Assessing Progress Toward Meeting Nutrient Reduction Goals for Maryland Coastal Plain Cropland

Proposal Submitted to: Harry R. Hughes Center for Agro-Ecology, Inc.

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Project Duration and Time Table

This project will have two separate but complementary components that will assess approaches for monitoring progress toward meeting nitrogen and phosphorus reduction goals in Maryland Eastern Shore watersheds. Both components will utilize previous data sets to evaluate changes that have occurred since the first studies were conducted and how these approaches might be used in the future.

The phosphorus component will involve extensive soil sampling, requiring that field activities take place primarily during fall through spring months when summer crops are not growing in the fields and when winter cereal crops are still in vegetative growth stages. Before sampling activities can begin, there will need to be a planning period involving local NRCS staff and farmers and landowners to gain field access. This is a critical phase since landowner cooperation is required for this project to move forward. The duration of the planning period will be at least 3 months. After the planning process is completed at least one full non-growing season sampling period (October-April) will be required to collect the soil samples needed, plus an additional year for sample and data analysis. Ideally, this component of the project could be completed in two years with a May 1 start date. For sampling to be completed during the 2009-2010 non-growing season a start date no later than July 1, 2009 would be needed. Later start dates would likely push sampling back into the 2010-2011 October-April period.

The nitrogen component of this study will utilize stream baseflow nitrate sampling in a network of tributaries of the Choptank River that were sampled extensively during the 1990's. The same 30 basins will be sampled monthly for two years, when possible at flow levels similar to those during the original study to evaluate changes in nitrogen delivery to tidal waters through subsurface flow paths. In addition, four watersheds in the Choptank basin where more intense baseline sampling was conducted in the 1990's will be sampled more intensively to make finer scale evaluations of changes in baseflow nitrate discharge during the last 10-20 years of Bay restoration activities. In conjunction with the sampling effort, a time line of land use changes and management activities implemented in the Choptank watershed since the Bay restoration effort began will be compiled along with the latest estimates of how these activities would be expected to change groundwater nitrate concentrations under cropland. The restoration effort timeline will be evaluated in the context of information on groundwater residence time to determine how baseflow nitrogen loads might be expected to change in the Choptank basin. Implementation data are not available at the subbasin level to match the stream sampling effort making it impossible to match implementation to stream data in each subbasin. Sampling will be conducted year round for two years in this study. Sample and data analysis will be ongoing as will compilation of implementation data. An additional 6 months will be needed after completion of sampling activities to complete sample and data analysis and prepare a final report.

In summary, two years will be needed to complete the phosphorus component of this study that will have a 3-6 month planning period, a 7 month sampling period, and a 1 year period for sample and data analysis and preparation of a final report. Since the nitrogen component does not require land owner cooperation, only a limited planning period is needed. Two years will be required to complete sampling activities and an additional 6 months for data analysis and report preparation. If results from both components are included in a single final report, the entire project will require 30 months to complete from the start date.

Hypotheses and Objectives

The primary hypothesis, or more accurately, the primary premise of this project is that straightforward sampling techniques can be used to evaluate progress toward meeting nutrient reduction goals from agriculturally dominated Eastern Shore watersheds by utilizing historical data sets of key nutrient parameters. Nitrogen and phosphorus move differently in watersheds and differing monitoring approaches are needed.

The specific objectives of this project are to:

1. Reevaluate soil phosphorus levels using GPS grid sampling on a field by field basis in the Green Run basin of the upper Pocomoke watershed to determine if soil P levels have changed since 2000 when soil P concentrations in the watershed were originally evaluated using GPS grid sampling.

2. Reevaluate stream baseflow nitrate concentrations in 30 sub watersheds of the Choptank River that were sampled intensively during the mid 1990’s to evaluate whether rates of groundwater nitrate delivery to tidal waters have changed in the last 10-20 years.

3. Construct a land use and implementation timeline in the Choptank River watershed to determine an expected stream baseflow nitrate response given estimates of groundwater residence times.

4. Evaluate whether sequential GPS based soil sampling and stream baseflow nitrate sampling are practical monitoring tools that can be used to verify progress toward meeting nutrient reduction goals.

