Report on Nutrient Synoptic Surveys in the Chincoteague Bay Watershed, Worcester County, Maryland, March 2004 as part of a Watershed Restoration Action Strategy.

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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.

Cover photo: Payne Ditch at Steel Pond Rd. by Niles Primrose

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Executive Summary

A nutrient synoptic survey was conducted during March, 2004 in the Chincoteague Bay watershed as part of the Chincoteague Bay WRAS. Samples were analyzed from thirty-six sites throughout the watershed. Nitrate/nitrite concentrations were found to be excessive in five subwatersheds, high in eight, moderately elevated in nine others, and baseline in the remaining fourteen subwatersheds. Instantaneous nitrate/nitrite yields were found to be excessive in five subwatersheds, moderate in seven, and baseline in the remaining twenty-four. Excessive concentrations of orthophosphate were found in eleven subwatersheds, high concentrations in eight, moderate concentrations in eight, and the remaining seven below baseline. Orthophosphate yields were found to be moderate in two subwatershed, and baseline in the remaining thirty-four. The majority of the excessive nitrate/nitrite concentrations and/or yields appear to be associated with animal and row crop agriculture in the Stockton and Greenbackville areas. The elevated orthophosphate concentrations were scattered throughout the watershed and appear to be associated with phosphorus rich soils in systems that had fine suspended sediment loads lingering in the water column. Only two of the sampled subwatershed in the Chincoteague Bay watershed had moderately elevated orthophosphate yields. All others were below baseline. No significant anomalies were found in the insitu measurements of dissolved oxygen, or temperature. Six subwatersheds clustered in the center of the watershed had low specific conductivity (<100 mmohs/cm). Two subwatersheds in this drainage had relatively high conductivity (>300 mmohs/cm) indicative of streams with possible organic enrichment. Depressed ph values (<6.5) followed the low conductivity indicative of streams susceptible to acid deposition degradation.

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Introduction

A nutrient synoptic survey was conducted during March, 2004 in the Chincoteague Bay watershed as part of the Chincoteague Bay Watershed Restoration Action Strategy.

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 (Table 1) 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 benchmark, 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.

Table 1. Nutrient Ranges and Rating

Rating	NO2+NO3 Concentration mg/L	NO2+NO3 Yield Kg/ha/day	PO4 Concentration mg/L	PO4 Yield Kg/ha/day
Baseline	<1	<.01	<.005	<.0005
Moderate	1 to 3	.01 to .02	.005 to .01	.0005 to .001
High	3 to 5	.02 to .03	.01 to .015	.001 to .002
Excessive	>5	>.03	>.015	>.002

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.

METHODS

Water Chemistry Sampling

Synoptic water chemistry samples were collected in early spring throughout the watershed. Sampling was halted for a minimum of 24 hours after rainfall events totaling more than .25 inches. 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 selected sites at the time of 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.

RESULTS

A nutrient synoptic survey was conducted during March, 2004 in the Chincoteague Bay watershed as part of the Chincoteague Bay WRAS. Samples were analyzed from 36 sites throughout the watershed. Sampling site locations are noted in Table 2 and mapped with subwatersheds in Figure 1. Dissolved nutrient concentrations and yields from all sites are noted in Table 3.

. Instantaneous nitrate/nitrite yields were found to be excessive in five subwatersheds, moderate in seven, and baseline in the remaining twenty-four (Figure 2). Instantaneous nitrate/nitrite yields were found to be excessive in five subwatersheds, moderate in seven, and baseline in the remaining twenty-four (Figure 3). Excessive concentrations of orthophosphate were found in eleven subwatersheds, high concentrations in eight, moderate concentrations in eight, and the remaining seven below baseline (Figure 4). Only two of the sampled subwatershed in the Chincoteague Bay watershed had moderately elevated orthophosphate yields. All others were below baseline (Figure 5). Temperature, dissolved oxygen, pH, and specific conductivity values are noted for all sites in Table 4. No significant anomalies were found in the insitu measurements of dissolved oxygen, or temperature. Six subwatersheds clustered in the center of the watershed had low specific conductivity (<100 mmohs/cm), and two subwatersheds in this drainage had relatively high conductivity (>300 mmohs/cm (Figure 6). Depressed ph values (<6.5) followed the low conductivity (Figure 7).

