# Atlantic Slope Consortium
## Annual Report – Year 1 (2001-02)

Prepared for:
U.S. Environmental Protection Agency
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**Goal**

The goal of the Atlantic Slope Consortium is to develop and test a set of indicators in freshwater and coastal systems that are ecologically appropriate, economically reasonable, and relevant to society. Our suite of indicators will produce integrated assessments of the condition, health and sustainability of aquatic ecosystems, based on ecological and socioeconomic information compiled at the scale of estuarine segments and small watersheds, and with clear connections to smaller and larger scales.

**Objectives**

1) To develop and test ecological and socioeconomic indicators of aquatic resource condition, construct models that use environmental, geographic, and stressor data to predict indicator responses, and use models to link upstream watersheds and downstream estuaries.

2) To develop large scale measures for characterizing landscape attributes and land-use patterns to serve as predictors of a range of environmental conditions.

3) To deliver a nested suite of indicators to managers, where the implications of aggregating models at various scales are considered, and for which reliability is known.

**Progress – Year 1**

The Atlantic Slope Consortium (ASC) consists of six institutional members and about 40 participating investigators. About 20 of these faculty, staff, and students are located at Penn State which serves an administrative and coordinating role, as well as participating in all phases of the research.

As planned, the ASC spent the majority of Year 1 refining the details of our sampling approaches, gathering and organizing information for our GIS, and building relationships among our geographically-dispersed team. Toward those ends, we held a series of all hands meetings and subgroup meetings (Table 1). In addition, ASC members participated in meetings, conference calls, and planning sessions with the other EaGLes funded by this STAR Program.

Our approach to this project has been to have three working groups that focus on the two major components of aquatic ecosystems, estuaries and watersheds, plus cross-cutting socioeconomics, now called human dimensions. Also, the GIS Team has supported the work of all three groups, and will provide the critically important applications of spatial linkages. Exchanges among the three working groups and GIS Team have been frequent, and membership overlaps considerably.

Our approach to this problem is to define an appropriate and relevant unit of assessment and management that is applicable to palustrine, lacustrine, riverine, and estuarine systems alike. A unit within an estuarine system can be denoted as an estuarine segment, composed of deepwater areas, vegetated and unvegetated shallows, tidal marshes and creeks, and the adjacent terrestrial habitats. An equivalent unit upstream of estuaries, is a small watershed (14-digit HUC). These areas are typically sized as tens to hundreds of $km^2$, and encompass several stream or river reaches, adjacent riparian corridors, associated wetlands and waterbodies, and the contributing drainage basin.

Considerable effort has been expended during Year 1 to select sampling methods that can acquire targeted data that has the potential to evolve into a reliable indicator. Also, ASC members have discussed at length how the various independent elements will relate to each other as we compile them into a suite of interrelated indicators. Although time consuming, these

discussions have proved invaluable for maintaining cohesiveness among the investigators and the potential indicators.

At this early stage in the project, we present here the edited narratives from the investigators from each participating institution. This approach demonstrates that all members are active in contributing important components to the overall goal of developing a set of indicators for estuaries and their contributing watersheds. In future annual reports, more and more integration will occur as the disparate pieces of information are synthesized.

**Changes in Project Scheduling and Products**

In general, only minor adjustments in the original schedule of events have occurred during Year 1. The ASC has held and/or attended more meetings than initially anticipated, but this has led to improved communication among the ASC's members and among investigators from the other EaGLe projects. Our original offer to host the first all EaGLes meeting was shifted to the second year, and now is scheduled for December 2002 in the Annapolis, MD area.

In the original proposal we left unspecified some personnel, anticipating that additional expertise in some areas would be beneficial. One productive arena has been the formal inclusion of Dr. G. P. Patil and the staff of his Center for Statistical Ecology and Environmental Statistics. Interactions among this Center and the Watershed and GIS teams have resulted in a novel and useful approach to selecting watersheds using clusters of land use patterns. In addition, Dr. Patil will be helping to organize an analytical and statistical session at the all EaGLes meeting in December 2002.

