

Project Description

Core network participants and their home institutions.

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Intellectual merit. The project proposes to network 150 herbaria in 15 states in the Southeast. SERNEC will integrate collections and expertise at a scale that can address the pressing impacts of habitat fragmentation, global warming, invasives, and invasive insect infestations. Networking at a regional scale will help preserve smaller herbaria while at the same time integrating them with larger research collections in order to answer the large-scale integrative questions that need to be addressed in the 21st century. The Southeast region of North America contains a significant portion of undeveloped land, a large number of herbarium collections, and a known record of past plant migrations, all of which make it an ideal model for evaluating our changing biota.

The goal of SERNEC is to provide a platform to 1) acquire funds to make regional collections available in digital form to the scientific community and general users, 2) coordinate research activities to help address the impact of humans on the biota and how that impact can be ameliorated, 3) coordinate teaching and learning activities to train new botanists, to help K-12 teachers develop new and richer curricula, and to spur greater botanical awareness among the general public, and especially among young people. Planned activities to promote participation include five annual regional symposia/workshops to be held in conjunction with the annual meeting of the Association of Southeastern Biologists (ASB), the Southern Appalachian Botanical Society (SABS) and The Society of Herbarium Curators (SHC) and state level symposia/workshops in years two and three of the project. An electronic discussion list is already in place to coordinate activities of the core network participants and a second has been created to coordinate a larger group representing 45 herbaria. An SHC/SERNEC website is currently online (<http://www.newberrynet.com/sabs/shc/>) and we will develop an electronic newsletter that can be distributed in hard copy to reach other interested parties.

Broader impacts. Databasing collections on a regional scale will provide information to address taxonomic, ecological, evolutionary, conservation and plant natural products research questions. This network of regional expertise will complement other large-scale data gathering and dissemination initiatives active in the region, such as NEON, SAMAB and NBII to generate a synergy of ideas for future research endeavors. Interactions among experts at various institutions can provide a “virtual campus” to assist in training biologists. This will provide needed expertise for federal, state and local agencies, and community colleges, and will offer training for teaching and research that is not available at many institutions. Herbaria and their curatorial expertise are an excellent source of information for K-12 teachers, students, and the broader community, and this network can provide the needed information to assist each herbarium in maximizing their outreach to the local public. Finally, this network will ensure the long-term preservation of and public access to unique research materials.

Project Description

I. Objectives.

The proposed SouthEast Regional Network of Expertise and Collections (SERNEC) will 1) network the 150 herbaria in 15 states in southeastern North America, 2) develop a strategy for advancing each state's ongoing databasing effort, and 3) publish online botanical resources that will be available to scientists, land managers, state and federal agencies, educators, and the general public. These data will provide a greater understanding of one of the most botanically diverse regions of the earth and will lead to better botanical research, better management planning, and a more well-informed public. To accomplish these objectives SERNEC will seek to meet six main goals.

GOAL 1. Develop a business plan that will provide long-term funding for databasing and digitization of the collections in the network, and determine the best appropriate use of shared technical expertise (estimated cost: \$10,000,000 to completely database the collections of plants, fungi, bryophytes, and algae in the Southeast). This would include workshops on grantwriting and funding opportunities, as well as collaborative grantseeking and resource-sharing.

GOAL 2. Develop a digital library, a "virtual herbarium," which will include a database of collection label data, specimen images and live plant images. The following tasks will be completed:

1. Provide a web presence for SERNEC and, where appropriate affiliate herbaria or groups of herbaria.
2. Assess the technical needs of individual herbaria and identify barriers that currently impede progress in databasing and digitization.
3. Develop and promulgate best practices and community standards for databasing and digitization of collections.
4. Expose metadata from at least 50 network herbaria through the Global Biodiversity Information Facility (GBIF) (<http://www.gbif.org/>).
5. Facilitate the georeferencing of specimen localities (using GEOLOCATE).
6. Make distribution maps available online for all taxa.
7. Make images of live plants or herbarium specimens available online for each species found in each state.
8. Maintain the ongoing development of best practices in terms of curation, databasing, digitization, and research.

GOAL 3. Increase the scope and diversity of SERNEC. This effort will be focused at the state level, as we determine the strengths and needs of the various institutions within each state.

1. Recruit curators that are not yet involved in SERNEC and The Society of Herbarium Curators (SHC).
2. Determine chain-of-command for those collections that do not have curators, encourage their involvement, and offer technical expertise.

3. Use the expertise of the curators at Delaware State University, a Historically Black College and University (HBCU), and the University of North Carolina at Pembroke, a historically Native American college, to develop a regional plan to include institutions with large minority populations into the network.
4. Through state-level workshops, identify expertise that can be shared by curators within the state and region with scientists at HBCUs and at other institutions with large minority student populations in the Southeast.
5. Develop collaborations and educational opportunities to reach minority students and encourage their participation in botanically-based research.