Table 2. Chincoteague Bay WRAS, March 2004 – Sampling Site Location

Station	Location	lat	long
Chinc 0	UT* to Waterworks Cr at Basketswitch Rd	38.21824	-75.29445
Chinc 1	Waterworks Cr. at Basketswitch Rd	38.21063	-75.29463
Chinc 3	Robbins Cr at Basketswitch Rd	38.19355	-75.29398
Chinc 5	UT to Robbins Cr at Taylor Rd	38.18889	-75.30131
Chinc 6	Scarboro Cr at Taylor Rd	38.17263	-75.30189
Chinc 7	Scarboro Cr off Taylor Rd	38.16608	-75.29736
Chinc 8	UT to Scarboro Cr at Taylor Rd	38.16549	-75.30648
Chinc 9	UT to Pawpaw Cr at Pawpaw Rd	38.16110	-75.31134
Chinc 10	Pawpaw Cr at Pawpaw Rd	38.15212	-75.31706
Chinc 11	Pawpaw Cr at McCabes Crnr Rd	38.14595	-75.32830
Chinc 13	Stagg Cr at Bayside Rd	38.14066	-75.29275
Chinc 14	UT to Tanhouse Cr at Stagg Rd	38.13279	-75.30749
Chinc 15	Tanhouse Cr at Stagg Rd	38.13535	-75.31601
Chinc 17	Tanhouse Cr at Pawpaw Rd	38.13306	-75.32678
Chinc 18	Tanhouse Cr at Ayers La	38.12827	-75.34822
Chinc 19	UT to Purnell Pond at Bayside Rd	38.11894	-75.30999
Chinc 20	Brimer Gut at Scotts Landing Rd	38.11639	-75.32584
Chinc 21	Rowley Cr at Bayview Rd	38.08982	-75.36377
Chinc 22	Scarboro Cr at Rt 12	38.08356	-75.39832
Chinc 23	Pikes Cr at Rt 12	38.07318	-75.40304
Chinc 24	Pikes Cr at Bird Hill Rd	38.07883	-75.41006
Chinc 25	UT to Pikes Cr at Rt 12 (S)	38.06421	-75.40145
Chinc 26	Riley Cr at Geenbackville Rd	38.04178	-75.39000
Chinc 27	Hancock Cr at Greenbackville Rd	38.03370	-75.39565
Chinc 29	UT to Hancock Cr at Greenbackville Rd	38.02577	-75.39793
Chinc 30	Sand Br at Swangut Rd	38.01067	-75.43811
Chinc 31	Bunn Ditch at Swangut Rd	38.01562	-75.45294
Chinc 32	Payne Ditch at Steel Pond Rd	38.03307	-75.45285
Chinc 33	Little Mill Rn at Steel Pond Rd	38.04214	-75.45952
Chinc 34	Paradie Br at Steel Pond Rd	38.04214	-75.45952
Chinc 35	UT to Little Mill Rn at Jones Rd (S)	38.03556	-75.46802
Chinc 36	UT to Little Mill Rn at Jones Rd (N)	38.03518	-75.46580
Chinc 37	Marshall Ditch at Jones Rd	38.03462	-75.47847
Chinc 38	Big Mill Pond at Sheephouse/Big Mill Rd	38.01601	-75.45523
Chinc 40	Powell Cr at State Line Rd	38.01227	-75.41103
Chinc 41	UT to Pikes Cr at Rt 12 (N)	38.06757	-75.40096

* UT= Unnamed tributary

Figure 1. Chincoteague Bay WRAS, March 2004
Nutrient Synoptic Subwatersheds and Sampling Sites

