1. Introduction. The synthesis of information about biodiversity holds great promise as a source of scientific progress in biogeography, evolution, and conservation. Significant advances in biodiversity science (Funk et al., 2002; Gaston, 2000; Myers et al., 2000), computerization of museum collections and specimen data (Krishtalka and Humphrey, 1998), our understanding of the tree of life (Hillis et al., 2005; Maddison and Schulz, 2007), and information technology will make large-scale synthetic approaches to biodiversity possible in the next few years. The Encyclopedia of Life (EoL) will quickly become a nexus for integration of biodiversity information from many fields, including taxonomy, phylogeny, morphology, genetics, biogeography, ecology and conservation. New ways of analyzing and combining large data sets will be required to make full synergistic use of the EoL’s broad and varied resources. The Biodiversity Synthesis Center (BioSynC), together with the other partner institutions of the EoL and groups of scientists worldwide, will promote scientific discovery related to the biodiversity and evolution of life, and contribute to the educational utility of the vast knowledge of the EoL.

Rapid access to information is arguably the defining revolution of our times. This is true of all fields in biology, as the growth of accessible information on species, geography, genetics, evolution and ecology transcends our ability to process and analyze it. The need for increased synthesis of biodiversity data is clear as human population growth, global climate change, and other environmental crises heighten the urgency with which we must discover, understand, and preserve biodiversity. A synthetic, integrative approach to biodiversity and evolution is also timely because rapid development of information technology and computational power is opening doors to new and innovative approaches to biodiversity and evolution. The Biodiversity Synthesis Center will play three major roles in the study of biodiversity: (a) accelerate the pace of scientific discovery in biodiversity and evolution by using the power of bioinformatics to answer large-scale questions; (b) provide a central location for scientific working groups to
convene and explore new ideas and develop tools for synthetic analysis in biodiversity bioinformatics; and (c) support the growth of the EoL by facilitating cross-disciplinary involvement of the scientific community in the EoL effort and contributing to the broader impacts of educational and conservation applications of the EoL.

2. Specific Goals. There are three primary objectives for the Synthesis Center.

A. Scientific discovery. The charter goal of the Biodiversity Synthesis Center will be the genesis of new insights into life’s diversity, distribution, evolution and conservation, emphasizing the innovative use and development of digital information technology. When concentrated information sources are integrated, people often arrive at insights and kinds of questions that were previously unattainable, just because the emergent properties of the data integration did not yet exist. This is our ultimate goal, to ask, and answer, new questions about biodiversity that are scientifically revolutionary. This insight will be sparked by exploration of high-performance computing and large-scale bioinformatics, including the integration of taxonomic names and specimen datasets with mapping tools, phylogenetic trees, genetic data, and other biological information. New tools for comparative biology will be developed, making synthesis of large data sets more readily available and allowing the testing of a range of hypotheses in biodiversity and evolution. A compelling aspect of the EoL project is that it is designed to promote discovery about biodiversity for a wide range of audiences, and BioSynC will contribute in key ways to the Encyclopedia of Life, educational materials, and conservation biology.

B. Center for scientific interaction. The Biodiversity Synthesis Center, based at The Field Museum of Natural History in Chicago, will be modeled on the national synthesis centers for ecology (NCEAS) and evolution (NESCent). These centers were established to catalyze synthesis and integrative research by bringing together novel and complementary groups of people to work toward common goals that are larger than any single person could achieve.
Likewise, BioSynC will act as a host facility for working groups focused on key questions in biodiversity informatics. The scientific goals of BioSynC will complement those of the existing NSF-funded centers at NCEAS and NESCent, and partnerships will be developed with these and other regional, national, and international organizations focused on biodiversity. BioSynC staff and many of the Synthesis Meetings will initially focus on taxonomy, museum collection databases, and integrating data sets from faunal studies. More synthetic objectives will emerge as we are able to make use of the new dynamic software architecture that will be used in the Encyclopedia of Life.

