List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:

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REVIEWERS NOT TO INCLUDE:

Not Listed

COLLABORATORS & OTHER AFFILIATIONS for:		Brian O'Meara				
Individual		Affiliation				
Name *(last name, first name)*	**Organization** *(current affiliation, if known)*	**Collaborator or Co-Author** *(last 48 mos.)*	**Co-Editor** *(last 24 mos.)*	**Graduate Advisor** *(my own)*	**Post Doc Sponsor** *(my own)*	**Ph.D. Advisee**
Aarssen, Lonnie	Queen's U	X				
Alamillo, Hugo	North Seattle Community College				X	
Armbruster, Scott	U of Portsmouth, UK	X				
Banbury, Barb	U Washington				X	
Beaulieu, Jeremy	NIMBioS				X	
Bertin, Robert	Holy Cross	X				
Boettiger, Carl	UC Davis	X				
Borstein, Sam	U Tennessee, Knoxville					X
Bosco, Jenn	U Tennessee, Knoxville					X
Burghardt, Gordon	U Tennessee, Knoxville	X				
Calaminus, Andre	U Florida	X				
Carstens, Bryan	Ohio State U	X				
Chai, JJ	Oak Ridge National Lab				X	
Collar, David	UC Santa Cruz	X				
Cornwell, William	U New South Wales	X				
Crane, Peter	Yale	X				
Cranston, Karen	NESCent	X				
Diggle, Pam	U Colorado	X				
Donoghue, Michael	Yale	X				
Fenster, Charlie	U Maryland	X				
FitzJohn, Richard	Macquarie U	X				
Gilchrist, Michael	U Tennessee, Knoxville	X				
Gillespie, Emily	Marshall U	X				
Goff, Stephen	iPlant	X				
Govaerts, Rafaël	Royal Botanic Gardens, Kew	X				
Graham, Kerrie	Texas State U	X				
Harder, Lawrence	U of Calgary, Canada	X				
Hardy, Christopher	Millersville U	X				

COLLABORATORS & OTHER AFFILIATIONS for:		Brian O'Meara				
Individual		Affiliation				
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Harmon, Luke	U Washington	X				
Hileman, Lena	U of Kansas	X				
Hufford, Larry	Washington State U	X				
Hulsey, Darrin	U Tennessee, Knoxville	X				
Huzurbazar, Snehalata	U Wyoming	X				
Jackson, Nathan	U Tennessee, Knoxville				X	
Jhwueng, Tony	Feng-Chia University				X	
Kawano, Sandy	NIMBioS	X				
Keck, Benjamin	U Tennessee, Knoxville	X				
Kumar, Sudhir	Arizona State U	X				
Lawing, Michelle	Texas A&M				X	
Leishman, Michelle	Macquarie U	X				
Lewis, Paul	U Connecticut	X				
Litt, Amy	U of California, Riverside	X				
Magallón, Susana	National Autonomous University of Mexico	X				
Martin, Ryan	NIMBioS				X	
Massana, Katie	U Tennessee, Knoxville					X
Matasci, Naim	iPlant	X				
Matzke, Nick	NIMBioS				X	
McGlinn, Daniel	Utah State U	X				
McKay, Sheldon	iPlant	X				
Michonneau, Francois	U Florida	X				
Moffatt, Andrew	U Tennessee, Knoxville	X				
Mounce, Ross	Natural History Museum, London	X				
Oleksyn, Jacek	U Minnesota	X				
Pellis, Sergio	U. Lethbridge	X				
Pontelli, Enrico	New Mexico State	X				
Reich, Peter	U of Western Sydney	X				

COLLABORATORS & OTHER AFFILIATIONS for:		Brian O'Meara				
Individual		Affiliation				
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Rosauer, Dan	Yale	X				
Royer, Dana	Wesleyan University	X				
Sanderson, Michael	U Arizona					X
Schwery, Orlando	U Tennessee, Knoxville					X
Smith, Stephen	U Michigan	X				
Smith, Stacey	U Colorado	X				
Soltis, Douglas	U Florida	X				
Soltis, Pamela	U Florida	X				
Stack, Conrad	State College PA	X				
Stevens, Peter	U of MIssouri	X				
Stoltzfus, Arlin	NIST	X				
Swenson, Nathan	Michigan State U	X				
Tank, David	U Idaho	X				
Tarasov, Sergei	NIMBioS				X	
Turelli, Michael	UC Davis					X
Vision, Todd	U North Carolina					X
Vos, Rutger	NCB Naturalis	X				
Ward, Phil	UC Davis					X
Warman, Laura	USDA Forest Service	X				
Westoby, Mark	Macquarie U	X				
Whitactre, Jamie	Natural History Museum, London	X				
Williams, Joseph	U Tennessee, Knoxville	X				
Wright, Ian	Macquarie U	X				
Zanne, Amy	George Washington	X				

COLLABORATORS & OTHER AFFILIATIONS for:		Susan Kalisz				
Individual		Affiliation				
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Auld, Josh R.	West Chester University	x				
Black, Brian	Bay College					x
Brandvain, Yaniv	University Minnesota	x				
Brockerhoff, Eckehard	New Zealand Forest Research Institute	x				
Brouwer, Nathan	Duquesne University					x
Busch, Jeremiah	Washington State University	x				
Catford, Jane	University of Melbourne	x				
Burd, Martin	Monash University	x				
Cheptou, Pierre-Olivier	CNRS, Montpelier, France	x				
Conner, Jeff	Michigan State University	x				
Escobar, Juan	University of Toronto	x				
Fei, Songlin	Purdue University	x				
Goldberg, Emma	University of Minnesota	x				
Grossenbacher, Dena	Washington State University	x				
Hale, Alison	University of Pittsburgh					x
Hazzouri, Khaled	University of Toronto	x				
Horvitz, Carol	University of Miami	x				
Hovick, Steve	Ohio State University	x				
Igic, Boris	University of Illinois, Chicago	x				
Inderjit	University of Delhi	x				
Knight, Tiffany M.	Helmholtz Centre for Environmental Research					x
Lapointe, Line	Laval University	x				
Leibhold, Andrew	US Forest Service	x				
McPeek, Mark	Dartmouth College	x				
Mortensen, David	Penn State University	x				
Ness, Rob W.	University of Edinburgh	x				
Newman, Killian	University of Toronto	x				
Nuñez, Martin	Universidad Nacional del Comahue	x				