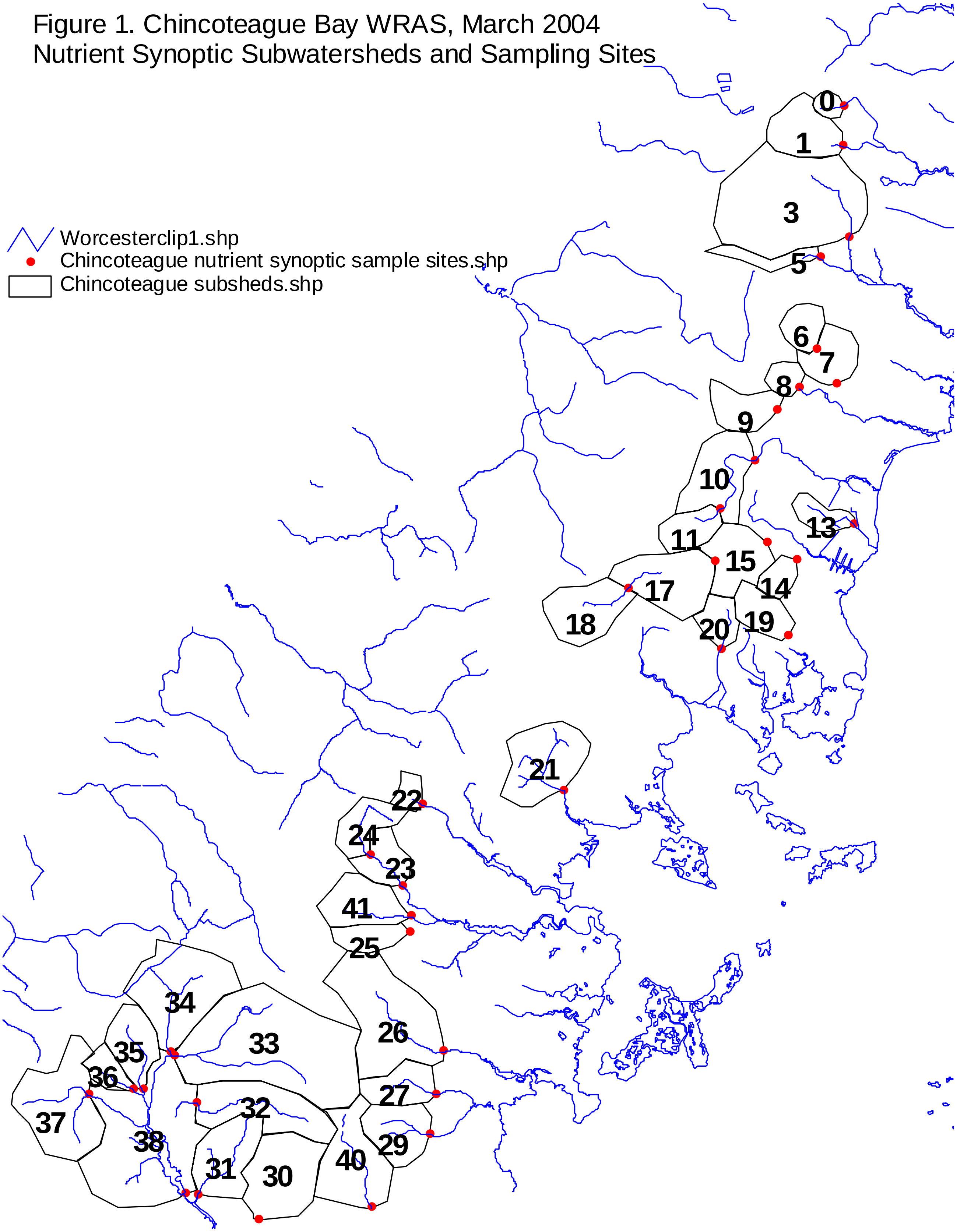


Table 3. Chincoteague Bay WRAS, March 2005
Nutrient Concentrations and Yields

Station	Date	Time	Discharge L/s	PO4 mg/L	NO23 mg/L	Area Hectares	PO4 yield Kg/h/d	N Yield Kg/h/d
Chinc 0	03/05/04	940	1.31064	0.033	0.06	28	0.0001335	0.0002427
Chinc 1	03/05/04	920	2.42316	0.006	1.06	147	0.0000085	0.0015097
Chinc 3	03/05/04	1015	0.332232	0.005	3.39	556	0.0000003	0.0001750
Chinc 5	03/05/04	1030	0.798576	0.004	4.74	56	0.0000049	0.0058401
Chinc 6	03/05/04	1055	0.0408432	0.025	4.08	71	0.0000012	0.0002028
Chinc 7	03/05/04	1120	2.135505	0.128	0.07	179	0.0001319	0.0000722
Chinc 8	03/05/04	1135	1.037844	0.01	0.47	45	0.0000199	0.0009366
Chinc 9	03/05/04	1525	0.23622	0.004	3.24	107	0.0000008	0.0006180
Chinc 10	03/05/04	1500	19.94916	0.083	0.19	283	0.0005055	0.0011572
Chinc 11	03/05/04	1440	3.544824	0.003	1.17	89	0.0000103	0.0040263
Chinc 13	03/05/04	1230	0.06477	0.011	0.28	62	0.0000010	0.0000253
Chinc 14	03/05/04	1245	3.608832	0.002	1.4	50	0.0000125	0.0087305
Chinc 15	03/05/04	1305	2.724912	0.005	0.02	536	0.0000022	0.0000088
Chinc 17	03/05/04	1325	0.54864	0.004	0.04	385	0.0000005	0.0000049
Chinc 18	03/05/04	1415	3.55092	0.015	0.04	173	0.0000266	0.0000709
Chinc 19	03/05/04	1345	2.261616	0.004	3.57	96	0.0000081	0.0072666
Chinc 20	03/05/04	1400	11.027664	0.003	3.12	77	0.0000371	0.0386066
Chinc 21	03/08/04	1400	28.28544	0.004	0.06	252	0.0000388	0.0005819
Chinc 22	03/08/04	1340	2.92608	0.036	4.04	66	0.0001379	0.0154752
Chinc 23	03/08/04	1320	23.78986	0.012	0.55	96	0.0002569	0.0117760
Chinc 24	03/08/04	1440	9.69264	0.011	0.52	199	0.0000463	0.0021883
Chinc 25	03/08/04	1245	2.098908	0.052	3.68	72	0.0001310	0.0092688
Chinc 26	03/08/04	1200	73.59396	0.033	5.81	385	0.0005450	0.0959558
Chinc 27	03/08/04	1145	11.87192	0.006	0.3	109	0.0000565	0.0028231
Chinc 29	03/08/04	1135	39.6621	0.002	0.18	143	0.0000479	0.0043135
Chinc 30	03/08/04	1045	37	0.011	7.25	244	0.0001441	0.0949869
Chinc 31	03/08/04	1020	35	0.02	6.93	163	0.0003710	0.1285664
Chinc 32	03/08/04	1530	16.494252	0.008	1.46	235	0.0000485	0.0088538
Chinc 33	03/08/04	1510	52.82184	0.004	2.72	664	0.0000275	0.0186951
Chinc 34	03/08/04	1500	6.091428	0.006	7.2	339	0.0000093	0.0111780
Chinc 35	03/08/04	1600	4.75488	0.013	0.91	123	0.0000434	0.0030394
Chinc 36	03/08/04	1615	2.86512	0.017	1.73	74	0.0000569	0.0057872
Chinc 37	03/08/04	915	30.87624	0.01	1.41	278	0.0000960	0.0135305
Chinc 38	03/08/04	945	277.48992	0.006	1.16	2253	0.0000638	0.0123441
Chinc 40	03/08/04	1110	36.80079	0.016	6.33	238	0.0002138	0.0845664
Chinc 41	03/08/04	1300	29.01696	0.009	1.17	149	0.0001514	0.0196864

Figure 2. Chincoteague Bay WRAS, March 2004
Nitrate/nitrite (NO2+NO3) concentrations.