GOAL 4. Make a database of botanical expertise available on a state-by-state level and for the entire region. The following tasks will be completed:

1. Categorize the expertise by taxonomic categories and by scientific methodology (morphology, molecular, ecological, phylogenetic, etc).
2. Organize state, physiographic and taxonomic working groups to develop research questions.
3. Develop a plan for a database of "gray literature" of technical reports and other unpublished data that have been generated by the scientists, searchable by taxon, region, or type of study.
4. Use the individual herbaria to seek local expertise in community colleges, corporations, K-12 schools, and agencies that could be included in the network.
5. Develop collaborations with state and federal parks, state and federal forests, state natural heritage programs, and The Nature Conservancy to make them aware of available expertise and assist in the curation and databasing of collections held by these groups.

GOAL 5. Evaluate strategies for disseminating information within the network and to the general public. Emphasis will be on region-wide initiatives, or programs that can be easily replicated state-by-state.

1. Provide state-by-state meetings of curators to discuss strengths, weaknesses, needs, and methods to generate collaboration.
2. Publish online teaching aids for K-12. These would include botany studies that are grade-specific and that make use of the database information in an inquiry-based approach.
3. Develop a series of state-level workshops to introduce teachers to the available resources and highlight case studies of their use.
4. Develop a series of state-level workshops to provide training in various technical aspects of systematics and taxonomy, such as Poaceae, Cyperaceae, and Asteraceae identification classes.
5. Interface with the National Science Digital Library (NSDL) to make this information available on a broader scale.
6. Provide information for state groups of wildflower societies and garden clubs about available resources and expertise.

GOAL 6. Determine ways to make botanical information in the Southeast accessible to all. This would include the following issues:

1. Determine how to integrate the ongoing All Taxa Biotic Inventory (ATBI) projects into the network.
2. Determine how to integrate botanical gardens into the network.
3. Determine how best to integrate the network into the broader community of collections and into the broader community of taxonomic groups.
4. Integrate this effort with American Society of Plant Taxonomists (ASPT).
5. Integrate with Index Herbariorum.
6. Determine how best to Integrate with National Ecological Observatory Network (NEON) and the National Biological Information Infrastructure (NBII).

II. Rationale.

Human society must learn how to address several critical ecological issues in the 21st century. Global climatic change, habitat fragmentation and loss, invasives, and infestations of invasive insects and fungi are impacting biodiversity on a global scale. To address these issues, we need to understand the distribution of biodiversity across the landscape. However, this level of detail is missing in current biocollection databasing efforts. Furthermore, for most regions of the earth and for most taxonomic groups, this distributional level of existing specimens simply does not exist because of the historical lack of academic institutions that supported collection efforts.

We assert that the approximately 150 herbaria of the southeastern United States collectively possess a level of distributional detail that make the region ideally positioned to be used as a model to explore critical ecological issues and to make long term decisions about how to ameliorate the impact of the current conditions. In order to make this information available for analysis, the 1) large and small collections must be viewed as parts of a whole, 2) the concomitant community of curators must develop standards of data collection that maximize the value of the collections, and 3) funds must be obtained to provide the needed human resources to digitize the information.

The herbaria in this country are a repository of a tremendous amount of information. Individual institutional databasing efforts, standardization of methods (Specify, Index Kentuckienesis, Darwin Core) and development of a web-based infrastructure (Global Biological Information Facility [GBIF], National Biological Information Infrastructure [NBII]) have set the stage for making this information widely available to the growing cyberinfrastructure. Most efforts to database herbarium collections have focused on the larger collections, since they tend to have greater resources. However, the ultimate research power of the available information in collections can be realized when both small and large collections are databased together in regions, such as the Southeast, that have experienced extensive collecting efforts over the past 100-150 years (Gilmour 2002). By developing a database across a region, using large and small collections to provide more complete coverage, we will develop a powerful research tool. By developing this database through long-term focus on 1) community standards, 2) sharing of expertise, and 3) improvement of information content per specimen, we can

provide a research tool to address ecological, systematic, evolutionary, and biogeographical questions. SERNEC will develop a research tool that can provide sufficient detail across the landscape at a scale to ask questions that are currently facing the scientific community and society.

There are several biotic and abiotic factors that also make the Southeast an appropriate model to generate such a database. The diversity of habitat, the complexity of the landscape and the general north-south orientation of the Southern Appalachians has generated significant levels of biodiversity and has protected this biodiversity from the climatic fluctuations of the last several million years (see *Castanea* Vol 66 No. 1-2, 2001 for several articles on this subject). Due to the efforts of palynologists Paul and Hazel Delcourt and others, we have a “broad brush” map of the plant migrations that have occurred in the region during the past 40,000 years (H. R. Delcourt and P. A. Delcourt 1975, 1991; Delcourt et al. 1980; P. A. Delcourt and H. R. Delcourt 1981, 1984). Although the Southeast is one of the most rapidly growing regions of the United States in terms of human population, conservation efforts and the history of land use have resulted in large portions of the region being maintained, at least in current times, in a somewhat “natural” state.

