# Report on Nutrient and Biological Synoptic Surveys in Portions of the Carroll County Drainage to Liberty Reservoir, April, 2002

MD Department of Natural Resources
Chesapeake and Coastal Watershed Service
Watershed Restoration Program
Watershed Evaluation Section
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This work supports Department of Natural Resources Outcomes –
#2 Healthy Maryland watershed lands, streams, and non-tidal rivers.
#3 A natural resources stewardship ethic for Marylanders.
#4 Vibrant local communities in balance with natural systems.

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## Executive Summary

The nutrient synoptic survey in the Carroll County portion of the Liberty Reservoir watershed sampled 43 sites in four subwatersheds during April, 2002. Seven sample sites were in the Snowden Run watershed, 14 sites in the Middle Run watershed, 6 sites in the Roaring Run watershed, and 16 sites in the West Branch watershed. Benthic macroinvertebrates were collected at 3 sites in Snowden Run and 9 sites in Middle Run. Fish were collected at 4 sites in Snowden Run and 4 sites in Middle Run. Although there were a number of subwatersheds with elevated or excessive nutrient (NO2+NO3, PO4) concentrations and/or yields, the concentrations and yields measured at the outlet of the watersheds were baseline or only moderately elevated, with the exception of an excessive NO2 +NO3 yield from Middle Run. The benthic index of biotic integrity scores determined from the macroinvertebrate samples were in the fair or good range with the exception of one site in Middle Run that appeared to have a localized water quality problem due to upstream pasture. Habitat ratings at the benthic sites were partially supporting or supporting of the macroinvertebrate and fish community. Eroding banks and subsequent deposition of sediment in riffles and pools was the major detraction in the habitat rating. Fish communities were indicative of the local habitat. Lack of riparian buffer and increased sedimentation appeared to have significant impacts on the fish community. Insitu water quality measurements of temperature, pH, conductivity, and dissolved oxygen found some pH and conductivity anomalies in Roaring Run and West Branch. Conductivity anomalies were attributed to the presence of limestone in the watersheds, and pH anomalies were attributed to natural biological processes.

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## Introduction

Nutrient synoptic sampling was scheduled for early spring to coincide with the period of maximum nitrogen concentrations in the free flowing fresh water streams. The major proportion of the nitrogen compounds are carried dissolved in the ground water rather than in surface runoff. The higher nitrogen concentrations in the late winter and early spring reflect the higher proportion of nitrogen rich shallow ground water present in the base flow at this time of year. Nitrogen concentrations are reduced in summer as the proportion of shallow ground water is reduced through plant uptake, and replaced by deeper ground water that may have lower nitrate concentrations, or has been denitrified through interaction with anoxic conditions in the soils below the streambed. Point sources can also contribute to in stream nitrate concentrations.

Orthophosphate is generally transported bound to suspended sediments in the water column. In stream orthophosphate concentrations can also be produced through mobilization of sediment bound phosphorus in anoxic water column and/or sediment conditions, sediment in surface runoff from areas having had surface applied phosphorus, ground water from phosphorus saturated soils, and point source discharges.

Ranges used for nutrient concentrations and yields were derived from work done by Frink (1991). The low end values are based on estimated nutrient exports from forested watersheds, and the high end values are based on estimated nutrient exports from intensively agricultural watersheds. As an additional bench mark, the Chesapeake Bay Program uses 1 mg/L total nitrogen as a threshold for indicating anthropogenic impact. The dissolved nitrogen fraction looked at in these synoptic surveys constitutes approximately 50% to 70% of the total nitrogen. For ease of discussion, the four divisions within the concentration and yield ranges will be considered *background, moderate, high,* and *excessive.*

*A Note of Caution*

*Estimates of annual dissolved nitrogen loads/yields from spring samples will result in inflated load estimates, but the relative contributions of subwatersheds should remain reasonably stable. More accurate nitrate/nitrite load/yield estimates need to include sampling during the growing season to account for potential lower concentrations and discharges. Storm flows can also significantly impact loads delivered to a watershed outlet.*

*The tendency of orthophosphate to be transported bound to sediments makes any estimates of annual orthophosphate loads/yields derived from base flow conditions very conservative. More accurate estimates of orthophosphate loads/yields in a watershed must include samples from storm flows that carry the vast majority of the sediment load of a watershed. Residual suspended sediments from recent rains, or instream activities of livestock or construction can produce apparently elevated orthophosphate concentrations and yields at base flow.*

Biological (macroinvertebrates and fish) sampling and habitat condition information are collected on a limited basis within the WRAS watersheds. Analysis of the biological data in conjunction with the nutrient and Stream Corridor Assessment information can provide good insight into the location, severity, and causes of water quality problems within a watershed.

Additional analysis that draws in existing and planned land use, and tax map information, can be a useful watershed planning tool to determine what areas might be targeted for protection or remediation.

## METHODS

### *Water Chemistry Sampling*

Synoptic water chemistry samples were collected in early spring at all accessible road crossings, or other designated sites within the watershed. Grab samples of whole water (500 ml) were collected just below the water surface at mid-stream and filtered using a 0.45 micron pore size (Gelman GF/C) filter. The samples were stored on ice and frozen on the day of collection. Filtered samples were analyzed by the Nutrient Analytical Services Laboratory at the University of Maryland's Chesapeake Biological Laboratory (CBL) for dissolved inorganic nitrogen ($NO_3$, $NO_2$), and dissolved inorganic phosphorus ($PO_4$). All analyses were conducted in accordance with U.S. Environmental Protection Agency (EPA) protocols. Stream discharge measurements were taken at the time of all water chemistry samples. Water temperature, dissolved oxygen, pH, and conductivity were measured in the field with a Hydrolab Surveyor II at the time of all water quality collections. Watershed areas used to calculate nutrient yields per unit area were determined from a digitized watershed map using Arcview software.

Where sites are nested in a watershed the mapped concentration data for the downstream site is shown only for the area between the sites. Yield calculations for a downstream site are based on the entire area upstream of the site, but are mapped showing just the area between sites. The downstream sites therefore illustrate the cumulative impact from all upstream activities.

### *Benthic Macroinvertebrate Sampling*

Aquatic macroinvertebrates were collected at the time of water chemistry samples during the spring to be within the MBSS spring index period. Macroinvertebrate collections were made over a $2m^2$ area of the best available habitat using a 0.3m wide dip net with a mesh size of 500 microns. The best available habitats include: gravel riffles, snags, submerged vegetation and root mats. Habitats were sampled in the proportion to their occurrence at the station. Samples were composited in a sieve bucket, fine sediments washed out, and large debris rinsed and discarded. The remaining sample was preserved in 70% ethanol and returned to the laboratory for subsampling. Subsampling was done using a gridded tray. Grids were chosen at random until the grid with the 100th organism had been completed. Organisms were identified to genus, recorded on a bench sheet, and archived future reference. Insitu water quality data (dissolved oxygen, pH, conductivity, temperature) were collected during each sampling episode with a Hydrolab Surveyor II. A macroinvertebrate index of biotic integrity (IBI)(MD DNR, 1998) was calculated to facilitate ranking of site quality.

### *Macroinvertebrate Habitat Assessment*

A habitat assessment was completed at the time of the macroinvertebrate collections to provide a qualitative measure of the in stream and riparian habitat quality. The assessment, modified from Plafkin et al. (1989) to focus on macroinvertebrate habitat, rates the in stream structure, channel and lower bank morphology, and the upper bank and riparian zone using a series of metrics. The metrics are weighted to provide more scoring potential to the parameters more directly influencing the in stream macroinvertebrate community. The macroinvertebrate habitat score is weighted by the number of equally scored metrics in each category.

The primary metrics rate in stream habitat quality and quantity available for use by the macroinvertebrate community. This includes the amount and type of woody debris, prevalence of undercut banks, degree of embeddedness (siltation) in riffles, pool depth, and water velocity and flow. These metrics are given the most weight because of their direct importance to the health and diversity of the in stream macroinvertebrate communities. Secondary metrics assess channel morphology, rating the quality of the lower stream bank and the structure of the channel. These metrics include relative measures of riffle extent, channel sinuosity, and extent of channel alterations caused by high flow events. These metrics are weighted less than the primary because of their less direct impact on the in stream macroinvertebrate communities. The tertiary metrics rate the quality of the upper banks and adjacent riparian areas. These metrics include scoring of the type and amount of bank vegetation, amount and frequency of bank erosion, and land use in the riparian area. These characteristics of the watershed are given the least weight because they are less important to the in stream macroinvertebrate community.

***Fish Sampling***

Fish were sampled during the summer to coincide with the MBSS index period for fish sampling. Backpack electroshockers were used for two passes through a 75 meter reach of stream with block nets at each end of the reach. All species were enumerated and weighed to obtain taxa richness and biomass estimates.

## Results

The Carroll County portion of the Liberty Reservoir watershed is comprised of a number of watersheds. Snowden Run, Roaring Run, and Middle Run watersheds were focus areas, with less intense sampling in the Western Branch watershed. Sample site locations are described in Table 1, and mapped for each watershed in Figures 1 through 4 Grab samples for dissolved nutrient analysis were collected at a total of 43 sites within the watershed focus areas. Benthic samples were collected at a subset of 10 sites in the Middle Run watershed and 3 sites in the Snowden Run watershed. Fish were sampled at 4 sites in Middle Run and 4 sites in Snowden Run. Repeated incidence of cattle in the stream upstream of Middle Run at Black Steer Rd. and at Louisville Rd. precluded fish sampling at these sites.

**Table 1. Synoptic Sampling Sites in Liberty Watershed, April, 2002**

| Station | Road Crossing | Latitude | Longitude | Sample Type* |
|---|---|---|---|---|
| Liberty 01A | Middle Run below Louiville Rd. | . | . | B |
| Liberty 01B | Middle Rn off Bobwhite Dr. | . | . | B |
| Liberty 1873 | Unnamed Trib to Middle Rn at Kibler Property | . | . | B,F |
| Middle Run 0 | Prugh Branch at Louiville Rd. | 39.45258 | -76.91706 | N |
| Middle Run 01 | Middle Rn at Louiville Rd. | 39.46094 | -76.90547 | N |
| Middle Run 02 | Middle Rn off Pin Oak Dr. | 39.46967 | -76.91431 | N |
| Middle Run 04 | Middle Rn at Rt 91 | 39.47169 | -76.92028 | N |
| Middle Run 06 | Unnamed Trib to Middle Rn at Bird View Rd.(S) | 39.49072 | -76.96208 | N |
| Middle Run 07 | Middle Rn at Black Steer Rd. | 39.48678 | -76.93362 | N,B |
| Middle Run 10 | Unnamed Trib to Middle Rn at Niner Rd. | 39.47506 | -76.93597 | N,B |
| Middle Run 11 | Unnamed Trib to Middle at Bird View Rd.(N) | 39.50497 | -76.94842 | N,B |
| Middle Run 13 | Middle Rn at Bird View Rd. | 39.49617 | -76.95189 | N,B,F |
| Middle Run 1317 | Unnamed Trib to Middle Rn off Wheatfield Rd. | 39.49706 | -76.94469 | B,F |
| Middle Run 15 | Middle Rn off end of Bollinger Mill Rd. | 39.44411 | -76.90183 | N,B |
| Middle Run 17 | Unnamed Trib to Middle off Pin Oak Dr. | | | N |
| Middle Run 18 | Middle Rn at Niner Rd. | 39.48186 | -76.93150 | N |
| Middle Run 1872 | Middle Rn at Haydon Property | 39.50175 | -76.96469 | B,F |
| Roaring 01 | Unnamed Trib to Roaring Rn off Appaloosa Way (N) | 39.52494 | -76.91169 | N |
| Roaring 02 | Roaring Rn at Brown Rd | 39.51861 | -76.89792 | N |
| Roaring 03 | Roaring Rn above Sandymount Rd. | 39.52869 | -76.91972 | N |
| Roaring 04 | Unnamed Trib to Roaring Rn above Sandymount Rd. | 39.52869 | -76.91972 | N |
| Roaring 05 | Unnamed Trib to Roaring Rn off Appaloosa Way (S) | 39.52486 | -76.91147 | N |
| Roaring 06 | Roaring Rn off Appaloosa Way | 39.52492 | -76.91172 | N |
| Snowden 0 | Snowdens Rn at Snowden Run Rd. | 39.40853 | -76.91447 | N,B,F |
| Snowden 02 | Unnamed Trib to Snowden at Bennet Rd. | 39.41333 | -76.92567 | N,B,F |
| Snowden 03 | Snowden Rn. Off Bennet Rd. | 39.41172 | -76.92736 | N,B,F |
| Snowden 04 | Unnamed Trib to Snowden at Monroe Rd. | 39.40003 | -76.92489 | N |
| Snowden 05 | Unnamed Trib to Snowden off Cavalier Dr. | 39.40011 | -76.91619 | N,F |
| Snowden 06 | Unnamed Trib to Snowden Rn off Bennet Rd.(S) | 39.41153 | -76.92731 | N |
| Snowden 08 | Unnamed Trib to Snowden at Sunset Rd. | 39.38794 | -76.91028 | N |
| Western Br. 0 | West Br at Sullivan Rd. | 39.59978 | -76.97928 | N |
| Western Br. 02 | Unnamed Trib to West Br. At Sunshine Way | 39.59158 | -76.98225 | N |
| Western Br. 03 | Cranberry Br. At Old Manchester Rd. | 39.58358 | -76.97092 | N |
| Western Br. 04 | Unnamed Trib to West Br. at Tannery Rd. | 39.57481 | -76.95572 | N |
| Western Br. 05 | West Br. At Tannery Rd. | 39.57481 | -76.95572 | N |
| Western Br. 06 | Unnamed Trib to West Br. at Tannery Rd. | 39.56856 | -76.94483 | N |
| Western Br. 07 | West Br. At Gorsuch Rd. | 39.56856 | -76.94483 | N |
| Western Br. 10 | Unnamed Trib to West Br at Reese Rd. | 39.55694 | -76.91950 | N |
| Western Br. 11 | West Br. At Carrollton Rd. | 39.55694 | -76.91950 | N |
| Western Br. 12 | Unnamed Trib to West Br. At Carrollton Rd. | 39.55383 | -76.91650 | N |
| Western Br. 13 | Unnamed Trib to West Br. At Patapsco Rd. | 39.53989 | -76.89864 | N |
| Western Br. 14 | West Br at Wesley Rd. | 39.53739 | -76.89369 | N |
| Western Br. 15 | East Br at Wesley Rd. | 39.53739 | -76.89369 | N |
| Western Br. 16 | Deep Rn at Emory Rd. | 39.53522 | -76.87558 | N |
| Western Br. 17 | North Br at Wesley Rd. | 39.53111 | -76.88375 | N |
| Western Br. 22 | Broad Rn at Emory Church Rd. | 39.53281 | -76.86278 | N |