Methodology and Procedures

Phosphorus component - This project will use relatively straightforward sampling methods combined with GPS and GIS technology to create high resolution maps of soil P concentrations in the South Fork Green Branch (720 ha) sub watershed of the Pocomoke River. This watershed was studied intensively from 1994-2000 as part of a study on the effects of focused implementation of P-based nutrient management planning and winter cover crops on nutrient discharge at the watershed scale (McCoy and Sturm 1998). As part of the original study, a GPS grid based sampling approach was used to precisely characterize soil surface P levels on all cropland in the basin. The same grid based sampling procedure will be used to determine if soil P levels have changed since the original study. The basin is located within a concentrated poultry producing region and poultry litter has been applied extensively to cropland in the watershed. Soil P levels in cropland in the basin varied widely in 2000, but had an average fertility index value (FIV) of over 400 for the 0-20 cm depth interval, a value more than four times greater than the range needed for optimum crop production (50-100). As in the original study, shallow soil samples will be collected from all cropland in the watershed at a density of one discrete sample/ha, or approximately on a 100 m x 100 m grid system depending on field configuration. Cores will be collected to a depth of 30 cm and subdivided into 0-5 cm, 5-20 cm, and 20-30 cm increments. Each sample will consist of 10 cores pooled together and the site of each sampling will be located using GPS coordinates. The same grids and sample locations will be used as in the original sampling effort. Samples will be dried and prepared for extraction at the Wye Research and Education Center (WREC). Extractions for P analysis will be prepared on a weight basis which is more accurate than the volumetric procedure used for routine analysis. A total of approximately 500 locations will be sampled at three depths yielding a total of 1500 discrete samples to be analyzed. Maps will be developed for each depth increment showing average field soil P levels. Within field variability also will be calculated to evaluate the adequacy of the sampling density for determining field average soil P levels.

In conjunction with soil sampling, an attempt will be made to obtain information from farmers on P inputs and removal rates from fields in the watershed so that changes in soil P can be linked to management activities. Nutrient management plans currently are not available to the public so this obtaining this information will be totally dependent on farmer willingness to cooperate. Cooperation was nearly complete in the original study but will likely be less given recent passage of new CAFO regulations in Maryland.

It should be noted that landowner cooperation is required to undertake this component of the project. In the original study, landowners were fully cooperative and all cropland in the watershed was sampled. However, there is no guarantee of landowner cooperation for a repeat of sampling efforts, and even less of a guarantee regarding availability of field management activities.

Nitrogen component - The baseflow sampling component of this project will focus on comparing current levels of stream baseflow nitrate in sub-basins of the Choptank River with results from extensive sampling of the same basins conducted during the 1990’s. The Choptank is the largest Eastern Shore tributary and has been the site of focused implementation efforts as well as many water quality studies. The overall rationale of this component is that baseflow nitrate concentrations are an integrated indicator of the overall level of groundwater nitrate contamination within a watershed in combination with the effectiveness of background nitrate attenuation mechanisms. Measuring either one of these components in a comprehensive way at the watershed scale is nearly impossible, but baseflow nitrate concentrations indicate their combined effects. It is the combined effect that determines subsurface nitrate loads delivered to tidal waters. The large amount of water stored in shallow coastal plain aquifers makes it difficult to determine progress toward reducing nitrate loads using stream data during short time intervals (<5 years). However, by utilizing historical data sets it will be possible to determine whether the primary N load from Eastern Shore watersheds has changed in the last decade.

Stream baseflow nitrate concentrations will be measured monthly for a two year period at the same location in approximately 40 sub-basins that were sampled intensively in the mid 1990’s in a study to evaluate the role of groundwater in delivering nitrogen to tidal waters from cropland. Although sampling generally follow a monthly schedule, specific sampling dates will be based on flow conditions to avoid the influence of storm flow. All sampling will be linked to flow levels at the USGS flow monitoring station located on the upper Choptank at Greensboro which has been operating since 1948. This will make it possible to target sampling in this study to match regional flow conditions during the sampling efforts in the 1990’s. Although there are year-to-year variations in seasonal baseflow conditions, sampling during a two year period will create a high likelihood that sample collection can be conducted during seasonal flow conditions similar to those in earlier monitoring efforts.

In addition to the monthly sampling, four basins within the Choptank system that have more detailed data records will be sampled more intensively to allow more extensive comparisons of current versus historical baseflow nitrate concentrations. During the 1990’s, intensive implementation of best management practices (BMPs) and monitoring of watershed discharge were carried out in the Jarmins Branch watershed (recently renamed from German Branch), a 12,000 acre agriculturally dominated sub watershed located in the Tuckahoe branch of the upper Choptank basin. The watershed was one of four watersheds selected in the Maryland Targeted Watershed Project in 1989 for intensive assessment and restoration of water quality and habitat for living resources. Streamflow in Jarmins Branch was sampled extensively throughout the 1990s as were subsurface nitrate concentrations within the watershed (Staver 2001). Within the Jarmins Branch watershed, Wildcat Branch is a smaller sub basin that has a more extensive baseflow data record. Mill Creek and Tuckahoe Creek are two additional basins that were sampled more intensively from the late 1980's through 2000 (Staver et al. 1996). These four basins will be sampled at approximately weekly intervals with sample analysis following the same procedures outlined for the monthly sampled basins.

