TABLE 1 (revised 10/31/94)

RESERVOIR VITAL SIGNS MONITORING ACTIVITIES, 1994

Run-of-the-River Reservoirs
--Basic Monitoring Strategy--

Reservoir	Sampling Locations[a]	Description[b]	Reservoir Vital Signs Monitoring Tools: Water Quality[c]	Sediment Quality[d] Toxicity	Sediment Quality[d] Phy/Chem	Benthic Invertebrates[e]	Fish Community[f] Diversity/RFAI
Kentucky	TRM 23.0	FB	M	A	A	A	A
	TRM 85.0	TZ	M	A	A	A	A
	TRM 200-206	I	-	-	-	A	A
	Big Sandy 7.4	E	M	A	A	A	A
Pickwick	TRM 207.3	FB	M	A	A	A	A
	TRM 230.0	TZ	M	A	A	A	A
	TRM 253-259	I	-	-	-	A	A
	Bear Creek 8.4	E	M	A	A	A	A
Wilson	TRM 260.8	FB	M	A	A	A	A
	TRM 273-274	I	-	-	-	A	A
Wheeler	TRM 277.0	FB	M	A	A	A	A
	TRM 295.9	TZ	M	A	A	A	A
	TRM 347-348	I	-	-	-	A	A
	Elk River 6.0	E	M	A	A	A	A
Guntersville	TRM 350.0	FB	M	A	A	A	A
	TRM 375.2	TZ	M	A	A	A	A
	TRM 420-424	I	-	-	-	A	A
Nickajack	TRM 425.5	FB	M	A	A	A	A
	TRM 469-470	I	-	-	-	A	A
Chickamuaga	TRM 472.3	FB	M	A	A	A	A
	TRM 490.5	TZ	M	A	A	A	A
	TRM 518-529	I	-	-	-	A	A
	Hiwassee 8.5	E	M	A	A	A	A

TABLE 1 (Cont'd)

Run-of-the-River Reservoirs
--Basic Monitoring Strategy (continued)--

Reservoir	Sampling Locations[a]	Description[b]	Reservoir Vital Signs Monitoring Tools: Water Quality[c]	Sediment Quality[d] Toxicity	Sediment Quality[d] Phy/Chem	Benthic Invertebrates[e]	Fish Community[f] Diversity/RFAI
Watts Bar	TRM 531.0	FB	M	A	A	A	A
	TRM 560.8	TZ	M	A	A	A	A
	TRM 600-601	I	-	-	-	A	A
	CRM 19-22	I	-	-	-	A	A
Fort Loudoun	TRM 605.5	FB	M	A	A	A	A
	TRM 624.6	TZ	M	A	A	A	A
	TRM 652	I	-	-	-	A	A
Tellico	LTRM 1.0	FB	M	A	A	A	A
	LTRM 15.0	TZ	M	A	A	A	A
Melton Hill	CRM 24.0	FB	M	A	A	A	A
	CRM 45.0	TZ	M	A	A	A	A
	CRM 59-66	I	-	-	-	A	A
		Totals	24	24	24	35	35

TABLE 1 (Cont'd)

RESERVOIR VITAL SIGNS MONITORING ACTIVITIES, 1994

Tributary Storage Reservoirs
--Limited Monitoring Strategy--

			Reservoir Vital Signs Monitoring Tools				
				Sediment Quality[d]			
Reservoir	Sampling Locations[a]	Description[b]	Water Quality[c]	Toxicity	Phy/Chem	Benthic Invertebrates[e]	Fish Community[f] Diversity/RFAI
Norris	CRM 80.0	FB	M	A	A	A	A
	CRM 125.0	MR	M	A	A	A	A
	PRM 30.0	MR	M	A	A	A	A
Cherokee	HRM 53.0	FB	M	A	A	A	A
	HRM 76.0	MR	M	A	A	-	A
	HRM 91	I	-	-	-	A	-
Douglas	FBRM 33.0	FB	M	A	A	A	A
	FBRM 51.0	MR	M	A	A	A	A
	FBRM 61	I	-	-	-	-	-
Ft.Pat Henry	SFHR 8.7	FB	M	A	A	A	A
Boone	SFHR 19.0	FB	M	A	A	A	A
	SFHR 27.0	MR	M	A	A	A	A
	WRM 6.5	MR	M	A	A	A	A
South Holston	SFHR 51.0	FB	M	A	A	A	A
	SFHR 62.5	MR/I	M	A	A	A	A
Watauga	WRM 37.4	FB	M	A	A	A	A
	WRM 45.5	MR	M	A	A	A	A
Fontana	LTRM 62.0	FB	M	A	A	-	A
	LTRM 81.5	MR	M	A	A	A	A
	TkRM 3.0	MR	M	A	A	A	A

TABLE 1 (Cont'd)

Tributary Storage Reservoirs
--Limited Monitoring Strategy (continued)--

Reservoir	Sampling Locations[a]	Description[b]	Reservoir Vital Signs Monitoring Tools				
			Water Quality[c]	Sediment Quality[d] Toxicity	Sediment Quality[d] Phy/Chem	Benthic Invertebrates[e]	Fish Community[f] Diversity/RFAI
Hiwassee	HiRM 77.0	FB	M	A	A	A	A
	HiRM 85.0	MR	M	A	A	A	A
	HiRM 90	I	-	-	-	A	-
Chatuge	HiRM 122.0	FB	M	A	A	A	A
	Shooting Cr 1.5	FB	M	A	A	A	A
Nottely	NRM 23.5	FB	M	A	A	A	A
	NRM 31.0	MR	M	A	A	A	A
Blue Ridge	ToRM 54.1	FB	M	A	A	A	A
Ocoee No.1	ORM 12.5	FB	M	A	A	A	A
Tims Ford	ERM 135.0	FB	M	A	A	A	A
	ERM 150.0	MR	M	A	A	A	A
Bear Creek	BCM 75.0	FB	M	A	A	A	A
L. Bear Creek	LBCM 12.5	FB	M	A	A	A	A
Cedar Creek	CCM 25.2	FB	M	A	A	A	A
Normandy	DRM 249.5	FB	M	A	A	A	A
Beech	BRM 36.0	FB	M	A	A	A	A
		Totals	33	33	33	32	33

Footnotes

a. BCM - Bear Creek Mile
CRM - Clinch River Mile
FBRM - French Broad River
LBCM - Little Bear Creek Mile
ORM - Ocoee River Mile
TRM - Tennessee River Mile
WRM - Watauga River Mile
BRM - Beech River Mile
DRM - Duck River Mile
HiRM - Hiwassee River Mile
LTRM - Little Tennessee River Mile
PRM - Powell River Mile
ToRM - Toccoa River Mile
PRM - Powell River Mile
CCM Cedar Creek Mile
ERM - Elk River Mile
HRM - Holston River Mile
NRM - Nottely River Mile
SFHR - So Fork Holston River Mile
TkRM - Tuckaseegee River Mile

b. FB - forebay; TZ - transition zone; MR - mid-reservoir; I - Inflow; and E - embayment. MR/I - Sampling location was referred to as an inflow location in the fish community evaluation (sampling done in autumn at lower reservoir water level elevations); and, as a mid-reservoir location in the evaluation of the water quality data (sampling done in summer at higher water level elevations).

c. --Basic Monitoring Strategy--
M - monthly water quality surveys (April through September). The surveys include: in situ water column measurements of temperature, dissolved oxygen, pH, and conductivity; Secchi depth measurements; surface fecal coliform and photic zone chlorophyll-a samples; and surface and near bottom water samples for nutrients (organic nitrogen, ammonia nitrogen, nitrate+nitrite nitrogen, phosphorus, and dissolved ortho phosphorus), total organic carbon, color, and suspended solids.
--Limited Monitoring Strategy--
M - monthly water quality surveys (April through October). The surveys include: in situ water column measurements of temperature, dissolved oxygen, pH, and conductivity; Secchi depth measurements; and, photic zone cholrophyll-a samples. Twice a year (April and August) surface water samples are collected for nutrients (organic nitrogen, ammonia nitrogen, nitrate+nitrite nitrogen, phosphorus, and dissolved ortho phosphorus), and total organic carbon. No samples are collected for fecal coliforms, color, and suspended solids.

d. A - annual summer samples of sediment pore water and bottom water are examined for acute toxicity (Rotifers and Ceriodaphnia). At the same time, the sediment is collected and analyzed for metals, total and volatile solids, particle size, and twenty-six trace organics (organochlorine pesticides and PCBs).

e. A - annual benthic invertebrate samples are collected, enumerated and identified to lowest practical taxon (genus or species) in the spring of year.

f. A - annual electroshocking and gill-netting techniques are used to evaluate the near shore fish community, during autumn.

Table 2. Scoring Criteria for Individual Metrics for Each Class of Reservoir

Reservoir Group	Reservoir Subgroup	STATION	METRIC	GEAR	ONE	THREE	FIVE
all	all	all	12. Percent anomalies	combined	< 0.02	0.02 - 0.05	> 0.05
BLUE RIDGE	all	forbay	1. Number of species	combined	< 8	8 - 15	> 15
BLUE RIDGE	all	forbay	2. Piscivore species	combined	< 3	3 - 5	> 5
BLUE RIDGE	all	forbay	3. Sunfish species	combined	< 2	2 - 3	> 3
BLUE RIDGE	all	forbay	4. Sucker species	combined	< 2	2 - 3	> 3
BLUE RIDGE	all	forbay	5. Intolerant species	combined	< 2	2 - 2	> 2
BLUE RIDGE	all	forbay	6. Percent tolerant species	Electrofishing	> .30	.15 - .30	< .15
BLUE RIDGE	all	forbay	6. Percent tolerant species	Gill netting	> .20	.10 - .20	< .10
BLUE RIDGE	all	forbay	7. Dominance(% composition of most abundant species)	Electrofishing	> 60	40 - 60	< 40
BLUE RIDGE	all	forbay	7. Dominance(% composition of most abundant species)	Gill netting	> 50	30 - 50	< 30
BLUE RIDGE	all	forbay	8. Percent omnivores	Electrofishing	> .10	.05 - .10	< .05
BLUE RIDGE	all	forbay	8. Percent omnivores	Gill netting	> .30	.15 - .30	< .15
BLUE RIDGE	all	forbay	9. Percent insectivores	Electrofishing	< .75	.75 - .85	> .85
BLUE RIDGE	all	forbay	9. Percent insectivores	Gill netting	< .03	.03 - .06	> .06
BLUE RIDGE	all	forbay	10. Lithophilic spawning species	combined	< 3	3 - 4	> 4
BLUE RIDGE	all	forbay	11. Average number of individuals	Electrofishing	< 30	30 - 60	> 60
BLUE RIDGE	all	forbay	11. Average number of individuals	Gill netting	< 10	10 - 18	> 18
BLUE RIDGE	all	transition	1. Number of species	combined	< 8	8 - 15	> 15
BLUE RIDGE	all	transition	2. Piscivore species	combined	< 3	3 - 5	> 5
BLUE RIDGE	all	transition	3. Sunfish species	combined	< 2	2 - 3	> 3
BLUE RIDGE	all	transition	4. Sucker species	combined	< 2	2 - 3	> 3
BLUE RIDGE	all	transition	5. Intolerant species	combined	< 2	2 - 2	> 2
BLUE RIDGE	all	transition	6. Percent tolerant species	Electrofishing	> .30	.15 - .30	< .15
BLUE RIDGE	all	transition	6. Percent tolerant species	Gill netting	> .20	.10 - .20	< .10
BLUE RIDGE	all	transition	7. Dominance(% composition of most abundant species)	Electrofishing	> 60	40 - 60	< 40
BLUE RIDGE	all	transition	7. Dominance(% composition of most abundant species)	Gill netting	> 50	30 - 50	< 30
BLUE RIDGE	all	transition	8. Percent omnivores	Electrofishing	> .10	.05 - .10	< .05
BLUE RIDGE	all	transition	8. Percent omnivores	Gill netting	> .30	.15 - .30	< .15
BLUE RIDGE	all	transition	9. Percent insectivores	Electrofishing	< .75	.75 - .85	> .85
BLUE RIDGE	all	transition	9. Percent insectivores	Gill netting	< .03	.03 - .06	> .06
BLUE RIDGE	all	transition	10. Lithophilic spawning species	combined	< 3	3 - 4	> 4
BLUE RIDGE	all	transition	11. Average number of individuals	Electrofishing	< 30	30 - 60	> 60
BLUE RIDGE	all	transition	11. Average number of individuals	Gill netting	< 10	10 - 18	> 18
INTER PLAT	BEAR SYS.	forbay	1. Number of species	combined	< 10	10 - 19	> 19
INTER PLAT	NORMANDY	forbay	1. Number of species	combined	< 8	8 - 17	> 17
INTER PLAT	TIMS FORD	forbay	1. Number of species	combined	< 10	10 - 20	> 20

Table 2 (Cont'd)

Reservoir Group	Reservoir Subgroup	STATION	METRIC	GEAR	ONE	THREE	FIVE
INTER PLAT	BEAR SYS.	forbay	2. Piscivore species	combined	< 3	3 - 6	> 6
INTER PLAT	NORMANDY	forbay	2. Piscivore species	combined	< 3	3 - 6	> 6
INTER PLAT	TIMS FORD	forbay	2. Piscivore species	combined	< 4	4 - 6	> 6
INTER PLAT	BEAR SYS.	forbay	3. Sunfish species	combined	< 2	2 - 3	> 3
INTER PLAT	NORMANDY	forbay	3. Sunfish species	combined	< 2	2 - 3	> 3
INTER PLAT	TIMS FORD	forbay	3. Sunfish species	combined	< 2	2 - 3	> 3
INTER PLAT	BEAR SYS.	forbay	4. Sucker species	combined	< 3	3 - 5	> 5
INTER PLAT	NORMANDY	forbay	4. Sucker species	combined	< 3	3 - 4	> 4
INTER PLAT	TIMS FORD	forbay	4. Sucker species	combined	< 4	4 - 6	> 6
INTER PLAT	BEAR SYS.	forbay	5. Intolerant species	combined	< 2	2 - 2	> 2
INTER PLAT	NORMANDY	forbay	5. Intolerant species	combined	< 2	2 - 2	> 2
INTER PLAT	TIMS FORD	forbay	5. Intolerant species	combined	< 2	2 - 2	> 2
INTER PLAT	all	forbay	6. Percent tolerant species	Electrofishing	> .30	.15 - .30	< .15
INTER PLAT	all	forbay	6. Percent tolerant species	Gill netting	> .35	.20 - .35	< .20
INTER PLAT	all	forbay	7. Dominance(% composition of most abundant species)	Electrofishing	> 60	40 - 60	< 40
INTER PLAT	all	forbay	7. Dominance(% composition of most abundant species)	Gill netting	> 50	30 - 50	< 30
INTER PLAT	all	forbay	8. Percent omnivores	Electrofishing	> .25	.10 - .25	< .10
INTER PLAT	all	forbay	8. Percent omnivores	Gill netting	> .60	.40 - .60	< .40
INTER PLAT	all	forbay	9. Percent insectivores	Electrofishing	< .60	.60 - .80	> .80
INTER PLAT	all	forbay	9. Percent insectivores	Gill netting	< .03	.03 - .06	> .06
INTER PLAT	BEAR SYS.	forbay	10. Lithophilic spawning species	combined	< 3	3 - 6	> 6
INTER PLAT	NORMANDY	forbay	10. Lithophilic spawning species	combined	< 3	3 - 6	> 6
INTER PLAT	TIMS FORD	forbay	10. Lithophilic spawning species	combined	< 4	4 - 6	> 6
INTER PLAT	all	forbay	11. Average number of individuals	Electrofishing	< 40	40 - 80	> 80
INTER PLAT	all	forbay	11. Average number of individuals	Gill netting	< 10	10 - 18	> 18
INTER PLAT	NORMANDY	transition	1. Number of species	combined	< 8	8 - 17	> 17
INTER PLAT	TIMS FORD	transition	1. Number of species	combined	< 11	11 - 20	> 20
INTER PLAT	NORMANDY	transition	2. Piscivore species	combined	< 3	3 - 6	> 6
INTER PLAT	TIMS FORD	transition	2. Piscivore species	combined	< 4	4 - 6	> 6
INTER PLAT	NORMANDY	transition	3. Sunfish species	combined	< 2	2 - 3	> 3
INTER PLAT	TIMS FORD	transition	3. Sunfish species	combined	< 2	2 - 3	> 3
INTER PLAT	NORMANDY	transition	4. Sucker species	combined	< 2	2 - 2	> 2
INTER PLAT	TIMS FORD	transition	4. Sucker species	combined	< 4	4 - 6	> 6
INTER PLAT	NORMANDY	transition	5. Intolerant species	combined	< 2	2 - 2	> 2
INTER PLAT	TIMS FORD	transition	5. Intolerant species	combined	< 2	2 - 2	> 2
INTER PLAT	all	transition	6. Percent tolerant species	Electrofishing	> .30	.15 - .30	< .15

Table 2 (Cont'd)

Reservoir Group	Reservoir Subgroup	STATION	METRIC	GEAR	ONE	THREE	FIVE
INTER PLAT	all	transition	6. Percent tolerant species	Gill netting	> .35	.20 - .35	< .20
INTER PLAT	all	transition	7. Dominance(% composition of most abundant species)	Electrofishing	> 60	40 - 60	< 40
INTER PLAT	all	transition	7. Dominance(% composition of most abundant species)	Gill netting	> 50	30 - 50	< 30
INTER PLAT	all	transition	8. Percent omnivores	Electrofishing	> .25	.10 - .25	< .10
INTER PLAT	all	transition	8. Percent omnivores	Gill netting	> .60	.40 - .60	< .40
INTER PLAT	all	transition	9. Percent insectivores	Electrofishing	< .50	.50 - .70	> .70
INTER PLAT	all	transition	9. Percent insectivores	Gill netting	< .03	.03 - .06	> .06
INTER PLAT	NORMANDY	transition	10. Lithophilic spawning species	combined	< 3	3 - 6	> 6
INTER PLAT	TIMS FORD	transition	10. Lithophilic spawning species	combined	< 4	4 - 6	> 6
INTER PLAT	all	transition	11. Average number of individuals	Electrofishing	< 40	40 - 80	> 80
INTER PLAT	all	transition	11. Average number of individuals	Gill netting	< 10	10 - 18	> 18
MAINSTREAM	LOWER MS	forbay	1. Number of species	combined	< 14	14 - 27	> 27
MAINSTREAM	MELTON H	forbay	1. Number of species	combined	< 13	13 - 24	> 24
MAINSTREAM	TELLICO	forbay	1. Number of species	combined	< 13	13 - 24	> 24
MAINSTREAM	UPPER MS	forbay	1. Number of species	combined	< 14	14 - 27	> 27
MAINSTREAM	LOWER MS	forbay	2. Piscivore species	combined	< 4	4 - 7	> 7
MAINSTREAM	MELTON H	forbay	2. Piscivore species	combined	< 4	4 - 7	> 7
MAINSTREAM	TELLICO	forbay	2. Piscivore species	combined	< 4	4 - 7	> 7
MAINSTREAM	UPPER MS	forbay	2. Piscivore species	combined	< 4	4 - 7	> 7
MAINSTREAM	LOWER MS	forbay	3. Sunfish species	combined	< 2	2 - 3	> 3
MAINSTREAM	MELTON H	forbay	3. Sunfish species	combined	< 2	2 - 4	> 4
MAINSTREAM	TELLICO	forbay	3. Sunfish species	combined	< 2	2 - 4	> 4
MAINSTREAM	UPPER MS	forbay	3. Sunfish species	combined	< 2	2 - 4	> 4
MAINSTREAM	LOWER MS	forbay	4. Sucker species	combined	< 4	4 - 6	> 6
MAINSTREAM	MELTON H	forbay	4. Sucker species	combined	< 4	4 - 6	> 6
MAINSTREAM	TELLICO	forbay	4. Sucker species	combined	< 4	4 - 6	> 6
MAINSTREAM	UPPER MS	forbay	4. Sucker species	combined	< 4	4 - 7	> 7
MAINSTREAM	LOWER MS	forbay	5. Intolerant species	combined	< 2	2 - 4	> 4
MAINSTREAM	MELTON H	forbay	5. Intolerant species	combined	< 2	2 - 3	> 3
MAINSTREAM	TELLICO	forbay	5. Intolerant species	combined	< 2	2 - 3	> 3
MAINSTREAM	UPPER MS	forbay	5. Intolerant species	combined	< 2	2 - 4	> 4
MAINSTREAM	all	forbay	6. Percent tolerant species	Electrofishing	> .45	.20 - .45	< .20
MAINSTREAM	all	forbay	6. Percent tolerant species	Gill netting	> .40	.20 - .40	< .20
MAINSTREAM	all	forbay	7. Dominance(% composition of most abundant species)	Electrofishing	> 60	40 - 60	< 40
MAINSTREAM	all	forbay	7. Dominance(% composition of most abundant species)	Gill netting	> 50	30 - 50	< 30
MAINSTREAM	all	forbay	8. Percent omnivores	Electrofishing	> .45	.20 - .45	< .20

