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An Analysis of Forest Riparian Buffer Zones on Military Installations in the Chesapeake Bay Watershed

Leslie Orzetti, PhD/Ecosystem Solutions, Inc

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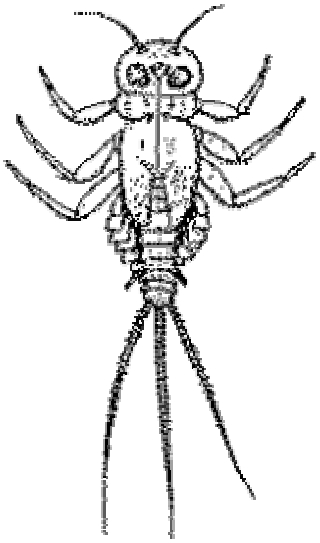
An Analysis of Forest Riparian Buffer Zones on Military Installations in the Chesapeake Bay – Year 2

Individual Installation Reports



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For

Legacy Resource Management Program

ECOSYSTEM
SOLUTIONS, INC.

An Analysis of Forest Riparian Buffer Zones on Military Installations in the Chesapeake Bay: St. Julien's Creek Annex, Norfolk, VA

Background:
Since 1997, the Department of Defense has invested significant financial resources on streamside forest restoration at over 85 installations in the Chesapeake Bay watershed. Streamside forested wetlands or forest buffer zones have been shown to reduce the impacts of both point source and non-point source pollution by filtering pollutants and sediments before they enter the adjacent stream. Much research has been done regarding the benefits of these restored areas for water quality control and improvement, but little has been done assessing recently planted buffers in the Chesapeake Bay watershed. As of yet, no study has examined the survivorship or benefits of restored streamside forests on military lands.

Objective:
This study tested the efficacy of restored forest riparian buffers along streams on military installations in the Chesapeake Bay watershed by examining stream macrobenthic community structure, and water and habitat quality.

Summary of Approach:
Three study sites were chosen at St. Julien's Creek Annex (Norfolk Naval Shipyard), Norfolk, Virginia. All sites are on St. Julien's Creek with one site directly adjacent to the South Branch Elizabeth River at the mouth of St. Julien's Creek. All sites are tributaries to the Elizabeth River, and are first – third order tidal streams. This installation is located in the Coastal Plain physiographic region. Samples were collected in the spring of 2007. Below is a description of sample collection and analysis.

Benthic macroinvertebrates
Samples were collected in one separate riffle/run habitat. In order to standardize assessments across streams, we collected organisms by disturbing the stream bottom for sixty seconds to a depth of approximately 10cm using rectangular framed kick nets (500 µm mesh). Organisms were collected from the nets using forceps and a 500µm sieve, and preserved in 95% ethanol for lab identification. Identification was done to family according to Merritt and Cummins (1984). Once identified, organisms were placed in vials and enumerated until at least 100 invertebrates per stream sample were counted. All data was entered into Excel spreadsheets and tolerance, feeding, habit and diversity metrics were calculated.

Water quality
Several water quality parameters were collected from each site within the 150-meter reach (riffle/run, pool, and mid-channel). Temperature (°C), specific conductance (microS/L), dissolved oxygen (mg/L), percent oxygen saturation, pH, and turbidity were measured using a YSI multiparameter probe. Water collected from each stream was sent to the Chesapeake Biological Laboratory for analysis of total phosphorus, soluble reactive phosphorus, nitrate-nitrogen, ammonia-nitrogen, and total suspended solids. All data was then entered into Excel spreadsheets.

Habitat Assessment
Habitat assessments were done at each site using the methods described in the Rapid Bioassement Protocols for Use in Wadeable Streams and Rivers (Barbour, 1999) for high gradient streams. Data sheets for each stream were filled out and overall habitat scores were calculated.

Watershed Landuse Analysis and Area
At site (immediately adjacent to and upland of buffer area) and upstream land use assessments were done, by acreage in land use category, using aerial photography if available and ground truthing. Hand held GPS units were used to obtain point stream location.

Results:
Data collected from study were compared with data from a previous study .(Orzetti 2004) assessing the effectiveness of riparian buffer zones in the Piedmont physiographic region. Since St. Julien's Creek Annex falls within the coastal plain province, we are pooling all coastal plain sites to statistically compare these sites to sites in the piedmont region in terms

of their age, water quality, habitat, and benthic macroinvertebrate community dynamics. At SJ 4, land use in the immediate riparian zone is a wetland and industrial development, and is highly tidally influenced by the South Branch Elizabeth River. SJ 3 is upstream of this site is has a grassy field with riparian plantings and a wetland in the immediate riparian zone. Finally, SJ 2 is further upstream and a small tidal creek with riparian plantings, grassy field and industrial development within the adjacent riparian zone. All sites are tidally influenced with site 2 having the least flow.

Water Quality

The water quality values for St. Julien's Creek Annex, Norfolk, VA can be found in Table 1. Nitrogen (nitrate and ammonium), fell within the baseline concentrations and soluble reactive phosphorus (SRP) fell within the moderately impaired for SJ 3 and 4 and excessively impaired for SJ 2 , according to the USGS NAQWA program standards.

Water Quality Parameter	SJ 2	SJ 3	SJ 4
Temperature (°C)	30.3	27	24.1
Specific Conductance (µhos)	15.9	23.17	23.44
Dissolved Oxygen (mg/l)	3.85	8.9	7.6
Dissolved Oxygen (% sat)	57.5	120	98.2
Salinity	9.3	14	14.1
NO_3^-(mg/l)	0.061	0.204	0.247
NH_4^+(µg/l)	0.515	0.302	0.223
SRP(µg/l)	0.0328	0.0077	0.008
Total Phosphorus(µg/l)	0.2274	0.0805	0.0602
TSS(mg/l)	70.7	42.0	33.3

Table 1: NWS Yorktown Water Quality Data

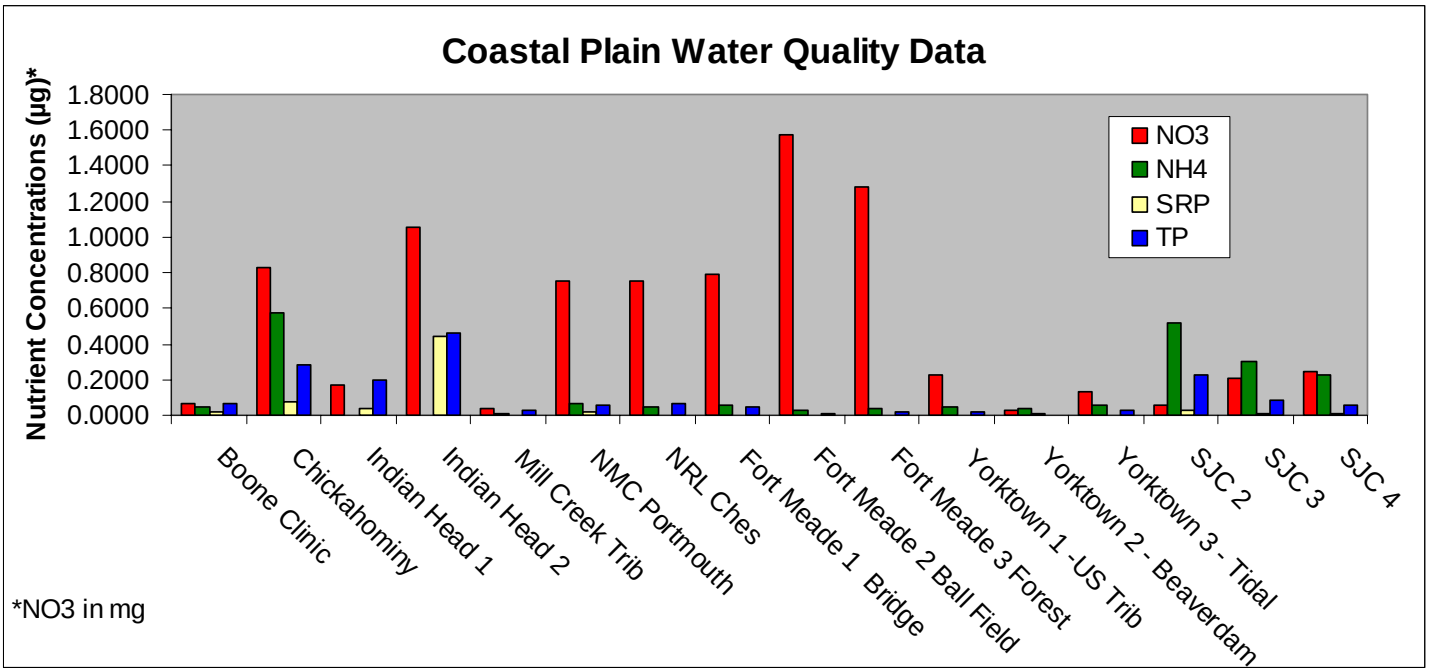

Figure 1: Comparison of NWS Yorktown water quality with similar aged sites in the Coastal Plain

Benthic Macroinvertebrates

We were unable to collect benthic macroinvertebrates at any of the St. Julien's Creek sites due to unstable sediments. The bottom sediments at these sites did not allow for invertebrate collection according to the above mentioned protocols.

Habitat

Since these were tidal creeks, some of the habitat criteria did not apply. However, we were able to compare some of the common habitat characteristics at SJ 3 and 4 with similar coastal plain sites (Figure 2). Habitat scores for St. Julien's Creek 3 and 4 were 112 and 107 respectively.