In addition to the baseflow sampling activities, a time line of restoration activities in the Choptank basin will be constructed in order to establish what changes in groundwater nitrate concentrations under crop fields would be expected given levels of implementation of nitrogen control strategies. Current estimates of the effectiveness of various practices will be used to calculate reductions in groundwater nitrate concentrations. These estimates of infield reductions will be combined with information on groundwater residence times compiled by USGS and studies conducted in the Jarmins Branch watershed (Staver 2001). Since past practice implementation is not compiled at the subbasin scale, it will only be possible to estimate in general how past implementation should lead to reductions in baseflow nitrate loads in throughout the Choptank basin.

Justification

Despite the more than two decade long effort to reduce nutrient inputs to Chesapeake Bay, very little verifiable progress has been made toward reducing nutrient losses from cropland. The problem has been especially apparent on the Eastern Shore, where nutrient inputs to tidal waters are dominated by agricultural sources. In addition, the dominant role of groundwater flow in delivering nitrogen to surface waters has made progress especially difficult to quantify. To date, tidal water quality monitoring efforts have indicated no downward trends in nitrogen concentration and in some cases there were indications of increasing nutrient loading rates through the first decade of the Chesapeake Bay restoration effort. (Norton and Fisher 2000). Phosphorus transport patterns in the Coastal Plain are even less clear than are those for nitrogen since direct measurement of loads requires high-quality flow data and volume-based sampling of storm-events, which is logistically difficult and expensive. Phosphorus concentrations can increase by an order of magnitude during storm flow making estimates based on limited sampling efforts generally unreliable (Staver et al. 1996). The lack of comprehensive data sets for P discharge rates, and the high cost of establishing the needed monitoring systems for accurately characterizing P discharge rates suggests that other approaches will need to be used to evaluate progress both looking back as well as into the future. Although many factors determine P losses in the short term, soil P levels probably are the best available indicator of progress toward meeting P reduction goals. To date, progress toward reaching nutrient reduction goals has largely been estimated using the Chesapeake Bay Program watershed model, but this effort has proven to be of little value for predicting the effect of watershed activities on delivered loads of N and P from Coastal Plain tributaries.

The lack of verifiable progress toward meeting nutrient reduction goals has created doubt as to whether current nutrient reduction strategies will ever achieve levels of nutrient reductions needed to restore Chesapeake Bay. This doubt has created more pressure for regulatory approaches to managing nutrients on cropland and calls for more funding to support incentive programs aimed at reducing nutrient losses. However, before adjustments can be made in nutrient control efforts it is critical that methods be developed that allow accurate assessment of actual changes in nutrient losses as a result of current activities or changes in key watershed factors such as soil P concentrations that will influence the potential for nutrient losses in the long term. It is clear that reducing delivered nutrient loads to Chesapeake Bay from Eastern Shore crop land will take much longer than originally projected due to storage of nitrate in shallow aquifers and high soil P reservoirs. Without reliable strategies for tracking progress, it will be difficult to even know if policy adjustments are necessary or if what is needed is more time for policies to work. Reliable strategies for tracking progress also are necessary to develop efficient regulatory and incentive programs that do not put undue burden on agricultural producers. This project will provide information on how delivered baseflow N loads have changed in last decade in typical central Eastern Shore basins and also how soil P levels have changed in a concentrated poultry producing region in the last ten years. It will also consider how the history of implementation of N control strategies would be expected to reduce groundwater nitrate concentrations under cropland, and the expression over time of those reductions in stream baseflow nitrate in the Choptank basin. More importantly, it will evaluate the feasibility of systematic approaches for evaluating progress toward meeting agriculture nutrient reduction goals.

The principal investigator on this project (Staver) has been conducting watershed and agricultural research projects at the UMD College of Agriculture and Natural Resources Wye Research and Education Center and throughout the Eastern Shore since 1984. The Center has full sample processing and analytical facilities. Research efforts have focused on hydrologic transport of nutrients in Maryland cash grain production systems through both subsurface and overland flow. The primary objective of most of this research has been to define patterns and causes of water and nutrient movement so that management decisions can be made that result in reduced rates of nutrient loss from agricultural systems while at the same time maintaining grain yields and profitability. These projects have involved collaboration with scientists from other state, federal and private research institutions and have addressed information needs of all the major government agencies involved in the management of land and water resources in Maryland. Relevant publications resulting from work conducted by the principal investigator are listed in the attached CV.

