biotic Integrity (IBI; Top Graph) and the Modified Index of Well-Being (MIwb; Bottom Graph) in Turtle Creek during 1983 and 1993.

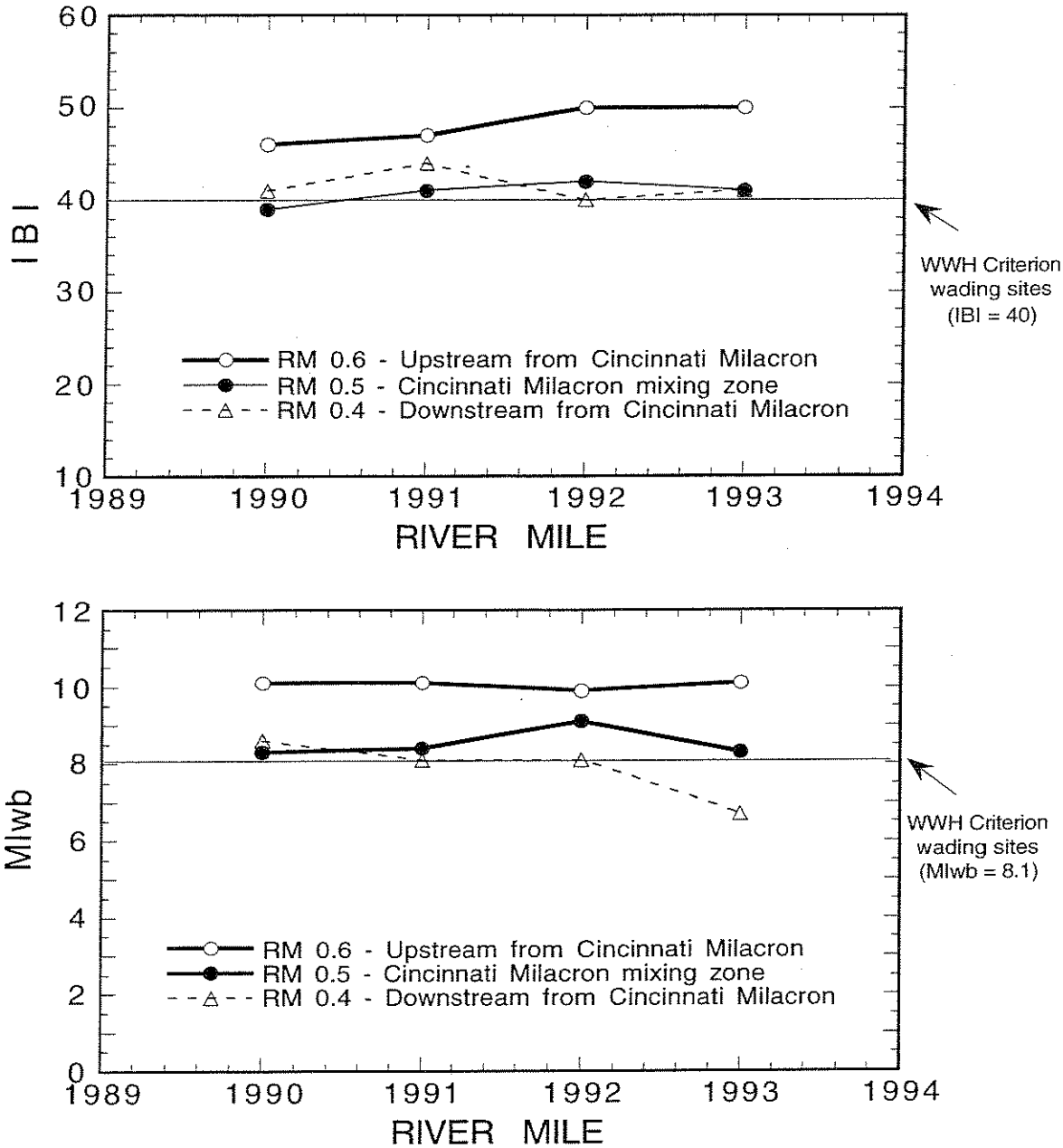


Figure 106. Temporal trends of the Index of Biotic Integrity (IBI; Top Graph) and the Modified Index of Well-Being (MIwb; Bottom Graph) in Turtle Creek from 1990 to 1993.