Chicago is an excellent central location for the Biodiversity Synthesis Center and will involve multiple institutions from the Chicago academic community (Field Museum, University of Chicago, University of Illinois, DePaul University, Northwestern University, collectively comprising a large pool of faculty and students working on past and present biodiversity) as well as across the US. More broadly, international participation is a central goal of BioSynC activities, and connections to existing scientific and conservation groups will be facilitated via Center activities. Creative energy and innovation will be harnessed from the world community of biodiversity scientists by soliciting proposals from synergistic groups of people to tackle specific problems relevant to biodiversity and the EoL. Each group might meet several times over the course of 6–18 months to produce the targeted synthesis of ideas and the desired results in terms of publications, software, or other tools. The Center will facilitate the coordination of effort around innovative ideas in biodiversity, taxonomy of understudied groups, biogeography, genomics, phylogenetics, and other areas. Beyond the core issue of identification and classification of species, the development of new analytical tools will reveal additional large-scale patterns in nature. For example, mapping of species distributions and integration of phylogenetic and evolutionary information with museum collection databases will enable us to better understand the patterns of distribution and evolution of life.
C. Academic participation in the EoL. The involvement of scientists worldwide is crucial to the success of the EoL effort. Thus, a third primary objective of the Biodiversity Synthesis Center is to involve experts in biodiversity, computer science, conservation, and other disciplines in EoL development and application of the EoL in scientific synthesis. In this aim the Center will work closely with the Secretariat to identify priority areas of biodiversity and taxonomic groups that may be simultaneously ripe for synthetic treatment as well as being key groups for which web content would enhance the EoL. BioSynC will help to forge important links between the diverse academic communities, the many users of the EoL and the various members of the EoL development team. A broad assortment of experts in this project could use the EoL web page content to integrate specimen databases, biogeographic mapping tools, and phylogenetics. BioSynC will recruit an internationally diverse community of biologists that may be interested in synthetic bioinformatics research and discovery, assistance with basic EoL page content, or efforts in educational or conservation approaches that make use of the EoL.

3. Major project themes for the Biodiversity Synthesis Center.

The Synthesis Center is designed to be a streamlined “grass-roots” organization in which the academic community develops the projects that are funded for Synthesis Meetings and then performs the integrative research that emerges from Center activities. In this effort, BioSynC management will not establish the agenda for group meetings; rather we have developed a set of overarching themes, viewed as being central issues in biodiversity informatics, to serve as a template for synthesis groups to use as a base for their own unique approach.

A. Biodiversity in space and time. The Synthesis Center will host groups that are developing new tools for biodiversity and biogeographic mapping, including integration of biogeographic data using the EoL platform. For example, BioSynC groups will explore the integration of biodiversity hot spot maps, museum specimen data, global geologic history, environmental variables, and ecosystem threats in new ways using the EoL and other biological data sets.
Large-scale question: Where do species live? It is largely unappreciated how fundamentally ignorant we are of this basic question, even if consideration is limited to known species (i.e., those with names). Range maps, both historical and current, are essentially inferences drawn from observational data (georeferenced specimens), and possibly other information about the biology of the species, and abiotic factors such as habitat and climate. Our ability to answer the question is being transformed by technological advances such as portable GPS units, satellite imagery and remote sensing data, and techniques for ecological niche modeling and predictive mapping. The Synthesis Center will encourage the integration of the latest in geographic mapping technology with modern specimen databases that are managed by the world’s major museums. In this way we will foster the discovery of previously unknown patterns of biodiversity that will answer long-standing questions about the origin and diversification of life.

Examples of synthetic biogeographic analysis of particular taxa abound, from the distribution of Andean plants (Bush et al., 2004; Young et al., 2002) to the center of biodiversity of coral reef fishes (Carpenter and Springer, 2005). A recent historical biogeographic analysis of marine bivalves using fossil and extant taxa (Jablonski et al., 2006) found strong support for an “out of the tropics” model of diversification, in which taxa preferentially originate in the tropics and expand toward the poles without losing their tropical presence. They showed that the tropics are thus both a cradle and a museum of biodiversity, and noted that a tropical diversity crisis would thus have profound evolutionary effects at all latitudes. This is the kind of synthetic approach that can be done on a grand scale with database integration tools that we will help to develop for the EoL and use for biodiversity science. This study received considerable press coverage, and has been developed as a module in Berkeley’s “Understanding Evolution” website, popular with K-12 teachers.

