

**Proposal for Inclusion of the Academy of Natural Sciences
As a Partner in the Chesapeake Watershed Cooperative Ecosystems Study Unit**

This document outlines how the Academy of Natural Sciences ("Academy") could contribute as a partner in the Chesapeake Watershed Cooperative Ecosystems Study Unit (CW-CESU). This proposal is submitted to the University of Maryland's Appalachian Laboratory (UMCES) in accordance with the "Suggestions for Prospective Partners" circulated by CW-CESU.

The Academy was established in 1812, and it is the oldest natural science research institution and museum in the Americas. Its mission, set forth by the Pennsylvania legislature in 1817, is "the encouragement and cultivation of the sciences".

The Academy is now recognized internationally for its vast collections, research, exhibits, and educational programs. It is a 501(c) (3) non-profit organization with an annual operating budget of about \$13 million and about 200 staff. The Academy's collection of over 17 million cataloged natural history specimens and artifacts is among the ten largest in the United States. The Academy also has one of the most significant natural science libraries in the world. The Academy website is www.ansp.org

The Academy implements its mission through four program goals:

- Improving understanding of the diversity, ecology, and evolution of life.
- Developing and applying science to protect the environment.
- Advancing public interest and engagement in natural sciences and environmental issues.
- Preserving the heritage of natural science in specimens, images, words, and numbers.

The Academy currently operates two research units, the Patrick Center for Environmental Research (PCER) and the Center for Systematic Biology and Evolution (CSBE).

The Patrick Center represents over 60 years of ecological research starting with the pioneering ecosystem studies of Dr. Ruth Patrick. Today, the center consists of a multidisciplinary group of environmental scientists and engineers devoted to:

- understanding aquatic and terrestrial ecosystems, including the effects of natural processes and human activities;
- applying this knowledge to assess ecosystems health and developing watershed-level strategies for enhancing environmental quality;
- working with diverse stakeholders, including government, community groups, industry and environmental organizations to improve environmental stewardship.

The Center for Systematic Biology and Evolution conducts significant research into biodiversity, ecology, evolution, molecular systematics and paleontology. CSBE curates and studies over 17 million specimens of plants and animals, both extant and fossil. The collections are of national and international significance. CSBE staff has special expertise in the identification, phylogeny and life history of a wide variety of taxa, including many with significant ecological functions.

Within its research operations, the Academy has specific projects and competencies that are closely connected to the current work of CW-CSEU. Units operated by PCER include phycology, fisheries, biogeochemistry, and ecosystem modeling. CSBE studies a variety of taxonomic groups, with particular emphasis on ichthyofauna, mollusks, arthropods, and plants. In addition, CSBE operates the Academy's Laboratory for Molecular Systematics and Evolution (LSME), with the capacity to provide a range of genetic analysis across the institution.

The Academy has world-class expertise in the study of diatoms. The Phycology Unit, under the direction of Dr. Don Charles, has specific expertise in the use of these organisms as indicators of water quality and the development of nutrient criteria. Among other projects, it is responsible for all diatom identification work within the USGS NAQWA program and helps to synthesize water quality-diatom data for this program in peer-review publications. The Academy houses the largest curated collection of diatom specimens in the U.S., providing a synergy between applied and collections-based science rarely found in other institutions.

The Academy's fisheries group, under the direction of Dr. Richard Horwitz, has conducted studies on a variety of freshwater and estuarine taxa, both regionally and internationally. They are doing important field work on the distribution and abundance of the American eel and the endangered bridled shiner in the Delaware River and Estuary. With the collaborative work of the fisheries and biogeochemistry units, Patrick Center has extensive experience on the distribution and sources of a variety of contaminants in various fish. The Academy is currently on contract to the state of New Jersey to set fish consumption standards for mercury and PCBs. Fisheries scientists in CSBE are among the lead partners in the "All-Catfish Inventory," a project funded by the NSF to begin filling gaps in our understanding of the systematics of particular groups.