*Benthic, Nutrient, Fish

Figure 1. Liberty WRAS; Snowden Run Watershed Synoptic Sampling Sites, April 2002

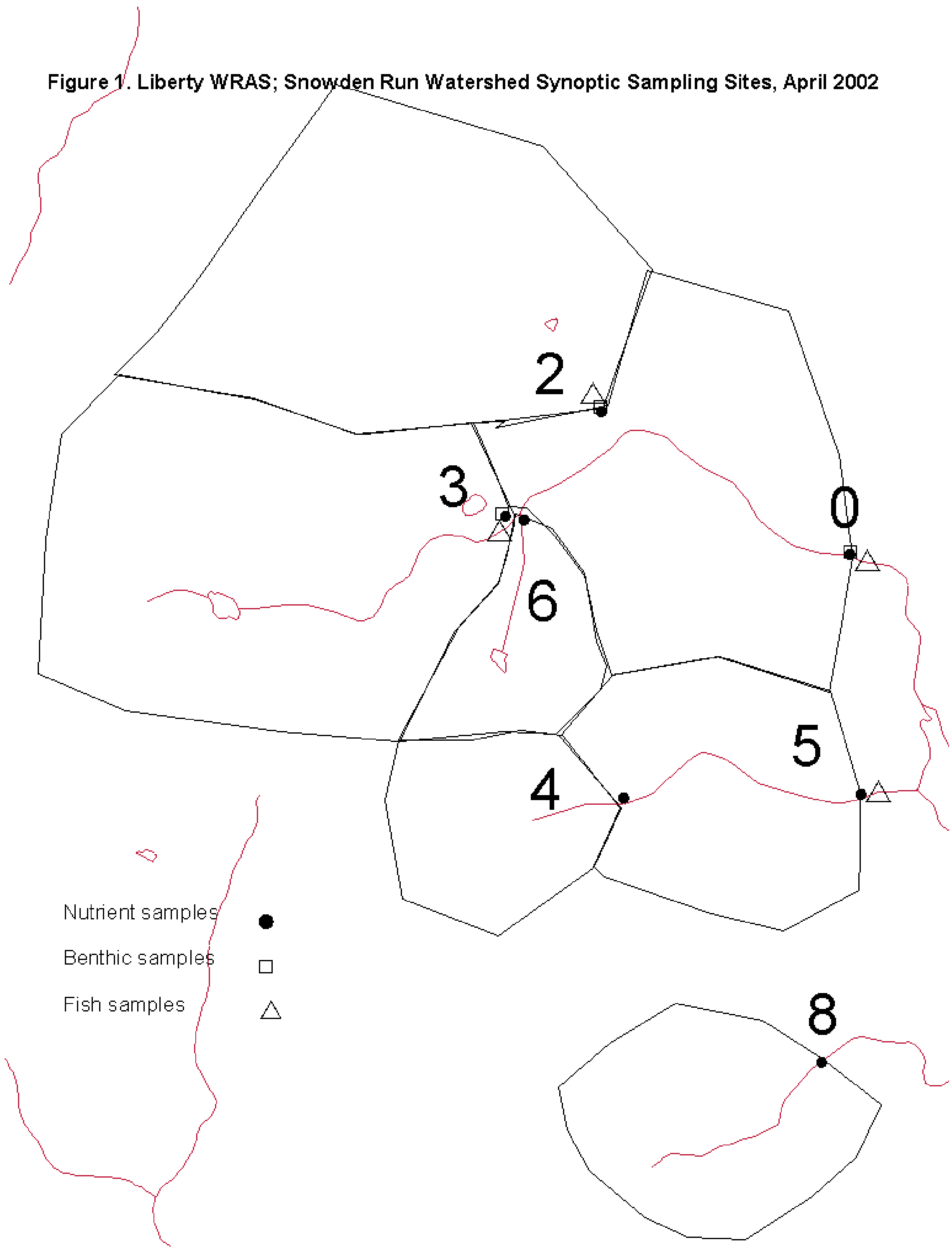


Figure 2. Liberty WRAS, Roaring Run Synoptic Sampling Sites, April 2002

Figure 3. Liberty WRAS, Middle Run Synoptic Sampling Sites, April 2002

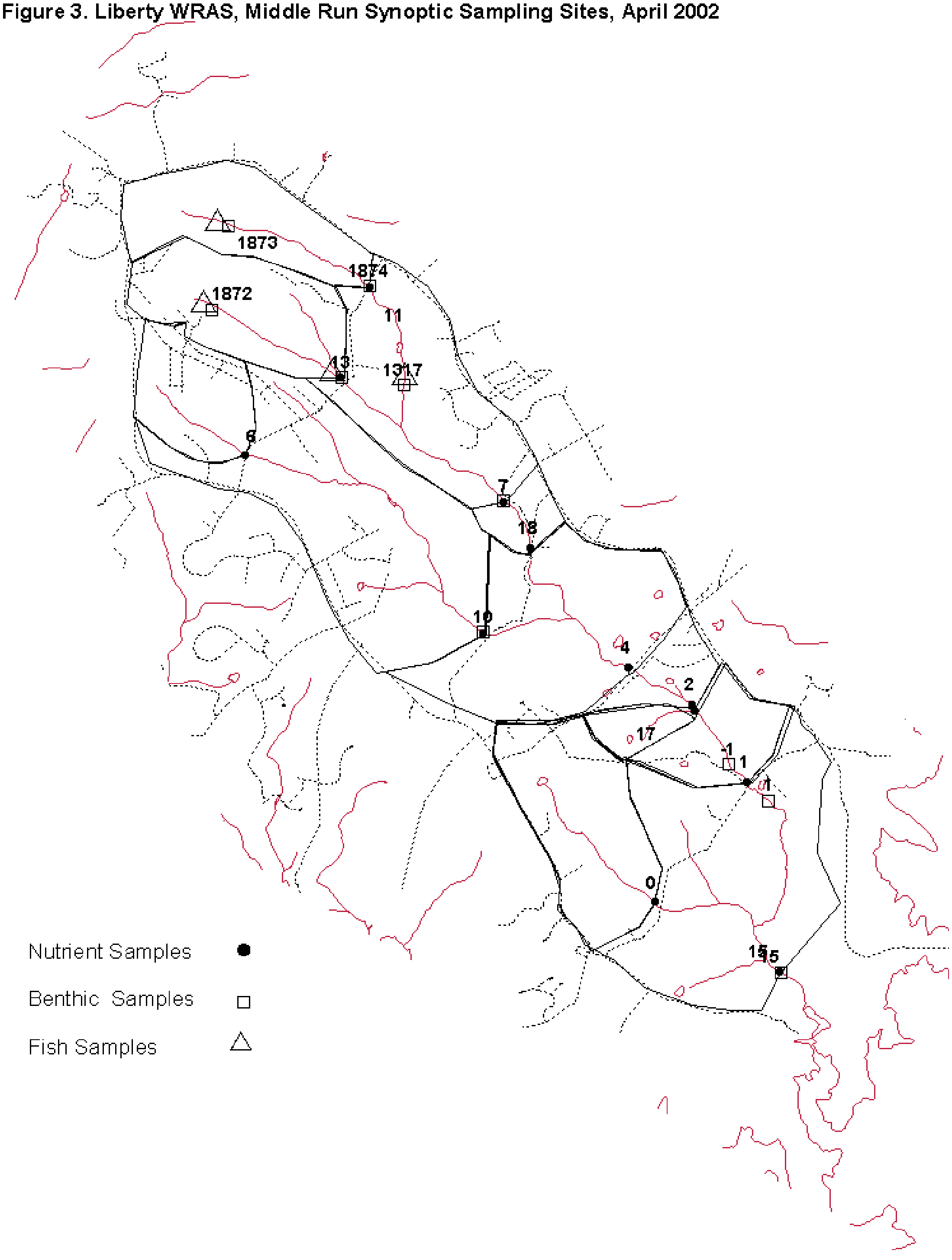
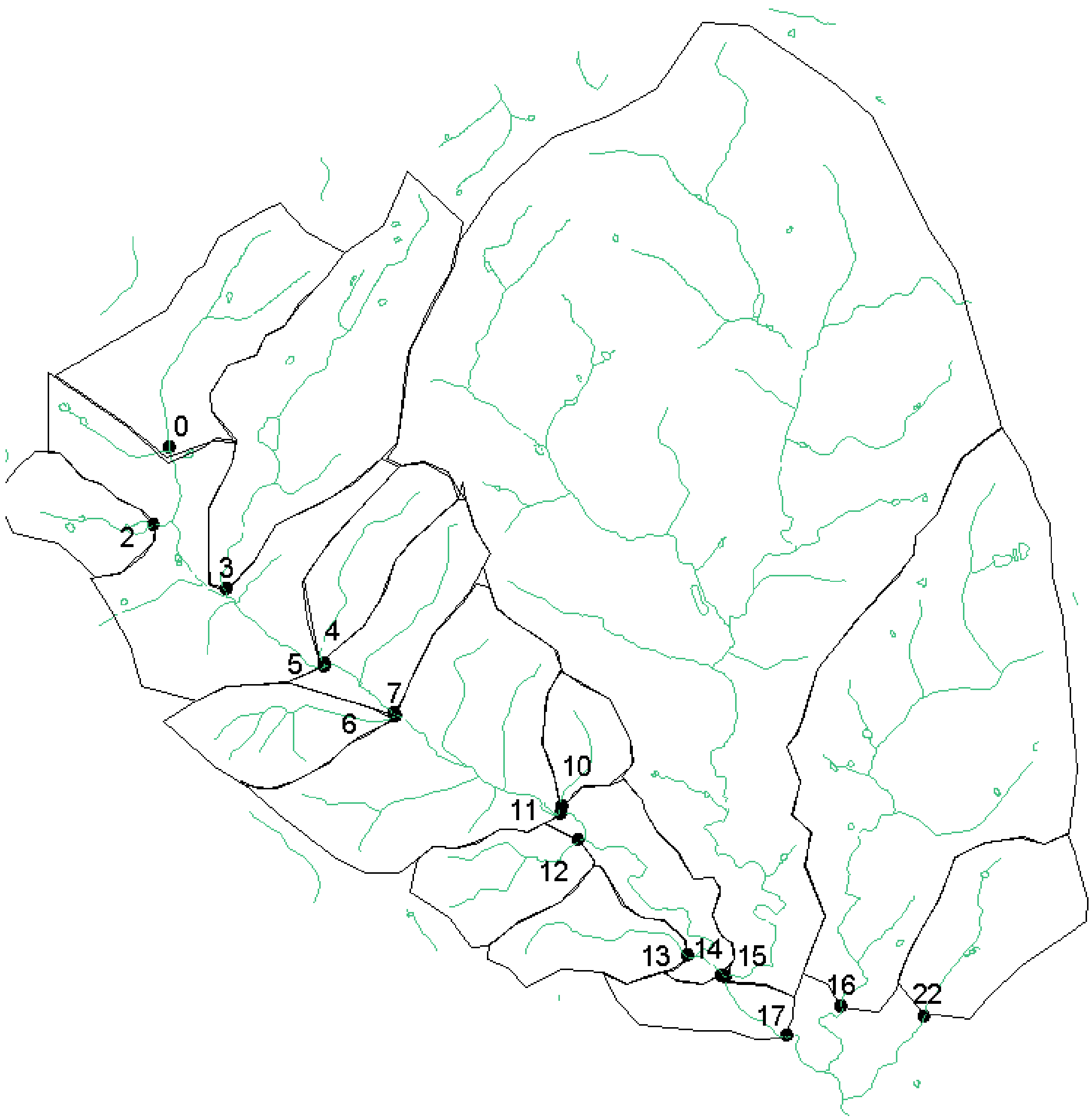


Figure 4. Liberty WRAS, Western Branch Synoptic Survey Sites, April 2002



## Snowden Run

Nitrate/nitrite concentrations coming from the Snowden Run subwatersheds were all above the 1 mg/L threshold, but would not be considered excessive (Table 2). All values are below the average for all Liberty sites as well as several other stream systems across the state (Table 3). Site 6, draining the old airstrip area, had the highest NO23 concentration within the watershed at 3.28 mg/L (Figure 5). The higher concentration at site 6 did not translate to a high daily yield due to its small size and minimal discharge. As shown in Figure 6, NO23 yields throughout the watershed were generally below baseline, with the exception of moderate yields at sites 5 and 8. These subwatersheds had higher discharges per area than the others, thus they had higher yields with similar concentrations.

Dissolved phosphorus concentrations and yields in Snowden Run were all below baseline at the time of sampling (Table 2, Figures 7 & 8), and below averages found in other watersheds (Table 3).

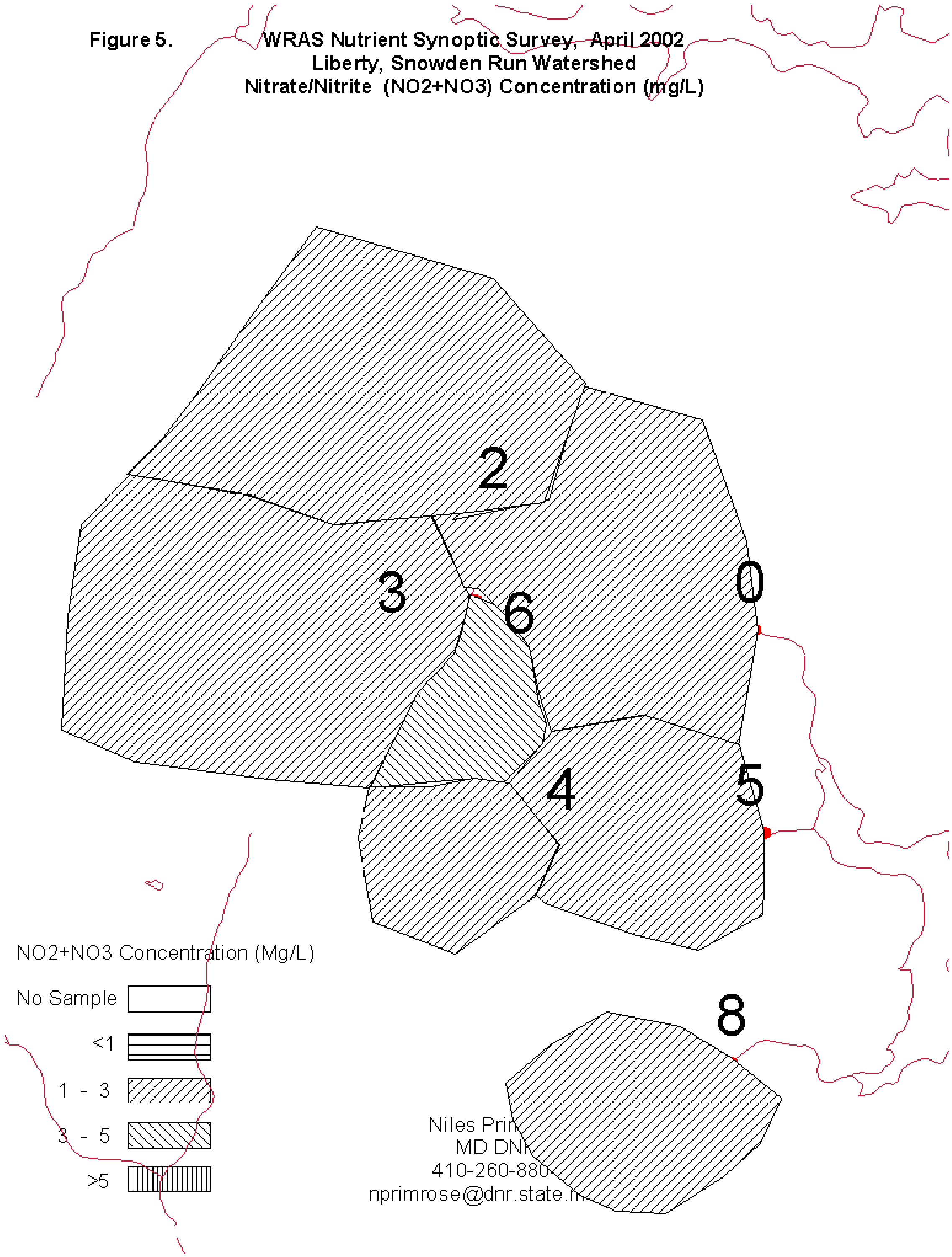
**Table 2. Snowden Run Watershed Nutrient Synoptic Results, April 2002.**