Other compelling examples that illustrate this theme and reach both scientific and public audiences include the generation and interpretation of large-scale biodiversity hotspot maps (Roberts et al., 2002), dynamically mapping the impact of global warming on plants and animals
(Peters and Lovejoy, 1993), making a wetland map of mangroves in the Gulf Coast region of Louisiana (Twilley et al., 2001), mapping the distribution of coral reef bleaching (Glynn, 1996), or illustrating the spread of introduced zebra mussels in the Great Lakes (Craft and Johnson, 2000). Mapping biodiversity resonates with a wide range of audiences and will translate readily into scientific advances in biodiversity, conservation applications and educational tools (Fig. 1). New tools that take advantage of major advances in information technology can make this effort easier and more readily accessible to scientists, policy makers and the public.

Figure 1. Biodiversity hotspot maps. A. Biodiversity map showing species of butterflyfishes on coral reefs, with a focus on the Western Pacific and biodiversity peak above the Philippines (Fessler, 2007). B. Conservation hotspot map illustrating diverse and threatened areas (Conservation International).
**B. The tree of life.** Phylogeny is the historical record of biodiversity and is our conceptual framework for the evolution of life. Branching diagrams among species and populations are our means of illustrating evolution and are a key source of hypothesis testing in biology (Hillis and Moritz, 1996; Huelsenbeck and Crandall, 1997). The science of phylogenetics is making great strides in deriving the tree of life for organisms ranging from bacteria to vertebrates, yet challenges remain to a full realization of the potential of this field to advance biodiversity science and impact humanity. Among these challenges are the need to know all of the species in a group and the ability to use phylogenetic trees of life in conjunction with the vast data on species traits, physiology, and ecology that can be interpreted in the revealing light of phylogeny. The Synthesis Center will host working groups that will explore the linking of taxonomic and phylogenetic databases (e.g., Tree of Life Web Project, TreeBase), and examine ways in which the tree of life may be used to discover and illustrate trends in the evolution of biodiversity.

Large-scale questions: How are species related and how is the tree of life shaped by the continents and oceans of Earth both today and in the past? With the appropriate tools and access to a wide array of databases, the EoL can be an instrument that can be used to integrate evolutionary biology and biogeography and to teach people about the evolutionary history of life. Working groups may explore this question at levels ranging from detailed studies of DNA change across megadiverse species groups, to the illustration of phylogenies on biodiversity maps, and the power of supercomputers in answering big evolutionary questions.

A fascinating example of this integration of genetics, genomics, and supercomputing to derive relationships among species is the recent success in outlining much of the topology of the entire tree of life (Fig. 2). A recent effort (Hillis et al., 2003) used an analysis of small subunit rRNA sequences sampled from about 3,000 species from throughout the Tree of Life (Fig. 2). Viewing this tree is fascinating and powerful, suggesting many interesting scientific questions, and sparking queries about the location of humans and other taxa, leading to an intuitive grasp of the centrality of phylogeny. In a complementary fashion, phylogenies have been generated from
complete genomes (Cicarrelli et al., 2006), but unlike the large-scale trees of life, those based on genomes are heavily weighted towards bacteria, because most genome projects to date have been based on complete bacterial genomes. Ultimately, we need to synthesize the databases of phylogenies, genomes, genome size, gene arrangements, chromosomal structures, lineage size, and morphological diversity in order to make major contributions in connecting genotypes to phenotypes, a long-term goal of evolutionary biology.

Figure 2. Phylogeny of the tree of life based on small subunit rRNA sequences sampled from about 3,000 species from throughout the Tree (Hillis et al., 2003). Available in high resolution at http://www.zo.utexas.edu/faculty/antisense/DownloadfilesToL.html.
Another important area of inquiry for synthesis across lineages is the coevolution of major groups of organisms that share patterns of diversification through geologic history. For example, a recent higher-level phylogeny of ants (Moreau et al., 2006) found that the timing of major ant radiations occurred during the diversification of flowering plants, suggesting a strong coevolutionary pattern that may have dominated the entire history of these and other species groups that are highly diverse. Future work in this area will require extensive phylogenies for both ants and plants, integration with fossil databases, and examination of ecological patterns of ants and their host plants. A related question is: Are biodiversity hotspots such as rain forests and coral reefs also hotspots of genetic change (e.g., Kahindo et al., 2007), or are species biodiversity and genetic diversity decoupled? Large data sets and high computational power are needed to answer such questions (Calsbeek et al., 2003), even for small taxonomic groups. Interesting phylogenetic research examples that can translate to the classroom include: how close is your dog breed to a wolf (and how do we know it)? What bird species are most susceptible to spreading the West Nile Virus, and why? From HIV/AIDS to the bird flu, the evolution of viruses is of central medical importance. These examples illustrate the kinds of integrative questions in evolutionary biology that may be answered with large data sets and new biodiversity tools, and they can also be powerful hooks to get the next generation of biodiversity scientists interested in science in the classroom.

