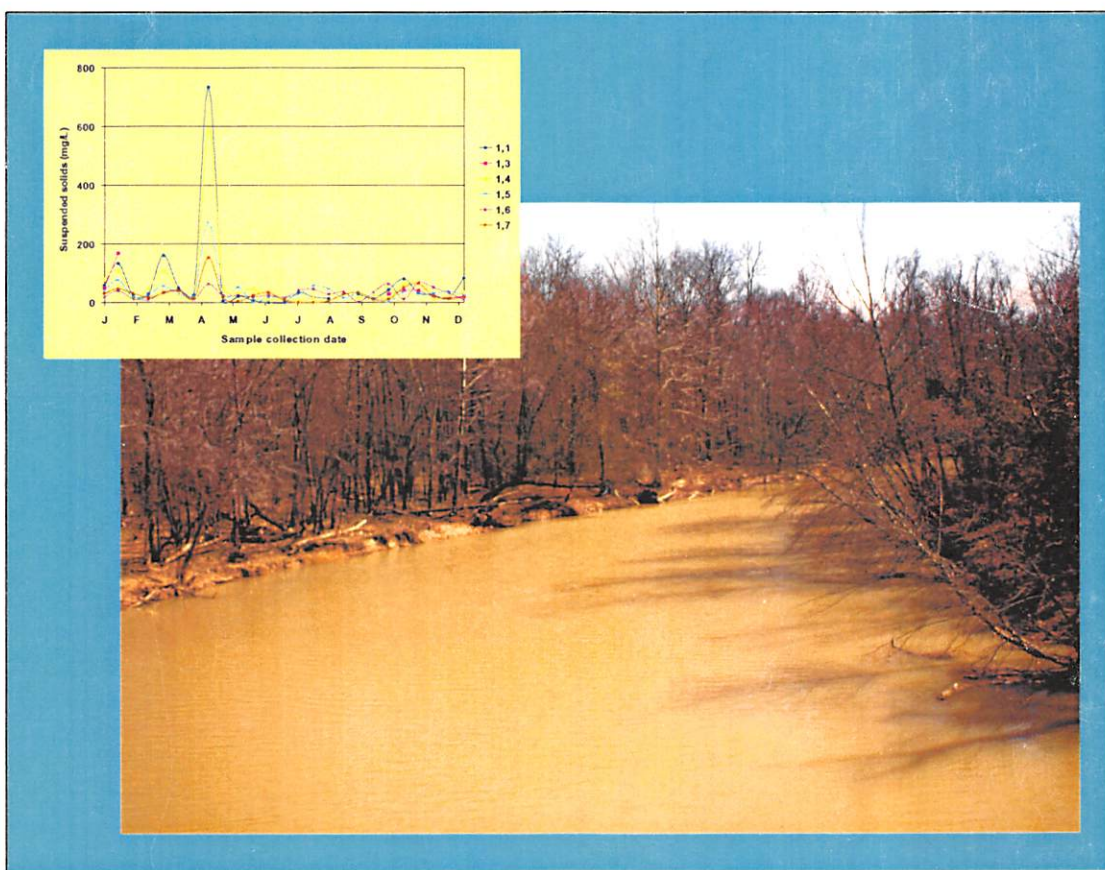




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Water Quality in Northern Mississippi Hill Land Streams in the Demonstration Erosion Control (DEC) Project



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EXECUTIVE SUMMARY

Statement of Purpose

As part of the Demonstration Erosion Control (DEC) Project in the Yazoo Basin, the Water Quality and Ecological Processes Research Unit at the USDA National Sedimentation Laboratory was requested by the US Army Corps of Engineers, Vicksburg District, to monitor current water quality. The DEC project in the Yazoo Basin is a cooperative interagency project including the Corps of Engineers, the Natural Resources Conservation Service and the Agricultural Research Service aimed at flood control and reducing erosion and channel instability. Additional goals of DEC include demonstration of innovative management techniques, total watershed planning and water quality and environmental enhancement. Currently, consistent monitoring of water quality is performed in eleven hill land stream watersheds as part of a larger database including habitat, animal, and plant diversity. Results are used to provide a constant monitoring of DEC water quality conditions and long term changes. Such information is also useful in determining total maximum daily loads (TMDLs) within the Yazoo Basin.

Evaluation

Samples from each watershed were routinely collected biweekly or monthly. Physical, chemical and biological water parameters measured were pH, temperature, dissolved oxygen, conductivity, depth to water, total, suspended and dissolved solids, filtered and total orthophosphate, ammonia, nitrate, fecal coliforms and enterococci. Analyses are performed according to standard water quality methods (APHA, 1992). In addition, the Yalobusha River was sampled for fish and aquatic invertebrates inhabiting the system in 1997 and 1998 to determine diversity and species composition.

Results

Fluctuations in temperature, dissolved oxygen, and conductivity were often associated with seasonal changes and low-flow drought conditions. Changes in pH were mostly associated with storm events and fluctuations in chlorophyll concentrations. Solids, specifically suspended solids concentrations exhibited fluctuations most frequently occurring with significant storm events (1" or more of rainfall). Fluctuations in nutrient concentrations were commonly associated with application processes and ensuing nutrient runoff after rainfall events. Observed changes in microbial counts during 1999 were due primarily to low flows during drought conditions occurring in summer and fall.

Most water quality parameters were consistently within acceptable limits of USEPA and MDEQ TMDL guidelines during 1999. Non-compliant values occurred at least once during 1999 for suspended solids, total orthophosphate, enterococci, and fecal coliforms in all eleven streams studied in the Yazoo basin. Seven of eleven streams had at least one pH value that exceeded TMDL guidelines during 1999. Yalobusha River (10) and Coldwater River/Pigeon Roost Creek (8) had the greatest number of water quality parameters that had exceeded TMDL guidelines at least once during 1999.

Species composition and diversity of aquatic insects and fish in the Yalobusha River showed 132 genera of aquatic invertebrates and 35 species of fish inhabiting the river during 1997 and 1998 through 2000. Greatest aquatic invertebrate diversity was for aquatic insects. Fish diversity was typical for warm waters in the southeastern United States and comparatively greater than similar rivers in the loess hills of northern Mississippi.

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All report tables and figures are labeled according to the DEC watershed number (e.g. "2" for Long watershed, "4" for Hotophia watershed, etc.). The report was formatted as such to facilitate access to certain information for specific watersheds. Because of this, there are no tables and figures with the numbers 10, 11, 12, 14, 15, or 16. The following is a complete list of watershed names and associated DEC numbers.

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INTRODUCTION

Degradation of stream surface water quality has been highlighted as a problem throughout the United States, but especially in areas with highly erodible soils, such as those found in northern Mississippi. Water quality degradation can be attributed to many factors, with sediment transport playing a major role. Other contributing factors include, but are not limited to, pesticides, nutrients, and animal and municipal waste. This research addresses the issue of water quality in north Mississippi streams of the Yazoo Basin which have been designated through the Demonstration Erosion Control (DEC) Project as impacted by at least one of the above mentioned contributing factors.

As part of the DEC Project in the Yazoo Basin, the Water Quality and Ecological Processes Research Unit at the USDA National Sedimentation Laboratory was requested by the US Army Corps of Engineers, Vicksburg District, to monitor current water quality. The DEC project in the Yazoo Basin is a cooperative interagency project including the Corps of Engineers, the Natural Resources Conservation Service and the Agricultural Research Service aimed at flood control and reducing erosion and channel instability. Additional goals of DEC include demonstration of innovative management techniques, total watershed planning and water quality and environmental enhancement.

Currently, consistent monitoring of water quality is performed in designated watersheds as part of a larger database including habitat, animal, and plant diversity. This information has proven valuable in assessing specific problems in DEC watersheds and in evaluating long-term changes resulting from DEC stabilization and rehabilitation efforts. Such information is also useful in determining total maximum daily loads (TMDLs) within the Yazoo Basin. TMDLs are based upon the total daily amount of a material (such as total solids, nutrients, etc.) in a body of water from natural, point and non-point sources that would not have a deleterious effect on aquatic life.

Sediment has been reported as the single most abundant pollutant (by volume) in the Nation's rivers and streams (Fowler and Heady, 1981). For example, the 1996 National Water Quality Inventory stated that about 40% of the nation's surveyed rivers, lakes, and estuaries had water quality impairment, and suspended sediment was the most widespread pollutant impacting surveyed rivers and streams (USEPA, 1997). Sediment-related problems are the most severe in certain regions developed for agriculture. Highly erodible soils in north Mississippi's geological landscape equate to potentially severe problems with sediment transport in streams. Sediment yield from the northern Mississippi hill land streams is about twice the national average, or about 3000 tons per square mile per year. Most streams in this region have experienced accelerated erosion within the last 30 years, often increasing their channel size three to tenfold. Statistics are not available for northern Mississippi alone, but on a statewide basis, 95% of all stream miles do not fully support aquatic life uses, and 91% do

not fully support swimming (MDEQ, 1999). These severe conditions produce a situation ideal for research and development of technology for widespread application. Because water is the basis for life, this issue is in critical need of attention. Maintaining water quality assures agriculture a water supply for crops and livestock. Likewise, it provides a potable supply of drinking water for municipalities. Hence, life itself hinges on water quality.

MATERIALS AND METHODS

Samples from each watershed were collected and preserved (using ice) twice each month, with the exception of the Toby Tubby, Burney Branch, Abiaca, Black, and Batupan Bogue watersheds, which were collected monthly. General site observations were made and noted at each sample collection. Water chemistry measurements of pH, temperature, dissolved oxygen, and conductivity using calibrated electronic meters were also collected at each site. Depth to water was also recorded from the top of the collection site (bridge rail) to the top of the water's surface at each sample collection.

Preserved samples were transported to the University of Mississippi Department of Biology. Physical and chemical parameters consisting of total solids, dissolved solids, suspended solids, ammonia, nitrates, filtered orthophosphate, total orthophosphate, total chlorophyll, fecal coliforms, and enterococci were analyzed using standard methods (APHA, 1992).

The Yalobusha River was further sampled to assess species composition and diversity of aquatic invertebrates and fish. Invertebrates were sampled throughout the watershed at 29 sites from 1998 through 2000 using methods described in Cooper and Testa, 1999. Fish were sampled from eight sites along the Yalobusha River during 1997 using methods described in Shields et al., 2000, and Knight et al., 2001.

RESULTS

Otocalofa

Most basic water quality parameters (temperature, conductivity, and dissolved oxygen) for *Otocalofa* sampling sites (Fig. 1) remained consistent according to typical seasonal fluctuations. Measurements of pH showed some fluctuations but were due in part to fluctuations in total chlorophyll concentrations and storm events. Depth to water remained constant throughout the year, fluctuating minimally with periods of drought and rain (see Figs. 2 and 3). Solids (total, dissolved, and suspended) remained fairly constant, with most noticeable deviation occurring on 4/26/99, which was associated with a significant rainfall event (approximately 1"). Likewise, orthophosphorus concentrations remained generally constant over the year, with the occasional peak, most likely due to nutrient application and ensuing runoff after rainfall events. Nitrate and ammonia concentrations followed similar patterns with peaks associated with animal

remains at or near the sampling locality. As for microbial analyses, two sampling sites (1,1 and 1,5) experienced separate spikes with site 1,1 exhibiting a significant increase in enterococci on 1/19/99. Site 1,5 exhibited a fecal coliform spike on 8/30/99. According to USEPA and Mississippi Department of Environmental Quality (MDEQ) water quality (TMDL) guidelines (USEPA, 1986; MDEQ, 1999), eight of 13 water quality parameters for Otoucalofa Creek were within acceptable limits. Exceptions were limited primarily to suspended solids (12 times during 1999), total phosphorus (30 times), enterococci (42 times) and fecal coliforms (26 times). For complete data see Table 1 and Figures 1-1 to 1-5.

Long

Sampling sites for Long Creek are shown in Figure 1. As with Otoucalofa, basic water quality parameters (temperature, conductivity, dissolved oxygen, and pH) were consistent according to seasonal fluctuations. Likewise, depth to water remained fairly constant with an occasional significant increase due to rainfall events. Solids concentrations (total, dissolved, suspended) were relatively constant with the exception of a distinguishing peak on 8/9/99 associated with a storm event which provided one inch of rainfall. Filtered orthophosphorus, total orthophosphate, ammonia, and nitrate concentrations were constant with exceptions of occasional peaks, most likely associated with nutrient application and ensuing runoff after rainfall, or animal remains. Enterococci had a significant increase in colonies during the summer months for all sites, while fecal coliforms exhibited a peaks during the middle of spring and all of summer. Similarly to Otoucalofa, most water quality parameters were within acceptable limits of USEPA and MDEQ TMDL guidelines. Non-compliance occurred primarily for suspended solids (13 times during 1999), total phosphorus (53 times), enterococci (60 times) and fecal coliforms (35 times). Complete data are shown Table 1 and in Figures 2-1 through 2-5.

Batupan Bogue

Sampling locations for Batupan Bogue Creek are presented in Figure 1. Temperature, conductivity, dissolved oxygen, and pH remained relatively constant (with seasonal fluctuations) throughout the year. Depth to water remained constant with the exception of a decrease in the watermark on 2/22/99. As before, solids concentrations (total, dissolved, and suspended) remained constant with the exception of a significant peak for total and suspended solids occurring on 1/25/99 most likely associated with a 4" rainfall event occurring on 1/23/99. Filtered and total orthophosphate concentrations, as well as nitrate concentrations exhibited an occasional peak, but were mostly consistent throughout the year. Ammonia showed several fluctuations throughout the year with most peaks occurring during the summer months. Microbes exhibited peaks, again, primarily during the summer months. The majority of water quality measurements were within acceptable limits of USEPA and MDEQ guidelines although exceptions occurred for suspended solids (eight times), total

phosphorus (21 times), enterococci (37 times) and fecal coliforms (24 times) during 1999. Complete data is available in Table 1 and Figures 3-1 to 3-5.

Hotophia

Locations for each sampling station along Hotophia Creek are shown in Figure 1. As with prior watersheds, temperature, conductivity, dissolved oxygen, and pH were consistent with seasonal fluctuations. Depth to water remained constant, with the exception of peaks on 4/5/99, 6/28/99, and 12/13/99 all of which were associated with significant (2" or more) rainfall events. Storm events influenced the peaks in solids concentrations during 6/14/99 and 8/9/99. Nutrient concentrations had significant peaks during the summer months with the exception of nitrates, which had a significant peak for all sites on 3/8/99. Both fecal coliforms and enterococci showed significant increases during the summer months. Most water quality parameters for Hotophia Creek were within acceptable limits of USEPA and MDEQ TMDL guidelines. Non-compliance occurred primarily for suspended solids (13 times), total phosphorus (21 times), enterococci (30 times) and fecal coliforms (12 times). Complete information is presented in Table 1 and Figures 4-1 to 4-5.

Hickahala

Sampling sites for Hickahala Creek are shown in Figure 1. Temperature, dissolved oxygen, conductivity, and pH were consistent with seasonal fluctuations. Depth to water remained relatively constant for most of the sites except site 5,1, which had significant fluctuations in depth throughout the year. Total and suspended solid concentrations had a marked peak on 3/29/99 that co-occurred with a one-inch rainfall event. Nutrient concentrations exhibited sporadic peaks primarily during the spring and early summer months and were probably associated with nutrient runoff and application processes at or near the sampling locality. A significant increase in fecal coliforms occurred for several sites on 3/29/99, 4/26/99 and 12/6/99. Only site 5,3 had a significant peak on 9/13/99. Significant peaks in enterococci were present for most sites on 9/13/99 and 12/6/99 while only site 5,8 exhibited a peak on 6/21/99. Again, the majority of water quality measurements were within acceptable limits of USEPA and MDEQ TMDL guidelines although non-compliance occurred for suspended solids (12 times), total phosphorus (44 times), enterococci (36 times) and fecal coliforms (30 times) during 1999. See Table 1 and Figures 5-1 to 5-5 for complete information.

Black

Locations for each sampling site along Black Creek are shown in Figure 1. Depth to water remained relatively constant throughout the year with minor fluctuations occurring during storm events and drought conditions. Temperature, conductivity, dissolved oxygen concentrations, and pH, were consistent with

seasonal fluctuations throughout the year. Suspended solids concentrations exhibited a significant peak during the winter months, primarily on 1/4/99, 2/1/99, and 3/1/99 and was associated with significant rainfall events (0.5 - 4") within 48h prior to sample collection. Nutrient and microbial analyses exhibited increases in concentrations during the winter and summer months and were most likely associated with nutrient runoff and application processes at or near the sampling locality. Microbial analyses showed increases in fecal coliforms for most sites during the winter months (1/4/99, 3/1/99, and 12/6/99) with site 6,2 having sporadic peaks throughout the year. Enterococci data showed increases for most sites on 3/1/99 and during the summer months (7/19/99 to 9/13/99). Nine of 13 water quality parameters were within acceptable limits of USEPA and MDEQ guidelines. Non-compliance occurred primarily for suspended solids (20 times during 1999), total phosphorus (38 times), enterococci (56 times) and fecal coliforms (41 times). For complete data refer to Table 1 and Figures 6-1 to 6-5.

Coldwater/Pigeon Roost

Sampling locations for the Coldwater River/Pigeon Roost Creek are presented in Figure 1. Depth to water measurements were relatively constant with peaks occurring on 2/1/99 and 3/15/99, which coincided with heavy rainfall events (3.5 - 4"). Water quality parameters (temperature, dissolved oxygen, and pH) were consistent with seasonal fluctuations. Conductivity appeared to exhibit an increase, primarily in the summer months, for sites 7,1, 7,3, X,2 and X,4. Suspended solids concentrations exhibited significant peaks during spring and early summer and were associated with significant rainfall events (1 - 1.5"; see Fig. 2). Site 7,1 had several other peaks on 7/19/99, 10/11/99, 11/22/99, 12/6/99 and 12/20/99 and are associated with recent land development in the area. Filtered and total orthophosphate had a significant peak on 4/26/99 in association with increased suspended solids concentrations during a heavy rainfall event. Again, site 7,1 had significantly higher phosphorus concentrations than other sites throughout the year due to recent land development near that site. Nitrate concentrations fluctuated throughout the year while ammonia fluctuated primarily during the winter and spring months. Both fecal coliforms and enterococci had significant increases on 3/15/99 and during the summer months and are most likely associated with dead animal remains and/or low-flow conditions. Coldwater/Pigeon Roost had only five of 13 water quality measurements that were within acceptable limits of USEPA and MDEQ TMDL guidelines. Temperature, dissolved oxygen, pH and ammonia exceeded the guidelines less than five times each during 1999. Similar to other watersheds examined, the greatest number of non-compliant values during 1999 occurred for suspended solids concentrations (50 times), total phosphorus (119 times), enterococci (87 times) and fecal coliforms (56 times). See Table 1 and Figures 7-1 to 7-5 for complete data.

Abiaca

Depth to water remained relatively constant throughout the year except for a peak occurring on 2/1/99 coinciding with a 4" rainfall event and a decrease on 5/24/99 coinciding with drought conditions. Temperature, dissolved oxygen and pH were consistent with seasonal fluctuations throughout 1999. Conductivity showed an increase during the summer months for nearly every site except 8,5 and 8,7. Suspended solids concentrations had significant peaks occurring on 2/1/99 and 7/19/99 in conjunction with significant rainfall events (1-4"). Filtered and total orthophosphate fluctuated throughout the year with peaks occurring on 1/4/99, 2/1/99, 4/26/99 and 7/19/99 often coinciding with heavy rainfall events. Nitrates and ammonia had significant increases during the winter months with the greatest peak occurring on 2/1/99, again coinciding with a heavy rainfall event. Microbial analyses indicated consistent numbers of fecal coliforms and enterococci throughout much of 1999 with a significant increase occurring during the summer (7/19/99). Similarly with Black Creek watershed, nine of 13 water quality parameters were within acceptable limits of USEPA and MDEQ guidelines. Non-compliance occurred primarily for suspended solids (23 times during 1999), total phosphorus (43 times), enterococci (63 times) and fecal coliforms (37 times). See Figure 1 for locations of sampling sites for Coldwater River/Pigeon Roost Creek. Refer to Table 1 and Figures 8-1 to 8-5 for complete information.

Toby Tubby

Depth to water remained relatively constant throughout the year with increases occurring on 3/15/99, 4/5/99, 6/28/99 and 12/13/99 in conjunction with significant storm events. Temperature and dissolved oxygen remained constant with seasonal fluctuations throughout 1999. Conductivity fluctuated throughout the year with a significant decrease occurring on 3/15/99 coinciding with a 3" rainfall event. Measurements of pH were acidic during most of the winter and spring, except on 3/15/99 where values became more basic after a storm event. Values of pH showed an increase throughout the summer and stabilized during fall. Total and suspended solids concentrations fluctuated throughout 1999 with a significant peak occurring on 6/28/99 coinciding with five consecutive days of rainfall. Nutrient analyses exhibited fluctuations throughout 1999 with increases in concentrations occurring primarily during the spring and summer months and were most likely associated with nutrient runoff and application processes at or near the sampling locality. Fecal coliform concentrations were consistent except for an increase occurring on 12/13/99. Enterococci concentrations fluctuated throughout the year with peaks occurring during winter and summer months. Most water quality parameters for Toby Tubby Creek were within acceptable limits of USEPA and MDEQ TMDL guidelines. Exceptions occurred primarily for pH (16 times during 1999), total phosphorus (11 times), enterococci (29 times)

and fecal coliforms (22 times). See Figure 1 for locations of Toby Tubby Creek sampling sites. More specific data are available in Table 1 and Figures 9-1 to 9-5.

Burney Branch

Several water quality parameters (temperature, conductivity, and dissolved oxygen) measured at sampling sites (Fig. 1) for Burney Branch Creek remained consistent according to typical seasonal fluctuations and storm events. Measurements of pH showed some fluctuations and a general increase throughout the year but were due in part to fluctuations in total chlorophyll concentrations and storm events. Depth to water remained constant throughout the year, with a peak occurring on 6/28/99 after five consecutive days of rainfall. Total, dissolved and suspended solids fluctuated throughout the year with site 13-3 having consistently greater concentrations. Observed fluctuations in solids concentrations are associated primarily with storm events and recent land development in the area. Filtered and total orthophosphate remained relatively stable throughout 1999 for sites 13,1 and 13,2 while site 13,3 fluctuated. Again, site 13,3 had significantly higher phosphorus concentrations than other sites throughout 1999 due to recent land development near that site. Ammonia concentrations exhibited occasional peaks during the summer and fall. Nitrate concentrations fluctuated throughout the year with site 13,3 having significantly greater amounts during the summer months. Microbial analyses revealed fluctuations in fecal coliform and enterococci numbers with spikes generally occurring during spring and summer months. Similarly with Toby Tubby Creek, eight of 13 water quality parameters for Burney Branch Creek were within acceptable limits of USEPA and MDEQ guidelines. Non-compliance occurred primarily for pH (7 times during 1999), total phosphorus (17 times), enterococci, and fecal coliforms (26 times each). See Table 1 and Figures 13-1 to 13-5 for more specific information.

Yalobusha

Sampling locations for the Yalobusha River are presented in Figure 1. Depth to water remained relatively constant throughout the year, with a significant peak occurring on 6/28/99 after five consecutive days of rainfall. Site 17,1 (Grenada Lake) had a consistent decrease in depth to water throughout the summer and fall due to drought conditions (Fig. 2). Temperature and dissolved oxygen remained constant with expected seasonal fluctuations throughout 1999. Conductivity increased during the summer months and remained high during fall for sites 17,5, 17,6, 17,7, 17,8, 17,9, and 17,10 due to low-flow associated with drought conditions. Measurements of pH had fluctuations during winter and spring due in part to fluctuations in total chlorophyll concentrations and storm events. Dissolved solids concentrations showed an increase during summer and fall for sites 17,5, 17,6, 17,8, 17,9, and 17,10 again, due to low-flow associated with drought conditions. Suspended solids concentrations fluctuated during 1999

with peaks for all sites occurring on 1/25/99, 6/1/99, 6/14/99 and 7/12/99 in association with significant rainfall events (1-4"; Fig. 3). Filtered orthophosphate, total orthophosphate, and ammonia concentrations exhibited fluctuations throughout 1999 with increases occurring primarily during the spring and summer months and were most likely associated with nutrient runoff and application processes at or near the sampling locality. Nitrates also fluctuated throughout the year but had significant increases during winter and early spring in association with storm events. Microbial analyses revealed fluctuations in fecal coliform and enterococci numbers with peaks generally occurring during summer and fall. Yalobusha River had only three of 13 water quality measurements that were within acceptable limits of USEPA and MDEQ TMDL guidelines throughout 1999. Temperature, pH, conductivity, dissolved solids, and ammonia exceeded the guidelines less than 10 times each during 1999. The greatest number of non-compliant values during 1999 occurred for dissolved oxygen concentrations (15 times), suspended solids concentrations (80 times), total phosphorus (137 times), enterococci (120 times) and fecal coliforms (62 times). Complete data are available in Table 1 and Figures 17-1 to 17-5.

Aquatic invertebrates collected and identified from the Yalobusha River from 1998 through 2000 consisted of 132 Genera from 82 Families and 20 different Orders (Table 2). Greatest aquatic invertebrate diversity was for aquatic insects and accounted for > 90% of the identified Genera. Remaining aquatic invertebrate diversity consisted primarily of crustaceans and annelids. Ephemeropteran, Plecopteran, and Trichopteran (EPT) diversity accounted for 20% of all identified Genera. Invertebrate diversity observed was typical for streams and rivers in the Yazoo drainage basin. Fish collected and identified from the same river during 1997 consisted of 35 species from 23 Genera and 13 different Families (Table 3). Centrarchids (sunfishes) and Cyprinids (minnows) accounted for nearly 50% of all fish species collected. Fish diversity was typical for warm waters in the southeastern United States and comparatively greater than similar rivers in the loess hills of northern Mississippi.

SUMMARY

Water quality parameters were measured for eleven hill land streams and rivers in the Yazoo drainage basin during 1999 and revealed expected patterns in yearly fluctuations. Fluctuations in temperature, dissolved oxygen, and conductivity were often associated with seasonal changes and low-flow drought conditions. Changes in pH were mostly associated with storm events and fluctuations in chlorophyll concentrations. Solids, specifically suspended solids concentrations exhibited fluctuations most frequently occurring with significant storm events (1" or more of rainfall). Fluctuations in nutrient concentrations were commonly associated with application processes and ensuing nutrient runoff after rainfall events. Observed changes in microbial counts during 1999 were due primarily to low flows during drought conditions occurring in summer and fall (see Fig. 2).

Comparisons of water quality data collected during 1999 and current TMDL guidelines proposed by USEPA (1986) and MDEQ (1999) were made to estimate the acceptability of current water quality parameters and guidelines. Most water quality parameters were consistently within acceptable limits of USEPA and MDEQ TMDL guidelines during 1999. Non-compliant values occurred at least once during 1999 for suspended solids, total orthophosphate, enterococci, and fecal coliforms in all eleven streams studied in the Yazoo basin. Seven of eleven streams had at least one pH value that exceeded TMDL guidelines during 1999. Yalobusha River (10) and Coldwater River/Pigeon Roost Creek (8) had the greatest number of water quality parameters that had exceeded TMDL guidelines at least once during 1999.

Aquatic invertebrates and fish collected and identified from the Yalobusha River during 1998-2000 and 1997 consisted of a relatively diverse fauna, despite degraded habitat due to stream channelization and soil erosion. Invertebrate diversity observed was typical for streams and rivers in the Yazoo drainage basin. Fish diversity was typical for warm waters in the southeastern United States and comparatively greater than similar rivers in the loess hills of northern Mississippi.

Monitoring of water quality during 1999 was performed in hill land watersheds of the Yazoo basin as part of a larger database including habitat, fisheries, benthic invertebrate populations and plant diversity. Specific studies and experiments such as the current aspect of water quality data monitoring are useful in helping to determine total maximum daily loads (TMDLs) within the Yazoo Basin. Results of the current study show stream water level was fairly stable throughout the year as most streams rely on shallow groundwater seepage for base flow. However, caution should be exercised since the use of data from a single year is considered preliminary and should be evaluated in light of long-term watershed changes.

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Table 1. Total number of water quality non-compliances for each Demonstration Erosion Control (DEC) watershed during 1999 based upon Mississippi Department of Environmental Quality (MDEQ) or US Environmental Protection Agency (USEPA) water quality guidelines^a (sample sizes in parentheses). See Note within text for an explanation of watershed identification numbers

Watershed Identification Number	Water quality parameter												
	1	2	3	4	5	6	7/X	8	9	13	17		
Temperature (C)	0 (131)	0 (199)	0 (50)	0 (74)	0 (130)	0 (104)	2 (300)	0 (102)	0 (41)	0 (39)	3 (304)		
Dissolved oxygen (mg/L)	0 (119)	0 (175)	0 (50)	0 (65)	0 (119)	0 (104)	1 (248)	0 (102)	0 (38)	0 (36)	15 (304)		
pH	19 (120)	2 (190)	0 (46)	2 (71)	7 (107)	0 (94)	22 (252)	0 (80)	16 (34)	7 (33)	20 (291)		
Conductivity (µmhos/cm)	0 (131)	0 (191)	0 (50)	0 (71)	0 (129)	0 (104)	0 (300)	0 (102)	0 (41)	0 (39)	7 (304)		
Dissolved solids (mg/L)	0 (130)	0 (176)	0 (48)	0 (72)	0 (122)	0 (101)	0 (298)	0 (99)	0 (40)	0 (39)	3 (297)		
Suspended solids (mg/L)	12 (130)	13 (174)	8 (48)	13 (72)	12 (121)	20 (100)	50 (298)	23 (94)	2 (39)	2 (39)	80 (297)		
Total phosphorus (mg/L)	30 (122)	53 (178)	21 (50)	21 (71)	44 (109)	38 (83)	119 (259)	43 (88)	11 (34)	17 (31)	137 (267)		
Nitrate (mg/L)	0 (125)	0 (199)	0 (49)	0 (71)	0 (129)	0 (104)	0 (311)	0 (101)	0 (41)	0 (39)	0 (303)		
Ammonia (mg/L)	0 (130)	0 (198)	0 (50)	0 (74)	0 (130)	0 (104)	1 (311)	0 (102)	0 (41)	0 (39)	1 (302)		
Enterococci (colonies/100 ml)	42 (55)	60 (91)	37 (50)	30 (45)	36 (60)	56 (93)	87 (144)	63 (96)	29 (34)	26 (32)	120 (186)		
Coliforms (colonies/100 ml)	26 (48)	35 (81)	24 (39)	12 (28)	30 (57)	41 (95)	56 (132)	37 (93)	22 (38)	26 (34)	62 (133)		

^aNo water quality criteria guidelines for either total solids or total chlorophyll concentrations.

Table 2. Aquatic invertebrates collected from the Yalobusha River in 1998.