When we conceptually couple the large number of available collections in the Southeast with the biotic and abiotic factors that have contributed to the rich biodiversity of the region, the model parameters emerge that indicate a great potential to make and test predictions, based upon the projected environmental changes of the next century. The high levels of diversity and endemism, the distribution of extant natural communities, our knowledge of past plant migrations, and the existence of extensive herbarium collections provide a tremendous opportunity for exploration by the scientific community. In order to make this opportunity a reality, the information in these collections must be made available in a digital form.

A second rationale for this project is based upon the lack of botanical awareness in the United States of America (Wundersee and Schussler 1999). This lack of awareness can be partly traced to several causes, such as a shift from an agrarian economy. It is clear that this level of ignorance has and will continue to have a significant impact on 1) the training of future botanists (Dennis 2003, Klein and Morse 2003, Sundberg 2003), and 2) on future decisions our society makes concerning conservation and the health of the planet. We need all the people power we can muster to address needs for botanical research through the 21st century. We view herbaria as an excellent outlet for botanical information and outreach to the community. By developing a network of small and large herbaria across the region, we can reach out to communities of various ethnic, religious and cultural groups and encourage people in these communities to learn more about botany and to encourage young people from minority populations to consider a career in the botanical sciences.

III. Justification.

The Southeast provides an excellent opportunity to develop a model for regional networking, generating a digital library of large, small, public and/or private collections in

the region and then using that network for 1) data mining, 2) research generation, and 3) outreach to the greater community of learning. The Southeast is an appropriate region to generate a model digital library for three reasons: First, the organizational infrastructure is in place to conduct the project; second, preliminary information has been generated about the needs and opportunities in the region; and third, this biologically diverse region is incompletely explored, yet is under tremendous pressure from human development.

Networks and collaborations on this scale do not develop overnight. The potential success of this network is rooted in the significant contributions made by biologists in the region over the past century that provide a solid foundation for this proposed effort. The Association of Southeastern Biologists (ASB) and the Southern Appalachian Botanical Society (SABS) have been meeting annually for the past 60 years. SHC grew out the curators group that has met annually with ASB/SABS. This group was formally organized in 2004 and is an affiliate of the Association of Southeastern Biologists and the Southern Appalachian Botanical Society. Southeastern botanists conducted three symposia in the past five years that generated information pertinent to this project. “Southeastern Endemics: Speciation of Biogeography”, presented as a symposium in 1999 and published in *Castanea* in 2001 (Vol. 66 No. 1-2), generated a summary of many of the biogeographical issues in the region. A second symposium conducted in 2001 focused on “The Future of Plant Collections in the Southeast” and this symposium and workshop culminated in the formation of SHC (*Southeastern Biology* Vol. 48 No. 2). A third symposium conducted in 2003 on a “Crisis in Field Botanical Training: Loss of People and Knowledge” documented the educational needs in the region at the colleges and universities and at the state and federal agencies, parks and forests in the region (*Southeastern Biology* Vol. 50 No. 2). This organizational and informational framework provides the basis for the project. The Society of Herbarium Curators has endorsed the development of SERNEC and the two will function as mutually supporting entities.

The diversity of the biota and the ongoing threat to this biota lends a real sense of urgency to this project. This biota has been explored by many botanists, beginning with Clayton, Michaux, Walter, Bartram, and Gray, for the past three centuries, and all have been startled by the diversity of the Appalachian Mountains, including the Blue Ridge, Ridge and Valley and the Cumberland Plateau, the Coastal Plain and Piedmont of the region, and the Ozark Mountains (Core 1970; Gilmour 2002). The floristic relationships have been explored by Asa Gray, Stanley Cain, A. J. Sharp, and others (Boufford and Spongberg 1983), and these biogeographical relationships have been further explored through the palynological work of Paul and Hazel Delcourt and Margaret Davis (Davis et al. 1991). The fact that this region has a long history of botanical and biogeographical research, coupled with a well-explored palynological record from the past 40,000 years, makes it extremely important as a region to plan for the future of conservation, stewardship, and biological restoration. This proposed project will provide the data needed to prepare for the future.

The future for the Southeast region, the North American continent and the world is inextricably tied to our botanical knowledge base. We have generated a one-two punch