Literature Review

Currently, little specific information exists on phosphorus transport rates from lower Eastern Shore watersheds where concerns are greatest regarding high rates of poultry litter to cropland. Jordan et al. (1997) reported relatively low annual P losses (0.15 kg/ha) from two small mixed land use watersheds in the Nanticoke River drainage basin based on water quality data collected during 1991. Although it was suggested that soils in the region were highly enriched in P, no soil data were reported from the watersheds where discharge data were collected. Baseline monitoring in the two Pocomoke sub watersheds where this project is being proposed indicated average annual P losses of 2.2 kg/ha from 1994-1997 (McCoy and Sturm 1999). These losses are similar to average values reported for row crops in a review by Beaulac and Reckow (1982). Assuming that P losses from forest land in the Pocomoke watersheds are much lower than from cropland, P losses from cropland in these two watersheds actually exceed rates reported from most crop settings. These high P discharge rates are not surprising given the elevated soil P concentrations that were detected in the pilot grid-based soil sampling study that was conducted in the Green Run watersheds in 2001.

While little research on P transport has been conducted on the lower Eastern Shore, long-term studies of P movement have been conducted in small field-scale watersheds in the Wye River drainage basin. One of the major findings of these studies was that dissolved P can be a major fraction of total P losses from Eastern Shore watersheds (Staver and Brinsfield 1995). Sharpley (1995) studied the dissolved P issue extensively and concluded that watershed dissolved P losses tend to increase as soil P levels increase, especially in uppermost soil horizons. This finding is supported by laboratory studies conducted with Maryland soils in which water extractable P was found to increase with increasing soil P levels for a given soil type (Coale and Olear 1996). Although, many factors influence P losses in the short term, in the long term it is clear that soil P concentrations play a major role in determining the potential for P losses (Staver and Brinsfield 2001). This is why the Water Quality Improvement Act passed in Maryland in 1998 mandates P based nutrient management that is aimed at intensifying management activities on high P soils and stopping the trend of increasing soil P concentrations that was occurring under N based nutrient management. However to date, there is virtually no information available on how mandated P-based nutrient management has affected soil P concentrations.

Systematic information also is lacking on the change in subsurface nitrate loads from agriculturally dominated watersheds in the Coastal Plain. While approximately 65 percent of discharge from the Chesapeake Bay watershed is routinely monitored as part of the Chesapeake Bay Program River Input Monitoring (RIM) program, less than 5 percent of the drainage from the Coastal Plain is captured by this system. The only RIM station within the Coastal Plain of Maryland is the USGS gauging station at Greensboro on the upper Choptank. Early efforts to estimate nutrient loads for the Choptank used area extrapolations of loading rates calculated for the gauged region (Fisher 1988; MDE 1991). However, assessment of hydrogeology on the Delmarva Peninsula suggests that the potential for N retention in the region draining to the gage at Greensboro is probably elevated relative to much of the peninsula (Hamilton et al. 1993). Expanded baseflow monitoring efforts have verified that N loading rates in the region are much higher than indicated by data collected at Greensboro (Bachman and Phillips 1996; Staver et al. 1996). A synoptic survey of stream baseflow nutrient concentrations in the Choptank watershed found nitrate concentrations at Greensboro to consistently rank the lowest of the 45 Choptank tributaries sampled (Staver and Brinsfield 1995a). Later efforts to model nutrient transport patterns in the Choptank have further verified that nutrient yields from the gauged region of the watershed cannot be used to accurately estimate nutrient loading rates for other parts of the watershed (Lee et al. 2001). Furthermore, Chesapeake Bay Program modeling efforts have proven to be totally unreliable for predicting changes in delivered nitrogen loads, since to date, the watershed model has not dealt with the storage of nitrate in shallow aquifers. Intensive groundwater studies in the Jarmins Branch watershed associated with the targeted implementation efforts during the 1990's indicated that the average travel time of groundwater from crop fields to stream discharge was 17 years, but that leachate from approximately half of the watershed is discharged in stream baseflow in less than 10 years (Staver 2001). This suggests that if there were effects from the targeted implementation efforts in the early 1990's, they would not have affected stream baseflow nitrogen concentrations during the targeted implementation period, but should now be starting to have a discernible effect. Comparing historic (>10 years old) data sets of stream baseflow nitrate with current data should provide an integrated assessment of whether nutrient management efforts have reduced rates of nitrate entry into shallow groundwater systems during the last ten years.