| | | Concentration | | | Daily Loads | | Area | Nutrient Yields/Hectare | |
|---|---|---|---|---|---|---|---|---|---|
| DATE | STATION | PO4 (mg P/L) | NO23 (mg N/L) | Discharge (L/s) | PO4 (kg/day) | NO23 (kg/day) | Hectares | PO4 (kg/day/ha) | NO23 (kg/day/ha) |
| 04/24/02 | Snowden 0 | 0.002 | 2.18 | 25.66 | 0.004433 | 4.832391 | 558 | 0.000008 | 0.008653 |
| 04/24/02 | Snowden 02 | 0.001 | 1.94 | 6.94 | 0.000600 | 1.163633 | 173 | 0.000003 | 0.006718 |
| 04/24/02 | Snowden 03 | 0.001 | 2.11 | 17.38 | 0.001502 | 3.168489 | 200 | 0.000007 | 0.015817 |
| 04/24/02 | Snowden 04 | 0.001 | 2.73 | 1.56 | 0.000134 | 0.366809 | 51 | 0.000003 | 0.007137 |
| 04/24/02 | Snowden 05 | 0.001 | 2.33 | 12.64 | 0.001092 | 2.544470 | 140 | 0.000008 | 0.018120 |
| 04/24/02 | Snowden 06 | 0.001 | 3.28 | 0.33 | 0.000028 | 0.092976 | 20 | 0.000001 | 0.004595 |
| 04/23/02 | Snowden 08 | 0.001 | 2.01 | 5.23 | 0.000452 | 0.908773 | 75 | 0.000006 | 0.012073 |

**Table 3. Annual & Spring Nutrient Concentration Averages from Other Nutrient Synoptic Surveys**

| | Piney | German Br. | Pocomoke | Bush | Breton Bay | Patuxent | Choptank | Liberty |
|---|---|---|---|---|---|---|---|---|
| **NO23 Spring** | 3.742 | 3.832 | 3.734 | 1.944 | 0.223 | 0.439 | 2.892 | 3.410 |
| **NO23 Annual** | 4.823 | 4.704 | 2.384 | | | | | |
| **PO4 Spring** | 0.800 | 0.043 | 0.028 | 0.006 | 0.004 | 0.012 | 0.023 | 0.004 |
| **PO4 Annual** | 1.177 | 0.067 | 0.022 | | | | | |

Figure 5. WRAS Nutrient Synoptic Survey, April 2002
Liberty, Snowden Run Watershed
Nitrate/Nitrite (NO2+NO3) Concentration (mg/L)



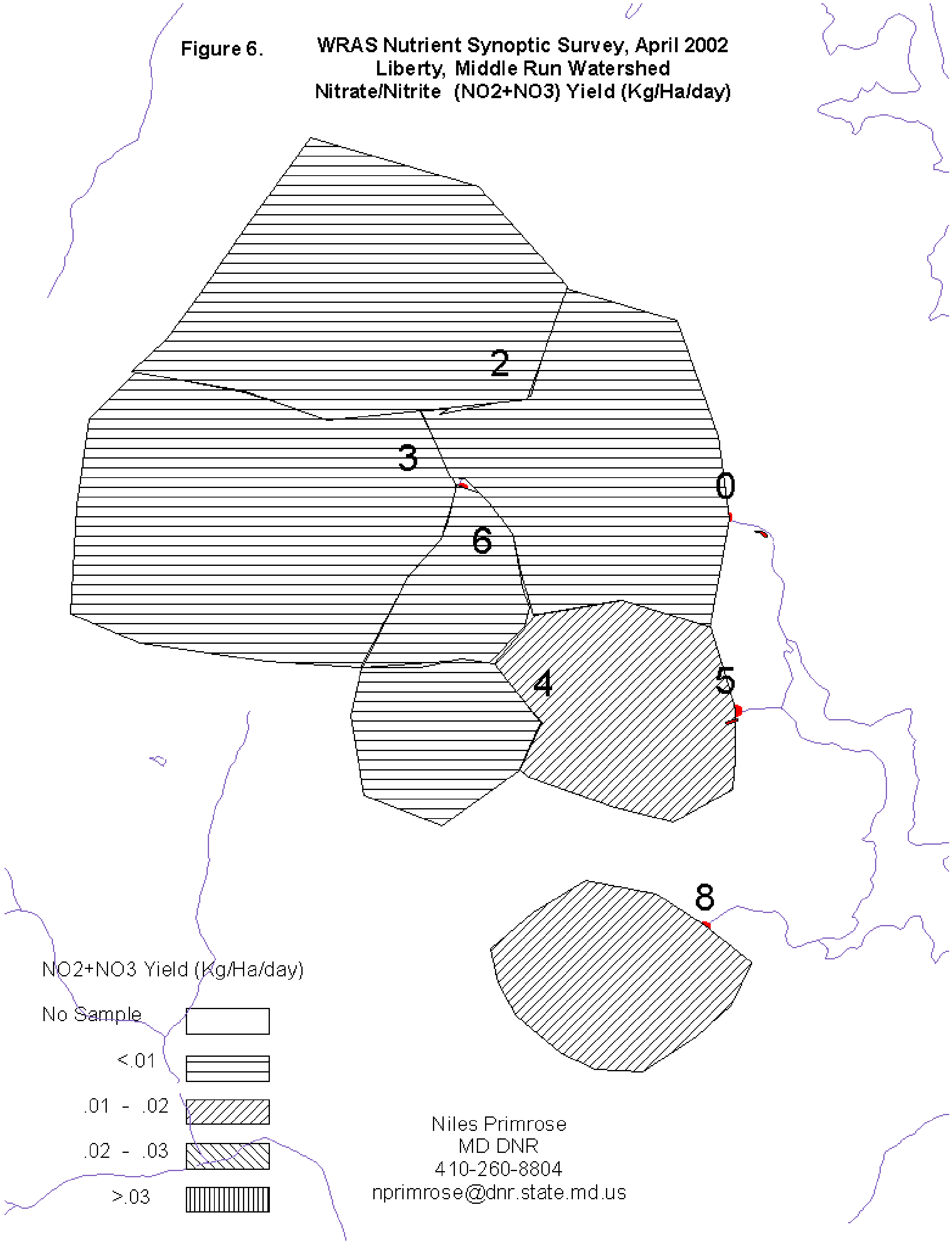


Figure 6.
WRAS Nutrient Synoptic Survey, April 2002
Liberty, Middle Run Watershed
Nitrate/Nitrite (NO2+NO3) Yield (Kg/Ha/day)
2
3
0
6
4
5
8
NO2+NO3 Yield (Kg/Ha/day)
No Sample
<.01
.01 - .02
.02 - .03
>.03
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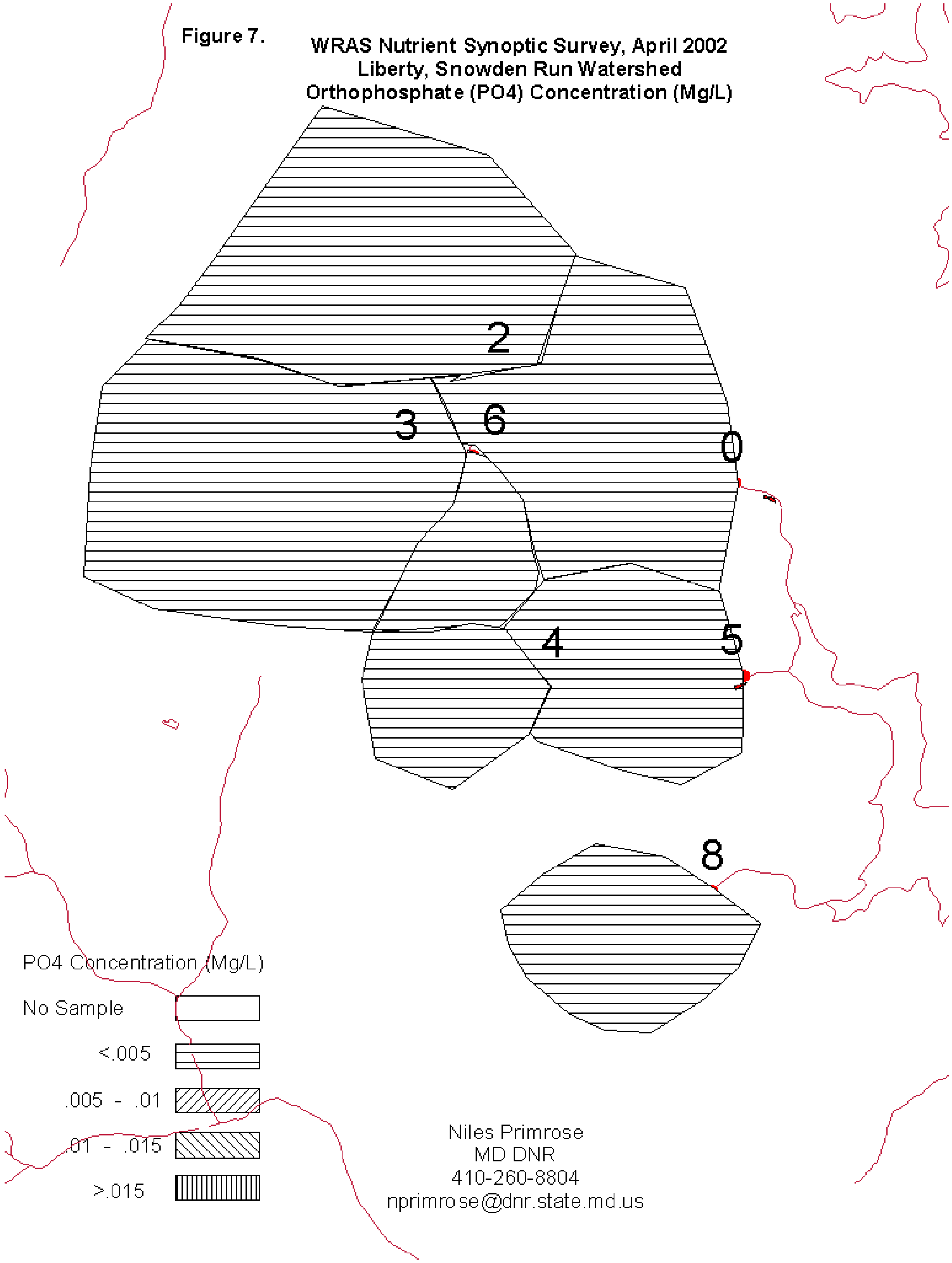
Figure 7.
WRAS Nutrient Synoptic Survey, April 2002
Liberty, Snowden Run Watershed
Orthophosphate (PO4) Concentration (Mg/L)
2
3
6
0
4
5
8
PO4 Concentration (Mg/L)
No Sample
<.005
.005 - .01
.01 - .015
>.015
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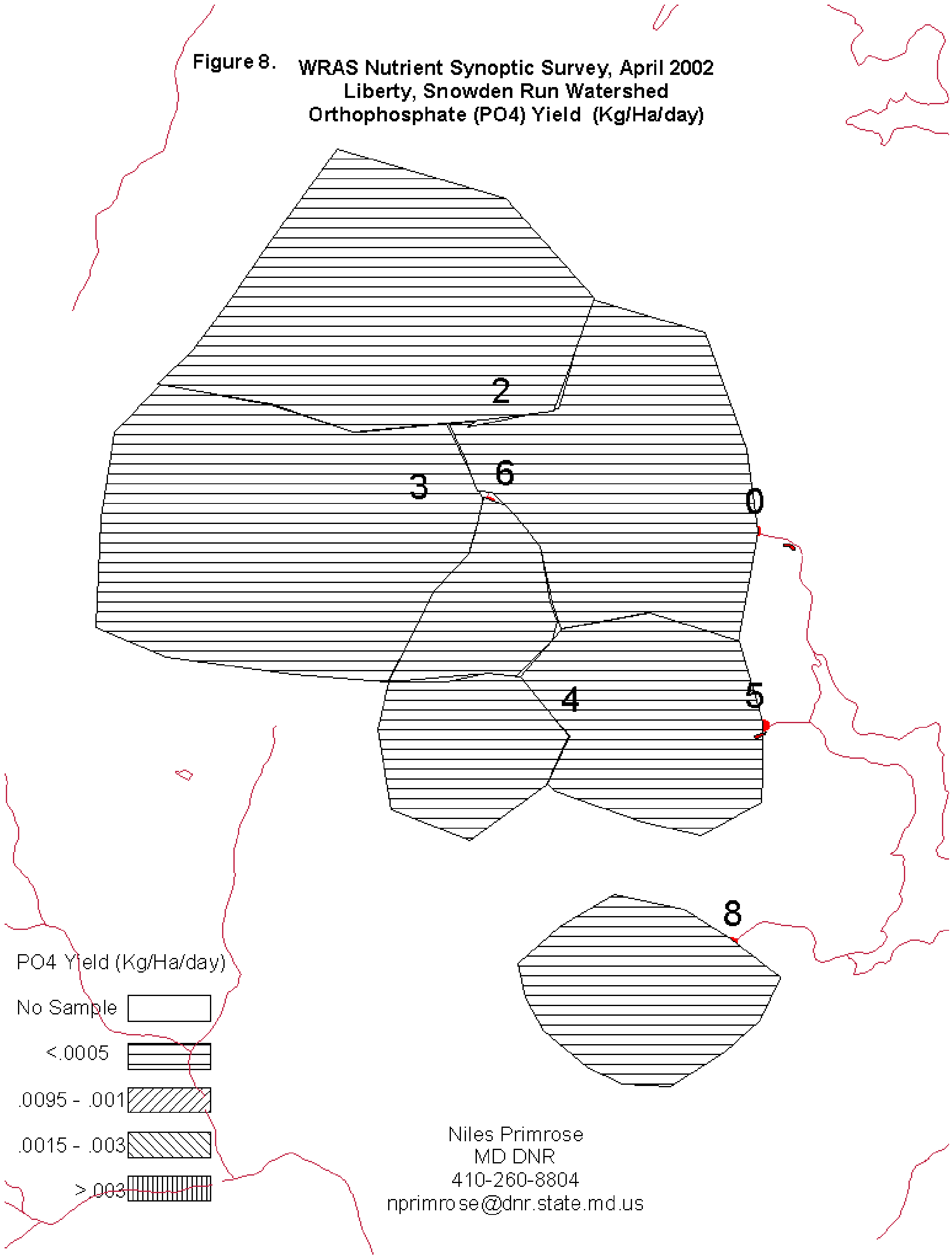
Figure 8.
WRAS Nutrient Synoptic Survey, April 2002
Liberty, Snowden Run Watershed
Orthophosphate (PO4) Yield (Kg/Ha/day)
2
3
6
0
4
5
8
PO4 Yield (Kg/Ha/day)
No Sample
<.0005
.0095 - .001
.0015 - .003
>.003
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The three Benthic samples collected in Snowden Run had some differences in individual metric scores, but all had IBI scores in the “fair” range (Table 4). The Hydrolab readings do not indicate any significant water quality problems at any sampling site (Table 5). Habitat variability could explain some of the minor differences between the various benthic metrics. As noted in Table 4, station 3 had the poorest habitat score. This site was in a recently drained beaver pond, and had considerably less gravel, more sand and poorer riparian vegetation than the other two sites. These factors could have contributed to the lower EPT related metric scores and the higher Diptera related metrics scores at site 3. While storm water damage was evident at all sites, site 3 also had a higher percentage of eroded banks and amount of unstable substrate.