Table 2 (Cont'd)

Reservoir Group	Reservoir Subgroup	STATION	METRIC	GEAR	ONE	THREE	FIVE
MAINSTREAM	all	forbay	8. Percent omnivores	Gill netting	> .45	.30 - .45	< .30
MAINSTREAM	all	forbay	9. Percent insectivores	Electrofishing	< .35	.35 - .70	> .70
MAINSTREAM	all	forbay	9. Percent insectivores	Gill netting	< .05	.05 - .15	> .15
MAINSTREAM	LOWER MS	forbay	10. Lithophilic spawning species	combined	< 4	4 - 6	> 6
MAINSTREAM	MELTON H	forbay	10. Lithophilic spawning species	combined	< 4	4 - 7	> 7
MAINSTREAM	TELLICO	forbay	10. Lithophilic spawning species	combined	< 4	4 - 7	> 7
MAINSTREAM	UPPER MS	forbay	10. Lithophilic spawning species	combined	< 3	3 - 6	> 6
MAINSTREAM	all	forbay	11. Average number of individuals	Electrofishing	< 50	50 - 100	> 100
MAINSTREAM	all	forbay	11. Average number of individuals	Gill netting	< 15	15 - 35	> 35
MAINSTREAM	LOWER MS	inflow	1. Number of species	combined	< 14	14 - 27	> 27
MAINSTREAM	MELTON H	inflow	1. Number of species	combined	< 13	13 - 24	> 24
MAINSTREAM	UPPER MS	inflow	1. Number of species	combined	< 14	14 - 27	> 27
MAINSTREAM	LOWER MS	inflow	2. Piscivore species	combined	< 4	4 - 7	> 7
MAINSTREAM	MELTON H	inflow	2. Piscivore species	combined	< 4	4 - 7	> 7
MAINSTREAM	UPPER MS	inflow	2. Piscivore species	combined	< 3	3 - 6	> 6
MAINSTREAM	LOWER MS	inflow	3. Sunfish species	combined	< 2	2 - 4	> 4
MAINSTREAM	MELTON H	inflow	3. Sunfish species	combined	< 3	3 - 4	> 4
MAINSTREAM	UPPER MS	inflow	3. Sunfish species	combined	< 3	3 - 4	> 4
MAINSTREAM	LOWER MS	inflow	4. Sucker species	combined	< 4	4 - 7	> 7
MAINSTREAM	MELTON H	inflow	4. Sucker species	combined	< 3	3 - 6	> 6
MAINSTREAM	UPPER MS	inflow	4. Sucker species	combined	< 3	3 - 6	> 6
MAINSTREAM	LOWER MS	inflow	5. Intolerant species	combined	< 3	3 - 6	> 6
MAINSTREAM	MELTON H	inflow	5. Intolerant species	combined	< 2	2 - 4	> 4
MAINSTREAM	UPPER MS	inflow	5. Intolerant species	combined	< 2	2 - 4	> 4
MAINSTREAM	all	inflow	6. Percent tolerant species	Electrofishing	> .55	.30 - .55	< .30
MAINSTREAM	all	inflow	7. Dominance(% composition of most abundant species)	Electrofishing	> 60	40 - 60	< 40
MAINSTREAM	all	inflow	8. Percent omnivores	Electrofishing	> .55	.30 - .55	< .30
MAINSTREAM	all	inflow	9. Percent insectivores	Electrofishing	< .25	.25 - .50	> .50
MAINSTREAM	LOWER MS	inflow	10. Lithophilic spawning species	combined	< 4	4 - 7	> 7
MAINSTREAM	MELTON H	inflow	10. Lithophilic spawning species	combined	< 3	3 - 5	> 5
MAINSTREAM	UPPER MS	inflow	10. Lithophilic spawning species	combined	< 4	4 - 7	> 7
MAINSTREAM	all	inflow	11. Average number of individuals	Electrofishing	< 50	50 - 100	> 100
MAINSTREAM	LOWER MS	transition	1. Number of species	combined	< 16	16 - 30	> 30
MAINSTREAM	MELTON H	transition	1. Number of species	combined	< 13	13 - 26	> 26
MAINSTREAM	TELLICO	transition	1. Number of species	combined	< 13	13 - 26	> 26
MAINSTREAM	UPPER MS	transition	1. Number of species	combined	< 15	15 - 29	> 29

Table 2 (Cont'd)

Reservoir Group	Reservoir Subgroup	STATION	METRIC	GEAR	ONE	THREE	FIVE
MAINSTREAM	LOWER MS	transition	2. Piscivore species	combined	< 4	4 - 7	> 7
MAINSTREAM	MELTON H	transition	2. Piscivore species	combined	< 4	4 - 7	> 7
MAINSTREAM	TELLICO	transition	2. Piscivore species	combined	< 4	4 - 7	> 7
MAINSTREAM	UPPER MS	transition	2. Piscivore species	combined	< 4	4 - 7	> 7
MAINSTREAM	LOWER MS	transition	3. Sunfish species	combined	< 2	2 - 3	> 3
MAINSTREAM	MELTON H	transition	3. Sunfish species	combined	< 2	2 - 4	> 4
MAINSTREAM	TELLICO	transition	3. Sunfish species	combined	< 2	2 - 4	> 4
MAINSTREAM	UPPER MS	transition	3. Sunfish species	combined	< 2	2 - 4	> 4
MAINSTREAM	LOWER MS	transition	4. Sucker species	combined	< 4	4 - 7	> 7
MAINSTREAM	MELTON H	transition	4. Sucker species	combined	< 4	4 - 6	> 6
MAINSTREAM	TELLICO	transition	4. Sucker species	combined	< 4	4 - 6	> 6
MAINSTREAM	UPPER MS	transition	4. Sucker species	combined	< 4	4 - 7	> 7
MAINSTREAM	LOWER MS	transition	5. Intolerant species	combined	< 3	3 - 4	> 4
MAINSTREAM	MELTON H	transition	5. Intolerant species	combined	< 2	2 - 4	> 4
MAINSTREAM	TELLICO	transition	5. Intolerant species	combined	< 2	2 - 4	> 4
MAINSTREAM	UPPER MS	transition	5. Intolerant species	combined	< 2	2 - 4	> 4
MAINSTREAM	all	transition	6. Percent tolerant species	Electrofishing	> .50	.25 - .50	< .25
MAINSTREAM	all	transition	6. Percent tolerant species	Gill netting	> .40	.20 - .40	< .20
MAINSTREAM	all	transition	7. Dominance(% composition of most abundant species)	Electrofishing	> 60	40 - 60	< 40
MAINSTREAM	all	transition	7. Dominance(% composition of most abundant species)	Gill netting	> 50	30 - 50	< 30
MAINSTREAM	all	transition	8. Percent omnivores	Electrofishing	> .50	.25 - .50	< .25
MAINSTREAM	all	transition	8. Percent omnivores	Gill netting	> .45	.30 - .45	< .30
MAINSTREAM	all	transition	9. Percent insectivores	Electrofishing	< .30	.30 - .60	> .60
MAINSTREAM	all	transition	9. Percent insectivores	Gill netting	< .07	.07 - .15	> .15
MAINSTREAM	LOWER MS	transition	10. Lithophilic spawning species	combined	< 4	4 - 7	> 7
MAINSTREAM	MELTON H	transition	10. Lithophilic spawning species	combined	< 4	4 - 7	> 7
MAINSTREAM	TELLICO	transition	10. Lithophilic spawning species	combined	< 4	4 - 7	> 7
MAINSTREAM	UPPER MS	transition	10. Lithophilic spawning species	combined	< 4	4 - 7	> 7
MAINSTREAM	all	transition	11. Average number of individuals	Electrofishing	< 50	50 - 100	> 100
MAINSTREAM	all	transition	11. Average number of individuals	Gill netting	< 15	15 - 35	> 35
RID & VALL	all	forbay	1. Number of species	combined	< 10	10 - 19	> 19
RID & VALL	all	forbay	2. Piscivore species	combined	< 3	3 - 6	> 6
RID & VALL	all	forbay	3. Sunfish species	combined	< 2	2 - 3	> 3
RID & VALL	all	forbay	4. Sucker species	combined	< 3	3 - 5	> 5
RID & VALL	all	forbay	5. Intolerant species	combined	< 2	2 - 2	> 2
RID & VALL	all	forbay	6. Percent tolerant species	Electrofishing	> .30	.15 - .30	< .15

Table 2 (Cont'd)

Reservoir Group	Reservoir Subgroup	STATION	METRIC	GEAR	ONE	THREE	FIVE
RID & VALL	all	forbay	6. Percent tolerant species	Gill netting	> .50	.30 - .50	< .30
RID & VALL	all	forbay	7. Dominance(% composition of most abundant species)	Electrofishing	> 60	40 - 60	< 40
RID & VALL	all	forbay	7. Dominance(% composition of most abundant species)	Gill netting	> 50	30 - 50	< 30
RID & VALL	all	forbay	8. Percent omnivores	Electrofishing	> .25	.10 - .25	< .10
RID & VALL	all	forbay	8. Percent omnivores	Gill netting	> .60	.40 - .60	< .40
RID & VALL	all	forbay	9. Percent insectivores	Electrofishing	< .60	.60 - .80	> .80
RID & VALL	all	forbay	9. Percent insectivores	Gill netting	< .03	.03 - .06	> .06
RID & VALL	all	forbay	10. Lithophilic spawning species	combined	< 2	2 - 4	> 4
RID & VALL	all	forbay	11. Average number of individuals	Electrofishing	< 40	40 - 80	> 80
RID & VALL	all	forbay	11. Average number of individuals	Gill netting	< 15	15 - 30	> 30
RID & VALL	all	transition	1. Number of species	combined	< 11	11 - 20	> 20
RID & VALL	all	transition	2. Piscivore species	combined	< 4	4 - 6	> 6
RID & VALL	all	transition	3. Sunfish species	combined	< 2	2 - 3	> 3
RID & VALL	all	transition	4. Sucker species	combined	< 3	3 - 6	> 6
RID & VALL	all	transition	5. Intolerant species	combined	< 2	2 - 2	> 2
RID & VALL	all	transition	6. Percent tolerant species	Electrofishing	> .30	.15 - .30	< .15
RID & VALL	all	transition	6. Percent tolerant species	Gill netting	> .50	.30 - .50	< .30
RID & VALL	all	transition	7. Dominance(% composition of most abundant species)	Electrofishing	> 60	40 - 60	< 40
RID & VALL	all	transition	7. Dominance(% composition of most abundant species)	Gill netting	> 50	30 - 50	< 30
RID & VALL	all	transition	8. Percent omnivores	Electrofishing	> .25	.10 - .25	< .10
RID & VALL	all	transition	8. Percent omnivores	Gill netting	> .60	.40 - .60	< .40
RID & VALL	all	transition	9. Percent insectivores	Electrofishing	< .50	.50 - .70	> .70
RID & VALL	all	transition	9. Percent insectivores	Gill netting	< .03	.03 - .06	> .06
RID & VALL	all	transition	10. Lithophilic spawning species	combined	< 3	3 - 6	> 6
RID & VALL	all	transition	11. Average number of individuals	Electrofishing	< 40	40 - 80	> 80
RID & VALL	all	transition	11. Average number of individuals	Gill netting	< 15	15 - 30	> 30

Table 3. Summary of RFAI Scores for 1990-1994 Based on 1994 Scoring Methods

		1991	1992	1993	1994
Beach Lake	Forebay	.	.	.	29
Bear Creek	Forebay	.	47	45	44
Blue Ridge	Forebay	40	37	39	42
Boone	Transition South Fork of The Holston	41	30	36	36
	Transition Watauga	34	34	34	37
	Forebay	30	35	24	34
Cedar Creek	Forebay	.	42	41	50
Chatuge	Forebay	35	43	40	43
	Shooting Creek	.	.	40	39
Cherokee	Transition	36	34	38	38
	Forebay	42	35	42	38
Chickamauga	Inflow	48	42	56	52
	Transition	45	41	51	41
	Forebay	44	46	45	41
	Embayment	.	.	48	42
Douglas	Transition	42	38	43	44
	Forebay	33	39	40	42
Fontana	Transition Little Tennessee	.	.	44	42
	Transition Tuckasegee	.	.	40	40
	Forebay	.	.	42	43
Fort Loudoun	Inflow	32	24	34	36
	Transition	33	33	34	38
	Forebay	35	41	41	37
Fort Patrick Henry	Forebay	.	.	46	33
Guntersville	Inflow	46	40	38	42
	Transition	33	40	38	35
	Forebay	46	39	46	30
Hiwassee	Transition	49	40	47	43
	Forebay	42	39	48	52
Kentucky	Inflow	46	36	38	34
	Transition	44	49	44	43
	Forebay	44	38	42	38
	Embayment	.	.	31	31
Little Bear Creek	Forebay	.	42	45	46
Melton Hill	Inflow	20	18	22	28
	Transition	36	30	43	43
	Forebay	42	31	40	49
Nickajack	Inflow	48	48	58	50
	Transition	40	.	.	.
	Forebay	45	36	49	45
Normandy	Transition	.	51	.	.
	Forebay	.	41	53	48
Norris	Transition Clinch	40	43	47	51
	Transition Powell	48	44	48	52
	Forebay	34	34	34	43
Nottely	Transition	.	.	40	37
	Forebay	37	35	37	38
Parksville - ocoee no 1	Forebay	32	36	34	42
Pickwick	Inflow	44	42	50	46
	Transition	45	40	47	47
	Forebay	40	34	50	43
	Embayment	.	.	42	44
South Holston	Transition	41	40	44	44

Table 3 (Cont'd)

	Forebay	34	39	51	43
Tellico	Transition	31	31	41	44
	Forebay	38	36	36	47
Tims Ford	Transition	.	48	51	47
	Forebay	.	40	46	50
Upper Bear Creek	Forebay	.	31	34	.
Watauga	Transition	32	31	42	35
	Forebay	33	29	30	31
Watts Bar	Inflow Clinch	40	34	44	40
	Inflow Tennessee	40	42	38	46
	Transition	46	44	53	46
	Forebay	42	35	39	43
Wheeler	Inflow	44	40	44	48
	Transition	36	31	47	43
	Forebay	43	40	49	41
	Embayment	.	.	41	50
Wilson	Inflow	38	46	54	40
	Forebay	44	39	44	45

Section 1

Reservoir Monitoring -- Overview of Approach, Methods, and 1994 Results

Appendix A.

Watershed and Reservoir Physical Description Including Summary of Ecological Health Results for Each Reservoir in 1994

Kentucky Reservoir Watershed

Duck River Watershed

Pickwick Reservoir - Wilson Reservoir Watershed

Wheeler Reservoir - Elk River Watershed

Guntersville Reservoir - Sequatchie River Watershed

Nickajack Reservoir - Chickamauga Reservoir Watershed

Hiwassee River Watershed

Watts Bar Reservoir, Fort Loudoun Reservoir, and Melton Hill Reservoir Watershed

Clinch River and Powell River Watershed

Little Tennessee River Watershed

French Broad River Watershed

Holston River Watershed

KENTUCKY RESERVOIR WATERSHED

The Kentucky Reservoir watershed area includes all streams flowing into the Tennessee River downstream of Pickwick Landing Dam at Tennessee River mile (TRM) 206.7 to the confluence of the Tennessee River with the Ohio River. The one exception is the Duck River which is considered a separate watershed. The Kentucky Reservoir watershed area is relatively large (4590 square miles) and has an average annual discharge of about 66,600 cfs. Of that, about 82 percent (54,000 cfs) comes into Kentucky Reservoir from Pickwick Landing Dam. The Duck River supplies about 6 percent (4075 cfs), with the remaining 11 percent coming from local inflows.

Kentucky Reservoir is the dominant feature of this watershed. There are four monitoring sites on Kentucky Reservoir--forebay, transition zone, inflow, and Big Sandy River embayment

The watershed also includes the seven small reservoirs on the Beech River. The largest, Beech Reservoir, is the only one included in Vital Signs monitoring. Given its small size, the forebay is the only site monitored.

Kentucky Reservoir

Kentucky Reservoir is the largest reservoir on the Tennessee River. The dam is located at Tennessee River Mile (TRM) 22.4, and the reservoir extends 184 miles upstream to Pickwick Dam at TRM 206.7. At full pool the surface area is 160,300 acres, and the shoreline is 2280 miles. Average annual discharge is about 66,600 cfs, which provides an average hydraulic retention time of about 22 days.

The Duck River, a major tributary to the Tennessee River (and Kentucky Reservoir), provides about 6 percent of the total flow through Kentucky Reservoir. The confluence of the Duck River with the Tennessee River is at TRM 110.7.

The transition zone sample location was moved prior to the 1992 sample season from TRM 112.0 to TRM 85.0. Results for 1990 and 1991 at TRM 112.0 indicated that location was more representative of a riverine environment than a transition environment. The 1992, 1993 and 1994 results indicate the new transition zone site is correctly located.

Vital Signs monitoring was expanded in 1993 to include a sample site in four of the largest embayments in the Tennessee Valley. One, the Big Sandy River embayment on Kentucky Reservoir, is the largest embayment in the Tennessee Valley. It covers 15,238 surface acres and has over 93 miles of shoreline. Because its watershed is only 629 square miles, there is very little water exchange.

Beech Reservoir

Beech Reservoir, the largest of seven small flood control projects on the Beech River system in western Tennessee, is formed by Beech Dam at Beech River mile 35.0. Beech Reservoir is only 5.3 miles long and averages only about 12 feet deep. It has no hydropower generating facilities, but is the primary source of water for the city of Lexington. The reservoir is an urban lake with considerable residential lakefront development. Consequently, it receives a large amount of recreational use relative to its small size (about 900 acres). Discharge from Beech Dam averages only about 14 cfs per day, resulting in a long hydraulic residence times of 300 to 400 days.