References

Bachman L.J, Phillips P.J. 1996. Hydrologic landscapes on the Delmarva Peninsula, Part 2: Estimates of base-flow nitrogen load to Chesapeake Bay. Journal of the American Water Resources Association 32: 779-791.

Beaulac, M.N. and K.H. Reckhow. 1982. An examination of land use - nutrient export relationships. Water Resources Bulletin. 18:1013-1024.

Coale, F.J. and J.A. Olear. 1996. The relationship between soil test phosphorus level and the concentration of dissolved and potentially transportable phosphorus in field drainage water. Final Report CRC Cooperative Agreement #NPS-UMD95, Chesapeake Research Consortium, Inc. Edgewater, MD.

Fisher, T.R. 1988. N and P loading of the Choptank River: Point and diffuse sources. Final Report Maryland DNR.

Hamilton, P.A., Denver, J.M., Phillips, P.J., and R.J. Shedlock. 1993. Water-Quality assessment of the Delmarva Peninsula, Delaware, Maryland, and Virginia—Effects of agricultural activities on, and distribution of, nitrate and other inorganic constituents in the surficial aquifer. U.S.G.S. Open-File Report 93-40.

Jordan T.E, Correll D.L, Weller D.E. 1997. Effects of agriculture on discharges of nutrients from Coastal Plain watersheds of Chesapeake Bay. Journal of Environmental Quality 26: 837-848.

Lee, K-Y., Fisher, T.R., and E.Rochelle-Newall. 2001. Modeling the hydrochemistry of the Choptank River basin using GWLF and Arc/Info: 2. Model validation and application. Biogeochemistry. 56: 311-348.

McCoy J.L, Sturm P. 1999. Upper Pocomoke calibration of the agricultural BMP evaluation, 1994-98. Annapolis (MD): Maryland Department of Natural Resources. Report no. CCWS-WRD-MN-99-02.

[MDE] Maryland Department of the Environment. 1991. Level I data summary reports covering the period 1986-1991. Baltimore (MD): Water Management Administration, Chesapeake Bay and Special Projects Division.

Norton, M.M. and T.R. Fisher. The effects of forest on stream water quality in tow coastal plain watersheds of the Chesapeake Bay. Ecological Engineering. 14: 337-362.

Sharpley, A.M. 1995. Dependence of runoff phosphorus on extractable soil phosphorus. J. Environ. Qual. 24:920-926.

Staver K.W., and Brinsfield R.B. 1995. The effect of erosion control practices on phosphorus transport from Coastal Plain agricultural watersheds. Pages 215-222 in Hill P, Nelson S, eds. Toward a Sustainable Watershed: The Chesapeake Experiment. Edgewater (MD): Chesapeake Research Consortium. CRC Pub. No. 149.

Staver, K.W. and R.B. Brinsfield. 1995a. Assessing the impact of changes in management practices on nutrient transport from Coastal Plain agricultural systems. Final Report Chesapeake Research Consortium. CRC Project CA NPS#3.

Staver L, Staver K, and J.Stevenson. 1996. Watershed discharge effects on water quality in the Choptank River estuary: Implications for watershed management. Estuaries 19: 342-358.

Staver, K.W. 2001. The effect of agricultural best management practices on subsurface nitrogen transport in the German Branch watershed. Final Report to MD DNR. Coastal Zone Management Grant Project 14-198-346czm025.

Staver, K.W. and R.B. Brinsfield. 2001. Agriculture and water quality on the Maryland Eastern Shore: Where do we go from here? Bioscience 51: 859-868

Year 1

Budget Item and Description	HRHCAE Requested Amount	Match and Source	Total Project Amount
Salaries			
P. I. (20%)	16,000	8,000	24,000
Field Technician (50%)	20,000	20,000	40,000
Lab Technician (50%)	20,000	0	20,000
Post-doc (50%)	26,000		26,000
Total	**82,000**	**28,000**	**110,000**
Fringe Benefits			
30% of Salaries	24,600	8,400	33,000
Subtotal Salaries & Benefits	**106,600**	**36,400**	**143,000**
Description of Equipment, Materials & Supplies			
Field Sampling Supplies	4,000		4,000
Stream Sampling Supplies	2,000		2,000
Soil Lab Supplies	4,000		4,000
Water Quality Lab Supplies	4,000		4,000
Subtotal Equipment, Materials & Supplies	**14,000**		**14,000**
Travel	3,000		3,000
50 Stream Sampling @ 50 miles			
30 Soil Sampling @ 100 miles			
Subtotal Travel	**3,000**		**3,000**
Other			
Subtotal Other			
TOTAL	**$123,600**	**$36,400**	**$160,000**