Initially, we envisioned having extensive contact with cooperators, both those that participate in the research and those that react to the implementation of indicators. During the first year, we developed an extensive list of both kinds of cooperators. Some cooperators attended selected meetings, and others were contacted to participate in the interviews and surveyed conducted by the Human Dimensions Group. Toward the end of the second year, we believe the timing will be appropriate to have more direct involvement with cooperators as was originally planned.

**Plans for Year 2 (2002/03)**

The second year of the project will require the initiation of a substantial number of independent, but integrated sampling efforts by ASC members, particularly during the summer sampling season, broadly defined. An all hands meeting is scheduled for November 2002 to review the data and findings of these various sampling efforts.

Estuary Group – Extensive sampling will be conducted of the physical, chemical, and biological components of near-shore areas of estuarine segments and the non-tidal stream, wetland, and riparian portions of estuarine watersheds.

Watershed Group – Selected, 14-digit HUC watersheds (about 100 $km^2$), will be chosen from the pool of 3,800 watersheds in the study area for further investigation. The same protocol used by the Estuary Group for rapid assessment of freshwater stream, wetland, and riparian conditions will be implemented in these watersheds.

Human Dimensions Group – Unique to our EaGLe project, we are compiling socioeconomic information and interviewing environmental managers and selected members of the public to determine if, and how they would use the ecological and socioeconomic indicators

developed during this project. Cooperators and other contacts throughout the study area will be included in this work.

GIS Team – In addition to supporting the work of the other three work groups, the GIS Team continues to acquire and modify remote-sensing and landscape-level datasets that are critical for the characterization of study sites and the overall study area. Once specific study sites are sampled, we will conduct analyses on the surrounding watersheds or immediate landscapes pertinent to each site. The results of these metrics and analyses will be compared to site-specific data collected by the ASC or obtained from other sources.

At the beginning of this project during our all hands meetings, we began developing a list of interim products that can be completed. Based on our progress so far, we anticipate that various papers, presentations, and approaches will be completed during the second, and subsequent years. Future annual reports will list these interim products.

Table 1. **Atlantic Slope Consortium Events Calendar***

| | |
|---|---|
| **2001** | |
| February 19 | STAR Grant awarded from U.S. Environmental Protection Agency |
| April 19-20 | ASC Director, Brooks, attended Great Lakes Environmental Indicators (GLEI) Science Advisory Council Meeting, Duluth, MN |
| April 24-27 | EaGLe Project Directors Meeting, in association with EMAP Symposium 2001, Pensacola, FL |
| May 8-9 | First All Hands ASC Meeting, State College, PA |
| June 11 | ASC Human Dimensions Group Meeting, University Park, PA |
| June 19 | ASC Watershed Group Meeting, Edgewater, MD |
| July 5 | ASC Human Dimensions Group Meeting, University Park, PA |
| September 7 | ASC Human Dimensions Group Meeting, University Park, PA |
| September 13 | ASC Estuary Group Meeting, Edgewater, MD |
| October 15-17 | Second All Hands ASC Meeting, Williamsburg, VA |
| December 3-4 | First Annual EaGLes Meeting, NC |
| December 12-13 | Third All Hands ASC Meeting, Cacapon, WV |
| **2002** | |
| March 13-14 | Fourth All Hands ASC Meeting, Cacapon, WV |
| June 12-13 | ASC *Ad hoc* Stream/Wetland/Riparian Sampling, Edgewater, MD |
| July 15-16 | ASC *Ad hoc* Stream/Wetland/Riparian Sampling, Edgewater, MD |
| September 29-Oct 2 | All EaGLes Director's Meeting, EPA Lab, Las Vegas, NV |
| November 13-15 | Fifth All Hands ASC Meeting, Williamsburg, VA |
| December 5-7 | Second Annual EaGLes Meeting, Annapolis/Edgewater, MD |
| **2003** | |
| December 4-7 | Third Annual EaGLes Meeting, CA |

*Major events are listed; does not include other working meetings, conference calls, and correspondence.