The Biogeochemistry section (organic and inorganic geochemistry) unit of the Patrick Center, under the direction of Dr. David Velinsky, includes capacity for nutrient studies, stable isotope mass spectrometry and organic contaminant studies. These techniques have been used to monitor well known contaminants such as PCBs but have also been applied to more novel contaminants such as nonophynols and PBDEs. This work is ongoing and includes a number of partners such as Duke University, Philadelphia University, and the Smithsonian Institution's Estuarine Research Center. This group has done extensive field work within the Potomac and Anacostia Rivers and has assisted in various modeling efforts on the fate and transport of trace metals and organic contaminants. Among the unit's projects have been studies of changes in the sediment and water chemistry of tidal wetlands due to climate change and related ecological shifts as determined from algal community analysis in sediment cores.

The Ecological Modeling Unit is under the direction of Dr. James McNair, and acts to support other projects within the Patrick Center as well as pursuing free standing research questions. Among these are the ecology and control of invasive plants in urban parks, the effects of land cover- and land use-stressors on stream health, individual- and population-level effects of chemical stressors on populations of aquatic and soil organisms, and turbulent transport of fine particulate organic matter, microorganisms and benthic invertebrate larvae.

Long-range, interdisciplinary projects by the Academy have included one of the first comprehensive studies of dam removal ever attempted, with Academy researchers documenting

changes over a two year period as a segment of the Manatawny Creek transitioned from lentic to lotic conditions. Other interdisciplinary efforts have included a study of invasive species in Fairmont Park, and the development of a computer based model for predicting changes in watershed ecological health relative to land-use and land-cover factors.

The Academy's Laboratory for Molecular Systematics and Evolution provides access to molecular data for systematic and ecological analysis by all of the Academy's research units. The LSME is under the direction of Dr. Daniel Graf, Curator of Malacology, and it is operated by geneticist Anthony Geneva. The LMSE is equipped to provide extraction, amplification and sequencing of both DNA fragments and whole gene sequences. Past projects have included studies of changes in the microbial composition of wetlands caused by sea level rise, and identification of phylogenetic trends in mollusks. A project that is currently underway will allow rapid assessment of diatom genes to evaluate water quality.

The Center for Systematics and Biological Evolution has world class expertise in taxonomy, systematics and natural history. The CSBE collections hold many organisms from the Chesapeake Watershed, including the material currently being cataloged from the PCER Stream surveys, covering mollusks, aquatic insects, diatoms, plants, birds and fish. These materials can be used to support a broad range of scientific questions. Scientists within CSBE are currently involved with identification and faunal listings of both mollusks and insects that are relevant to CW-CESU.

In terms of specific biogeographical experience in the Chesapeake region, the Academy originated and for 20 years operated the Estuarine Research Center in Solomons Island, Maryland. Since the Center's operations were moved to Morgan State University in 2004, the Academy has maintained a working partnership with the institution. Beyond the work of the ERC, the Academy's regional and national level projects have often taken place in the Chesapeake watershed. This has included the upper watershed in Pennsylvania, as well as work in the estuary as well as current projects involves monitoring PCB concentrations in sediments and waters of the Anacostia and Potomac Rivers in Washington DC.

The two research centers of the Academy span the spectrum of scales in the natural sciences, from molecules to organisms to ecosystems. This provides a capacity for rich interdisciplinary collaborations which could be expanded to partnerships within CW-CESU. In addition, the Academy houses one of the foremost libraries in the world for the study of taxonomy and systematics; the institution has recently begun an Environmental Policy Unit which is synthesizing Academy science with issues that relate to public policy.

It is expected that the following research units and scientists would be active in CW-CESU projects:

Biogeochemistry Section

Dr. David Velinsky is a marine biogeochemist with over 20 years experience in marine and freshwater studies related to nutrient cycling, isotope biogeochemistry, and wetland nutrient and

metal geochemistry. He has published studies related to many aspects of biogeochemistry and has a broad range in the cycling of bioactive elements.