from global warming and habitat fragmentation that have created a worldwide biodiversity crisis. At the same time, there is a decrease in the number of students embarking on careers in the botanical sciences, and a real lack of knowledge about the value of plants among the general public. This project will provide several needed products over the long term to address these pressing issues. First, we will be able to identify areas that need further field investigations, based upon limited collections or unrecognized areas of endemism or uniqueness. It is clear that the region is not fully known, given that a whole new community (Ketona Dolomite Glade) was recognized in the Southeast in 1999 (Allison and Stevens 2001), and the International Classification of Ecological Communities: Terrestrial Vegetation of the Southeastern United States (Weakley et al. 2000) includes several new alliances. Second, we will be able to recognize taxonomic problems and taxa in need of phylogenetic analyses, by providing expert specimen taxonomic verification. The need for further taxonomic and phylogenetic analyses can best be exemplified by the current estimate that there are 20+ recognized but unnamed species in North Carolina alone (NC Rare Plant Group Technical Report 2005). Third, we will provide information to land managers and conservation biologists to identify areas in need of conservation and to provide the data needed to steward and reconstruct communities. A symposium conducted jointly by SABS and the U.S. Forest Service in 2002 entitled "The Crisis in Field Botany: Loss of People and Knowledge" highlighted, from the perspective of a single federal agency, the need for more data and more trained botanists to assist them in their management efforts (*Southeastern Biology* 50(2): 91). Finally, if current models of global warming are correct, we will be faced in the near future with a global change that requires knowledge of how we can construct whole new communities or alliances. In order to accomplish these tasks, we must have a searchable database of what is there now. This project will provide the information and synergy needed to meet the demands of the 21st century.

This project will have a great impact on a critical issue currently facing the botanical community. There has been a reduction in the number of students going into the field of botany over the past two decades, and this has been coupled with the demise of departments of botany among many of the universities in the country. Although there are many probable causes for these occurrences, we believe that SERNEC will provide an effective response to stop and even reverse these trends. Herbaria have the potential to be a driving force in botanical education. Evidence suggests that early exposure of children to the wonders of plants through a mentor will often lead to a career in botany (Wandersee and Schussler 1999). There are a few herbaria in SERNEC that have web sites that receive a significant number of visits per year, such as the Univ. of Tennessee (<http://tenn.bio.utk.edu/index.html>) and the Univ. of South Carolina Moore Herbarium (<http://cricket.biol.sc.edu/acmoore//index2.html>). SERNEC will serve as a conduit to share this capability throughout the region. During the last three decades we have not only witnessed demise in interest in botanical careers (Noss 1996, Sundberg 2003), but also a significant decrease in the support for herbarium collections throughout academia (Haynes 1999, Murrell 1999). Although a portion of this problem is strictly financial, where colleges and universities have a greater expectation for revenue generation per square foot of space and

herbaria require a large amount of space to function. A second aspect of this problem appears to be a lack of understanding among administrators concerning the value of herbaria as a research tool (Funk and Morin 2000, Funk 2003). In the rationale for the development of SERNEC as a model system, we have indicated that the ultimate value of these collections can only be realized when the amassed data from both large and small herbaria are made available at a regional scale. The development of SERNEC will provide a tangible example of the value of herbaria to academic administrators. The development and implementation of methods of outreach to the greater community will increase the value of herbaria to the local community as they come to understand the education potential available through the collections and as they develop a “pride of place” as they come to understand the unique natural resources found in their own local areas.

The formation and development of SERNEC is timely in that it will co-occur with the ongoing development of NEON. NEON is currently being developed as a way to gather broad scale ecological data. This fits very well with the goals of SERNEC, and we would argue that the information that can be generated via SERNEC can make a significant contribution to the success of NEON. Although most digitizing projects have focused on specimen label data and/or on image capture, there is considerably more ecological information that can be gleaned from specimens. The easiest to capture is the reproductive state of the specimen. It is of consequence that Darwin Core has a field for this information, but there is no agreement within the herbarium community to standardize this field (or create multiple fields). With SERNEC we have the opportunity to develop community standards that maximize the available data from each specimen. This, in turn, can maximize the value of these data for analysis of ecological issues at a regional scale. For instance, by coupling flowering time across many taxa from collections made over the past 150 years, we can begin to determine how flowering times have responded to small scale climatic changes. This would allow us to extrapolate from this information into the future and make better predictions of the impact of climatic change on various taxa. Furthermore, by obtaining species distributions across a broad region, we can provide a level of detail that remains unavailable for any other region of the country. The information that can be made available through the efforts of SERNEC will be an invaluable resource for NEON. The development of SERNEC can provide a model to other regions of the country to facilitate the development of a national database at an appropriate scale to maximize the available data.

SERNEC will improve access to specimen-based data for the diverse flora of the southeastern United States. Such access will be critical for a region that lacks a published flora for VA, GA, AL, MS, LA, and TN, and no published atlases in AL, KY or MS. The rich flora of the region makes it a significant area to protect from loss of biodiversity. The region has been a leader in yielding previously undescribed species (Hartman and Nelson 1998 [which covers the period from 1975-1994]), and this region continues to yield many new species. For instance, 16 new species of *Carex* (Cyperaceae) were described from the Southeast during 1995-2004 (Naczi, pers. comm.). New plant species to science have been found in Kentucky (probably the least

collected state in the eastern U.S.) at an average rate of one species per year for the last 25 years (Jones pers. comm.). Estill and Cruzan (2001), LeBlond (2001), and Sorrie and Weakley (2001) have added to our knowledge of Southeastern endemics and have documented the high levels of endemism and diversity in the region. However, as documented by Funk and Morin (2000), there are relatively few specimens per state suggesting that areas need to be identified for increased collection efforts. Even within one of the most well-collected southeastern states – North Carolina – collecting effort has been largely uneven and centered primarily around large metropolitan areas (Krings 2001). By developing the database for the region, we can make information on many narrow endemics and their co-occurring species available for plant systematic research around the world, as we make specimens available through GBIF, as well as help us determine target areas for more intensive botanical explorations.