Reservoir: Kentucky 1994 Score: 71%

	Prevoius Scores		
	Reported	1994 Criteria	1994 Criteria w/o Big Sandy
1991	77	76	76 (FB and Inf only)
1992	88	88	76 (FB, TZ, and Inf)
1993	75	76	83 (FB, TZ, and Inf)
1994	71	71	81 (FB, TZ and Inf)

Effect of method change between 1993 and 1994: very little as reflected in 1993 scores; 1993 results on 1993 criteria = 75% and 1993 results on 1994 criteria = 76%

Impact of special case scores (i.e., ex/include embayments / TZ moved): Like 1993, inclusion of Big Sandy results had significant influence on overall score; reduction of 10% in 1994 and 8% in 1993 (see special case scores)

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	3	5	1	na	9		0	0	0		0
DO	4.5	5	2	5	16.5		0.5	0	-2.5	1	-1
Sediment	4	5	3	na	12		-1	0	1		0
Benthos	3	4	3	4	14		-2	-1	-1	1	-3
Fish	3	4	2	3	12		-1	0	0	0	-1
Total	17.5	23	11	12	63.5	Net	-3.5	-1	-2.5	2	-5

Explanation/discussion of differences: Between 1993 and 1994 biggest single changes were: (1). **Benthos** in forebay (FB) decrease of -2 (5 of 8 metrics lower; general community decrease) -- possible cause was DO related. In 1992 all DO was good in FB, in 1993 FB had some anoxia (DO's = 0 ppm) and about six weeks of DO $\leq$ 2 ppm.; and (2). **DO** decrease of -2.5 in Big Sandy embayment (all DO measures were lower in 1994 than in 1993). Hypothesis -- 1993 was an irregular flow year and the pulsing and surcharging of Kentucky reservoir in 93 (to help control flooding on the Ohio-Mississippi rivers) may have caused an exchange of water between the embayment and the main reservoir, i.e. pulled out poor, low DO water from Big Sandy. This did not happen in 1994, resulting in lower DO's in Big Sandy in '94.

Overall story for 1994: Kentucky still basically a "good reservoir"; biggest single influence on overall reservoir score is the lower scores in Big Sandy embayment (all yellows or reds). Kentucky Reservoir overall score is in the 80's if Big Sandy is excluded. Other important issures were: (1) benthos worse in 1994 than 1993 at all locations but the inflow; probably due to poor DO in summer of 1993 (which would reflect on 1994 benthos -- good benthos in '93 likely a relection of good DO in 1992); (2) DO in Big Sandy was <2 ppm near bottom for about 4-5 months. DO was measured <0.2 ppm in June, July, & September of 1994 in Big Sandy. See hypothesis in (2) above for explanation. Low DO in 1994 may be more typical in Big Sandy than the unusual events (and higher DO) of 1993; (3) Overall DO's were better in 1994 at FB and transition zone (TZ) and inflow -- due to higher summertime flows in Tennessee River in 1994; and (4) very high summer chlorophylls caused "red" rating in Big Sandy embayment in 1994.

Macrophytes - Aquatic plants were estimated to covered only about 415 acres of Kentucky Reservoir in 1994, a significant decline from 1993 when plants covered about 3500 acres. Most of the aquatic plants were found downstream of the Duck River in shallow water areas around islands and in shallow embayments.

Reservoir: Beech **1994 Score: 56%**

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	NA	27 (chloro, DO, fish)	
1992	NA	40 (chloro, DO)	
1993	65	70 (chloro, DO, sed, benthos)	
1994	56	56 (chloro, DO sed,benthos, fish)	

Effect of method change between 1993 and 1994: Overall score for '93 results on '93 criteria was 65%; '93 results on '94 criteria = 70. Change of 5% due to new methods for benthos, which increase the benthos contribution to total score 1 pt (1 pt change = 5% for Beech because only one sample location).

	1994 Results					Differences between 1993 and 1994			
	FB	TZ	Inf	Total		FB	TZ	Inf	Net
Chlorophyll	2			2		-3			-3
DO	1			1		0			0
Sediment	5			5		1			1
Benthos	4			4		0			0
Fish	2			2		NA (no fish in '93)			NA
Total	14			14	Net	-2			-2

Explanation/discussion of differences: between 1993 and 1994: Biggest change was for chlorophyll (-3 pts). In '93 mean chlorophyll was 9 and maximum was 14 (a mean below 10 is good, green, and above is fair, yellow). In '94 mean was 13 and maximum was 72 (mean above 10 would cause fair rating but very high maximum caused rating to be downgraded to poor, red). Sediment improved (+1) in '94 (no problems of any kind) compared to '93 (slight toxicity was found).

Overall story for 1994: Beech Reservir was relatively poor in '94. Biggest contributors to low overall rating were: (1). Chlorophyll--much higher in '94 (see above explanation) causing RP color change from green in '93 to red in '94. Higher flows in '94 probably boosted chlorophyll in Beech instead of lowering it like in the mainstream reservoirs. Beech has a long retention time in both wet and dry years. Wet years actually increase chlorophyll production because more nutrients are washed into the lake by the higher runoff. In dry years little new nutrients are washed in and nutrients present are depleted resulting in less chlorophyll. (2). DO was very poor in Beech again in '94 (RP red in both '93 and '94). Much of the water column had DO < 2 ppm and much of that water had no DO at all. (3). Fish will appear as yellow in RP in '94 but it is important to note that the actual fish score was only one point from being red. Poor characteristics were too many tolerant species, many omnivores, few insectivores--bascially poor community balance).

Note (Other color changes in RP for '94 compared to '93 RP): Sediment change color from yellow to green (see above explanation). Benthos change color from yellow to green, but this is totally due to a change in methods ('93 would have been green if '94 methods used). A good benthos in a reservoir with such poor DO would not be expected. One important consideration is that the new methods compare Beech only to similar reservoirs in the same geographical area (Bear, Little Bear, Cedar, and Normandy). A green rating means Beach has a good benthos community compared to this group of rerservoirs. Basically, you don't expect a lot so it doesn't take a lot to be good.

(beeres94)

DUCK RIVER WATERSHED

The Duck River Watershed includes all streams flowing into the Duck River. It has an area of 3500 square miles and an average annual discharge of 4075 cfs to Kentucky Reservoir on the Tennessee River. The Duck River basin is underlain almost entirely by limestone, or phosphatic limestone; consequently, waters in the streams draining this basin are fairly hard and contain large concentrations of minerals. Large deposits of phosphate ores permit phosphate mining and refining operations in the basin. Phosphate concentrations in surface and groundwater are significantly higher than in most of the Tennessee Valley. The soils are thin with limestone outcrops at the surface in many places, and sinkholes are common throughout the watershed.

Normandy Reservoir is the only reservoir in this watershed. This is a relatively small reservoir and only the forebay is included in the Vital Signs monitoring program. There is one stream monitoring site on the Duck River at mile 26..

Normandy Reservoir

Normandy Reservoir is formed by Normandy Dam at Duck River mile (DRM) 248.6. Normandy Reservoir, constructed primarily for flood control and water supply, has a drainage area of 195 square miles and no electric power generation capacity. One of TVA's smaller reservoirs, Normandy at full pool elevation has about 3200 surface acres, 73 miles of shoreline, and about 17 miles of impounded backwater. The reservoir has an average depth of about 35 feet and an average annual drawdown of about 11 feet. The average annual discharge from Normandy Dam is about 320 cfs, providing an average annual retention time of about 175 days.

Reservoir: Normandy 1994 Score: 68%

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	NR	NR	NA
1992	NR	NR	NA
1993	56	56	NA
1994	68	68	NA

Effect of method change between 1993 and 1994: None

Impact of special case scores (i.e., ex/include embayments / TZ moved): NA

	1994 Results					Diff. between '93/'94			
	FB	TZ	Inf	Total		FB	TZ	Inf	Net
Chloro	5					0			0
DO	1					0			0
Sediment	5					3			3
Benthos	2					1			1
Fish	4					-1			-1
Total	17					3			3

Explanation/discussion of differences: between 1993 and 1994: Big improvement in **sediment quaity**. No problems in '94 so sediment rated good (green); in '93 had toxicity and ammonia so rated poor (red). **Benthos** had slightly higher score in '94 than '93 but not enough to move another color range (red both years). The same was true for **fish**, just in the opposite direction--slight decrease in score but not enough to move to a lower color range (green both years). Note: **D0** was very poor both years--anoxic and much of water column had low (<2) DO. Normandy had the poorest DO conditions in 1994 of all 30 reservoirs mointored.

Overall story for 1994: Ecological health in Normandy improved over that in 1993. This was primarily due to improvements in sediment quality--no problems found in 1994. Sediment quality added 3 points to overall rating creating an increase of 12 % to overall reservoir score. RP color for sediments changed red in '93 to green in '94. Normandy continued to have very poor DO conditions. Also benthos poor again, although slight improvements were seen.

nomres94

PICKWICK RESERVOIR - WILSON RESERVOIR WATERSHED

Pickwick Reservoir and Wilson Reservoir on the Tennessee River are the most notable features of this drainage area. Only a small part of the flow leaving this watershed actually originates within the watershed itself. The average annual discharge from Pickwick Dam is 54,900 cfs. Of that, 49,500 cfs (90 percent) is the discharge from Wheeler Dam into Wilson Reservoir. About 2100 cfs enters Wilson Reservoir through local tributaries and about 3400 cfs originates in tributaries to Pickwick Reservoir. The streams within this watershed drain an area of about 3230 square miles. The largest tributaries are Bear Creek, a tributary to Pickwick Reservoir with a drainage area of about 945 square miles, and Shoal Creek, a tributary to Wilson Reservoir, with a drainage area of about 445 square miles.

Four small reservoirs were built on Bear Creek in the late 1970s and early 1980s for flood control and recreation. These are Bear Creek, Little Bear Creek, Cedar Creek, and Upper Bear Creek Reservoirs.

Reservoir monitoring activities occur at the forebay, transition zone, and inflow on Pickwick Reservoir and at the forebay and inflow on Wilson Reservoir. Wilson is relatively short and has no definable transition zone. Because of their smaller size, only the forebays of Bear Creek, Little Bear Creek, and Cedar Creek Reservoirs are monitored. No monitoring activities are conducted on Upper Bear Creek because of TVA's program to destratify and oxygenate water in the forebay. The only stream monitoring site is on Bear Creek at Bear Creek mile 27.3.

Pickwick Reservoir

Pickwick Reservoir is immediately upstream of Kentucky Reservoir on the Tennessee River. Pickwick Dam is located at TRM 206.7. Like the rest of the mainstream, run-of-the-river reservoirs, Pickwick is much shorter (53 miles long) and smaller (43,100 acres and shoreline of 496 miles) than Kentucky Reservoir. Average annual discharge is about 55,000 cfs, which provides an average hydraulic retention time of about eight days.

A major tributary, Bear Creek, joins the Tennessee River in Pickwick Reservoir at about mile 225. Bear Creek provides, on the average, about 2.5 percent of the flow through Pickwick Reservoir.

Reservoir Monitoring activities were expanded on Pickwick Reservoir in 1993 to include a Vital Signs monitoring site in Bear Creek embayment. This rather large embayment (7200 acres) extends from the mouth of Bear Creek upstream about 17 miles to the point where flow is not affected by backwater from Pickwick Dam.

Wilson Reservoir

Wilson Reservoir is quite different from other mainstream Tennessee River reservoirs in both length and depth. Wilson Dam is located at TRM 259.4 and Wheeler Dam is at TRM 274.9, providing a length of only 15.5 miles, a shoreline of 154 miles, and surface area of 15,500 acres. Water depth in the forebay is slightly over 100 feet. This short, deep pool, coupled with the largest hydroelectric generating plant in the TVA system, provides for short hydraulic retention times (six days). Average annual discharge from Wilson is 51,500 cfs. Because of the physical characteristics, design, and operation of Wilson Dam (primarily upper strata withdrawal for hydropower generation), low DO conditions develop in deeper strata of the forebay during summer months.

Bear Creek Reservoir

With a surface of only 700 acres, Bear Creek is one of the smallest reservoirs in the TVA system. It is relatively long (16 miles), narrow, and deep (74 feet at the dam). The average annual discharge is 380 cfs providing an average hydraulic retention time of about 13 days. Average annual drawdown is about 11 feet. Bear Creek Reservoir stratifies in the summer and develops hypolimnetic anoxia. Another water quality concern is abandoned strip mines in the watershed.

Little Bear Creek Reservoir

Little Bear Creek Reservoir is relatively short (7.1 miles long) and deep (84 feet at the dam). It has a surface area of 1600 acres. With an average annual discharge of 101 cfs, the hydraulic retention time is 225 days. Compared to Bear Creek Reservoir, the lower flow into the reservoir and larger reservoir volume make the retention time much longer in Little Bear Creek Reservoir. Average annual drawdown is about 12 feet.

Cedar Creek Reservoir

Like the other reservoirs in the Bear Creek watershed, Cedar Creek Reservoir is small (only nine miles long and 4200 acres surface area) and deep (79 feet at the dam). The low average annual discharge from the dam (282 cfs) creates a relatively long average retention time (168 days). This combination of physical features lead to thermal stratification and hypolimnetic anoxia in the summer. Average annual drawdown is about 14 feet.

Reservoir:Pickwick **1994 Score: 84%**

	Prevoius Scores		
	Reported	1994 Criteria	1994 Criteria w/o Bear Cr
1991	77	74	74
1992	75	78	78
1993	73	71	77
1994	84	84	88

Effect of method change between 1993 and 1994: Virtually no effect as reflected in total scores for 93 (71 vs 73)

Impact of special case scores (i.e., ex/include embayments / TZ moved): Like 1993, inclusion of Bear Creek embayment lowered overall reservoir rating about 4 % points.

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	2	5	3	na	10		-1	2	2		3
DO	5	5	4.5	4	18.5		1	1	1	1	4
Sediment	5	5	5	na	15		1	1	2		4
Benthos	5	5	2	4	16		1	1	0	-1	1
Fish	4	4	4	4	16		0	0	0	0	0
Total	21	24	18.5	12	75.5	Net	2	5	5	0	12

Explanation/discussion of differences: between 1993 and 1994: Biggest changes compared to 1993 were DO and sediment ratings (both +4). Embayment and TZ locations showed most improvement, both with lower chlorophyll concentrations in 1994 than in 1993. DO was better in 1994 at all four locations. At the FB a single high chlorophyll sample (algal bloom) lowered the score. Sediment was better at all three locations in 1994. No toxicity nor high concentrations of metals found in 1994. (In 1993 had some ammonia and slight toxicity at FB and Bear Creek embayment sediments)

Overall story for 1994: Big improvement in 1994 over 1993 (from 73% to 84%). DO improved at all four locations (with three of four yellows changing to green). Average chlorophyll concentrations were improved (i.e. lower) at all three locations (FB, TZ, and Embay) in 1994 compared with 1993. Note-The "red" color rating for chlorophyll at the FB was due to a lowering of the rating from "yellow" because of a single high sample indicating a large (undesirable) algal bloom. These improvements could all be attributed to increased flows in 1994 compared with 1993, especially during the critical summer months. At TZ all five indicators (DO, chlorophyll, sediment, benthos, and fish) change from yellow in 1993 to green in 1994. Sediment improved from yellow in 1993 to green in 1994 at all three locations. No toxicity no high metal concentrations were found (found some ammonia and toxicity in sediment in FB and Bear Creek in 1993).

Note on Benthos-Trend of poorer benthos in 1994 due to low DO's in 1993 not as evident in Pickwick as in Kentucky. Did see lowered score at inflow in 1994 where worse DO conditions were found in 1993. Bear Cr benthos were poor in 1994; they were reported as fair in 1993 but based on new criteria for 1994, the 1993 would rate poor - no change in community characteristics.

picres94

Reservoir: Wilson **1994 Score: 71%**

	Previous Scores	
	Reported	1994 Criteria
1991	60	60
1992	68	68
1993	71	74
1994	71	71

Effect of method change between 1993 and 1994: Virtually no effect as reflected in total scores for 1993 (71% vs 74%).

Impact of special case scores (i.e., ex/include embayments / TZ moved): N/A

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	3			na	3		0				0
DO	3.5			5	8.5		2.5			1	3.5
Sediment	3			na	3		-1.5				-1.5
Benthos	2			5	7		-1			0	-1
Fish	4			3	7		0			-2	-2
Total	15.5			13	28.5	Net	0.0			-1	-1

Explanation/discussion of differences: between 1993 and 1994: (1) **Sediments** -- substantial improvements in DO at both FB (+2.5) and inflow (+1); (2) substantially worsened sediments -- toxicity to both test organisms in 1994 compared to no toxicity in 1993; (3) **Benthos** in FB scored lower in 94 compared to 93 -- probably due to lower DO's in 1993 impacting benthos in 94; (4) **Fish** assemblage was "fair" in 1993 at inflow -- but when rated using 1994 criteria, 1993 rated good (great) and 1994 fish assemblage rated fair at the inflow (a lower rating than 1993 using an apples-to-apples comparison). RiverPulse (RP) showed a yellow for fish in 1993 at the inflow and will show a yellow for 1994.

Overall story for 1994: Overall score about the same as 1993, improvements in DO offset by declines in sediment and fish DO's much better at FB in 1994 ("red" in 1993 -- almost "green" in 1994), with much less volume of low DO water in Wilson in 1994 than in 1993. Also DO's better in the inflow (discharge from Wheeler dam), change from yellow in 93 to green in 94. All likely due to the higher summertime flows (during the critical time of the year -- less time for stagnation). At the FB, significant sediment toxicity in 1994, little toxicity in 1993. Sediment sampling is difficult because there is a lot of bottom area and we sample only a very small part of the bottom. Given that the bottom is not uniform, substantial differences cam be found between samples (and between years). This is further complicated when floods like the spring of 1994 potentially bring in new sediments which may contain materials harmful to test organisms. Benthos at FB scored lower in 1994 than 1993, probably due to poor DO conditions in summer of 1993.

wilres94

Reservoir: Bear Creek 1994 Score: 56%

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	NS	NS	
1992	NS	NS	
1993	60	56	
1994	56	56	

Effect of method change between 1993 and 1994: Decrease of 4 % in total score for '93 (on '94 methods) due to a 1 point difference in benthos.

Impact of special case scores (i.e., ex/include embayments / TZ moved): NA

	1994 Results					Diff. Bet '93 and '94 ('94 Methods)				
	FB	MR-	MR-	Total		FB	MR-	Mr-	Net	
Chloro	3			3		0			0	
DO	1			1		0			0	
Sediment	3			3		1			1	
Benthos	3			3		-1			-1	
Fish	4			4		0			0	
Total	14	0	0	14		0			0	

Explanation/discussion of differences: between 1993 and 1994 (both years on '94 methods): Sediment improved 1 point compared to '93. In '93 found toxicity and ammonia so rated poor (red); in '94 found toxicty again but no ammonia so rated fair (yellow). **Benthos** decreased by 1 point due to decreases in long-lived animals and taxa richness, also less community balance. RP color for benthos change green in '93 to yellow in '94. DO very poor again in '94--5 months anoxic and much of water column with DO <2 during most of summer. Bascially similar to other reservoirs in this class.