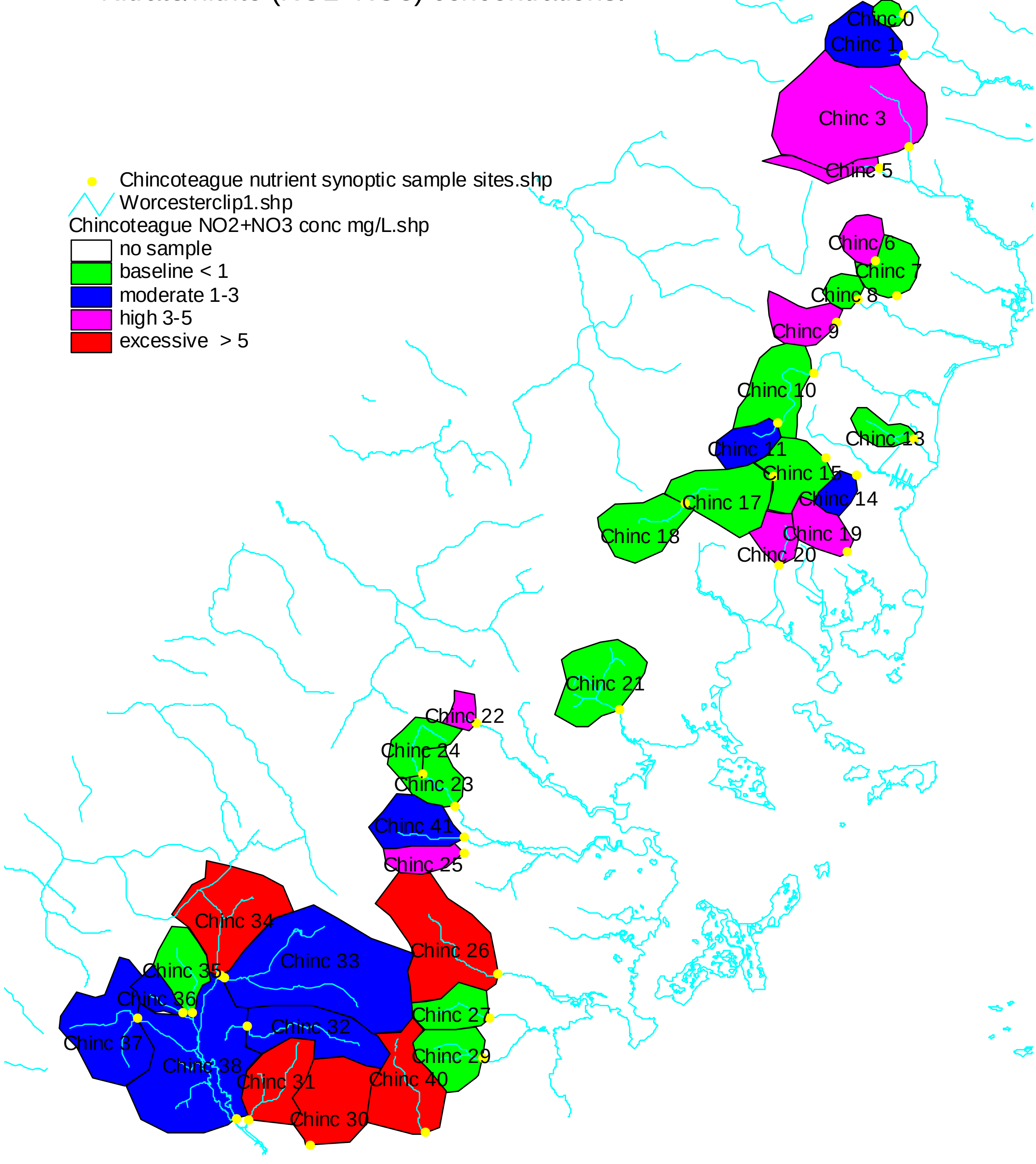


Figure 3. Chincoteague Bay WRAS, March 2004
Nitrate/nitrite (NO2+NO3) yield Kg/H/D