SERNEC currently has 19 core participants (see below), 47 herbaria that are committed to the project, and the endorsement of SHC. We have obtained funding from SAIN to begin web-enabling at least 15 collections in the network and making them accessible through the GBIF portal (using DiGIR). The University of Tennessee's SunSITE Program will provide the central IT support necessary for SERNEC success (see below). However, a tremendous amount of resources, expertise and collaborative effort are needed to make this network a functional tool for scientific research. We are seeking funds to 1) support the coordination and development of the network by the Project Coordinator/PI (Murrell) and SHC, 2) gather the community of curators annually for the next five years for symposia/workshops to exchange ideas and generate research initiatives, 3) gather state level groups of curators to develop funding initiatives and research goals, 4) gather K-12 teachers in regional workshops to facilitate botanical training, 5) provide technical expertise to individual collections to maximize their educational outreach and scientific potential, 6) provide a dynamic atlas of plant distributions that is web-accessible and based upon searchable specimen data, 7) provide expertise and information to assist groups of herbaria (taxonomic, regional, state) in their efforts to obtain funding for data collection. We view the Research Coordination Network funding as a necessary source of support to enable us to reach our goal of a fully digitized network of Southeastern herbaria by the year 2015.

IV. Research Coordination Activities.

A. Management Plan.

Three major aspects of SERNEC management will help guarantee the success of the network. First, SERNEC can utilize the existing infrastructure of ASB, SABS and SHC to support the network. Second, SERNEC will use consensus decision-making as the method of choice in guiding the network. Third, SERNEC will provide state-level autonomy of the collections to ensure each state of equal representation in the network.

The Principal Investigator (Murrell) will serve as the Project Director for the duration of the project. Funding of a $\frac{3}{4}$ time Project Coordinator will help provide the needed organization to conduct the project. The Core Participants (Steering Committee) will serve as the initial decision-making body. Decisions that cannot be reached by

consensus will be voted upon by the 18 member Steering Committee with the Project Director/PI casting tie-breaking votes when needed. The Steering Committee position held by the President of The Society of Herbarium Curators (Michael Woods) should rotate to the next SHC President. However, since Murrell is President-elect of this organization, Woods has agreed to continue in his role as a Core Participant/Steering Committee member as past-President of SHC.

As the network develops, SERNEC will make a transition from decision-making by the Core Participants to decision-making by all the herbaria in the network. This transition will begin with the first meeting of participants in Spring 2006. When fully developed, we would expect major decisions to be made by all participating herbaria at the annual meetings, with arrangements made for proxy votes. Decisions that need to be made in the intervening periods will be carried out by the Steering Committee.

The Core Participants were organized to represent the 15 state region of SERNEC and SHC. Also included are representatives from SAIN and SunSITE. We expect some change in this group over the funding period, with the addition of a representative from the Gulf Coast region and possibly a second from Virginia or Maryland. The roles and areas of representation of the Steering Committee members are as follows:

1. Zack Murrell, Dept. of Biology, Appalachian State University, Project Director/PI.
2. Franciel Azpurua-Linares, Representative for Southern Appalachian Information Node (SAIN/NBII).
3. Paul Davison, Dept. of Biology, University of Northern Alabama. Representative for Alabama and the bryological community, with expertise in education materials for botanical instruction.
4. Donna Ford-Werntz, Biology Dept., West Virginia University. Representative for West Virginia.
5. Johnnie Gentry, Univ. of Arkansas Herbarium, University of Arkansas. Coordinator of the Arkansas Vascular Flora Project. Representative for Arkansas.
6. Kerry Hefner, Dept. of Biology, University of Louisiana-Monroe. Representative for Louisiana.
7. Chris Hodge, Office of Information Technology, University of Tennessee, representative of SunSITE and to provide technical expertise for digital library.
8. Ron Jones, Dept. of Biological Sciences, Eastern Kentucky University. Representative for Kentucky.
9. Alexander Krings, Dept. of Botany, North Carolina State University. Representative for the Research Triangle Virtual Herbarium and to provide technical expertise.
10. Lucile McCook, Dept. of Biology, University of Mississippi. Representative for Mississippi.
11. Rob Naczi, Claude E. Phillips Herbarium, Delaware State University. Representative for Delaware and Maryland and for the Historically Black College and Universities (HBCU) collections.
12. Eric Nagy, Dept. of Biology, University of Virginia and Mountain Lake Biological Station. Representative for field stations in the Southeast.
13. John Nelson, A. C. Moore Herbarium, University of South Carolina, Columbia. Representative for South Carolina.
14. Jonathan Shaw, Dept. of Biology, Duke University. Representative for the bryological community.
15. Alan Weakley, UNC Herbarium, North Carolina Botanical Garden, Chapel-Hill. Representative for North Carolina and Virginia.
16. Norris Williams, University of Florida Herbarium, Florida Museum of Natural History. Representative for Florida.
17. B. E. Wofford, Dept. of Ecology and Evolutionary Biology, University of Tennessee. Representative for Tennessee.
18. Michael Woods, Dept. of Biology, Troy University. President, The Society of Herbarium Curators.
19. Michelle Zjhra, Dept. of Biology, Georgia Southern University. Representative for Georgia.