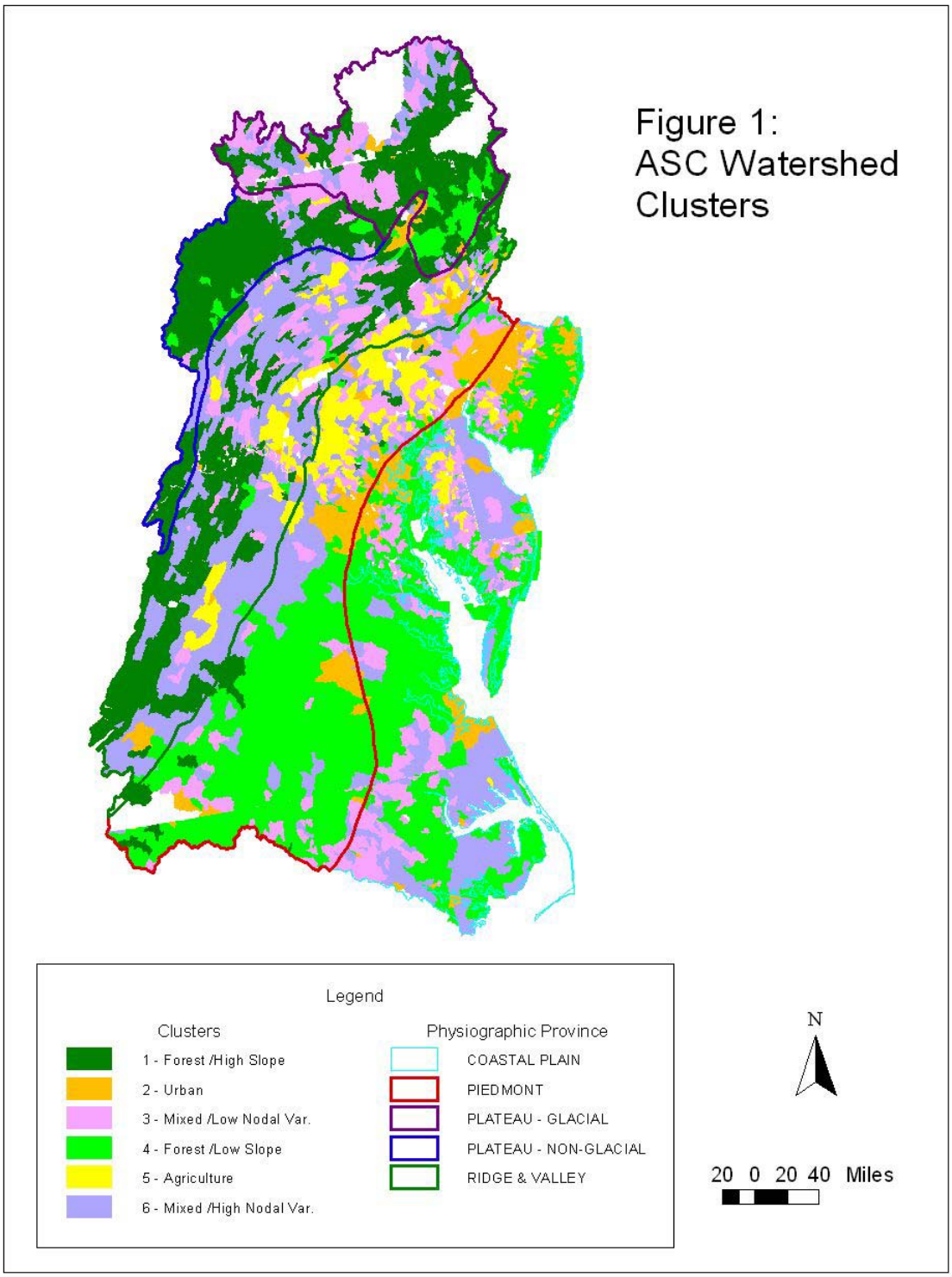
Figure 1:
ASC Watershed
Clusters
Legend
Clusters
1 - Forest /High Slope
2 - Urban
3 - Mixed /Low Nodal Var.
4 - Forest /Low Slope
5 - Agriculture
6 - Mixed /High Nodal Var.
Physiographic Province
COASTAL PLAIN
PIEDMONT
PLATEAU - GLACIAL
PLATEAU - NON-GLACIAL
RIDGE & VALLEY
N
20 0 20 40 Miles