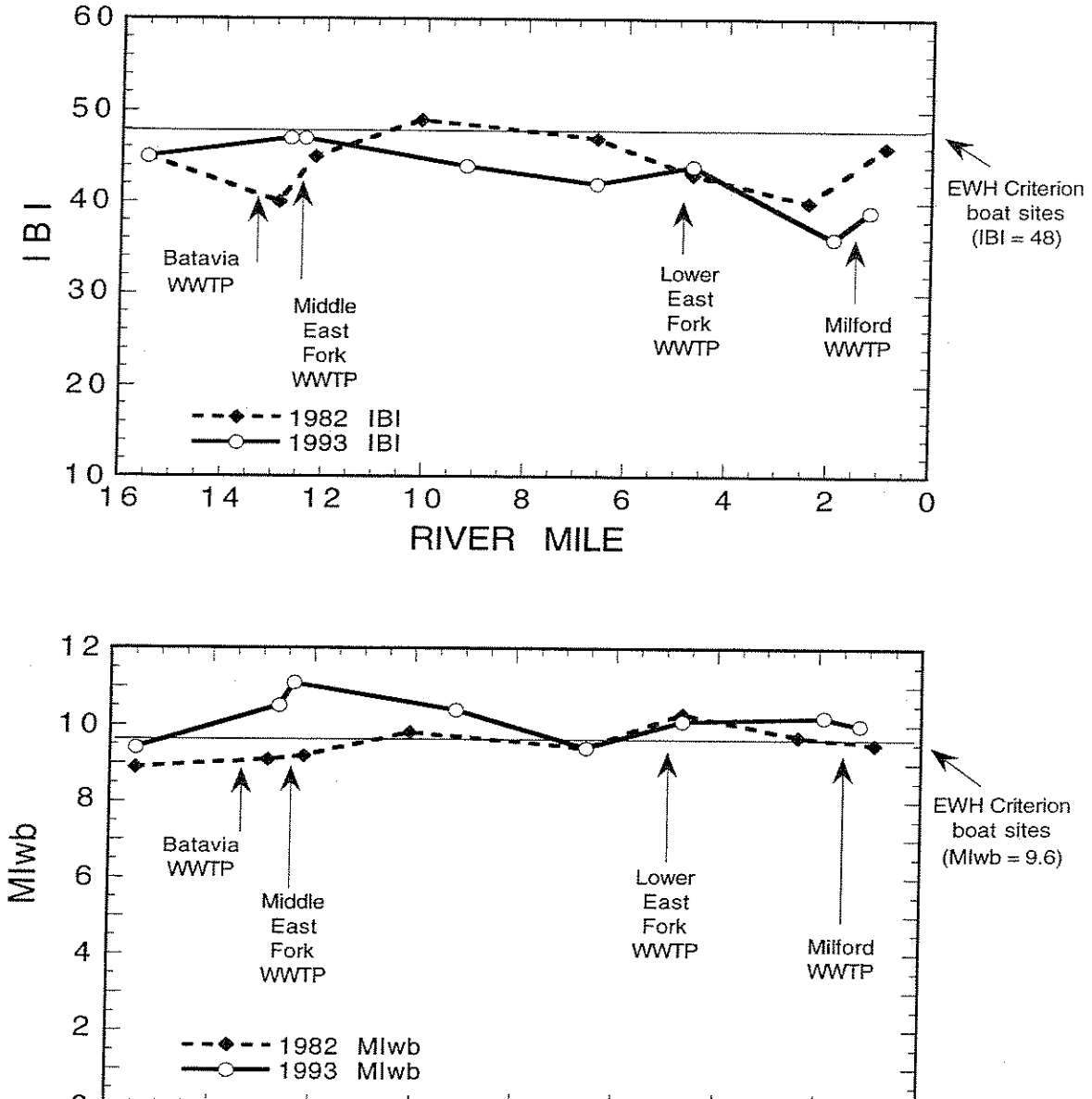


Figure 107. Longitudinal trends of the Index of Biotic Integrity (IBI; Top Graph) and the Modified Index of Well-Being (MIwb; Bottom Graph) in the East Fork of the Little Miami River during 1982 and 1993.