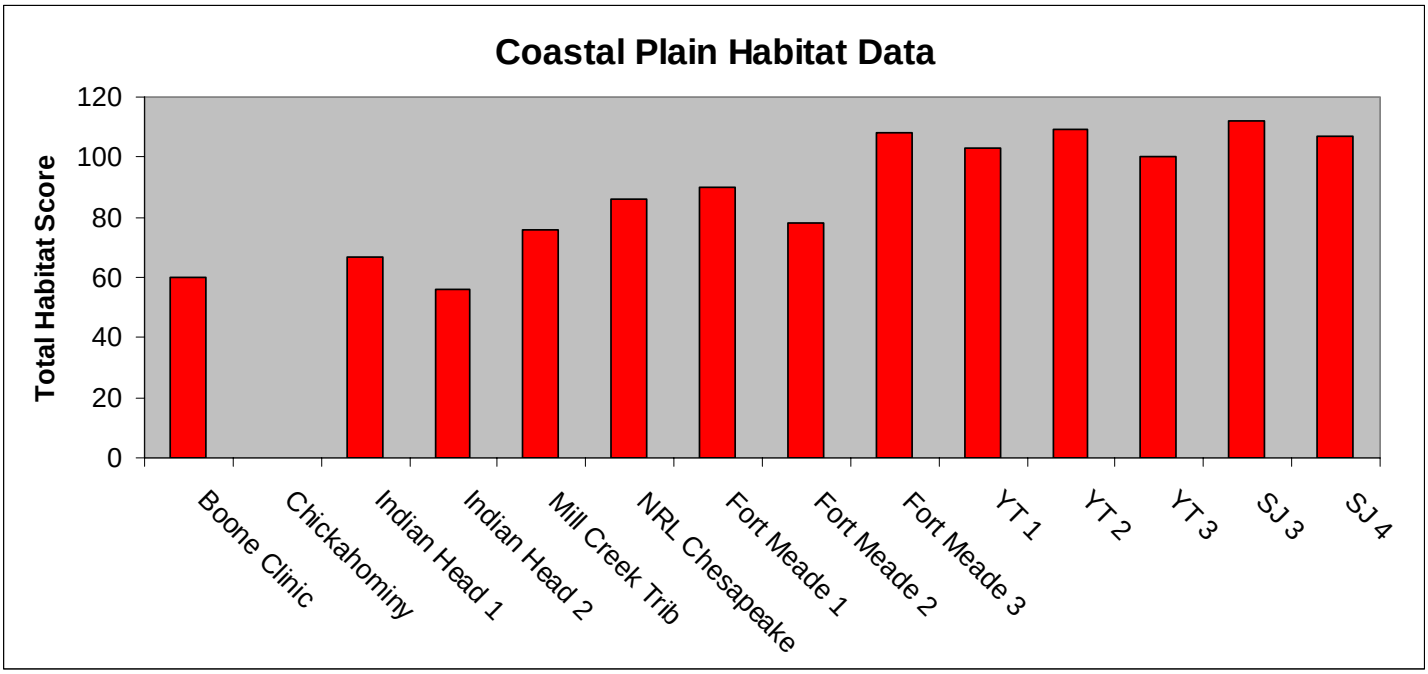

Figure 2: Comparison of St. Julien's Creek Annex habitat scores with other sites in the Coastal Plain

Recommendations

In addition to the 3 sampled sites, we visited a site at the former New Gosport Housing facility. This site was a dry creek bed/wetland area. While the planting appeared to be healthy, there were some invasive plants that could be controlled through chemical or mechanical means. However, since there was no sampleable flowing stream at the site, we were unable to collect any water quality or macroinvertebrate samples.

All of the plantings at St. Julien's Creek Annex appeared to be in relatively good health. The sites were difficult to locate, but once there, plantings were evident. The most upstream site (SJ2) appeared to be receiving the most benefits from the riparian plantings. It is difficult to determine the benefits of riparian plantings in heavily tidally influenced streams as SJ 3 and 4 were. Since a large part of the sediment and nutrient load can be from downstream sources, and the soil is usually sandy with a short water retention time, it is often difficult to monitor the influence that restored riparian zones can have at these types of sites. While we do not recommend that plantings should not be done in these areas, it is often more advantageous to restore riparian zones in the upstream areas or headwaters of these areas to receive the most benefit from your planting. We would recommend more plantings in the upstream reaches of the planted areas with some invasive plant control at the other sites.

Benefit:

Many financial resources have been spent on the restoration of riparian forest buffer zones on military installations in the Chesapeake Bay, with no follow-up assessment to determine if this restoration, and therefore money spent has actually proven beneficial to the military. This study assessed if these buffer zones are functioning correctly, and therefore provide the military with a preliminary cost/benefit analysis of the forest riparian buffer zone program. This project also provides land managers on installations recommendations for management actions that may be necessary to improve these restored areas. Data from this project can also be used to address issues concerning the DoD Total Maximum Daily Load program (TMDL).

This project was funded under an award from the Legacy Resource Management Program (LRMP). The Legacy Program is a congressionally appropriated program under the Department of Defense Conservation Program that funds natural and cultural resource projects. This is the first of a two year project that will continue through 2007 and will culminate with a final report and updated database for the DoD Chesapeake Bay Program.

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References

Barbour, M.T., J. Gerritsen, B.D. Snyder, J.B. Stribling, 1999. Rapid Bioassessment Protocols for use in Stream and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA-841-B-99-002. U.S. Environmental Protection Agency; Office of Water, Washington, D.C.

Merrit, R.W., Cummins, K.W., 1984. An Introduction to the Aquatic Insects of North America, Second Edition, Kendall/Hunt Publishing Company, Dubuque, Iowa.

Orzetti, L. L. (2004). Stream Community Structure- An Analysis of Riparian Forest Buffer Restoration in the Chesapeake Bay Watershed. Fairfax, VA, George Mason University**:** 253.

An Analysis of Forest Riparian Buffer Zones on Military Installations in the Chesapeake Bay: NWS Yorktown, Yorktown, VA

Background:
Since 1997, the Department of Defense has invested significant financial resources on streamside forest restoration at over 85 installations in the Chesapeake Bay watershed. Streamside forested wetlands or forest buffer zones have been shown to reduce the impacts of both point source and non-point source pollution by filtering pollutants and sediments before they enter the adjacent stream. Much research has been done regarding the benefits of these restored areas for water quality control and improvement, but little has been done assessing recently planted buffers in the Chesapeake Bay watershed. As of yet, no study has examined the survivorship or benefits of restored streamside forests on military lands.

Objective:
This study tested the efficacy of restored forest riparian buffers along streams on military installations in the Chesapeake Bay watershed by examining stream macrobenthic community structure, and water and habitat quality.

Summary of Approach:
Three study sites were chosen at NWS Yorktown, Yorktown, Virginia. Both of these sites are tributaries to the York River, and are first order streams. This installation is located in the Coastal Plain physiographic region. Samples were collected in the spring of 2007. Below is a description of sample collection and analysis.

Benthic macroinvertebrates
Samples were collected in one separate riffle/run habitat. In order to standardize assessments across streams, we collected organisms by disturbing the stream bottom for sixty seconds to a depth of approximately 10cm using rectangular framed kick nets (500 µm mesh). Organisms were collected from the nets using forceps and a 500µm sieve, and preserved in 95% ethanol for lab identification. Identification was done to family according to Merritt and Cummins (1984). Once identified, organisms were placed in vials and enumerated until at least 100 invertebrates per stream sample were counted. All data was entered into Excel spreadsheets and tolerance, feeding, habit and diversity metrics were calculated.

Water quality
Several water quality parameters were collected from one site within the 150-meter reach (riffle/run, pool, and mid-channel). Temperature (°C), specific conductance (microS/L), dissolved oxygen (mg/L), percent oxygen saturation, pH, and turbidity were measured using a YSI multiparameter probe. Water collected from each stream was sent to the Chesapeake Biological Laboratory for analysis of total phosphorus, soluble reactive phosphorus, nitrate-nitrogen, ammonia-nitrogen, and total suspended solids. All data was then entered into Excel spreadsheets.

Habitat Assessment
Habitat assessments were done at each site using the methods described in the Rapid Bioassement Protocols for Use in Wadeable Streams and Rivers (Barbour, 1999) for high gradient streams. Data sheets for each stream were filled out and overall habitat scores were calculated.

Watershed Landuse Analysis and Area
At site (immediately adjacent to and upland of buffer area) and upstream land use assessments were done, by acreage in land use category, using aerial photography if available and ground-truthing. Hand held GPS units were used to obtain point stream location.

Results:
Data collected from study were compared with data from a previous study.(Orzetti 2004) assessing the effectiveness of riparian buffer zones in the Piedmont physiographic region. Since NWS Yorktown falls within the coastal plain province, we are pooling all coastal plain sites to statistically compare these sites to sites in the piedmont region in terms of their age, water quality, habitat, and benthic macroinvertebrate community dynamics. At site one, land use in the immediate riparian zone was a small wetland with smaller woody vegetation. At site two, the land use is a sloped forested hill, which

is downstream of site one. There has been significant beaver activity at site two, which has led to flooding of the site. Natural Resource managers at the installation have removed the blockage and the site is free flowing again. Site 3 is a planted field to the left, and an older growth forest on the right side of the stream. Sites 1 and 2 are not tidal, while site 3 is tidally influenced.

Water Quality

The water quality values NWS Yorktown, Yorktown, VA can be found in Table 1. Nitrogen (nitrate and ammonium), and soluble reactive phosphorus (SRP), fell within the baseline concentrations according to the USGS NAQWA program standards.