Class / Order	Family	Genus
AMPHIPODA	Gammaridae	<i>Gammarus</i>
	Talitridae	<i>Hyalella</i>
ANNELIDA	Unknown	Leeches
	Lumbriculidae	<i>Lumbriculus</i>
	Naididae	<i>Amphichaeta</i>
		<i>Naispseudobtusa</i>
	Tubificidae	<i>Branchiura</i>
		<i>Isochaetides</i>
CLADOCERA	Unknown	Unknown
COELENTERATA	Unknown	Unknown
DECAPODA	Astacidae	Unknown
	Cambaridae	Unknown
	Palaemonidae	<i>Macrobrachium</i>
EUCOPEPODA	Unknown	Unknown
GASTROPODA	Ancylidae	Unknown
	Lymnaeidae	Unknown
	Physidae	<i>Physella</i>
	Planorbidae	Unknown
HYDRACARINA	Mites	Unknown
ISOPODA	Asellidae	<i>Caecidotea</i>
NEMATODA	Unknown	Unknown
NEMATOMORPHA	Gordiidae	Unknown
OSTRACODA	Seedshrimp	Unknown
PELECYPODA	Corbiculidae	<i>Corbicula</i>
	Sphaeriidae	Unknown
	Unionidae	Unknown
PODOCOPA	Clamshrimps	Unknown
TURBELLARIA	Planariidae	<i>Dugesia</i>
INSECTA		
COLEOPTERA	Curculionidae	<i>Listronotus</i>
	Dryopidae	<i>Helichus</i>
	Dytiscidae	<i>Celina</i>
		<i>Cybister</i>
		<i>Hydroporus</i>
		<i>Illybius</i>
		<i>Laccophilus</i>
		<i>Uvarus</i>
	Elmidae	<i>Ancyronyx</i>
		<i>Dubiraphia</i>
		<i>Macronychus</i>
		<i>Stenelmis</i>
	Gyrinidae	<i>Dineutus</i>
		<i>Gyrinus</i>
	Haliplidae	<i>Peltodytes</i>
	Hydrochidae	<i>Hydrochus</i>
	Hydrophilidae	<i>Berosus</i>
		<i>Enochrus</i>

Table 2. Continued.

Class / Order	Family	Genus
		<i>Hydrobius</i>
		<i>Laccobius</i>
		<i>Paracymus</i>
		<i>Tropisternus</i>
	Noteridae	<i>Hydrocanthus</i>
	Scirtidae	<i>Cyphon</i>
		<i>Scirtes</i>
	Staphylinidae	Unknown
COLLEMBOLA	Entomobryidae	Unknown
	Isotomidae	
	Sminthuridae	
DIPTERA	Ceratopogonidae	<i>Bourletiella</i>
		<i>Alluaudomyia</i>
		<i>Atrichopogon</i>
		<i>Bezzia</i>
		<i>Ceratopogon</i>
		<i>Culicoides</i>
		<i>Mallochohelea</i>
		<i>Monohelea</i>
		<i>Probezzia</i>
		<i>Seromyia</i>
	Chaoboridae	<i>Chaoborus</i>
		<i>Mochlonyx</i>
	Chironomidae	<i>Chironomus</i>
	Culicidae	<i>Anopheles</i>
		<i>Culex</i>
	Dixidae	Unknown
	Empididae	<i>Clinocera</i>
		<i>Hemerodromia</i>
	Ephydriidae	<i>Ochthera</i>
	Muscidae	<i>Muscida</i>
	Simuliidae	<i>Prosimulium</i>
		<i>Simulium</i>
	Syrphidae	Unknown
	Tabanidae	<i>Chrysops</i>
		<i>Tabanus</i>
	Tipulidae	<i>Antocha</i>
		<i>Gonomyia</i>
		<i>Limonia</i>
		<i>Tipula</i>
EPHEMEROPTERA	Baetidae	<i>Acentrella</i>
		<i>Acerpenna</i>
		<i>Baetis</i>
		<i>Centroptilum</i>
		<i>Cloeon</i>
		<i>Heterocloeon</i>
		<i>Paraclaeodes</i>
		<i>Psuedocloeon</i>

Table 2. Continued.

Class / Order	Family	Genus
HEMIPTERA	Caenidae	<i>Brachycercus</i> <i>Caenis</i>
	Ephemeridae	<i>Hexagenia</i>
	Heptageniidae	<i>Heptagenia</i> <i>Stenacron</i> <i>Stenonema</i>
	Isonychiidae	<i>Isonychia</i>
	Leptophlebiidae	<i>Paraleptophlebia</i>
	Belostomatidae	<i>Belostoma</i>
	Corixidae	<i>Hesperocorixa</i> <i>Palmacorixa</i> <i>Trichocorixa</i>
	Gelastocoridae	<i>Gelastocoris</i>
	Gerridae	<i>Gerris</i> <i>Limnoporus</i> <i>Rheumatobates</i> <i>Trepobates</i>
	Hebridae	<i>Lipogomphus</i>
	Hydrometridae	<i>Hydrometra</i>
	Mesoveliidae	<i>Mesovelia</i>
	Naucoridae	<i>Pelecoris</i>
	Nepidae	<i>Ranatra</i>
	Pleidae	<i>Paraplea</i>
LEPIDOPTERA	Veliidae	<i>Microvelia</i>
MEGALOPTERA	Unknown	Unknown
ODANATA	Corydalidae	<i>Chauliodes</i> <i>Corydalus</i> <i>Nigronia</i>
	Sialidae	<i>Sialis</i>
	Sysyridae	<i>Climacia</i>
	Aeschnidae	<i>Basiaeschna</i> <i>Boyeria</i>
	Calopterygidae	<i>Calopteryx</i>
	Coenagrionidae	<i>Agria</i> <i>Chromagrion</i> <i>Enallagma</i> <i>Ischnura</i>
	Cordulegastridae	<i>Cordulegaster</i>
	Corduliidae	<i>Epithea</i> <i>Somatochlora</i>
	Gomphidae	<i>Aphylla</i> <i>Dromogomphus</i> <i>Gomphus</i> <i>Progomphus</i>
	Libellulidae	<i>Erythemis</i> <i>Libellula</i> <i>Perithemis</i>
	Macromiidae	<i>Didymops</i>

Table 2. Continued.

Class / Order	Family	Genus
PLECOPTERA	Nemouridae	<i>Macromia</i>
	Perlidae	<i>Amphinemura</i>
	Perlodidae	<i>Perlesta</i>
TRICHOPTERA	Brachycentridae	<i>Isoperla</i>
	Hydropsychidae	<i>Brachycentrus</i>
		<i>Cheumatopsyche</i>
		<i>Hydropsyche</i>
	Hydroptilidae	<i>Hydroptila</i>
	Leptoceridae	<i>Nectopsyche</i>
		<i>Oecetis</i>
	Limnephilidae	Unknown
	Polycentropodidae	<i>Phylocentropus</i>
	Rhyacophilidae	<i>Rhyacophila</i>

Table 3. Fish collected from the Yalobusha River in 1997.

Family	Genus	Species
Amiidae	<i>Amia</i>	<i>calva</i>
Atherinidae	<i>Labidesthes</i>	<i>sicculus</i>
Catostomidae	<i>Ictiobus</i>	<i>bubulus</i>
	<i>Ictobus</i>	<i>cyprinellus</i>
	<i>Minytrema</i>	<i>melanops</i>
Centrarchidae	<i>Lepomis</i>	<i>cyanellus</i>
	<i>Lepomis</i>	<i>gulosus</i>
	<i>Lepomis</i>	<i>humilis</i>
	<i>Lepomis</i>	<i>macrochirus</i>
	<i>Lepomis</i>	<i>macrolophus</i>
	<i>Micropterus</i>	<i>punctulatus</i>
	<i>Pomoxis</i>	<i>annularis</i>
	<i>Pomoxis</i>	<i>nigromaculatus</i>
Clupeidae	<i>Dorosoma</i>	<i>cepedianum</i>
Cyprinidae	<i>Cyprinella</i>	<i>venusta</i>
	<i>Cyprinus</i>	<i>carpio</i>
	<i>Lythrurus</i>	<i>fumeus</i>
	<i>Lythrurus</i>	<i>umbratilis</i>
	<i>Notropis</i>	<i>atherinoides</i>
	<i>Notropis</i>	<i>buchanani</i>
	<i>Opsopoeodus</i>	<i>emiliae</i>
	<i>Pimephales</i>	<i>notatus</i>
	<i>Pimephales</i>	<i>vigilax</i>
Esocidae	<i>Esox</i>	<i>americanus</i>
Fundulidae	<i>Fundulus</i>	<i>olivaceus</i>
Ictaluridae	<i>Ameiurus</i>	<i>natalis</i>
	<i>Ictalurus</i>	<i>furcatus</i>
	<i>Ictalurus</i>	<i>punctatus</i>
	<i>Polydictus</i>	<i>olivaris</i>
Lepisosteidae	<i>Lepisosteus</i>	<i>oculatus</i>
	<i>Lepisosteus</i>	<i>osseus</i>
	<i>Lepisosteus</i>	<i>platostomus</i>
Moronidae	<i>Morone</i>	<i>chrysops</i>
Poeciliidae	<i>Gambusia</i>	<i>affinis</i>
Sciaenidae	<i>Aplodinotus</i>	<i>grunniens</i>

Figure 1. Map of Demonstration Erosion Control (DEC) project watersheds and sampling locations for each watershed during 1999. See Note within text for an explanation of watershed identification numbers.

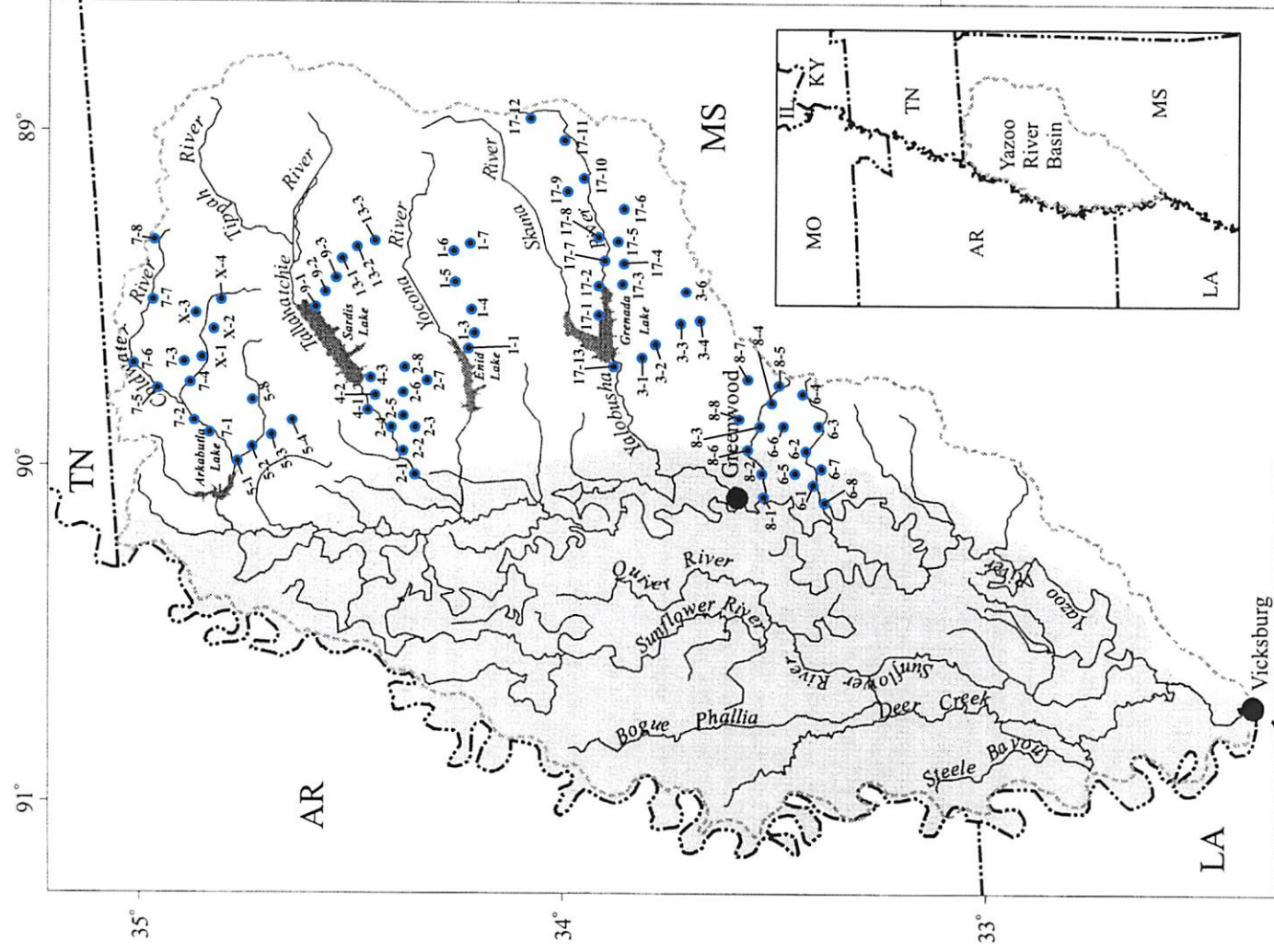
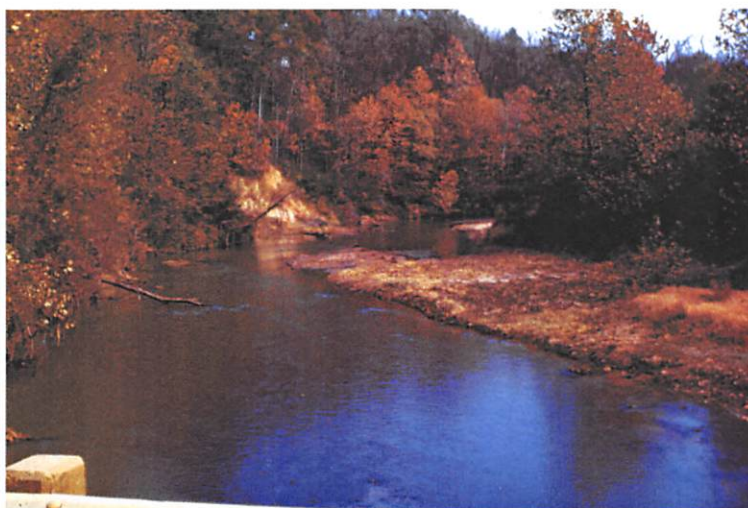


Figure 2. Low flow conditions in (a) Abiaca Creek, 1991 and (b) Yalobusha River, 1997.



(a)



(b)

Figure 3. High flow conditions in (a) Coldwater River, 1991 and (b) Yalobusha River, 1997.



(a)



(b)

Fig. 1-1. 1999 depth to water, temperature, and conductivity measurements for Otoucalofa Creek.

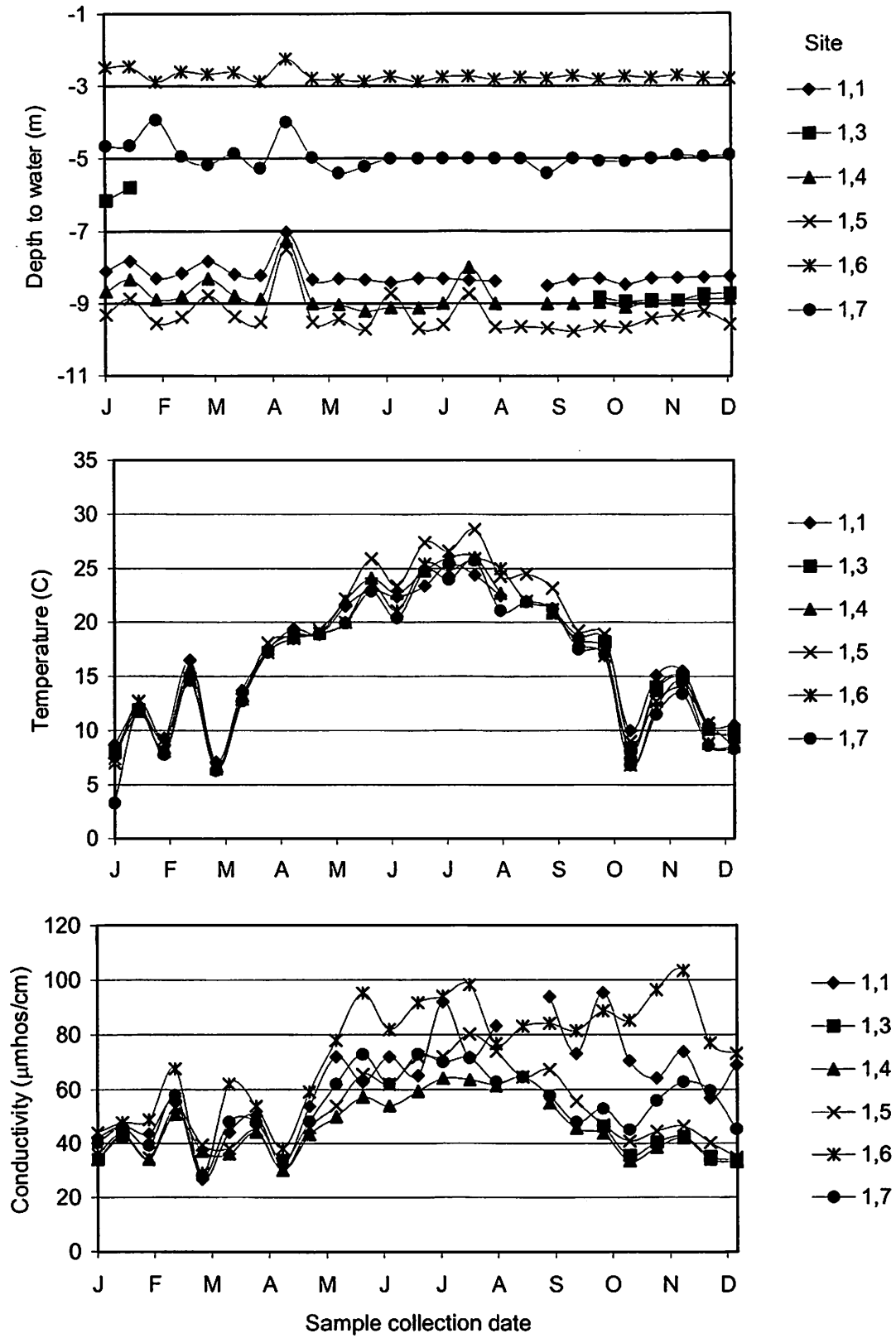


Fig. 1-2. 1999 dissolved oxygen, pH and total solids measurements for Otoucalofa Creek

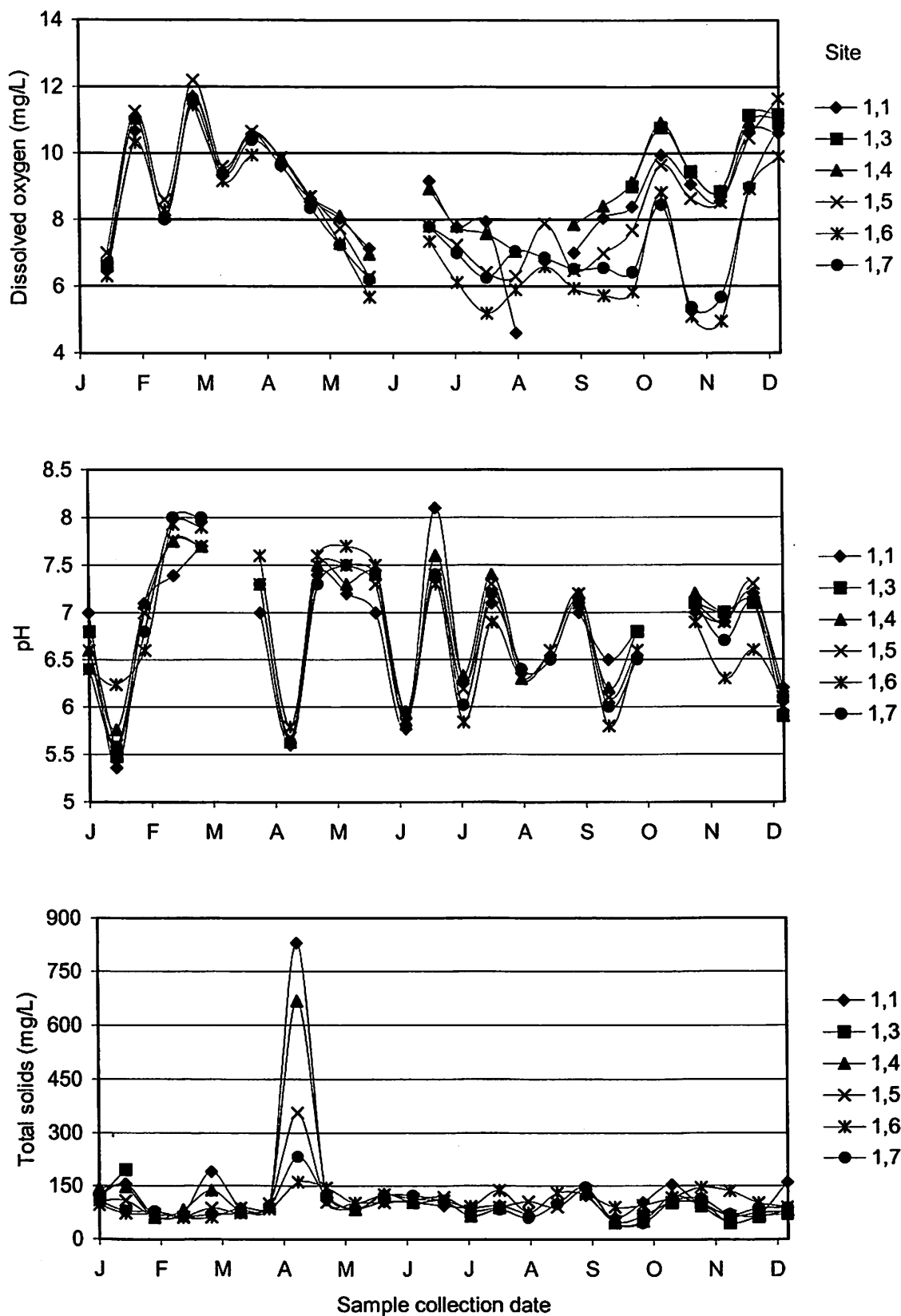


Fig. 1-3. 1999 dissolved and suspended solids, and filtered orthophosphate measurements for Otoucalofa Creek.

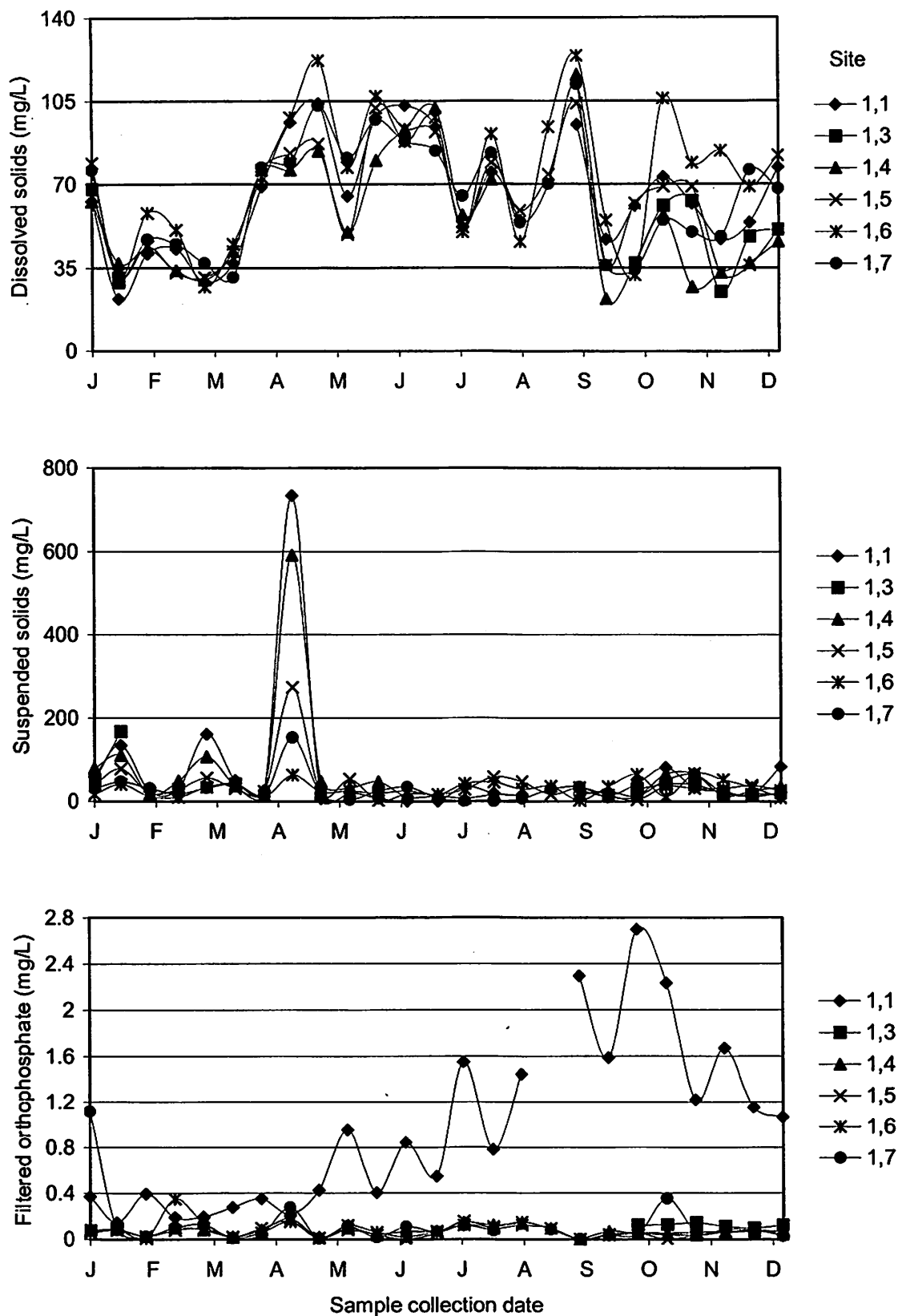


Fig. 1-4. 1999 total orthophosphate, ammonia, and nitrate measurements for Otoucalofa Creek.

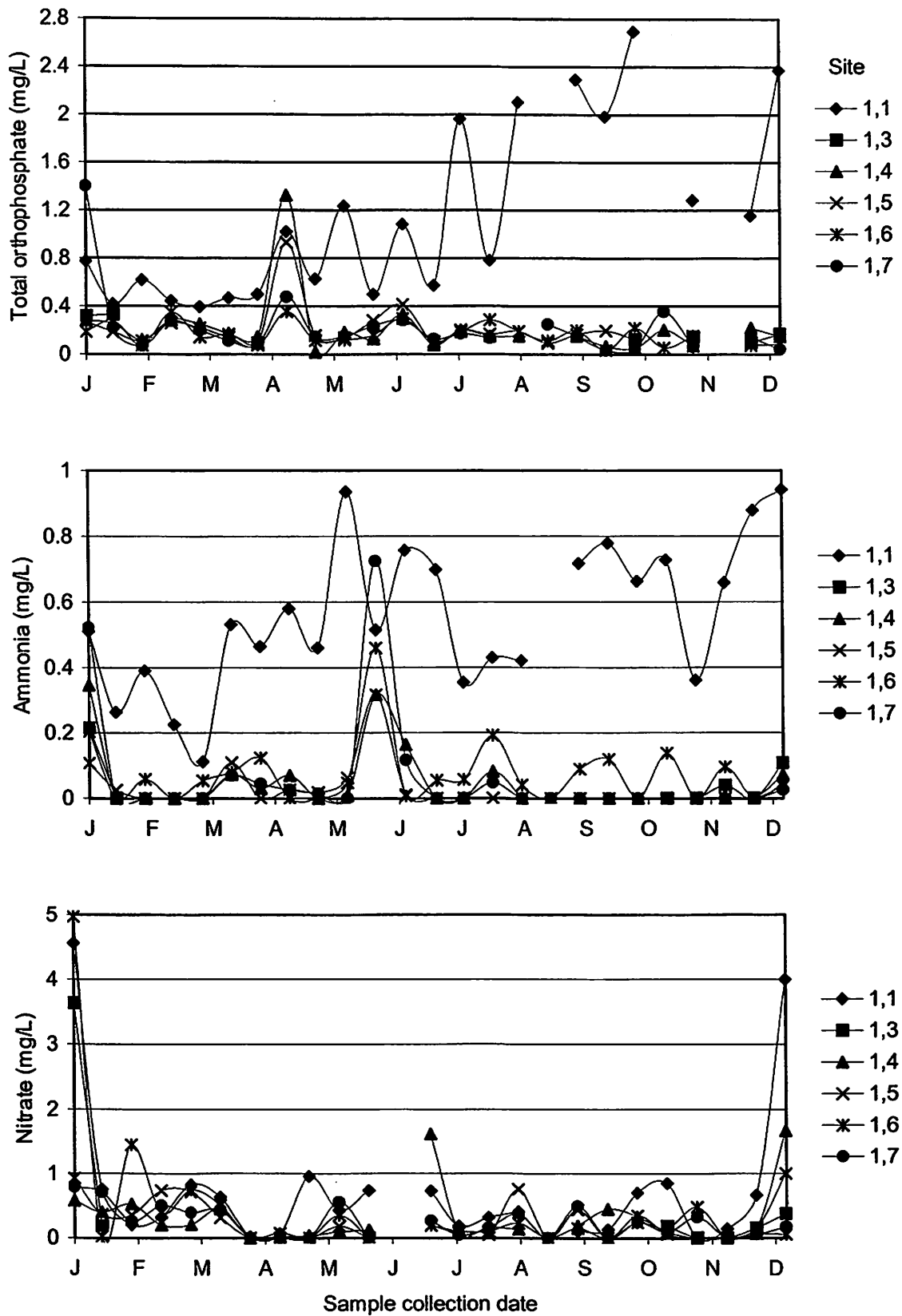


Fig. 1-5. 1999 chlorophyll, fecal coliform, and enterococci measurements for Otoucalofa Creek.

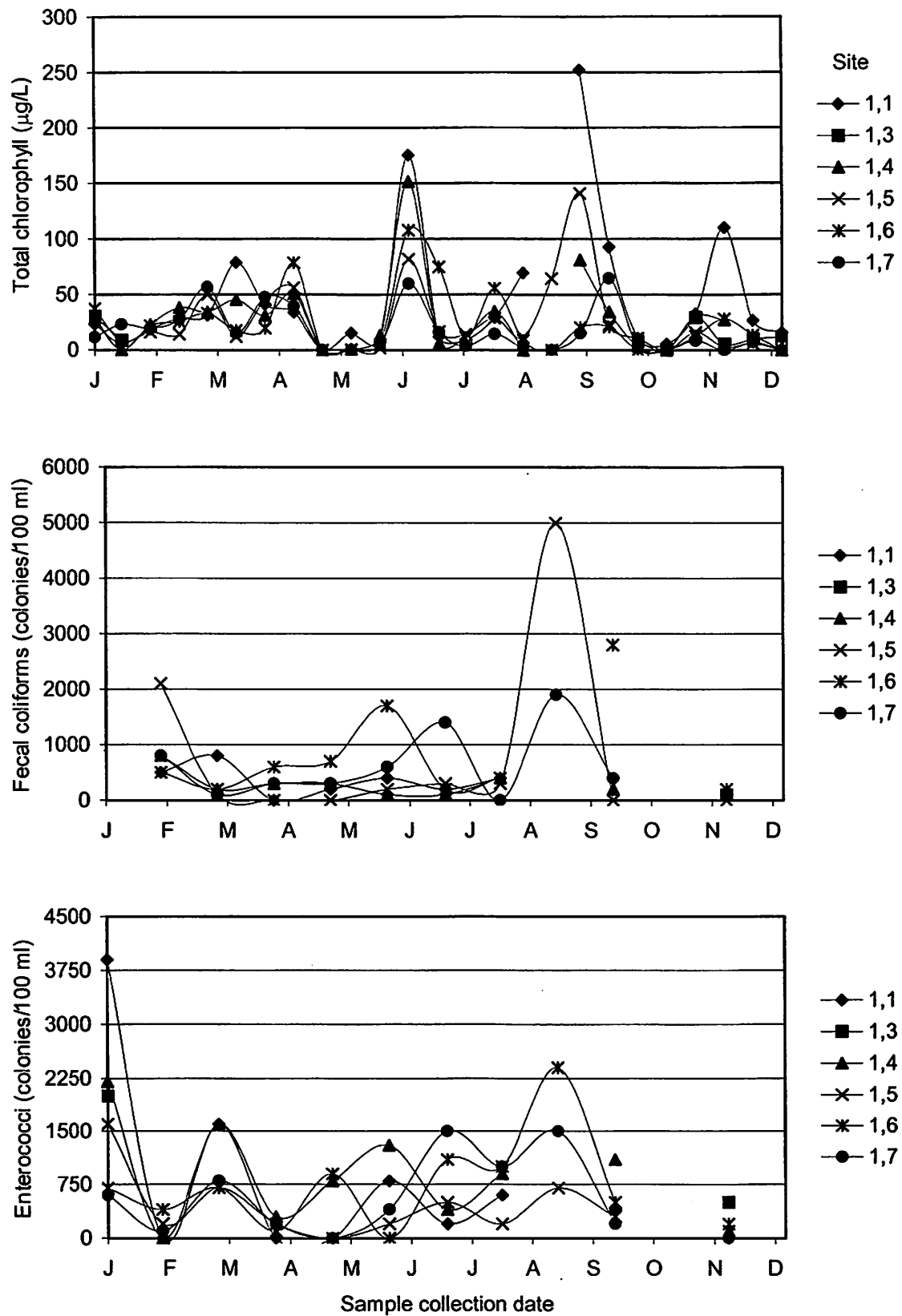


Fig. 2-1. 1999 depth to water, temperature, and conductivity measurements for Long Creek.