Year 2

Budget Item and Description	HRHCAE Requested Amount	Match and Source	Total Project Amount
Salaries			
P. I. (20%)	16,000	8,000	24,000
Field Technician (50%)	20,000	20,000	40,000
Lab Technician (50%)	20,000	0	20,000
Post-doc (100%)	52,000		52,000
Total	**108,000**	**28,000**	**136,000**
Fringe Benefits			
30% of Salaries	32,400	8,400	40,800
Subtotal Salaries & Benefits	**140,400**	**36,400**	**176,800**
Description of Equipment, Materials & Supplies			
Field Sampling Supplies	2,000		2,000
Stream Sampling Supplies	2,000		2,000
Soil Lab Supplies	2,000		2,000
Water Quality Lab Supplies	4,000		4,000
Subtotal Equipment, Materials & Supplies	**10,000**		**10,000**
Travel	3,000		3,000
50 Stream Sampling @ 50 miles			
30 Soil Sampling @ 100 miles			
Subtotal Travel	**3,000**		3,000
Other			
Subtotal Other			
TOTAL	**$153,400**	**$36,400**	**$189,800**

Year 3

Budget Item and Description	HRHCAE Requested Amount	Match and Source	Total Project Amount
Salaries			
P. I. (20%)	16,000	8,000	24,000
Field Technician (50%)		10,000	10,000
Lab Technician (50%)	20,000	0	20,000
Post-doc (50%)	26,000		26,000
Total	**62,000**	**18,000**	**80,000**
Fringe Benefits			
30% of Salaries	18,600	5,400	24,000
Subtotal Salaries & Benefits	**80,600**	**23,400**	**104,000**
Description of Equipment, Materials & Supplies			
Field Sampling Supplies	0		
Stream Sampling Supplies	0		
Soil Lab Supplies	1,000		1,000
Water Quality Lab Supplies	2,000		2,000
Subtotal Equipment, Materials & Supplies	**3,000**		**3,000**
Travel			
Subtotal Travel	0		0
Other			
Subtotal Other			
TOTAL	**$83,600**	**$23,400**	**$107,000**

Overall

Budget Item and Description	HRHCAE Requested Amount	Match and Source	Total Project Amount
Salaries			
P. I. (20%)	48,000	24,000	72,000
Field Technician (50%)	40,000	50,000	90,000
Lab Technician (50%)	60,000	0	60,000
Post-doc	104,000		104,000
Total	**252,000**	**74,000**	**326,000**
Fringe Benefits			
30% of Salaries	75,600	22,200	97,800
Subtotal Salaries & Benefits	**327,600**	**96,200**	**423,800**
Description of Equipment, Materials & Supplies			
Field Sampling Supplies	6,000		6,000
Stream Sampling Supplies	4,000		4,000
Soil Lab Supplies	7,000		7,000
Water Quality Lab Supplies	10,000		10,000
Subtotal Equipment, Materials & Supplies	**27,000**		**27,000**
Travel			
50 Stream Sampling @ 50 miles	6,000		6,000
30 Soil Sampling @ 100 miles			
Subtotal Travel	**6,000**		**6,000**
Other			
Subtotal Other			
TOTAL	**$360,600**	**$96,200**	**$456,800**

Outreach

Dr. Staver has been, and continues to be, actively involved in local, state, and federal activities related to agricultural water quality in Maryland and throughout the region. He is currently involved in Chesapeake Bay Program and state of Maryland efforts to reevaluate the effectiveness of agricultural management practices designed to reduce nutrient losses from cropland. He also routinely make presentations to scientific, farm and government agency groups and has conducted research projects funded by all of the major state and federal agencies as well as private producer organizations with an interest in managing nutrient losses from cropland. Dr. Staver currently is serving on the 2010 Trust Fund Evaluation Workgroup that is developing monitoring priorities for projects funded through the newly created 2010 Trust Fund. Previous research conducted by Dr. Staver has been instrumental in the development of the current cover crop cost share program in Maryland. He also has been appointed for nearly ten years to the Choptank Tributary Strategy Team, where he serves in a key advisory capacity regarding developing strategies for reducing nutrient losses from cropland.