Water Quality Parameter	Yorktown Site 1 Upstream Trib	Yorktown Site 2 Beaverdam	Yorktown Site 3 Tidal Branch
Temperature (°C)	16.6	22	19.2
Specific Conductance (µhos)	203.6	279.6	459.2
Dissolved Oxygen (mg/l)	7.92	5.2	7.7
Dissolved Oxygen (% sat)	80.1	59.2	83.6
Salinity	0	0	0.2
NO_3^-(mg/l)	0.225	0.029	0.133
NH_4^+(µg/l)	0.050	0.037	0.053
SRP(µg/l)	0.0022	0.005	0.0022
Total Phosphorus(µg/l)	0.0209	No data	0.0139
TSS(mg/l)	9	6.5	13.5

Table 1: NWS Yorktown Water Quality Data

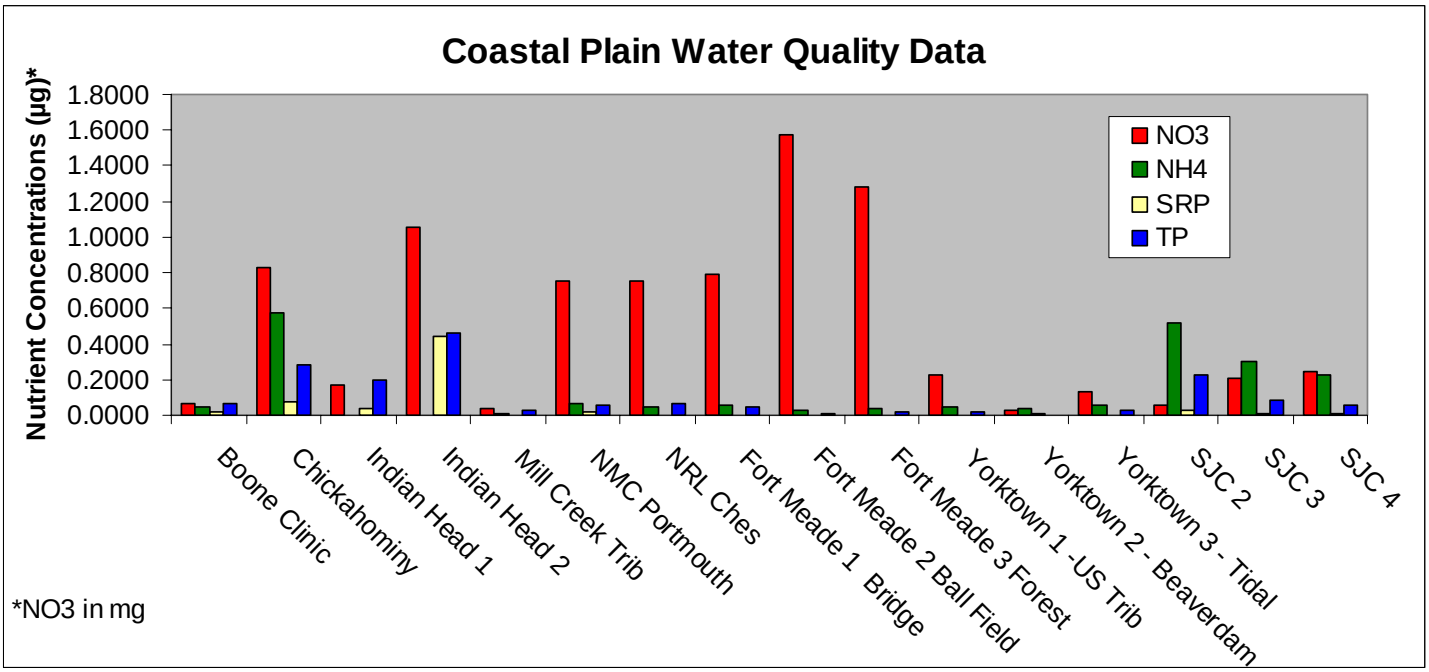

Figure 1: Comparison of NWS Yorktown water quality with similar aged sites in the Coastal Plain

Benthic Macroinvertebrates

The benthic macroinvertebrate diversity and tolerance metrics for Sites 1, 2 and 3 at NWS Yorktown can be found in Table 2. As with water quality data, the results for NWS Yorktown sites varied among sites of similar ages (Figures 2 and 3).

Metric	Yorktown Site 1 Upstream Trib	Yorktown Site 2 Beaverdam	Yorktown Site 3 Tidal Branch
%EPT	0.900	0	0
% Plecoptera	0	0	0
% Ephemeroptera	0	0	0
% Trichoptera	0.900	0	0
No. Intolerant Organisms	1	0	0
% Tolerance	21.62162	84.54545	67.90123
% Dominance	77.47748	65.45455	65.4321
FBI	6.27	7.182	6.704

Table 2: NWS Yorktown benthic macroinvertebrate results

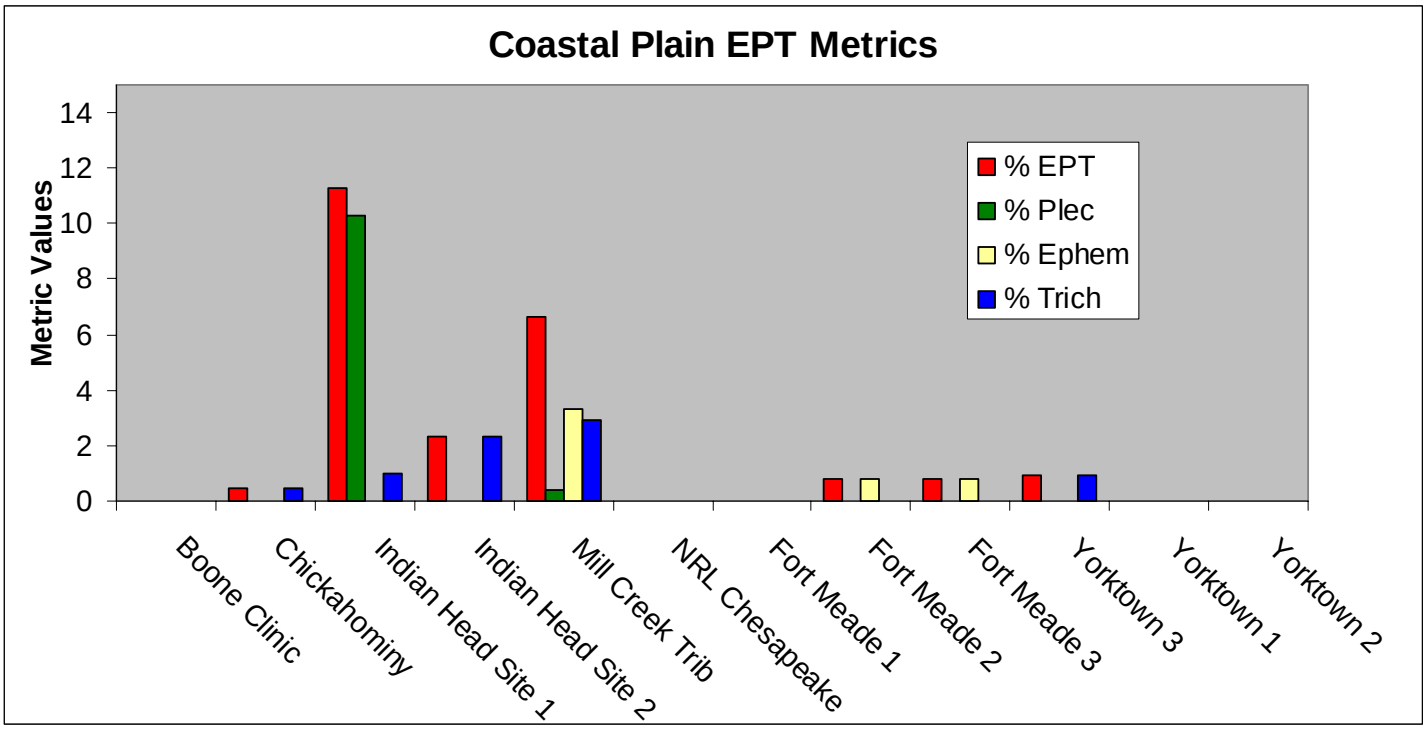

Figure 2: Comparison of NWS Yorktown benthic macroinvertebrate EPT metrics with other sites in the Coastal Plain

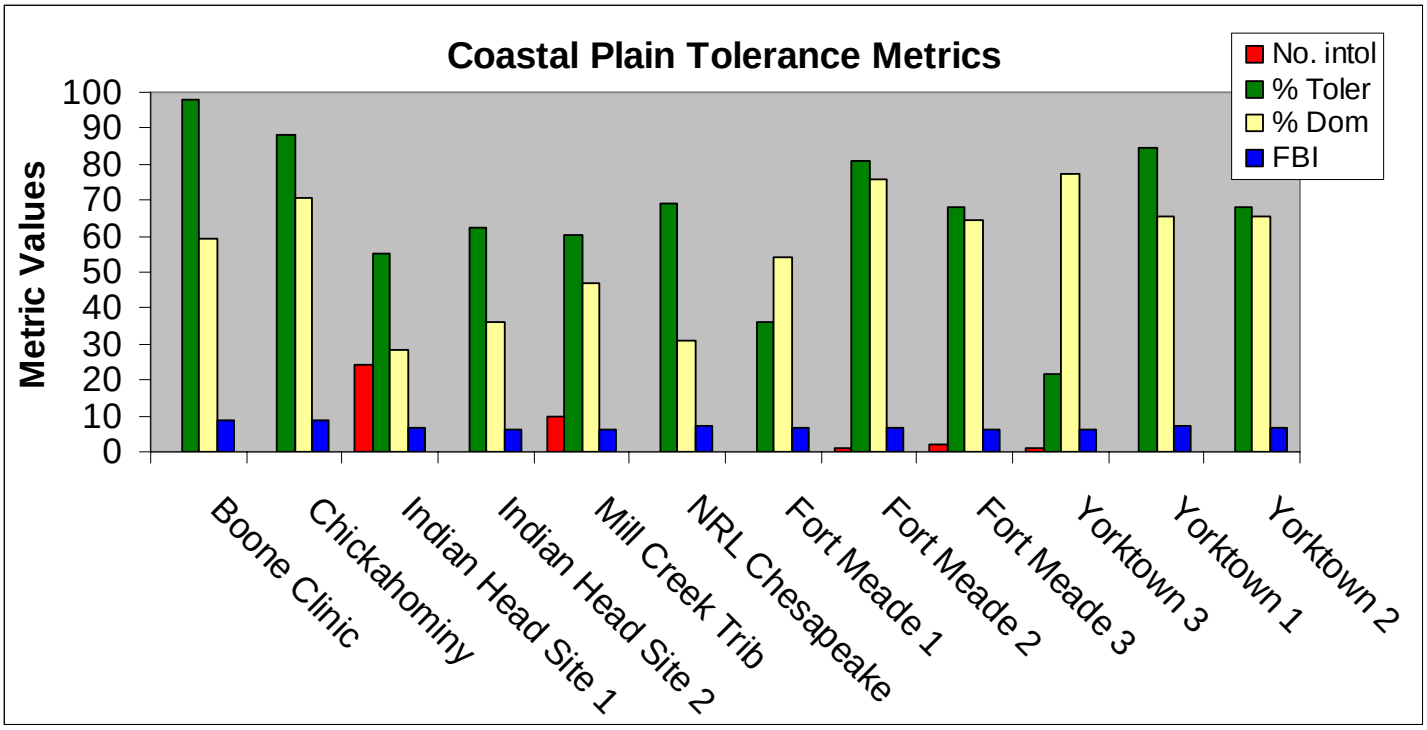

Figure 3: Comparison of NWS Yorktown benthic macroinvertebrate tolerance metrics with other sites in the Coastal Plain

Habitat

Habitat scores for NWS Yorktown 1, 2 and 3 were 182, 169, and 166 respectively. These scores tend to show improvement with age of buffer (Figure 4).