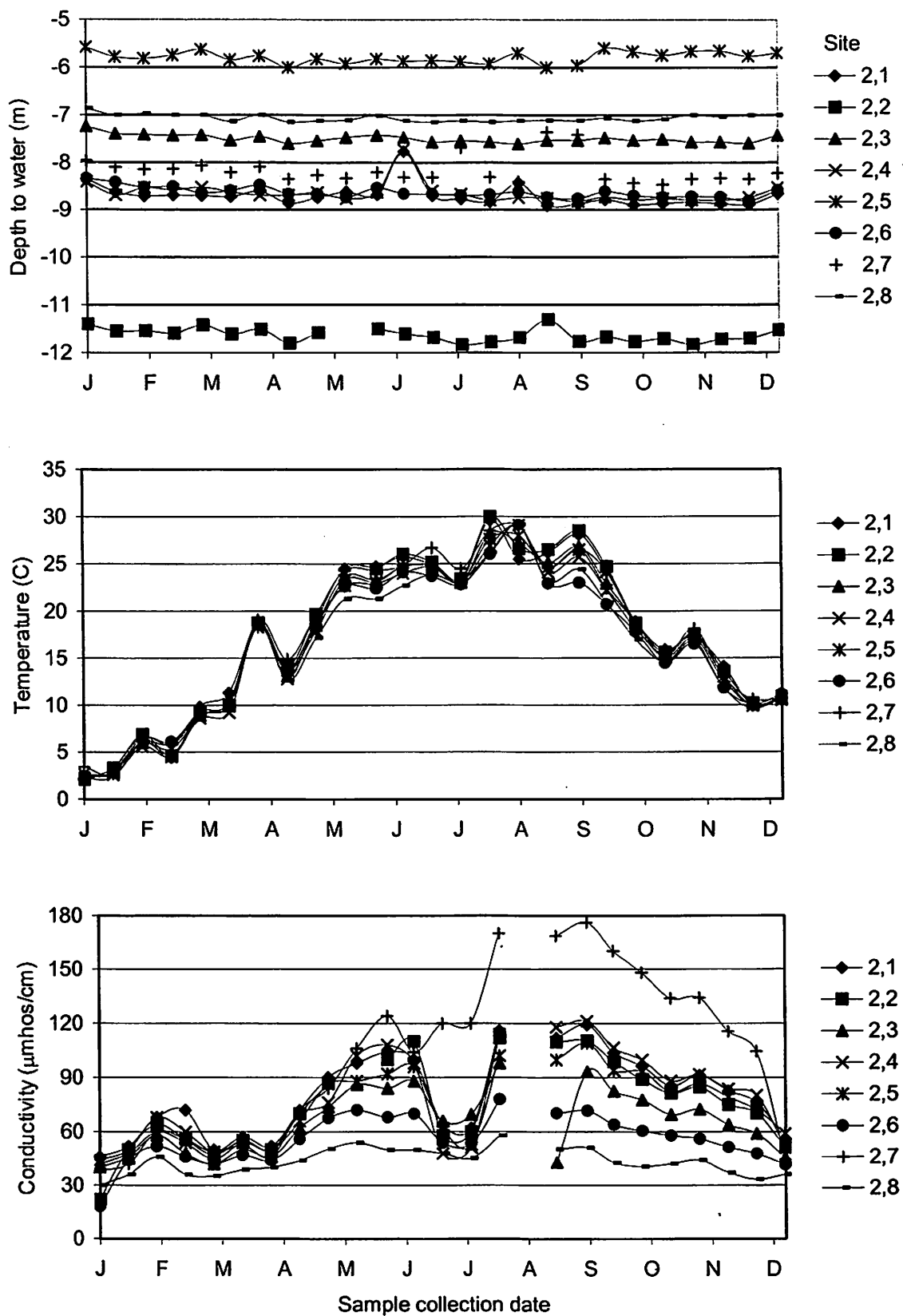


Fig. 2-2. 1999 dissolved oxygen, pH, and total solids measurements for Long Creek.

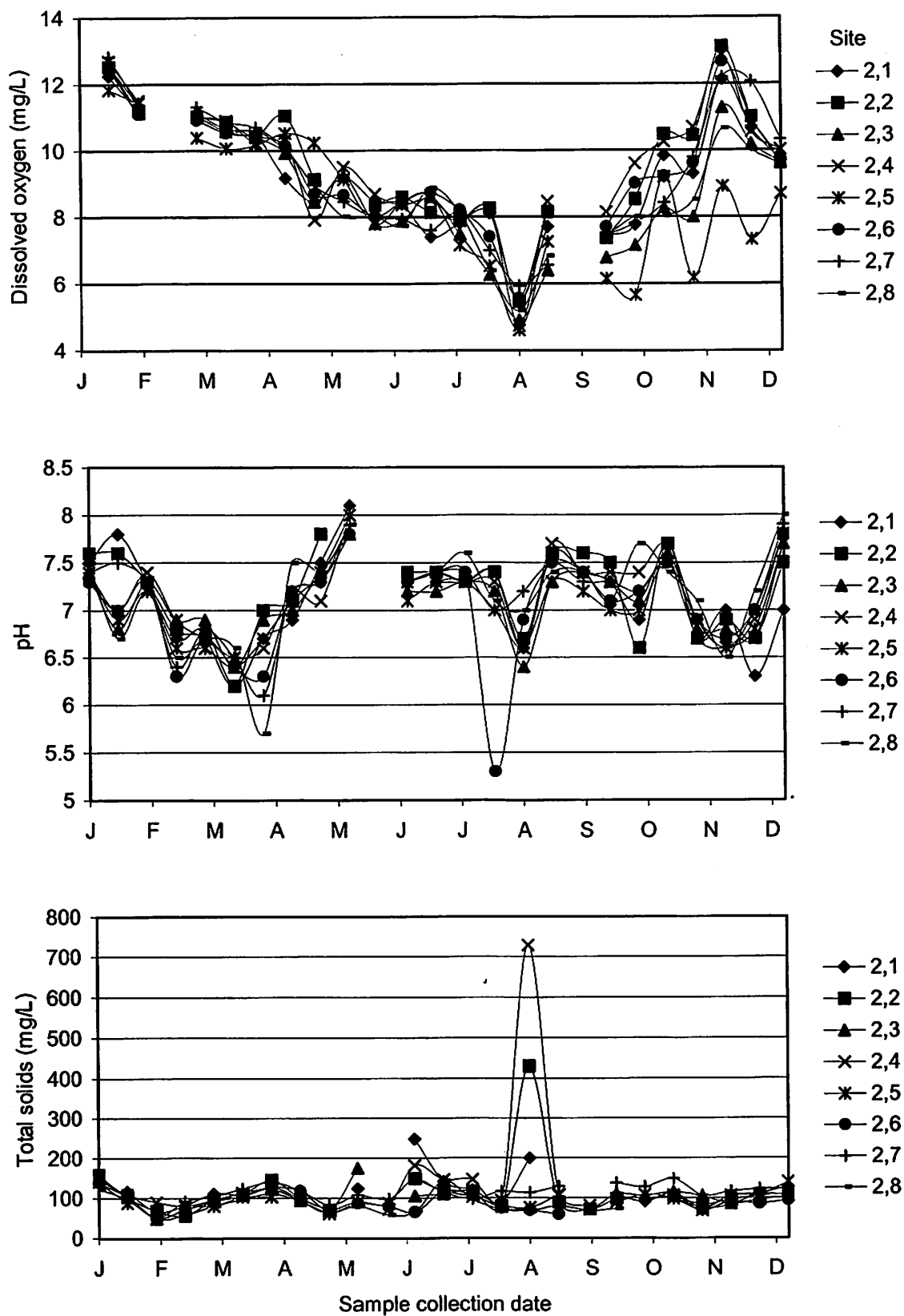


Fig. 2-3. 1999 dissolved and suspended solids, and filtered orthophosphate measurements for Long Creek.

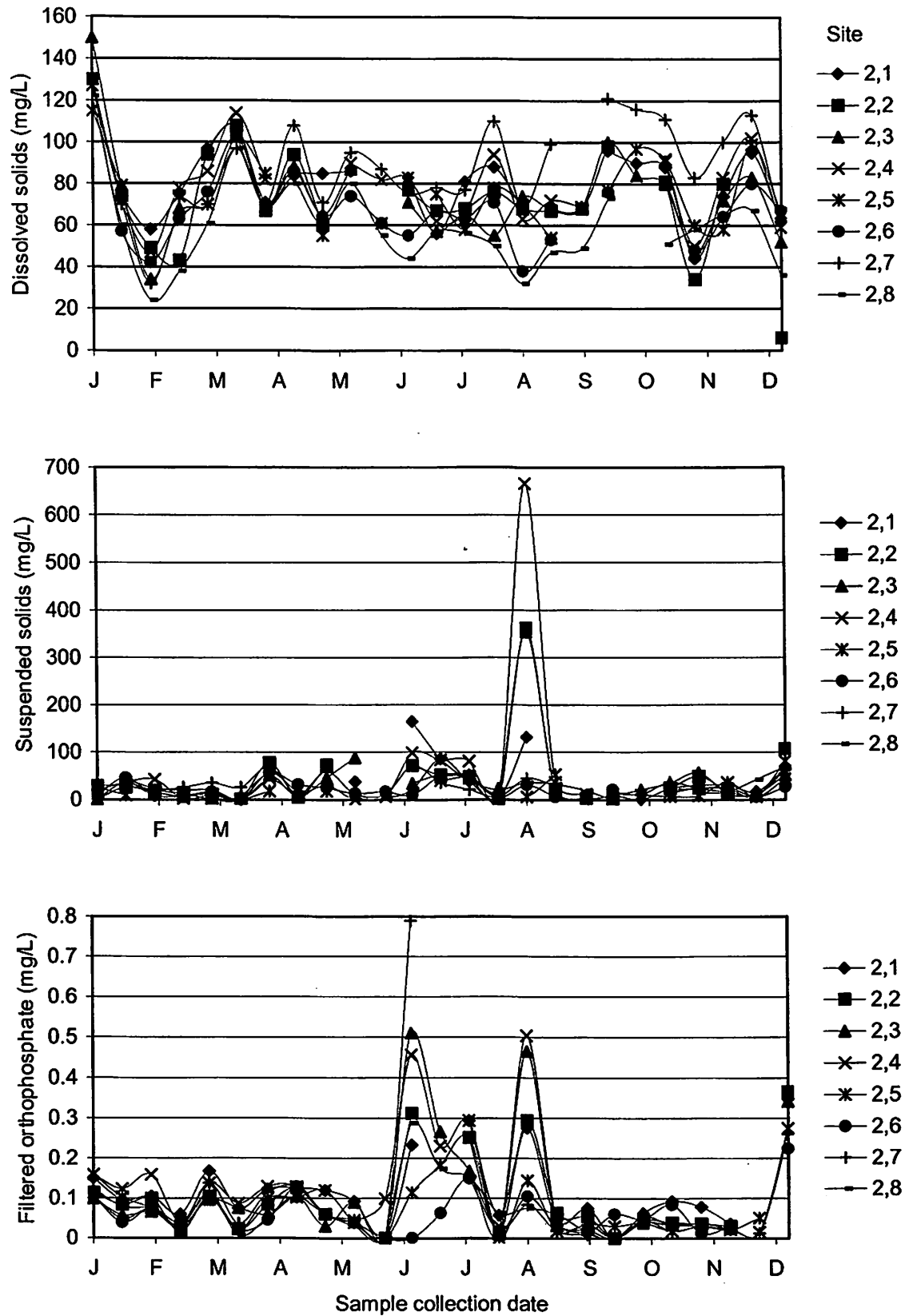


Fig. 2-4. 1999 total orthophosphate, ammonia, and nitrate measurements for Long Creek.

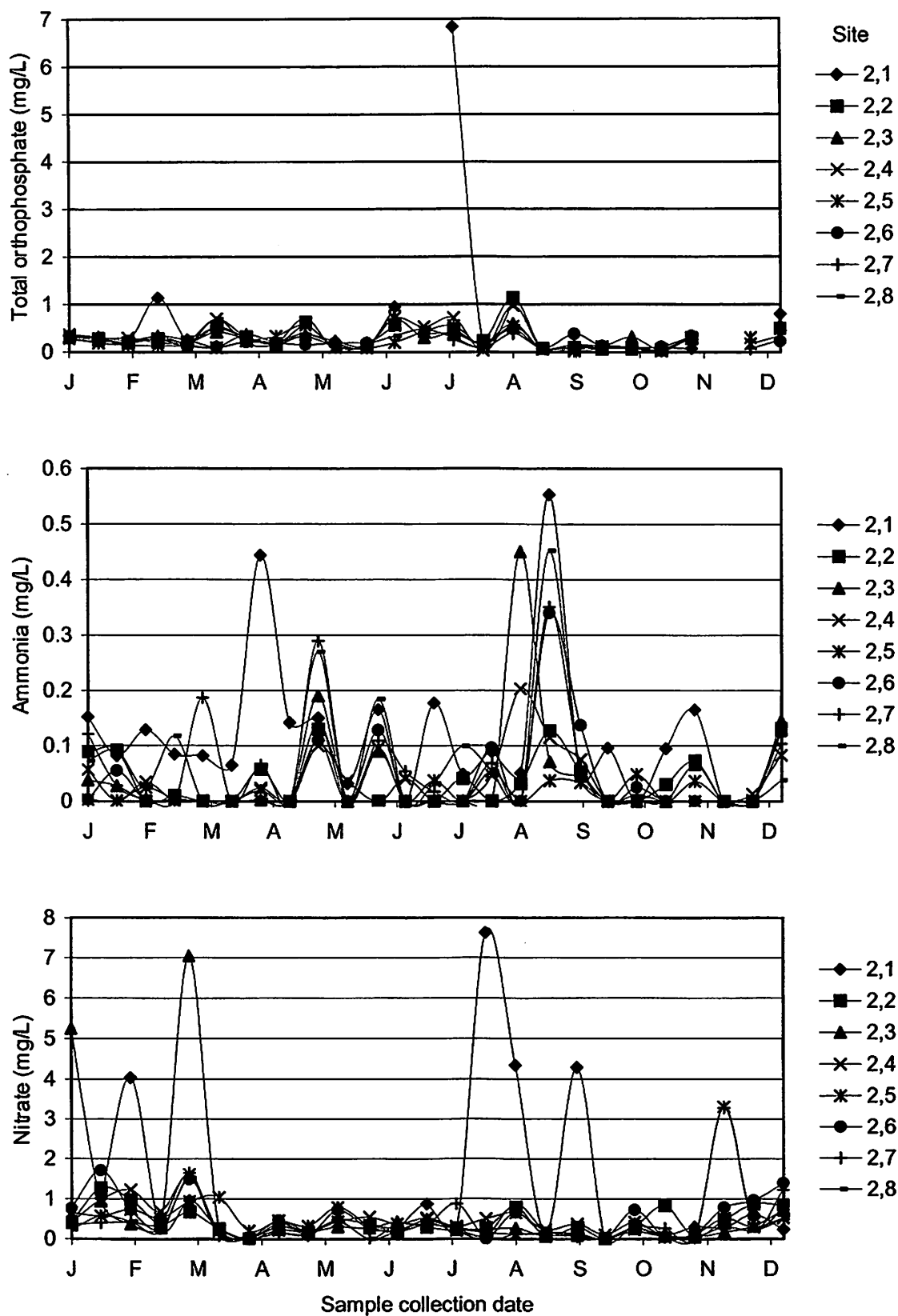


Fig. 2-5. 1999 chlorophyll, fecal coliform, and enterococci measurements for Long Creek.

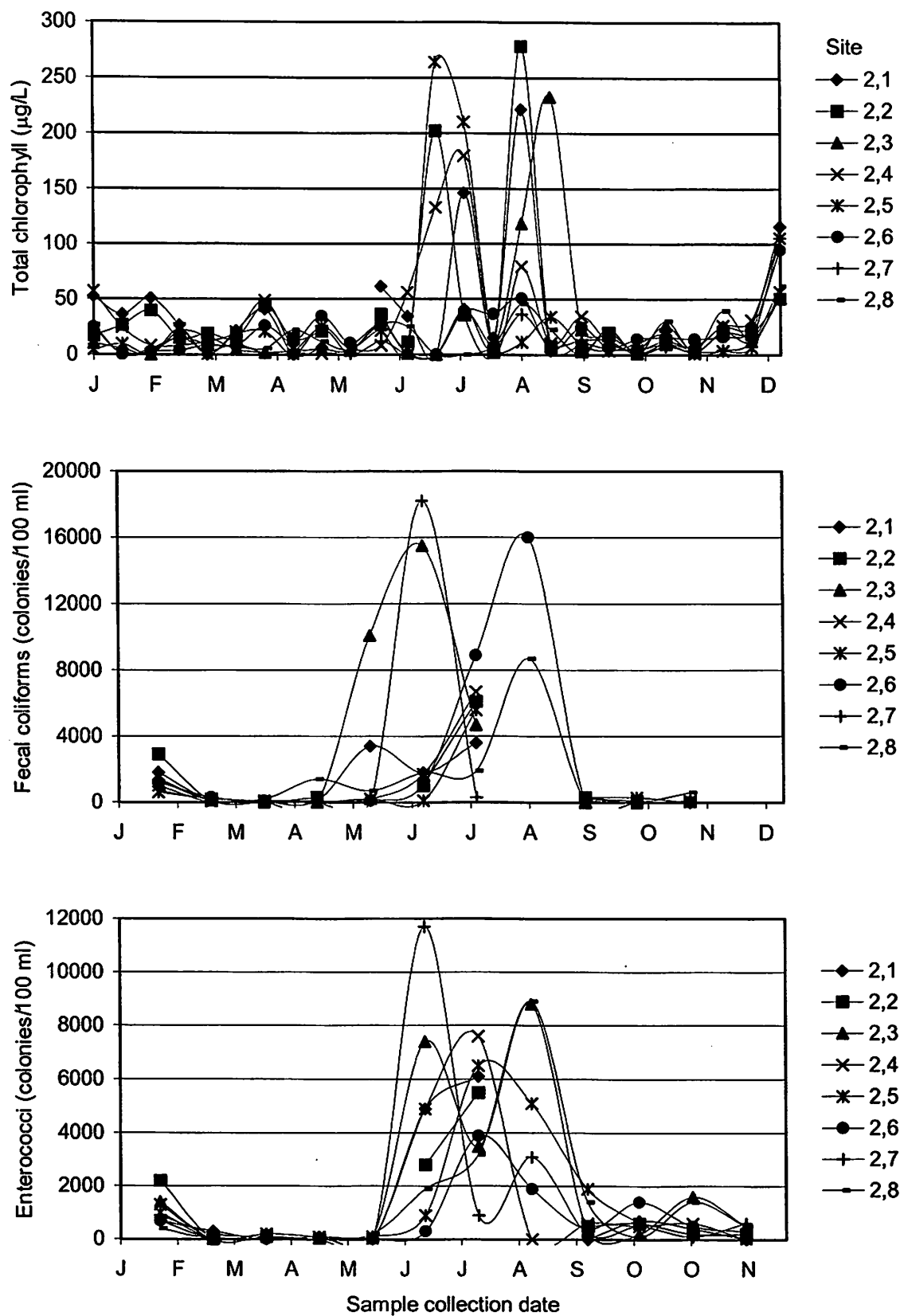


Fig. 3-1. 1999 depth to water, temperature, and conductivity measurements for Batupan Bogue Creek.

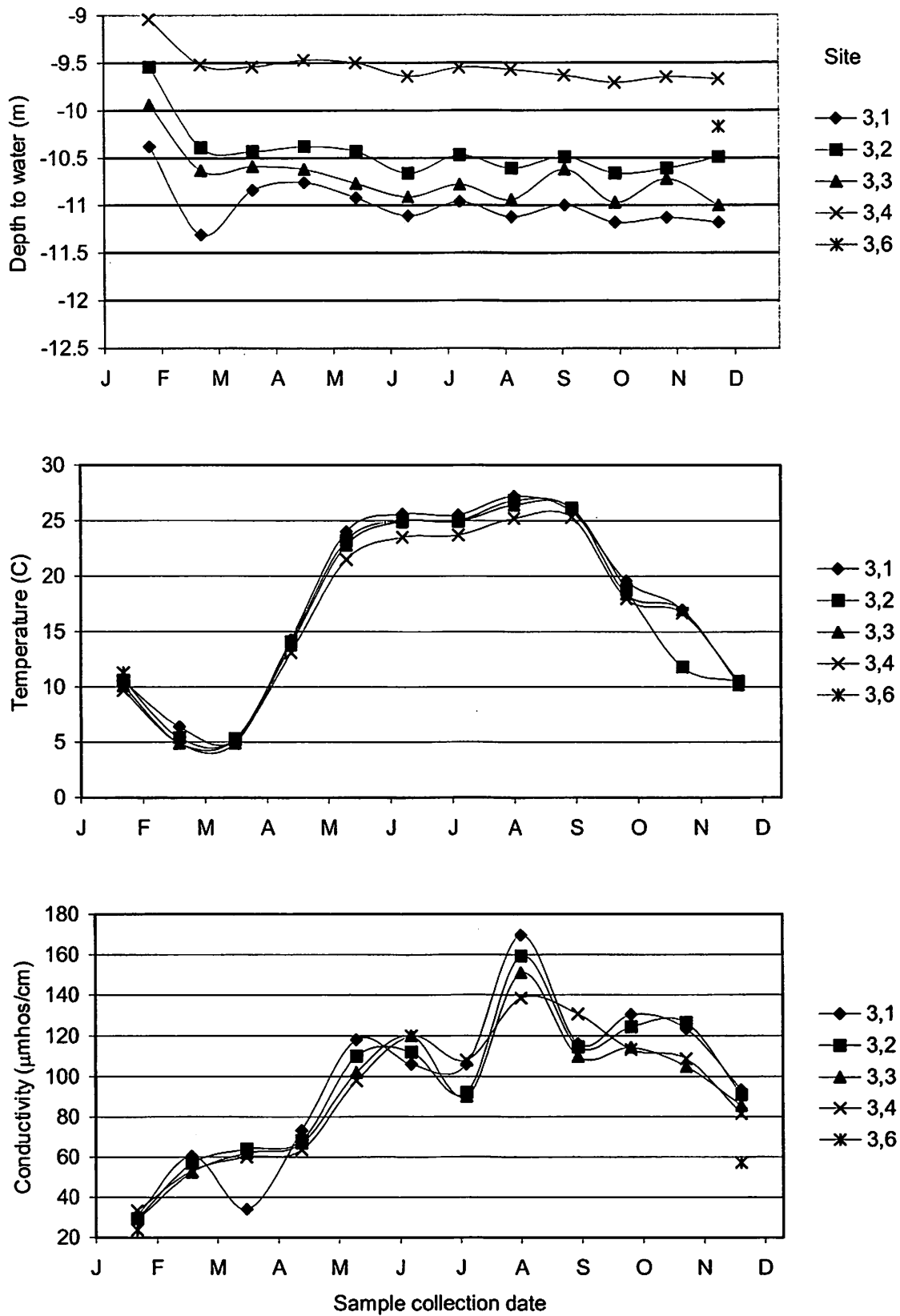


Fig. 3-2. 1999 dissolved oxygen, pH, and total solids measurements for Batupan Bogue Creek.

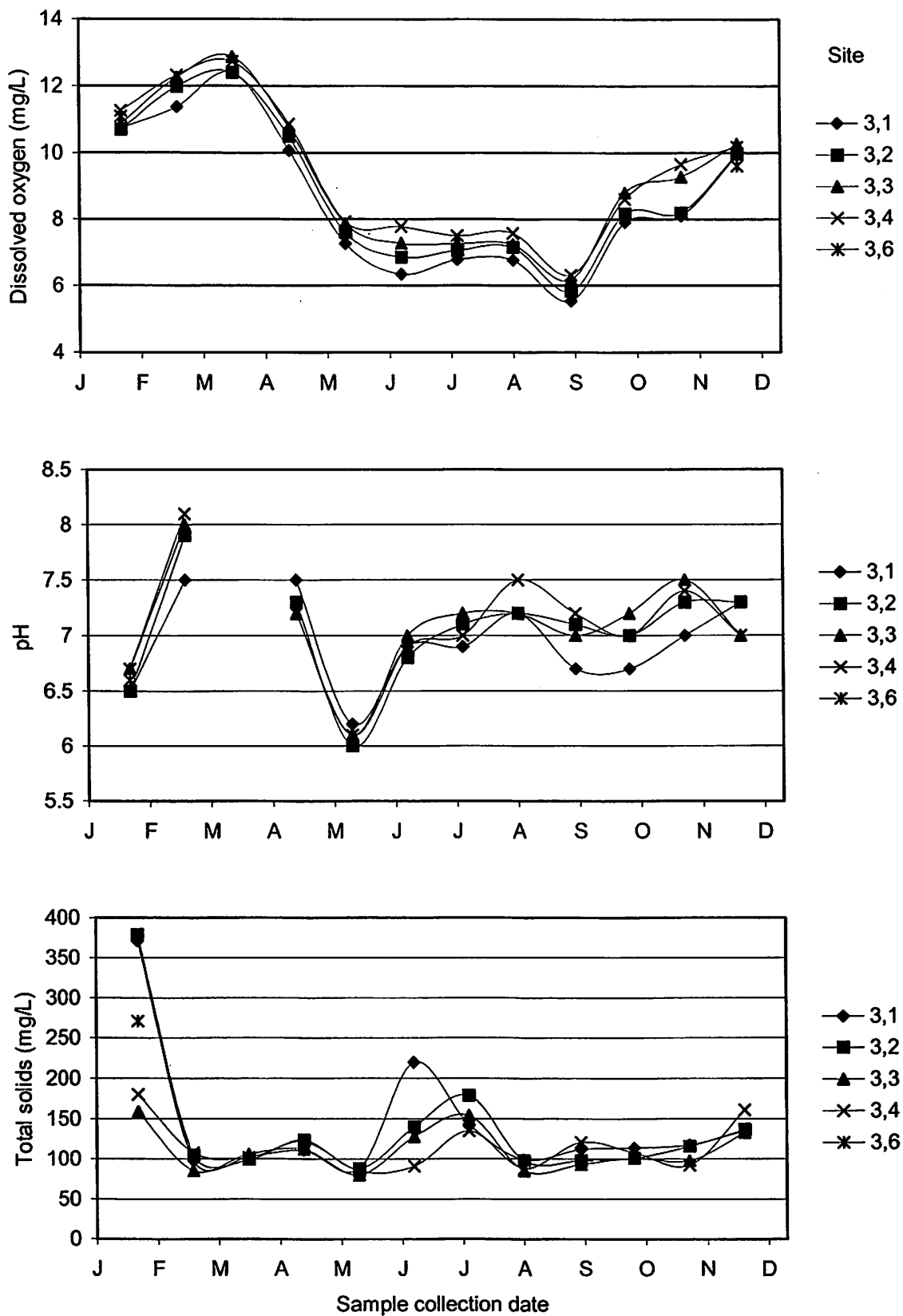


Fig. 3-3. 1999 dissolved and suspended solids, and filtered orthophosphate measurements for Batupan Bogue Creek.

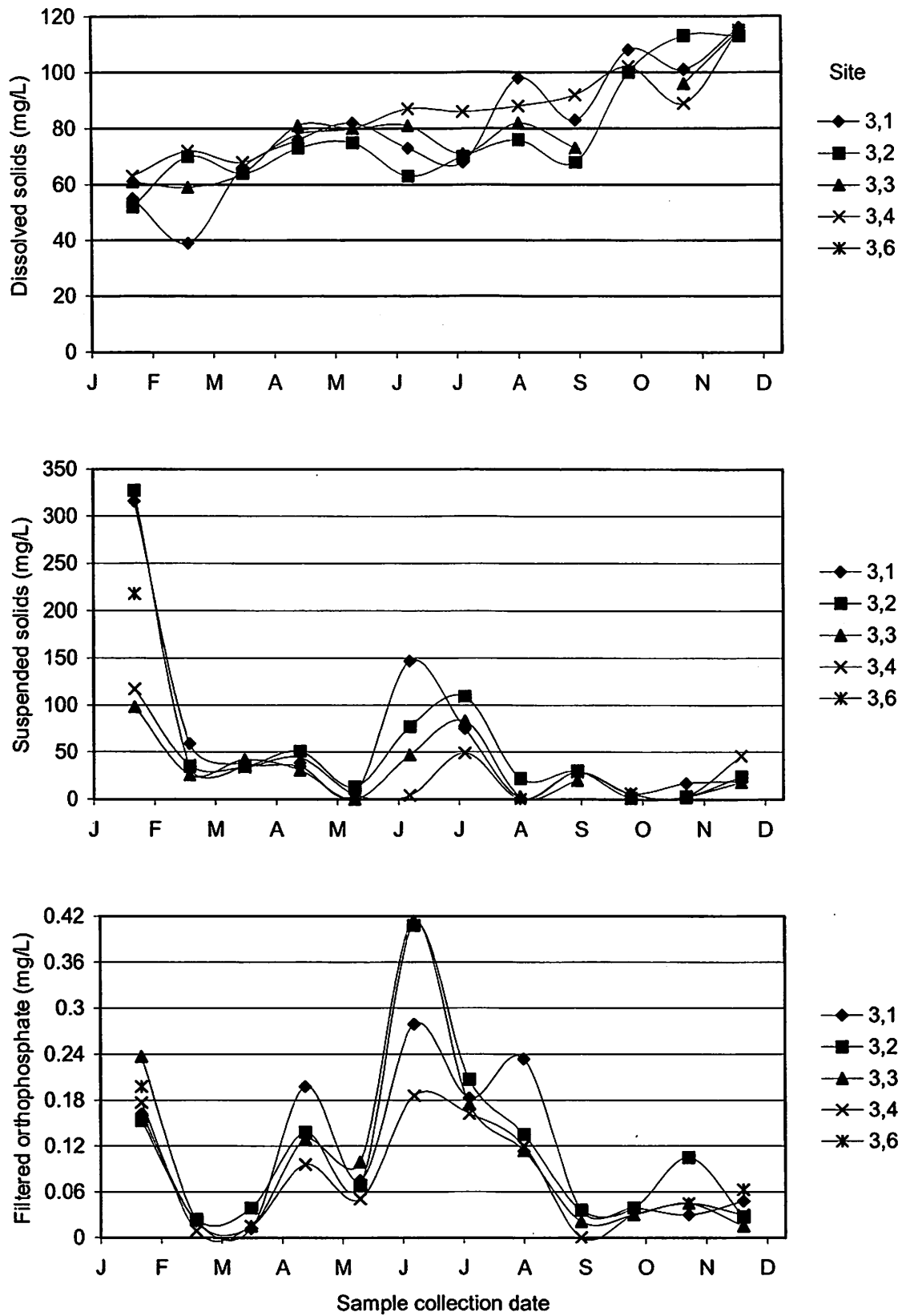


Fig. 3-4. 1999 total orthophosphate, ammonia, and nitrate measurements for Batupan Bogue Creek.