**Table 4. Snowden Run Watershed Benthic IBI Calculations**

| site | # Taxa/ score | # EPT taxa score | #Ephem taxa score | # Diptera taxa score | % Ephem score | % Tanytarsini of total chir score | intol taxa score | % tolrnt taxa score | % collecters score | total score | IBI score/ #metrics | rating | Habitat Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Snowden 0 | 22/3 | 11/3 | 4/3 | 9/3 | 35/5 | 3/3 | 6/3 | 12/3 | 37/5 | 31 | 3.44 | fair | supporting |
| Snowden 2 | 20/3 | 11/3 | 6/5 | 4/1 | 26/5 | 0/1 | 5/3 | 0/5 | 24/3 | 29 | 3.22 | fair | supporting |
| Snowden 3 | 24/5 | 8/3 | 4/3 | 12/5 | 11/3 | 4/3 | 7/3 | 33/3 | 23/3 | 31 | 3.44 | fair | partially |

**Table 5. Snowden Run Insitu Water Quality**

| | | | InSitu Hydrolab Readings | | | |
|---|---|---|---|---|---|---|
| DATE | STATION | TIME | Temp. | pH | Cond. | DO |
| 04/24/02 | Snowden 0 | 820 | 9.51 | 7.72 | 0.178 | 9.54 |
| 04/24/02 | Snowden 02 | 850 | 8.61 | 7.41 | 0.084 | 8.83 |
| 04/24/02 | Snowden 03 | 930 | 10.18 | 7.70 | 0.233 | 9.60 |
| 04/24/02 | Snowden 04 | 810 | 10.54 | 7.02 | 0.273 | 9.03 |
| 04/24/02 | Snowden 05 | 755 | 8.70 | 6.93 | 0.282 | 9.08 |
| 04/24/02 | Snowden 06 | 920 | 10.00 | 6.84 | 0.081 | 9.43 |
| 04/23/02 | Snowden 08 | 800 | 7.81 | 7.22 | 0.343 | 13.48 |

The considerably lower number of sculpins and higher number of bluntnosed minnows found at site 3 is also indicative of these habitat differences (Table 6). The fish communities at all four sites are comparable to MBSS findings in the Carroll County portion of the Patapsco watershed (MD DNR, 1997).

**Table 6. Fish Species and Numbers from Snowden Run**

| Common name | Genus | species | Site 0 | 2 | 3 | 5 |
|---|---|---|---|---|---|---|
| creek chub | *Semotilus* | *atromaculatus* | 1 | 38 | 1 | 2 |
| blacknose dace | *Rhinichthys* | *atratulus* | 5 | 54 | 3 | 66 |
| rosyside dace | *Clinostomus* | *funduloides* | | 12 | | |
| longnose dace | *Rhinichthys* | *cataractae* | 53 | | 6 | 14 |
| bluntnose minnow | *Pimephales* | *notatus* | 7 | 1 | 45 | |
| white sucker | *Catostomus* | *commersoni* | 5 | 6 | 4 | |
| yellow bullhead | *Ameiurus* | *natalis* | 2 | | 1 | |
| mottled sculpin | *Cottus* | *bairdi* | 388 | 121 | 62 | 188 |
| sculpin UNID | *Cottus* | sp. | | | 1 | |
| brook trout | *Salvelinus* | *fontinalis* | | | | 1 |
| smallmouth bass | *Micropterus* | *dolomieu* | | | 2 | |
| largemouth bass | *Micropterus* | *salmoides* | 2 | 4 | 5 | |
| green sunfish | *Lepomis* | *cyanellus* | 3 | 2 | 2 | 17 |
| bluegill | *Lepomis* | *macrochirus* | | 3 | 1 | 5 |
| tessellated darter | *Etheostoma* | *olmstedi* | 30 | 1 | | |
| | | **TOTAL #** | **496** | **242** | **133** | **293** |

## Roaring Run

The entire Roaring Run watershed had elevated nitrate/nitrite concentrations (Table 7). Excessive concentrations were found at site 3, moderate concentrations at site 4, and high concentrations at the other four sites (Figure 9). The excessive concentration of nitrate/nitrite at station 3 translated into an excessive yield as well (Figure 10). Site 1 translated a high concentration into an excessive yield of nitrate/nitrite. The high yields at sites 0 and 6 probably reflect the excessive yields contributed by sites 1 and 3, respectively, rather than being generated from within their mostly wooded drainage areas. Dissolved phosphorus concentrations and yields remained below baseline levels throughout the watershed (Figures 11 & 12).

**Table 7. Roaring Run Nutrient Synoptic Results, April 2002**

| DATE | STATION | Concentration PO4 (mg P/L) | Concentration NO23 (mg N/L) | Discharge (L/s) | Daily Loads PO4 (kg/day) | Daily Loads NO23 (kg/day) | Area Hectares | Nutrient Yields/Hectare PO4 (kg/day/ha) | Nutrient Yields/Hectare NO23 (kg/day/ha) |
|---|---|---|---|---|---|---|---|---|---|
| 04/24/02 | Roaring 0 | 0.002 | 4.06 | 21.8832 | 0.003781 | 7.676277 | 695 | 0.000005 | 0.011045 |
| 04/26/02 | Roaring 01 | 0.002 | 3.59 | 8.031496 | 0.001388 | 2.491177 | 40 | 0.000035 | 0.06218 |
| 04/24/02 | Roaring 03 | 0.003 | 5.81 | 4.652231 | 0.001206 | 2.335346 | 68 | 0.000018 | 0.034147 |
| 04/24/02 | Roaring 04 | 0.001 | 2.42 | 0.907152 | 0.000078 | 0.189675 | 91 | 0.000001 | 0.002074 |
| 04/24/02 | Roaring 05 | 0.004 | 3.03 | 0.085302 | 0.000029 | 0.022331 | 21 | 0.000001 | 0.001041 |
| 04/26/02 | Roaring 06 | 0.001 | 4.87 | 10.51919 | 0.000909 | 4.42614 | 293 | 0.000003 | 0.015065 |

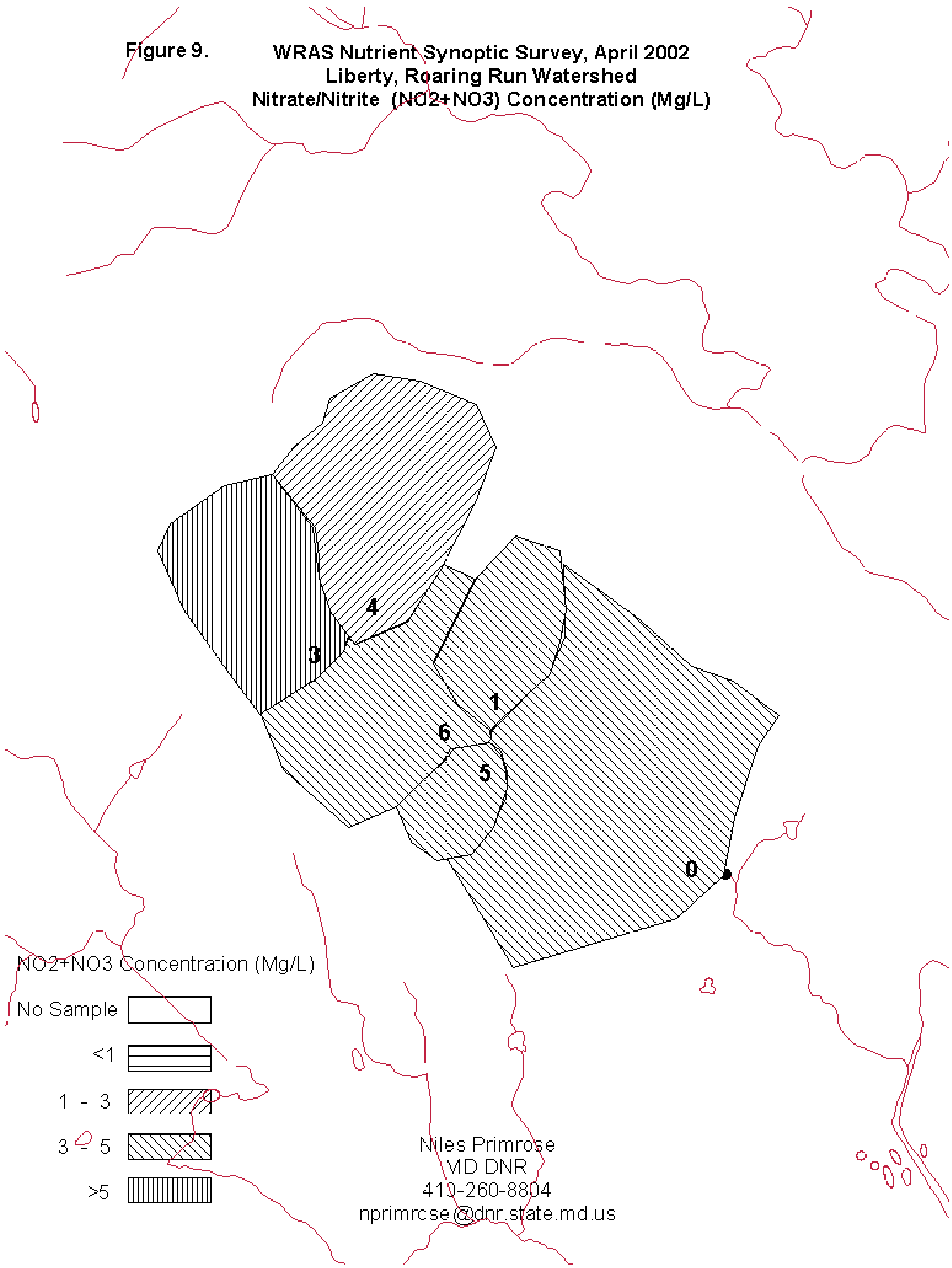


Figure 9.
WRAS Nutrient Synoptic Survey, April 2002
Liberty, Roaring Run Watershed
Nitrate/Nitrite (NO2+NO3) Concentration (Mg/L)
4
3
1
6
5
0
NO2+NO3 Concentration (Mg/L)
No Sample
<1
1 - 3
3 - 5
>5
Niles Primrose
MD DNR
410-260-8804
nprimrose@dnr.state.md.us

Figure 10. WRAS Nutrient Synoptic Survey, April 2002
Liberty, Roaring Run Watershed
Nitrate/Nitrite (NO2+NO3) Yield (Kg/Ha/day)