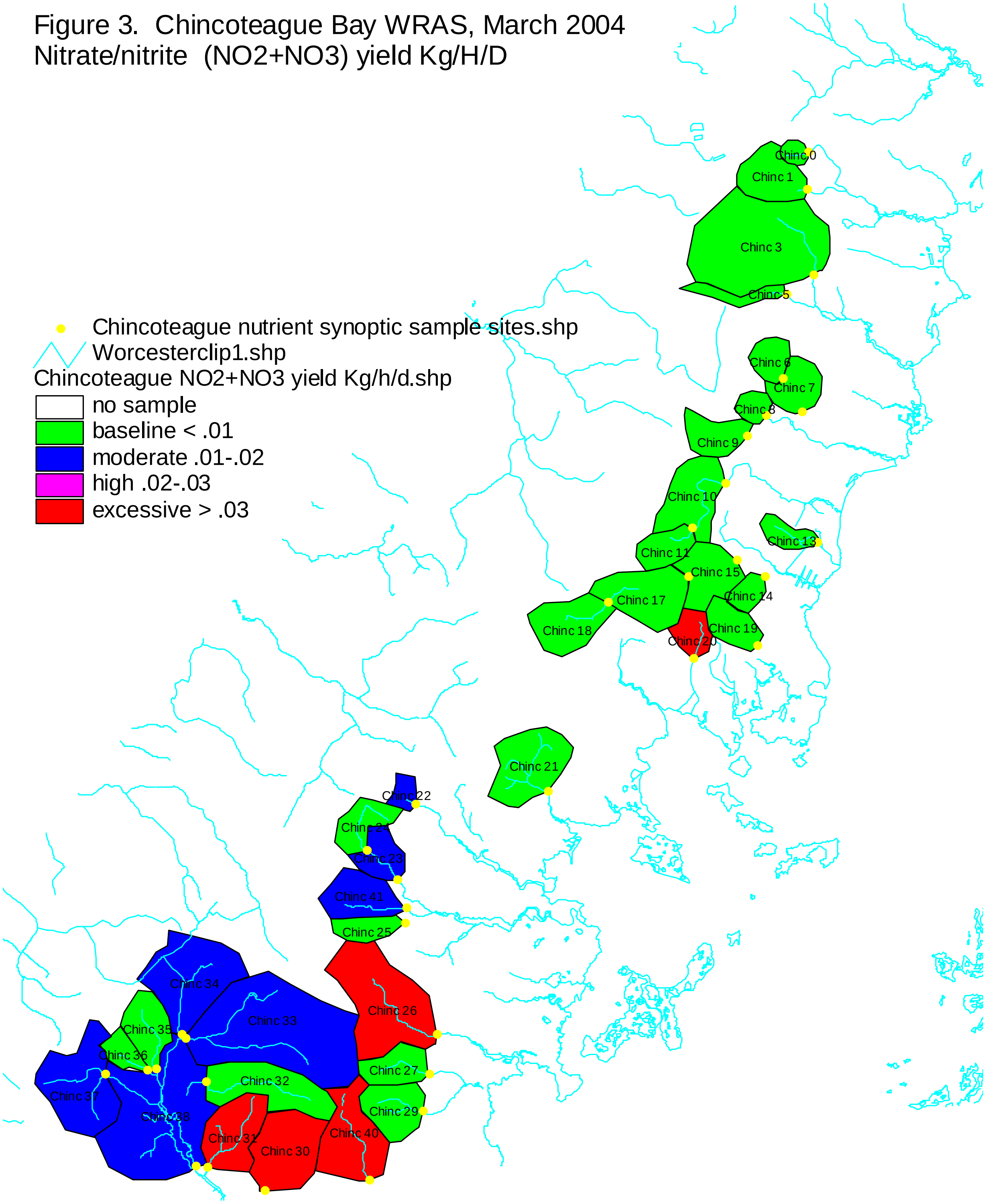


Figure 4. Chincoteague Bay WRAS, March 2004
Orthophosphate (PO4) conc. mg/L.