**Pennylvania State University**

Robert P. Brooks and Denice Heller Wardrop, PIs

The role of investigators at Penn State are incorporated throughout this report, particularly in the areas of administration, coordination, and integration of the subproposals, but a few other specific activities are mentioned here. In addition to the work by the Human Dimensions Group (described elsewhere), the investigators at the Penn State Cooperative Wetlands Center have worked with the GIS Team and the Center for Statistical Ecology and Environmental Statistics to develop a new and unique way of selecting watersheds based on patterns of land use among the various ecoregions featured in the project study area. A map of the color-coded watersheds sorted for the Watershed Group is shown in Figure 1.

Data collection for the Piedmont and Coastal Plain Bird Community Indices (BCIs) was completed for 83 sites during 2001. The collection of these data was funded by other sponsors, but is essential to the completion of the Atlantic Slope objectives. This information on birds will be used to calibrate new BCIs that can be used as indicators of condition across broad landscapes for these two ecoregions.

Investigators in the Penn State Cooperative Wetlands Center working with the GIS Team have continued to explore ways of assessing wetland condition on a watershed basis. Pilot studies were completed for watersheds in several ecoregions. This work will be pertinent to the overall assessment of aquatic ecosystems for the Atlantic Slope project. Further progress was made during Year 1 on the final calibration of hydrogeomorphic (HGM) models for assessing wetland condition in selected ecoregions.

Penn State is leading the effort by all wetland scientists in the Atlantic Slope Consortium to develop a standard HGM/NWI wetland classification system for the Mid-Atlantic Region that will facilitate comparisons among different field teams and across ecoregions.

Penn State organized a mini-symposium on Ecological Scaling Methods and Issues that was presented at one of the all hands meetings. Both ASC personnel and other scientists contributed.

**Smithsonian Environmental Research Center**

Dennis Whigham, PI and Coordinator
Donald Weller, PI
Thomas Jordan, PI
Anson Hines, PI
Charles Gallegos, PI
Peter Marra, PI
Ryan King, Research Associate
Matthew Baker, Research Associate
Darrick Sparks, Biological Technician
Colin Studds, Biological Technician
William Deluca, Graduate Student

In the first year of the project, SERC PIs focused their efforts on six aspects of the Atlantic Slope project.

1. SERC worked with the other partners to formalize the overall approach that would be used in the project. This effort consisted of 'in-house' meetings, 'all hands' meetings at Penn State, VIMS, SERC, and two at Cacapon State Park (WVA), and inter- and intra-disciplinary meetings of subgroups formed to focus on specific parts of the project. SERC staff also participated in the first 'All EaGles' meeting at Morehead City, NC.

2. SERC, lead primarily by Don Weller, contributed to the identification of existing data sets that would be included in the project. Data sets containing information on the more than 400 watersheds that SERC has studied were provided to Penn State. SERC also provide names and contact information for regulators and managers in Maryland who potentially could be contact for interviews by PSU collaborators.

3. A major SERC goal in the first year of the project was to select estuarine segments that would be used for intensive field-work in 2002 and 2003. Estuarine segments were defined as coastal watersheds that are physically linked to the mesohaline (5-18 parts per thousand salinity) portion of an estuary. All potential estuarine segments consisted of terrestrial ecosystems dominated by one three land-use categories (agriculture, forested, urban-suburban), a freshwater stream systems, riparian buffers, brackish wetlands, and open-water estuarine habitats. Existing spatial data were used to identify more than 60 potential estuarine segments. In addition to compiling land-use data, SERC identified other sources of existing data for each (e.g., water quality, benthic survey data, fish survey data, stream survey data) potential estuarine segment. The process resulted in the selection of 31 estuarine segments and a plan for sampling in 2002 and 2003.