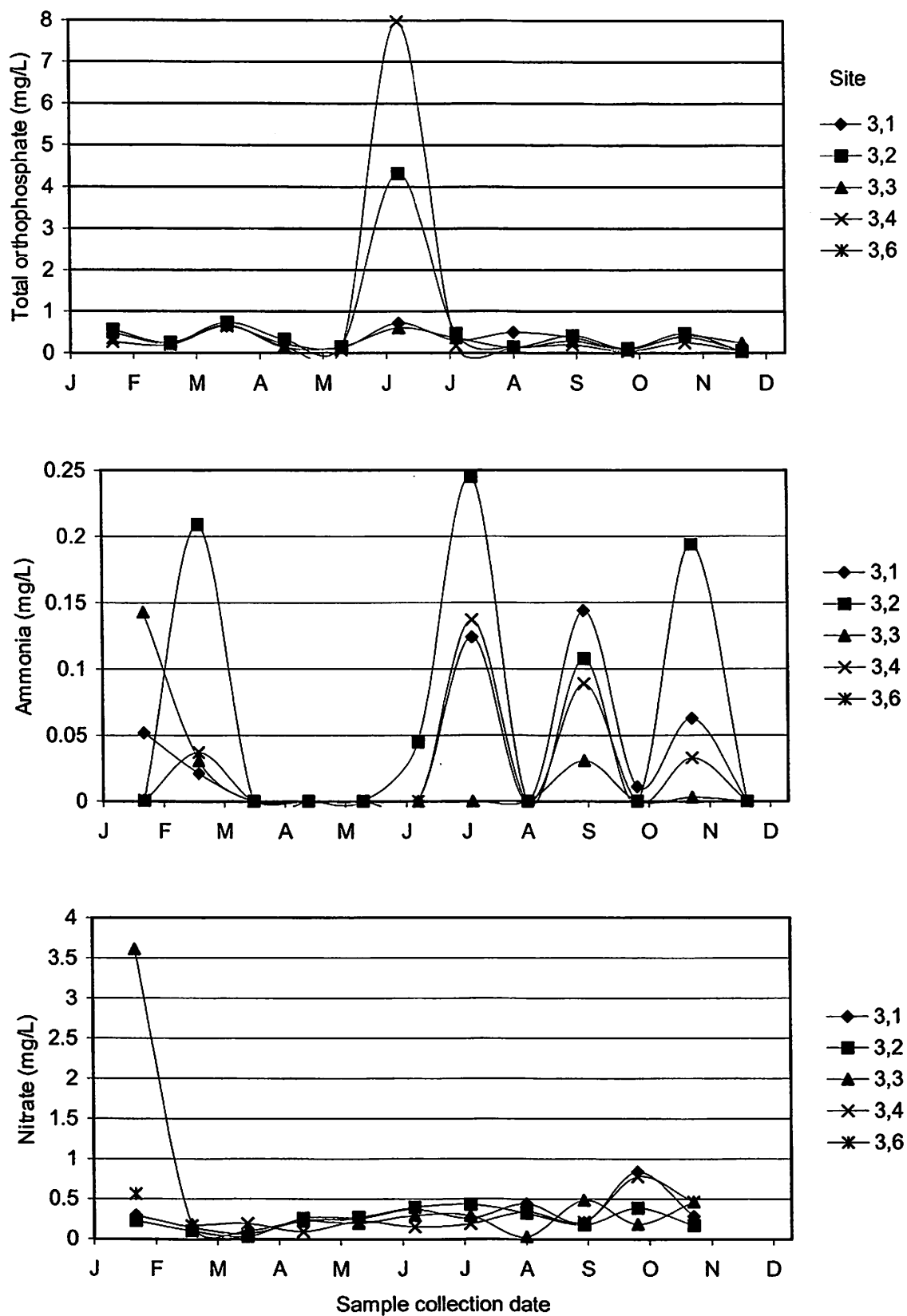


Fig. 3-5. 1999 chlorophyll, fecal coliform, and enterococci measurements for Batupan Bogue Creek.

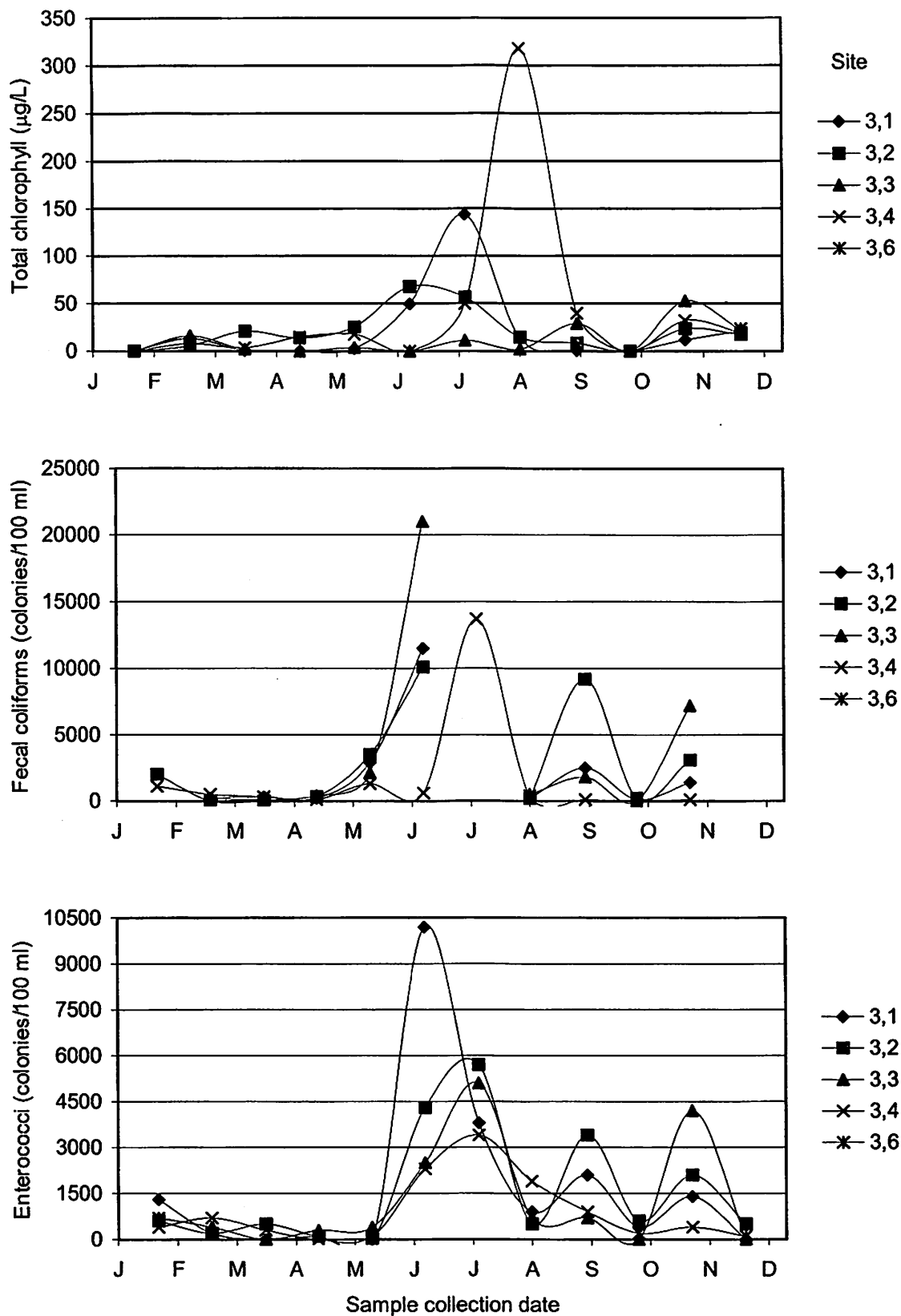


Fig. 4-1. 1999 depth to water, temperature, and conductivity measurements for Hotophia Creek.

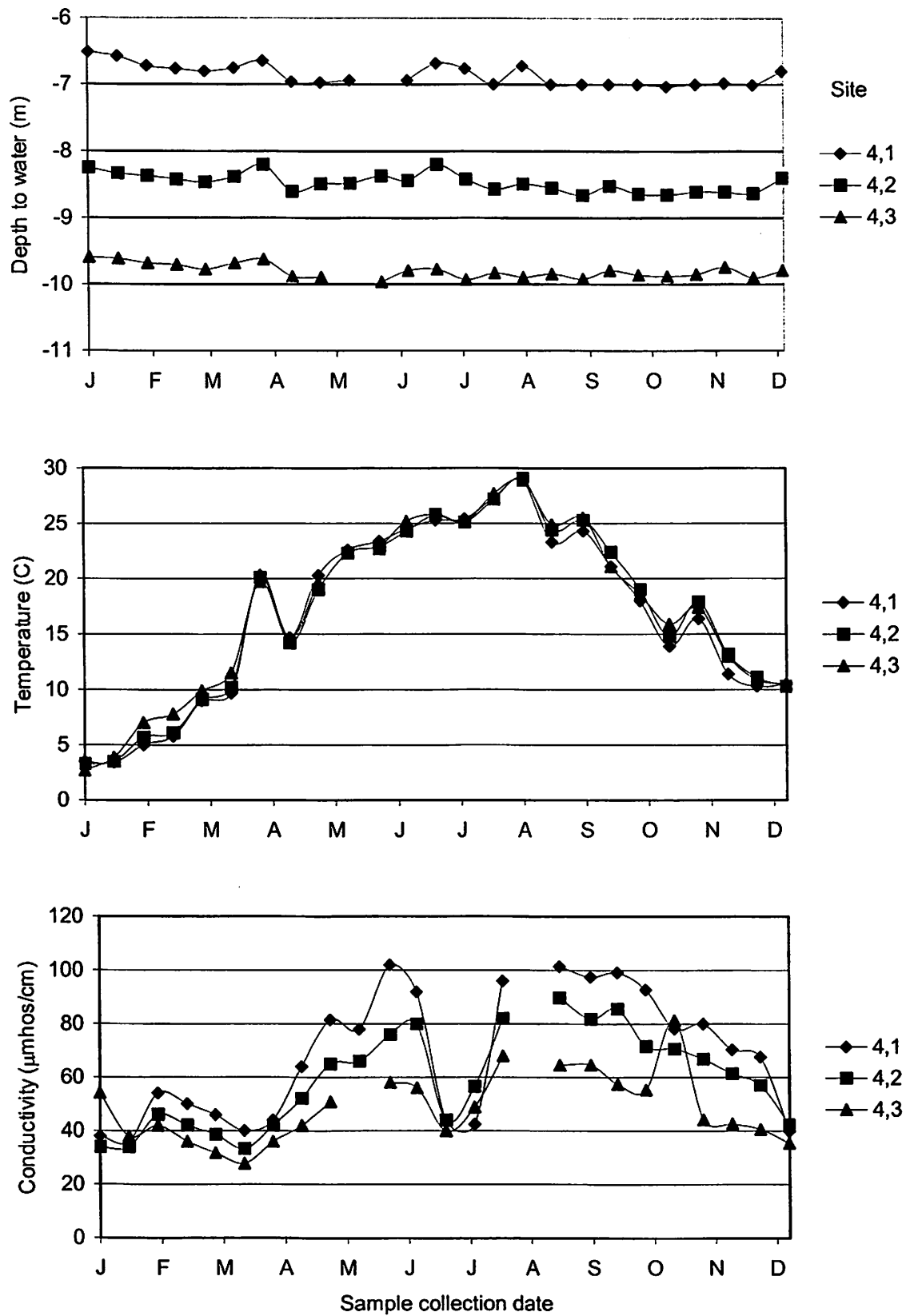


Fig. 4-2. 1999 dissolved oxygen, pH, and total solids measurements for Hotophia Creek.

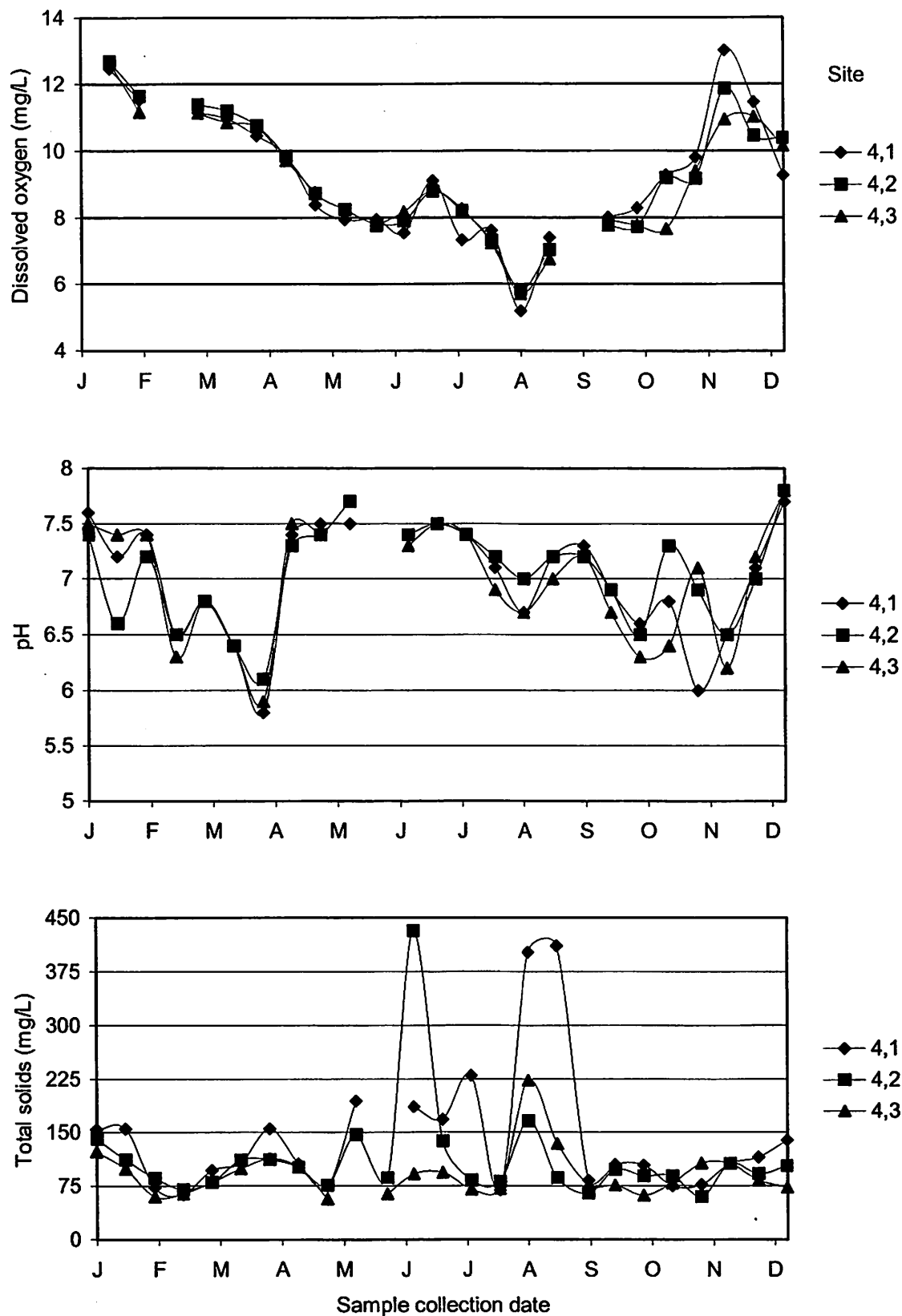


Fig. 4-3. 1999 dissolved and suspended solids, and filtered orthophosphate measurements for Hotoophia Creek.

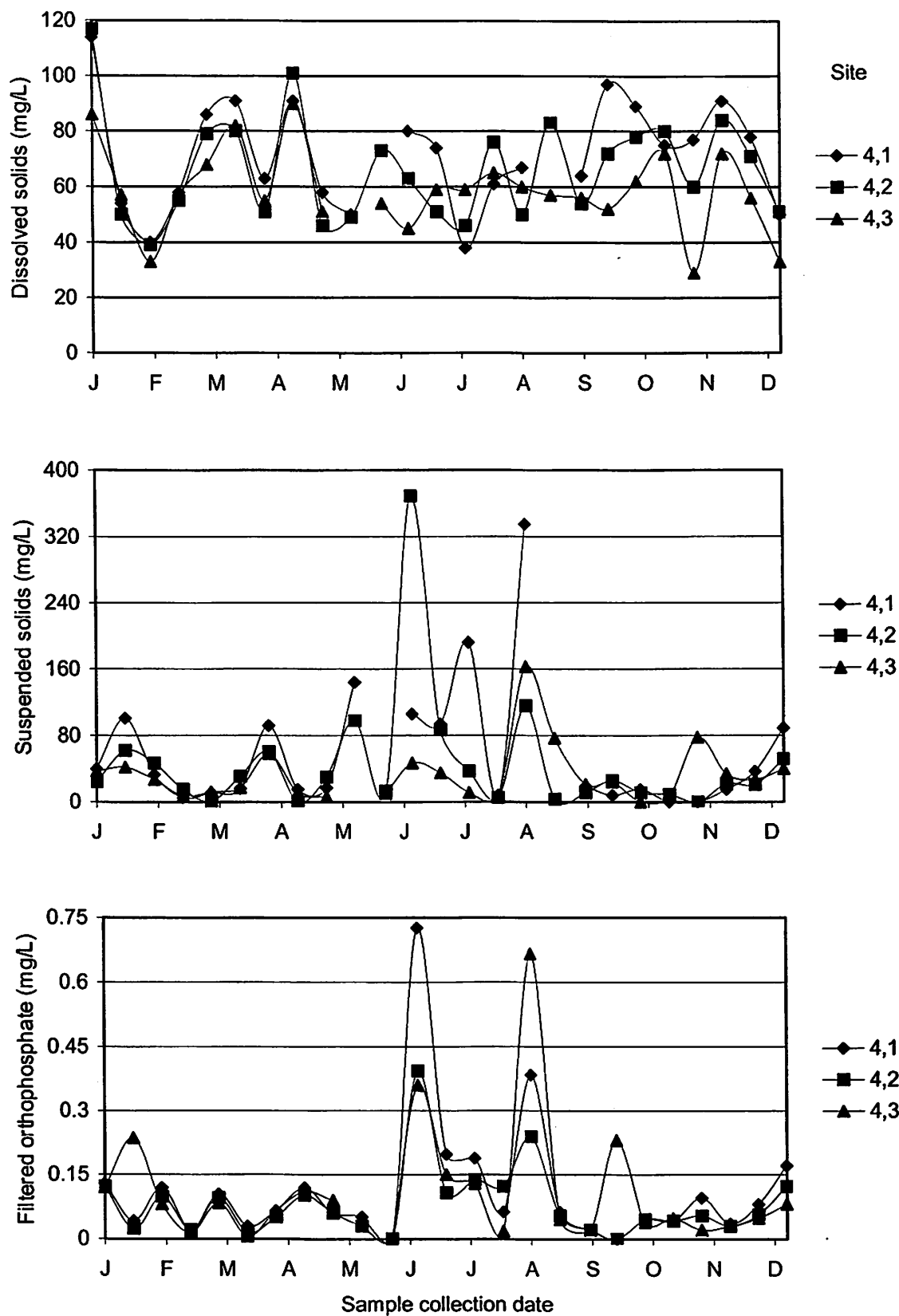


Fig. 4-4. 1999 total orthophosphate, ammonia, and nitrate measurements for Hotophia Creek.

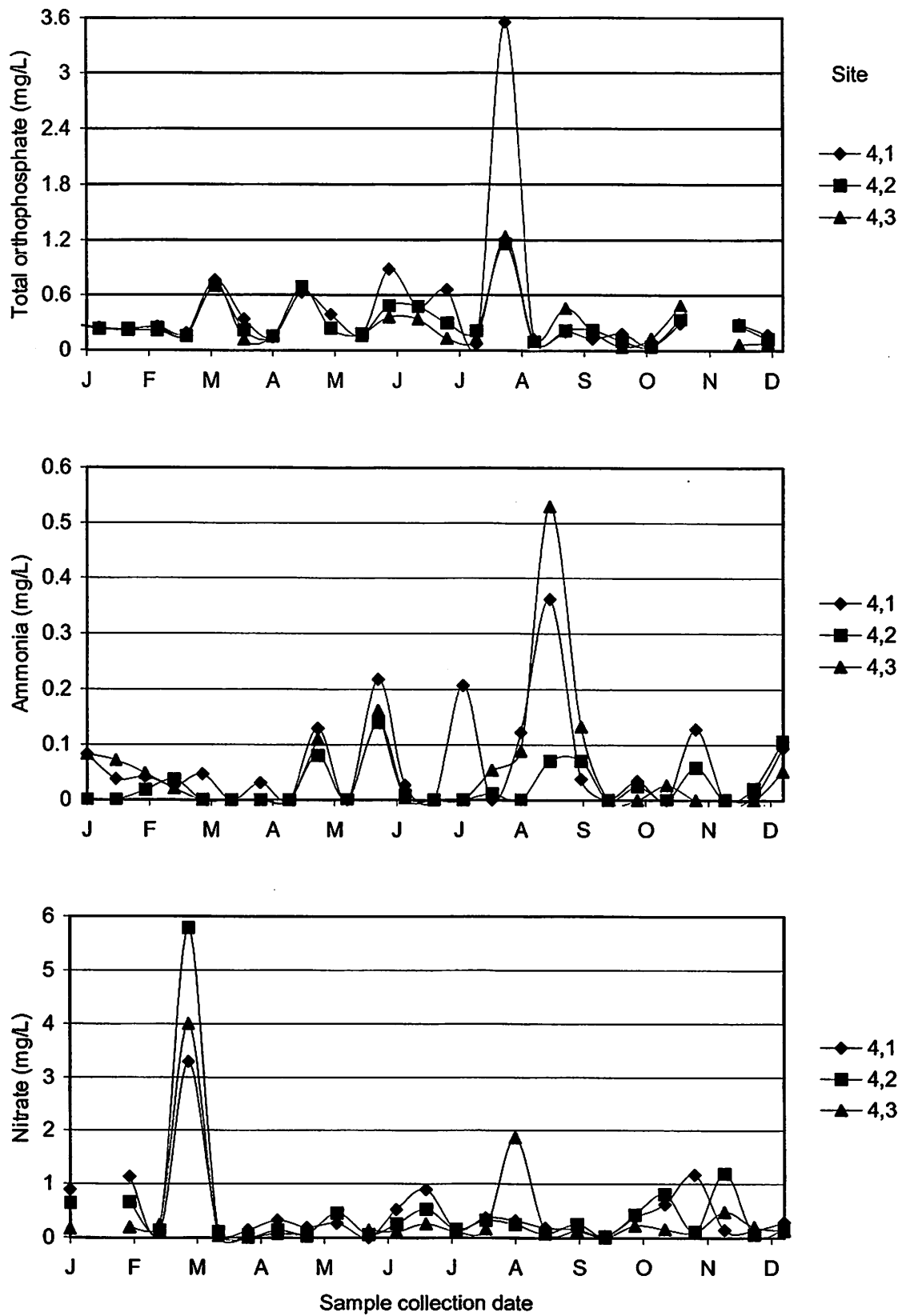


Fig. 4-5. 1999 chlorophyll, fecal coliform, and enterococci measurements for Hotophia Creek.

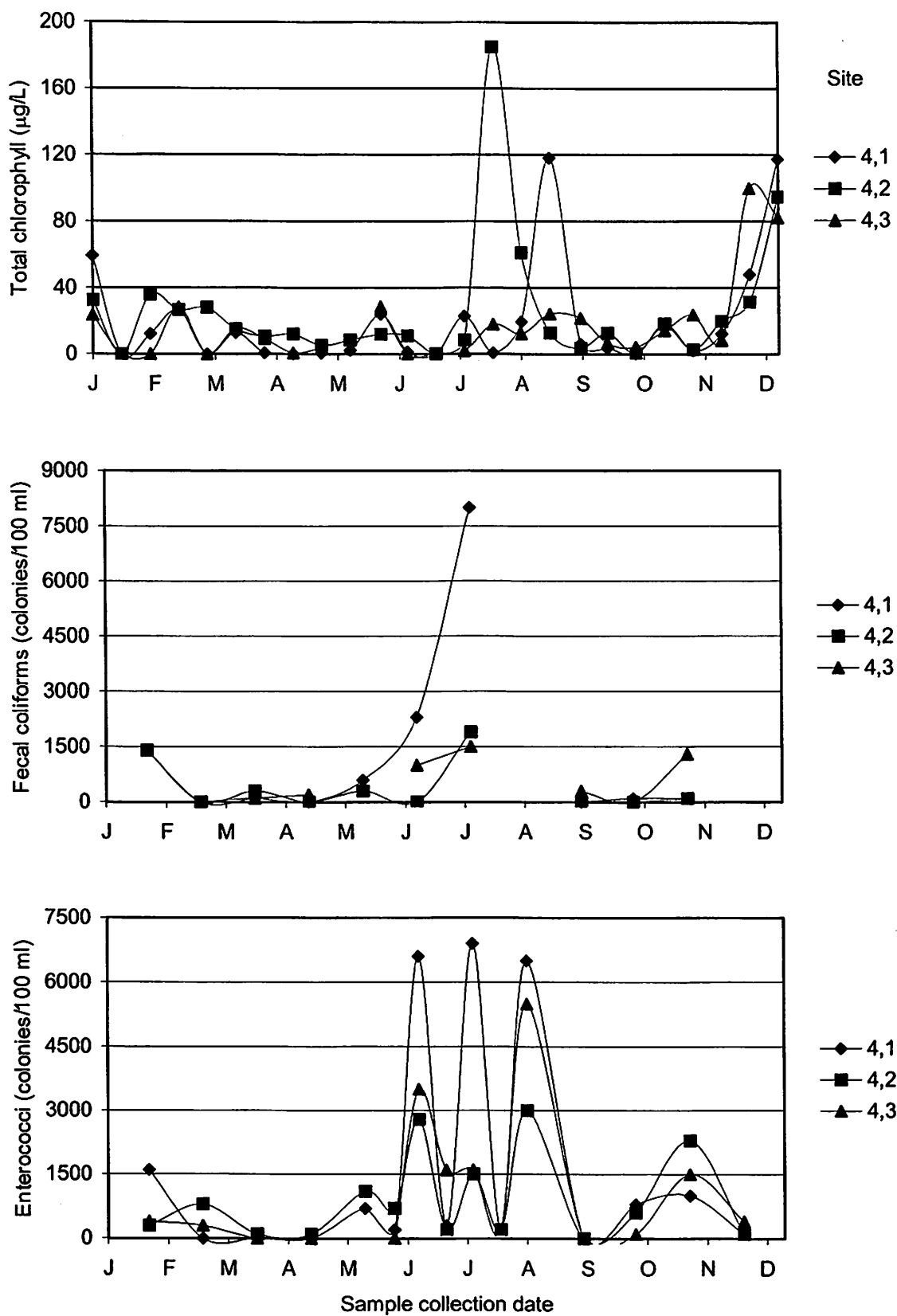


Fig. 5-1. 1999 depth to water, temperature, and conductivity measurements for Hickahala Creek.

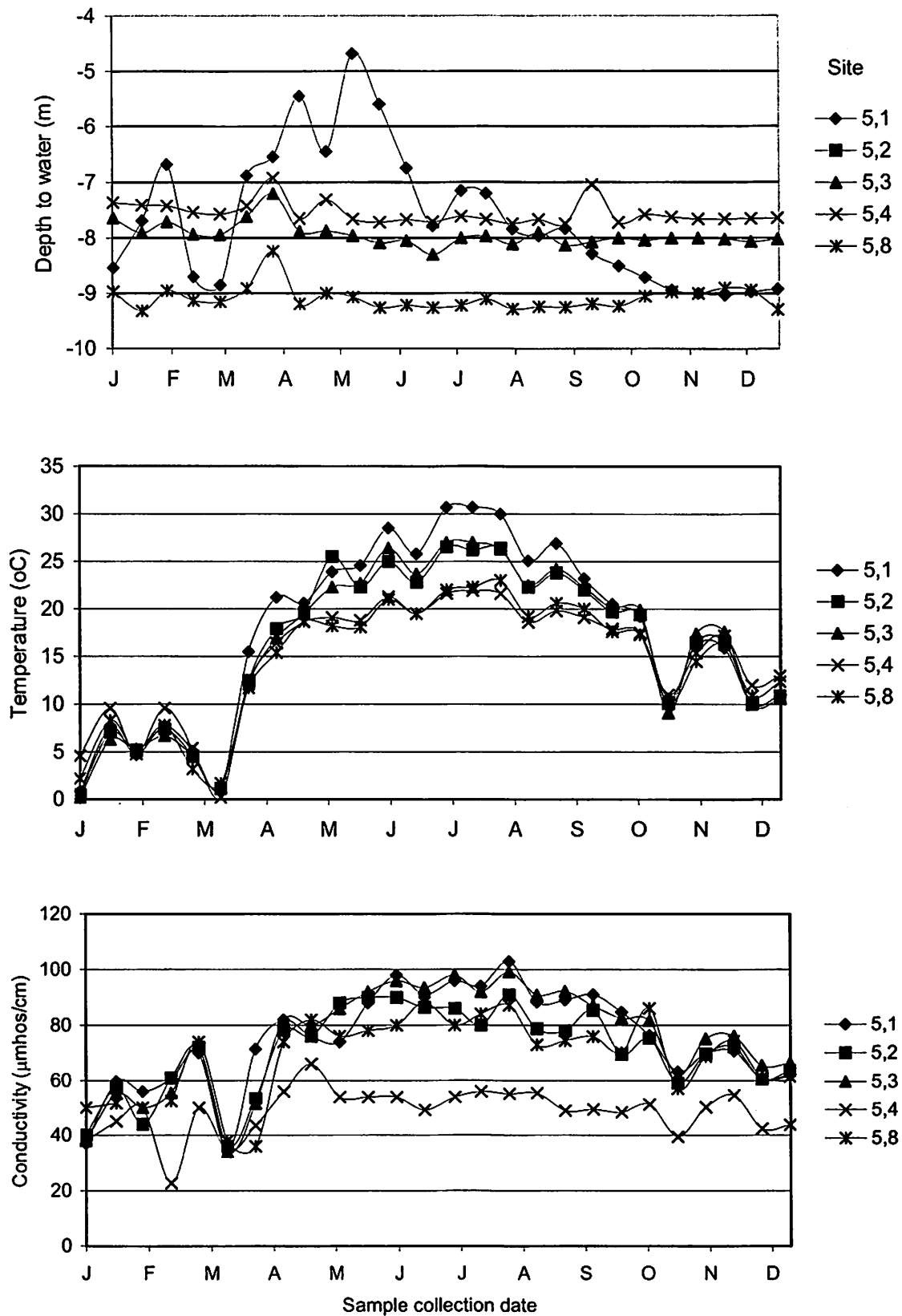


Fig. 5-2. 1999 dissolved oxygen, pH, and total solids measurements for Hickahala Creek.