Overall story for 1994: Bear Creek similar to '93; although slight change in overall score moved it from the low end of the fair range in '93 to the high end of the poor range in '94. This change was due to benthos--two contributing factors: the community was not as good in '94 as it was in '93 and a change in methods (RP color change from green in '93 to yellow in '94). Sediment Quality improved some --had toxicity in '94, same as in '93, but ammonia found in '93 was not found in '94. This was an improvement from poor (red in '93 RP) to fair (yellow in '94 RP). Fish change green in '93 to yellow in '94 due to a very small change in score ('93 just over the cut-off point to be considered good, and in '94 just under the cut-off). The fish community in '94 had more tolerant species and more omnivores than in '93. DO very poor; represents the most obvious problem in Bear Creek Reservoir.

beasum94

Reservoir: Little Bear Creek 1994 Score: 64%

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	NS	NS	
1992	NS	NS	
1993	64	64	
1994	64	64	

Effect of method change between 1993 and 1994: None

Impact of special case scores (i.e., ex/include embayments / TZ moved): NA

	1994 Results					Diff. Bet '93 and '94 ('94 Methods)				
	FB	MR-	MR-	Total		FB	MR-	Mr-	Net	
Chloro	5			5		0			0	
DO	1			1		0			0	
Sediment	3			3		0			0	
Benthos	3			3		0			0	
Fish	4			4		0			0	
Total	16	0	0	16		0			0	

Explanation/discussion of differences: between 1993 and 1994: No change in any indicators between '94 and '93.

Overall story for 1994: Little Bear Creek Reservoir same an in '93--fair. Biggest observation is the very poor DOs--anoxic on bottom and much of water column with low DO (<2.0). Sediments were toxic to one type of test animal causing fair (yellow) rating. Benthos only fair because community made up of mostly tolerant animals. (See last years writeup if more discussion wanted).

lbrsum94

Reservoir: Cedar Creek 1994 Score: 80%

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	NS	NS	
1992	NS	NS	
1993	56	60	
1994	80	80	

Effect of method change between 1993 and 1994: Change in '93 score on '94 criteria of 4% due to one point change in fish.

Impact of special case scores (i.e., ex/include embayments / TZ moved): N/A

	1994 Results					Diff. Bet '93 and '94 ('94 Methods)				
	FB	MR-	MR-	Total		FB	MR-	Mr-	Net	
Chloro	5			5		2			2	
DO	1			1		0			0	
Sediment	5			5		1			1	
Benthos	5			5		2			2	
Fish	4			4		0			0	
Total	20	0	0	20		5			5	

Explanation/discussion of differences: between 1993 and 1994 (all '94 criteria): Biggest improvements between years was in chlorophyll and benthos (2 points each). **Chlorophyll** improvement was actually a borderline change--mean concentration in '93 (2.8) was just below the level considered good (3.0) so rated fair (yellow in RP in '93); in'94 the mean concentration was slightly higher (3.7) but was within the good range so rated good (green for RP). **Benthos** improved substantially in '94 compared to '93. This was a true community improvement--in '94 with 7 of the 8 metrics improved compared to '93 (remember this is an apples to apples comparision because both years were scored on '94 methods). This was the highest benthos score of all Interior Plateau tributary reservoirs. **Sediment Quality** improved in '94 (no problems found, so green in RP) compared to '93 (ammonia found so yellow in RP). **DO** very poor again in '94. No DO near bottom most of summer and low DO in much of water column most of summer.

Overall story for 1994: Cedar Creek significantly improved in '94 compared to '93. Cedar Creek was a red reservoir in 1993 RP and will be a green in '94 RP. There was a 24% increase in score. A small part of this increase (4%) was due to methods change between years. The rest was due to actual improvements in indicators. Chlorophyll made a borderline change from yellow (3 pts) in '93 to green (5 pts) in '94, which contributed 8 % to the total score. Sediment quality was good in '94 because no problems were found, whereas, in '93 ammonia was found; this added 4% to the total score (RP color change yellow in '93 to green in '94). Benthos showwed significant improvement in essentially all community attributes and added 8 % to the total score (RP color change yellow in '93 to green in '94). Fish score did not change but color changed yellow to green due to methods change('93 fish would have been green if '94 methods were used).

Note: In reservoirs with only one sample site, small changes in metrics cause substantial change in total score (e.g., chlorophyll).

Note: Caution must be excerised in evaluating these results. There are only two years of data for Cedar Creek Reservoir. Each shows vastly different scores. There is no way of knowing which most accurately reflects true environmental conditions.

(cedsum94)

WHEELER RESERVOIR - ELK RIVER WATERSHED

The Wheeler Reservoir - Elk River watershed drains about 5140 square miles in north central Alabama and south central Tennessee. Wheeler Reservoir is the fourth of nine reservoirs on the Tennessee River. About 24,500 square miles of the Tennessee Valley are upstream of this watershed. Wheeler Reservoir receives an average annual inflow of 40,700 cfs from Guntersville Dam. Discharges from Wheeler Dam average 49,400 cfs on an annual basis leaving 8700 cfs which originate within the watershed.

The largest tributary to Wheeler Reservoir is the Elk River, which has a drainage area of about 2250 square miles and contributes about 3000 cfs. The remaining flow enters from tributaries directly to Wheeler Reservoir.

Wheeler Reservoir is the largest reservoir within this watershed followed by Tims Ford Reservoir on the Elk River. There are four Vital Signs monitoring sites on Wheeler Reservoir--forebay, transition zone, inflow, and the Elk River embayment. Two sites are monitored for Vital Signs on Tims Ford Reservoir--forebay and mid-reservoir. Woods Reservoir on the Elk River is not included in this monitoring program because it is property of the Arnold Engineering Development Center, Arnold Air Force Base. The only stream monitoring site within this watershed is on the Elk River at mile 36.5.

Wheeler Reservoir

Wheeler Reservoir has the third-largest surface area (67,100 acres) of all reservoirs in the TVA system. It is 74 miles long (dam at TRM 274.9) and has 1063 miles of shoreline. Average annual discharge is about 49,400 cfs which provides an average hydraulic retention time of about 11 days. Information collected in 1990 and 1991 indicated a more riverine than transition environment at TRM 307.5; consequently, in 1992 the transition zone sampling location was relocated further downstream to TRM 295.9. Results for 1992 and 1993 are being evaluated to determine if this new site is suitably located or if it needs to be moved further downstream.

The Elk River joins the Tennessee River in the downstream portion of Wheeler Reservoir at about mile 284 and provides, on the average, about 6 percent of the flow through Wheeler Reservoir.

Vital Signs monitoring activities were expanded in 1993 to include a site in the Elk River embayment. This was one of four embayments added to the Vital Signs program in 1993. The Elk River embayment covers about 4900 acres. Given the relatively high flows in the Elk River (about 3000 cfs annual average), there is substantial water exchange in this embayment.

Tims Ford Reservoir

Tims Ford Reservoir in middle Tennessee is formed by Tims Ford Dam at Elk River mile (ERM) 133.3. The reservoir is 34 miles long at full pool and has a surface area of 10,600 acres. The depth at the dam is 143 feet and the average depth is about 50 feet. Average annual discharges from Tims Ford Dam are about 940 cfs, resulting in a hydraulic residence time of about 280 days. Tims Ford Reservoir is designed for a useful controlled drawdown of 30 feet (895-865 feet MSL) for flood protection; however, annual drawdowns average about 18 feet.

Reservoir: Wheeler **1994 Score: 75%**

	Previous Scores		
	Reported	1994 Criteria	1994 Criteria w/o Elk R
1991	89	70	70 (inflow & FB only)
1992	80	78	78 (inflow, TZ & FB)
1993	72	74	83 (inflow, TZ & FB)
1994	75	75	81 (inflow, TZ & FB)

Effect of method change between 1993 and 1994: Very little effect as reflected in total scores for 1993 (72% vs 74%).

Impact of special case scores (i.e., ex/include embayments / TZ moved): Inclusion of Elk River embayment lowered scores (9% points in 1993 and 6% points in 1994) -- considerably poorer quality in Elk River embayment than reservoir as a whole.

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	3	3	1	na	7		0	-2	0		-2
DO	5	5	3	5	18		3	0	1	0	4
Sediment	3.5	4	5	na	12.5		-1.5	-1	1		-1.5
Benthos	2	5	2	5	14		-1	1	0	0	0
Fish	4	4	4	4	16		0	0	0	0	0
Total	17.5	21	15	14	67.5	Net	0.5	-2	2	0	0.5

Explanation/discussion of differences: between 1993 and 1994: Biggest changes compared to 1993 were: (1) a large improvement in **DO** at FB, +3, (no anoxia and all DO's > 2 ppm in 1994) resulting in change from "red" in 1993 to "green" in 1994 -- and at Elk River, +1, change from "red" in 1993 to "yellow" in 1994; (2) **Chlorophyll** at TZ changed from just "5", green, (x=4.0) in 1993 to "3", yellow, (x=2.2) in 1994 -- probably flow related (TZ pushed further downstream); (3) **Sediments** -- toxicity to test organisms at FB in 1994, no toxicity in 1993 -- and DDT detected in 1994 at TZ, none found in 1993 (sediments at both FB and TZ change from green in 1993 to yellow in 1994); (4) sediments in Elk R. improved from 4 in 1993 to 5 (yellow to green) in 1994, no ammonia found in 1994 as was found in 1993.

Note -- very high chlorophyll concentrations found in Elk R., highest of Vital Signs monitoring stations. Related to naturally high conc of nutrients in Elk River watershed.

Overall story for 1994: Good, with slight improvement over 1993; inclusion of Elk R. pulls reservoir score down (75% w/ compared to a 81% w/o). Important to note Elk R. improved over 1993 with better DO (red in 93 to yellow in 94), fish (yellow in 93 to green in 94), and sediment (yellow in 93 to green in 94). DO and sediment (no ammonia) improvements due to higher flows in 1994; fish may be higher due to better living conditions?? Chlorophyll in Elk R. still quite high and benthos poor. Biggest observation for reservoir in 1994 was significant improvement of DO at the FB -- changed from red in 1993 to green in 1994 -- again due to increased flows through the river system. Several changes in sediment quality: DDT found at TZ in 1994, not found previously (green in 93 to yellow in 94); toxicity at FB in 1994 not found in 1993 (green in 93 to yellow in 94); and an improvement at Elk R (no ammonia) in 1994 (yellow in 93 to green in 94).

Macrophytes - No estimates of aquatic plants were made for Wheeler Lake in 1994. Aquatic plants covered about 6600 acres on Wheeler Lake in 1993.

Reservoir: Tims Ford 1994 Score: 58%

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	NR	60 (DO and Chlorophyll only)	
1992	60	63 (DO, Chlorophyll, and Fish)	
1993	58	58 (all 5 indicators)	
1994	58	58 (all 5 indicators)	

Effect of method change between 1993 and 1994: No net change.

Impact of special case scores (i.e., ex/include embayments / TZ moved): Data for all 5 indicators for 1993 and 1994 only.

	1994 Results					Diff. Bet '93 and '94 ('94 Methods)				
	FB	MR-	MR-	Total		FB	MR-	Mr-	Net	
Chloro	5	5		10		0	0		0	
DO	1	1		2		0	0		0	
Sediment	2	5		7		-2	3		1	
Benthos	1	1		2		0	0		0	
Fish	4	4		8		0	-1		-1	
Total	13	16	0	29		-2	2		0	

Explanation/discussion of differences: between 1993 and 1994 (both years on '94 methods): No net change; Sediment Quality changed substantially by station and fish made a border-line change. **Sediment Quality** at FB in '94 had significant toxicity to both species and had elevated Ni so rated poor (red in RP). In '93 had Ni and ammonia but no toxicity so rated fair (yellow in '93 RP). At Mid-Res in '94 did not find any problems (no toxicity or elevated chemicals) so rated good (green). In '93 found toxicity and ammonia so rated poor (red in '93 RP). We do not have a good explanation for this shift. **Fish** community scores at FB slightly higher in '94 than in '93 but not enough to move to another category. However, RP color will change from yellow in '93 to green in '94 due to a methods change ('93 would have been green if '94 methods had been used).

Overall story for 1994: Tims Ford Reservoir changed little in overall health from '93 to '94--low end of fair range both years. Biggest contributors to relatively low score were poor DO and benthos. DO problems were anoxia in summer and much of water column with low DO (<2) during summer; typical of this type of reservoir. Benthos rated very poor both years, comprised of only chironomids and tubificids--only scored 8 in '94, the lowest possibe score. Sediment Quality rated good (green) at Mid-Res in '94. This was an improvement over '93 when sediments rated poor (red) due to toxicity and high ammonia. Sediment Quality at FB rated poor (red) in '94 due to significant toxicity and high nickel. This was lower than in '93 when sediments rated fair (yellow) due to high ammonia and nickel (no toxicity found in '93). Fish community color change at FB from yellow in '93 to green in '94 was mainly due to a change in methods. Fish score at Mid-Res in '94 was a little lower than in '93 but not enough to cause a color change (green both years).

GUNTERSVILLE RESERVOIR - SEQUATCHIE RIVER WATERSHED

This watershed includes Guntersville Reservoir and all tributaries draining directly to Guntersville Reservoir. As with the other watershed areas on the mainstem of the Tennessee River, most of the water leaving the watershed through Guntersville Dam enters the watershed area through discharges from the upstream dam (Nickajack). About 35,900 cfs enter from Nickajack Dam and about 40,700 cfs is discharged from Guntersville Dam on an annual average basis. The remaining 4800 cfs originates with the Guntersville Reservoir-Sequatchie River watershed area. The largest contributor of this flow is the Sequatchie River (about 800 cfs). The total watershed area is 2669 square miles. The area drained by the Sequatchie River is about 600 square miles.

Guntersville Reservoir is the dominant characteristic of this watershed. There are three Vital Signs monitoring site on Guntersville Reservoir: forebay, transition zone, and inflow. There is a stream monitoring site on the Sequatchie River at mile 6.3.

Guntersville Reservoir

Guntersville Dam, located at TRM 349.0, creates a 76 mile long reservoir with a surface area of 67,900 acres and a shoreline of 949 miles at full pool. Average annual discharge is about 40,700 cfs, corresponding to an average hydraulic retention time of about 13 days.

Guntersville Reservoir is similar to Wheeler Reservoir in several size characteristics, but it differs in one important feature. The average controlled storage volume of Guntersville is about half that of Wheeler. This is due to the shallow nature of Guntersville Reservoir at the inflow area and extensive shallow overbank areas. As a result, winter drawdown on Guntersville Reservoir is nominal to maintain navigation. The shallow drawdown allows the large overbank areas to be permanently wetted creating good habitat for aquatic macrophytes. Guntersville has the greatest area coverage of aquatic plants of any TVA reservoir.

The Sequatchie River joins the Tennessee River at about TRM 423, in the upstream portion of Guntersville Reservoir, just downstream from Nickajack Dam. On the average the Sequatchie River contributes less than 2 percent to the total flow of the Tennessee River through Guntersville Reservoir.

Data collected in 1990 and 1991, indicated a more riverine than transition environment at TRM 396.8. Consequently, in 1992 the transition zone sampling location was relocated further downstream to TRM 375.2. Results from the new site are being reviewed to determine if it is suitably located.

Reservoir: Guntersville 1994 Score: 83%

	Previous Scores		
	Reported	1994 Criteria	1994 Criteria
1991	66	81	81 (no TZ)
1992	83	85	85 (FB, TZ, Inf)
1993	78	81	81 (" " ")
1994	83	83	83 (" " ")

Effect of method change between 1993 and 1994: very little, '93 = 78% on '93 criteria and 81 % on '94 criteria

Impact of special case scores (i.e., ex/include embayments / TZ moved): All years are apples to apples except '91 - no TZ data because TZ moved in '92.

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	5	3	NA	NA	8		0	-2	NA	NA	-2
DO	5	5	NA	5	15		0.5	0	NA	4	4.5
Sediment	4	5	NA	NA	9		0	0	NA	NA	0
Benthos	4	5	NA	4	13		0	0	NA	0	0
Fish	2	3	NA	4	9		-2	0	NA	1	-1
Total	20	21		13	54	Net	-1.5	-2		5	1.5

Explanation/discussion of differences: between 1993 and 1994: (1) **DO** biggest change, primarily at inflow, concentrations very low in 1993 (1.8 ppm) but much higher in 1994 (all >5.0). Improvement was due to higher flows in 1994. (2) **Chlorophyll** at TZ changed from just "5" (x = 4.0) in 1993 to just "3" (x = 2.7) in 1994. Higher flows in '94 pushed the actual TZ downstream from our collection site. (3) No reduction seen in **benthos** in 1994; this differed from other reservoirs which were poorer in '94 due to poor DO's in '93. This was because G'ville DO's in '93 were good except at inflow (which were poor); should have seen reduction there in '94 but didn't?? (4) FB **fish** dropped 2 points (high yellow to low yellow for RP)--'94 assemblage had low abundance, no suckers, and high anomalies. (5) **Sediment** - no change in score--in 1993 chlordane at FB and '94 found PCBs.

Overall story for 1994: Still good! Biggest change was improved DO ('93 red and '94 green for RP) at inflow (see #1 above); this was off-set somewhat by lower chlorophylls at TZ, which was also a flow effect -- we sample at fixed sites but the actual TZ is not fixed, under higher flows it will be pushed downstream, sometimes below where we sample - such was probably the case in 1994. Increased turbidity which limits light penetration and hinders algal growth is also related to high flows. Benthos at forebay changed color for RP from green in '93 to yellow in '94--this was a "borderline" change; '93 was "just" over the scoring line and '94 was "just" under it.

Macrophytes - Almost 9600 acres of aquatic plants ocurred on Guntersville Reservoir in 1994, reflecting the steady increase over the last few years. Aquatic plants covered about 7600 acres in 1993, 6000 acres in 1992, and 5200 acres in 1991. Guntersville has more aquatic plants than any other lake in the Tennessee Valley, almost half of the combined plant acreages in all the Tennessee Valley lakes.

gunres94

NICKAJACK RESERVOIR - CHICKAMAUGA RESERVOIR WATERSHED

Nickajack and Chickamauga Reservoirs are primary features of this watershed. The Hiwassee River is the only sizeable tributary which merges with the Tennessee River within the watershed area. The drainage basin of the Hiwassee River is large enough to be designated a separate watershed. The remaining area drained by tributaries to these two reservoirs is 1780 square miles. On an annual average basis, about 3200 cfs is contributed to the Tennessee River from streams within this watershed. This compares to 27,100 cfs entering the upper end of Chickamauga Reservoir from Watts Bar Dam and 5600 cfs from the Hiwassee River, for a total average annual discharge from Nickajack Dam of 35,900 cfs.

There are two Vital Signs monitoring sites on Nickajack Reservoir, one at the forebay and one at the inflow. There is no transition zone site on Nickajack because the reservoir is short and water exchange is quite rapid. This causes conditions at the location that might be considered the transition zone to be similar to those at the forebay. Chickamauga Reservoir has four Vital Signs monitoring sites--the forebay, the transition zone, the inflow, and a new site established in 1993 in the Hiwassee River embayment.

Nickajack Reservoir

Nickajack Reservoir is one of the smallest reservoirs on the mainstem of the Tennessee River. With the dam at TRM 424.7, Nickajack has a length of 46 miles, surface area of 10,370 acres, and a shoreline of 192 miles at full pool. Average annual discharge from Nickajack is approximately 35,900 cfs which provides an average hydraulic retention time of only about three or four days, the shortest retention time among the reservoirs monitored in this program.