It is critical in the formation of a network of this size to provide as much local autonomy as possible to each state and to each herbarium. There has been a strong tradition in the botanical community to work within state boundaries, as can be seen in the floras produced in the Southeast over the past 50 years: *Flora of West Virginia* (Strausbaugh and Core 1977), *Manual of the Vascular Flora of the Carolinas* (Radford, Ahles and Bell 1968), *Atlas of Tennessee Vascular Plants*, 2 volumes (Chester et al. 1993, 1997), *Guide to the Trees, Shrubs and Woody Vines of Tennessee* (Wofford and Chester 2002), *Plant Life of Kentucky* (Jones 2005). An exception to this state-level work is the *Guide to the Vascular Plants of the Blue Ridge* (Wofford 1989) that includes portions of five states. Another exception, yet unfinished, is Weakley's on-going *Flora of the Carolinas, Virginia, and Georgia*. Each state in the SERNEC region is at a different stage of botanical knowledge, for example, Georgia and Virginia have published (or on-line) atlases of plant distributions but no published flora. North Carolina and South Carolina have a published flora and atlas in one volume (Radford, Ahles, and Bell 1968). There is a recently updated on-line atlas for South Carolina (<http://cricket.biol.sc.edu/herb/>) and a new on-line atlas is being developed for North Carolina. There are no published floras or atlases for Mississippi or Alabama, although progress is being made in each state. Louisiana has a published atlas (Thomas and Allen 1993, 1996, 1998), but no flora. Tennessee has a published atlas of vascular plants (Chester et al. 1993; Chester et al. 1997), but no flora. Kentucky has an illustrated guide with keys to the vascular flora (Jones 2005), but no published atlas of plant distributions (there is an on-line preliminary atlas).

Based upon the past and present research patterns, SERNEC will use states or groups of states to organize at a local level. SERNEC will identify leaders within each Branch (see below) and develop meetings and workshops to help each Branch 1) identify goals, 2) identify needs, 3) identify and evaluate the condition of all the collections in each Branch, and 4) determine priorities to protect and database the collections and to disseminate information to local, state and/or Branch level learning communities to further the overarching goals of SERNEC.

SHC will be the Trunk of the network, with states or groups of states providing the Branches and the individual herbaria representing the Leaves. The concept is to use current networks and interactions. For instance, the Research Triangle Virtual Herbarium (<http://www.cals.ncsu.edu/botany/ncsc/virtual/>) could be expanded to serve as the Branch for NC, Virginia, Maryland, and Delaware. These need to be adjusted at the local level to be the most efficient working groups we can organize.

Symposia and workshops will be held in years 2006, 2007, 2008, 2009, and 2010 at each of the Association of Southeastern Biologists meetings. These will be organized by the PI and the Steering Committee. Each meeting will address funding sources, development of proposals, and determination of local and regional research directions. Meetings in 2007-2010 will include progress reports from the local, branch and regional projects as they develop.

The following are the tentative topics for these meetings.

2006. Community Standards and Research Questions. Here SERNEC will develop a set of community standards for data collection. These will be based on the Darwin Core. The development of community standards will facilitate research and provide greater access to the collections. This meeting will also address research questions, with a focus both at the regional and the state/Branch level.
2007. Research questions, data ownership, and getting credit for effort. This meeting will address how to get smaller collections and the curators associated with these collections involved in collaborative research projects in the region. This will lead to higher visibility and better support for these collections. As more collections become web-enabled, we will need to make sure that each collection gets credit for effort and input into the larger research initiatives.
2008. Outreach to the community and to K-12 students and teachers. This meeting will address methods of outreach via web sites, newsletters, local and regional media. It will also address state and regional methods to integrate our efforts with those of the K-12 learning community. This meeting will build the framework for meetings in 2009 and 2010 that will involve teachers in botanical learning.
2009. Development of a “virtual campus” of curators and herbaria. The focus of the meeting will be on activities to provide training opportunities to field schools, state and federal agencies and botanical gardens to train post-docs, graduate and undergraduate students and researchers in organismal and field based research methods and opportunities.
2010. Where to go from here? This meeting will summarize the results of the five year funding period. The focus will be on the success or failure of initiatives within SERNEC and a determination of what is needed to achieve the goal of completion of the database by 2015.