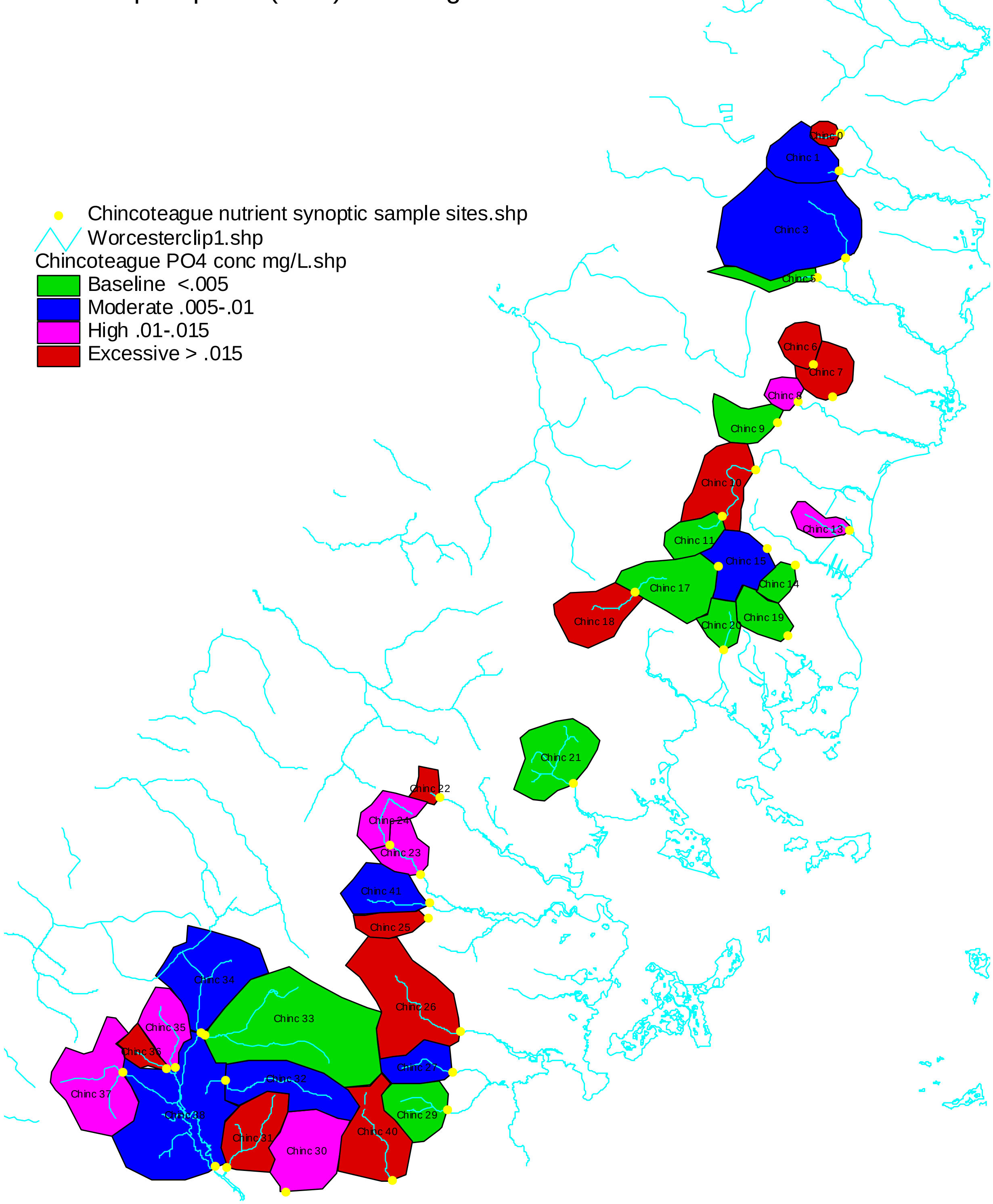


Figure 5. Chincoteague Bay WRAS, March 2004
Orhtophophate (PO4) yield Kg/H/D

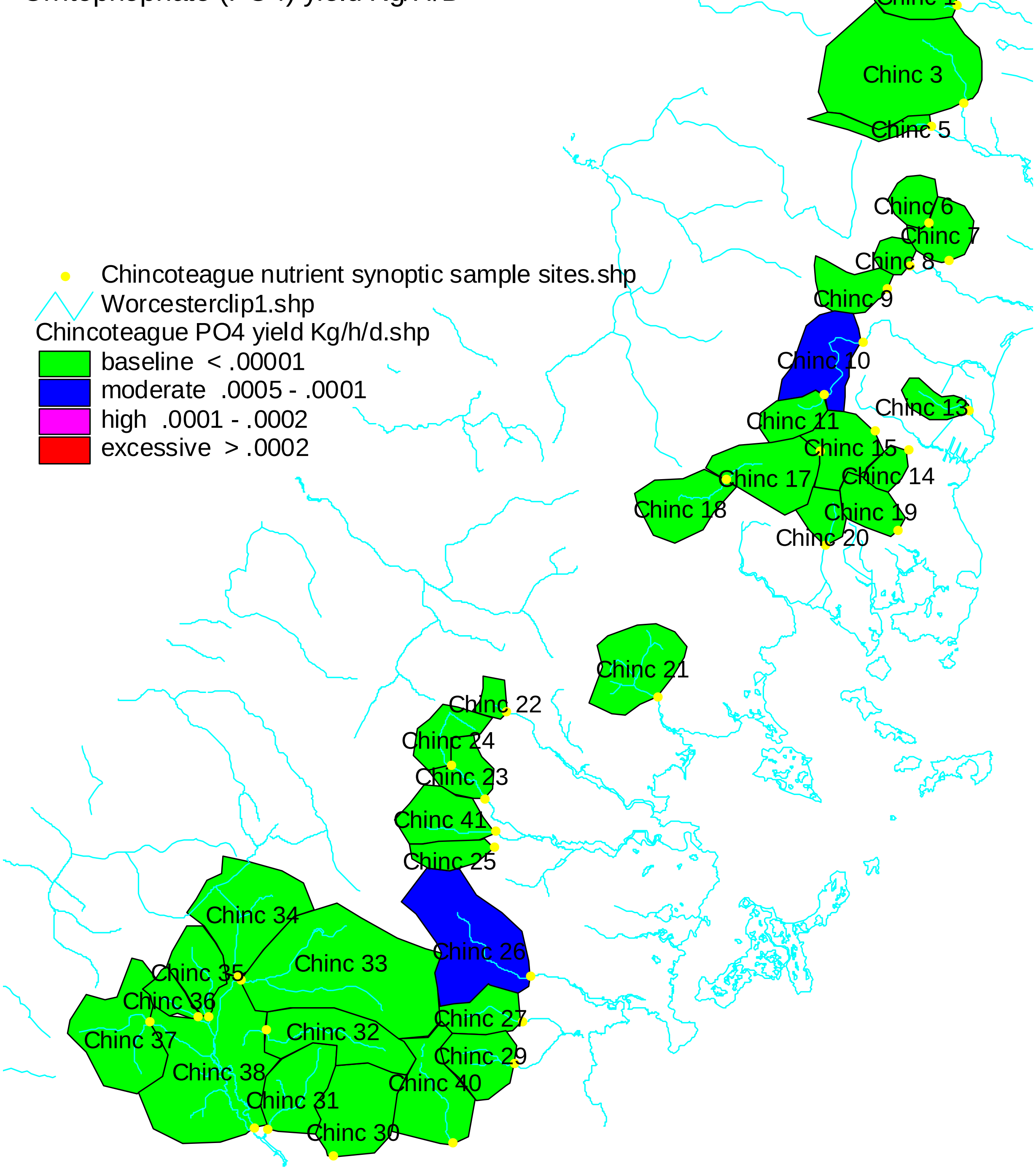


Table 4. Chincoteague Bay WRAS, Nutrient Synoptic Survey March, 2004
Insitu Water Quality Parameters

Station	date	time	temp	pH	cond	do
Chinc 0	5-Mar-04	940	11.96	5.66	109	5.54
Chinc 1	5-Mar-04	930	12.56	6.87	192	6.83
Chinc 3	5-Mar-04	1015	11.67	5.91	131	7.01
Chinc 5	5-Mar-04	1030	12.04	6.80	193	7.91
Chinc 6	5-Mar-04	1055	12.51	6.71	312	7.03
Chinc 7	5-Mar-04	1120	12.61	6.65	211	6.20
Chinc 8	5-Mar-04	1135	15.28	5.92	137	7.92
Chinc 9	5-Mar-04	1525	13.84	6.70	221	7.80
Chinc 10	5-Mar-04	1500	16.22	6.48	88	7.67
Chinc 11	5-Mar-04	1440	14.10	6.13	136	8.70
Chinc 13	5-Mar-04	1230	13.36	6.08	394	6.52
Chinc 14	5-Mar-04	1245	16.91	6.58	143	7.50
Chinc 15	5-Mar-04	1305	15.17	5.54	94	5.25
Chinc 17	5-Mar-04	1325	14.37	5.26	42	6.00
Chinc 18	5-Mar-04	1415	16.20	6.21	99	6.71
Chinc 19	5-Mar-04	1345	15.58	6.35	2	7.81
Chinc 20	5-Mar-04	1400	14.66	6.60	183	8.30
Chinc 21	8-Mar-04	1400	10.45	6.25	96	6.80
Chinc 22	8-Mar-04	1340	11.79	7.07	220	8.01
Chinc 23	8-Mar-04	1320	9.84	6.70	127	8.04
Chinc 24	8-Mar-04	1440	10.05	6.50	106	7.41
Chinc 25	8-Mar-04	1245	10.09	6.92	285	7.40
Chinc 26	8-Mar-04	1200	9.36	6.60	299	7.23
Chinc 27	8-Mar-04	1145	8.22	5.57	131	7.85
Chinc 29	8-Mar-04	1135	8.64	4.68	86	6.45
Chinc 30	8-Mar-04	1045	9.54	6.94	257	7.57
Chinc 31	8-Mar-04	1020	8.07	6.13	284	7.49
Chinc 32	8-Mar-04	1530	9.78	6.54	118	6.07
Chinc 33	8-Mar-04	1510	9.63	6.69	177	7.40
Chinc 34	8-Mar-04	1500	10.09	6.80	227	7.64
Chinc 35	8-Mar-04	1600	10.50	6.62	183	7.37
Chinc 36	8-Mar-04	1615	10.01	6.84	121	8.05
Chinc 37	8-Mar-04	915	8.19	6.38	196	7.26
Chinc 38	8-Mar-04	945	10.62	7.15	194	7.51
Chinc 40	8-Mar-04	1110	9.77	6.76	274	7.40
Chinc 41	8-Mar-04	1300	8.65	6.42	114	7.11