Table 13. Comparison of Area of Degradation (ADV) statistics for the Little Miami River mainstem and selected tributaries in the study area originally sampled in 1982-83 and resampled in 1993 (calculated using the ecoregion biocriterion as the background community performance).

Stream Index	Upper RM	Lower RM	Mini-mum	Maxi-mum	ADV	**ADV/ Mile**	P-VP ADV	Miles FULL	Miles PARTIAL	Miles NON	Miles Poor-VP
Upper Little Miami River (1993)											
IBI			33	52	2412	**46.3**	0				
MIwb	102.1	50.0	7.8	10.5	320	**6.1**	0	19.5	32.6	0.0	0.0
ICI			40	52	44	**0.8**	0				
Lower Little Miami River (1993)											
IBI			29	50	1632	**32.6**	0				
MIwb	50.0	0.0	7.3	11.0	255	**5.1**	0	21.4	25.6	3.0	0.3
ICI			12	58	743	**14.9**	0				
Upper Little Miami River (1983)											
IBI			26	51	4083	**84.7**	0				
MIwb	101.4	50.0	6.9	9.4	2085	**45.5**	0	0.0	15.5	35.9	0.0
ICI			18	38	568	**116.9**	0				
Lower Little Miami River (1983)											
IBI			33	48	1949	**39.0**	0				
MIwb	50.0	0.0	7.5	9.5	625	**12.5**	0	1.5	39.0	9.5	0.0
ICI			20	52	1069	**21.4**	0				
Beaver Creek (1993)											
IBI			32	37	12	**60.0**	0				
MIwb	0.5	0.3	7.9	8.7	0	**0**	0	0.0	0.4	0.0	0.0
ICI			48	48	0	**0**	0				
Beaver Creek (1983)											
IBI			31	33	18	**60.0**	0				
MIwb	0.5	0.2	7.7	8.6	0	**0**	0	0.0	0.4	0.0	0.0
ICI			30	42	2	**6.7**	0				
Little Beaver Creek (1993)											
IBI			12	33	359	**78.0**	39				
MIwb	4.7	0.1	7.0	7.0	30	**300.0**	0	0.0	0.7	4.3	2.1
ICI			2	40	619	**134.6**	73				
Little Beaver Creek (1982)											
IBI			12	33	795	**165.6**	371				
MIwb	5.0	0.1	12.0	0.0	-	-	-	0.0	0.0	5.0	4.2
ICI			0	30	1240	**253.1**	330				

Table 13. Continued.

Stream Index	Upper RM	Lower RM	Mini-mum	Maxi-mum	ADV	**ADV/ Mile**	P-VP ADV	Miles FULL	Miles PARTIAL	Miles NON	Miles Poor-VP
Turtle Creek (1993)											
IBI			39	50	0	**0**	0				
MIwb	6.3	0.1	6.7	10.1	5	**1.1**	0	5.9	0.4	0.0	0.0
ICI			16	36	47	**7.6**	0				
Turtle Creek (1983)											
IBI			12	42	470	**75.8**	145				
MIwb	6.3	0.1	5.2	9.2	165	**35.9**	1	1.6	0.7	4.0	2.9
ICI			0	36	625	**102.5**	139				
Sycamore Creek (1993)											
IBI			12	38	30	**150.0**	15				
MIwb	0.5	0.1	0.0	7.7	5	**25.0**	0	0.0	0.3	0.3	0.1
ICI			20	32	10	**25.0**	0				
Sycamore Creek (1983)											
IBI			26	27	56	**186.7**	2				
MIwb	0.6	0.1	5.2	6.9	15	**50.0**	1	0.0	0.0	0.6	0.6
ICI			0	30	70	**140.0**	18				
East Fork Little Miami River (1993)											
IBI			36	47	221	**15.7**	0				
MIwb	15.5	0.8	9.3	11.1	0	**0**	0	7.1	7.8	0.0	0.0
ICI			44	54	0	**0**	0				
East Fork Little Miami River (1982)											
IBI			40	49	102	**6.9**	0				
MIwb	15.5	0.8	8.9	10.3	5	**0.3**	0	10.0	4.8	0.0	0.0
ICI			42	52	0	**0**	0				

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