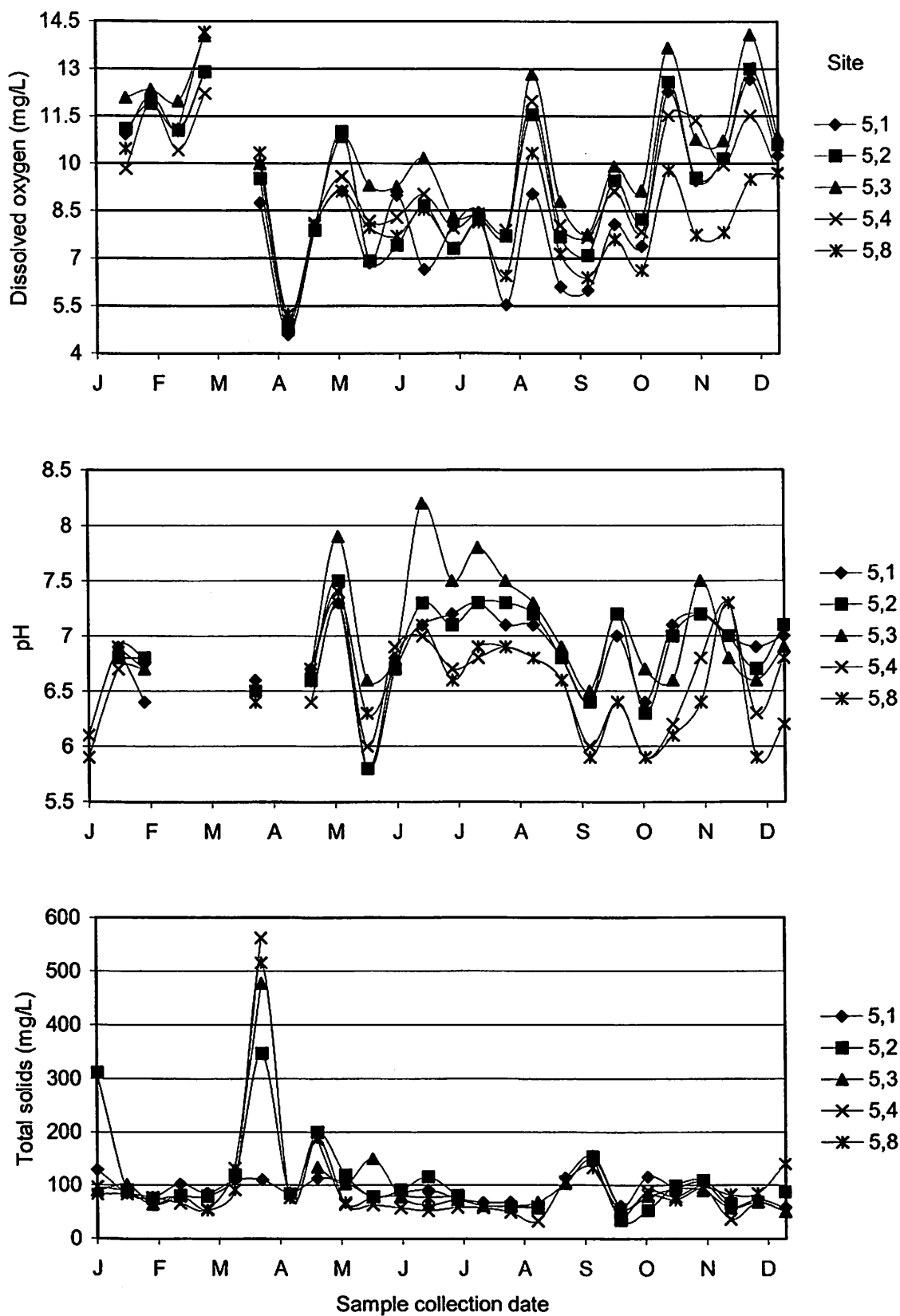


Fig. 5-3. 1999 dissolved and suspended solids, and filtered orthophosphate measurements for Hickahala Creek.

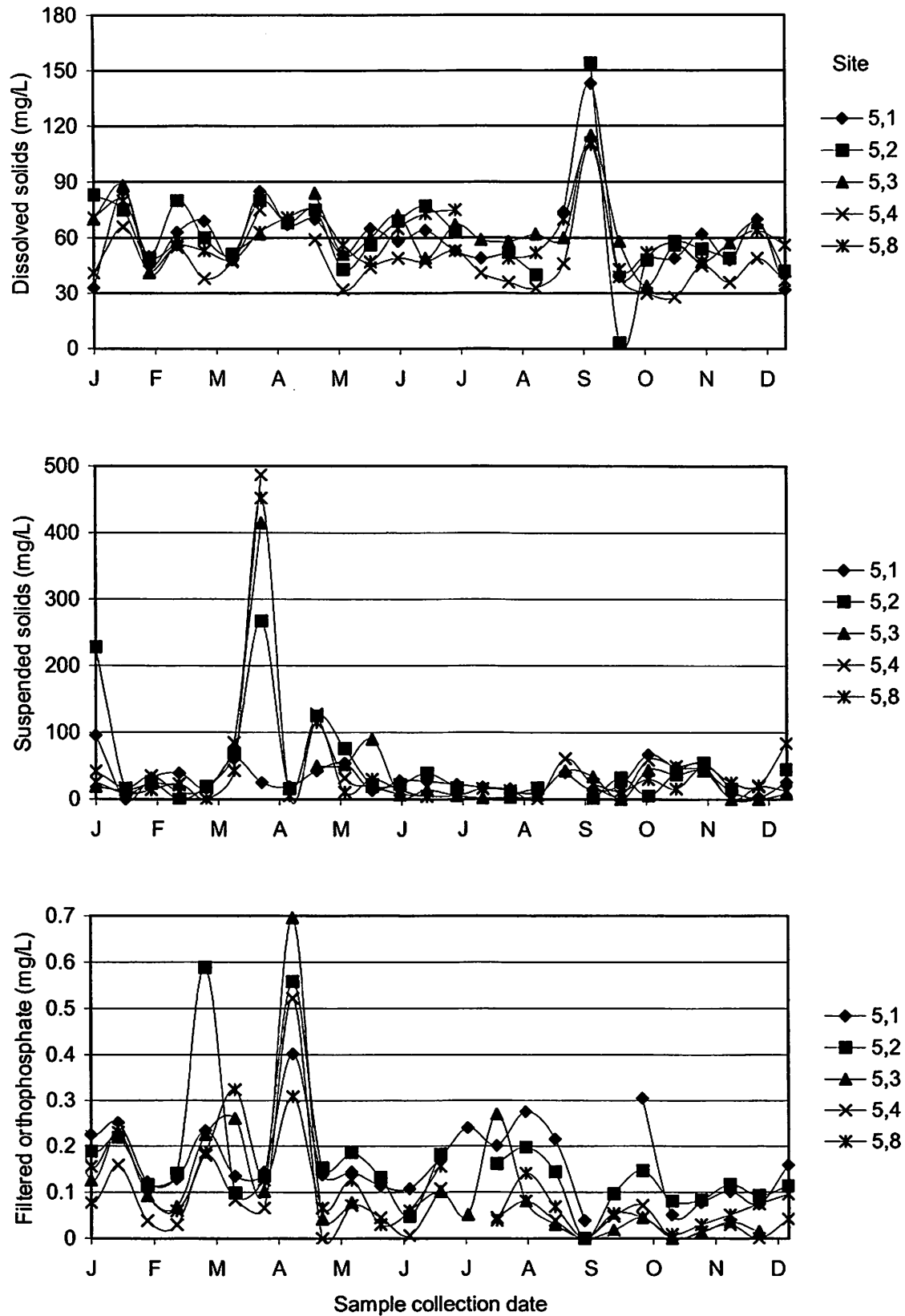


Fig. 5-4. 1999 total orthophosphate, ammonia, and nitrate measurements for Hickahala Creek.

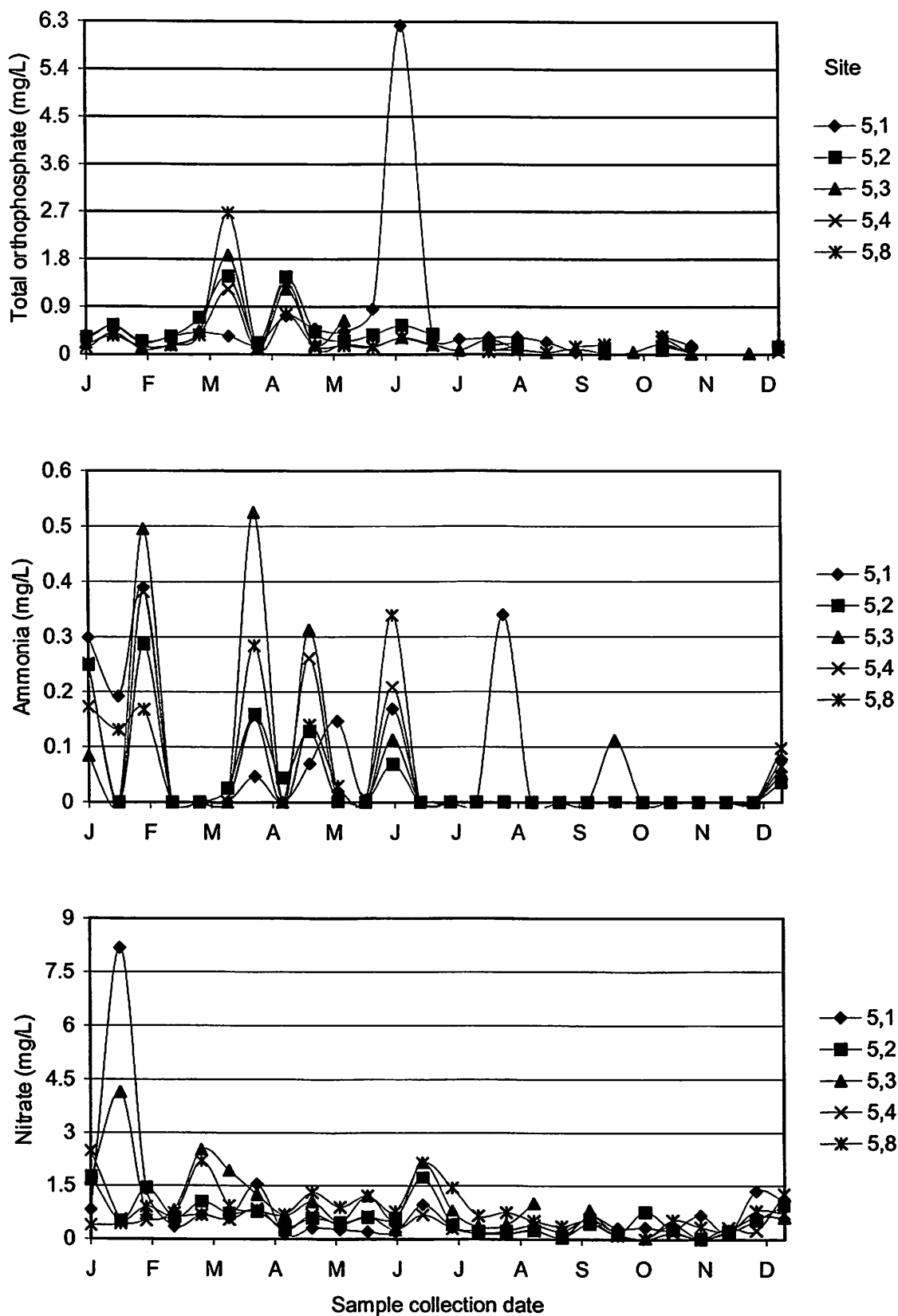


Fig. 5-5. 1999 chlorophyll, fecal coliform, and enterococci measurements for Hickahala Creek.

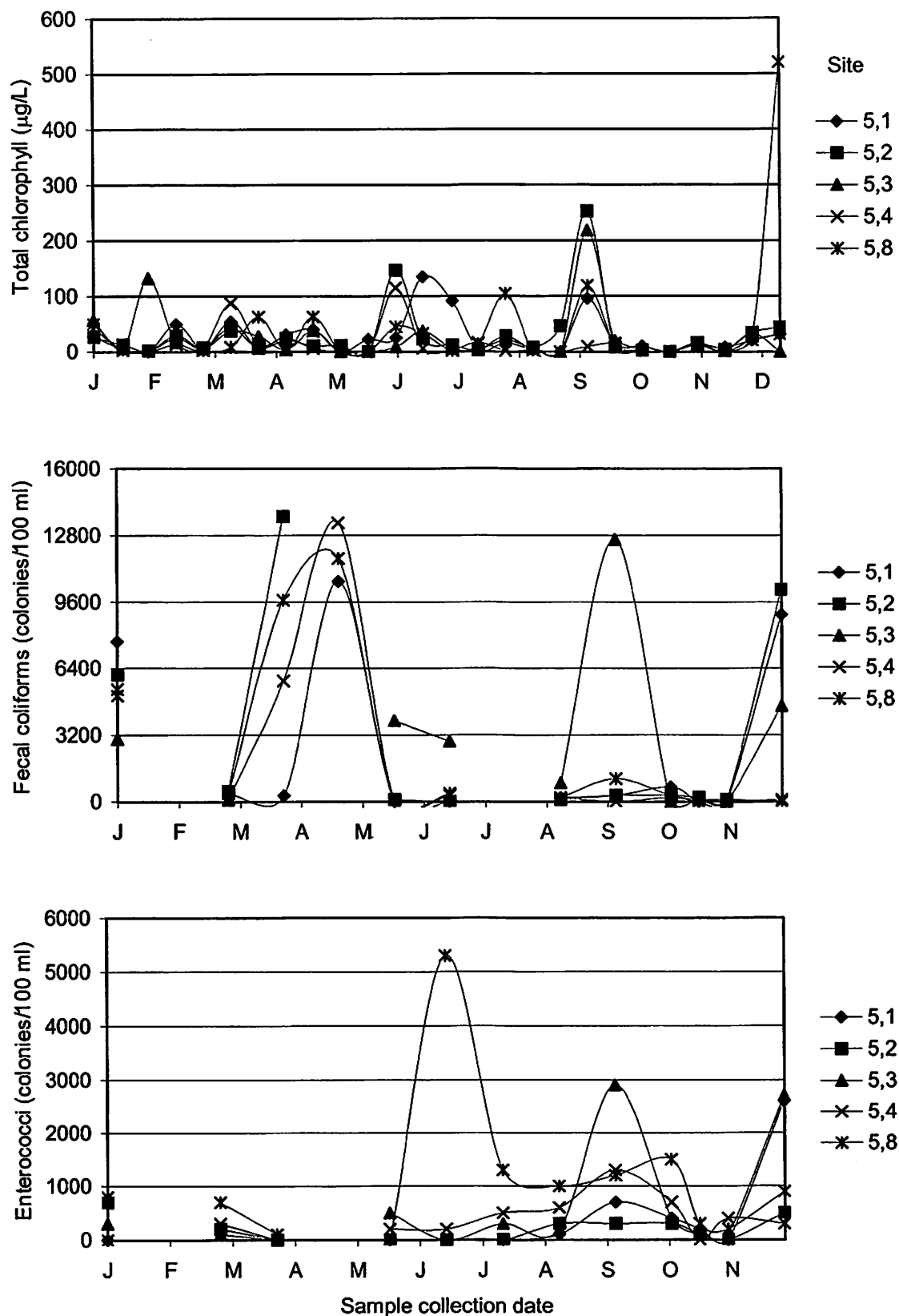


Fig. 6-1. 1999 depth to water, temperature, and conductivity measurements for Black Creek.

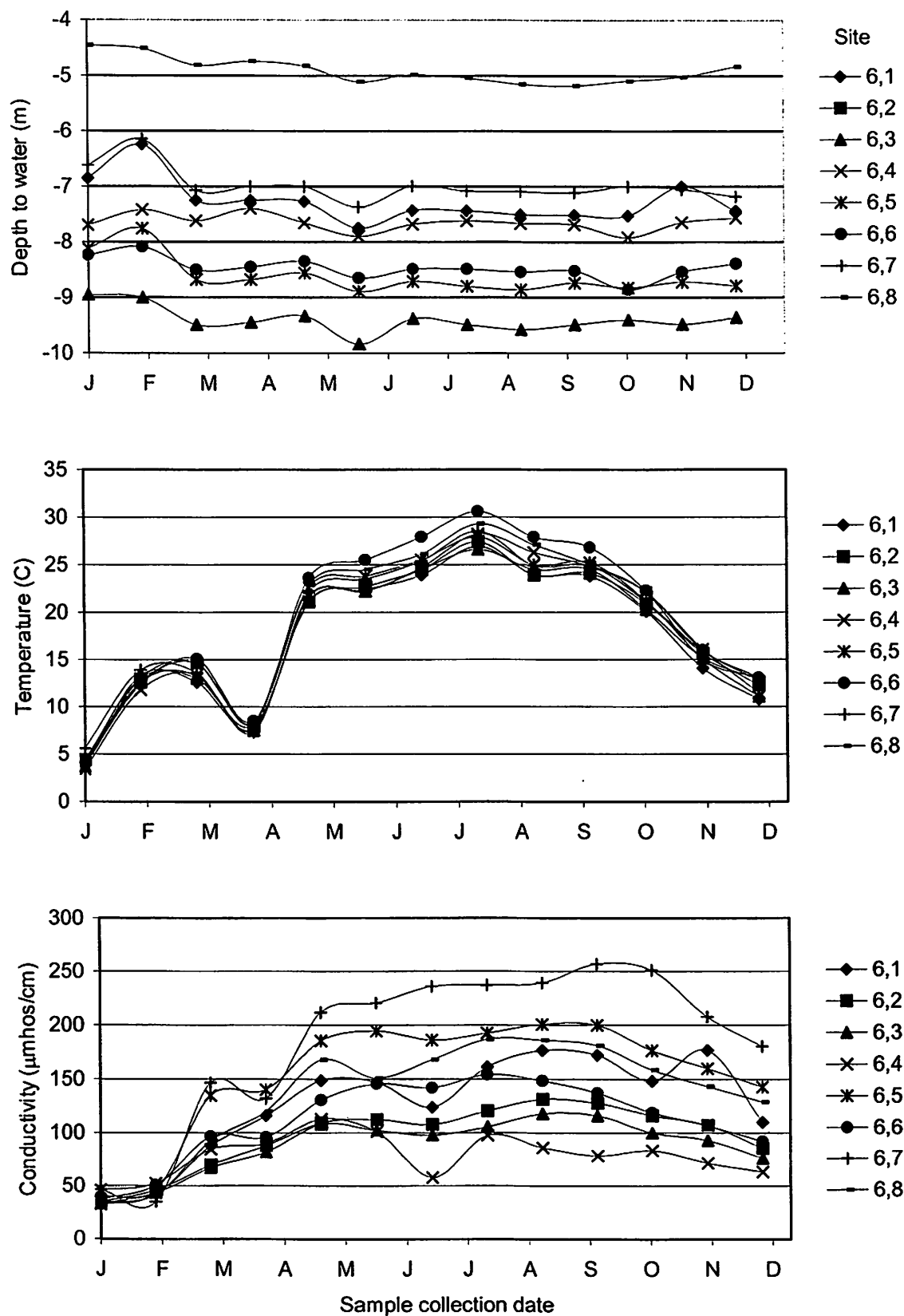


Fig. 6-2. 1999 dissolved oxygen, pH, and total solids measurements for Black Creek.

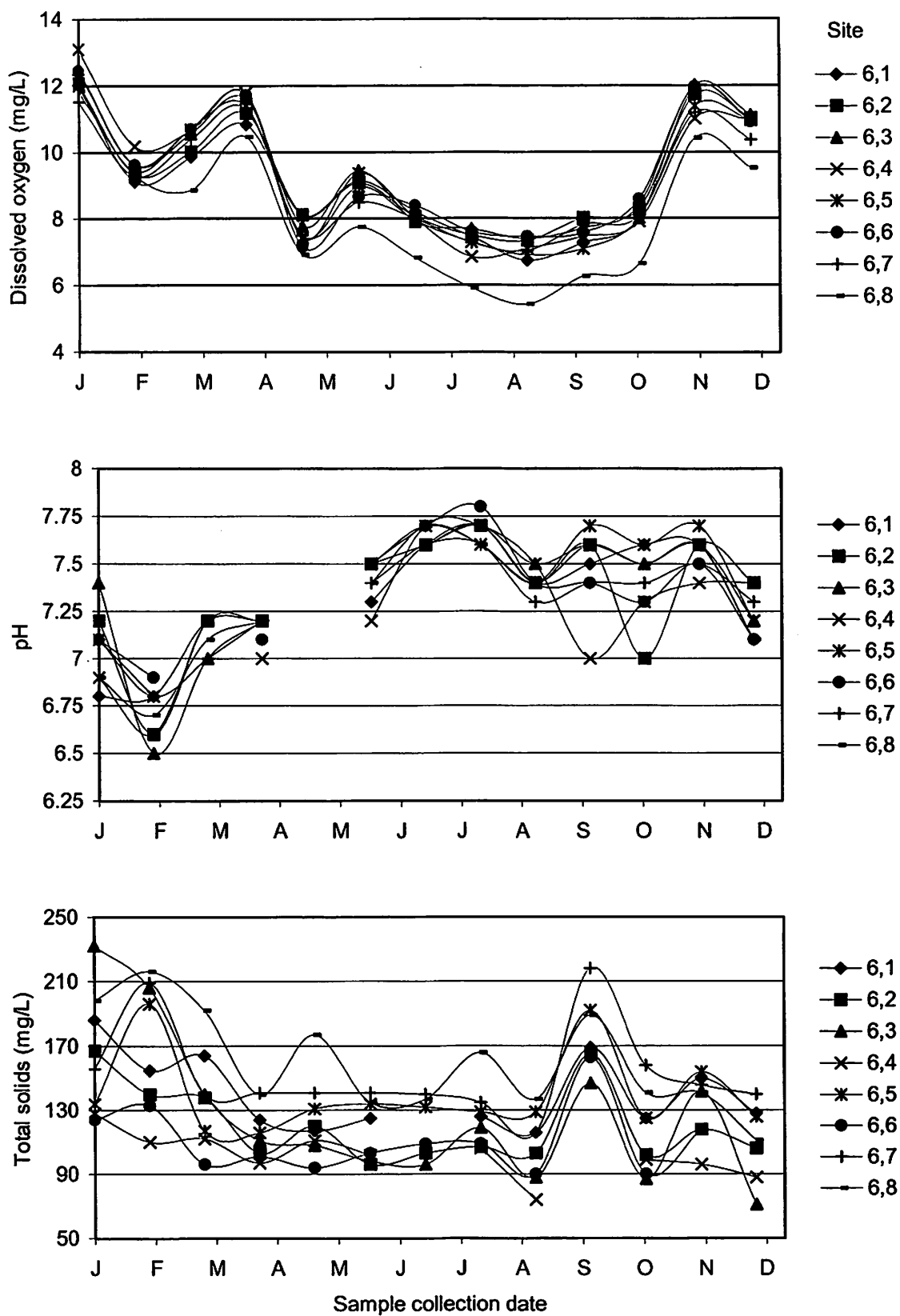


Fig. 6-3. 1999 dissolved and suspended solids, and filtered orthophosphate measurements for Black Creek.

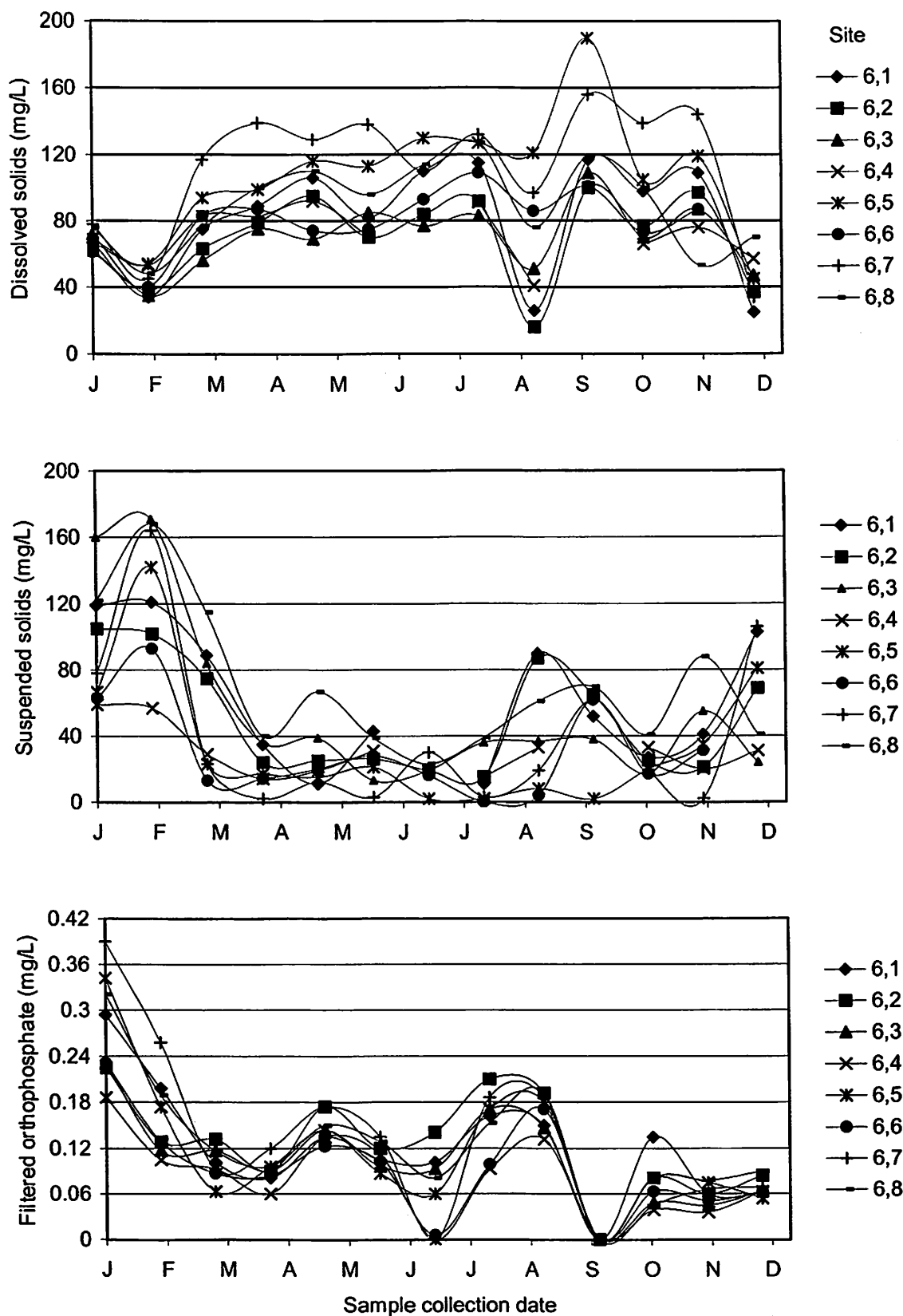


Fig. 6-4. 1999 total orthophosphate, ammonia, and nitrate measurements for Black Creek.

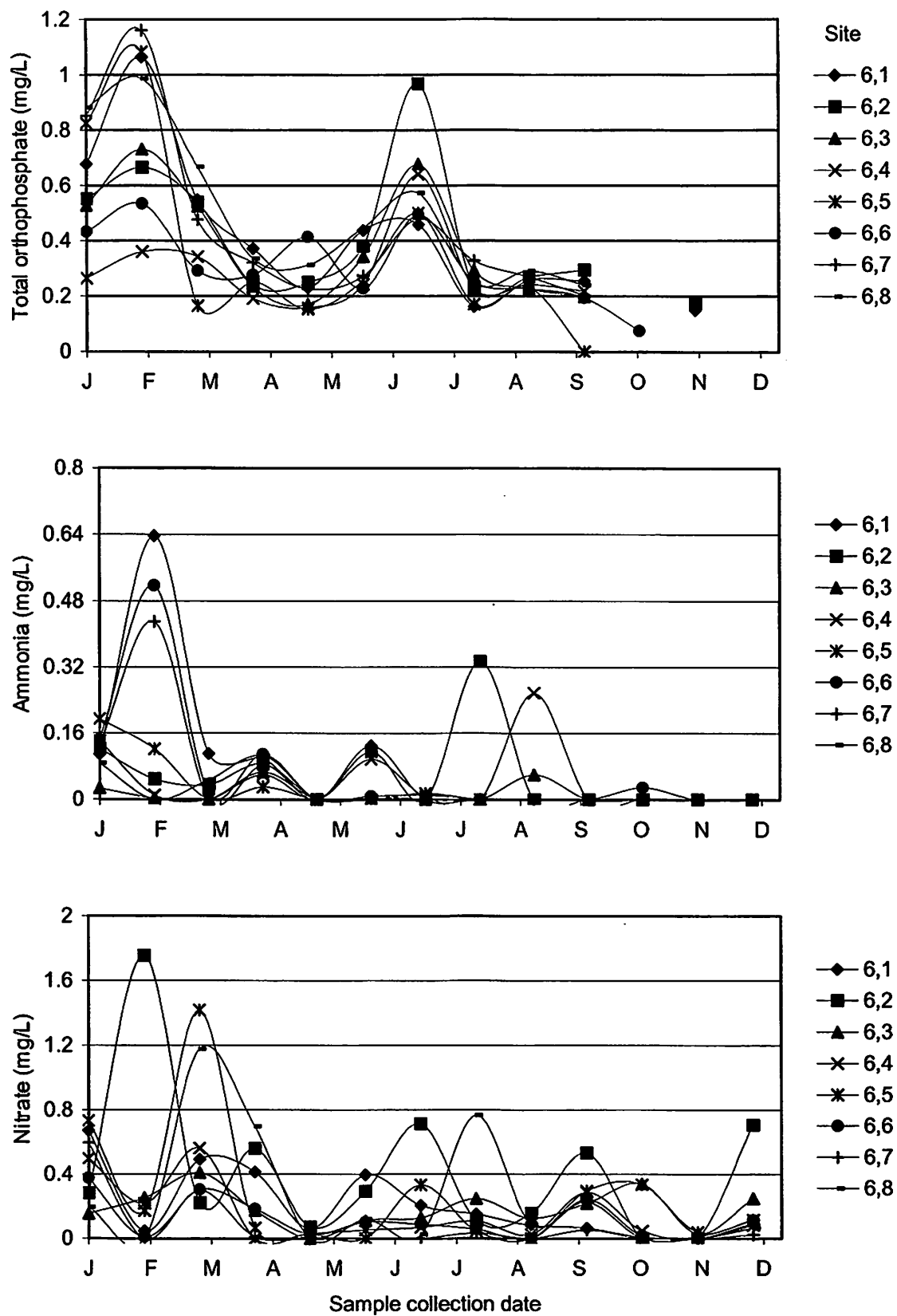


Fig. 6-5. 1999 chlorophyll, fecal coliform, and enterococci measurements for Black Creek.