A specific example of a new tool for comparative biology that BioSynC could develop in collaboration with partners such as Tree of Life Web Project, is that of a web-based, interactive visualization and navigation tool for large phylogenetic hierarchies. Imagine a tree of life browser that would smoothly zoom between levels, from relations among Kingdom and Phyla, up the branches to insects, angiosperms, crustaceans, lichens, fishes or birds. Keep zooming with a simple mouse motion to see relationships among species, with pop-up photos and links back to EoL content. The tools we envision serve both research and outreach purposes; they are customizable for the needs of different projects, including the EOL and its partners; they feature links to relevant web pages and integrate images and other content from distributed databases;
they are extensible to accommodate advanced features such as branch/node coloring and content filtering based on user feedback. A number of groups are currently engaged in relevant efforts (Hillis et al., 2005), and the Biodiversity Synthesis Center could make an impact on its progress and help incorporate it into the EoL.

C. Quantum leaps in discovering and describing biodiversity.

Perhaps the single most daunting challenge in biodiversity science is the discovery, description, and cataloguing of species so that we know the units of biodiversity. Efforts to generate this basic knowledge are coordinated by biologists and taxonomists in museums and universities worldwide. This effort is particularly poignant in megadiverse groups of organisms such as insects, protists, fungi and other groups for which the number of unknown species greatly exceeds the named taxa. In many cases, the task is slowed by limitations of information access, availability of literature, and the process of researching the specimens held in multiple museums. Thus, the synthesis of specimen data and taxonomic information for large, diverse yet understudied or problematic groups of organisms is a key priority for the Encyclopedia of Life and for the Biodiversity Synthesis Center.

*The key question here is: How many species are there?* We have no truly accurate idea, is the unfortunate answer. Estimates range from 5 million to 30 million, or more. The Synthesis Center will support the Secretariat in convening large groups of biologists to consider the EoL content and the integration of biodiversity data for these fascinating groups of organisms. Some of these groups are surprisingly charismatic (like mushrooms, millipedes and beetles) and will make excellent education and outreach content. In addition to critical assessment of taxonomic issues, sessions involving specific groups will consider how information technology can best be used to transform systematics and propel it into uncharted territory and rates of progress.

A flagship example of this is the beetles. With over 400,000 already-named species and several thousand new ones named each year, beetles dominate most terrestrial ecosystems in
species numbers. Although they represent the most diverse and rapid radiation of any terrestrial group of organisms, we are still in the early stages of developing knowledge of the phylogeny of this phenomenal insect order. Beetles show dramatic variation in form and function within their overall body plan of hind flight wings protected by modified forewings and present nearly every feeding habit known among insects, from saprophagy, herbivory, and predation to fungivory, parasitism, and kleptoparasitism. Understanding how this species richness and ecological diversity arose requires the integration of multiple data sets, from phylogenetic hypotheses to knowledge of habits and their distribution, obtainable only through collaboration by a broad array of specialists.

Similarly, systematic and evolutionary research on bivalve mollusks has entered a phase of renewed vigor due to a critical mass of worldwide researchers, new data sets, and increasing sophistication of analytical methods (Giribet & Distel, 2003; Bieler, 2006; Jablonski et al., 2006). There has been, however, little effort to coordinate such studies, which often were based on non-overlapping suites of characters and exemplar species in shell-morphological, soft-anatomical, and molecular analyses, and have rarely considered phylogenetic patterns synchronously with spatial biogeographic relationships. Synthetic approaches are needed, involving and engaging the currently disparate efforts of paleontologists, molecular biologists, and other researchers.