Results from the 1990 and 1991 monitoring indicated that both the forebay and transition zone sampling sites had quite similar water quality. This was expected since the two sites are relatively close together (separated by only 7.5 river miles), and Nickajack is a well-mixed, run-of-the-river reservoir. Therefore, sampling at the transition zone in Nickajack Reservoir was discontinued in 1992.

Chickamauga Reservoir

Chickamauga Dam is located at TRM 471.0. The reservoir is 59 miles long, has 810 miles of shoreline, and has a surface area of 35,400 acres at full pool. The average annual discharge is approximately 34,200 cfs which provides an average hydraulic retention of nine to ten days.

The Hiwassee River, a major tributary to the Tennessee River, flows into the middle portion of Chickamauga Reservoir at about TRM 499. The flow from the entire Hiwassee River watershed

contributes approximately 16.5 percent of the flow through Chickamauga Reservoir. About 10 percent of the 16.5 percent is from the Ocoee River and tributaries in the lower end of the Hiwassee watershed (i.e., downstream of Apalachia Dam).

Vital Signs monitoring activities were expanded in 1993 to include a site in the Hiwassee River embayment, which covers about 6500 acres. Given the relatively high flows in the Hiwassee River (about 5600 cfs annual average), there is substantial water exchange in this embayment, much greater than in any of the other three embayments monitored.

Reservoir: Nickajack 1994 Score: 90%

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	89	85	NA
1992	83	83	NA
1993	88	88	NA
1994	90	90	NA

Effect of method change between 1993 and 1994: no change in total score for '93; 88 using '93 criteria or '94 criteria

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	3			NA	3		-2			NA	-2
DO	5			5	10		0			3	3
Sediment	5			NA	5		1			NA	1
Benthos	5			5	10		0			0	0
Fish	4			4	8		0			-1	-1
Total	22			14	36	Net	-1			2	1

Explanation/discussion of differences: between 1993 and 1994: Biggest difference was in **DO** scores at inflow (+3 points). All inflow DO measurements good (>5ppm) in 1994 compared to low (2.2 ppm) DO concentrations in 1993. Improved DO result of increased flows in 1994. Another large change was for **chlorophyll** (-2 pts). Mean concentration at FB changed from 6 (good, score = 5) in '93 to 2.7 (fair, score = 3) in '94 (mean of 3.0 is cut-off). This was most likely due to higher flows in '94 reducing retention time in Nickajack to point it was essentially a flow-through reservoir, not allowing time even in FB for algae to "set-up house keeping". **Sediment** improved slightly in 1994; found chlordane in 1993, found nothing in 1994. Fish score decreased at inflow by 1 pt due to change/improvement in scoring criteria - no color change in RP; at forebay score changed very little but RP color changed yellow to green due to method change.

Overall story for 1994: Very good again, still one of best in system (highest score observed in 1994 = 90% as it was in 1993 = 88%). Biggest story to note was improved DO at inflow--changed from red in '93 to green in '94 (see above for detail). As with other mainstream reservoirs, this resulted from increased flows in '94. These high flows negatively impacted chlorophyll levels at FB causing levels to be just below that needed to maintain good fish populations. Sediments at FB rated better in 1994 (chlordane found in '93 but not '94) color change yellow to green. No true change in fish at FB, color change due to a change in the wasy data were evaluated.

Macrophytes - No estimates of aquatic plants were made Nickajack Lake in 1994. Aquatic plants covered about 1000 acres on Nickajack Lake in 1993.

nicres94

Reservoir: Chickamauga **1994 Score: 87%**

	Previous Scores		
	Reported	1994 Criteria	1994 Criteria w/o Hiwassee Embay
1991	90	88	88 (inflow, TZ, FB)
1992	73	81	81 (inflow, TZ, FB)
1993	83	86	85 (inflow, TZ, FB)
1994	87	87	87 (inflow, TZ, FB)

Effect of method change between 1993 and 1994: Had small effect as reflected in total scores for 1993 (83% vs 86%)

Impact of special case scores (i.e., ex/include embayments / TZ moved): Inclusion/exclusion of Hiwassee embayment had almost no effect on overall reservoir scores (see above).

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	5	5	5	na	15		0	0	0		0
DO	5	5	5	3	18		1	0.5	0	0	1.5
Sediment	3.5	5	5	na	13.5		0.5	2	1		3.5
Benthos	4	5	3	3	15		-1	0	-1	-1	-3
Fish	4	4	4	5	17		0	-1	0	0	-1
Total	21.5	24	22	11	78.5	Net	0.5	1.5	0	-1	1

Explanation/discussion of differences: between 1993 and 1994: (1) Biggest change was improvement in **sediments** -- TZ in 1993 had slight toxicity and chlordane but in 1994 neither were found resulting in (+2) change; Hiwassee Embay had high copper (>50 ppm) in 1993 but not (<50 ppm) in 1994 (this was a "border-line" change) resulting in a (+1) change; at FB had slight improvement (+0.5), high Cu and Zn (and chlordane) in 1993 vs. high Cu and Zn in 1994 (with PCB in only one of two duplicates) in 1994. (2) **DO** improved at FB (+1) and TZ (+0.5) -- flow related, no anoxia or low DO's observed in 1994. (3) **Benthos** decreased by 1 pt at FB, inflow, and Hiwassee Embay (the FB and inflow had poor DO in 1993). No low DO's at TZ in 93 or 94 and benthos was good at this location in 93 and 94. The decrease of 1 for benthos on Hiwassee Embay is not likely DO related (some other reason?). (4) **Fish** decreased by 1 pt at TZ in 1994, few fish collected and few suckers at TZ.

Overall story for 1994: Chickamauga Reservoir was good again in 1994, slight overall improvement compared to 1993 (87% in 1994 and 83% in 1993). (1) As expected, some improvement in DO was observed -- FB changed from yellow in 1993 to green in 1994 (flow related); TZ and Hiwassee Embay green both years; and inflow yellow both years (low DO releases from Watts Bar). (2) Also, as expected benthos was lower in 1994 at FB, inflow, and Hiwassee Embay (due largely to lower 1993 DO's impacting 1994 benthos particularly at FB and inflow) -- FB and Hiwassee benthos change green to yellow -- while at inflow remains yellow, but score was lower in 1994 compared to 1993). (3) Large change observed in sediments. TZ sediments change from yellow to green (copper just above cutoff in 1993 and just below in 1994). At FB continued to measure high concentrations of zinc and copper as in past years (yellow, again). (4) Fish at TZ changed from green in 1993 to yellow in 1994 - not many fish collected (especially by electrofishing) and few sucker species (indicators of habitat condition, i.e. more = better conditions).

Macrophytes - No estimates of aquatic plants were made on Chickamauga in 1994. Aquatic plants covered about 1200 acres Chickamauga Lake in 1993.

HIWASSEE RIVER WATERSHED

The headwaters of the Hiwassee River extend into the Blue Ridge Mountains in Tennessee, North Carolina, and Georgia. Streams in this watershed have naturally low concentrations of nutrients and dissolved minerals. These streams change from steep gradient, cold water trout streams in the mountains to lower gradient warm water streams in the valley.

The Hiwassee River Watershed has an area of 2700 square miles and an average annual discharge to the Tennessee River of 5640 cfs. The confluence of the Hiwassee River with the Tennessee River is in Chickamauga Reservoir at Tennessee River Mile 499.4. The lower portion of the Hiwassee River is impounded by backwater from Chickamauga Dam. The impounded portion of the Hiwassee River forms a large embayment (about 6500 surface acres) which extends over 20 miles up the Hiwassee River.

The largest tributary to the Hiwassee River is the Ocoee River, with a drainage area of about 640 square miles. Due to past copper mining and industrial activities in the Copperhill area, several streams and reservoirs in the Ocoee River basin have degraded water quality.

There are eight TVA reservoirs in the Hiwassee River. Vital Signs monitoring activities are conducted on the five largest reservoirs: Hiwassee Reservoir (forebay, mid-reservoir, and inflow); Chatuge Reservoir (forebay sites on the Hiwassee River and Shooting Creek arms); Nottely Reservoir (forebay and mid-reservoir); Ocoee Reservoir No. 1 (forebay only); and Blue Ridge Reservoir (forebay only). Apalachia, Ocoee No. 2, and Ocoee No. 3 Reservoirs are not included in this monitoring because of their small size.

There is a stream monitoring site on the Hiwassee River at HiRM 36.9, about 2.5 miles upstream of the confluence of the Ocoee River. A new site was added in 1994 on the Ocoee River at mile 2.5. Vital Signs monitoring also includes a site on the Hiwassee River embayment (at HiRM 10) of Chickamauga Reservoir.

Hiwassee Reservoir

Hiwassee Reservoir, in the southwestern corner of North Carolina, is the second-largest of the five reservoirs in the Hiwassee River watershed included in the Vital Signs monitoring program. Hiwassee Reservoir is impounded by Hiwassee Dam at river mile 75.8. At full pool level, its backwater storage pool is about 22 miles long, 6100 acres in surface area, and has a mean depth of about 69 feet (with a maximum depth of about 255 feet at the dam). It has an average annual discharge of about 2020 cfs and average residence time of about 105 days. Hiwassee Reservoir has an average annual drawdown of 45 feet.

Chatuge Reservoir

Chatuge Reservoir is located on the Georgia-North Carolina state line in northeastern Georgia and is formed by Chatuge Dam at Hiwassee River mile (HiRM) 121.0. At full pool elevation, the reservoir is 13 miles long and has a surface area of about 7000 acres. Its maximum depth at the dam is 124 feet, and it has a mean depth of 33 feet. An average annual discharge of 459 cfs results in an average hydraulic residence time of about 260 days. Chatuge Reservoir has a potential useful controlled storage of 23 feet (1928-1905 feet MSL), however, the annual drawdown averages only ten feet.

Only the forebay of Chatuge Reservoir was monitored prior to 1993. A new monitoring site was added in 1993 in the Shooting Creek arm to further evaluate this rather large part of the lake. Because of its physical features, the Shooting Creek site would be expected to be representative of forebay conditions.

Nottely Reservoir

Nottely Reservoir is formed by Nottely Dam at Nottely River mile 21.0 in northern Georgia. At full pool elevation, the reservoir is 20 miles long, covers 4200 acres, and has a mean depth of 40 feet, with a maximum depth of about 165 feet at the dam. Long-term flows from Nottely Dam average about 415 cfs which result in an average hydraulic retention time of about 206 days. The annual drawdown averages about 24 feet on Nottely Reservoir.

Blue Ridge Reservoir

Blue Ridge Dam impounds the Toccoa River at mile 53.0 in rural northwest Georgia. The watershed is mountainous and forested, with a significant portion of the basin lying within the Chattahoochee National Forest. At full pool, Blue Ridge Reservoir is about 11 miles long, 3300 acres in surface area, and 155 feet deep at the dam, with a average depth of 59 feet. The rate of discharge of water from Blue Ridge Reservoir averages about 610 cfs, which results in an average theoretical residence time of about 159 days. The annual drawdown of Blue Ridge Reservoir averages 36 feet.

Ocoee Reservoir No. 1 (Parksville Reservoir)

Ocoee No. 1 Reservoir, also known as Parksville Reservoir, is formed by Ocoee No. 1 Dam at Ocoee River mile 11.9. At full pool elevation, the reservoir has a surface area of about 1900 acres and length of 7.5 miles. Ocoee No. 1 Reservoir is located downstream from the Copper Basin, and decades of

erosion have caused significant filling of the reservoir. Ocoee No. 1 Reservoir has lost about 25 percent of its original volume, has an average depth of 45 feet and is about 115 feet deep at the dam. An average annual discharge of about 1400 cfs from Ocoee No. 1 Dam results in a reservoir retention time of approximately 30 days. Although Ocoee No. 1 Reservoir is not operated for flood control (only for peaking power generation), its annual drawdown averages about seven feet.

Reservoir: Hiwassee **1994 Score: 68%**

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	82 (No Sed/Bug; Incl Inflow)	70 (No Sed/Bug; No Inflow)	70 (No Sed/Bug; No Inflow)
1992	69 (No Sed/Bug; Incl Inflow)	73 (No Sed/Bug; No Inflow)	73 (No Sed/Bug; No Inflow)
1993	58 (Incl Sed/Bug; No Inflow)	65 (Incl Sed/Bug; No Inflow)	85 (No Sed/Bug; No Inflow)
1994	68 (Incl Sed/Bug; No Inflow)	68 (Incl Sed/Bug; No Inflow)	70 (No Sed/Bug; No Inflow)

Effect of method change between 1993 and 1994: New methods in '94 increased '93 score by 7%, mostly due to changes in chlorophyll and fish methods

Impact of special case scores (i.e., ex/include embayments / TZ moved): Special case provides an apples to apples comparision through time.

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	3	3			6		-2	-2			-4
DO	2	4			6		-1.5	0			-1.5
Sediment	5	5			10		3	3			6
Benthos	1	2			2		0	0			0
Fish	5	4			9		1	0			1
Total	16	18			34	Net	0.5	1			1.5

Explanation/discussion of differences: between 1993 and 1994: There were several substantial shifts in indicators which tended to off-set one another. **Chlorophyll** ratings decreased substantially because of high chlorophyll concentrations at both sampling locations in '94--twice as high as ever seen since monitoring began there in 1991. (Note: "high" concentration is relative to the expectations for a reservoir in the Blue Ridge Ecoregion--good <4; fair 4 - 7; and poor >7). In '94 mean chlorophyll at FB was 6 and Mid-Res was 5 (previously had seen about 3 at FB and 3.5 at Mid-Res. The high mean at the FB was driven by a very high sample (22) collected in April. This wasn't the case for the relatively high level at the Mid-Res--most monthly samples were above the long-term mean. **DO** declined at the FB in '94 compared to '93 but was similar to '91 and '92. Less severe DO conditions in '93 were probably due to special hydro-electric operations (greater discharge) during the very dry summer months and greater draw-down to allow maintenance operations during autumn. **Sediment Quality** improved significantly in '94 compared to '93 (the first year sediments were sampled on Hiwassee). Sediments rated good at both locations in 1994, but in '93 there had been significant toxicity and chlordane at the FB and Mid-Res (both rated poor). **Fish** improved slightly in '94--will be good (green) in RP; in '93 they were reported as fair (yellow) but on '94 methods, '93 is good (green).

Overall story for 1994: Hiwassee rated fair in '94. Most notable observations for '94:
(1) Chlorophyll highest ever seen on Hiwassee (see above for details). (2) Improvements in DO seen in '93 (rated fair) were not seen in '94 (rated poor, like in '92) (see above for explanation). (3) Sediments much improved in '94 --rated good, no problems found. In '93 both locations rated poor due to toxicity and chlordane. (Note: chlordane in '93 may have been a 'false positive' due to methods Echem used in '93). (4) Benthos rated poor again (same as in '93) at both locations--7 of 8 metrics received "1" at FB and 5 of 8 received "1" at the Mid-Res.
Note: In '94 sampling was discontinued for fish and benthos at the upper/inflow location on the Hiwassee).

Reservoir: Chatuge **1994 Score: 77%**

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	60	60	60(For all '91-Chloro, DO, Fish, FB only)
1992	56	80	80(For all '92-Chloro, DO, Fish, FB only)
1993	67	75	80(For Special Case-only used above)
1994	77	77	90(For Special Case-only used above)

Effect of method change between 1993 and 1994: Methods change had significant effect. Results from '93 scored 8% higher on '94 menthods than on '93 methods. Main contriibutor was chlorophyll--expections for reservoirs in Blue Ridge Ecoregion changed beginning in '94 (good<4; fair=4-7; and poor>7).

Impact of special case scores (i.e., ex/include embayments / TZ moved): Goal for Special Case is to provide apples to apples comparison. In this case, all years good except '91, which had poor DO rating, not seen in other years. In '91 and '92 only sample site was forebay and only sampled chlorophyll, DO and fish. In '93 added Shooting Creek and sediments and benthos.

	1994 Results						Differences between 1993 and 1994				
	FB	Sh Cr	Emb	Inf	Total		FB	Sh Cr	Emb	Inf	Net
Chlorophyll	5	5			10		0	0			0
DO	4.5	4			8.5		0.5	0.5			1
Sediment	4	4			8		1	1			2
Benthos	2	3			5		-2	-1			-3
Fish	4	3			7		1	0			1
Total	19.5	19			38.5	Net	0.5	0.5			1

Explanation/discussion of differences: between 1993 and 1994: Little overall change between '94 and '93 when '93 results are scored on '94 methods. Several indicators shifted substantially, generally off-setting one another. **DO** rating at FB improved from fair in '93 (anoxic part of summer) to good in '94 (no anoxia found). At Shooting Creek DO improved also but not enough for a change in rating--no anoxia in '94 but x-section >10%, compared to anoxia and x-section >10% in '93. **Sediment** improved at both locations, but not enough for a color change in RP. At FB only problem found in '94 was elevated Cu (rated fair); in '93 found toxicity but no other problems (rated fair). At Shooting Creek found Chromium and Copper in '94 (rated fair); same as in '93 except list in '93 also included Nickel (rated fair). **Benthos** was only indicator to decline in '94 compared to '93. Both locations had much lower abundance in '94 and those animals present were mostly chironomids. Benthos rated fair (yellow) at both locations in '94 compared to good (green) in '93. **Fish** improved slightly at FB but not enough for a color change.

Overall story for 1994: Chatuge had good ecological health in '94. In '93 it had been reported as fair, but it would have been good if '94 methods had been used (see "Effect of Method Change" above). None of the indicators were poor (red) in '94, same as in '93. Sediments improved slightly but the most noteworthy observation on sdeiments is presernce of elevated chromium in Shooting Creek. This is the only reservoir with elevated chromium. Also had high concentrations of Cu and Ni in Shooting Creek in both '93 and '94. For some reason very few benthic organisms collected in '94; we don't know why. Benthos color in RP will be yellow both for sites in '94; both sites green in '93.

Reservoir: Nottely **1994 Score: 56%**

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	60	60	60 (For all '91-Chloro, DO, Fish, FB only)
1992	60	53	53 (For all '92-Chloro, DO, Fish, FB only)
1993	64	62	60 (For Special Case-only used above)
1994	56	56	47 (For Special Case-only used above)

Effect of method change between 1993 and 1994: Very little change over all (only 2%). Chlorophyll method changes tended to lower reservoir score (concentrations too high for a reservoir in Blue Ridge Ecoregion) and benthos changes tended raise score but not quite as much as the chlorophyll reduction.

Impact of special case scores (i.e., ex/include embayments / TZ moved): The goal for Special Case is to provide an apples to apples comparision through time. In '91 and'92 the only sample site was FB and only chlorophyll, DO, and fish were sampled. The Mid-Res site and sediments and benthos were added in '93. For this case, the lower score in '94 (47) was due to chlorophyll being too high.

	1994 Results						Differences between 1993 and 1994				
	FB	Mid-Re	Emb	Inf	Total		FB	Mid-Re	Emb	Inf	Net
Chlorophyll	3	3			6		-2	0			-2
DO	1	2			3		0	1			1
Sediment	4	3			7		1	-2			-1
Benthos	2	4			6		0	-1			-1
Fish	3	3			6		0	0			0
Total	13	15			28	Net	-1	-2			-3

Explanation/discussion of differences: between 1993 and 1994: **Chlorophyll** concentrations were higher in '94 than seen since monitoring began in 1991. The mean at the FB in '94 was 5.4 (rated fair, yellow), compared to means in previous years between 3 and 4. At Mid-Res mean was 6.7 in '94 (rated fair, yellow) compared to means in previous years between 5 and 6. **DO** was slightly improved at Mid-Res in '94--less low DO water, not enough improvement to result in a category shift (still poor as in previous years). **Sediments** improved slightly at FB in '94 (toxicity to one test animal) compared to '93 (toxicity to both test animals). Both years rated fair (yellow in RP). At Mid-Res sediments were highly toxic to one test animal (all killed) in '94 resulting in a fair rating. No problems were seen there in '93 so rated good. **Benthos** at Mid-Res declined slightly in '94 from a very good score in '93 (green) to a slighlty lower score in '94 (high yellow).