Figure 6. Chincoteague Bay WRAS, March 2004
pH

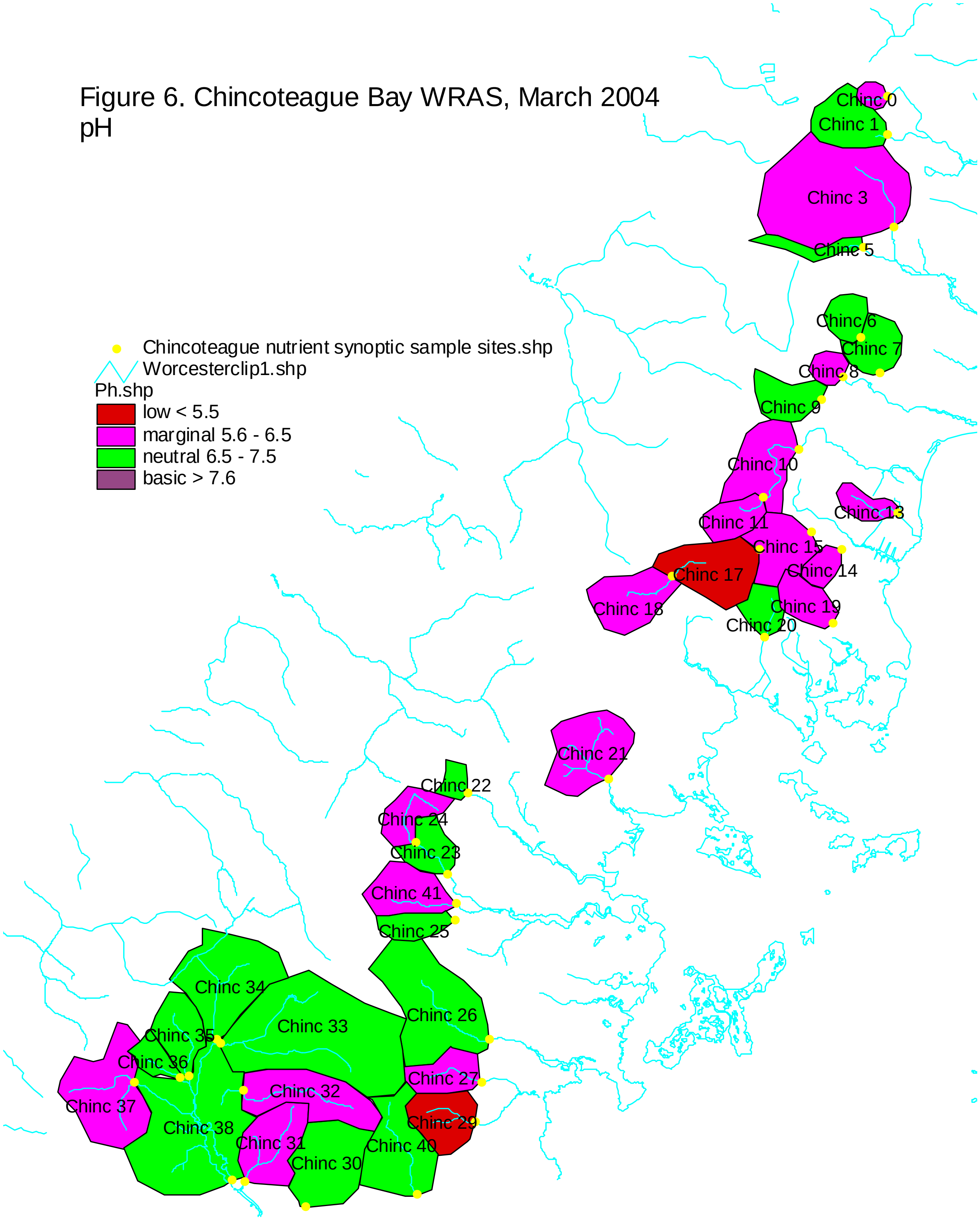
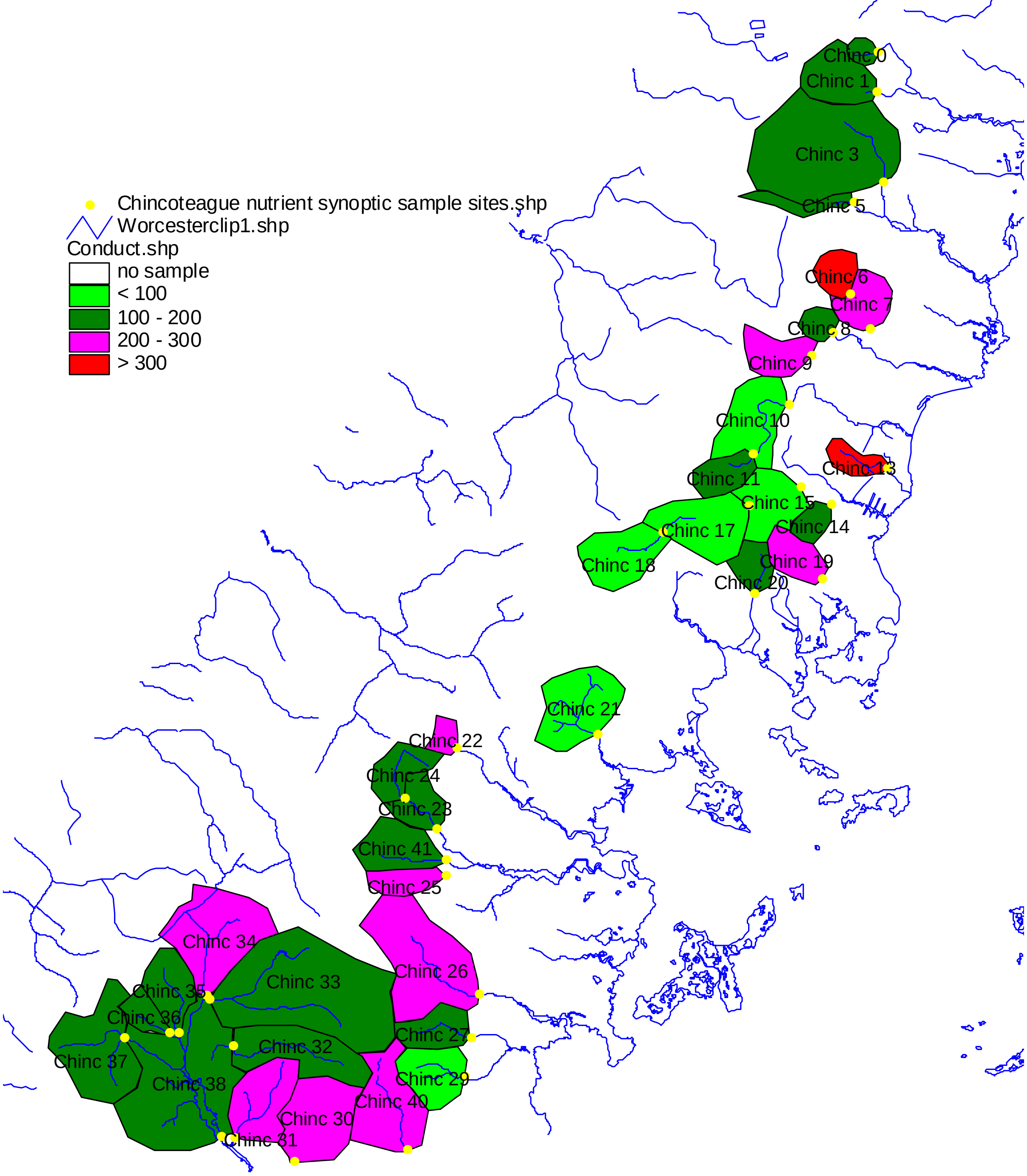