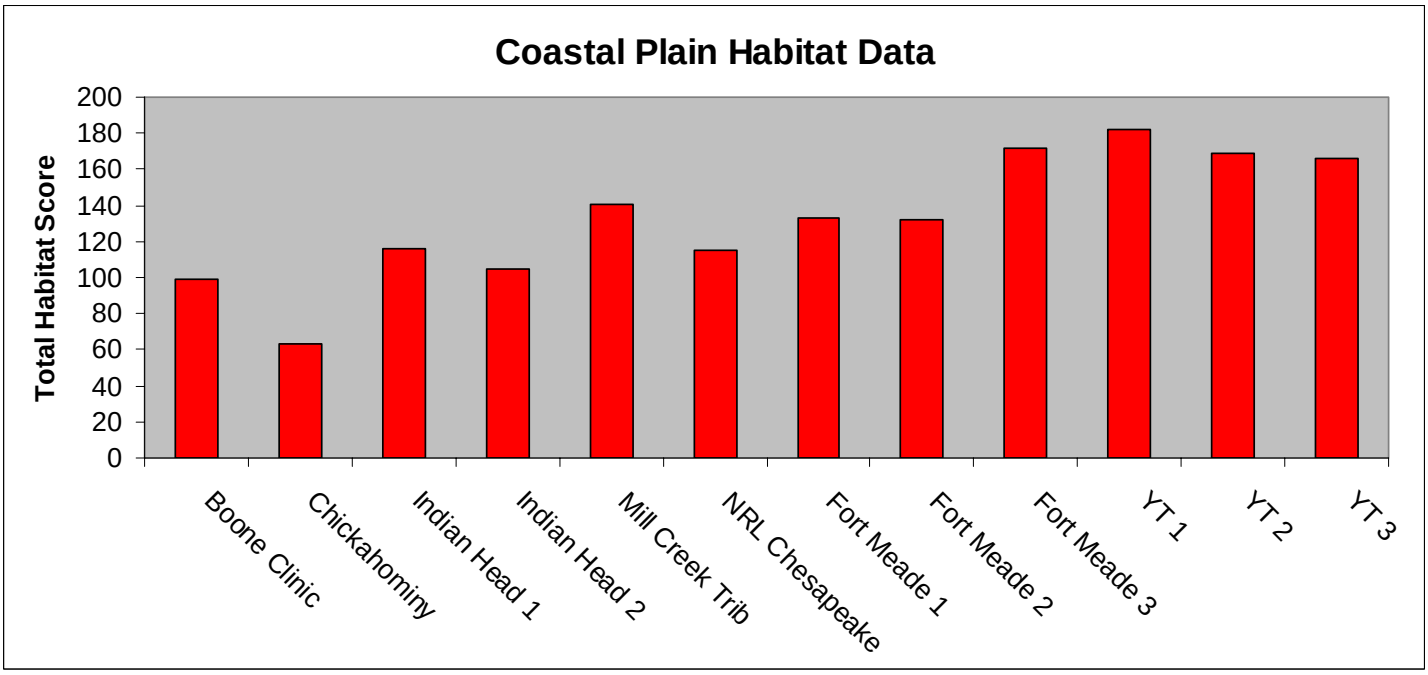

Figure 4: Comparison of NWS Yorktown habitat scores with other sites in the Coastal Plain

Recommendations

Site 1 at NWS Yorktown was adjacent to a wetland and just off a paved road. The area was planted 10 years ago, and appears to be a well functioning forested wetland stream. Recommendations for the site would be to attempt to control the invasive species and help to maintain downstream flow through beaver control.

The restored buffer at site 2 is growing well. However, there is an abundance of beaver activity flooding the area periodically. Therefore we recommend continuing beaver control at the site, and invasives control where appropriate.

Site 3 appeared to be an adjacent older growth forest on the right side of the stream with a planting sandwiched between 2 small streams. This site appears to be in adequate condition. We recommend an additional planting to enhance the woody vegetation in the field with some mowing and tree shelters to help ensure best survival.

Benefit:

Many financial resources have been spent on the restoration of riparian forest buffer zones on military installations in the Chesapeake Bay, with no follow-up assessment to determine if this restoration, and therefore money spent has actually proven beneficial to the military. This study assessed if these buffer zones are functioning correctly and therefore provides the military with a preliminary cost/benefit analysis of the forest riparian buffer zone program. This project also provides land managers on installations recommendations for management actions that may be necessary to improve these restored areas. Data from this project can also be used to address issues concerning the DoD Total Maximum Daily Load program (TMDL).

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Orzetti, L. L. (2004). Stream Community Structure- An Analysis of Riparian Forest Buffer Restoration in the Chesapeake Bay Watershed. Fairfax, VA, George Mason University: 253.

An Analysis of Forest Riparian Buffer Zones on Military Installations in the Chesapeake Bay: Fort Meade, Laurel, MD

Background:

Since 1997, the Department of Defense has invested significant financial resources on streamside forest restoration at over 85 installations in the Chesapeake Bay watershed. Streamside forested wetlands or forest buffer zones have been shown to reduce the impacts of both point source and non-point source pollution by filtering pollutants and sediments before they enter the adjacent stream. Much research has been done regarding the benefits of these restored areas for water quality control and improvement, but little has been done assessing recently planted buffers in the Chesapeake Bay watershed. As of yet, no study has examined the survivorship or benefits of restored streamside forests on military lands.

Objective:

This study tested the efficacy of restored forest riparian buffers along streams on military installations in the Chesapeake Bay watershed by examining stream macrobenthic community structure, and water and habitat quality.

Summary of Approach:

Three study sites were chosen at Fort Meade, MD. All of these sites are tributaries to the Patuxent River, and are first to second order streams. Samples were collected in the spring of 2007. Below is a description of sample collection and analysis activities.

Benthic macroinvertebrates

Samples were collected in one separate riffle/run habitat. In order to standardize assessments across streams, we collected organisms by disturbing the stream bottom for sixty seconds to a depth of approximately 10cm using rectangular framed kick nets (500 µm mesh). Organisms were collected from the nets using forceps and a 500µm sieve, and preserved in 95% ethanol for lab identification. Identification was done to family according to Merritt and Cummins (1984). Once identified, organisms were placed in vials and enumerated until at least 100 invertebrates per stream sample were counted. All data was entered into Excel spreadsheets and tolerance, feeding, habit and diversity metrics were calculated.

Water quality

Several water quality parameters were collected from each site within the 150-meter reach (riffle/run, pool, and mid-channel). Temperature (°C), specific conductance (microS/L), dissolved oxygen (mg/L), percent oxygen saturation, pH, and turbidity were measured using a YSI multiparameter probe. Water collected from each site was sent to the Chesapeake Biological Laboratory for analysis of total phosphorus, soluble reactive phosphorus, nitrate-nitrogen, ammonia-nitrogen, and total suspended solids. All data was then entered into Excel spreadsheets.

Habitat Assessment

Habitat assessments were done at each site using the methods described in the Rapid Bioassement Protocols for Use in Wadeable Streams and Rivers (Barbour, 1999) for high gradient streams. Data sheets for each stream were filled out and overall habitat scores were calculated.

Watershed Landuse Analysis and Area

At site (immediately adjacent to and upland of buffer area) and upstream land use assessments were done, by acreage in land use category, using aerial photography if available and ground-truthing. Hand held GPS units were used to obtain point stream location.

Results:

Data collected from study were compared with data from a previous study (Orzetti 2004) assessing the effectiveness of riparian buffer zones in the Piedmont physiographic region. Since Fort Meade falls within the coastal plain province, we are attempting to pool all coastal plain sites to statistically compare these sites to sites in the piedmont region in terms of their age, water quality, habitat, and benthic macroinvertebrate community dynamics. Land use in the immediate riparian

zone varied from ball fields at site two to wetland and forested areas in sites one and three respectively. Sites appeared to be relatively healthy with moderate to good riffle/run structures.

Water Quality

The water quality values for all sites at Fort Meade can be found in Table 1. Nitrate and SRP concentrations for site 1 fell within the baseline concentrations category for stream quality while sites 2 and 3 were within the moderately impaired water quality category for nitrate and SRP according to the USGS NAQWA program standards.

Water Quality Parameter	Fort Meade Site 1 –Bridge	Fort Meade Site 2 –Ball fields	Fort Meade Site 3 –Forest
Temperature (°C)	21.1	19.1	20.5
Specific Conductance (µhos)	350.1	268.3	301.1
Dissolved Oxygen (mg/l)	9.54	11.35	11.6
Dissolved Oxygen (% sat)	106.7	116.6	118.5
NO_3^-(mg/l)	0.796	1.573	1.278
NH_4^+(µg/l)	0.057	0.028	0.038
SRP(µg/l)	0.0035	0.0027	0.0021
Total Phosphorus(µg/l)	0.0443	0.0079	0.0172
TSS(mg/l)	4.3	2.4	3.1