There are numerous compelling examples of megadiverse groups that are prime for synthesis because they are understudied and under funded, because they are being actively worked on but could use financial assistance to make a persuasive case study in biogeography or evolution, or are so diverse and problematic that they need a group effort just to get started in compiling EoL species pages. Most unknown species are members of understudied groups such as beetles, flies, mollusks, nematodes, fungi, protists and bacteria. These diverse groups are the foundation of biodiversity and the key species in many food webs, and we must develop the information base for systematic exploration of these groups.
How can we facilitate the dissemination of species identification skills from taxonomic experts to other biologists and the public? Taxonomic training is an important part of biodiversity science that has been traditionally under funded (with the exception of the excellent NSF PEET program) and there is usually no central source for accessing basic taxonomic information and identification aid. A potential comparative tool to be developed by synthesis groups at the Center is a flexible electronic field guide program that could be used by taxonomists and enthusiasts alike, and would be useful for both understudied and well-known groups of organisms. For example, a new Field Guide to the Birds of Peru (Schulenberg et al. in press) provides identification and rough distribution information of more than 1800 birds from that country (comprising 18% of the worlds’ currently recognized species), but the authors also have a detailed database of localities for known specimens. Such a resource on a well-studied group could be a test case for a electronic field guide in which pages could be downloaded (and new data uploaded) remotely to quickly enhance our understanding of biodiversity in real time. In partnership with such organizations as MorphBank, such a tool could include the latest in image recognition software, allowing biologists to rapidly compare key characters to aid identifications and speed the discovery of new species.

D. Conservation of biodiversity. Biodiversity is a central part of human life and culture, representing the resources upon which families, communities, nations and future generations depend. A deeper understanding of biodiversity and its evolutionary history can lead directly to improvements in the preservation of biodiversity through informed decision-making processes by governments, conservation organizations, and the general public. Conservation of biodiversity may focus on key regions such as rainforests and reefs, on particular species that are emblematic of biodiversity loss, and genetic diversity that is just beginning to be understood. This focus on the application of biodiversity science for preservation is a natural offshoot of the scientific agenda outlined above. The large questions in conservation science are often information intensive (e.g., Overpeck et al., 1991), highlighting once again the value of integrated data sets
on species, distribution data, evolutionary trees, genetics, and ecology that the EoL aims to collate.

As an example, the IUCN Red List (IUCN, 2006; http://www.iucnredlist.org/) reports the conservation status of organisms in the wild, based on the analysis and opinions of more than 7,000 experts. The list is global in scope, updated annually, and revised fully every four to five years. The global Red List as well as the smaller-scale Red Data Books (information on specific taxa and/or particular countries) represent a tremendous resource, however, they are labor-intensive to produce, rapidly outdated, and not linked to conservation action. With a fully developed EoL and integrated datasets (modeled and known species distributions, protected area coverages, maps of large-scale environmental threats), not only could the production of the Red List and Red Data Books be accelerated, the results could be translated into concrete recommendations for decision-makers.

E. Educational applications. Each of the initiatives of the Biodiversity Synthesis Center will have aspects that may translate readily to a broader audience, reaching beyond the scientific community into the classroom and the living room. Each working group and Synthesis Meeting will include in their program the consideration of broader issues related to education, conservation, and elevating public awareness of biodiversity. This will aid cooperative efforts with the Harvard and Smithsonian EoL Education and OutReach groups to develop new approaches to biodiversity education, including details of particular groups (beetles, fungi, etc), specific themes (biogeography, evolution) or the process of scientific discovery itself.

4. Mission, Structure and Governance

The mission of the Biodiversity Synthesis Center is to promote the integration of biodiversity information and the synthesis of new knowledge about the distribution and evolution of life. The charter goals of BioSynC are (1) to explore, analyze and synthesize biological
information in order to accelerate the pace of new discoveries, and (2) to supply the academic community with a forum for exchanging ideas about biodiversity.

Global and local community. The Biodiversity Synthesis Center will be formed from a global community of scientists studying the biodiversity and evolutionary patterns of organisms ranging from bacteria and protists to angiosperms and vertebrates. Biologists of all disciplines from any location may join BioSynC as Members online, and receive information about Center activities and calls for proposals. Members will be able to apply for synthesis meetings to be held at BioSynC and will have access to early versions of new computational tools for exploration of biodiversity.