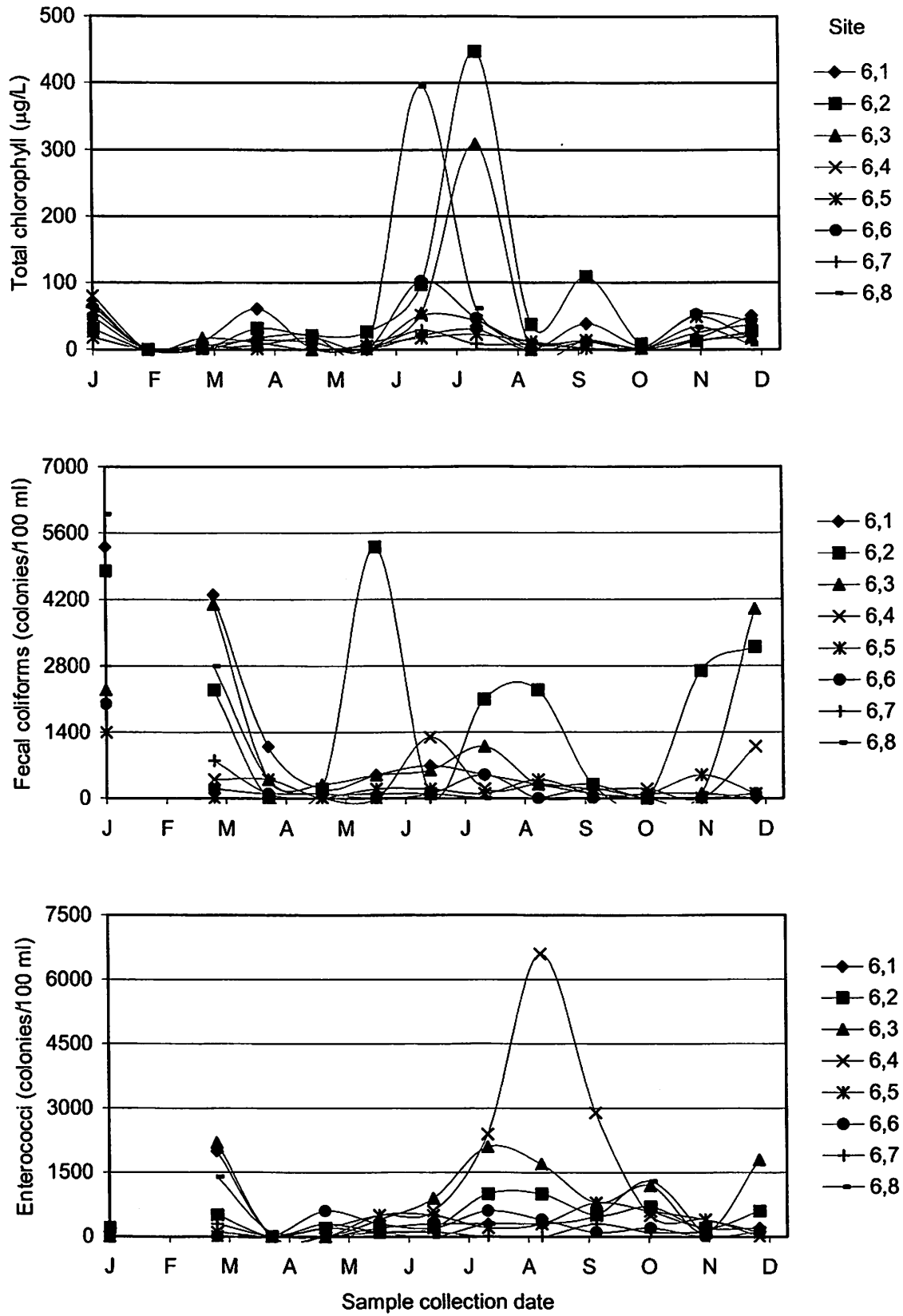


Fig. 7-1. 1999 depth to water, temperature, and conductivity measurements for Coldwater River/Pigeon Roost Creek.

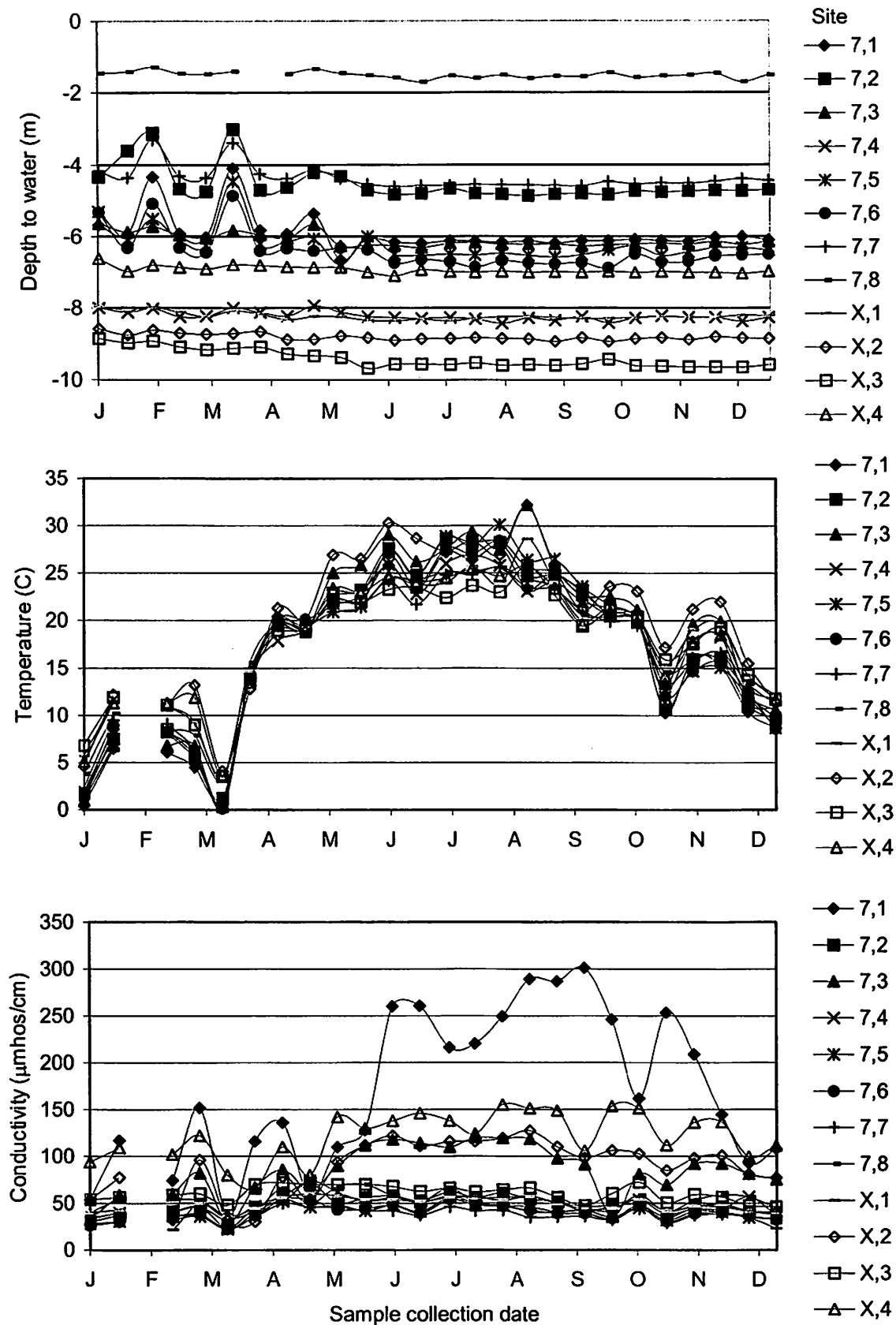


Fig. 7-2. 1999 dissolved oxygen, pH, and total solids measurements for Coldwater River/Pigeon Roost Creek.

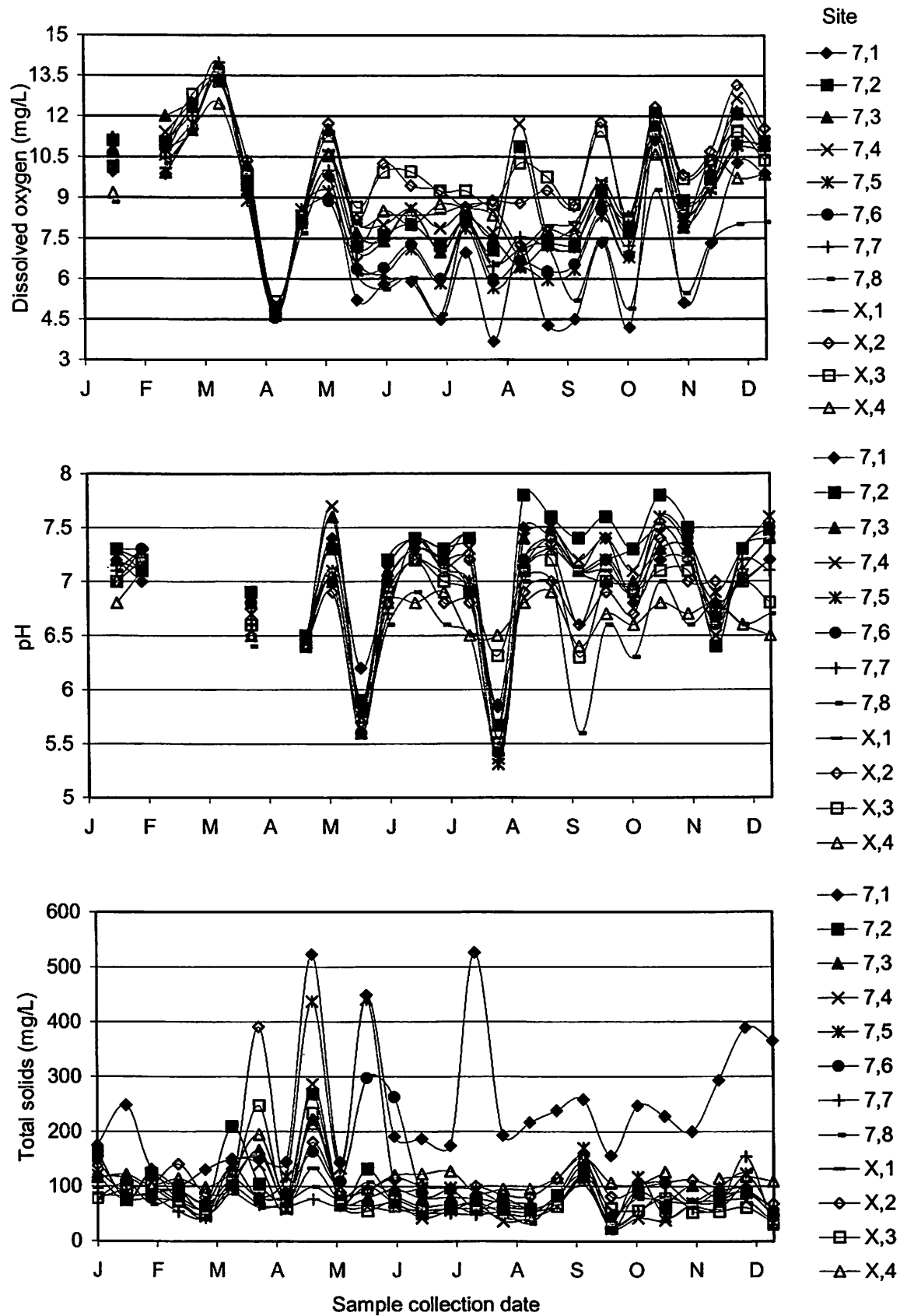


Fig. 7-3. 1999 dissolved and suspended solids, and filtered orthophosphate measurements for Coldwater River/Pigeon Roost Creek.

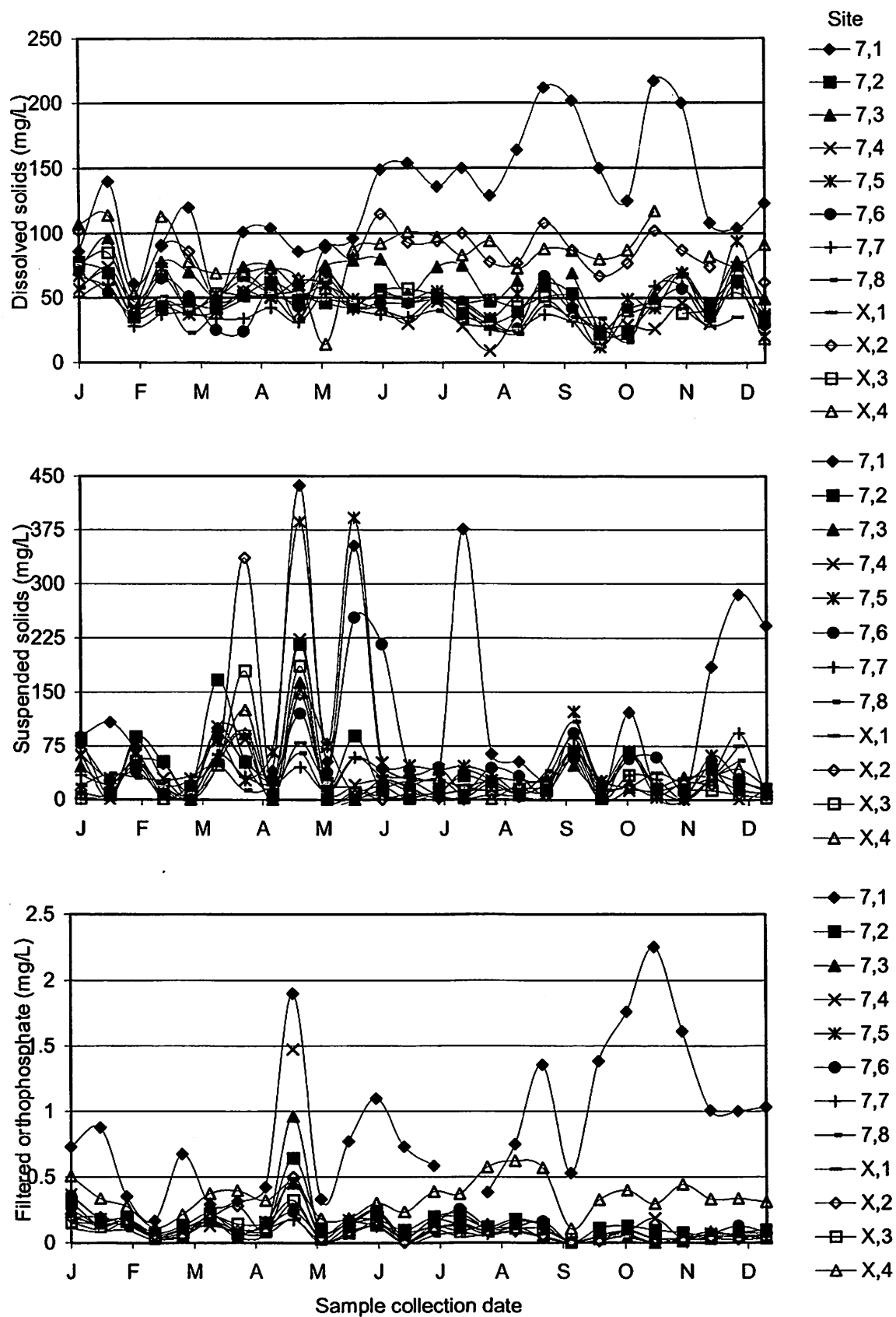


Fig. 7-4. 1999 total orthophosphate, ammonia, and nitrate measurements for Coldwater River/Pigeon Roost Creek.

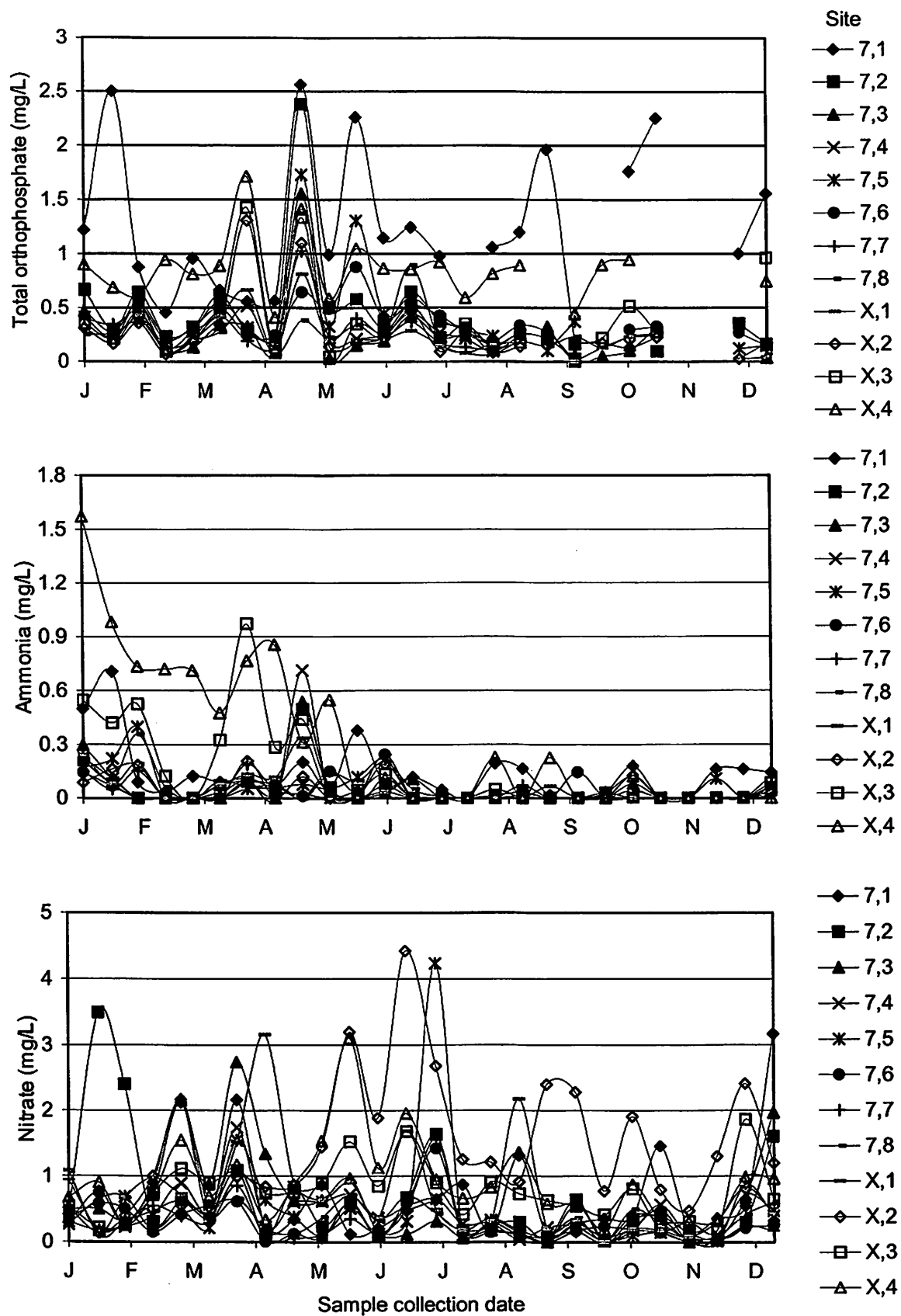


Fig. 7-5. 1999 chlorophyll, fecal coliform, and enterococci measurements for Coldwater River/Pigeon Roost Creek.

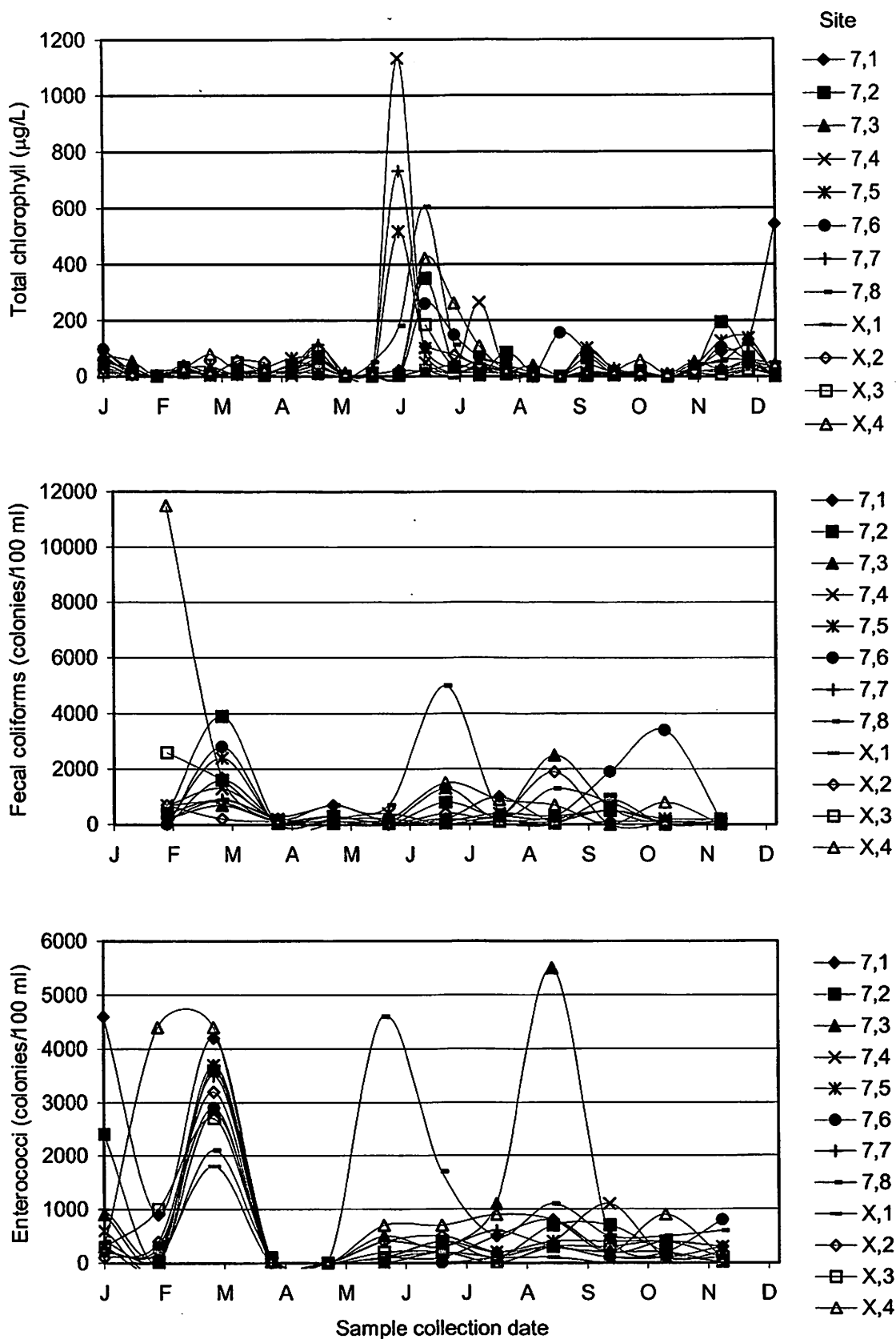


Fig. 8-1. 1999 depth to water, temperature, and conductivity measurements for Abiaca Creek.

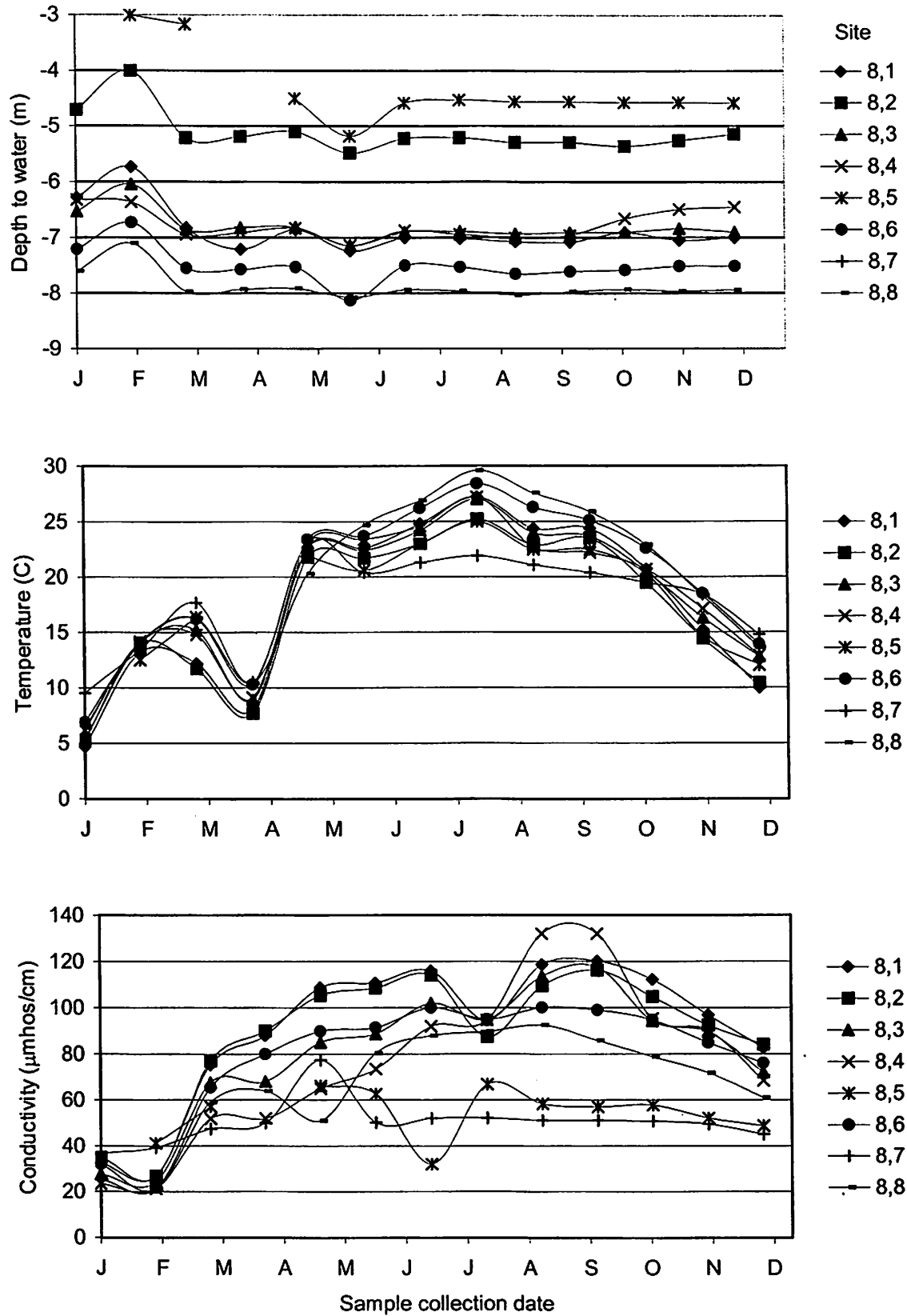


Fig. 8-2. 1999 dissolved oxygen, pH, and total solids measurements for Abiaca Creek.

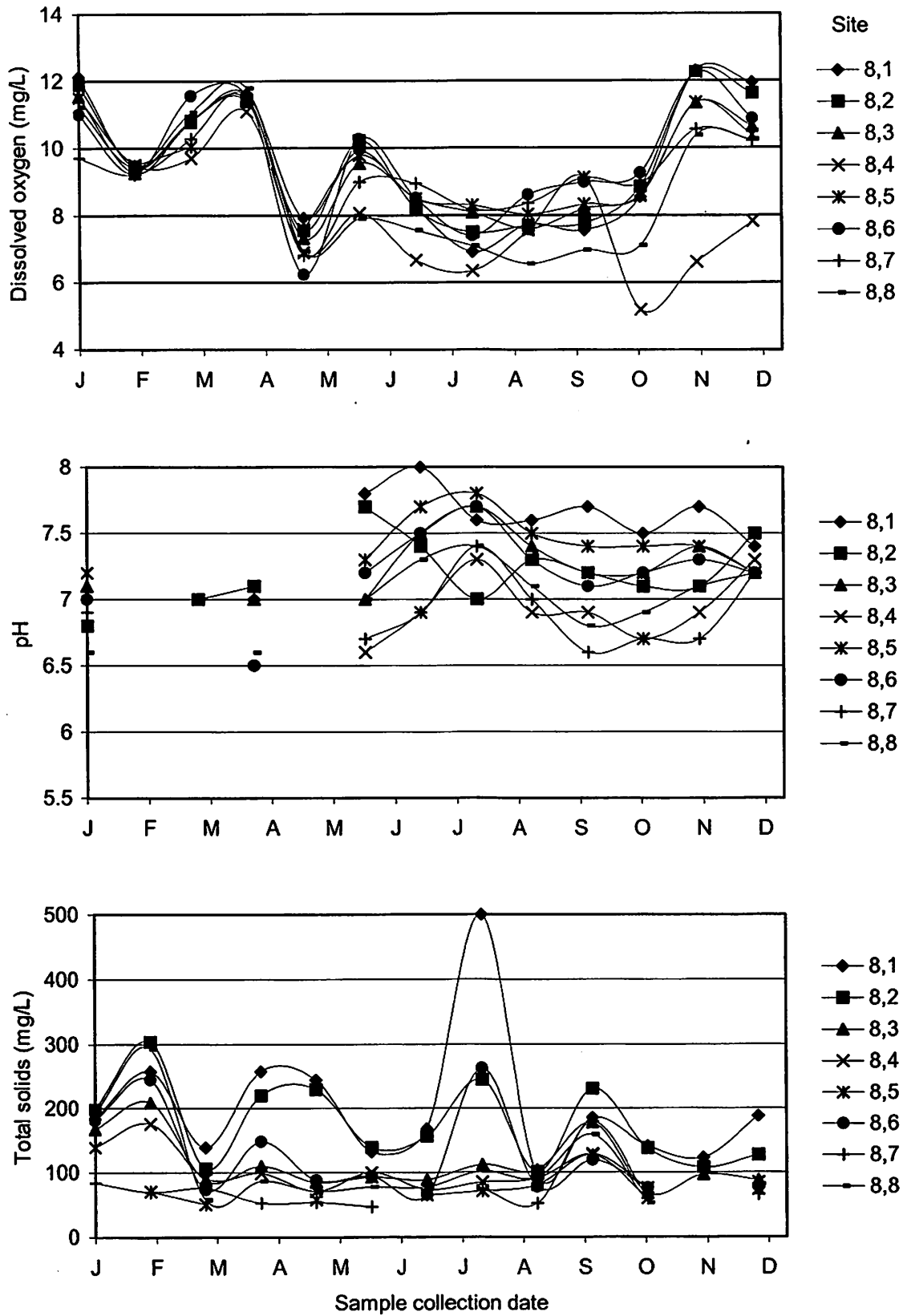


Fig. 8-3. 1999 dissolved and suspended solids, and filtered orthophosphate measurements for Abiaca Creek.

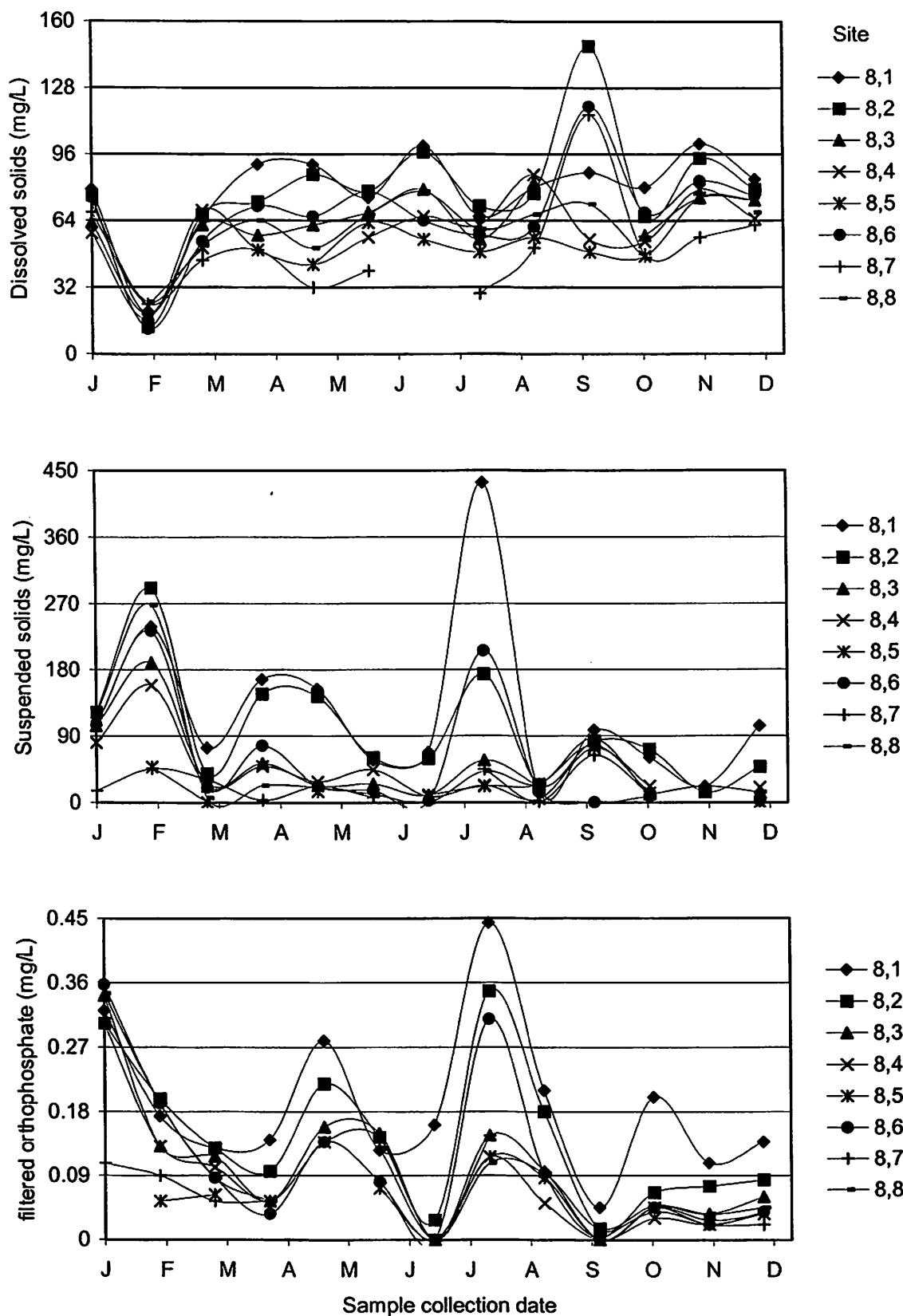


Fig. 8-4. 1999 total orthophosphate, ammonia, and nitrate measurements for Abiaca Creek.