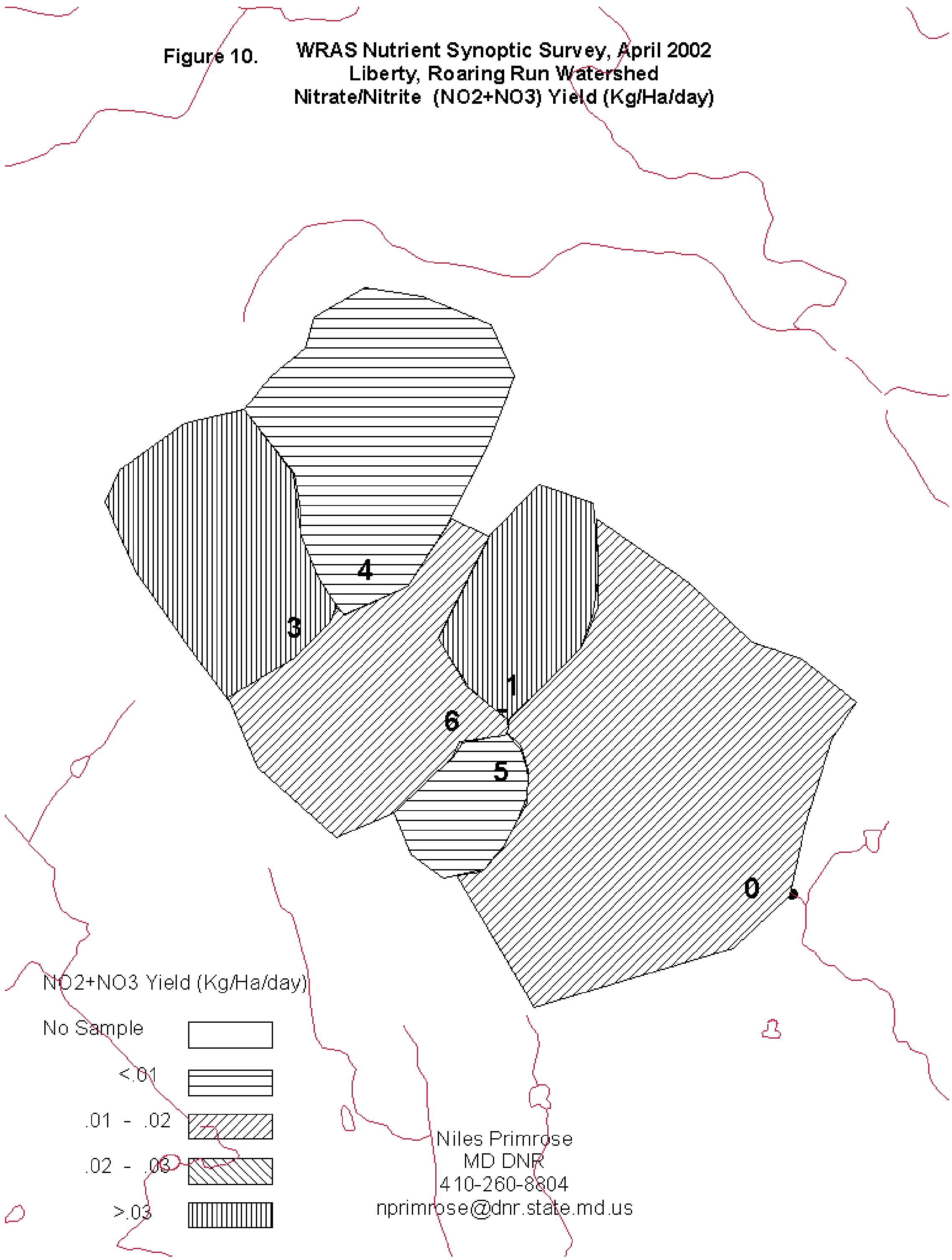
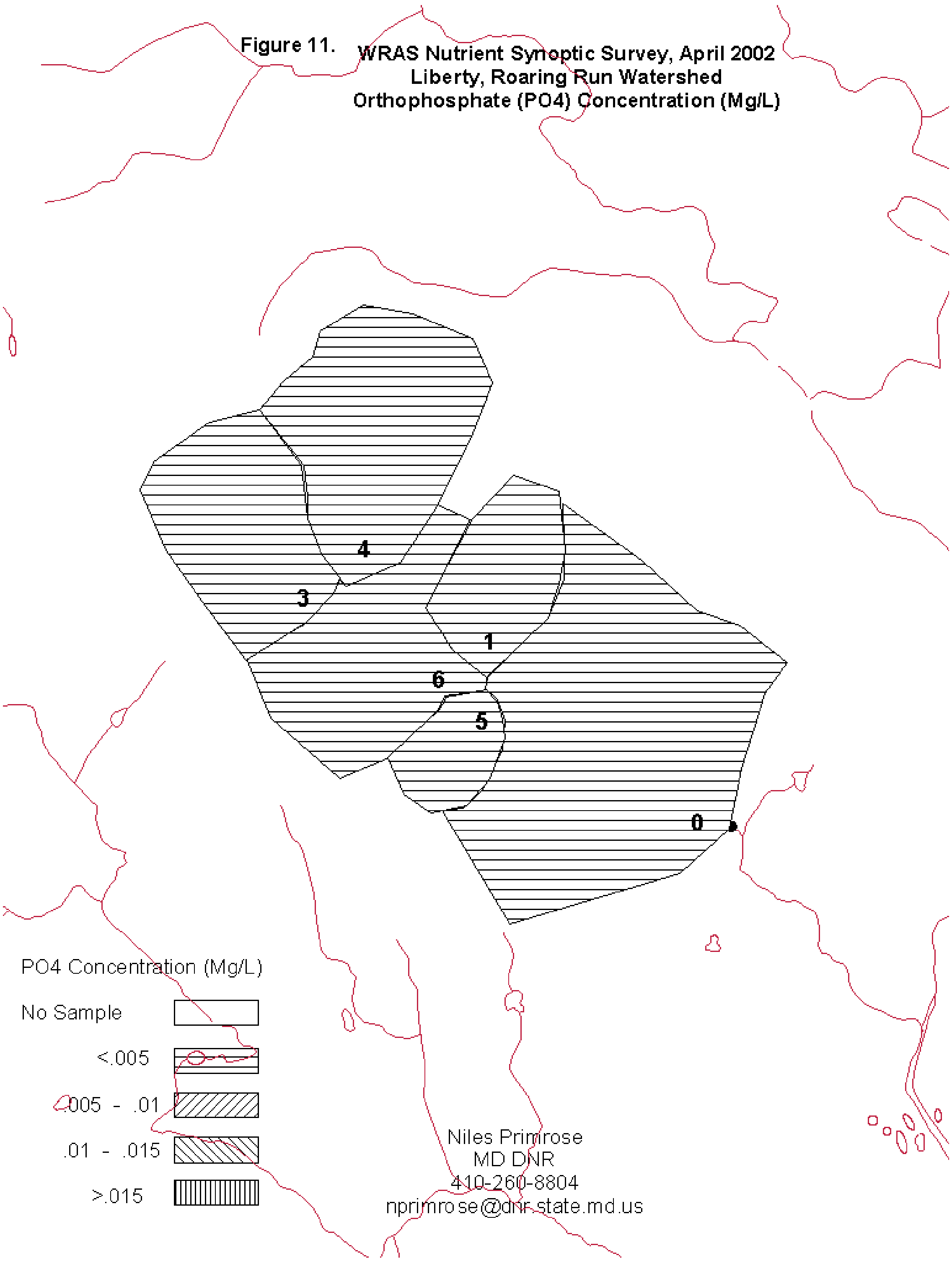


Figure 11. WRAS Nutrient Synoptic Survey, April 2002
Liberty, Roaring Run Watershed
Orthophosphate (PO4) Concentration (Mg/L)



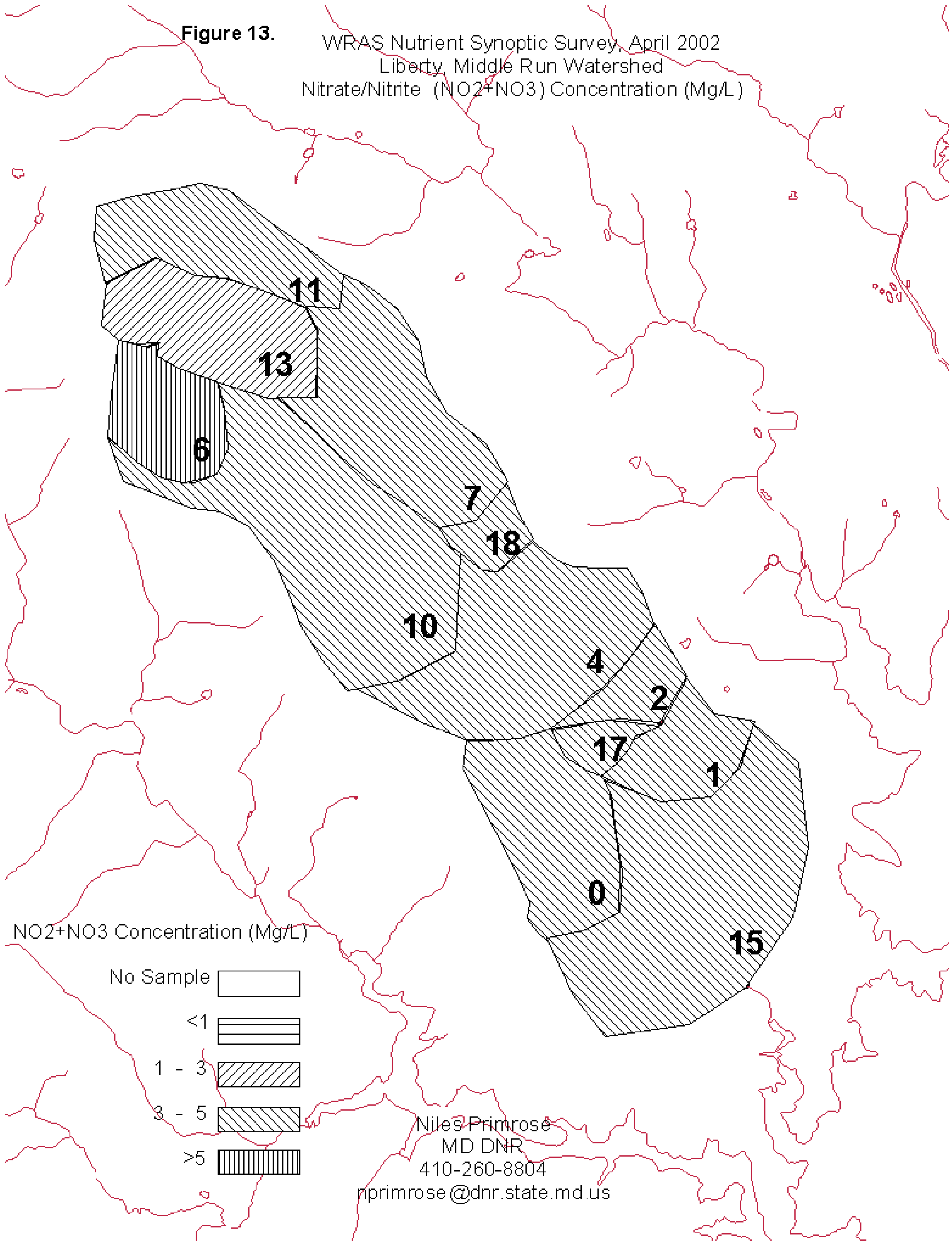


Figure 13.
WRAS Nutrient Synoptic Survey, April 2002
Liberty, Middle Run Watershed
Nitrate/Nitrite (NO2+NO3) Concentration (Mg/L)
11
13
6
7
18
10
4
2
17
1
0
15
NO2+NO3 Concentration (Mg/L)
No Sample
<1
1 - 3
3 - 5
>5
Niles Primrose
MD DNR
410-260-8804
nprimrose@dnr.state.md.us

crossing immediately upstream. Site 5 had an elevated conductivity reading that could be due to run off from Rt. 140 or seepage from septic tanks/sewer lines.

**Table 8. Roaring Run Insitu Water Quality**

| | | | InSitu Hydrolab Readings | | | |
|---|---|---|---|---|---|---|
| DATE | STATION | TIME | Temp. | pH | Cond. | DO |
| 04/24/02 | Roaring 0 | 1520 | 14.35 | 8.30 | 0.218 | 8.60 |
| 04/26/02 | Roaring 01 | 1237 | 15.03 | 7.58 | 0.163 | 8.01 |
| 04/24/02 | Roaring 03 | 1320 | 14.39 | 7.28 | 0.260 | 8.51 |
| 04/24/02 | Roaring 04 | 1325 | 15.51 | 7.35 | 0.045 | 7.58 |
| 04/24/02 | Roaring 05 | 1245 | 12.74 | 7.60 | 0.477 | 8.39 |
| 04/26/02 | Roaring 06 | 1230 | 13.35 | 7.15 | 0.272 | 8.27 |

### Middle Run

Nutrient concentrations, and in some cases yields, were elevated throughout the Middle Run watershed (Table 8). Nitrate/nitrite concentrations were excessive at site 6, moderate at site 13, and high at all of the remaining sites (Figure 13). These concentrations translated to excessive yields at site 6, high yields at sites 0 and 10, below baseline at 13 and 17, and moderate yields at the remainder, including at the outlet site 15 (Figure 14). The presence of significant numbers of livestock with access to the streams, coupled with a dry spring could be part of the cause for these elevated concentrations and yields. Orthophosphate concentrations were high at sites 10 and 11, moderate at sites 4, 7, and 18, and baseline at the remainder (Figure 15). The presence of livestock in the streams creating sediment plumes could be part of the cause for elevated orthophosphorus concentrations. All orthophosphorus yields were below baseline (Figure 16).

**Table 9. Middle Run Nutrient Synoptic Results, April 2002**

| DATE | STATION | Concentration PO4 (mg P/L) | Concentration NO23 (mg N/L) | Discharge (L/s) | Daily Loads PO4 (kg/day) | Daily Loads NO23 (kg/day) | Area Hectares | Nutrient Yields/Hectare PO4 (kg/day/ha) | Nutrient Yields/Hectare NO23 (kg/day/ha) |
|---|---|---|---|---|---|---|---|---|---|
| 04/23/02 | Middle Run 0 | 0.004 | 4.4 | 10.40 | 0.003595 | 3.955011 | 195 | 0.000018 | 0.020276 |
| 04/23/02 | Middle Run 01 | 0.004 | 3.4 | 78.17 | 0.027014 | 22.96205 | 1435 | 0.000019 | 0.016006 |
| 04/23/02 | Middle Run 02 | 0.004 | 3.56 | 67.15 | 0.023207 | 20.65445 | 1316 | 0.000018 | 0.015699 |
| 04/23/02 | Middle Run 04 | 0.006 | 3.63 | 62.45 | 0.032374 | 19.58657 | 1264 | 0.000026 | 0.015493 |
| 04/23/02 | Middle Run 06 | 0.001 | 5.78 | 8.64 | 0.000747 | 4.315612 | 109 | 0.000007 | 0.039643 |
| 04/23/02 | Middle Run 07 | 0.006 | 3.43 | 23.03 | 0.01194 | 6.82543 | 560 | 0.000021 | 0.012178 |
| 04/23/02 | Middle Run 10 | 0.012 | 4.69 | 19.14 | 0.019848 | 7.757334 | 385 | 0.000052 | 0.020135 |
| 04/23/02 | Middle Run 11 | 0.011 | 4.47 | 6.40 | 0.00608 | 2.470819 | 155 | 0.000039 | 0.015941 |
| 04/23/02 | Middle Run 13 | 0.002 | 2.95 | 5.36 | 0.000926 | 1.365548 | 169 | 0.000005 | 0.008092 |
| 04/23/02 | Middle Run 15 | 0.003 | 3.05 | 103.13 | 0.026732 | 27.17766 | 2187 | 0.000012 | 0.012427 |
| 04/23/02 | Middle Run 17 | 0.003 | 3.72 | 0.31 | 7.99E-05 | 0.099122 | 42 | 0.000002 | 0.002333 |
| 04/23/02 | Middle Run 18 | 0.007 | 3.46 | 39.07 | 0.023632 | 11.68118 | 596 | 0.000040 | 0.019596 |

Benthic macroinvertebrate samples were collected at 10 sites within the Middle Run watershed. The site locations are noted on Figure 3. Only one site, 1874, was rated as "poor" due to a predominance of chironomids (*Diptera*) (Table 9). The habitat at this site was noted as being "supporting", thus a water quality problem is suspected. Sites 1872, 1304, 1873, 18, 1317 where rated "fair", and sites 1A, 15, 7, and 10 where rated "good". Habitat at these sites was rated as supporting, or partially supporting. Bank erosion was a major problem in the watershed beginning upstream of Bird View Rd. and moving downstream to the reservoir.

Fish were collected at four upstream sites (Table 10). Two downstream sites (1,7) could not be sampled because of continual water clarity problems due to suspended sediment from upstream livestock activities. Sites 1872 and 1873 were very small headwater streams. Site 1873 was in a pasture area with only grass in the riparian zone, and livestock access to the stream. Site 1872 was in heavy mature woodland with no development within 500 feet of the site. The other two sites were mostly shallow riffle habitat that is generally unsuitable for the sunfish, bass, and white sucker community. Additionally, there is a significant fish blockage at the culvert under Rt. 91 that could be impacting the upstream community.