Figure 7. Chincoteague Bay WRAS, March 2004
Specific Conductivity (Mmohs/cm)



Discussion

The subwatersheds with high or excessive nitrate/nitrite concentrations appear to be associated with row crop agriculture and/or concentrations of septic systems. The areas around Girdletree (subwatershed # 22) and Stockton (subwatersheds # 24 & 25) are two population centers within subwatersheds with high and excessive nitrate concentrations respectively. Translating the concentrations to yields produced a number of subwatersheds with excessive yields, particularly at the state line and around Purnell Bay where concentrations were excessive. The better drained soils in these subwatersheds support row crop agriculture and good percolation for septic systems, but are also efficient conduits for nutrients to the surface aquifer.

High and excessive orthophosphate concentrations showed some coincidence with lack of forest cover. Although sampling was done during dry weather, frequent spring rains coupled with farming and construction activities tended to produce suspended sediment loads that lingered in the water column for several days after a rain event. This sediment from phosphorus rich soils would produce elevated concentrations. With only two subwatersheds noted as having even moderate orthophosphate yields, export of this nutrient to Chincoteague Bay appears to be minor.

On average, the Chincoteague watershed has relatively low nutrient concentrations compared to other Eastern Shore watersheds (Table 5.). The higher proportion of forest and wetland versus row crop agriculture may contribute to these lower concentrations. Forested areas are generally low in nutrient concentrations and denitrification occurs in the hypoxic/anoxic conditions found at groundwater discharge areas in wetlands.

As noted, no significant anomalies were found in the insitu measurements of dissolved oxygen, or temperature. There were a number of subwatersheds that had depressed (< 6.5) pH and two that had low (<5.5) pH. These low pH watersheds appeared to drain mostly forested areas. Water standing in woodlands and draining through leaf litter will leach tannic acid producing low ph values. Streams with depressed ph values (<6.5) and low specific conductivity (<100 mmohs/cm) may be susceptible to acid deposition degradation Two subwatersheds in this drainage had relatively high conductivity (>300 mmohs/cm). The sampling site for watershed number 13 was relatively close to tidewater, thus the elevated conductivity could be from saltwater intrusion. The reason for the elevated conductivity in watershed number 6 is unclear, but could be due to organic enrichment or residual road salt.

Table 5. Annual & Spring Nutrient Concentration Averages from Other Nutrient Synoptic Surveys

Mg/L	Piney	German Br.	Pocomoke	**Upper Chester**	Middle Chester	**Chincoteague Bay**	**Newport Sinepuxent**
NO2+NO3 Spring	3.742	3.832	3.734	**3.538**	4.87	**2.29**	**1.93**
NO2+NO3 Annual	4.823	4.704	2.384				
PO4 Spring	0.800	0.043	0.028	**0.007**	0.012	**0.018**	**0.03**
PO4 Annual	1.177	0.067	0.022				

Conclusions

The most significant finding from the nutrient synoptic survey is the excessive nitrate/nitrite concentrations and yields from the streams in the lower portion of the watershed and around population centers. The enrichment of ground water from septic systems in well drained soils has been noted in a number of coastal plain and piedmont watersheds in the state. Areas with intense row crop agriculture also contribute to groundwater nutrient levels, especially if cover crops are not used on a regular basis.

Literature Cited

Frink, Charles R.. 1991. *Estimating Nutrient Exports to Estuaries*. Journal of Environmental Quality. 20:717-724.