The key audiences for the result of this project will be all agencies and organizations interested in reducing nutrient losses from cropland. At present there is great uncertainty regarding whether past and ongoing efforts to reduce nutrient losses have, or ever will achieve nutrient reduction goals deemed necessary for the restoration of Chesapeake Bay. This project will help reduce some of the uncertainty regarding past efforts and will make it possible to make needed adjustments in the current strategy to increase the likelihood that nutrient reduction goals will be met in the future. This project also will evaluate the utility of strategies for monitoring progress that have the potential of keeping policy makers and the public much more informed regarding whether progress is being made toward achieving nutrient reductions goals.

Research Summary

Currently there is little concrete evidence that efforts to reduce nutrient losses from crop land have been effective. This lack of effective methods for monitoring progress has created uncertainty regarding how efforts to reduce nutrient losses from cropland should proceed. Have past strategies been effective? Do efforts need to be intensified or does the current strategy just need time to deliver the desired result? Monitoring strategies must be developed that can answer these types of questions if effective strategies are to be developed and maintained in the future. Unfortunately, the extent of monitoring efforts in the first decade of the Chesapeake Bay restoration effort were very limited and inadequate for making large scale assessments of progress. However, the limited data sets that were collected provide an opportunity for small scale assessments of progress. This project proposes to collect selected water and soil data that will be comparable to key historic data sets that were collected from 1990-2000 to evaluate whether there is evidence of progress toward achieving nutrient reduction goals. To look at the effectiveness of P management strategies in an area of intense poultry production, a sub watershed in the Pocomoke watershed that was sampled intensively in 1999-2000 will be resampled in the same locations using GPS information to see how soil P levels have changed. The effectiveness of nitrogen management strategies is somewhat more difficult to evaluate since much of the nitrogen lost from cropland moves into shallow groundwater systems where it can take many years to reach streams. However, enough time has now passed since the beginning of the Chesapeake Bay restoration effort that effects on stream nitrogen levels should now starting to become apparent. Intensive stream sampling was conducted in the Choptank basin during the 1990’s. Nitrogen levels in these streams during similar flow conditions as those in the original study will be resampled to determine if changes have occurred after more than a decade of nutrient management efforts. While this project will provide small scale evaluations of progress during the last decade, the more important outcome will be the testing of techniques that could make it possible to more closely track progress on a widespread basis toward meeting nutrient reduction goals. This will help policy makers determine whether changes are needed in nutrient management strategies and increase public confidence that resources used in the restoration effort are not being wasted.

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Education

Ph.D.	University of Maryland	1994	Agric. Engineering
M.S.	University of Maryland	1984	Estuarine Science
B.A.	Cornell University	1979	Biology

Brief bio and research interests

Ken Staver has worked at the Wye Research and Education Center since 1984 conducting research on water, nutrient and energy flows in Coastal Plain watersheds. The emphasis of his work has been on the development of strategies to minimize negative environmental impacts of agricultural activities while maintaining agricultural productivity and enhancing soil and water resources. More recently, he has focused more on nutrient and energy flows at larger scales, and the potential of biofuel production to increase overall nutrient use efficiency in agricultural systems and to reduce net carbon emissions. He also is an owner/operator of a grain farm in Queen Anne's county where he lives with his wife and three children.

Selected Publications

Staver, K.W. 2006. Using switchgrass in a small-scale boiler to supplement farm heating needs. (11). In M.A. Sanderson et al (eds.). Proceedings of the Fifth Eastern Native Grass Symposium, Harrisburg, PA, October 10-13, 2006.

Angel, R., Applegate, T., Becker, J.G., Burnham, D., Humphrey, B., Malone, G., Ottinger, M.A., Sims, T., Staver, K., Powers, W. 2006. Broiler production and the environment: 2006. Pub. EB 368, U. MD. College of Agriculture and Natural Resources. College Park, MD. 36 p.

Staver, K.W. 2004. Efficient utilization of poultry litter in cash grain rotations. Final Report submitted to: Maryland Grain Producers Utilization Board, Delmarva Poultry Industry, Inc., and Maryland Center for Agro-Ecology, Inc. 73 p.

Staver, K.W., 2004. Linking field nutrient levels to nutrient losses in the Pocomoke watershed. Final Report submitted to Maryland Department of the Environment.

Staver, K.W. 2003. Developing options for direct application of dredge material to cropland. Final Report Final Report submitted to Maryland Environmental Services. 63 p.

Rutherford, D.W., Bednar, A.J., Garbarino. J.R., Needham, R., Staver, K. W., and R.L. Wershaw. 2003. Environmental fate of roxarsone in poultry litter. Part II. Mobility of arsenic in soils that have been amended with poultry manure. Environmental Science and Technology: 37: 1515-1520.