Partner institutions. How can BioSynC play an effective role in advancing the goals of biological synthesis with the many other groups addressing this same global need? The Center will develop its own focus that is complementary to and collaborative with the goals of partner organizations such as biodiversity or evolutionary centers, foundations, universities or departments, governmental organizations, non-profit or conservation organizations, schools and other entities. The Center should contribute in key ways to the overall success of the EoL, and also take some of the first steps in making use of the EoL to aid in the efforts of basic taxonomy and evolution of as many groups as it can with available funding. The most effective way to do this is through holding broadly integrative and effective synthesis meetings at the Center, involving and aiding partner institutions and groups of many kinds. Many of the institutions that join the EoL may want to also partner specifically with the Biodiversity Synthesis Center along lines of mutual interest. A partial list of partnerships that have already begun include alliances with NESCent, NCEAS, regional biodiversity centers such as the California Center for Biodiversity at UC Berkeley and the Australian Centre for Coral Reef Biodiversity, database consortia such as TreeOfLifeWeb, TreeBase, GBIF, OBIS, and other taxonomic databases, and
conservation organizations such as Conservation International and Wildlife Conservation Society.

**Affiliated faculty and students.** The Chicago area is home to numerous academic institutions with faculty that may join the Biodiversity Synthesis Center as local affiliated members in order to participate regularly in on-site programs or apply to host a synthesis meeting. The large number of faculty, curators, graduate students and postdocs actively working on biodiversity questions in the area will provide a rich pool of expertise and a stimulating environment for synthesis meetings. This approach to strong local involvement in combination with a careful focus on broad national and international involvement in synthesis meetings and research projects is a proven recipe for success at the other national synthesis centers.

**Administrative Structure.** The Biodiversity Synthesis Center is organized around an external, international Advisory Board and the office of the BioSynC Director.

**External Advisory Board.** A group of 15 prominent scientists in biodiversity, evolution, or bioinformatics from around the world will form the Advisory Board in order to provide advice to BioSynC staff and leadership for the activities of the Center. The board will meet quarterly and will evaluate Center structure, advise BioSynC staff on operations, evaluate proposals, and assess the performance of the Center in reaching established milestones. Members of the board may also participate in the Center projects and outreach efforts.

**Director’s Office.** The Director of the Biodiversity Synthesis Center will engage in planning of major BioSynC projects, communicate with the EoL, Advisory Board, and other groups, engage the scientific community and national scientific societies, perform fundraising and promotion duties, supervise the Center staff and help evaluate synthesis meeting proposals. The Director will be appointed by the Vice President, Collections and Research, Provost, and President of the Field Museum, with EoL Board approval, and will typically serve for a 2-year term.
Staff. Employees of the Center may include scientific staff, administrative staff, postdoctoral researchers, graduate students and interns. Staff will generally report to the Director of the Center, within the administrative structure of Collections and Research at the Field Museum. In cases of affiliated staff working in the Center, performance review will be handled by the appropriate Department Chair or Supervisor from the home institution in consultation with BioSynC staff.

Governance. Governance and oversight of the Biodiversity Synthesis Center is performed by the Encyclopedia of Life Board, the local faculty and Advisory Board of the Synthesis Center, as well as internal evaluation within the Field Museum.

Advisory Board. The Board will visit the Biodiversity Synthesis Center periodically and will provide a written evaluation of the performance of the Center, and make recommendations for future activities, programs, and structure. The board will consider the staffing and administrative structure, advise BioSynC staff on operations, determine the timing and wording of staff hiring efforts and participation in calls for proposals for synthesis meetings to be held at the Center. This oversight will play an important role in the success of BioSynC in the academic community at large.

Field Museum Governance. Additional governance and oversight will be provided by standard internal Field Museum review procedures within Academic Affairs, the President’s Office and Committees of the Board of Trustees, as appropriate.

5. Biodiversity Synthesis Center Staff. The Synthesis Center will be a dynamic group of 10-12 full-time employees plus a group of students, postdoctoral researchers, and visiting researchers. The full-time staff will be dedicated to the twin goals of BioSynC; scientific discovery in biodiversity and holding effective synthesis meetings for the community. Short position descriptions of primary staff members follow:
**Director**: oversight of major projects, communication with Advisory Board and national societies, fundraising and promotion, participation in synthesis projects.