Workshops will be held at the state/branch level in years two, three, and five. These will allow state curators to meet in a more intimate setting to make decisions regarding their future research and funding efforts. At these meetings the groups will set state and local priorities and assist each other in determining how to best meet their goals for the future.

One round of meetings will be organized to interface with K-12 teachers in year four. These meetings will be coordinated with the National Science Teachers Association (NSTA) and associated state-level entities associated with NSTA. We will use these meetings to inform teachers about the opportunities that can be accessed for botanical learning via SERNEC.

One round of meetings will be organized to train botanists and land managers in each branch. This will coincide with the year three meeting at the state/branch level. This will be advertised as a regional wildflower identification workshop and we will use this opportunity to inform professional biologists of the research and information value of

SERNEC. Johnnie Gentry at the University of Arkansas has conducted similar workshops at the state level and he will take the lead on helping SERNEC develop this at a regional level.

SERNEC will work closely with SHC, ASB and SABS over this five year period to coordinate activities and provide mutual support. These groups have provided the foundation to develop SERNEC and it is expected that these groups will continue to work together to facilitate research, education and outreach efforts within and outside of the region.

B. Information and Material Sharing.

SERNEC currently has one electronic discussion list that supports communication among the members of the Steering Committee and a second list that supports communication among the members of SERNEC. SHC has a web site hosted by Newberry College (<http://www.newberrynet.com/sabs/shc/>). SERNEC will develop this web site to link the SHC site to the Branches and Leaves of SERNEC. Branches can develop their own websites (using SunSITE's resources), if they do not already have a site. If participating herbaria require additional disk storage, this can be provided through SunSITE, as part of its in-kind contribution. SunSITE will also work with participating herbaria to explore the use of emerging technologies of cooperation to increase the efficacy of online interaction.

It is important to provide participants with a tangible view of their efforts as part of the network. One way to do this is through a dynamic map that can provide up-to-date species distributions as we add specimen data to the database. We will cooperate with ongoing efforts such as DIVA-GIS, HerpNet, MaNIS, ORNIS, and Biotics, to determine how their GIS-based mapping protocols can be used and enhanced in an interoperable network environment. We will take what has been done and create a system that will provide synoptic views of the Southeast. This will involve a team effort of GIS and database experts to create a searchable database that supports advanced geospatial querying, data aggregation, and filtering methods. SERNEC is seeking funds from NSF to develop this capability as part of this grant proposal. These funds will support contract efforts to assist collections in the development of an interactive mapping capability. Through its partnership with SAIN, SERNEC will make sure that its mapping methods and spatial database protocols are compatible with NBII, NatureServe, GBIF and other important players in this rapidly evolving field.

The funds for a ½ time Graduate Assistant (GA), housed at SunSITE will be matched by SunSITE to provide a full-time GA to work with SERNEC and SAIN to develop an interactive mapping capability. The GA will be supervised by Chris Hodge (SunSITE) and will work closely with Hodge, Wolf Naegeli (Energy, Environment, and Resources Center, University of Tennessee, Systems Architect of NBII-SAIN with expertise in systems integration, interoperability, geospatial technologies, and biodiversity informatics) and Franciel Aspuru-Linares (SAIN) to develop the mapping protocol and make this available to participating herbaria.

The SunSITE Program was created in 1995 as part of UT's Office of Information Technology, as a means to promote the implementation of emerging and advanced technologies and applications, and to provide additional support for various University research projects. SunSITE is currently providing support for the USGS National Biological Information Infrastructure's Southern Appalachian Node as well as the Southern Appalachian Man and Biosphere Project, which together maintain 2Tb of biological and geospatial data.

UT's SunSITE Program will work with SERNEC to develop and implement an information management system that will provide for the ingestion, consolidation, storage and dissemination of the data generated by this project. Specific steps to be taken in developing this system will include:

- Developing a process whereby raw data generated by this project will be collected and consolidated on a single server, and automating this process wherever possible;
- Developing mechanisms and tools for converting and translating data into whatever formats are necessary;
- Developing a database schema for the project, in conjunction with UT's Computer System Services Database Administration (CSSDA), and implementing the schema in an Oracle Enterprise environment;
- Developing a standards-based metadata schema to increase access to the project data, and to ensure that the data interacts with other biological and geospatial data hosted by SunSITE (as well as other standards-based data repositories), and automating the creation of metadata as much as possible;
- Developing a policy for securing access to the management system, and where necessary, creating a mechanism for securing the data itself, through encryption; and
- Developing a web-based interface for making the data accessible and searchable for various audiences and with various levels of access.

SERNEC will deliver regular reports to NSF throughout the course of the grant, as well as publishing an annual report with financial statement. Participation in SERNEC will not be limited to SHC members, but participating curators will be encouraged to join.