**Table 10. Middle Run Watershed Benthic IBI Calculations**

| site | # Taxa/ score | # EPT taxa score | #Ephem taxa score | # Diptera taxa score | % Ephem score | % Tanytarsini of total chir score | intol taxa score | % tolrnt taxa score | % collecters score | total score | IBI score/ #metrics | rating | Habitat Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Middle Run 1A | 23/5 | 11/3 | 6/5 | 8/3 | 49/5 | 1/3 | 9/5 | 8/5 | 36/5 | 39 | 4.33 | good | supporting |
| Middle Run 1874 | 21/3 | 6/3 | 2/3 | 9/3 | 12/3 | 0/1 | 4/3 | 20/3 | 17/3 | 25 | 2.78 | poor | supporting |
| Middle Run 15 | 27/5 | 13/5 | 6/5 | 12/5 | 14/3 | 10/5 | 6/3 | 15/3 | 40/5 | 39 | 4.33 | good | supporting |
| Middle Run 1872 | 22/5 | 6/3 | 1/1 | 12/5 | 38/5 | 2/3 | 7/3 | 16/3 | 14/3 | 31 | 3.44 | fair | supporting |
| Middle Run 1304 | 19/3 | 9/3 | 4/3 | 5/3 | 66/5 | 9/5 | 8/3 | 2/5 | 52/5 | 35 | 3.89 | fair | supporting |
| Middle Run 1873 | 24/5 | 6/3 | 3/3 | 11/5 | 9/3 | 3/3 | 5/3 | 28/3 | 41/5 | 33 | 3.67 | fair | partially |
| Middle Run 7 | 24/5 | 10/3 | 4/3 | 10/5 | 18/3 | 7/5 | 5/3 | 7/5 | 42/5 | 37 | 4.11 | good | partially |
| Middle Run 1B | 24/5 | 8/3 | 4/3 | 12/5 | 30/5 | 2/3 | 4/3 | 13/3 | 33/5 | 35 | 3.89 | fair | supporting |
| Middle Run 10 | 23/5 | 8/3 | 5/5 | 12/5 | 34/5 | 2/3 | 4/3 | 9/5 | 31/5 | 39 | 4.33 | good | supporting |
| Middle Run 1317 | 28/5 | 10/3 | 4/3 | 13/5 | 17/3 | 10/5 | 7/3 | 16/3 | 24/3 | 33 | 3.67 | fair | supporting |

**Table11. Fish Species and Numbers from Middle Run**

| | | | Site | | | |
|---|---|---|---|---|---|---|
| **Common name** | **Genus** | **species** | **13** | **1873** | **1872** | **1317** |
| creek chub | *Semotilus* | *atromaculatus* | 8 | 3 | 2 | 5 |
| blacknose dace | *Rhinichthys* | *atratulus* | 43 | 2 | 58 | 74 |
| rosyside dace | *Clinostomus* | *funduloides* | | | | 2 |
| longnose dace | *Rhinichthys* | *cataractae* | 1 | | | 16 |
| mottled sculpin | *Cottus* | *bairdi* | 80 | | 11 | 187 |
| bluegill | *Lepomis* | *macrochirus* | 2 | | | |
| | | **Total #** | **134** | **5** | **71** | **284** |

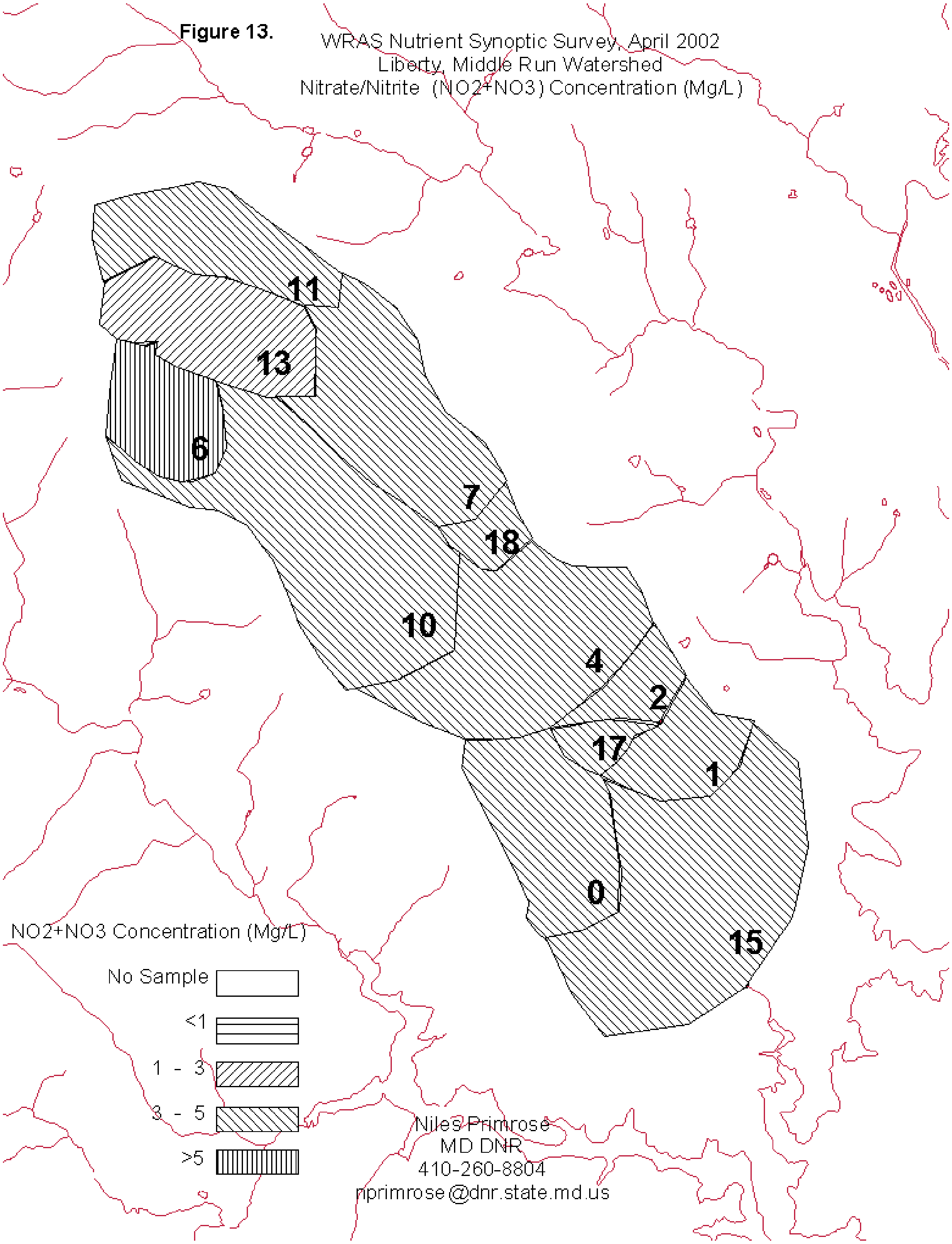


Figure 13.
WRAS Nutrient Synoptic Survey, April 2002
Liberty, Middle Run Watershed
Nitrate/Nitrite (NO2+NO3) Concentration (Mg/L)
11
13
6
7
18
10
4
2
17
1
0
15
NO2+NO3 Concentration (Mg/L)
No Sample
<1
1 - 3
3 - 5
>5
Niles Primrose
MD DNR
410-260-8804
nprimrose@dnr.state.md.us

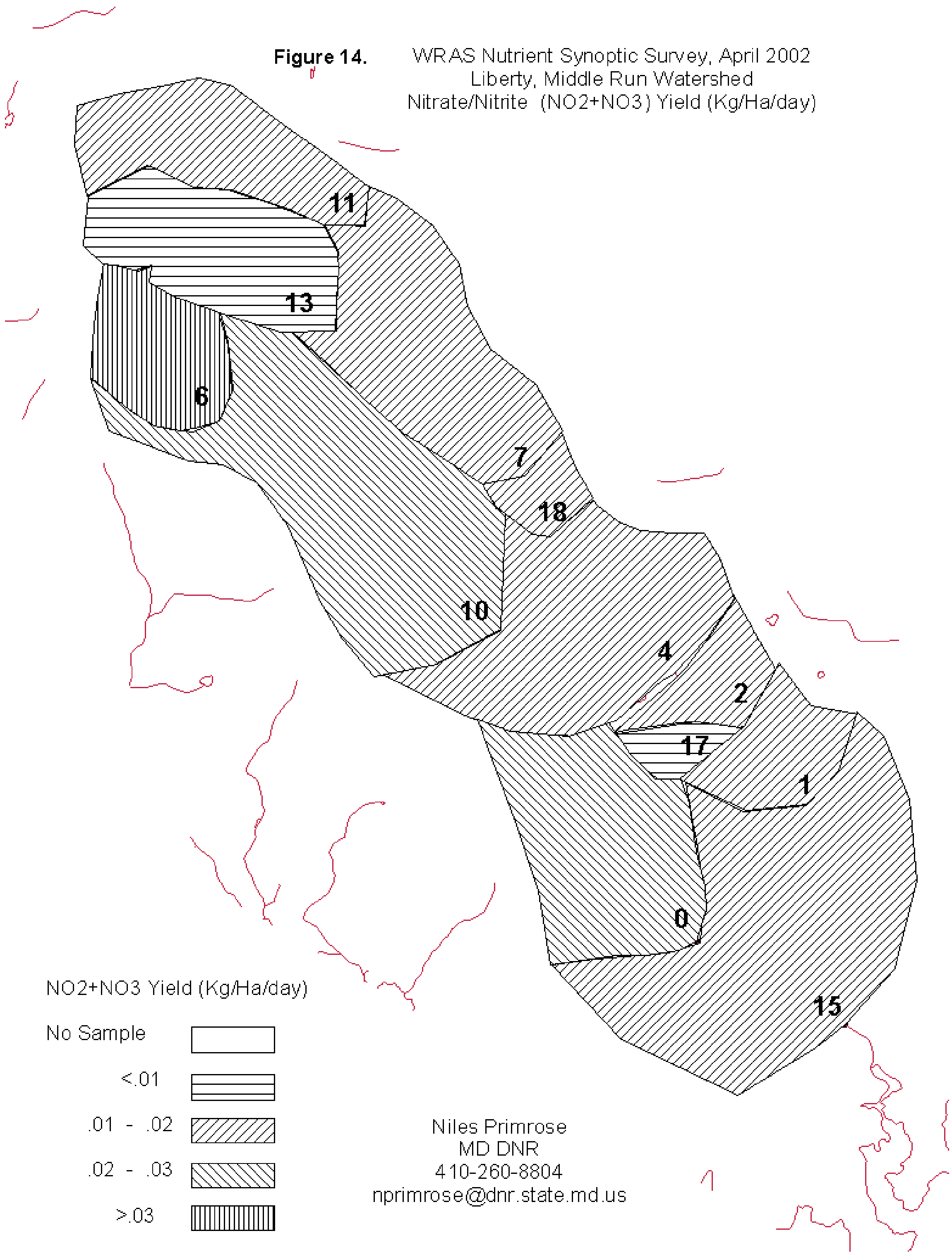
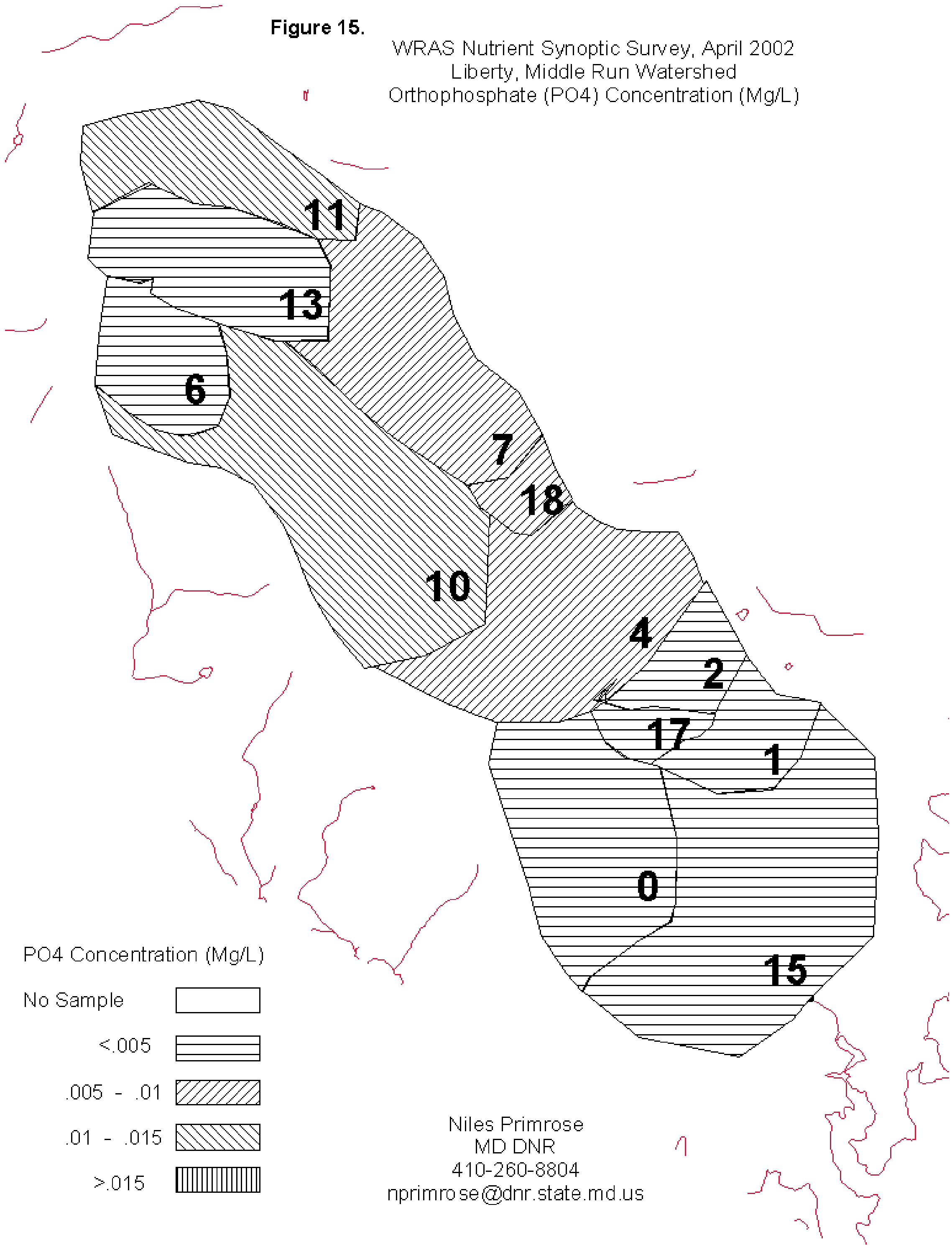
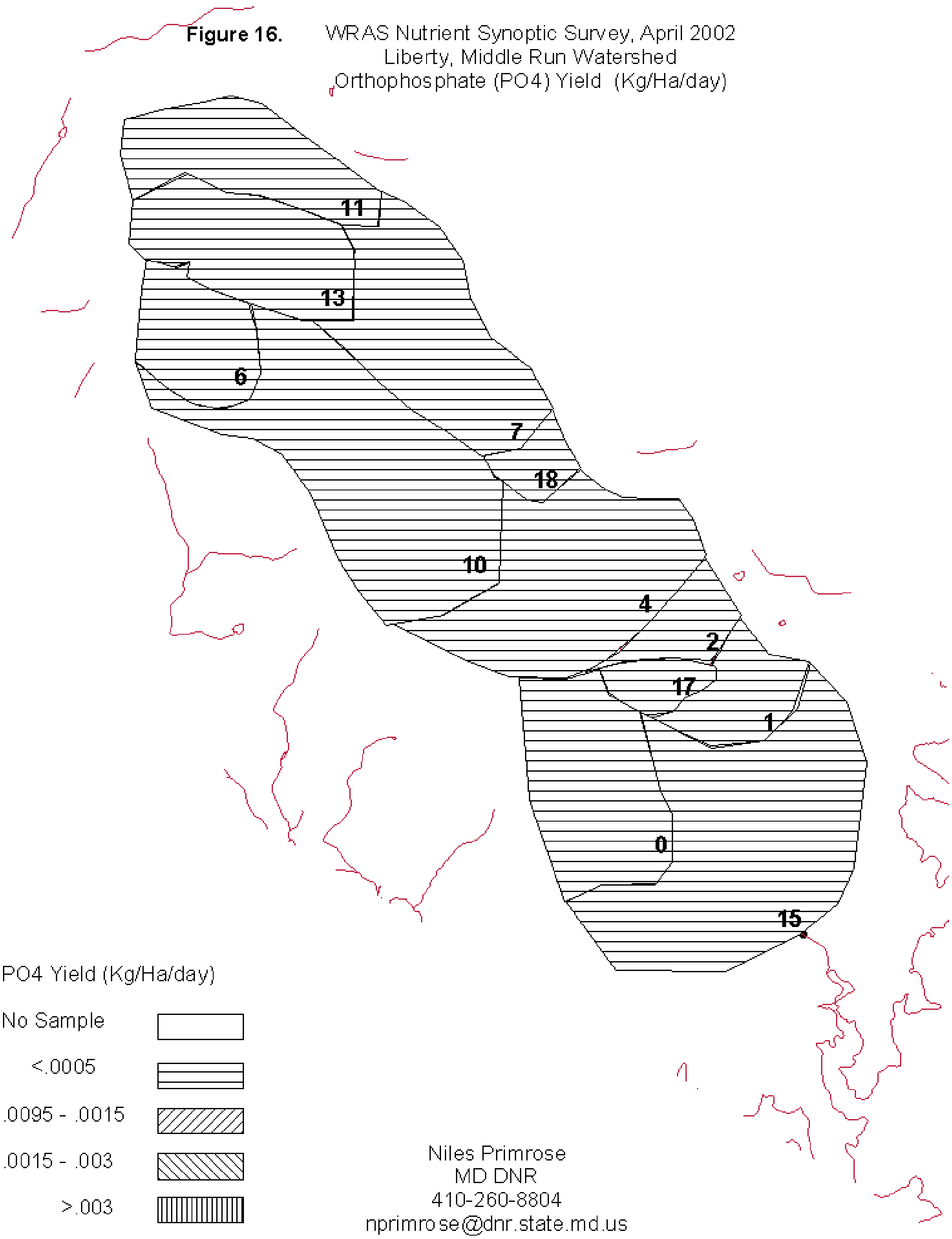