Staver, K.W., 2002. Nutrient Uptake Dynamics and Biofuel Potential of Switchgrass in Maryland. Proceedings of the 3rd Eastern Native Grass Symposium, Chapel Hill, NC. USDA/ARS/NRCS. Beltsville, MD.

Staver, K.W. and R.B. Brinsfield. 2001 Agriculture and water quality on the Maryland Eastern Shore: Where do we go from here? Bioscience 51: 859-868.

Staver, K.W. 2001. Increasing N retention in Coastal Plain agricultural watersheds. In: Optimizing Nitrogen management in Food and Energy Production and Environmental Management: Proceedings of the 2nd International Nitrogen Conference on Science and Policy. The ScientificWorld 1: 207-215.

Staver, K.W. 2001. The effect of agricultural best management practices on subsurface nitrogen transport in the German Branch watershed. Final Report to MD DNR. Coastal Zone Management Grant Project 14-198-346czm025.

Staver, K. W. and R.B. Brinsfield. 2000. Evaluating changes in subsurface nitrogen discharge from an agricultural watershed into Chesapeake Bay after implementation of a groundwater protection strategy. Final Report MD Depart. Environ., Section 319 Grant. Project 14-98-340-EPA-029. 92 p.

Staver, K.W. 1999. Production and nutrient uptake by native warm-season grasses. In: Proceedings of the 2nd Eastern Native Grass Symposium, Baltimore, MD. USDA/ARS/NRCS. Beltsville, MD.

Staver, K.W. and R.B. Brinsfield. 1998. Using cereal grain winter cover crops to reduce groundwater nitrate contamination in the Mid-Atlantic Coastal Plain. Journal of Soil and Water Conservation 53:230-240.(voted best 1998-99 feature article)

Staver, K.W. and R.B. Brinsfield. 1998. Crop management systems for reduction of hydrologic nutrient transport. Final Report Maryland Department of Agriculture (Governor's Council on Chesapeake Bay Research). 121 p.

Staver, L., K. Staver, and J. Stevenson. 1996. Watershed discharge effects on water quality in the Choptank River estuary: Implications for watershed management. Estuaries. 19:342-358.

Staver, K.W. and R.B. Brinsfield. 1996. Groundwater nitrate seepage into the Wye River estuary from a riparian agroecosystem. Estuaries. 19:359-370.

Staver, K.W. and R.B. Brinsfield. 1995. The effect of erosion control practices on phosphorus transport from Coastal Plain agricultural watersheds. In: Proceedings 1994 Chesapeake Bay Research Conference. 215-222. CRC Pub. No. 149, Chesapeake Research Consortium, Edgewater, MD.

Lowrance, R., L.S. Altier, J.D. Newbold, R.R. Schnabel, P.M. Groffman, J.D. Denver, D.L. Correll, J.W. Gilliam, J.L. Robinson, R.B. Brinsfield, K.W. Staver, W.C. Lucas, and A.H. Todd. 1995.

Water quality functions of riparian forest buffer systems in the Chesapeake Bay watershed. Environmental Management 21: 687-712.

Staver, K.W. and R.B. Brinsfield. 1991. Monitoring agrochemical transport into shallow unconfined aquifers. In: Agrochemical Residue Sampling Design and Techniques: Soil and Groundwater. American Chemical Society Symposium Series No. 465. pp 264-278.

Staver, K.W. and R.B. Brinsfield. 1990. Patterns of soil nitrate availability in corn production systems: Implications for reducing groundwater contamination. Journal of Soil and Water Conservation 45:318-322.

Staver, K.W., R. Brinsfield, and J. Stevenson. 1989. The effect of best management practices on nitrogen transport into Chesapeake Bay. In: J. B. Summers and S. S. Anderson (eds.) Toxic Substances in Agricultural Water Supply and Drainage. U. S. Committee on Irrigation and Drainage, Denver, CO. pp 163-180.

Relevant Activities

1. Technical Review Committee – Chesapeake Bay Commission Biofuels and the Bay Report.

2. Technical Review Committee – Chesapeake Bay Program cover crop efficiency reevaluation.

3. Member- Chesapeake Bay Cabinet Public Drainage Task Force

4. Technical advisor to Maryland Department of the Environment Total Maximum Daily Load (TMDL) modeling department. (1998-2001)

5. Member-USDA-ARS Farming Systems Project Focus Group

6. Maryland Department of Agriculture Cover Crop Technical Advisory Committee

7. Choptank Tributary Strategy Team

8. Project technical coordinator - Scientific summit on the impacts of growth on water quality, May 15, 2007.