All reports and plans that are developed during the funding period will be attributed to SERNEC: SouthEast Regional Network of Expertise and Collections. The developing database will also be attributed to this entity. The publication of ASB (*Southeastern Biology*) will be used as an outlet for information. The newsletter *Chinquapin*, published by SABS, will also provide a source of outreach. SERNEC and SHC will jointly develop an electronic newsletter and this will be made available to interested parties through individual herbaria.

Given that we view this project as a model for other regions of the country, it is important that the details of project development and implementation be made available to the greater scientific community. As we develop the network, we will target avenues

for publicity to inform others within the scientific community and in the general public of our efforts. We will conduct a symposium at the 2009 national meeting of the Botanical Society of America. The symposium will outline the project, goals, progress to date, and research efforts that have resulted from the network. We will also seek access to the leadership of NEON at the national and regional level, to inform them of our progress and to encourage interactions between SERNEC and NEON.

C. Increasing Diversity.

1. Plan to increase participation of under-represented groups.

The Southeast has historically had a large population of people in lower economic levels (Appalachia, minorities throughout the region, etc.). Also, the amount of funding available for education has been low in comparison with other regions of the country. There are many HBCUs (historically black college or university) in the region that maintain a high percentage of minority students. Each of these characteristics of the Southeast can be viewed as opportunities for outreach and training that are potentially very large in scope.

2. Plan to involve investigators at a variety of organizational settings.

The project is designed to include collections at colleges, universities, state and national parks and forests, field stations, museums, botanical gardens, and also private collections. If we are to be successful in this endeavor, it is imperative that we include collections from all of these organizational settings. We will determine what expertise is associated with these collections at each of the institutions and enlist these investigators in our efforts.

The Nature Conservancy and Natural Heritage Programs have accessed many of the herbaria in the Southeast to obtain information regarding imperiled plants. Some of these programs have very good relationships with certain herbaria. For example, the Natural Heritage Program of South Carolina posts a botanist at the University of South Carolina Herbarium, and the Kentucky Natural Heritage Program has an office at the Center for Biodiversity Studies at Western Kentucky University. We will encourage further interactions with these groups to develop local and regional research endeavors.

The All Taxa Biotic Inventory in the Great Smoky Mountains National Park has sparked similar interests among other state and national parks. We will cultivate these relationships between herbaria and the parks to develop better working relationships, share data, and seek funds to support research.

The 2003 symposium sponsored by SABS and the U.S. Forest Service (*Southeastern Biologist* 50(2)) highlighted the need for curators to be involved in training field botanists to provide expertise to the state and national forests. We will develop these relationships, both from the standpoint of increased research and to train botanists via the "virtual campus."

As we develop community standards that include mining life history, ecological and developmental information, we will develop a database that is of great value to biologists in all of the life sciences. We are particularly interested in developing these

data to interact with NEON, since we perceive this as a database that will be necessary for the success of the NEON project. SERNEC will permit truly global floristic analyses, particularly since many of the genera found in the Southeast (including some endemic to the region) are shared only with eastern Asia, western North America, or the mountains of Mexico.

3. Plan to involve new researchers, post-docs, graduate students, and undergraduates.

It is a stated goal of SERNEC to increase student interest in botany. We believe that by helping scientists understand the real value of herbaria as a research tool, we will attract undergraduate and graduate students toward an area of research that has been unavailable to date.

As we reach the smaller collections in the Southeast, we will be able to help teacher/researchers at those institutions to justify their efforts to administrators. As these people are included in the ongoing effort, they will provide new energy and ideas to explore plants in the region. By increasing the value of herbaria, we intend to help researchers at the smaller institutions obtain release time to assist in our research initiatives.

As we develop a “virtual campus” of botanists and obtain more research funds, we foresee the ability to hire post-docs to conduct research and assist with research efforts within SERNEC.

Herbaria have traditionally housed several taxonomic groups (fungi, algae, lichens, non-vascular plants and vascular plants). Many of these collections are very small or orphaned due to retirements, etc. It is not uncommon for a small herbarium to have a taxonomist with training in only one of these groups who is expected to curate all these taxa. By creating a virtual collection, we will provide these curators with the expertise in the various taxonomic groups that will facilitate better curation and use of these under-utilized collections.

4. How the plans for increasing diversity are integrated with the proposed project plan.

SERNEC is a model project based upon the premise that the best way to 1) develop an interest in botany among all sociopolitical, economic and racial groups, and 2) to make the field of botany more exciting as a career choice, is to include both small and large collections within the network. In this sense, the plan to increase diversity is a fundamental part of SERNEC. In reaching out to the smaller collections we will include the HBCU as part of the network. Because our premise is that all herbaria are of value, we will encourage the interactions of interested scientists associated with collections of any size. By providing a network of expertise and support, we will also build a network of researchers that can encourage students from HBCUs and from areas that are historically economically disadvantaged (such as Appalachia and the Gulf Coast) to embark on a career in botany that may not have previously been viewed as a career choice option.

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