Table 1: Fort Meade Water Quality Data

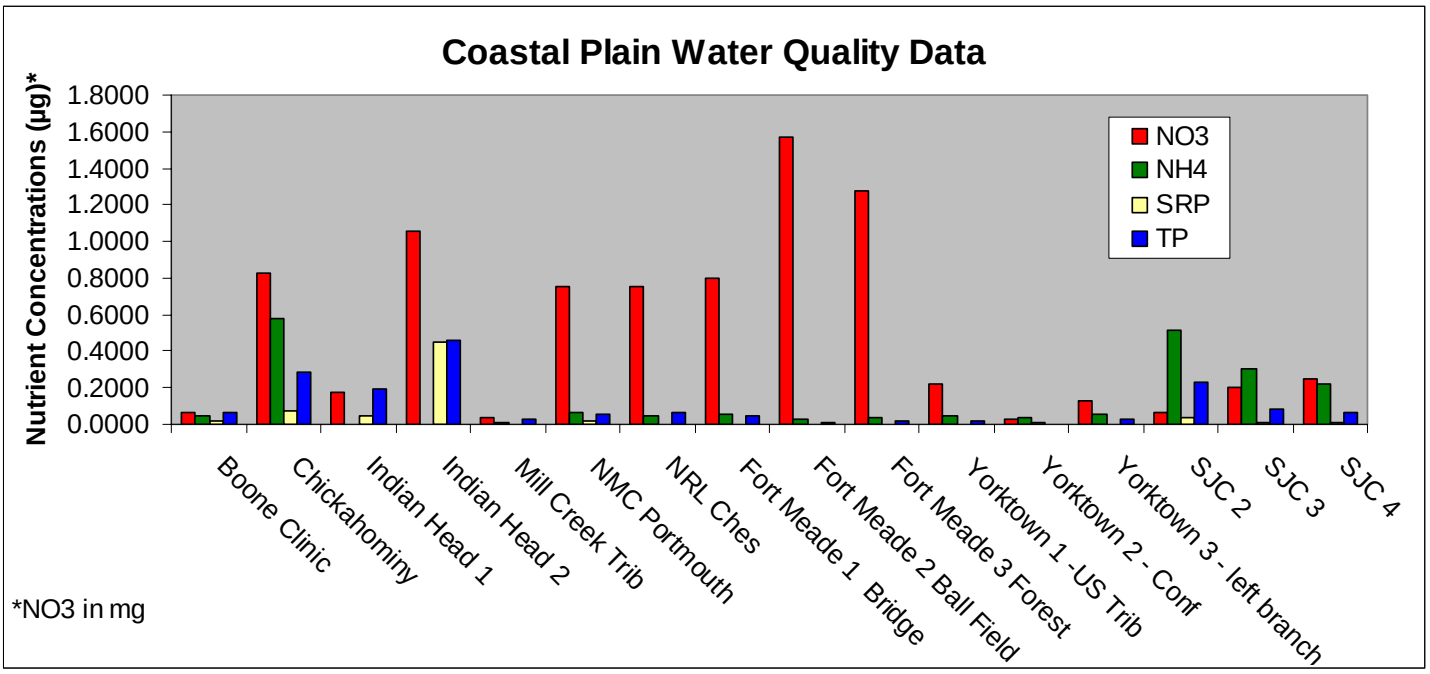

Figure 1: Comparison of Fort Meade water quality with similar aged sites in the Coastal Region

Benthic Macroinvertebrates

The benthic macroinvertebrate diversity and tolerance metrics for Fort Meade sites can be found in Table 2. As with water quality data, the results for Fort Meade sites varied among sites of similar ages (Figure 3).

Metric	Fort Meade Site 1 –Bridge	Fort Meade Site 2 –Ball fields	Fort Meade Site 3 –Forest
%EPT	0	0.763	0.775
% Plecoptera	0	0	0
% Ephemeroptera	0	0.763	0.775
% Trichoptera	0	0	0
No. Intolerant Organisms	0	1	2
% Tolerance	36.036	80.916	68.217
% Dominance	54.054	75.572	64.341
FBI	6.514	6.809	6.14

Table 2: Fort Meade benthic macroinvertebrate results

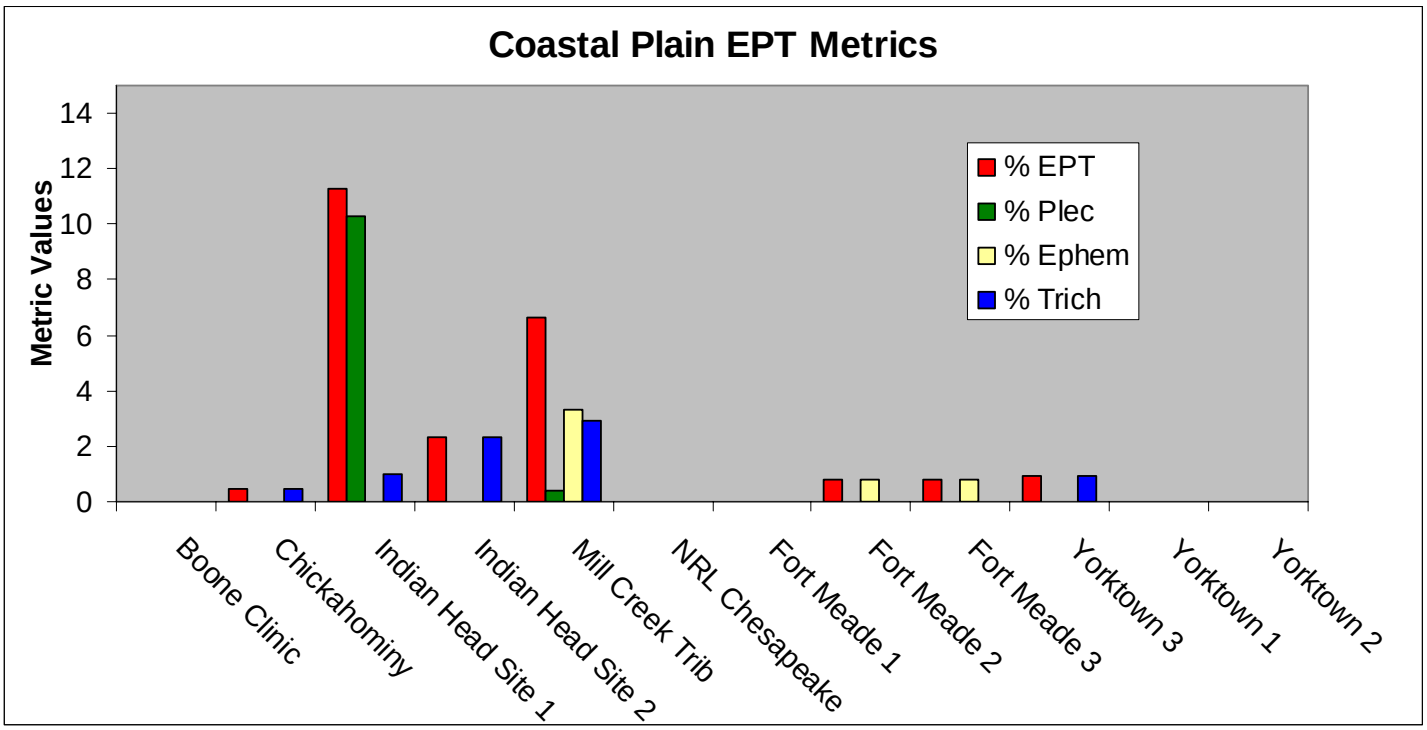

Figure 2: Comparison of Fort Meade benthic macroinvertebrate EPT metrics with similar aged sites in the Coastal Plain

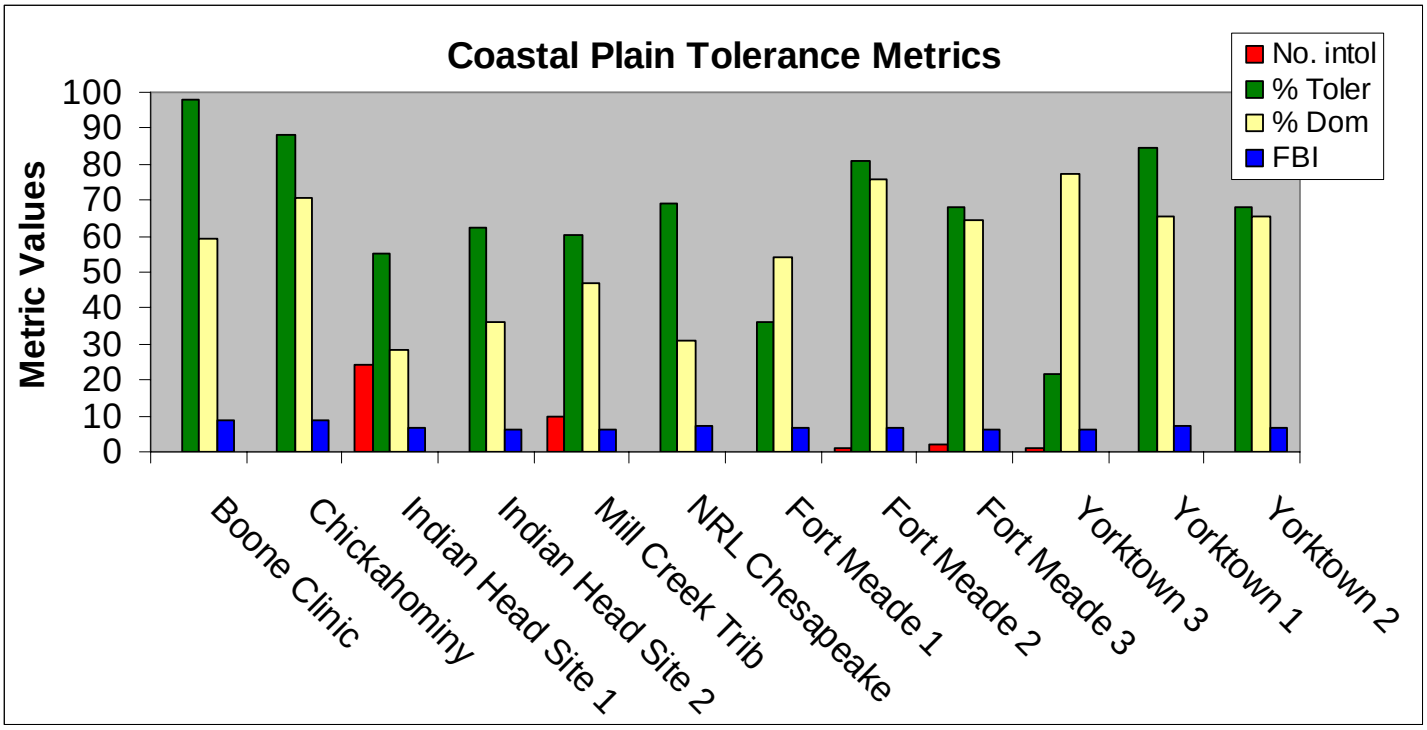

Figure 3: Comparison of Fort Meade benthic macroinvertebrate tolerance metrics with similar aged sites in the Coastal Plain

Habitat

Habitat scores for Fort Meade sites were 132, 133 and 172 respectively. These scores are commensurate with sites of similar age, and tend to show improvement with age of buffer (Figure 7).