Overall story for 1994: Nottely borderline poor in '94; generally reduced from '93. None of the indicators rated good (green) at either location. Chlorophyll was fair (yellow) at both locations in '94 because concentrations were high for a reservoir in the Blue Ridge Ecoregion--higher than seem in any previous year. Low DO still a problem in Nottley--poor (red) at both lcoations in '94 and '93. Benthos at FB was similar in '94 to that in '93, but RP will show a color change from yellow in '93 to red in '94 due to method change (i.e., '93 would have been red if '94 methods had been used). Benthos at Mid-Res rated fair (yellow) in '94; a borderline change from '93 which rated good (green). Fish rated fair because no intolerant species and few suckers were found at both sites and because of numerous abnormalities at the Mid-Res.

Reservoir: Blue Ridge 1994 Score: 86%

	Previous Scores	
	Reported	1994 Criteria
1991	87	80 (only Chl, DO, and fish)
1992	73	83
1993	72	80
1994	86	86

Effect of method change between 1993 and 1994: Results for '93 scored higher on '94 methods due to change in chlorophyll -- beginning with '94 methods -- expectations for chlorophyll accept low concentrations as "good" for reservoirs in Blue Ridge Ecoregion, (see table below).

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	5	na	na	na	5		0	na	na	na	0
DO	4.5	na	na	na	4.5		-0.5	na	na	na	-0.5
Sediment	5	na	na	na	5		2	na	na	na	2
Benthos	3	na	na	na	3		-2	na	na	na	-2
Fish	4	na	na	na	4		2	na	na	na	2
Total	21.5	na	na	na	21.5	Net	1.5	na	na	na	1.5

Explanation/discussion of differences: between 1993 and 1994: (1) **Chlorophyll** concentrations for both '93 and '94 scored good using '94 methods ('93 was fair on previous methods; RP color change yellow in '93 to green in '94). (2) **DO** conditions were not quite as good in '94 as '93 -- a small volume of low DO water with short duration observed in '94, but not enough to reduce rating from good. (3) **Sediment** -- No problems found in '94 (good); in '93 found toxicity (fair). (4) **Benthos** -- '93 benthos in Blue Ridge lake was best for all Blue Ridge Ecoregion reservoirs. In '94 several metrics were reduced -- much fewer animals collected, mostly chironomids, fewer taxa, fewer EPT, some samples had no animals. RP color yellow for '94 (green in '93). (5) **Fish** -- increased diversity (all species groups/metrics) was main contributor to improved score compared to '93; few fish collected in both '93 and '94. Note: RP will not show a color change (yellow in both '93 and '94), but there were improvements in the fish community in '94. This isn't seen in RP because '93 methods scored '93 results fair (yellow), while '94 methods scored '93 results poor (red).

Overall story for 1994: Blue Ridge lake good again in '94. The high score results from both a new way of evaluating chlorophyll (RP color change yellow in '93 to green in '94) and real/true improvements in sediment (no problems in '94 = good) and fish (found greater variety of fish species in '94; Note - still very few fish collected). The overall score for Blue Ridge was the highest of all tributary reservoirs for the last three years. Benthos score decreased in '94 (see above for explanation) compared to '93; RP color change green in '93 to yellow in '94. Note: none of the indicators rated poor for Blue Ridge in '94.

Nutrient Limited Watershed (Blue Ridge Ecoregion):

Chlorophyll Concentrations	Rating
< 4 ug/L	good - 5
4 - 7 ug/l	fair - 3
> 7 ug/l	poor - 1

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Reservoir: Parksville 1994 Score: 60%

	Previous Scores	
	Reported	1994 Criteria
1991	47	70 (only Chl, DO, and fish - assumed poor "1" sediment)
1992	53	70 (only Chl, DO, and fish - assumed poor "1" sediment)
1993	52	68
1994	60	60

Effect of method change between 1993 and 1994: Results for '93 scored higher on '94 methods due to change in chlorophyll. Beginning with '94 methods, expectations for chlorophyll accept low concentrations as "good" for reservoirs in Blue Ridge Ecoregion, (see table below).

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	5	na	na	na	5		0	na	na	na	0
DO	5	na	na	na	5		0	na	na	na	0
Sediment	0	na	na	na	0		-2	na	na	na	-2
Benthos	1	na	na	na	1		-1	na	na	na	-1
Fish	4	na	na	na	4		1	na	na	na	1
Total	15	na	na	na	15	Net	-2	na	na	na	-2

Explanation/discussion of differences: between 1993 and 1994: (1) **Chlorophyll** concentrations for both '93 and '94 scored good using '94 methods ('93 was poor on previous methods; RP color change red in '93 to green in '94). (2) **DO** good in Parksville again -- little oxygen demand. (3) **Sediments** -- chemically, sediments in Parksville are so bad as to be in a class by themselves (high/very high concentrations of arsenic, copper, lead, zinc, cadmium, and PCB's). In '93 sediments rated poor (bad chemically but no pore water toxicity found. In '94 sediments rated very poor (bad chemically and significant toxicity). RP color for sediment is red for both '93 and '94. Sediment score contributed to overall ecological health purposefully reduced from "1" to "0" to acknowledge the very poor chemical status and toxicity for '94. (4) **Benthos** poor in both '93 and '94 (RP color red both years) but was even poorer in '94 than '93 -- 7 of 8 metrics scored "1" for benthos in '94. (5) **Fish** improved over previous years. Most metrics (especially species metrics) improved, more individuals, more insectivores, still no suckers, no abnormalities either year ('93 or '94).

Overall story for 1994: Parksville score in '94 higher than any previously reported score but the '94 score was the lowest among '91, '92, '93, and '94 when all data are evaluated using the same '94 methods. The most significant method change was for chlorophyll. New method accepts low chlorophyll concentrations as good for Blue Ridge Ecoregion reservoirs (naturally low in nutrients). This is an important change for all the Hiwassee Watershed reservoirs. Parksville's biggest problems are sediment quality (see above) and poor benthos -- both red.
Note: There are signs that Parksville is continuing to recover. Over past few years we have seen more fish and a greater variety of fish in Parksville lake.

Nutrient Limited Watershed (Blue Ridge Ecoregion):

Chlorophyll Concentrations	Rating
< 4 ug/L	good - 5
4 - 7 ug/l	fair - 3
> 7 ug/l	poor - 1

WATTS BAR RESERVOIR, FORT LOUDOUN RESERVOIR, AND MELTON HILL RESERVOIR WATERSHED

This watershed area is relatively small (1370 square miles) and includes three reservoirs: Fort Loudoun and Watts Bar Reservoirs on the Tennessee River and Melton Hill Reservoir on the Clinch River. All three are run-of-the-river reservoirs with relatively short retention times and annual pool drawdowns of only a few feet. The inflow of Fort Loudoun Reservoir is actually the origin of the Tennessee River. The Holston and French Broad Rivers merge at that point to form the Tennessee River. The Little Tennessee River, another major tributary to the Tennessee River, enters Fort Loudoun Reservoir near the forebay. Watts Bar Reservoir is immediately downstream of Fort Loudoun. The Clinch River, another major tributary, merges with the Tennessee River upstream of the transition zone on Watts Bar Reservoir. Melton Hill Dam bounds the upper end of Watts Bar Reservoir on the Clinch River and Fort Loudoun Reservoir bounds it on the Tennessee River.

Like the other watershed areas formed around one or more of the reservoirs on the mainstream of the Tennessee River, very little of the water leaving this watershed area originates from within. The average annual discharge through Watts Bar Reservoir is about 27,000 cfs. Of this, about 25 percent (6800 cfs) enters from the French Broad River, 16 percent (4500 cfs) from the Holston River, 21 percent (5700 cfs) from the Little Tennessee River, and 15 percent (4200 cfs) from the Melton Hill Dam on the Clinch River. Another five percent (1400 cfs) is contributed by the Emory River, a tributary to the Clinch River near the confluence with the Tennessee River. The remaining 18 percent (4800 cfs) originates from streams which drain directly to one of these reservoirs.

Vital Signs monitoring activities are conducted at the forebays, transition zones, and inflows of all three of these reservoirs. Watt Bar Reservoir has two inflow sites, one near Fort Loudoun Dam and one near Melton Hill Dam. There is one stream monitoring site on the Emory River at Emory River Mile 18.3.

Watts Bar Reservoir

Watts Bar Reservoir impounds water from both the Tennessee River and one of the major tributaries to the Tennessee River, the Clinch River. The three dams which bound Watts Bar Reservoir are: Watts Bar Dam located at Tennessee River Mile (TRM) 529.9, Fort Loudoun Dam located at TRM 602.3, and Melton Hill Dam located at Clinch River mile (CRM) 23.1. The total length of Watts Bar Reservoir, including the Clinch River arm is 96 miles, the shoreline length is 783 miles, and the surface area is 39,000 acres. The average annual discharge from Watts Bar is approximately 27,000 cfs, providing an average hydraulic retention time of about 19 days.

The confluence of the Clinch and Tennessee Rivers is upstream of the transition zone sampling location in Watts Bar, so biological sampling was conducted at the forebay, transition zone, and both the Tennessee River and Clinch River inflows. Water entering Watts Bar from Melton Hill Reservoir is quite cool due to the hypolimnetic withdrawal from Norris Reservoir (a deep storage impoundment) upstream from Melton Hill. Water entering Watts Bar Reservoir from Fort Loudoun Dam is usually warmer and lower in DO during summer months than water entering from Melton Hill Dam.

The Emory River is a major tributary to the Clinch River arm of Watts Bar Reservoir and supplies about 5 percent of the average annual flow through Watts Bar Reservoir. The Tennessee and Little Tennessee Rivers (i.e., discharge from Fort Loudoun Dam) account for about 75 percent of the flow, and the Clinch River (i.e., discharge from Melton Hill Dam) accounts for about 15 percent through Watts Bar Reservoir.

Fort Loudoun Reservoir

Fort Loudoun Reservoir is the ninth and uppermost reservoir on the Tennessee River with the dam located at TRM 602.3. The surface area and shoreline are relatively small (14,600 acres and 360 miles, respectively) considering the length (61 miles), indicating it is mostly a run-of-the-river reservoir. The average annual discharge from Fort Loudoun Dam is 18,400 cfs which provides an average hydraulic retention time of about ten days.

Fort Loudoun Reservoir (and the Tennessee River) is formed by the confluence of the French Broad and Holston Rivers, with both of these rivers having a major reservoir upstream. Douglas Dam, 32.3 miles up the French Broad River, and Cherokee Dam, 52.3 miles up the Holston River, form deep storage impoundments, each having long retention times. Both of these deep storage impoundments become strongly stratified during summer months resulting in the release of cool, low DO, hypolimnetic water during operation of the hydroelectric units. Some warming and reaeration of the water occurs downstream from Cherokee and Douglas Dams, but both temperature and DO levels are sometimes low when the water reaches Fort Loudoun Reservoir.

Fort Loudoun Reservoir also receives surface waters from the Little Tennessee River, via the Tellico Reservoir canal, which connects the forebays of the two reservoirs. (Since Tellico Dam has no outlet, under most normal conditions, water flows into Fort Loudoun Reservoir from Tellico Reservoir.) Water from Tellico Reservoir (Little Tennessee River) is often cooler and higher in DO, and has a much lower conductivity than water in Fort Loudoun Reservoir (Tennessee River). In 1992, the forebay sampling location on Fort Loudoun Reservoir (originally located at TRM 603.2) was moved upstream to

TRM 605.5. This resulted in a better assessment of the water quality conditions of the Tennessee River in the forebay portion of Fort Loudoun Reservoir by minimizing the effects of the Little Tennessee River and Tellico Reservoir on the data gathered in the forebay of Fort Loudoun Reservoir.

Although Fort Loudoun Reservoir is a mainstream reservoir, its complex set of hydrologic conditions (cool water inflows from the Holston, French Broad, and Little Tennessee Rivers) often causes it to exhibit several characteristics that are more typical of a storage impoundment. In fact, analysis of historical fisheries data for the Tennessee Valley indicates the fish community of Fort Loudoun Reservoir is more similar to that in Valley storage impoundments than in other mainstream reservoirs.

Melton Hill Reservoir

Melton Hill Dam is located at mile 23.1 on the Clinch River and is 56.7 miles downstream of Norris Dam. Impounded water extends upstream from Melton Hill Dam about 44 miles. Melton Hill Reservoir has about 170 miles of shoreline and 5690 surface acres at full pool. Average flow through Melton Hill is about 4900 cfs resulting in an average retention time of approximately 12 days. Melton Hill is TVA's only tributary dam with a navigation lock.

The predominant factor influencing the aquatic resources of Melton Hill Reservoir, especially the inflow and mid-reservoir areas, is the cold water entering from Norris Dam discharges. During summer, water discharged from Norris is cold and low in oxygen content. Oxygen concentrations are improved by a re-regulation weir downstream of Norris Dam and by atmospheric reaeration in the river reach between Norris Dam and upper Melton Hill Reservoir. However, water is warmed little and is still quite cool when it enters upper Melton Hill Reservoir. Bull Run Steam Plant, located at about CRM 47, warms the water some, but water temperatures are still too cool to support warm water biota and too warm to support cold water biota.

Reservoir: Watts Bar **1994 Score: 79%**

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	69	71	
1992	71	76	
1993	68	74	
1994	79	79	

Effect of method change between 1993 and 1994: Created a 6% pt improvement mostly due to scores for fish and benthos being higher using '94 criteria.

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Inf- TN	Inf-Clinch	Total		FB	TZ	Inf-TN	Inf-Clinch	Net
Chlorophyll	3	5	na	na	8		-2	0	na	na	-2
DO	4	5	4	5	18		2	0	1	0	3
Sediment	4	4	na	na	8		2	0	na	na	2
Benthos	3	5	4	2	14		0	0	2	-1	1
Fish	4	4	4	3	15		1	-1	1	-1	0
Total	18	23	12	10	63	Net	3	-1	4	-2	4

Explanation/discussion of differences: between 1993 and 1994: (1) Low **DO** water much reduced in '94 compared with '93, however still had some anoxia in '94 at the FB - this is expected given dam characteristics; overall improvement due to higher flows in '94. (2) **Chlorophyll** at FB higher in '94 (x=11) just over cutoff from good to fair -- have seen these higher concentrations before at FB. (3) **Sediment** score at FB much better -- '93 had significant toxicity and ammonia while in '94 neither found, but did find low levels of PCB's in sediment for first time (improved lab analytical methods lowered detection limit for PCB's in '94). TZ no color change but '93 found chlordane and '94 found PCB's. (4) **Benthos** -- contrary to other reservoirs, saw no change or improvements at most locations; greatest improvement was at Inf-TN -- gained 2 pts (RP red to yellow). Note that 1993 DO's at Inf-TN were not significantly different from other years, so DO's not as big a factor. Also, note benthos change of 2 pts was borderline -- high "2" in '93 and low "4" in '94. Benthos at FB decreased slightly (RP green in '93 to yellow in '94) and at TZ increased slightly (yellow to green) -- more difficult to discern DO "influences in Watts Bar because the FB typically has at least some DO problems even in good flow years. Also, need to note scoring methods changes may be important -- FB benthos may have been rated too high in '93 -- was green in RP and rated "4" in '93 using '93 criteria, whereas using '94 criteria, 1993 results would be colored yellow and rate "3" -- the reverse situation occurred at TZ.

Overall story for 1994: Overall score improved substantially (1994 = 79%); highest score ever for Watts Bar. Main contributors were: (1) improved scoring methods, especially those for benthos (more significant for Watts Bar than other reservoirs). (2) Higher flows helped improve DO at FB and at Inf-TN (compared to 1993), with RP color change red to yellow at FB. (3) Sediment quality at FB improved (RP red in '93 to yellow in '94), no toxicity found in '94 as was found in '93, but did find low concentrations of PCB's (improved methods lowered detection limit in '94). (4) Benthos community was better at Inf-TN in '94 than any previous year (real change, not due to methods) and RP color will be yellow for first time -- will be interesting to see if we find this again in '95. Other color changes for benthos (FB green to yellow and TZ yellow to green) mostly due to methods change as noted above in # 1). (5) Fish color changes at TZ, RP color will be green for '94 ('93 results using '93 criteria resulted in yellow, but '93 results using '94 criteria would be green, so no real change in fish assemblage). At Inf-TN color change from yellow to green was true improvement in fish assemblage (fewer tolerant species and better community balance).

wbrres94

Reservoir: Fort Loudoun 1994 Score: 61%

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	60	63	
1992	53	59	
1993	58	60	
1994	61	61	

Effect of method change between 1993 and 1994: Very little effect (only 2% pts difference in '93 using '93 and '94 criteria)

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	3	3	na	na	6		0	0	na	na	0
DO	4.5	5	na	na	9.5		-0.5	0	na	na	-0.5
Sediment	4	4	na	na	8		2	0	na	na	2
Benthos	1	2	na	1	4		0	0	na	0	0
Fish	3	3	na	3	9		-1	0	na	0	-1
Total	15.5	17		4	36.5	Net	0.5	0		0	0.5

Explanation/discussion of differences: between 1993 and 1994: Results for '93 and '94 quite similar; only rating/point changes occurred at FB -- there **sediment** was biggest change from "2" in '93 to "4" in '94 (+2); (i.e. RP color change red to yellow). '93 sediments at FB rated red because of toxicity, high zinc and chlordane. In '94 FB did not show toxicity, but was yellow because of high zinc and PCB's (lowered DL for PCB's in '94). Change of -1 point for **fish** was "border line" change (4 pts in '93 compared with 3 pts in '94, but no color change in RP).

Overall story for 1994: Very little change from previous years. (1) Sediments at FB improved -- color change red to yellow (see above). Note: Sediment at TZ also had PCB's in '94 (lower DL in '94) and had chlordane in '93. (zinc also high both years and color yellow both years at TZ) (2) Benthos poor at all three locations in '94. Color changes between '93 and '94 -- benthos change yellow to red at both FB and TZ (stays red at inflow). At FB, this is totally due to change in scoring methods (should have been red in '93 by new '94 criteria). At TZ, the score was actually a little lower in '94 than '93 (basically changes from low yellow to high red). (3) Fish at TZ and inflow change from red in '93 to yellow in '94. This was due to change in scoring methods (both '93 and '94 score about the same using '94 scoring methods). No change in fish assemblage between the two years at TZ and inflow. (4) Only DO green (and green at both locations FB and TZ) in Fort Loudoun reservoir.

ftlres94

Reservoir: Melton Hill 1994 Score: 72%

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	80	72	
1992	67	66	
1993	68	69	
1994	72	72	

Effect of method change between 1993 and 1994: Very small effect overall (1% change from 68% using '93 criteria to 69% using '94 criteria.