**Assistant Director**: daily operations, hiring in consult with Advisory Board, organization of calls for research proposals, review, grant writing, participation in synthesis projects.

**Scientific Staff**: scientific experts from a computational and/or biological background paired with one or more working groups or synthesis meetings interested in a particular problem, taxonomic group, software application, or conservation initiative. Possible areas of interest might include (1) biogeography, GIS, mapping; (2) phylogenetics, high performance computing; (3) systematics and taxonomy of diverse and understudied groups; (4) genetics, genomics; (5) application programming and web design.

**Support staff**: primary support for synthesis meetings, including daily operations and communication, organization of meetings, travel, grant-writing, accounting and finance.


Calls for proposals will be developed each year to invite groups of scientists to hold Synthesis Meetings on topics of relevance to biodiversity, evolution, conservation and the Encyclopedia of Life. The proposal requests will include a sample of biodiversity topics that are seeds for integrative meetings but each RFP will encourage the formulation of ideas and topics that are novel and build new bridges among disciplines. Synthesis proposals will be short (5 pages) and will include the leaders of the group, a concise summary, a clear statement of goals including how the group will answer an important issue in biodiversity, contributions to or use of the EoL, a list of participants, the duration and tentative agenda of the initial meeting, proposed future meetings, desired outcomes and products from the group, and the requested financial support and staffing needs requested from BioSynC. The primary goal should be to highlight an important question in biodiversity (taxonomy, biodiversity, phylogeography, or other area of interest), but the broader impacts to conservation and the relation to possible educational
materials should also receive mention in the proposal and discussion time at the Synthesis Meetings.

*Preliminary list of Synthesis Meeting suggested topics:*

1. **Biogeography** - tools for biodiversity mapping in space and time, incorporating current and historical distribution records, fossils, predictive range maps.
2. **Phylogenetics** - integrating the tree of life in the EoL, and tools for visualizing patterns of biodiversity on phylogenetic trees.
3. **Megadiverse species groups** (beetles, flies, ants, mollusks, nematodes, fungi, protists and bacteria) both for review of names and EoL page content (coordinated with Secretariat) or for additional synthesis of biogeography and evolution of a particular set of taxa.
4. **Conservation biology**, and the development of practical tools to aid biologists and policy makers in identifying and preserving biodiversity.
5. **Genetics and genomics** - assembling and analyzing large data sets, computational phylogenetic questions, illustration tools for genetic diversity overlaid on species diversity maps.
6. **Computing and software applications** - new applications for the use of supercomputers and grid networks for high performance bioinformatics applications.

**7. Milestones and Measures of Success:**

*Annual Goals for Synthesis Programs.* Each year of the project will involve a series of Synthesis Meetings that are generated by members of the scientific community, as well as the pursuit of biodiversity programs by the staff of BioSynC on a regular basis. Synthesis Meetings would typically be held in Chicago or at other national or international venues. We would encourage at least one international Synthesis Meeting each year. A projected annual set of goals:

**Year 1.**
- Select/hire Director, establish physical home, hire support staff.
- Select and convene Advisory Board.
- Host major meetings on key synthetic initiatives: Biogeography, Phylogenetics, Taxonomy
• Call for proposals and ideas on synthetic initiatives related to EoL.

Year 2–4.

• Host annual community-driven meetings for synthetic uses of EoL content and databases, in response to outside proposals and internally driven initiatives. These would include biogeographic mapping and GIS technology, phylogenetic applications integrated with EoL, treebase, TOLWeb, inclusion of fossil taxa and techniques for looking at time, etc.

• Host meetings each year focused on synthetic uses of the exemplar, flagship examples for well-known taxa (flowering plants, birds, mammals, reef fishes).

• Host meetings each year focused on synthesis in megadiverse groups, and pushing the content and breadth of EoL pages for poorly-known taxa (bacteria, protists, fungi, various insects, bivalves).

• First sets of publications and successful grant proposals involving BioSynC will emerge.

Year 5. Primary goals and deliverables of BioSynC are:

• Publications in prominent journals using a synthetic approach to the EoL and bioinformatics in general.

• Grants that either support EoL, its use and application, or use the EoL and our new tools in related disciplines.