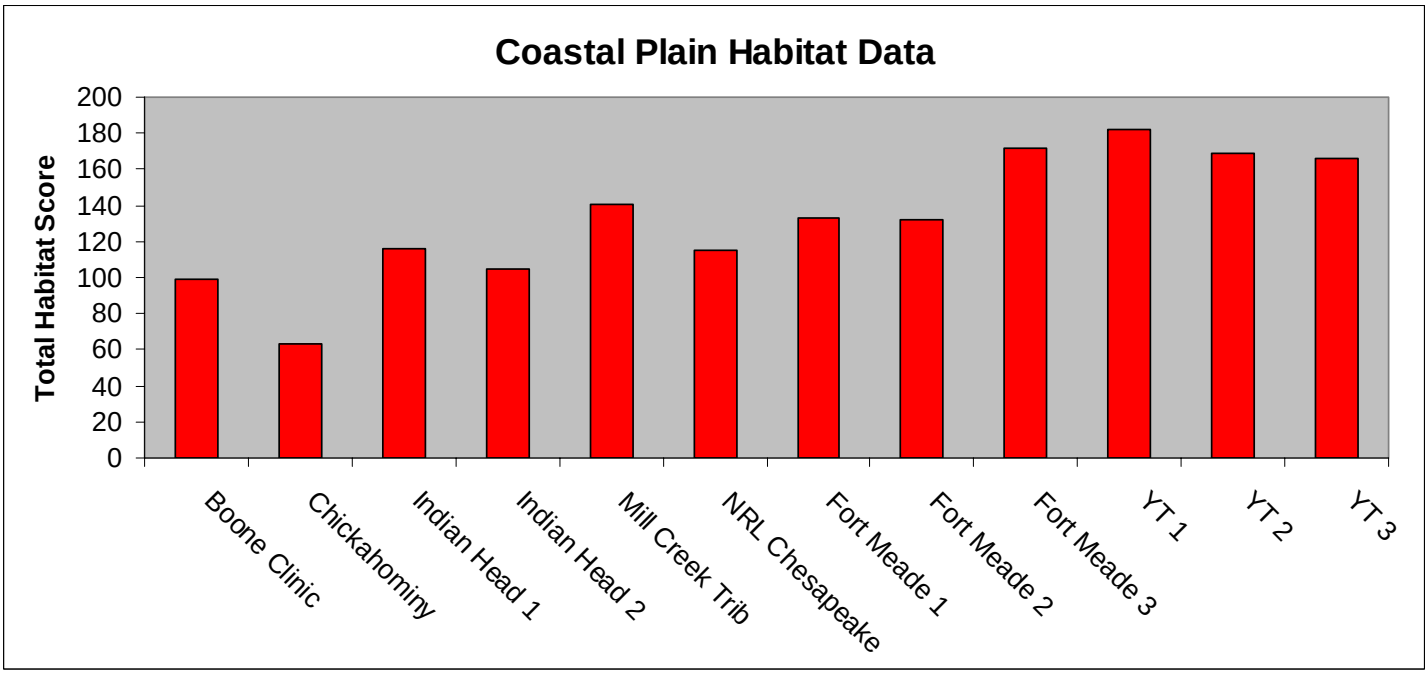

Figure 4: Comparison of Fort Meade habitat scores with similar aged sites in the Coastal Plain Region

Recommendations

Site 1 at Fort Meade was adjacent to a wetland and just off a paved road. The area was planted over 10 years ago, and appears to be a well functioning forested wetland stream. Recommendations for the site would be plant additional woody

species, attempt to control the poison ivy, possibly install some instream structures to maintain a diverse benthic habitat, and maintain the current distance from the road.

The restored buffer at site 2 appears to be growing well. However, there are several areas where invasive plants have choked out planted trees and shrubs. Site 2 recommendations include continued maintenance in the form of mowing, weed control, possibly reduction of fertilizing the adjacent playing fields. Additional recommendations include preserving the buffer between the stream and the main road, and enhancing the buffer with additional plantings on the left side of the stream.

Site 3 appeared to be an older growth forest with a small amount of plantings to enhance the upstream end of the stretch by the road crossing. In order to sample a stable riffle run habitat, we had to travel a distance downstream, therefore, instream enhancement at the upstream end of the reach nearer to the road would be recommended to ensure stable riffle/run benthic habitat.

Benefit:

Many financial resources have been spent on the restoration of riparian forest buffer zones on military installations in the Chesapeake Bay, with no follow-up assessment to determine if this restoration, and therefore money spent has actually proven beneficial to the military. This study assessed if these buffer zones are functioning correctly, and therefore provide the military with a preliminary cost/benefit analysis of the forest riparian buffer zone program. This project also provides land managers on installations recommendations for management actions that may be necessary to improve these restored areas. Data from this project can also be used to address issues concerning the DoD Total Maximum Daily Load program (TMDL).

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References

Alliance for the Chesapeake Bay (ACB), 1998. Stream Releaf: Forest Buffer Toolkit. Accessed: http://www.dep.state.pa.us/dep/deputate/watermgt/wc/Subjects/StreamReleaf/Forestbufftool/tkit_TOC.pdf

Barbour, M.T., J. Gerritsen, B.D. Snyder, J.B. Stribling, 1999. Rapid Bioassessment Protocols for use in Stream and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA-841-B-99-002. U.S. Environmental Protection Agency; Office of Water, Washington, D.C.

Merrit, R.W., Cummins, K.W., 1984. An Introduction to the Aquatic Insects of North America, Second Edition, Kendall/Hunt Publishing Company, Dubuque, Iowa.

Palone, R.S., Todd, A.H. (Editors), 1997. *Chesapeake Bay riparian handbook:: A Guide for Establishing and Maintaining Riparian Forest Buffers*. USDA Forest Service. NA-TP-02-97. Randor, PA.

Orzetti, L. L. (2004). Stream Community Structure- An Analysis of Riparian Forest Buffer Restoration in the Chesapeake Bay Watershed. Fairfax, VA, George Mason University**:** 253.

An Analysis of Forest Riparian Buffer Zones on Military Installations in the Chesapeake Bay: Carlisle Barracks, Carlisle, PA

Background:

Since 1997, the Department of Defense has invested significant financial resources on streamside forest restoration at over 85 installations in the Chesapeake Bay watershed. Streamside forested wetlands or forest buffer zones have been shown to reduce the impacts of both point source and non-point source pollution by filtering pollutants and sediments before they enter the adjacent stream. Much research has been done regarding the benefits of these restored areas for water quality control and improvement, but little has been done assessing recently planted buffers in the Chesapeake Bay watershed. As of yet, no study has examined the survivorship or benefits of restored streamside forests on military lands.

Objective:

This study tested the efficacy of restored forest riparian buffers along streams on military installations in the Chesapeake Bay watershed by examining stream macrobenthic community structure, and water and habitat quality.

Summary of Approach:

Two study sites were chosen at Carlisle Barracks, Carlisle, PA. This site falls within the Piedmont physiographic region. Both of these sites (on Letort Creek) are tributaries to Conodoguinet Creek and eventually the Susquehanna River. The sites are first order streams. The sites were planted over the past 10 years, and appear to be healthy restored areas. Samples were collected in the spring of 2007. Below is a description of sample collection and analysis activities.

Benthic macroinvertebrates

Samples were collected in one separate riffle/run habitat. In order to standardize assessments across streams, we collected organisms by disturbing the stream bottom for sixty seconds to a depth of approximately 10cm using rectangular framed kick nets (500 µm mesh). Organisms were collected from the nets using forceps and a 500µm sieve, and preserved in 95% ethanol for lab identification. Identification was done to family according to Merritt and Cummins (1984). Once identified, organisms were placed in vials and enumerated until at least 100 invertebrates per stream sample were counted. All data was entered into Excel spreadsheets and tolerance, feeding, habit and diversity metrics were calculated.

Water quality

Several water quality parameters were collected from one site within the 150-meter reach (riffle/run, pool, and mid-channel). Temperature (°C), specific conductance (microS/L), dissolved oxygen (mg/L), percent oxygen saturation, pH, and turbidity were measured using a YSI multiparameter probe. Water collected from each stream was sent to the Chesapeake Biological Laboratory for analysis of total phosphorus, soluble reactive phosphorus, nitrate-nitrogen, ammonia-nitrogen, and total suspended solids. All data was then entered into Excel spreadsheets.

Habitat Assessment

Habitat assessments were done at each site using the methods described in the Rapid Bioassement Protocols for Use in Wadeable Streams and Rivers (Barbour, 1999) for high gradient streams. Data sheets for each stream were filled out and overall habitat scores were calculated.

Watershed Landuse Analysis and Area

At site (immediately adjacent to and upland of buffer area) and upstream land use assessments were done, by acreage in land use category, using aerial photography if available and ground-truthing. Hand held GPS units were used to obtain point stream location.

Results:

Data collected from study was pooled with data from a previous study (Orzetti 2004) assessing the effectiveness of riparian buffer zones in the Piedmont physiographic region. Since the Carlisle Barracks falls within the piedmont province, we were able to statistically compare these sites in terms of their water quality, habitat, and benthic

macroinvertebrate community dynamics. Land use in the immediate riparian zone is suburban, while upstream landuse is a mixture of urban, suburban and agriculture.

Water Quality

The water quality values for unnamed Letort Creek 1 and 2 at Carlisle Barracks can be found in Table 1. All nutrient and solids concentrations were higher in site 1 than in site 2, while specific conductance was lower. Nitrate and SRP concentrations fell within the highly impaired category for stream water quality category according to the USGS NAQWA program standards. When compared to other sites of the same age in the piedmont region, Carlisle Barracks show lower nutrient concentrations results (Figure 1).