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	5	5	na	na	10		0	0	na	na	0
DO	5	5	na	na	10		0	0	na	na	0
Sediment	5	4	na	na	9		0.5	0	na	na	0.5
Benthos	2	1	na	1	4		1	-1	na	0	0
Fish	4	4	na	2	10		1	0	na	0	1
Total	21	19	na	3	43	Net	2.5	-1	na	0	1.5

Explanation/discussion of differences: between 1993 and 1994: (1) **Fish** change of +1 pt between '93 and '94 was due to improvements in essentially all metrics; '93 results on '94 criteria would rate fair (score = 3) and '94 results rated good (score = 4). (2) **Benthos** at FB only a borderline change ('93 = high "1" and '94 = low "2" on '94 criteria). RP color changes discussed below. Benthos at TZ declined 1 pt due to borderline change ('93 = low "2" and '94 = high "1").

Overall story for 1994: Similar to previous years, slight improvement. Improvement was mostly due to better fish assemblages at FB in 1994 (most fish metrics improved), need to note that RP color change from red to green was partially influenced by this. The whole story is that '93 should have been yellow rather than red based on '94 scoring methods, beyond that the community looked better in '94 than in '93 (basically, double color change due partly to change in scoring methods and partly to an improved community).

Color change for benthos at FB (yellow to red) was due to scoring methods change ('93 should have been red rather than yellow based on new scoring methods). Although there was slight change in benthos score at TZ, it was not enough to cause RP color change.

Note -- Benthos poor at all locations in '94 - basically very few benthic animals present, and those present were tolerant types; cannot specifically say why so poor, although low water temperature may have been influential.

Note -- Sediment color was yellow in '93 and '94 but there was a change in the cause (chlordane in '93 and PCB's in '94).

CLINCH RIVER AND POWELL RIVER WATERSHED

This long, narrow watershed lies in southwest Virginia and northeast Tennessee. Streams in the watershed have high concentrations of dissolved minerals and generally low concentrations of nutrients.

For management purposes, an artificial ending point of the watershed has been established at Norris Dam, which is near Clinch River mile 80. The remainder of the Clinch River is associated with the Watts Bar, Fort Loudoun, and Melton Hill Reservoir Watershed area. As defined, this watershed drains an area of 2912 square miles and has an average annual discharge of about 4200 cfs. The Clinch and Powell Rivers contribute about 80 percent of this flow.

Norris Reservoir is the only major reservoir in the watershed; essentially all streams upstream from Norris are free flowing. There are three Vital Signs monitoring sites in Norris Reservoir (forebay and mid-reservoir sites on the Clinch and Powell arms) and two stream sites, one each on the Clinch and Powell Rivers.

Norris Reservoir

Norris Reservoir is formed by Norris Dam at Clinch River mile (CRM) 79.8. It is a large, dendritic, tributary storage impoundment of the Clinch and Powell Rivers which flow together about nine miles upstream of the dam. Norris is one of the deeper TVA tributary reservoirs, with depths over 200 feet. Annual drawdown averages about 32 feet. At full pool, the surface area of the reservoir is 34,200 acres, the shoreline is about 800 miles in length, and water is impounded 73 miles upstream on the Clinch River and 53 miles upstream on the Powell River. Norris Reservoir has a long average retention time (about 245 days) and an average annual discharge of approximately 4200 cfs. Due to the great depth and long retention time of Norris Reservoir, significant vertical stratification is expected.

Because of the confluence of the Clinch and Powell Rivers relatively close to the dam, three reservoir sampling locations were established: one forebay site; and two mid-reservoir sites--one on the Clinch River and one on the Powell River.

Reservoir: Norris **1994 Score: 69%**

Previous Scores

	Reported	1994 Criteria	Special Case/1994 Criteria
1991	57	73	
1992	67*	73*	(*Benthos excluded in both columns)
1993	67	71	
1994	69	69	

Effect of method change between 1993 and 1994: Increaseof 4 % on '93 (67 versus 71) due to methods change for benthos. In '94 methods Norris was grouped with a smaller number of more similar reservoirs (Ridge and Valley Ecoregion) and benthos was best among this group.

Impact of special case scores: Benthos not reported in '92 so benthos were excluded from calculating '92 score using '94 methods.

	1994 Results					Diff. Bet '93 and '94 ('94 Methods)				
	FB	MR-C	MR-P	Total		FB	MR-C	MR-P	Net	
Chloro	3	3	5	11		0	-2	0	-2	
DO	1	1	1	3		-1	0	0	-1	
Sediment	4	5	4	13		0	1	0	1	
Benthos	3	5	4	12		-2	0	1	-1	
Fish	4	4	5	13		1	0	1	2	
Total	15	18	19	52		-2	-1	2	-1	

Explanation/discussion of differences: between 1993 and 1994: **Chlorophyll** at Mid-Res on Clinch made a border-line change--in '93 mean concentration was 4.1 (good, green) and in '94 it was 2.7 (fair, yellow; 3.0 is cut-off). (Note: this may have been due to higher flows pushing the transition zone further downstream in '94). **DO** at the FB scored lower in '94 than in '93 because the volume of low DO water was much greater in '94 (20% of x-section and 40% of bottom) than in '93 (10% of x-section and 20% of bottom). DO rated poor both years (red in RP both years). **Sediment Quality** improved at Mid-Res on Clinch due to not finding ammonia in '94 that had been found in '93. Note: Still had high concentration of lead in FB--consistently found every year. **Benthos** scored lower at FB in '94 than '93 due to very few animals being collected; of these, there were no EPT and very few long-lived). RP color in '94 will be yellow. Benthos at FB were reported as fair (yellow) in '93 but would have been green if '94 methods used. At Mid-Res on Powell benthos rated good (green) in '94 compared to fair (yellow) in '93 because more animals were collected in '94. At Mid-Res on Clinch benthos also change from yellow in '93 to green in '94; this was a border-line change with very little difference in communities between the two years. **Fish** at FB had an improved score in '94 over '93 but not enough for a color change in RP (basically a low yellow in '93 and a high yellow in '94). Improvements at the FB in '94 occurred in several species metrics and found more lithophilic spawners. Fish at Mid-Res Powell rated good (green) in '94. The score was higher than in '93, which rated good (green) previously.

Overall story for 1994: Norris ecolgical health in '94 was similar to previous years--high end of fair. Although not a color change in RP between '93 and '94 (both red), DO's were much worse in '94 than in '93 at FB (see above). Chlorophyll at Mid-Res Clinch changed color (green in 93 to yellow in '94) due to low concentrations in '94 (just below cut-off for good). Sediment Quality at the Mid-Res on Clinch was good in '94 (no problems found); in '93 had ammonia causing a fair rating then). Benthos improved at both Mid-Res locations (both changing from yellow in '93 to green in '94). Fish at FB improved a little in '94 but not enough to change colors.

LITTLE TENNESSEE RIVER WATERSHED

The Little Tennessee River Watershed encompasses 2672 square miles, mostly in Tennessee and North Carolina with a small area in Georgia. Much of the watershed is forested, with the headwaters in the Blue Ridge Mountains. The basin is underlain mostly by crystalline and metasedimentary rocks of the Blue Ridge province. This watershed is home to a large variety of federally listed threatened and endangered species.

Most of the streams in the watershed are steep gradient and generally have low concentrations of both dissolved minerals and nutrients. The two largest tributaries to the Little Tennessee River are the Tuckasegee River which merges with the Little Tennessee in Fontana Reservoir and the Tellico River which merges with the Little Tennessee in Tellico Reservoir.

There are several reservoirs in the watershed but only Fontana Reservoir in the mountainous area and Tellico Reservoir at the lower end of the watershed are monitored. TVA does not monitor the other reservoirs either because of their small size or because they are owned by the Aluminum Company of America (ALCOA).

Two sites are monitored on Tellico Reservoir (the forebay and transition zone) and three sites on Fontana Reservoir (the forebay and mid-reservoir sites on the Little Tennessee River and Tuckasegee River). There is one stream monitoring site in the watershed, on the Little Tennessee River upstream of Fontana Reservoir. Another stream monitoring site (on the Tuckasegee River) was added in 1994.

Tellico Reservoir

Tellico Dam is located on the Little Tennessee River just upstream of the confluence of the Little Tennessee and Tennessee Rivers. It is the last dam completed in the TVA system with dam closure in 1979. Tellico Reservoir is 33 miles long, has a shoreline of 373 miles, and has a surface area of about 16,000 acres at full pool. The average estimated flow through Tellico Reservoir is approximately 5700 cfs which provides an average retention time of about 37 days. Very little of this water is discharged through Tellico Dam. Rather, it is diverted through a navigation canal to Fort Loudoun Reservoir near the dam for hydroelectric power production. Water characteristics in these two reservoirs differ considerably. The hydrodynamics and exchange of water via the inter-connecting canal significantly affect water quality within Tellico Reservoir (and Fort Loudoun Reservoir). The canal is only 20-25 feet deep, but the depth of Tellico Reservoir at the forebay is about 80 feet. Thus, water at strata below about 25 feet is essentially trapped and becomes anoxic during much of the summer in the forebay of Tellico Reservoir.

The impounded water of Tellico Reservoir extends upstream of the confluence of the Little Tennessee and Tellico Rivers. The transition zone site selected for sample collection in 1990, 1991, and 1992 was in the Little Tennessee River, just upstream of the confluence with the Tellico River at Little Tennessee River Mile (LTRM) 21.0. Water conditions at that site are largely controlled by discharges from Chilhowee Dam at LTRM 33.6. This water is cold, nutrient poor, and has a low mineral content, conditions that are not conducive to establishing a diverse, abundant aquatic community. In 1993, the transition zone sampling location in Tellico Reservoir was moved six miles downstream to LTRM 15.0, just below the confluence of the Tellico River--a site more characteristic of a transition environment rather than riverine conditions.

Fontana Reservoir

Fontana Reservoir is located in the Blue Ridge Mountains of western North Carolina. Fontana is the deepest reservoir in the TVA system. At full pool it has a maximum depth of 460 feet, a length of 29 miles, a shoreline of 248 miles, and a surface area of 10,640 acres. Fontana Reservoir has a relatively large drawdown, which averages about 64 feet annually. Every fifth year Fontana is drawn even deeper to allow sluice gate access for maintenance.

Fontana Dam is located at Little Tennessee River Mile 61.0. Average annual discharge is 3840 cfs which provides an average hydraulic retention time in the reservoir of 186 days.

Water in Fontana Reservoir is quite clear due to limited photosynthetic activity and a mostly forested watershed. Water entering the reservoir is low in nutrients and dissolved minerals.

Reservoir: Tellico 1994 Score: 71%

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	48	54 (FB only)	54 (FB only)
1992	48	48 (FB only)	48 (FB only)
1993	63	57	46 (FB only)
1994	71	71	66 (FB only)

Effect of method change between 1993 and 1994: 6% loss (63% using '93 methods vs. 57% using '94 methods) due mostly to change in chlorophyll methods for low nutrient reservoirs-watersheds (inflows from Ft Loudoun may bring higher chlorophylls and nutrients into Tellico forebay). See table below for nutrient limited watersheds and chlorophyll ratings.

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	3	5	na	na	8		2	0	na	na	2
DO	4.5	5	na	na	9.5		1	0	na	na	1
Sediment	3	4	na	na	7		1	2	na	na	3
Benthos	2	1	na	na	3		0	0	na	na	0
Fish	4	4	na	na	8		1	0	na	na	1
Total	16.5	19	na	na	35.5	Net	5	2	na	na	7

Explanation/discussion of differences: between 1993 and 1994: 4 of 5 indicators improved in '94 at FB. **Chlorophyll** (exercise caution with interpretation due to methods change) results for '93 rated good ("5", green) on '93 methods but on '94 methods would rate poor ("1", red). The new methods assume Tellico is a nutrient poor reservoir and low chlorophyll concentrations would be expected. Inflows from Ft Loudoun FB probably bring in nutrients and higher chlorophyll, complicating the evaluation of Tellico FB results. Using '94 criteria, chlorophyll concentrations at FB improved in '94 (x = 5, yellow) compared to '93 (x = 7.2, red-but just above the cutoff). **DO** gained 1 pt at the FB, no anoxia found in '94. **Sediment** improved 1 pt at FB in '94 -- toxicity in both '93 and '94, however chlordane reported in '93 was not found in '94. Also, sediment improved at TZ (+2 pts) due to less significant toxicity in '94 than in '93 and the absence of chlordane in '94. **Fish** improved 1 pt -- fewer tolerant species, better balance in abundance among species, fewer omnivores and more insectivores.

Overall story for 1994: Much improved, highest score ever. Best score ever for DO at the FB (green for first time). We changed the way chlorophyll in Tellico is evaluated, which changed RP color green to yellow at FB (see chlorophyll discussion above). Sediments also improved -- no chlordane at FB or TZ in '94 (note - there may have been false positives for chlordane in '93 per ECHEM). Sediments at FB and TZ change red to yellow. Fish assemblage at FB best ever (first time green) due to improvements in most fish metrics. Benthos at TZ change from yellow to red - this was due to method change (should have been red in '93 if '94 scoring methods used). Benthos at both FB and TZ red for '94 - basically very poor as indicated by most metrics - can't specify exact cause, but cold water, low DO and toxicity probably play important role.

Nutrient Limited Watersheds

Chlorophyll Concentrations	Rating
< 4 ug/L	good - 5
4 - 7 ug/l	fair - 3
> 7 ug/l	poor - 1

Reservoir: Fontana **1994 Score: 67%**

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	N/S	N/S	
1992	N/S	N/S	
1993	64 (No FB Bug)	75 (No FB Bug)	
1994	67 (No FB Bug)	67 (No FB Bug)	

Effect of method change between 1993 and 1994: Chlorophyll method change (new expectations for reservoirs in Blue Ridge Ecosystem) accounted for most of the change ('93 results on '93 methods=64; '93 results on '94 methods=75). This added a total of 6 pts (9%) to overall score.

Impact of special case scores (i.e., ex/include embayments / TZ moved): N/A

	1994 Results						Differences between 1993 and 1994				
	FB	MR-L'T	MR-Tu	Inf	Total		FB	MR-LT	MR-Tu	Inf	Net
Chlorophyll	5	5	5		15		0	0	0		0
DO	4.5	5	3.5		13		1	0	1.5		2.5
Sediment	2	2	2		6		0	-3	-2		-5
Benthos	N/S	1	1		2		N/A	-2	-1		-3
Fish	4	4	3		11		0	0	0		0
Total	15.5	17	14.5		47	Net	1	-5	-1.5		-5.5

Explanation/discussion of differences: between 1993 and 1994: **DO** was the only indicator to improve in '94 compared to '93--the volume of low DO water was less and there was no anoxia at both the FB and Mid-Res on Tuckasegee in '94 compared to '93. Both locations had higher rating in '94 compared to '93--FB changed from fair (yellow) in '93 to good (green) and Mid-Res on Tuck changed from poor (red) to fair (yellow). **Sediment Quality** was much poorer in '94 compared to '93 (the first time sediments were sampled on Fontana). Chlordane and significant toxicity were found at all three locations in 1994. In '93 toxicity was found only at the FB and chlordane was found only at the Mid-Res on Tuck and at the FB. As a result of the '94 results, Sediment Quality rated poor (red in RP) at all three locations. **Benthos** (not collected at FB) at Mid-Res on L' T rated much lower in '94 than in '93--species richness and abundance much reduced, no EPT, no long-lived (in either '93 or '94 for long-lived), and a higher proportion of chironomids. This caused benthos rating for Mid-Res on L'T to be poor in '94 compared to fair in '93. At the Mid-Res Tuck location the poor community found in '93 was even poorer in '94 (7 of 8 metrics scored "1").

Overall story for 1994: Ecological health rating for Fontana Reservoir was fair in '94, same as in '93. The overall score for '94 was slightly higher than reported last year. However, in reality (i.e., comparing apples to apples) the ecological health of Fontana was not as good in '94 as in '93. (Note: if '94 methods had been used in '93, Fontana's total score would have been 75 and it would have been rated good overall). The overall decrease was not readily apparent due to several "opposing" influences on '94 score. A change in methods for chlorophyll increased the overall score about 9%. Also, a true improvement in DO caused the overall score to increase about 4 %. However, these contributions to a higher score were more than off-set by true decreases in sediment quality and benthos (see above for details). It is noteworthy that Sediment Quality and benthos rated poor at all locations in '94 and will be red in RP.

FRENCH BROAD RIVER WATERSHED

The French Broad River watershed is one of the largest (5124 square miles) watersheds in the Tennessee Valley. About half the watershed is in Tennessee and half is in North Carolina. The French Broad River and its two large tributaries (Nolichucky and Pigeon Rivers) originate in the Blue Ridge Mountains. All three of these rivers merge at the upper end of Douglas Reservoir, the only sizable reservoir in the watershed. The water in the French Broad River is moderately hard and relatively high in nutrients.

There are two reservoir Vital Signs monitoring sites on Douglas Reservoir and one stream monitoring site each on the French Broad and Nolichucky Rivers. A stream monitoring site on the Pigeon River was added in 1994. All stream monitoring sites are upstream of Douglas Reservoir.

Douglas Reservoir

Douglas Reservoir is a deep storage impoundment (tributary reservoir) on the French Broad River. Douglas Dam is located 32.3 miles upstream of the confluence of the French Broad and Holston Rivers which form the Tennessee River. Reservoir drawdown during late summer and autumn is rather large, with an annual average of about 48 feet. The large annual fluctuation in surface water elevation causes other physical characteristics such as surface area, reservoir length, and retention time to vary greatly during the year. At full pool, maximum depth at the dam is 127 feet, surface area is 30,400 acres, the shoreline is 555 miles, and the length is 43 miles. Average annual discharge is approximately 6780 cfs, which provides an average hydraulic retention time of about 105 days.

Lengthy retention times and lack of mixing due to their deep nature tend to cause storage impoundments to have strong thermal stratification during summer months. Undesirable conditions often develop in the hypolimnion due to anoxia, which in most cases extends from the forebay to the mid-reservoir sampling location.

Reservoir: Douglas **1994 Score: 64%**

	Previous Scores		
	Reported	1994 Criteria	Special Case/1994 Criteria
1991	42	60 (FB only)	60 (Includes original Mid-Res)
1992	56	52 (FB only)	57 (Includes original Mid-Res)
1993	58	58	[Note: Mid-Reservoir relocated in 1993]
1994	64	64	

Effect of method change between 1993 and 1994: None on overall score.

Impact of special case scores (i.e., ex/include embayments / TZ moved): The mid-reservoir site was moved after 1992; including the data from the old site has little effect on reservoir rating.

	1994 Results						Differences between 1993 and 1994				
	FB	M-R	Emb	Inf	Total		FB	M-R	Emb	Inf	Net
Chlorophyll	5	5			10		0	2			2
DO	1	2			3		0	1			1
Sediment	5	2			7		0	0			0
Benthos	2	2			4		0	N/A			0
Fish	4	4			8		1	0			1
Total	17	15			32	Net	1	3			4

Explanation/discussion of differences: between 1993 and 1994: **Chlorophyll** at Mid-Res location made a borderline shift in '94--mean=9.9, just below the maximum end of the good range (10.0). The caused the rating for '94 to be good. In '93 the mean was only slightly higher (10.3) but was above the cutoff so it rated fair. Obviously, not a significant change but it still added 2 points (4%) to the overall score. **DO** at the Mid-Res location improved in '94 compared to '93--volume of low DO water was much less (6% of x-section in '94 and 18% in '93). Both years rated poor (red in RP), but the '94 DO contributed 1 point more to the overall score than in '93. The 1 point change in **fish** between years was due to methods change (i.e., '93 results on '94 criteria scored almost identical to '94 results on '94 criteria). (Note: benthos were not collected at the Mid-Res in '93.)