Figure 14.
WRAS Nutrient Synoptic Survey, April 2002
Liberty, Middle Run Watershed
Nitrate/Nitrite (NO2+NO3) Yield (Kg/Ha/day)
11
13
6
7
18
10
4
2
17
1
0
15
NO2+NO3 Yield (Kg/Ha/day)
No Sample
<.01
.01 - .02
.02 - .03
>.03
Niles Primrose
MD DNR
410-260-8804
nprimrose@dnr.state.md.us

Figure 15.
WRAS Nutrient Synoptic Survey, April 2002
Liberty, Middle Run Watershed
Orthophosphate (PO4) Concentration (Mg/L)






No unusual readings were found in insitu Hydrolab readings within the Middle Run watershed (Table 12).

**Table 12. Middle Run Insitu Water Quality**

| | | | InSitu Hydrolab Readings | | | |
|---|---|---|---|---|---|---|
| DATE | STATION | TIME | Temp. | pH | Cond. | DO |
| 04/23/02 | Middle Run 0 | 930 | 9.01 | 7.30 | 0.171 | 13.52 |
| 04/23/02 | Middle Run 01 | 1000 | 10.06 | 7.16 | 0.154 | 13.43 |
| 04/23/02 | Middle Run 02 | 1100 | 9.90 | 7.33 | 0.155 | 13.63 |
| 04/23/02 | Middle Run 04 | 1530 | 15.06 | 7.11 | 0.146 | 11.93 |
| 04/23/02 | Middle Run 06 | 1150 | 11.45 | 6.97 | 0.207 | 13.00 |
| 04/23/02 | Middle Run 07 | 1430 | 14.80 | 6.87 | 0.117 | 11.08 |
| 04/23/02 | Middle Run 10 | 1505 | 14.08 | 6.99 | 0.164 | 12.49 |
| 04/23/02 | Middle Run 11 | 1235 | 12.49 | 7.05 | 0.127 | 11.74 |
| 04/23/02 | Middle Run 13 | 1300 | 14.40 | 6.88 | 0.094 | 10.00 |
| 04/24/02 | Middle Run 1317 | 1145 | 12.47 | 7.33 | 0.114 | 8.15 |
| 04/23/02 | Middle Run 15 | 850 | 9.08 | 7.74 | 0.145 | 13.40 |
| 04/23/02 | Middle Run 17 | 1110 | 9.29 | 7.39 | 0.137 | 13.26 |
| 04/23/02 | Middle Run 18 | 1450 | 14.03 | 7.04 | 0.124 | 11.75 |
| 04/24/02 | Middle Run 1872 | 1040 | 12.71 | 6.72 | 0.148 | 6.22 |

### Western Branch

A total of sixteen sites were sampled for nutrients in the Western Branch watershed. Nitrate/nitrite concentrations ranged from moderate to excessive (Table 13, Figure 17). The subwatersheds with excessive concentrations were the headwaters of Western Branch or small tributaries. These excessive and high concentrations were diluted to moderately elevated levels by the time they reached the watershed outlet at site 17. Nitrate/nitrite yields followed a similar pattern, with the highest in the upper watershed and only moderately elevated yields at the outlet (Figure 18.). Two of the subwatersheds with excessive nitrate/nitrite concentration, also had excessive (13) or high (10) orthophosphate concentrations. All other watersheds had baseline concentrations (Figure 19). Orthophosphate yields were baseline at all sites including the watershed outlet (Figure 20).

Insitu Hydrolab readings from the Western Branch sites are shown in Table 14. The high conductivity readings from some of the upper watershed tributaries may be related to limestone in the watershed. The higher pH levels at the lower end of the watershed are probably related to the wide shallow nature of the streams, elevated temperatures, and abundant diatom/algal growth.

**Table 13. West Branch Nutrient Synoptic Results, April 2002**

| DATE | STATION | Concentration PO4 (mg P/L) | Concentration NO23 (mg N/L) | Discharge (L/s) | Daily Loads PO4 (kg/day) | Daily Loads NO23 (kg/day) | Area Hectares | Nutrient Yields/Hectare PO4 (kg/day/ha) | Nutrient Yields/Hectare NO23 (kg/day/ha) |
|---|---|---|---|---|---|---|---|---|---|
| 04/26/02 | Western Br. 0 | 0.002 | 6.12 | 23.94 | 0.004136 | 12.656256 | 517 | 0.000008 | 0.024480 |
| 04/26/02 | Western Br. 02 | 0.001 | 3.37 | 3.18 | 0.000275 | 0.925662 | 202 | 0.000001 | 0.004575 |
| 04/26/02 | Western Br. 03 | 0.001 | 1.65 | 2.23 | 0.000192 | 0.317580 | 840 | 0.000000 | 0.000378 |
| 04/26/02 | Western Br. 04 | 0.001 | 2.17 | 17.08 | 0.001475 | 3.201690 | 1752 | 0.000001 | 0.001827 |
| 04/26/02 | Western Br. 05 | 0.001 | 3.82 | 7.37 | 0.000637 | 2.433671 | 237 | 0.000003 | 0.010280 |
| 04/26/02 | Western Br. 06 | 0.001 | 2.8 | 6.51 | 0.000562 | 1.573909 | 261 | 0.000002 | 0.006020 |
| 04/26/02 | Western Br. 07 | 0.001 | 2.46 | 17.27 | 0.001492 | 3.671405 | 2276 | 0.000001 | 0.001613 |
| 04/26/02 | Western Br. 10 | 0.014 | 5.11 | 5.96 | 0.007207 | 2.630483 | 139 | 0.000052 | 0.018896 |
| 04/26/02 | Western Br. 11 | 0.001 | 2.16 | 71.49 | 0.006177 | 13.341657 | 3337 | 0.000002 | 0.003998 |
| 04/26/02 | Western Br. 12 | 0.002 | 2.38 | 9.50 | 0.001642 | 1.954449 | 243 | 0.000007 | 0.008036 |
| 04/24/02 | Western Br. 13 | 0.047 | 5.46 | 3.92 | 0.015934 | 1.851069 | 225 | 0.000071 | 0.008212 |
| 04/24/02 | Western Br. 14 | 0.002 | 2.2 | 114.57 | 0.019797 | 21.776882 | 4066 | 0.000005 | 0.005356 |
| 04/24/02 | Western Br. 15 | 0.002 | 3.37 | 250.87 | 0.043350 | 73.045148 | 5564 | 0.000008 | 0.013127 |
| 04/26/02 | Western Br. 16 | 0.006 | 4.26 | 65.03 | 0.033710 | 23.933820 | 1746 | 0.000019 | 0.013706 |
| 04/24/02 | Western Br. 17 | 0.002 | 2.96 | 438.21 | 0.075723 | 112.070494 | 9781 | 0.000008 | 0.011458 |
| 04/26/02 | Western Br. 22 | 0.002 | 3.59 | 10.53 | 0.001820 | 3.266617 | 376 | 0.000005 | 0.008680 |

**Table 14. West Branch Insitu Water Quality**

| DATE | STATION | TIME | InSitu Hydrolab Readings Temp. | pH | Cond. | DO |
|---|---|---|---|---|---|---|
| 04/26/02 | Western Br. 0 | 900 | 7.91 | 6.83 | 0.257 | 12.60 |
| 04/26/02 | Western Br. 02 | 930 | 8.17 | 7.06 | 0.409 | 13.52 |
| 04/26/02 | Western Br. 03 | 945 | 9.73 | 7.40 | 0.353 | 11.85 |
| 04/26/02 | Western Br. 04 | 1000 | 10.34 | 7.66 | 0.342 | 12.47 |
| 04/26/02 | Western Br. 05 | 1005 | 9.32 | 7.60 | 0.198 | 13.36 |
| 04/26/02 | Western Br. 06 | 1030 | 10.29 | 7.61 | 0.372 | 12.52 |
| 04/26/02 | Western Br. 07 | 1045 | 11.75 | 7.91 | 0.266 | 14.92 |
| 04/26/02 | Western Br. 10 | 1115 | 11.06 | 7.63 | 0.156 | 12.18 |
| 04/26/02 | Western Br. 11 | 1100 | 11.75 | 7.91 | 0.266 | 14.92 |
| 04/26/02 | Western Br. 12 | 1130 | 9.94 | 7.42 | 0.193 | 13.43 |
| 04/24/02 | Western Br. 13 | 1350 | 13.10 | 7.37 | 0.165 | 8.25 |
| 04/24/02 | Western Br. 14 | 1405 | 17.36 | 8.80 | 0.195 | 8.63 |
| 04/24/02 | Western Br. 15 | 1415 | 15.98 | 8.56 | 0.173 | 8.54 |
| 04/26/02 | Western Br. 16 | 1145 | 10.92 | 7.45 | 0.184 | 12.18 |
| 04/24/02 | Western Br. 17 | 1435 | 15.80 | 8.67 | 0.194 | 8.32 |
| 04/26/02 | Western Br. 22 | 1245 | 14.57 | 7.30 | 0.162 | 11.78 |