• Development of new applications that make the database of EoL, and biodiversity in general, come to life and reveal patterns in ways that were previously unattainable.

• Completion of major community-driven initiatives on flagship examples such as birds, as well as hit benchmarks for quality for under-studied groups that received special attention (beetles, bivalves, etc).
Measures of success. The metrics of performance, scientific impact and overall success of an integrative Center such as BioSynC are fortunately well established. We will track the major products of the Center such as publications, grants involving BioSynC, major software or informatics products, educational ideas and curricula with a source in synthesis, and the contributions to the EoL. The Synthesis Center will be particularly interested in tracking the success of partnerships, both within the EoL across the 5 major contributing institutions but also with international biodiversity organizations, governments, and NGOs. In addition, it will be critical to track the use of the Center by keeping statistics about the level of participation of the scientific community (number of attendees), and the public. It will be critical to document that the Center has been used by the broad scientific community, tracking variables such as the inclusion in Synthesis Meetings of a variety of institutions (research institutions, liberal arts colleges, agencies, NGO’s), whether participants are coming from all career stages, different geographic regions, multiple vs. first-time participants, gender balance among participants, and the involvement of Minority-Serving Institutions. A central tenet of the success of BioSynC relies on the scientific community finding that the center is a service to them, and these statistics will be a useful self-check as well as a tool for those evaluating the center.
## Biodiversity Synthesis Center Budget: 5yr Summary

### YEAR 1

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**Travel and Meetings**

3 group meetings 5 days each

Computers, software, supplies

**Year 1 Budget**

$646,800

### YEAR 2

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<td>$565,500</td>
</tr>
<tr>
<td>Fringe</td>
<td>$138,548</td>
</tr>
</tbody>
</table>

**Travel and Meetings**

6 group meetings 5 days each

Computers, software, supplies

**Year 2 Budget**

$1,104,048

### YEAR 3

<table>
<thead>
<tr>
<th>Personnel</th>
<th>Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director</td>
<td>$118,965</td>
</tr>
<tr>
<td>Assistant Director</td>
<td>$82,400</td>
</tr>
<tr>
<td>Biodiversity/Synthesis staff (4)</td>
<td>$226,600</td>
</tr>
<tr>
<td>Support Staff (3)</td>
<td>$154,500</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>$582,465</td>
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<tr>
<td>Fringe</td>
<td>$145,616</td>
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</table>

**Travel and Meetings**

6 group meetings 5 days each

Computers, software, supplies

**Year 3 Budget**

$1,078,081

### YEAR 4

<table>
<thead>
<tr>
<th>Personnel</th>
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</thead>
<tbody>
<tr>
<td>Director</td>
<td>$122,534</td>
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<tr>
<td>Assistant Director</td>
<td>$84,872</td>
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<tr>
<td>Biodiversity/Synthesis staff (4)</td>
<td>$233,398</td>
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<td>Support Staff (3)</td>
<td>$159,135</td>
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<td><strong>Subtotal</strong></td>
<td>$599,939</td>
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<td>Fringe</td>
<td>$152,984</td>
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</table>

**Travel and Meetings**

6 group meetings 5 days each

Computers, software, supplies

**Year 4 Budget**

$1,102,923

### YEAR 5

<table>
<thead>
<tr>
<th>Personnel</th>
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</thead>
<tbody>
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<td>Assistant Director</td>
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<tr>
<td>Biodiversity/Synthesis staff (4)</td>
<td>$240,400</td>
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<td>Support Staff (3-4)</td>
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<td><strong>Subtotal</strong></td>
<td>$617,937</td>
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<tr>
<td>Fringe</td>
<td>$160,664</td>
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</tbody>
</table>

**Travel and Meetings**

6 group meetings 5 days each

Computers, software, supplies

**Year 5 Budget**

$1,128,601

### TOTAL DIRECT COSTS

$5,060,453

**Indirect Costs (15%)**

$759,068

### TOTAL 5 YEAR BUDGET

$5,819,521

**Total Budget Request from EoL Foundation budget:**

$5,819,521

**Matching fund-raising target for Field Museum:**

$5,000,000

Note: Yearly totals are calculated as 12 months from start date of grant (i.e., year 1 is the last half of 2007 and first half of 2008).
Literature Cited