Dr. Jeffrey T.F. Ashley (a Research Associate of the Academy and Associate Professor at Philadelphia University) has expertise in organic contaminant biogeochemistry. Interests include the sources, transport, and fate of bioaccumulative, persistent organic contaminants in natural waters; modeling the bioaccumulation of pollutants in aquatic food webs; the role of eutrophication in determining organic contaminant exposure to organisms; environmental analytical chemistry, assessment of contaminated fisheries.

Fisheries Section

Dr. Richard J. Horwitz has over 30 years experience with the collection, identification and analysis of fish specimens from throughout the United States and other parts of the world (e.g., Canada, Central and South America, Nepal, Africa), statistical analysis of ecological data, and analysis of relationships between disturbance and fish communities.

Mr. Paul F. Overbeck has over 20 years experience in field collection, identification, and analysis (including otolith-based age and growth measures) of freshwater and marine specimens from throughout the United States. David Keller has experience with invasive species, including the flathead catfish and the northern snakehead, and is conducting research on the native white catfish.

Phycology Section

Dr. Don Charles has over 20 years experience in the ecology and taxonomy of freshwater algae, particularly diatoms as water quality indicators; paleolimnological approaches for inferring change in biology and chemistry of lakes; lake management; assessment of perturbations in aquatic ecosystems due to municipal and industrial effluents, land-use change, acid deposition, eutrophication and climate change.

Dr. Marina Potapova studies community ecology of algae in flowing waters; algae as water quality indicators; distinguishing natural and pollution causes of algal species distributions; algae in Russian rivers and the Baltic Sea; algal taxonomy; effects of industrial and urban activities on aquatic systems. Dr. Potapova has recently accepted a Curator's position in the Diatom Herbarium within the Academy systematics group.

Center for Systematics and Biological Evolution

Dr. Gary Rosenberg, Pilsbry Chair of Malacology and Vice-President for Systematic Biology and Library, studies the magnitude and origin of species-level diversity in the Mollusca. He has been developing electronic databases to better document the known diversity of mollusks and to estimate their total diversity. One such database is Malacolog, for Western Atlantic marine gastropods, and includes the mollusk taxa of Virginia and Maryland.

Dr. Jon Geilhaus Associate Curator of Entomology has expertise in the systematics, biogeography and ecology of worldwide Tipuloidea (crane flies). His work has included collection, identification and cataloging of crane flies in the Chesapeake watershed.

The Academy of Natural Sciences has a long and distinguished history in understanding and promoting the stewardship of watersheds. The institution originated a coordinated, interdisciplinary ecosystem approach to the study of watershed processes, and continues with that research approach today. The Academy has historical data sets from over half a century of biological surveys of streams and rivers, as well as one of the largest collections in the world of biological specimens.

Much of the Academy's past and present research has concentrated on environmental change in watershed ecosystems, particularly for those watersheds transitioning into urban land use. There is particular expertise and interest on how anthropogenic impacts relate to changes in community composition, geomorphology, and the fate and effects of contaminants, as well as in using biological indicators to assess environmental impacts.

As a member of CW-CESU, the Academy would look forward to continuing and expanding its strong tradition of organizational partnerships and scientific collaborations. It would contribute specific areas of expertise as well as a culture of excellence in research and scientific applications. The Academy looks forward to joining with the other distinguished member institutions and adding its capabilities to the work of the CW-CESU.

Please also note that we recently entered into an MOU with the National Fish & Wildlife Forensics Laboratory in Oregon, with a view to cooperating on a range of issues involving wildlife law enforcement.

Education and Exhibits

The Academy has over 200,000 visitors annually, about half from schools, and it conducts various educational programs in natural sciences for children and adults. This proposal does not describe them, but agencies involved with the CESU network should note that the Academy offers significant assets in this area. Additional information on public programs is posted on the Academy webpage.

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