4. Considerable effort was placed on staffing. By the end of the first year of the project, we had hired two Research Associates (Ryan King and Matthew Baker) and two biological technicians (Derrick Sparks and Colin Studds). William Deluca, a graduate student at George Mason University, also joined the team. Deluca's MS thesis will focus on bird communities in the wetland portions of the estuarine segments. By May 2002, a technician with a focus on estuarine animals will be hired to complete the SERC team. Ryan King

provides overall coordination of the field teams and expertise in wetland assessment, assessment of stream IBIs, and quantitative analysis of spatial data. Matthew Baker will work closely with Donald Weller and Thomas Jordan on the watershed portion of the project. He provides expertise in landscape modeling. Derrick Sparks will assist Charles Gallegos and has been working with Ryan King to conduct stream IBI assessments. Sparks has started the water quality sampling, using water collected from streams sampled for stream IBIs. Sparks and King completed a bioassessment training program provided by the Maryland Department of Natural Resources. Studds and Deluca will assist Peter Marra in assessment of various aspects of the bird communities associated with estuarine segments. Several interns will participate in the project in the summer of 2002.

5. By April 2002, SERC staff had established study sites in most of the estuarine segments and had developed sampling protocols and sampling schedules for birds, vegetation, stream IBIs, estuarine animals (benthos and fish), and estuarine water quality. Sampling equipment has been purchased for the estuarine field work. Nearly 60 stream sites within the estuarine segments have already been sampled for water chemistry, riparian and instream habitat condition, and macroinvertebrate assemblages. This effort is being coordinated with the Maryland Biological Stream Survey, which is part of the MD DNR. MD DNR is also working in most of the same estuarine segments, thus is a synergistic activity that benefits both parties.
6. Interactions with other EaGLe's. Gallegos will participate in a cruise scheduled for April 16-19 by the Horn Point contingent of the ACE INC EaGLes project. Gallegos will measure profiles of optical properties in situ and map surface optical properties in the Choptank and Patuxent Rivers, while Harding (ACE INC) measures profiles of spectral irradiance. Measurements made by Gallegos will complement those made by Harding, while water samples collected by Harding will add to the spatial coverage available to SERC.

**Virginia Institute of Marine Sciences**
Carl Hershner, PI

The VIMS activities in the first year of this project included:

1. Hiring a post-doctoral researcher for the project. Dr. Donna Marie Bilkovic was hired and tasked with leading the estuarine segment fisheries index development.

2. Initiated the estuarine segment fisheries habitat index development by conducting an extensive literature review of fisheries indexes developed for characterizing habitat and or stock conditions. In addition, an exhaustive search of databases in the Delaware Bay, Chesapeake Bay, and Albemarle-Pamlico Sound regions was conducted for any and all useful fish stock, benthos, plankton, and water quality data sets. Preliminary analyses of this information was undertaken. The preliminary work has been prepared for presentation at the 2002 ASLO meeting in Victoria, British Columbia.

3. Coordination of the 2002 field sampling has been undertaken with project collaborators at the Smithsonian Environmental Research Center. We have assisted in identification of their sample sites in Virginia, and we have made arrangements to conduct shoreline assessment surveys in Maryland this summer using the VIMS protocol.

4. Development of watershed condition indexes based on landuse management goals has been initiated in collaboration with researchers from Penn State University. This work is designed to develop stratified indices of aquatic system conditions using potential optima for each of four possible mixes of landuse/landcover conditions in the Atlantic slope region. The approach follows the conceptual model used in wetland hydrogeomorphic classifications. Data collection and conceptual model development is currently ongoing.

5. Development of a conceptual model of aquatic system condition based on cumulative condition from headwaters to estuarine segments is under development. Literature reviews and correspondence with researchers in other regions (including other nations) is currently underway. The goal is to finalize a conceptual model by the end of 2002, and then undertake some testing using extant databases of fish stocks, benthic community indexes, and water quality conditions.