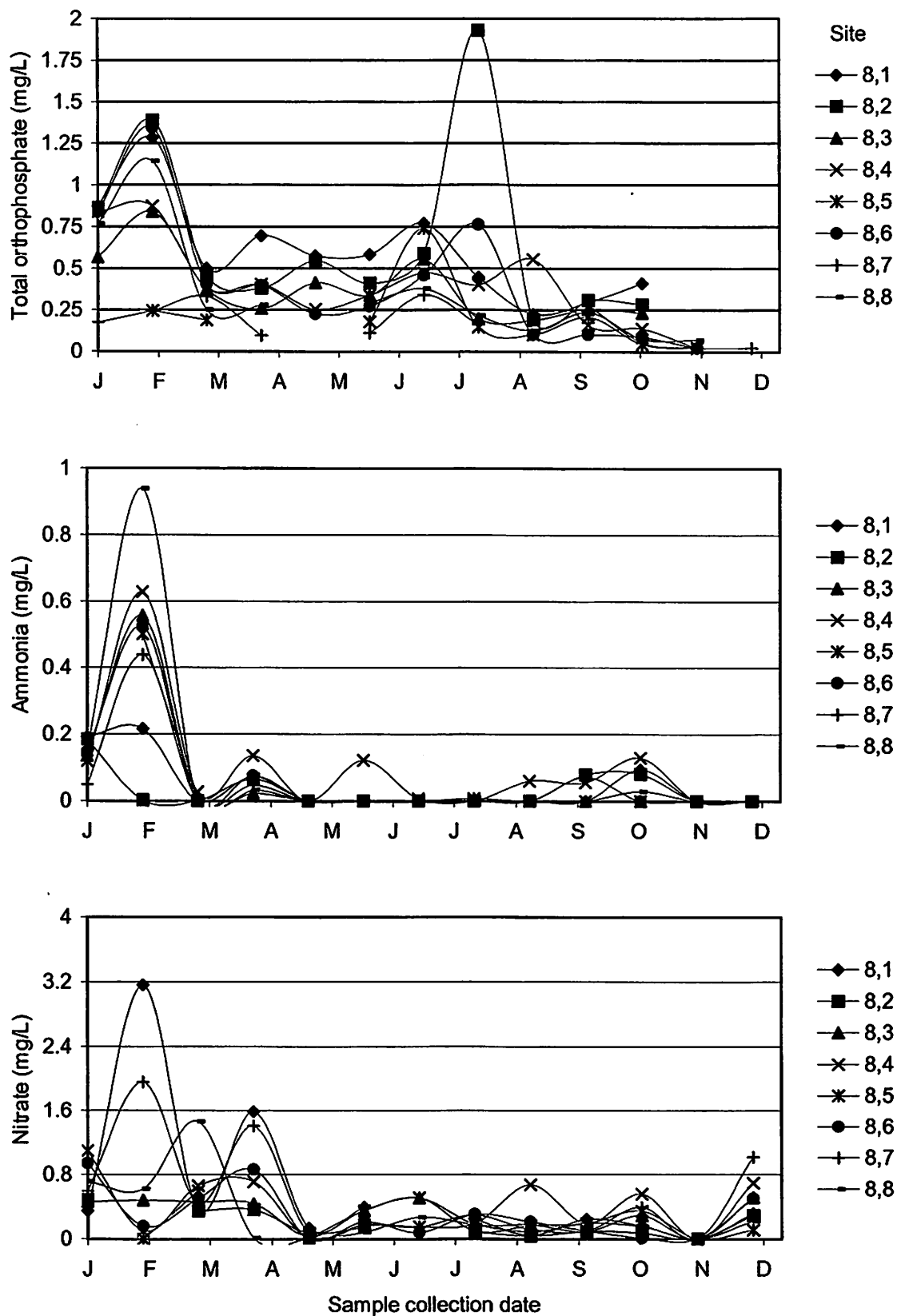


Fig. 8-5. 1999 chlorophyll, fecal coliform, and enterococci measurements for Abiaca Creek.

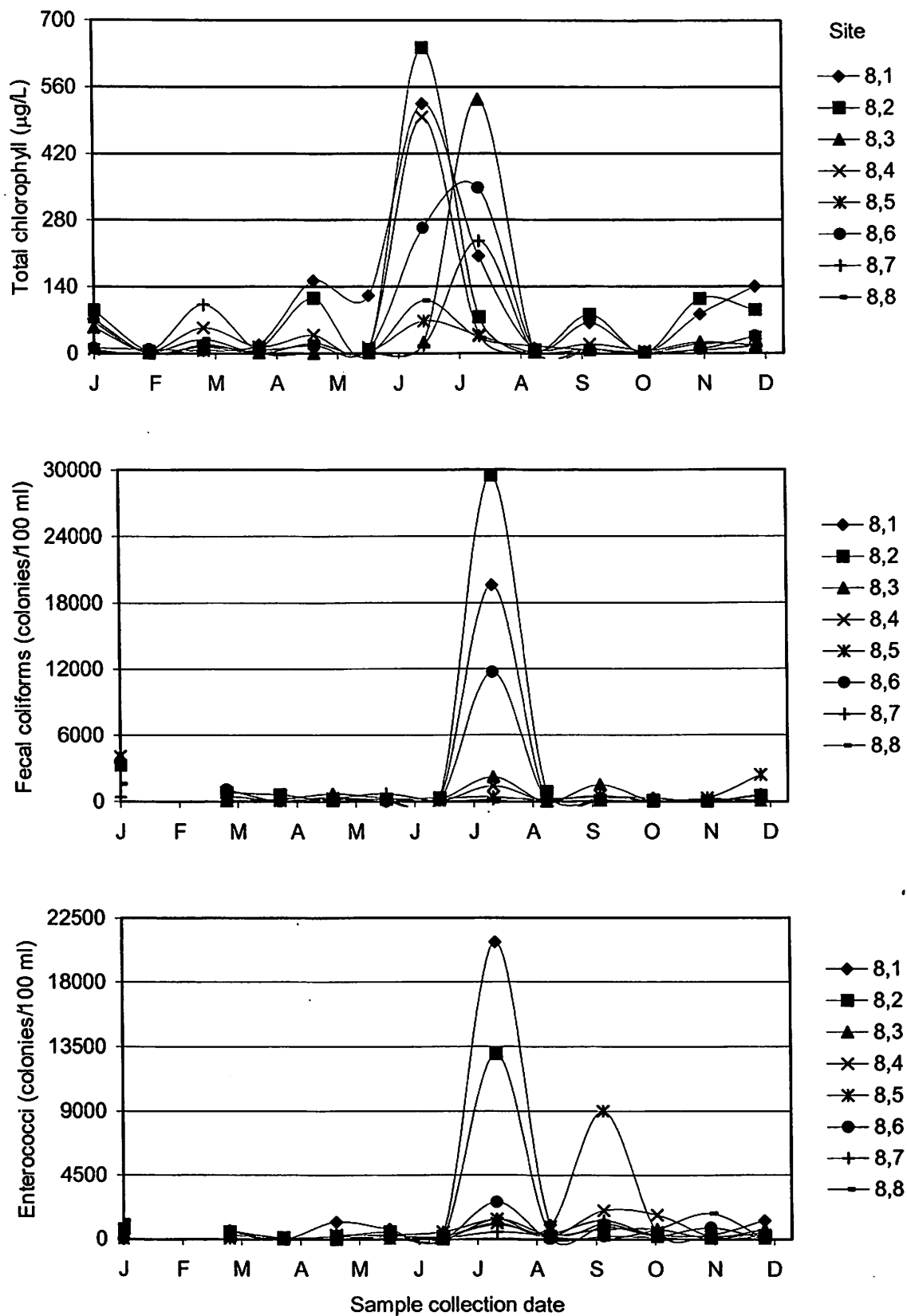


Fig. 9-1. 1999 depth to water, temperature, and conductivity measurements for Toby Tubby Creek.

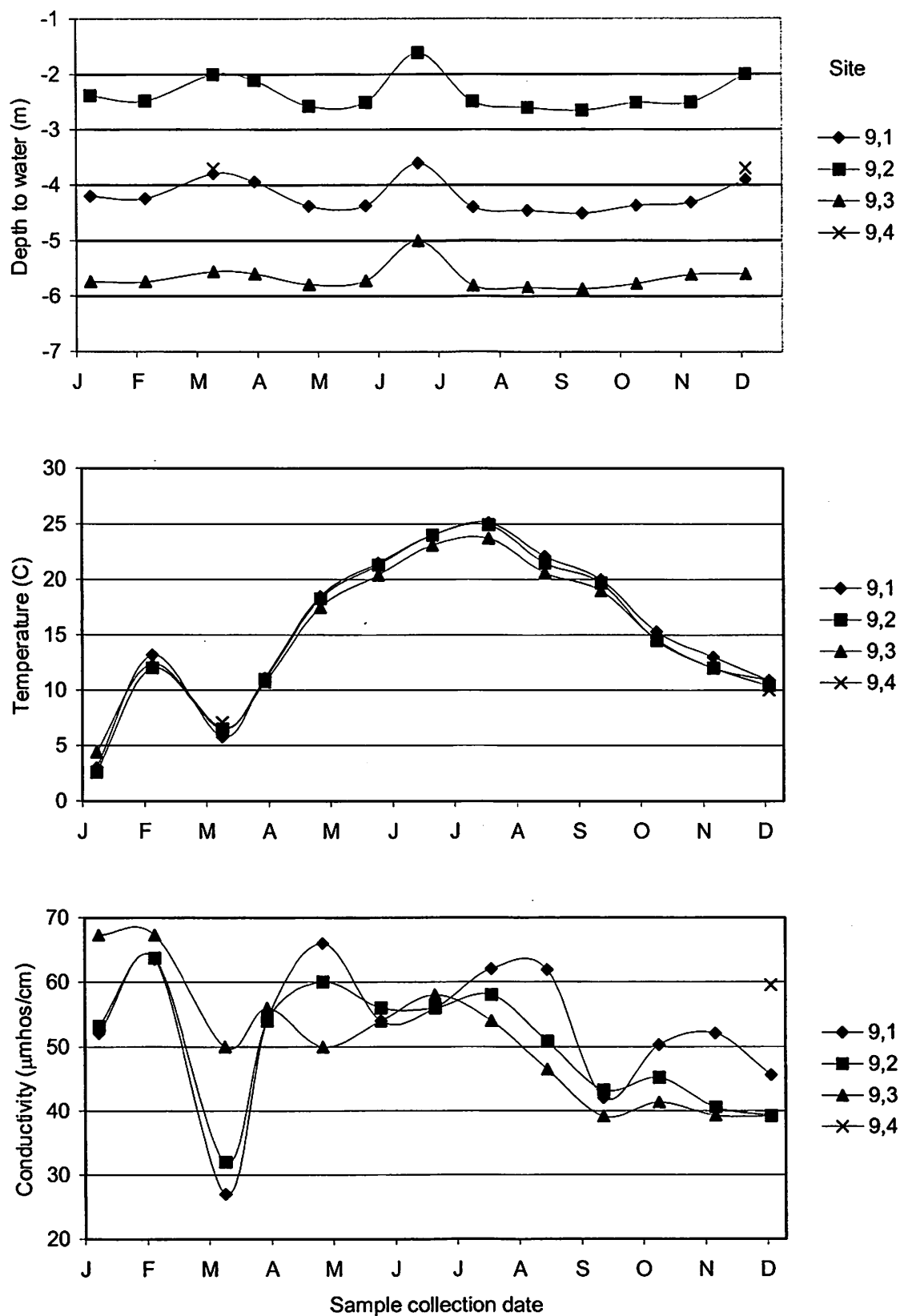


Fig. 9-2. 1999 dissolved oxygen, pH, and total solids measurements for Toby Tubby Creek.

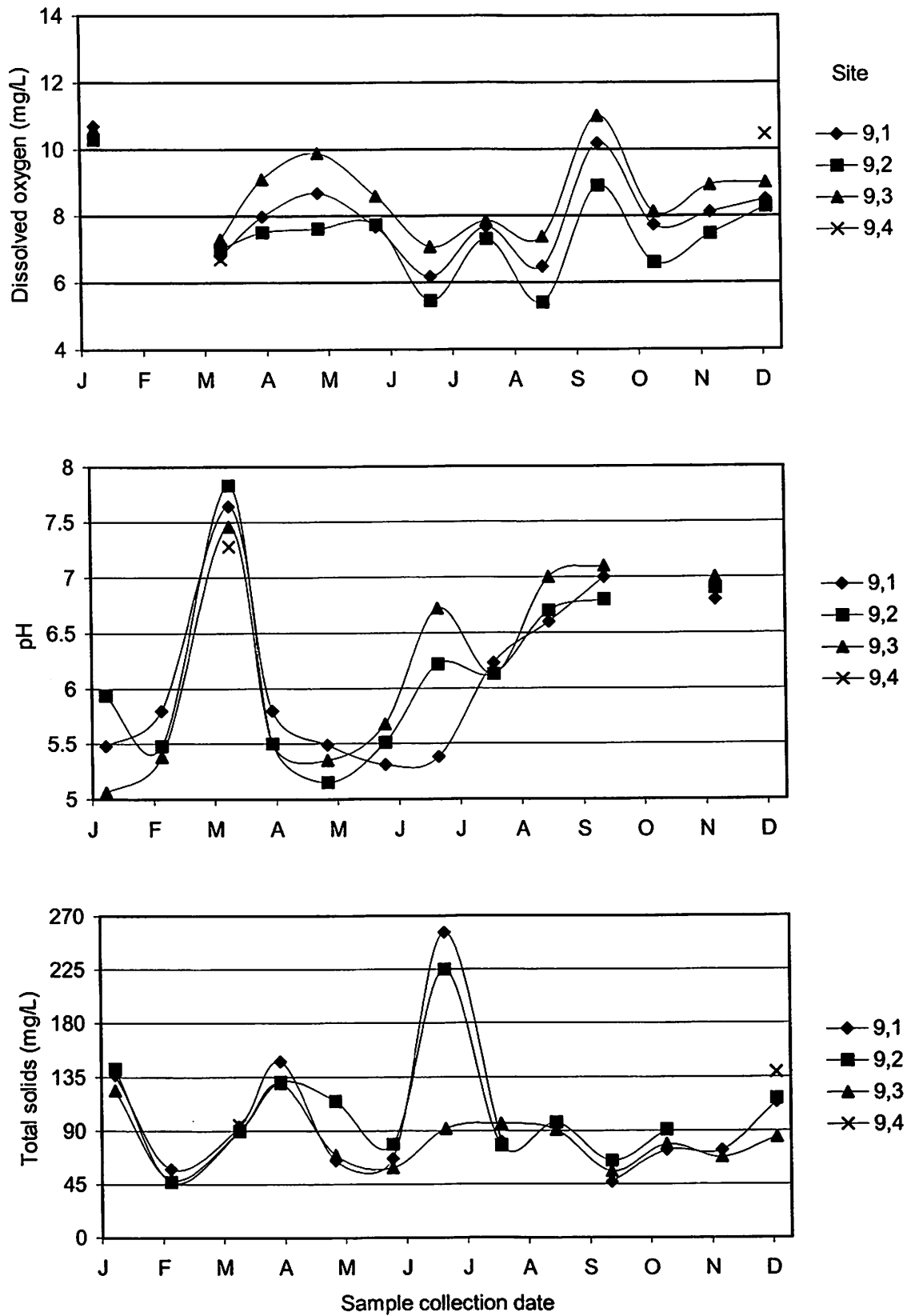


Fig. 9-3. 1999 dissolved and suspended solids, and filtered orthophosphate measurements for Toby Tubby Creek.

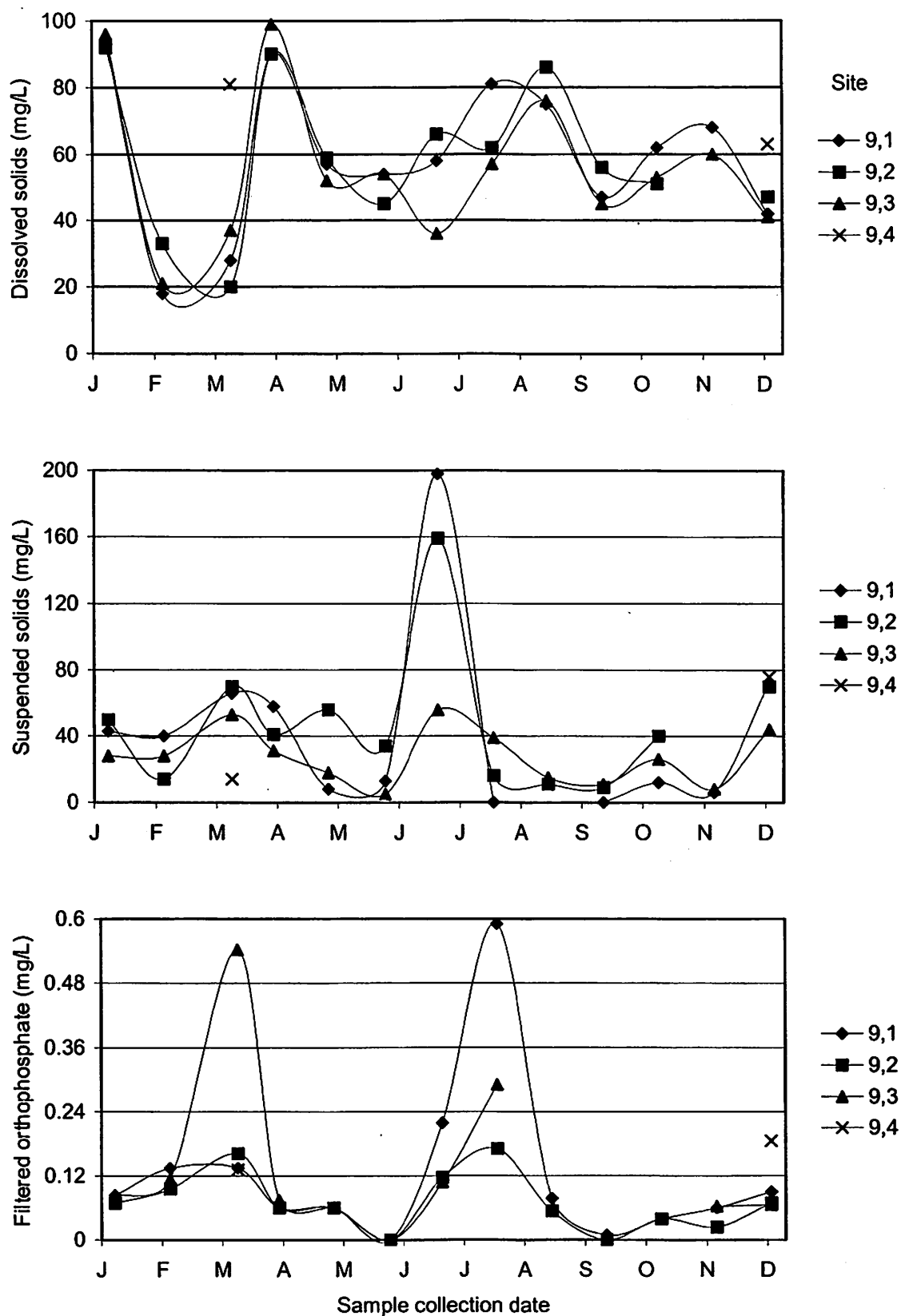


Fig. 9-4. 1999 total orthophosphate, ammonia, and nitrate measurements for Toby Tubby Creek.

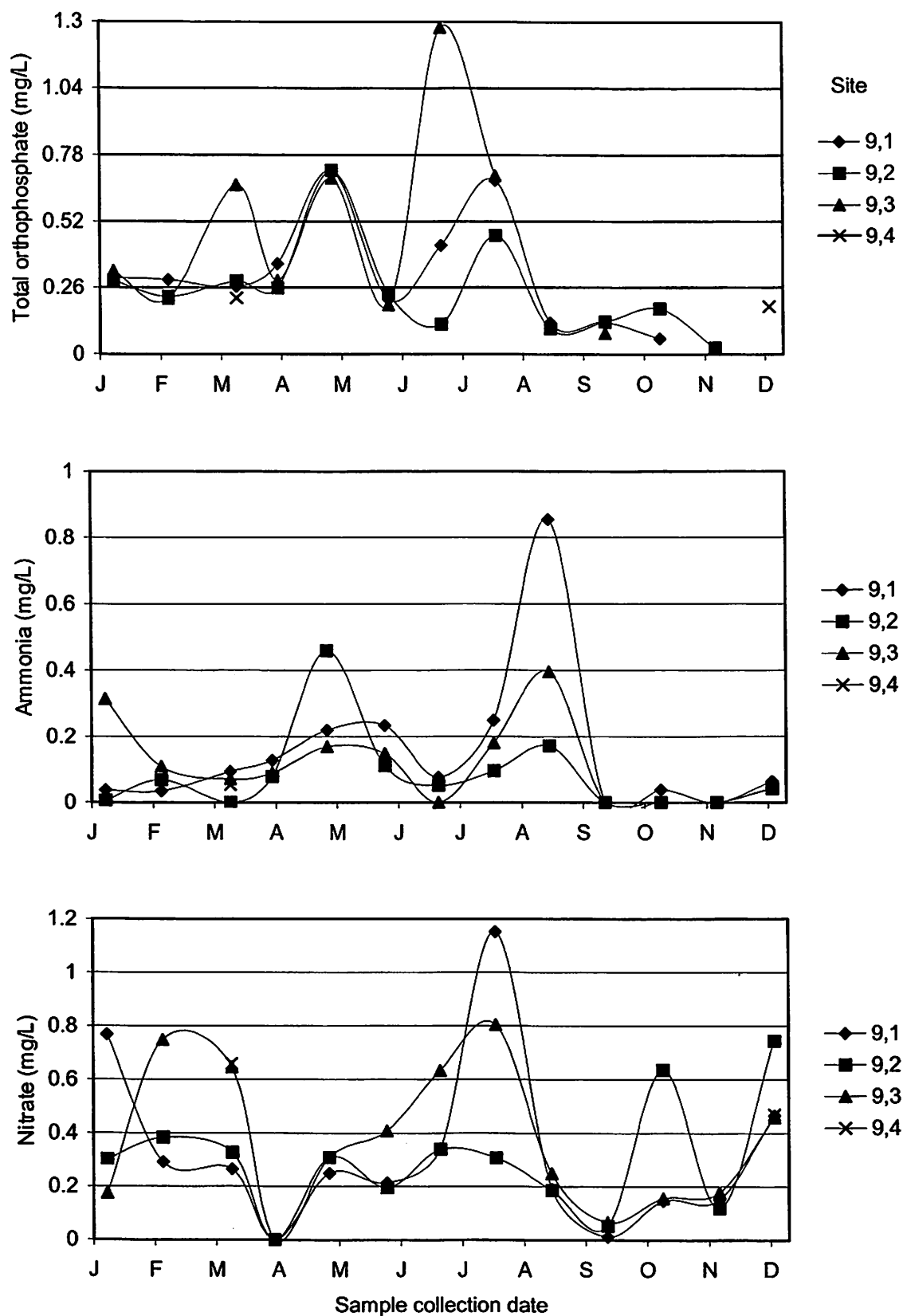


Fig. 9-5. 1999 chlorophyll, fecal coliform, and enterococci measurements for Toby Tubby Creek.

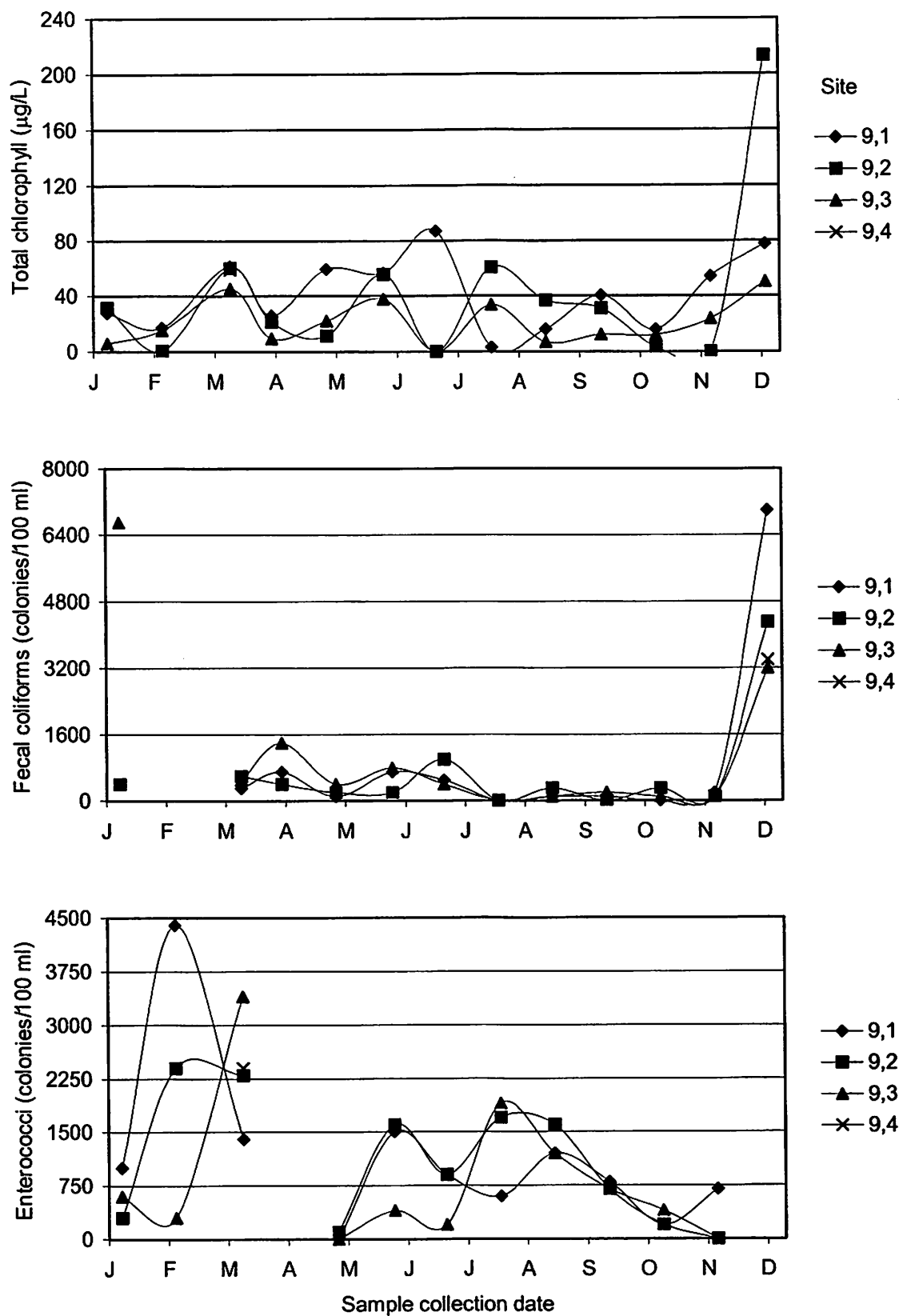


Fig. 13-1. 1999 depth to water, temperature, and conductivity measurements for Burney Branch Creek.

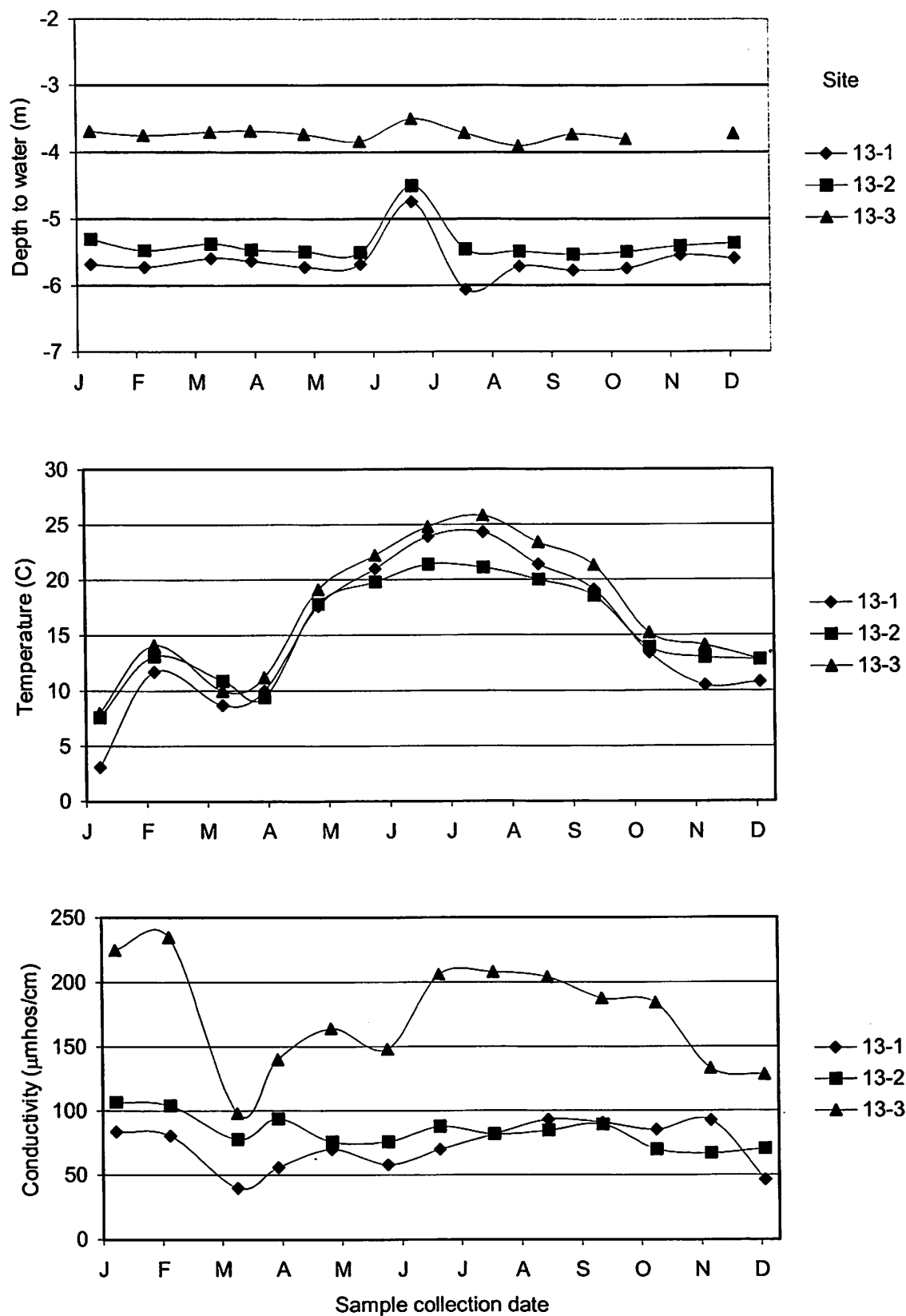


Fig. 13-2. 1999 dissolved oxygen, pH, and total solids measurements for Burney Branch Creek.

