**PI:** Brian O’Meara, Dept of Ecology and Evolutionary Biology

**Summary Title:** Next generation biodiversity

**Priority area to be addressed:** Other: Next generation biodiversity

**Names of core participants:** Brian O’Meara (Ecology & Evolutionary Biology), Charlie Kwit (EEB & Forestry, Wildife, & Fisheries, John Moulton (Entomology & Plant Pathology), Meg Staton (Entomology & Plant Pathology), Susan Kalisz (EEB), Barbara Heath (external evaluator, EMEC LLC)

**Overarching theme, vision, and goals of the proposed NRT**: The US faces a key need for next generation biodiversity researchers. For understanding emerging infectious diseases, detecting and stopping invasive species, managing resources such as fish stocks, and understanding how to conserve biodiversity in the face of anthropogenic change we need biologists trained in a wide array of skills (Tewksbury et al. 2014). However, our training efforts often result in a relative handful of researchers with deep taxonomic and evolutionary knowledge of one group but little training in how to apply it, or workers trained in details of resource management but without sufficient depth of knowledge of evolutionary or ecological contexts. Regardless of training path, many graduates lack skills in the latest technology revolutionizing fields, ranging from next generation sequencing abilities allowing detection of organisms from wisps of DNA in a stream or sequencing entire viral genomes in a day, drones allowing remote sensing of biodiversity data, and geographic information systems to allow precise mapping and correlation of abiotic factors with responses of organisms. Moreover, none of our training of potential leaders in this area covers necessary skills such as project management.

Our strategy to remedy this is a new program that capitalizes on the University of Tennessee's academic expertise while also engaging with local and national partners. The program covers three modular areas: 1) core biology training: areas such as ecology, evolution, genetics, and especially natural history; 2) technological training: remote sensing, genomics, GIS; 3) vocational training: project management, assessment. The core biology training builds on existing courses but will also feature two week intense field courses. The technological training will largely be delivered in workshops. Our faculty already offer a few workshops that can draw interest from hundreds of applicants; by streaming these online, we can reach many more trainees than the core set of students supported by the program. Tutorials and field courses also offer a mechanism for long term sustainability of this initiative through participant fees. For vocational training we will capitalize on relevant courses in project management and team building, including coordinating with colleagues on the creation of new courses. Trainees will also participate in at least one internship with our partners, which will help build their professional networks and expose them to concrete issues. Throughout the life of the grant, integration with our external partners will help us tailor training to meet key needs they identify.

UT Knoxville is the ideal location to establish such a program. For biodiversity experts, we are already a key destination given our high biodiversity and existing groundwork to map it (such as the All Taxa Biodiversity Inventory, which has mapped 19,000 species in Great Smoky Mountains National Park), and our faculty already teach key courses about fish, fungi, plants, reptiles, amphibians, and spiders. We have a tradition of collaboration with, and placement of graduates in, outside groups such as The Nature Conservancy and the Tennessee Clean Water Network. Our technological skills are at the cutting edge, with expertise in environmental DNA monitoring, high performance computing, next generation sequencing, and use of drone and satellite imagery for addressing biological questions.

**Traineeship model and its components and how they are integrated with NRT research activities:** The traineeship model has three main components: 1) core coursework in ecology, evolution, statistics, GIS, and related areas, 2) two week field courses focused on particular groups of organisms, 3) intensive workshops in skills, and 4) internships. The **core coursework** utilizes existing UT courses, such as FWF430 - Introduction to Geographic Information Systems (GIS) for Natural Resources or MATH 405 - Models in Biology, FWF 416 - Planning and Management of Forest, Wildlife and Fisheries Resources, EDAM 560 – Grant Writing and Project Management, ENMG 536 - Project Management, ENMG 541 - Managing Change and Improvement in Technical Organizations, ENVE 561 - Climate and Environmental Informatics, GEOG 517 - Geographic Information Management and Processing, as well as more targeted graduate courses depending on the needs of the trainee. Capitalizing on established courses helps make the program more sustainable after its funding runs out and exposes trainees to a students and instructors from a variety of perspectives. **Field courses** are key ways to promote learning (McLaughlin and Johnson 2006) and UT faculty have experience teaching in field courses for a variety of organisms. Assessment of domain knowledge at the beginning, completion, and a year after each course will help highlight effective strategies and long term impact.

**The STEM graduate population that will be served: \_\_\_\_\_\_\_\_**

**The novel, potentially transformative research that the NRT will catalyze:** The world faces a biodiversity crisis: human activities are driving some species to extinction, invasive species are a major economic risk ($70.4 billion for the agriculture in the US alone (Paini et al. 2016)), and those with the skills to identify critical species are facing threats themselves (Agnarsson and Kuntner 2007).

**Broader impacts: how will both the training components and major research efforts contribute broadly to the achievement of “societally relevant outcomes”: \_\_\_\_\_\_\_\_\_\_\_\_**

**A description of the recruitment, mentoring, and retention plan: \_\_\_\_\_\_\_\_\_\_**

**Plans for assessing the success of the training, including specific expected competencies and outcomes:** External evaluation will come from East Main Evaluation and Consulting, LLC, a group with experience with evaluating NSF and other projects, including being the evaluator for the iPlant / CyVerse projects ($94.1M in total). The evaluation of this Research Traineeship Program will follow a process and outcome framework. This evaluation approach will provide a comprehensive model to analyze the project activities and gather data for the program effects. Within this process and outcome framework, a logic model will be developed in coordination with the project team and will be used to represent the sequence of steps between program services and outcomes. The process evaluation will include thorough descriptions of the project activities and their outputs. The outcome evaluation will link the program services to the benefits of the program on the target population. This will provide a means for measuring the intermediate effects of the training program on the participants, as well as, determining achievement of the long-term program goals. Data collection methods will be selected once the logic model is defined. It is anticipated that methods will include document review, surveys, pre/post content measures, and interviews. Some data collection instruments will be developed while others will be leveraged from existing literature. Ongoing analysis of the data will result in formative feedback for the project team so that data informed decisions can be made in a timely manner. Annual reports will be generated and submitted with a summative report prepared at the conclusion of the project effort; all reports will also be posted publicly for greater impact and transparency. Publications for peer review will be prepared and submitted in an effort to disseminate the process and related findings of the training program.

Agnarsson, I., and M. Kuntner. 2007. Taxonomy in a changing world: Seeking solutions for a science in crisis. Systematic Biology **56**:531-539.

McLaughlin, J. S., and D. K. Johnson. 2006. Assessing the Field Course Experiential Learning Model: Transforming Collegiate Short-Term Study Abroad Experiences into Rich Learning Environments. Frontiers: The Interdisciplinary Journal of Study Abroad **13**:65-85.

Paini, D. R., A. W. Sheppard, D. C. Cook, P. J. De Barro, S. P. Worner, and M. B. Thomas. 2016. Global threat to agriculture from invasive species. Proceedings of the National Academy of Sciences **113**:7575-7579.