6. Potential use of hydrodynamic models of the Chesapeake Bay to index potential water quality conditions in selected estuarine segments is currently underway. The approach involves use of a three dimensional hydrodynamic model to determine relative importance of various sources (fall line and open ocean boundary conditions) to the composition of water column constituents in selected segments. This work is based on a well developed hydrodynamic and water quality modeling program, validated with the extent water quality monitoring data for the Chesapeake Bay.

**East Carolina University**

Mark Brinson and Richard Rheinhardt, PIs

The ECU portion of the project contributed the following:

1. Participation in all of the meetings by one or both of us, including the all-Eagles meeting in Morehead City.

2. Suggestions for a substantial revision to the wetland classification, which includes elimination of the palustrine component and placing riverine tidal in the estuarine fringe rather than the riverine category.

3. Providing names of collaborators from North Carolina.

4. Providing information on riparian condition data sets and locations from Virginia, Maryland, and North Carolina.

5. Contributions toward dealing with beaver as a modifier of riparian areas by involving a graduate student with this interest.

6. Developing a draft plan for the assessment of condition of riparian corridors and wetlands for the estuarine segment portion of the project, and to be applied to other physiographic provinces. Excerpts from this plan are:
    a. **Objective:** To develop a plan for determining the extent and land use of uplands and riparian/wetland corridors in estuarine segments. Land uses will serve as estimates of ecosystem condition relative to reference standard conditions.
    b. **Scope of study:** The plan will be applied initially to estuarine segments. Once the methodology is worked out for these inner coastal plain watersheds, it will be applied in other physiographic provinces, with the ridge and valley province as a high priority.
    c. **Questions to be answered:** What is the pattern of upland and riparian corridor condition in a downstream sequence from headwater regions of drainage networks?
    d. **Concept:** The condition of aquatic resources in a watershed is dependent on upstream (and occasionally downstream) land uses in both uplands and riparian/wetland corridors. These two sources need to be resolved as one proceeds from watershed headwaters to the aquatic resources of higher order riparian corridors.
    e. **Draft plan:**
    i. Extend mapping of the stream network to the upstream boundary between the ephemeral channel and intermittent stream flow.
    ii. Map floodplain-upland boundaries below the transition between headwater riparian corridor and floodplain development.
    iii. Width issues: Determine land covers within and beyond the riparian corridor from widely available remote sensing data in sources.
    iv. Length issues: Determine what stream segment lengths are manageable from a data-handling perspective and useful in detecting land use within normal level 1 approaches.
    v. 'Independent' variables: Identify metrics for channel segments that may influence the degree, but probably not the type, of riparian corridor condition.

**Penn State Human Dimensions Group**

James Shortle, PI

Human Dimensions of Ecological Indicators

A major objective of the PSU HD group is to provide scientific results supporting the choice and communication of suites of environmental indicators that environmental managers and other audiences will find useful for:

- characterizing the condition of resources and ecosystems at multiple scales;
- diagnosing likely causes of degraded conditions;
- evaluating (when linked with hydrological, ecological process, socioeconomic, and other models) the probable consequences of changes in measurable landscape attributes; and

- setting management priorities and selecting management strategies.

In the past year a structured protocol was developed to examine the use of environmental indicators and the informational needs and preferences of environmental managers working for state agencies. A copy of the interview form is included with this report. This form has been pretested and is being administered to a sample of environmental managers throughout the Atlantic Slope region. The pretests do not provide sufficient observations for statistically valid inference, but revealed definite themes about desired characteristics of environmental indicators. These include scientific validity, relevance to regulatory mandates, realism for planning, flexibility, cost-effectiveness, usefulness for developing restoration strategies by linking conditions to stressors, and usefulness for capturing spatial and temporal trends.

We are planning additional interviews and mail surveys to examine the use of environmental indicators and informational needs and preferences of other stakeholders (e.g., environmental managers of large municipalities and counties, watershed associations in the study area).

Integrated Economic Value of Information Modeling

The four-year duration of the project is too short to test actual improvements in resource management from the use of particular suites of indicators. As an alternative, we are using model-based simulation experiments to explore the value of indicators in environmental management. The primary insights we expect to gain are about the relative values of alternative types of information, such as information on the responses of stressors to remediation activities, the costs of remediation activities, responses of conditions to changes in stressors, and economic benefits of improved conditions.