Overall story for 1994: Douglas Reservoir ecological health rated fair in '94, slightly higher than in previous years. Most of the apparent "improvement" was due to a border-line change at the Mid-Res location in chlorophyll. Although this caused a color change for chlorophyll in RP (yellow in '93 and green in "94), this small change (see above) is easily within sampling variability and shouldn't be used to imply water quality has improved. DO at Mid-Res improved in '94 compared to '93 but it was still sufficiently bad to be poor (red) again in RP.

dousum94

HOLSTON RIVER WATERSHED

The Holston River Watershed encompasses 3776 square miles, mostly in upper east Tennessee and southwest Virginia and a small area in North Carolina. The area is relatively highly populated with substantial industrial development.

Much of the area is underlain with limestone and dolomite which results in high concentrations of dissolved minerals in the streams. There is also substantial zinc mining in the watershed.

There are several reservoirs in the watershed with varying size, depth, flow, and water quality characteristics. The largest is Cherokee Reservoir on the Holston River near the lower end of the watershed. The uppermost reservoirs are Watauga Reservoir on the Watauga River and South Holston Reservoir on the South Fork Holston River. Downstream from these reservoirs, the Watauga and South Holston Rivers merge in Boone Reservoir. Immediately downstream from Boone Dam is Fort Patrick Henry Reservoir, the smallest of the five reservoirs in this watershed included in the Vital Signs Monitoring Program. A few miles downstream from Fort Patrick Henry Dam the South Fork and North Fork Holston Rivers merge to form the Holston River.

Vital Signs monitoring activities are conducted at one, two, or three locations depending on reservoir size and characteristics. There is a stream monitoring site on the Holston River upstream of Cherokee Reservoir and one on the North Fork Holston River, which was established in 19940.

The average annual discharge from Cherokee Dam is 4460 cfs. The Holston River merges with the French Broad River at Knoxville to form the Tennessee River.

Cherokee Reservoir

Cherokee Reservoir is formed by Cherokee Dam at Holston River mile (HRM) 52.3. Like Norris and Douglas Reservoirs, it is a large, relatively deep, tributary storage impoundment with a substantial drawdown which begins in late summer. When the water surface is at full pool, maximum depth at the dam is 163 feet and winter drawdown is 53 feet. However, full pool is not reached most years, and the long-term average drawdown is about 28 feet. At full pool, Cherokee Reservoir is 54 miles long, has a surface area of 30,300 acres, and a shoreline of 393 miles. Average annual discharge is about 4500 cfs which provides an average hydraulic retention time (at full pool) of approximately 165 days.

Like other deep storage impoundments with long retention times, Cherokee Reservoir exhibits strong vertical stratification during summer months. The hypolimnetic oxygen deficit on Cherokee is one

of the worst of all Vital Signs monitoring reservoirs and has been well documented in numerous past studies (Iwanski, 1978; Iwanski et al., 1980; Hauser et al., 1987).

Fort Patrick Henry Reservoir

Fort Patrick Henry Reservoir is one of the smaller reservoirs included in the Vital Signs Monitoring Program. It is only ten miles long, has a surface area of about 870 acres, and has a shoreline of 37 miles. Although it is a tributary reservoir, it has characteristics of a run-of-river reservoir, rather than a storage reservoir. Annual fluctuation in elevation is only five feet. Also, retention time is short; with an average discharge of 2650 cfs, the hydraulic retention time is only about five days. Maximum depth is about 80 feet. Fort Patrick Henry Dam is located at South Fork Holston River mile 8.2.

This reservoir had not been sampled as part of this monitoring effort prior to 1993. Because of its small size, only the forebay is monitored for Vital Signs.

Boone Reservoir

Boone Dam is located at South Fork Holston River mile (SFHRM) 18.6, approximately 1.4 miles downstream of the confluence of the South Fork Holston and the Watauga Rivers. At normal maximum pool (1384 feet MSL), Boone Reservoir extends upstream approximately 17.4 miles on the South Fork Holston River and 15.3 miles on the Watauga River for a total reservoir length of approximately 32.7 miles. Boone Reservoir has a surface area of 4300 acres, a shoreline length of approximately 122 miles, an average depth of 44 feet, and a maximum depth of 129 feet near the dam. Annual average discharge from Boone Dam is about 2500 cfs, which results in an average hydraulic residence time of about 38 days. Annual drawdowns of Boone Reservoir usually average about 25 feet.

Three locations were selected for ecological health monitoring in Boone Reservoir, one at the forebay and two mid-reservoir sampling locations, one on the Watauga River arm and one on the South Fork Holston River arm. Sediment and benthic macroinvertebrate sampling were added for the first time in 1993.

South Holston Reservoir

South Holston Reservoir in northeastern Tennessee and southwestern Virginia is created by South Holston Dam, located on the South Fork of the Holston River at mile 49.8. The dam creates a storage pool approximately 24 miles long, over 230 feet deep near the dam, with an average depth of 86.5 feet and approximately 7600 acres in surface area. With an average annual discharge of about 980 cfs from the dam, the average hydraulic residence time is almost one year (340 days)--one of the longest residence times of any TVA reservoir. Average annual drawdown of South Holston Reservoir is about 33 feet.

Two locations are monitored for Vital Signs--the forebay and mid-reservoir. Sediment and benthic macroinvertebrate sampling were added for the first time in 1993.

Watauga Reservoir

Watauga Dam in the northeastern corner of Tennessee impounds the Watauga River at mile 36.7. It forms a pool 16 miles in length, approximately 6400 acres in surface area, about 274 feet deep at the dam, and an average depth of about 89 feet, making it the second-deepest reservoir sampled as part of TVA's Vital Signs Monitoring Program. With an annual average discharge of about 700 cfs, Watauga Reservoir also has the longest hydraulic residence time of any of the Vital Signs reservoirs (about 400 days). Average annual drawdown of Watauga Reservoir is about 26 feet.

Two locations are monitored on Watauga Reservoir, the forebay and mid-reservoir. Sediment quality and benthic macroinvertebrates were examined for the first time in 1993.

Reservoir: Cherokee **1994 Score: 53%**

	Previous Scores	
	Reported	1994 Criteria
1991	50	62
1992	53	60
1993	64	64
1994	53	53

Effect of method change between 1993 and 1994: None

	1994 Results						Differences between 1993 and 1994				
	FB	MR	Emb	Inf	Total		FB	MR	Emb	Inf	Net
Chlorophyll	3	1	na	na	4		-2	-4	na	na	-6
DO	1	1	na	na	2		0	0	na	na	0
Sediment	5	4	na	na	9		1	2	na	na	3
Benthos	3	ns	na	na	3		-1	ns	na	na	-1
Fish	3	3	na	na	6		-1	0	na	na	-1
Total	15	3	na	na	24	Net	-3	-2	na	na	-5

Explanation/discussion of differences: between 1993 and 1994: Biggest change between '93 and '94 was in chlorophyll -- too much in '94. **Chlorophyll** at FB in '93 - good (x = 7.6) and in '94 - fair (x = 11.6); at MR in '93 - good (x = 9.4) and in '94 - poor (x = 16.7). Higher chlorophyll concentrations in '94 than '93 or previous years cannot be readily explained. It would not be a reservoir flow issue because Cherokee has a long retention time under all flow regimes. The most likely explanation would be increased nutrient loads due to heavy runoff in '94. **Sediment** improved at both the FB and MR. At FB had ammonia in '93 (fair); no ammonia in '94 (good). At MR had copper, ammonia, and toxicity (poor) in '93; only copper found in '94 (fair). **Benthos** (not sampled at MR) at FB scored lower in '94 than in '93 but not enough to cause a color change (both years in fair range). **Fish** at FB same story as benthos - reduced score in '94 but both years in fair range.

Overall story for 1994: Cherokee poor in '94, mostly due to too much chlorophyll at both FB and MR; highest concentrations found in Cherokee lake since this monitoring program began in 1990. RP color for chlorophyll changes green to yellow at FB and green to red at MR (see above for "explanation" of increased chlorophylls). DO very poor at both locations both years. Sediment improved in '94 -- no ammonia at either sample location and no toxicity, only "problem" was elevated copper at MR (elevated copper at MR found in all previous years). RP color changes for sediment -- at FB yellow to green and at MR red to yellow (see above for more detail). Benthos and fish at FB scored slightly lower in '94 than '93 but not enough to result in a color change.
Note: Discontinued sampling at the upper reservoir inflow location on Cherokee (fish and benthos) in '94.

cheres94

Reservoir: Ft Patrick Henry 1994 Score: 60%

	Previous Scores	
	Reported	1994 Criteria
1991	--	--
1992	--	--
1993	72	80
1994	60	60

Effect of method change between 1993 and 1994: Method change for benthos and fish resulted in each scoring slightly higher when '93 results evaluated on '94 criteria ('93 results on '93 methods = 72% and '93 results on '94 methods = 80%).

	1994 Results						Differences between 1993 and 1994				
	FB	TZ	Emb	Inf	Total		FB	TZ	Emb	Inf	Net
Chlorophyll	1	na	na	na	1		-2	na	na	na	-2
DO	5	na	na	na	5		0	na	na	na	0
Sediment	4	na	na	na	4		0	na	na	na	0
Benthos	2	na	na	na	2		-2	na	na	na	-2
Fish	3	na	na	na	3		-1	na	na	na	-1
Total	15	na	na	na	15	Net	-5	na	na	na	-5

Explanation/discussion of differences: between 1993 and 1994: (1) **Chlorophyll** -- too much in '94; (in '93 x = 10.3, "fair"; in '94 x = 15.9, "poor"). Similar to observations in Cherokee (more chlorophyll in '94 than '93) -- most likely due to high nutrient loading due to heavy runoff in '94. (2) **Benthos** -- community not as good in '94 as in '93 (no EPT, community dominated by tolerant organisms, i.e. Tubificids and Chironomids); benthos score declined from high end of fair range to low end of range so no color change for RP. (3) **Fish** -- same as benthos with poorer community in '94 (fewer fish collected and greater proportion of tolerant individuals) so lower score but not enough to cause color change.

Overall story for 1994: Fort Pat ecological health declined from "good" in '93 to "fair" in '94. Chlorophyll was high in Fort Pat in '93 and rated fair -- in '94 it was even higher and rated "poor". Saw similar increase just downstream in Cherokee. Assumption is that in this nutrient-rich watershed, the increased runoff in spring and summer of '94 flushed added nutrients into Fort Pat, stimulating algal productivity and higher chlorophylls. Benthos and fish both scored lower in '94 than '93 -- but neither was enough to cause a color change in RP -- both were a high "yellow" in '93 and a low "yellow" in '94, so RP colors don't change but overall score is lower. (Special note for fish -- lots of big bass collected). Sediments -- no color change between '93 and '94, but in '93 found ammonia and in '94 found small amounts of PCB's and chlordane. Note: This was the biggest decline in ecological health scores of all reservoirs sampled (between '93 and '94). These results must be evaluated conservatively because there are only two years of data for Fort Pat, and each shows vastly different scores. Without more information, there is no definitive way to know which year most accurately reflects true condition, (or perhaps the answer is somewhere between the two). Another important consideration is that Fort Pat only has one sample location. A small change in a metric (e.g. DO, fish, etc.) can cause a large change in the overall reservoir score (e.g. a 1 pt change for a metric like fish causes a 4% change in the overall reservoir score).

fptres94

Reservoir: Boone 1994 Score: 59%

	Previous Scores	
	Reported	1994 Criteria
1991	51	52 (only Chl, DO, and fish)
1992	64	63 (only Chl, DO, and fish)
1993	59	61
1994	59	59

Effect of method change between 1993 and 1994: Little effect of change (59% vs 61%)

	1994 Results						Differences between 1993 and 1994				
	FB	MR-SFH	MR-Wat	Inf	Total		FB	MR-SFH	MR-Wat	Inf	Net
Chlorophyll	5	1	3	na	9		0	-2	0	na	-2
DO	4.5	2	5	na	11.5		1.5	0	1	na	2.5
Sediment	3	4	3	na	10		-1	0	0	na	-1
Benthos	2	1	2	na	5		-1	-1	0	na	-2
Fish	3	3	3	na	9		1	0	0	na	1
Total	17.5	11	16	na	44.5	Net	0.5	-3	1	na	-1.5

Explanation/discussion of differences: between 1993 and 1994: Overall, very little difference, but there were changes for individual indicators/metrics, which essentially off-set one another. (1) **Chlorophyll** -- higher at both MR locations but only at SFH-MR was the average concentration increased enough to effect a change in score and color (from fair to poor). (2) **DO** improved at FB and Watauga-MR (both change fair to good between '93 and '94). At FB only a small volume of low DO existed in '94, and at MR-Watauga no low DO (>2 mg/l) water was observed. (3) **Sediment** -- FB lower in '94 compared to '93 due to some toxicity in '94 and none in '93 (but no color change - fair "yellow" both years). Note for sediments -- chlordane found at all three sampling locations in both '93 and '94; and in '94 also found PCB's at FB and MR-Watauga. (4) **Benthos** -- not too good anywhere in '93. In '94 benthos was worse at FB and MR-SFH (both locations having a borderline change from fair, "yellow" in '93 to poor, "red" in '94). At MR-Watauga there was also a borderline change from poor, "red" in '93 to fair, "yellow" in '94 for the benthos. (5) **Fish** -- improved at FB in '94 from poor (red) to fair (yellow) due to increased species richness, better balance of individuals among species, and more fish. No change in fish at MR-SFH. At MR-Watauga there was little change in the community but there will be a color change in RP (red in '93 to yellow in '94) due to a change in methods ('93 would be yellow if scored using '94 methods).

Overall story for 1994: Very little change in overall score, but several indicators shifted up or down. Most notable change from '93 is the decrease in conditions at MR-SFH site. Chlorophyll and benthos changed from fair in '93 to poor in '94 (yellow to red). DO was poor both years and sediment and fish only fair both years at MR-SFH site. The reduced chlorophyll rating caused by higher summer chlorophyll concentrations is consistent with observations at Ft Pat and Cherokee in '94. On the plus side, DO was generally better (improved at FB and MR-Watauga) and fish community improved at the FB. Sediments containing chlordane and PCB's represent a concern. Benthos communities at all three locations are fair to poor (see above).

Reservoir: South Holston 1994 Score: 66%

	Previous Scores	
	Reported	1994 Criteria
1991	60	63 (only Chl, DO, and fish)
1992	57	63 (only Chl, DO, and fish)
1993	65	69
1994	66	66

Effect of method change between 1993 and 1994: Change in fish methods resulted in a 1 point increase at both FB and MR results in a 4% change in '93 score using '94 criteria.

	1994 Results						Differences between 1993 and 1994				
	FB	MR	Emb	Inf	Total		FB	MR	Emb	Inf	Net
Chlorophyll	3	5	na	na	8		-2	0	na	na	-2
DO	2	1	na	na	3		-0.5	0	na	na	-0.5
Sediment	5	5	na	na	10		1	1	na	na	2
Benthos	3	1	na	na	4		2	-2	na	na	0
Fish	4	4	na	na	8		-1	0	na	na	-1
Total	17	16	na	na	33	Net	-0.5	-1	na	na	-1.5

Explanation/discussion of differences: between 1993 and 1994: (1) **Chlorophyll's** about the same as they were last year. A "borderline" change from x = 3.4 in '93 to x = 2.9 in 94 results in a color change at FB from green to yellow. No "real" difference between years. (2) **DO's** about the same as '93, with about 10% of X-section at FB with low DO (<2 mg/l) and 30% of the X-section at MR with low DO. (3) **Sediment** - no problems in '94. (Had slight toxicity at FB and ammonia and chlordane at MR in '93). (4) **Benthos** improved at FB (poor in '93 to fair in '94) -- all 8 benthos metrics were "1" in '93, but in '94 only 3 were "1". Benthos declined at MR from fair in '94 to poor in '94. (6 of 8 metrics were "1" in '94, compared to 3 of 8 in '93, and in '94 at MR only Tubificids and Chironomids). (5) **Fish** - no color change in RP. Slight decline in fish community at FB in '94 (fewer intolerant species in '94).

Overall story for 1994: About the same as '93. Biggest concerns in South Holston continue to be low DO's near the bottom in summer and poor benthos communities (possibly related?).

Note: Chlorophyll concentrations in '94 not higher (like Boone, Ft Patrick Henry, Cherokee) because South Holston is upstream of major urban areas. Higher runoffs in urban areas will carry proportionally higher concentrations of nutrients (compared to rural/forested areas) and result in greater algal productivity/higher chlorophyll's.

shlres94

Reservoir: Watauga 1994 Score: 65%

	Previous Scores	
	Reported	1994 Criteria
1991	80	77 (only Chl, DO, and fish)
1992	57	72 (only Chl, DO, and fish)
1993	61	63
1994	65	65

Effect of method change between 1993 and 1994: Very little change

	1994 Results						Differences between 1993 and 1994				
	FB	MR	Emb	Inf	Total		FB	MR	Emb	Inf	Net
Chlorophyll	5	5	na	na	10		0	0	na	na	0
DO	4	1.5	na	na	5.5		-0.5	-1.5	na	na	-2
Sediment	3	4	na	na	7		1	0	na	na	1
Benthos	2	3	na	na	5		1	2	na	na	3
Fish	2	3	na	na	5		0	-1	na	na	-1
Total	16	16.5	na	na	32.5	Net	1.5	-0.5	na	na	1

Explanation/discussion of differences: between 1993 and 1994: (1) **DO** conditions slightly worse in '94 than in '93 at the FB. Biggest change at MR where about twice as much low DO water in '94 compared to '93. Both will result in a color change for RP (FB green to yellow and MR yellow to red). (2) **Sediments** improve slightly at FB in '94. FB sediments poor in '93, fair in '94 (in '94 had toxicity just like '93, but didn't find ammonia and chlordane like in '93). At MR found chlordane in '94 and in '93, no other sediment concerns at MR. (3) **Benthos** -- improved at both FB and MR in '94 compared to '93. In '93 very poor benthos at both places. In '94 FB score improved but not enough to result in color change (red in '93 and '94). At MR community improved slightly ('93 - poor and '94 - fair with more taxa and more individuals collected). (4) **Fish** at MR scored slightly lower in '94 than '93 but not enough to result in color change. At FB the community changed very little but the RP color will change from red (in '93) to yellow (in '94). This was totally due to a change in methods ('93 fish would have been yellow if '94 methods used).

Overall story for 1994: Little overall change in ecological health of Watauga (fair both years), possibly slight improvement overall. Big picture = improved benthos scores off-set by reduced DO scores. We don't have an explanation why Watauga DO scores were lower than previous years. (possible explanation -- Higher pool levels and lower discharges result in longer retention times [and more time for hypolimnetic anoxia development] holding back heavy spring and summer rains to diminish downstream flooding as in '94 -vs.- lower pool levels and higher discharges to supplement flows downstream and in the Tennessee River result in shorter retention times [and less time for hypolimnetic anoxia development] during low flow years as in '93.) In past years Watauga has not had as bad of DO problems as the other deep tribs??? Although benthos improved over '93, they were still only fair at one location and poor at the other. One of the problems for benthos in Watauga is the great depth.