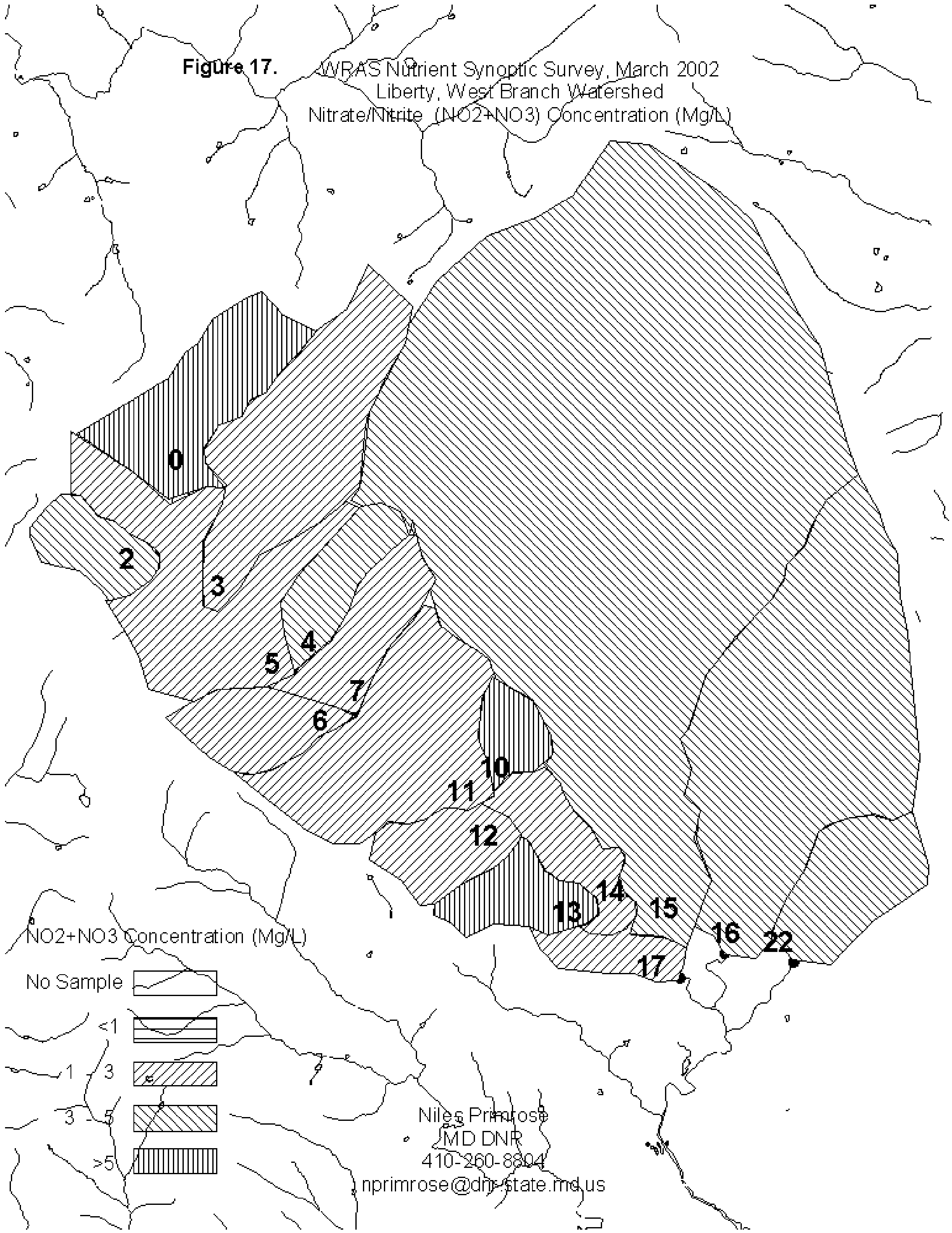
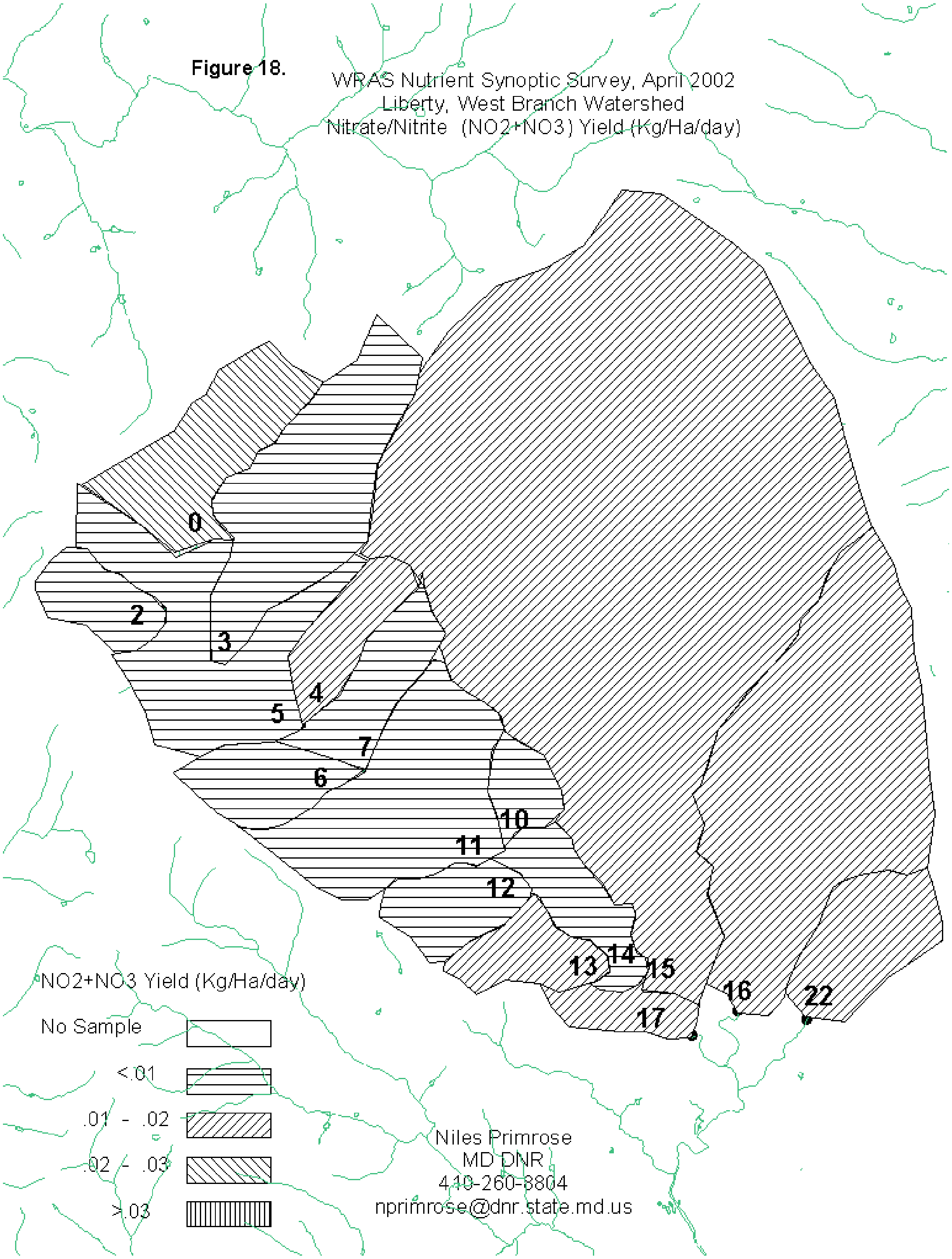


Figure 17.
WRAS Nutrient Synoptic Survey, March 2002
Liberty, West Branch Watershed
Nitrate/Nitrite (NO2+NO3) Concentration (Mg/L)
0
2
3
4
5
6
7
10
11
12
13
14
15
16
17
22
NO2+NO3 Concentration (Mg/L)
No Sample
<1
1 - 3
3 - 5
>5
Niles Primrose
MD DNR
410-260-8804
nprimrose@dnr.state.md.us

**Figure 18.**


WRAS Nutrient Synoptic Survey, April 2002
Liberty, West Branch Watershed
Nitrate/Nitrite (NO2+NO3) Yield (Kg/Ha/day)
0
2
3
4
5
7
6
10
11
12
13
14
15
16
22
17
NO2+NO3 Yield (Kg/Ha/day)
No Sample
<.01
.01 - .02
.02 - .03
>.03
Niles Primrose
MD DNR
410-260-8804
nprimrose@dnr.state.md.us

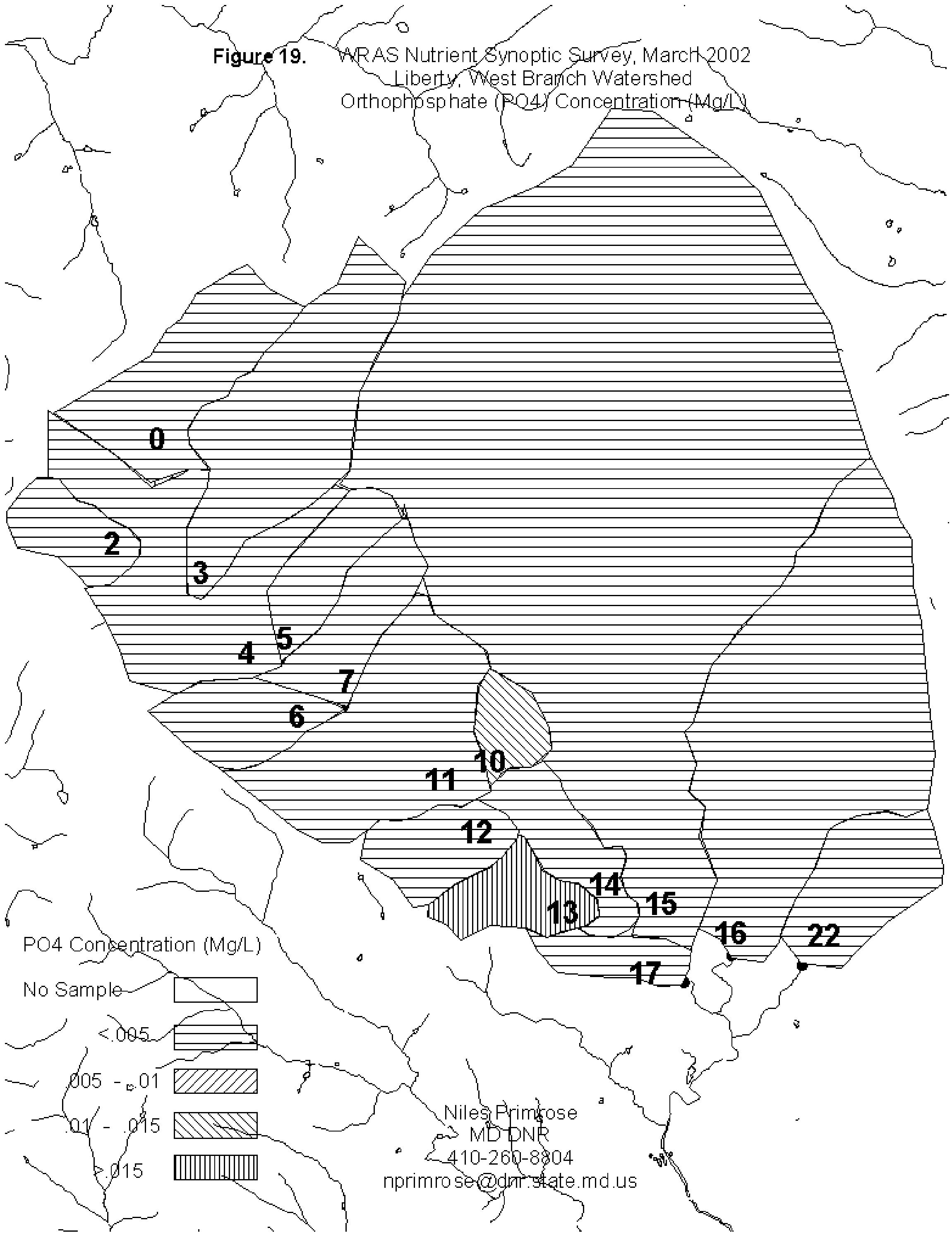


Figure 19. WRAS Nutrient Synoptic Survey, March 2002
Liberty, West Branch Watershed
Orthophosphate (PO4) Concentration (Mg/L)
0
2
3
4
5
6
7
10
11
12
13
14
15
16
17
22
PO4 Concentration (Mg/L)
No Sample
<.005
.005 - .01
.01 - .015
>.015
Niles Primrose
MD DNR
410-260-8804
nprimrose@dnr.state.md.us

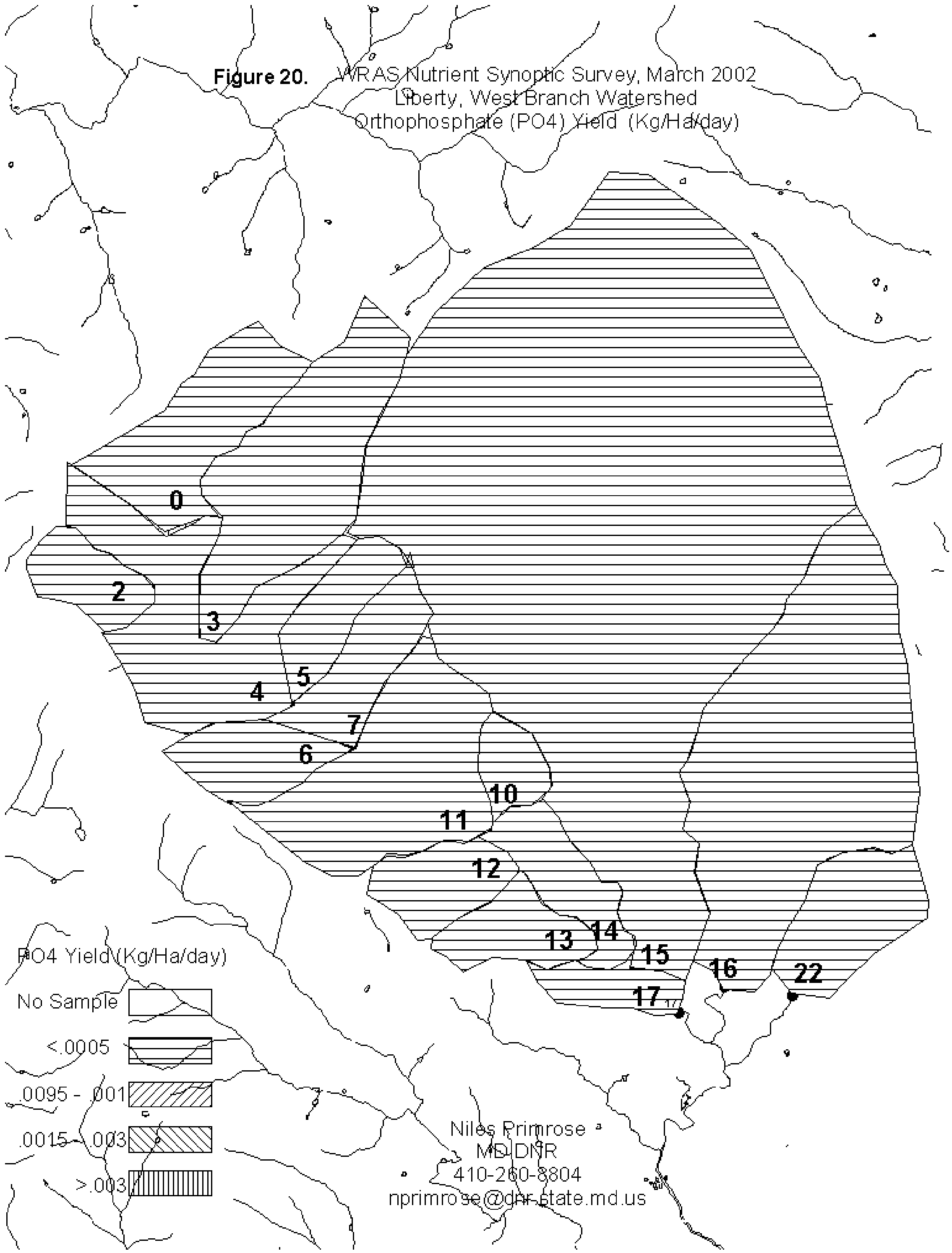


Figure 20. WRAS Nutrient Synoptic Survey, March 2002
Liberty, West Branch Watershed
Orthophosphate (PO4) Yield (Kg/Ha/day)
0
2
3
4
5
6
7
10
11
12
13
14
15
16
17
22
PO4 Yield (Kg/Ha/day)
No Sample
<.0005
.0095 - .001
.0015 - .003
>.003
Niles Primrose
MD DNR
410-260-8804
nprimrose@dnr.state.md.us

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