We have developed a model of nitrogen pollution loads from an array of sources in the Pennsylvania portion of the Susquehanna River Basin. As developed to this point, the simulation model combines hydrologic and economic components that can be used to explore hypotheses about the value of economic and certain types of stressor-response information for water quality management. During the second year we will explore these hypotheses, and expand the types of environmental indicators that can be captured by the model.

Integrated Assessment of Economic and Ecological Status of Watersheds

A significant achievement during the first year has been the formation of a cross-disciplinary sub-group to develop theory and methods for integrated assessment of the status of watersheds. One accomplishment of this group has been to develop a theoretical foundation for defining reference conditions for integrated assessment (presented at the March 2002 all hands meeting). We are now moving towards implementing this framework using available socioeconomic and environmental data.

As part of our integrated assessment activity, we have also developed a catalogue of socioeconomic indicators that are used or have been proposed for use in water quality and aquatic ecosystem management. We are evaluating these indicators using criteria similar to those proposed by Jackson et al. (EPA/620/R-99/005 May 2000).

Presentations:
Borisova T., J. Shortle, and R. Brooks. The Choice and Value of Environmental and Economic Indicators in the TMDL Process. American Water Resources Association's Annual Water Resources Conference. November, 2001, Albuquerque, New Mexico.

Abstracts:
Borisova, T., J. Shortle, and R. Brooks. The Choice and Value of Environmental and Economic Indicators in the TMDL Process. Abstract Proceedings of the American Water Resources Association's Annual Water Resources Conference. November 12-15, 2001, Albuquerque, New Mexico.

**Environmental Law Institute**
James McElfish

In the first project year the Environmental Law Institute, a subcontractor, was a participant in the Human Dimensions Group and conducted the following work:

1. Produced and revised a conceptual template identifying institutional decisionmakers in the Atlantic Slope region. This template will be used in years 2-4 of the project to examine in more detail the users and potential users of the ecological indicators being developed by the project team.

2. Contributed to the development of the socioeconomic team's survey instrument.

3. Completed preliminary research on the legal authorities and institutional authorities on land use regulation, coastal zones, environmental regulations, river basins, and metropolitan planning organizations in the Atlantic Slope region.

4. Attended and participated in the discussions leading to the development of watershed selection criteria. Tasks were completed within the first year budget, and there were no unforeseen or unexpected changes in either budget or task categories.

**FTN Associates, Inc.**
Kent Thornton

**Contributions in Year 1**
1. During 2001, FTN provided support to the Atlantic Slope Consortium research project primarily through workshop facilitation and concept presentations.

2. On 11-13 June 2001, the ASC PI and Assistant PI met with representatives from the EPA Mid-Atlantic Integrated Assessment (MAIA) initiative and the Canaan Valley Institute to discuss mutual interactions among organizations. The workshop was held in Hidden Valley, PA. FTN facilitated this meeting and prepared a workshop summary

(Attachment A). The workshop identified opportunities to leverage the research to be conducted in the ASC with application tools being developed by the Canaan Valley Institute and on-going studies being coordinated through MAIA and the EPA Regional Vulnerability Program (ReVA).

3. The December ASC workshop was held in Cacapon, WV. FTN facilitated portions of this workshop and also provided a presentation on the importance of considering time and length scales when selecting and considering ecological indicators (Attachment B). FTN discussed various approaches that might be used to assess appropriate time and space scales among indicators and ensure that indicators can be compared and associated among ecosystem categories (e.g., watersheds, streams, wetlands, and estuaries).

**Anticipated Year 2 Contributions**

FTN will assist the ASC PI in facilitating meetings to focus on integration and synthesis. In addition, FTN will work with the ASC PI and co-leads in preparing strawperson examples for illustration and discussion among ASC participants. These will be prepared prior to the workshop and included with workshop information packets. No problems or issues were encountered.