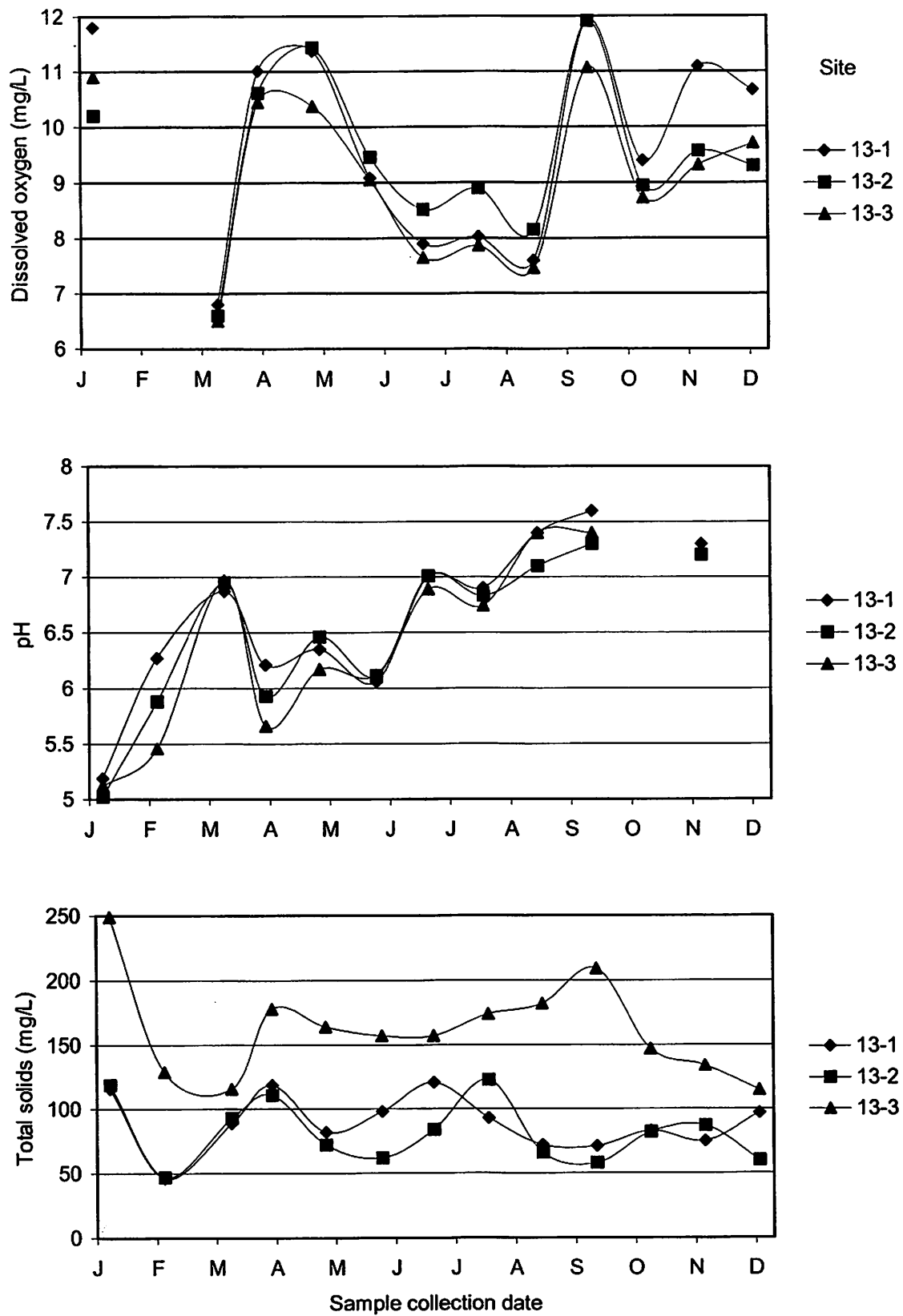


Fig. 13-3. 1999 dissolved and suspended solids, and filtered orthophosphate measurements for Burney Branch Creek.

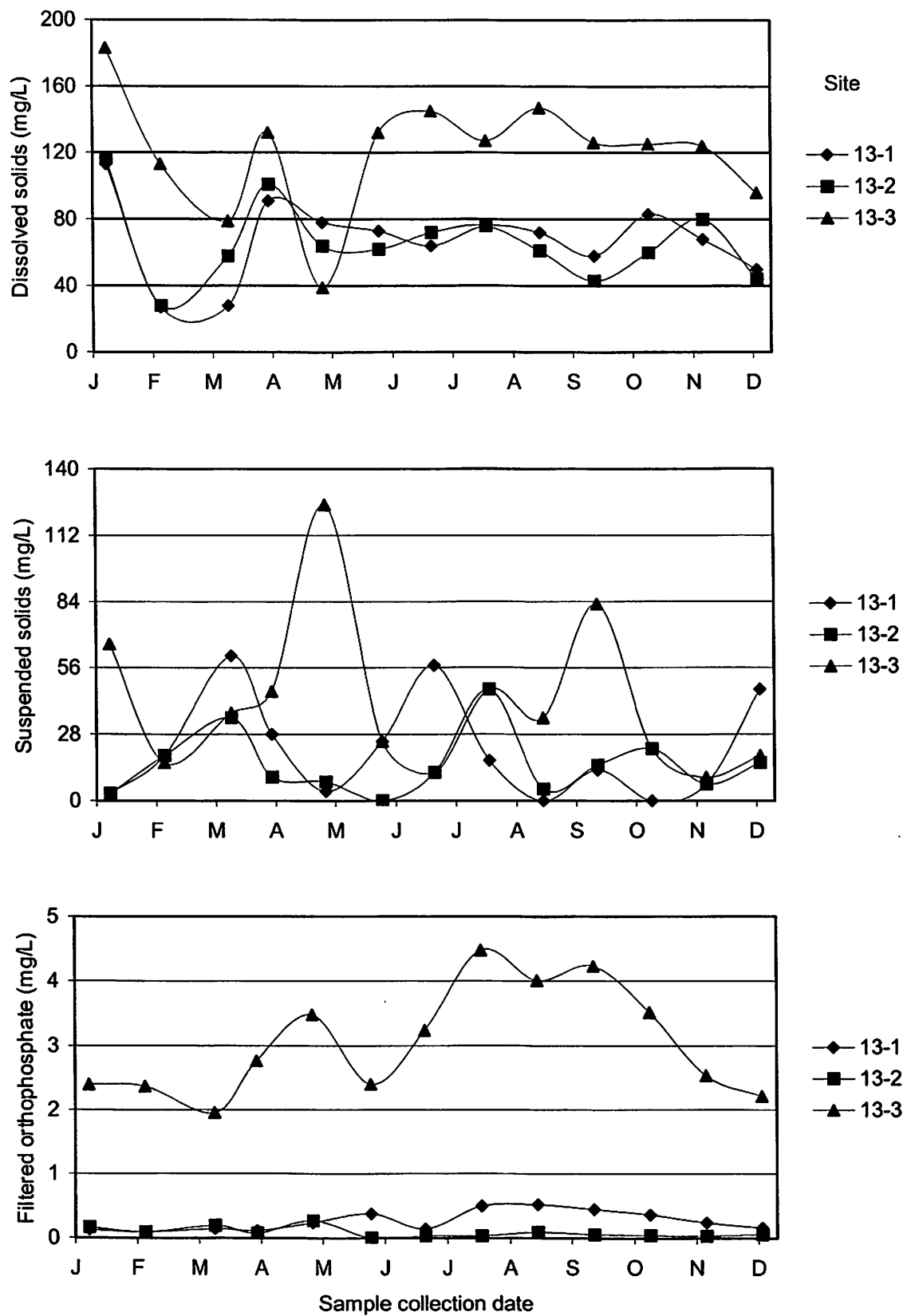


Fig. 13-4. 1999 total orthophosphate, ammonia, and nitrate measurements for Burney Branch Creek.

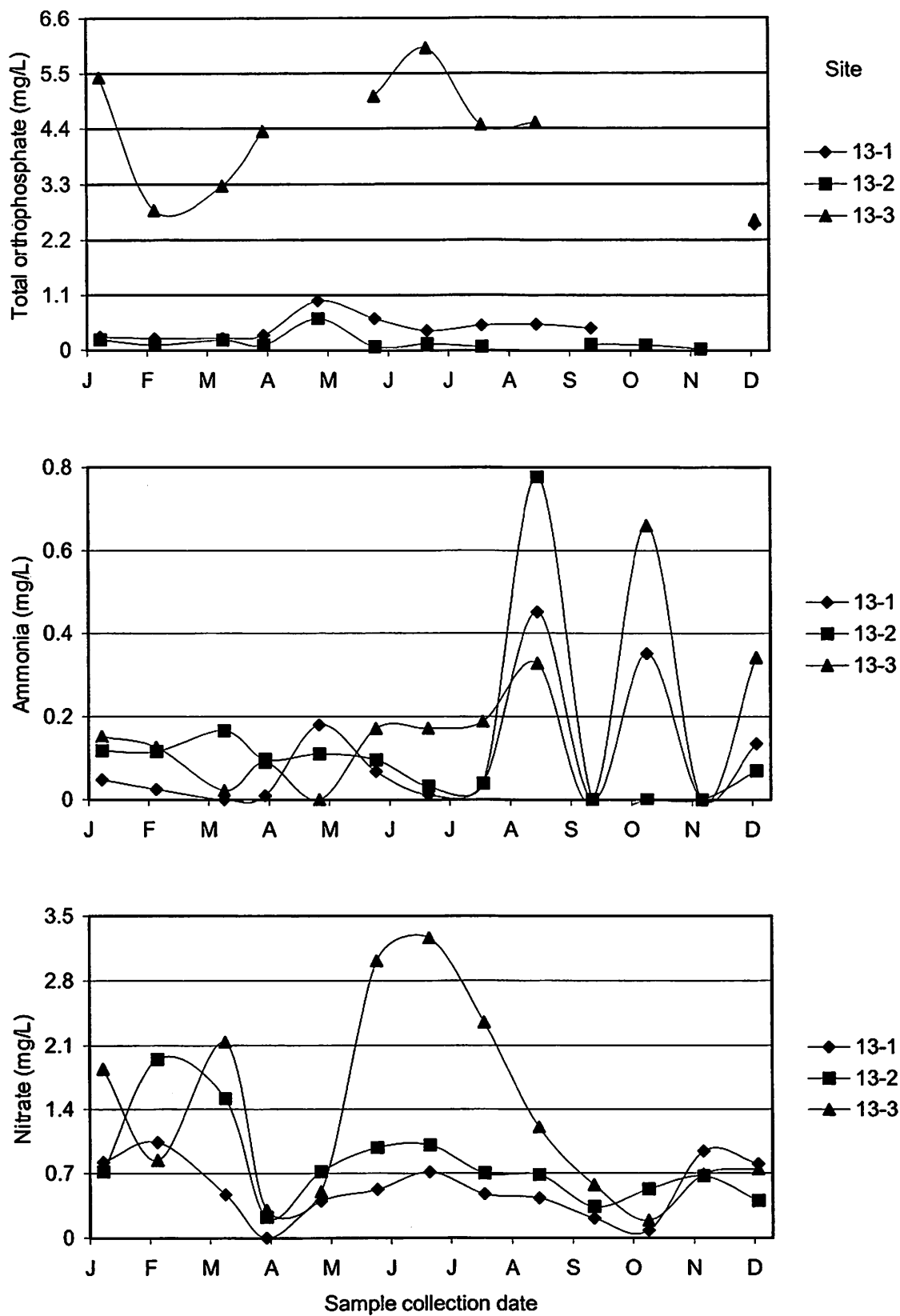


Fig. 13-5. 1999 chlorophyll, fecal coliform, and enterococci measurements for Burney Branch Creek.

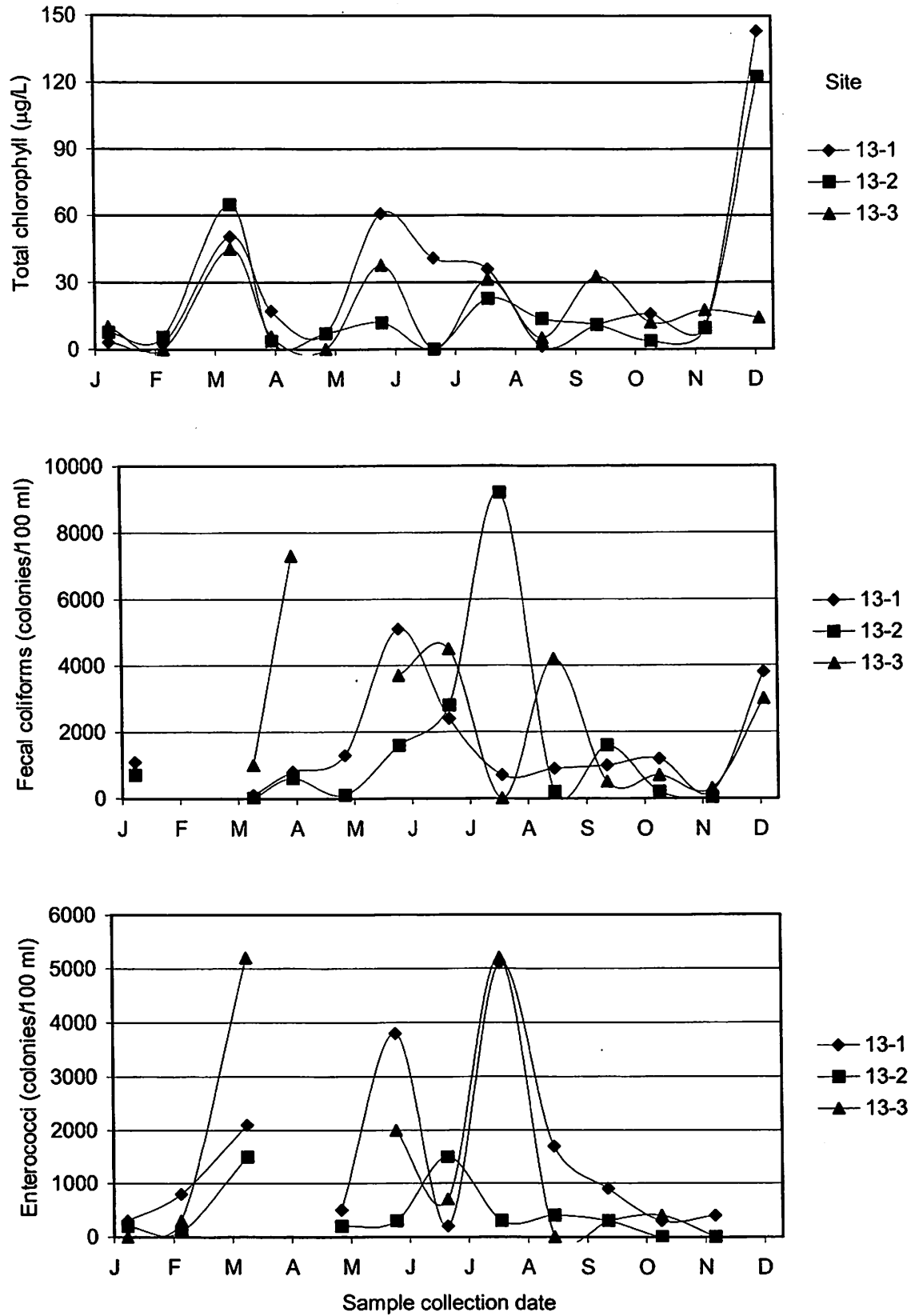


Fig. 17-1. 1999 depth to water temperature, and conductivity measurements for Yalobusha River.

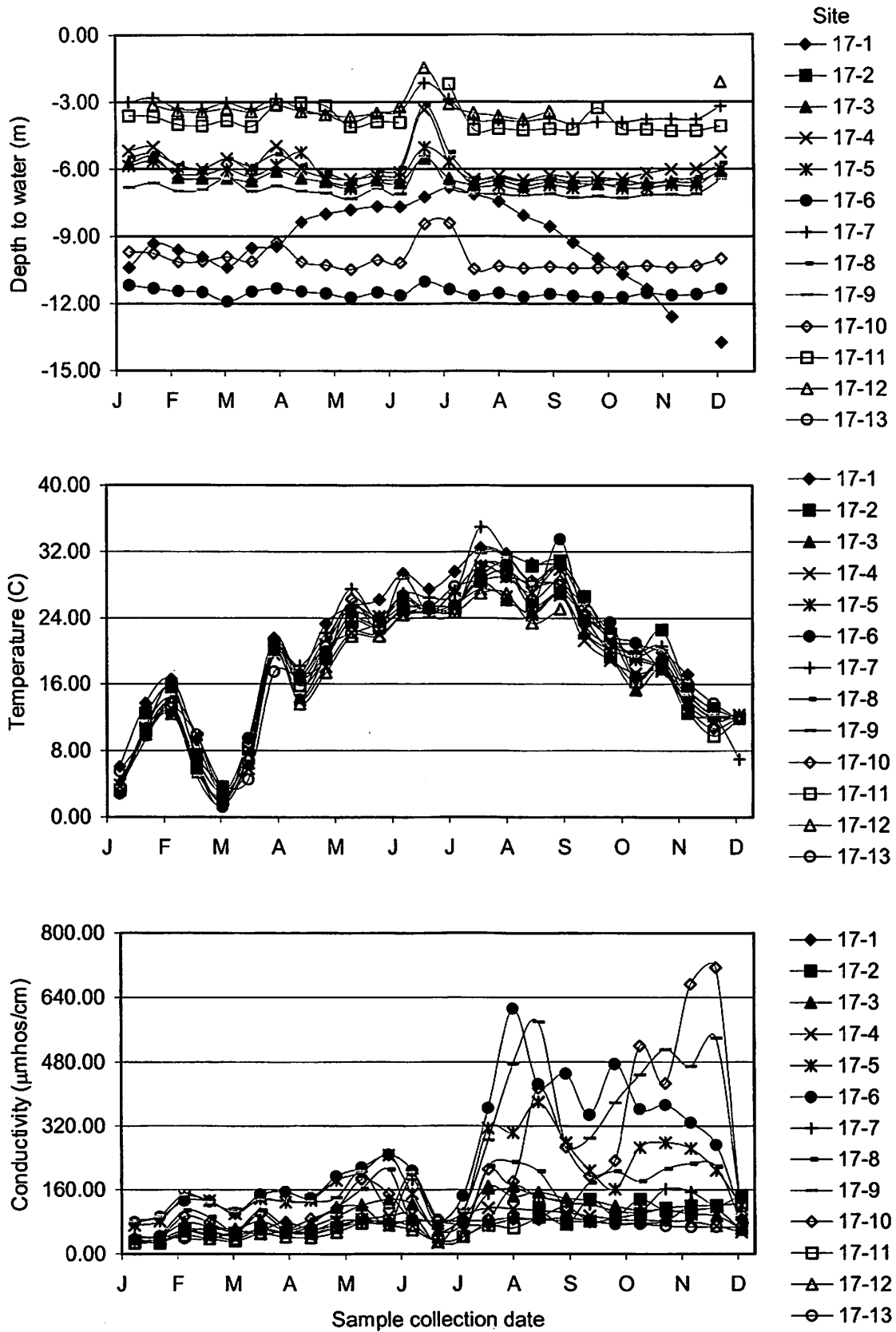


Fig. 17-2. 1999 dissolved oxygen, pH, and total solids measurements for Yalobusha River.

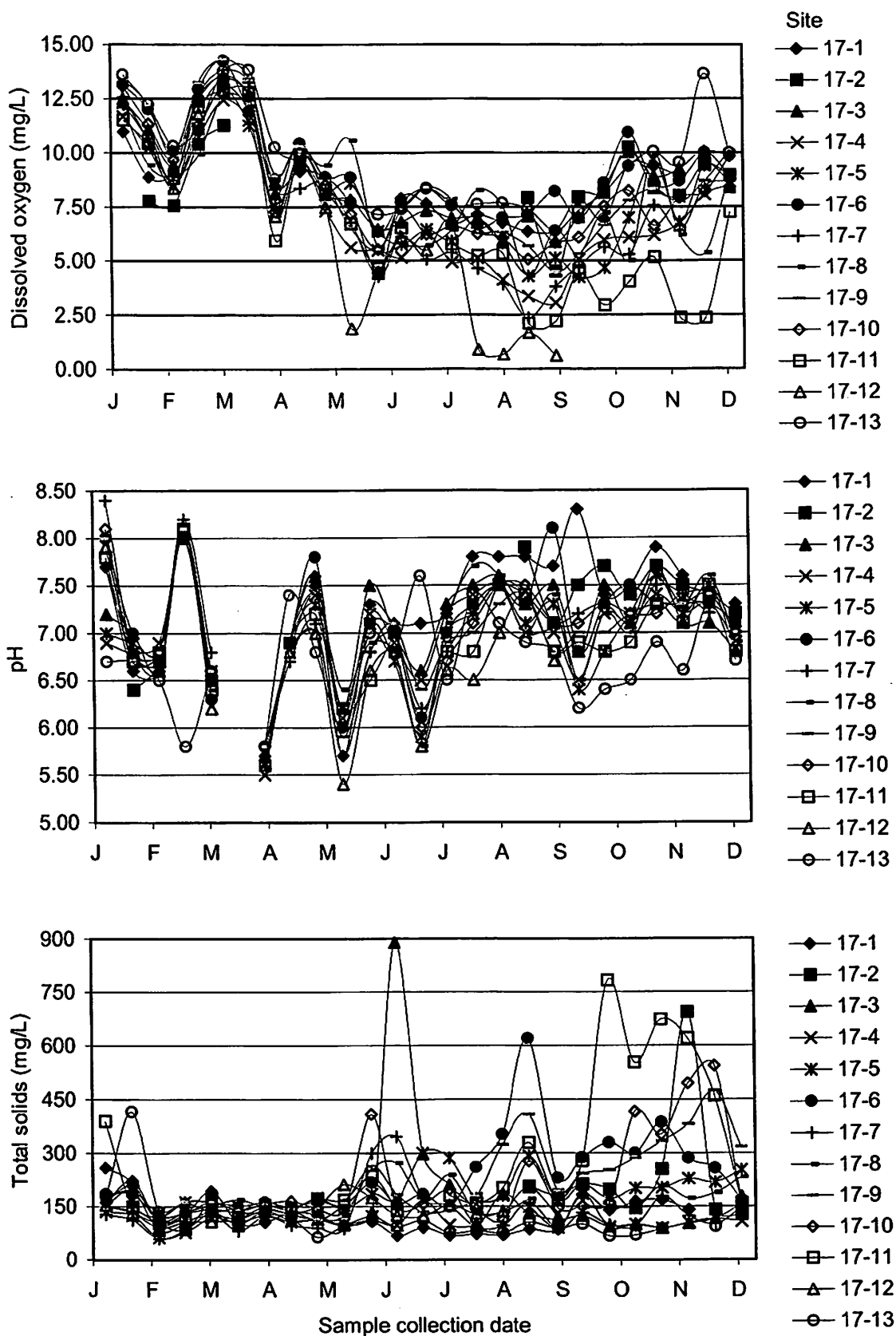


Fig. 17-3. 1999 dissolved and suspended solids, and filtered orthophosphate measurements for Yalobusha River.

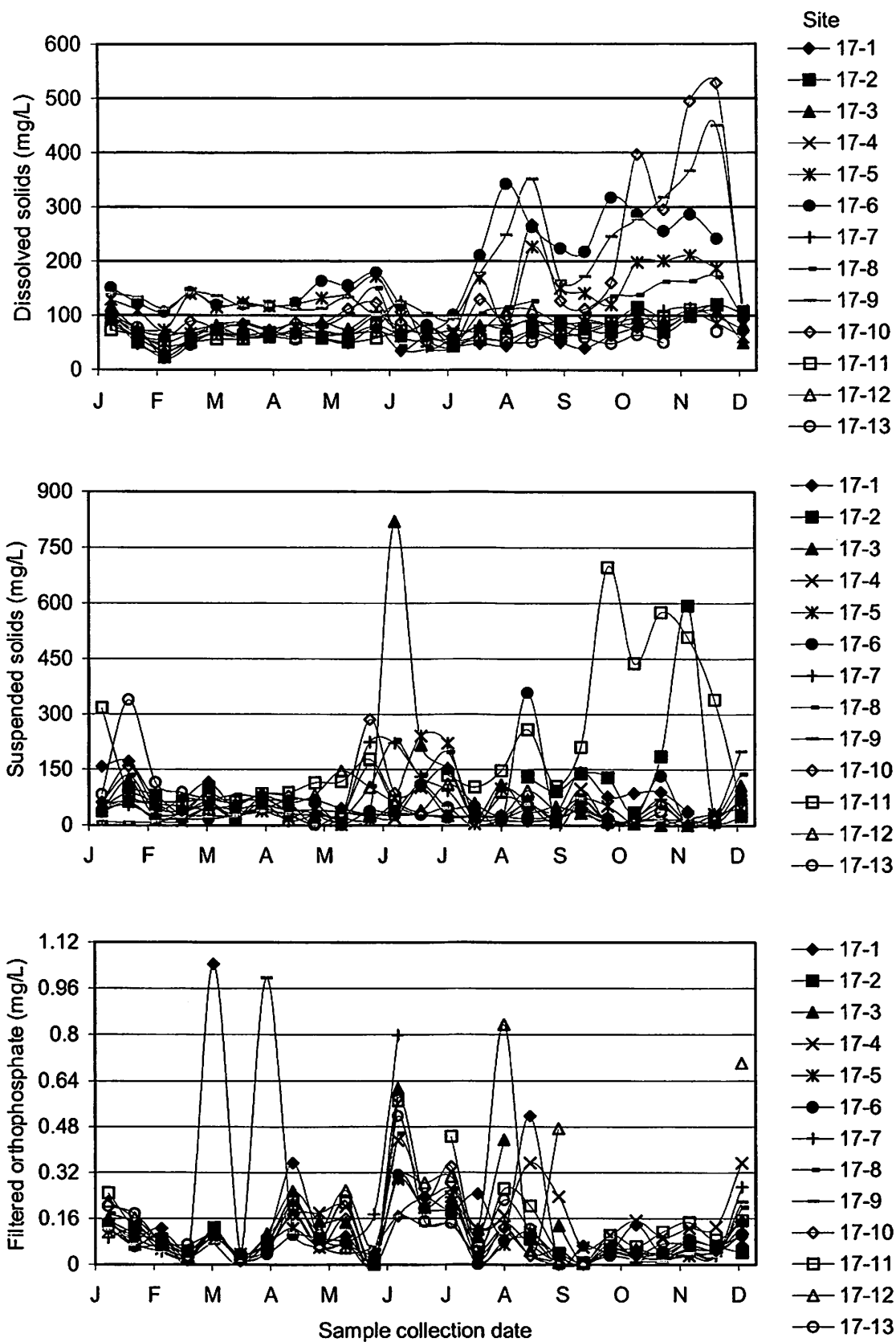


Fig. 17-4. 1999 total orthophosphate, ammonia, and nitrate measurements for Yalobusha River.

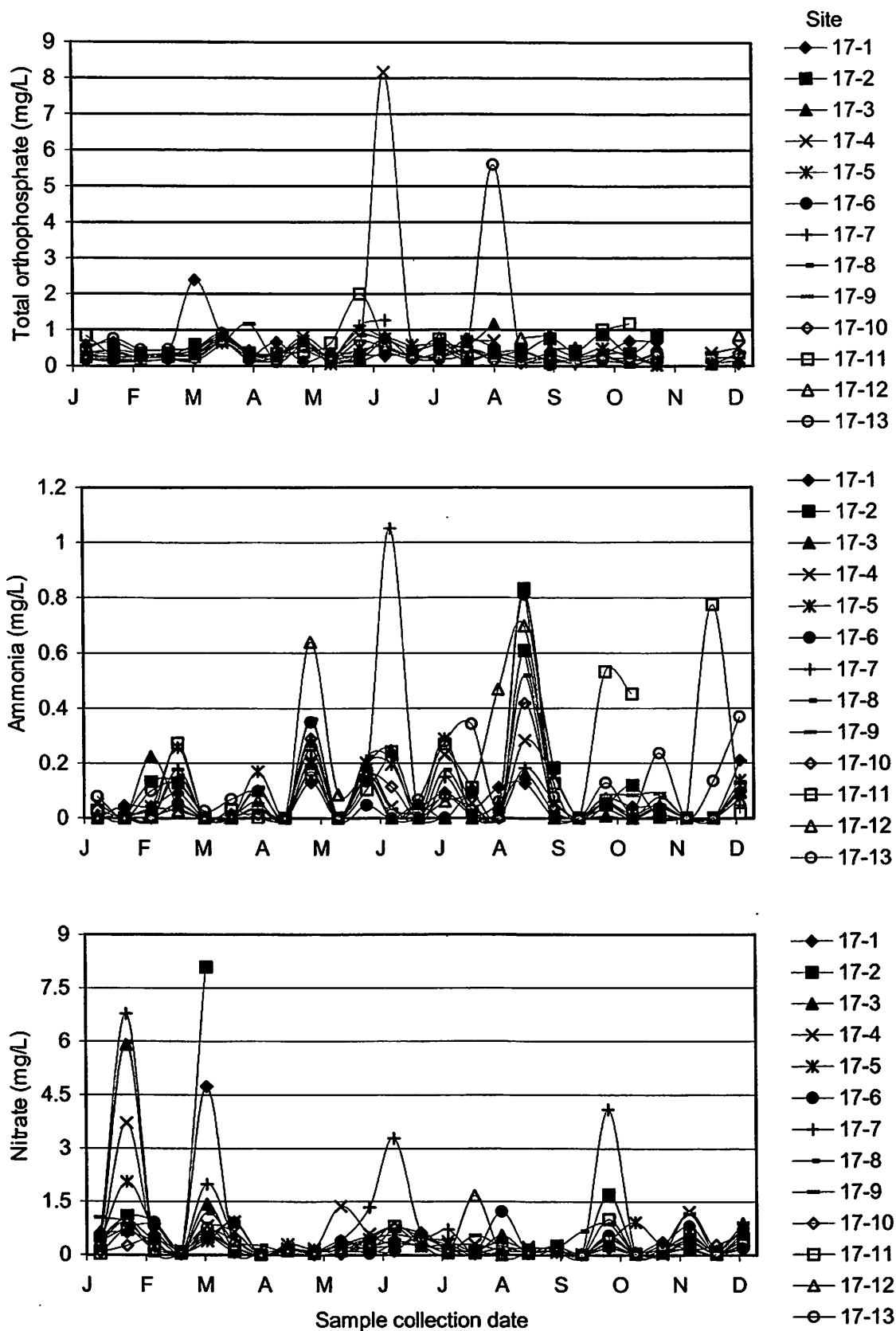


Fig. 17-5. 1999 chlorophyll, fecal coliform, and enterococci measurements for Yalobusha River.