Water Quality Parameter	Letort Creek 1	Letort Creek 2
Temperature (°C)	14.4	14.1
Specific Conductance (µhos)	534	546
Dissolved Oxygen (mg/l)	11.25	11.2
Dissolved Oxygen (% sat)	111.8	110.1
NO_3^-(mg/l)	6.43	6.14
NH_4^+(µg/l)	0.027	0.007
SRP(µg/l)	0.0029	0.0016
Total Phosphorus(µg/l)	0.0095	0.0089
TSS(mg/l)	5.3	4.2

Table 1: Fort Detrick Water Quality Data

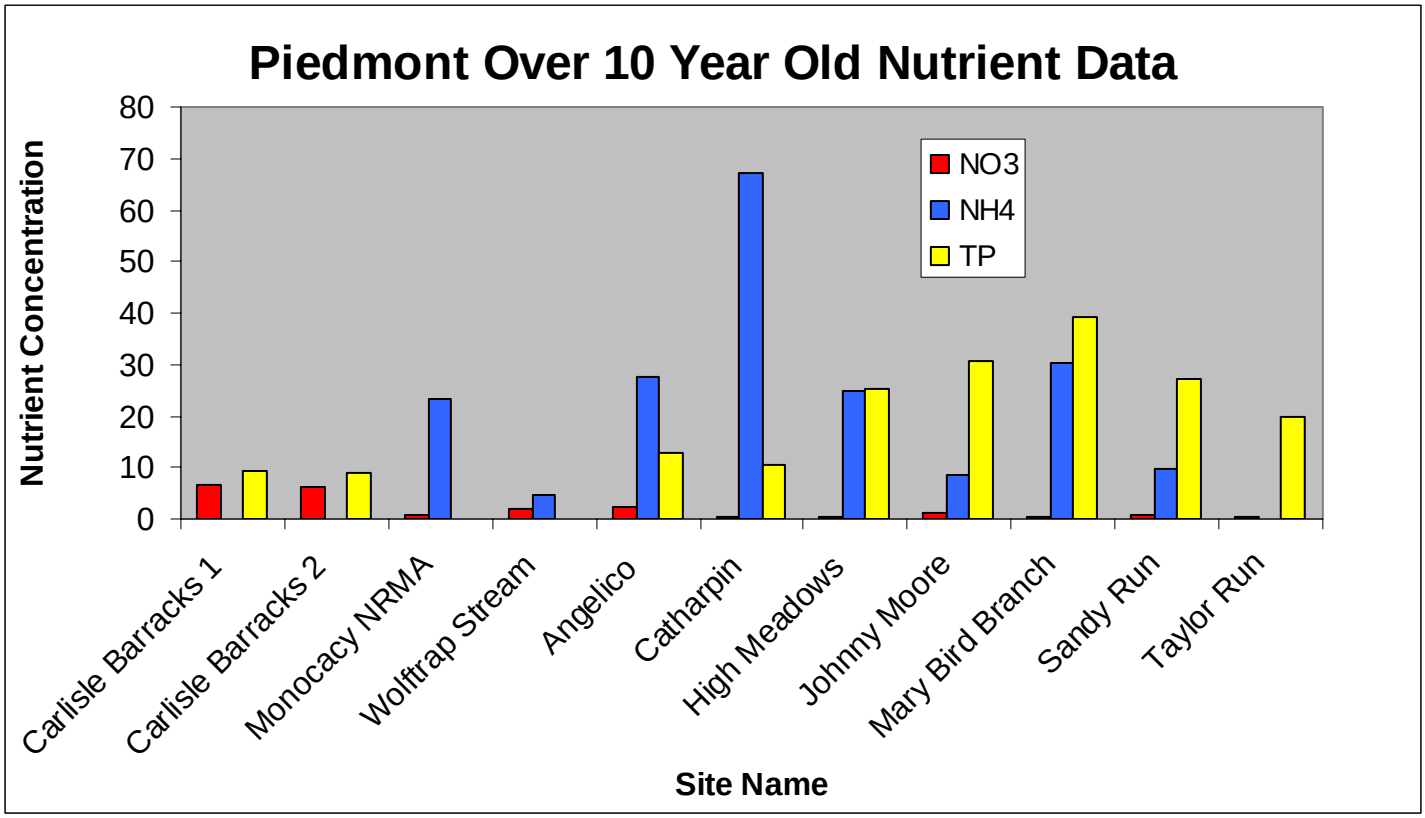

Figure 1: Comparison of Carlisle Barracks (Letort Creek) water quality with similar aged sites in the Piedmont Region

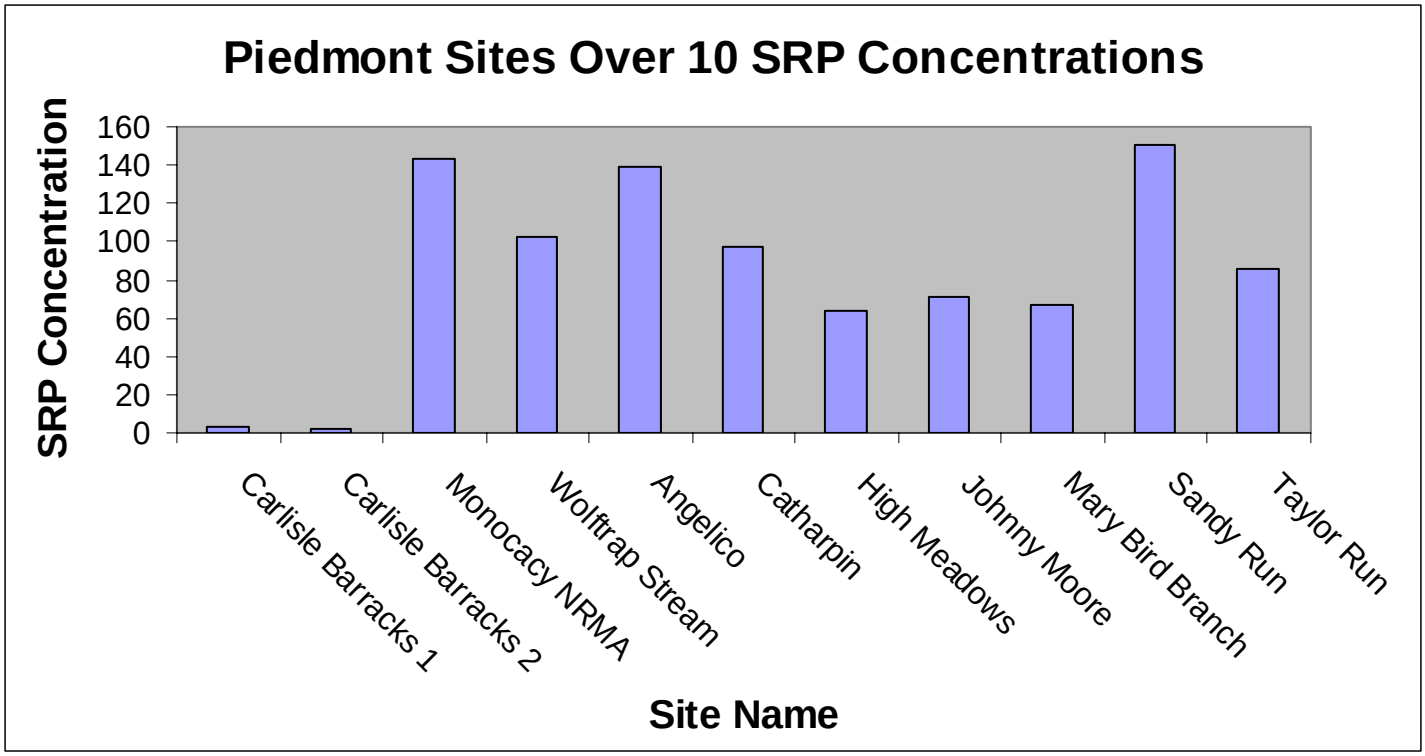

Figure 2: Soluble Reactive Phosphorus concentration for site in the Piedmont

Benthic Macroinvertebrates

The benthic macroinvertebrate diversity and tolerance metrics for Carlisle Barracks Letort Creek 1 and 2 can be found in Table 2. As with water quality data, the results for Carlisle Barracks' sites differed among sites of similar ages (Figures 3 and 4).

Metric	Letort Creek 1	Letort Creek 2
%EPT	1.55	1.39
% Plecoptera	0	0
% Ephemeroptera	1.55	0.699
% Trichoptera	0	0.699
No. Intolerant Organisms	1	0
% Tolerance	7.75	36.36
% Dominance	72.09	33.56
FBI	6.008	6.26

Table 2: Carlisle Barracks benthic macroinvertebrate results

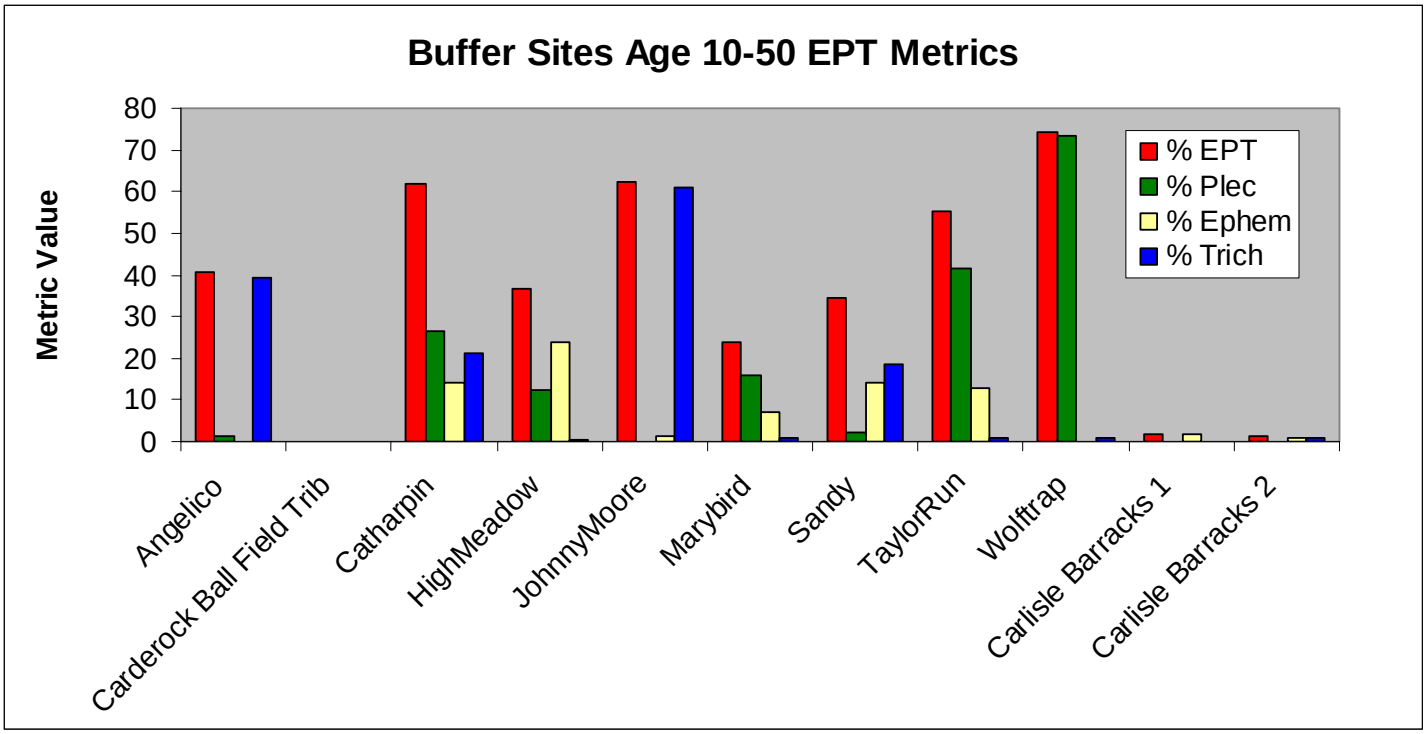

Figure 3: Comparison of Carlisle Barracks (Letort Creek) benthic macroinvertebrate EPT metrics with similar aged sites in the Piedmont Region

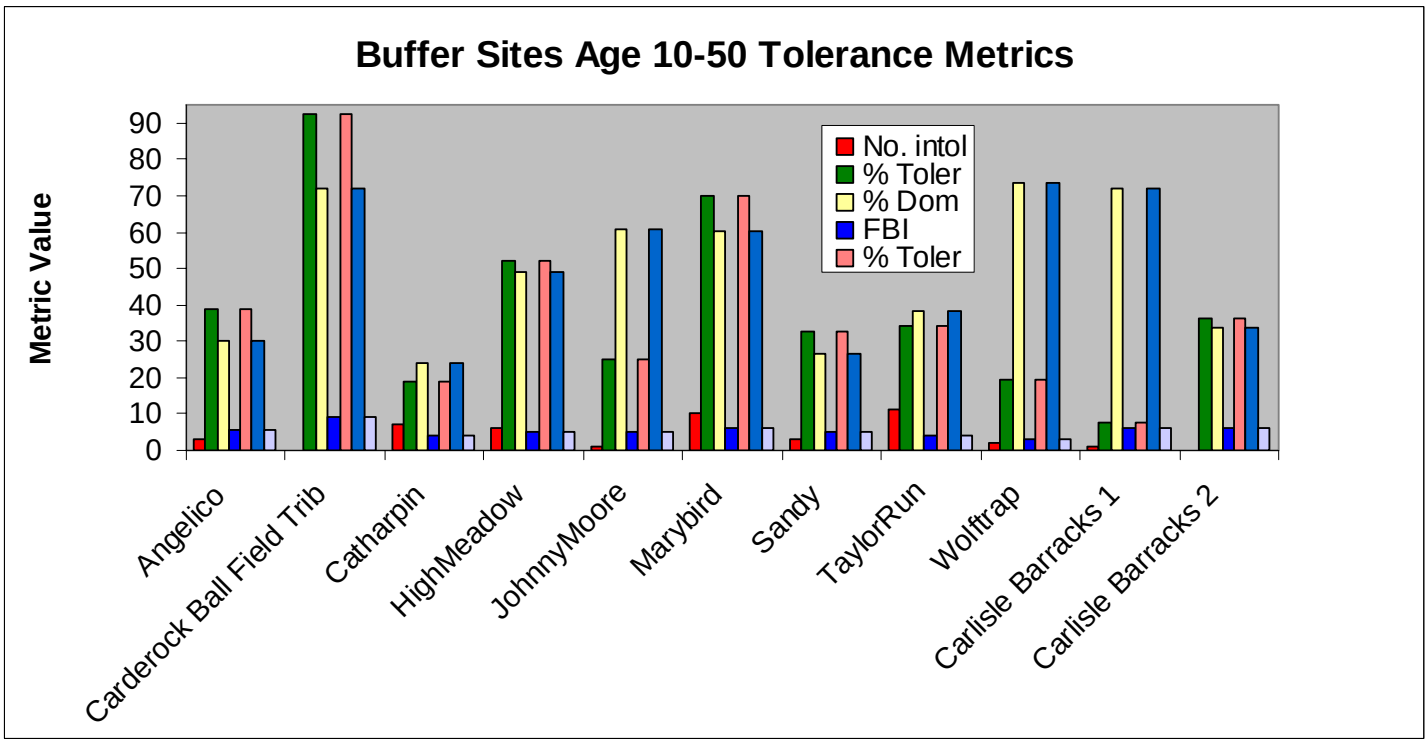

Figure 4: Comparison of Carlisle Barracks (Letort Creek) benthic macroinvertebrate tolerance metrics with similar aged sites in the Piedmont Region

<u>Habitat</u>

Habitat scores for Letort Creek sites 1 and 2 were 116 and 132 respectively. These scores are commensurate with sites of similar age, and tend to show improvement with age of buffer (Figure 5).

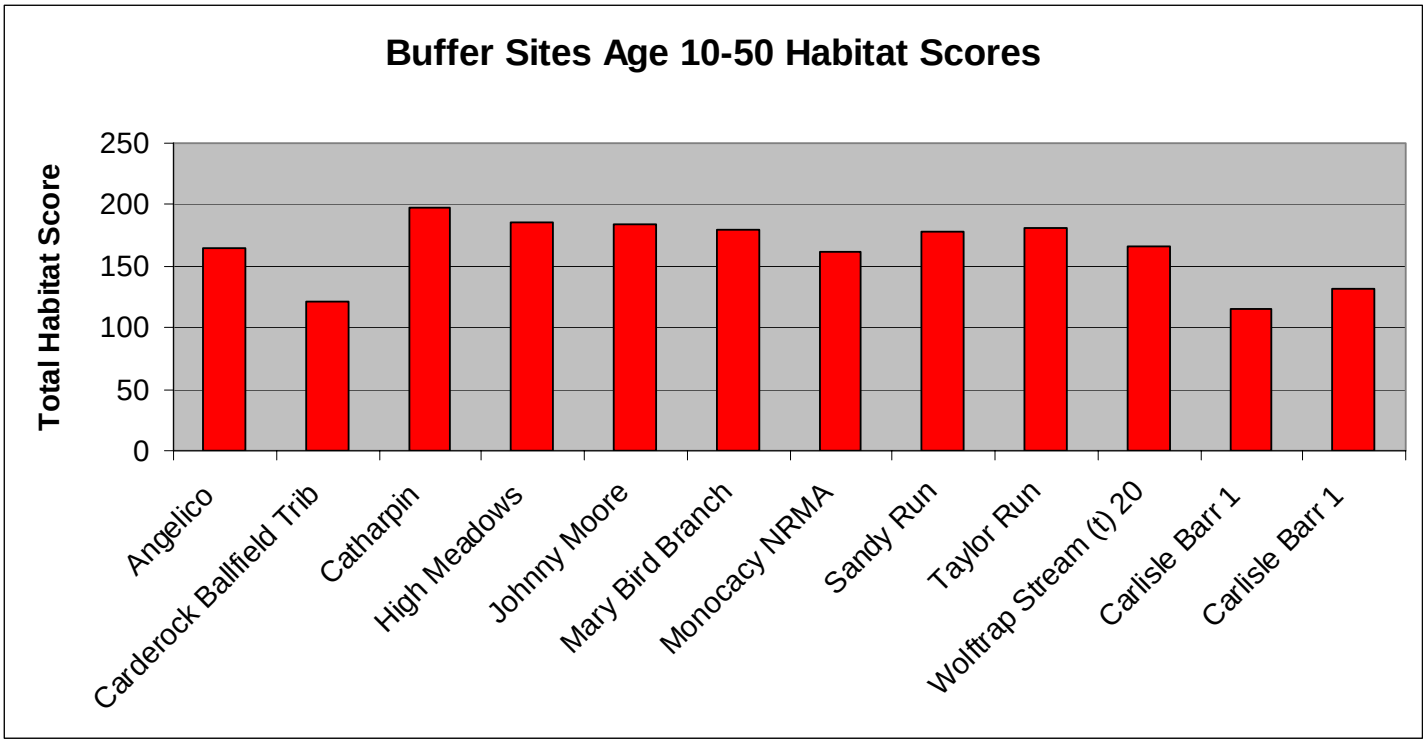

Figure 5: Comparison of Carlisle Barracks (Letort Creek) habitat scores with similar aged sites in the Piedmont Region

Recommendations

The sites at Carlisle were both very maintained through mowing and interplanting with a plan to ensure the best survival possible. Additional plantings are ongoing, with plantings occurring as late as last fall. Recommendations for the site include continued maintenance in the form of mowing, weed control, and ensuring there is enough water during periods of drought. In addition, to return the stream to a more natural condition, we would recommend a plan to remove the walls running the length of the stream which isolate the stream from its flood plain. This will help the buffer perform its desired functions and possibly help lower nutrient concentrations and increase instream habitat conditions.

Benefit:

Many financial resources have been spent on the restoration of riparian forest buffer zones on military installations in the Chesapeake Bay, with no follow-up assessment to determine if this restoration, and therefore money spent has actually proven beneficial to the military. This study assessed if these buffer zones are functioning correctly, and therefore provide the military with a preliminary cost/benefit analysis of the forest riparian buffer zone program. This project also provides land managers on installations recommendations for management actions that may be necessary to improve these restored areas. Data from this project can also be used to address issues concerning the DoD Total Maximum Daily Load program (TMDL).

This project was funded under an award from the Legacy Resource Management Program (LRMP). The Legacy Program is a congressionally appropriated program under the Department of Defense Conservation Program that funds natural and cultural resource projects. This is the first of a two year project that will continue through 2007 and will culminate with a final report and updated database for the DoD Chesapeake Bay Program.

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References

Barbour, M.T., J. Gerritsen, B.D. Snyder, J.B. Stribling, 1999. Rapid Bioassessment Protocols for use in Stream and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA-841-B-99-002. U.S. Environmental Protection Agency; Office of Water, Washington, D.C.

Merrit, R.W., Cummins, K.W., 1984. An Introduction to the Aquatic Insects of North America, Second Edition, Kendall/Hunt Publishing Company, Dubuque, Iowa.

Orzetti, L. L. (2004). Stream Community Structure- An Analysis of Riparian Forest Buffer Restoration in the Chesapeake Bay Watershed. Fairfax, VA, George Mason University**:** 253.