COLLABORATORS & OTHER AFFILIATIONS for:		Susan Kalisz				
Individual		Affiliation				
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Pannell, John	University of Lausanne	x				
Pauw, Anton	University South Africa	x				
Petanidou, Theodora	University of the Aegean	x				
Quesada, Andrea	University of Costa Rica					x
Randle, April	University of San Francisco					x
Rubio, Rafael	University of Granada	x				
Salcedo, Adriana	University of Toronto	x				
Schemske, Douglas	Michigan State University			x		
Simberloff, Daniel	University of Tennessee, Knoxville	x				
Slotte, Tanja	Uppsala University	x				
Spigler, Rachel	Temple University	x				
Wardle, David	Swedish University of Ag Sci	x				
Wingfield, Michael	University of Pretoria	x				
Winn, Alice	Florida State University	x				

COLLABORATORS & OTHER AFFILIATIONS for:		Charles Kwit				
Individual		Affiliation				
Name *(last name, first name)*	**Organization** *(current affiliation, if known)*	**Collaborator or Co-Author** *(last 48 mos.)*	**Co-Editor** *(last 24 mos.)*	**Graduate Advisor** *(my own)*	**Post Doc Sponsor** *(my own)*	**Ph.D. Advisee**
Argarwal, Sujata	University of Tennessee	X				
Classen, Aimee	Natural History Museum of Denmark	X				
Collins, Beverly	Western Carolina University	X			X	
Efroymson, Rebecca	Oak Ridge National Laboratories	X				
Ewert, David	Tennessee Nature Conservatory	X				
Franklin, Jennifer	University of Tennessee	X				
Greenberg, Cathryn	U.S. Forest Service	X				
Hall, Christopher	U.S. Environmental Protection Agency	X				
Helmer, Eileen	U.S. Forest Service	X				
Hill, Rachel	University of Tennessee	X				
Jager, Henriette	Oak Ridge National Laboratories	X				
Keyser, Patrick	University of Tennessee	X				
Kilgo, John	U.S. Forest Service	X				
King, David	U.S. Forest Service	X				
Landis, Douglas	Michigan State University	X				
Lash, Chloe	University of Tennessee					X
Leggett, Zakiya	Weyerhauser	X				
Levey, Douglas	National Science Foundation				X	
Lincicome, David	Tennessee Department of Environmental Conservation	X				
Marcello, Gregg	Milleken University	X				
McCarty, John	University of Nebraska-Omaha	X				
McKinney, Michael	University of Tennessee	X				
Miller, Darren	Weyerhauser	X				
Miller, Chelsea	University of Tennessee					X
Moulton, John K.	University of Tennessee	X				
Nageswara-Rao, Nadhugiri	New Mexico State University					X
O'Meara, Brian	University of Tennessee	X				

COLLABORATORS & OTHER AFFILIATIONS for:		Charles Kwit				
Individual		Affiliation				
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Pearson, Scott	Washington Department of Natural Resources	X				
Pfennigwerth, Alix	University of Tennessee	X				
Platt, William	Louisiana State University				X	
Ridley, Caroline	U.S. Environmental Protection Agency	X				
Sargent, Sarah	Audubon Pennsylvania	X				
Stambaugh, Michael	University of Missouri	X				
Staton, Margaret	University of Tennessee	X				
Stevens, M. Henry H.	Miami University	X				
Stewart, C. Neal	University of Tennessee	X				
Swanson, Mark	Washington State University	X				
Vanderyacht, Andy	University of Tennessee					X
Watson, Brian	ESRI	X				
Wunderle, Joseph	U.S. Forest Service	X				

COLLABORATORS & OTHER AFFILIATIONS for:		John K. Moulton				
Individual		Affiliation				
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Adler, Peter	Clemson University	X		X		
Aksoy, Serop	Yale University	X				
Alexander, Elizabeth	Kin';s County (WA) Sheriff's Dept.	X				
Attardo, Geoffrey	Yale University	X				
Baumann, Aaron	University of TN	X			X	
Benoit, Joshua	University of Cincinnati	X				
Bernard, Ernest	University of TN	X				
Bittner, Tonya	Cornell University	X				
Blaschke, Jeremy	Union College					X
Cerretti, Pierfilippo	University of Rome	X				
Courtney, Gregory	Iowa State University	X				
Curler, Gregory	N/A	X				X
Davis, D.J.	Wright State University	X				
Dennehy, Timothy	Bayer, Inc.				X	
Faccoli, Massimo	University of Padova	X				
Flint, Oliver	USNM, emeritus	X				
Floyd, Michael	USFWS	X				
Grant, Jerome	University of TN	X				
Greenwalt, Dale	Smithsonian Institution	X				
Gryganskyi, Andrii	Duke University	X				
Haddow, Andrew	USAMRIID	X				
Hadziabdic, Denita	University of TN	X				
Hajek, Ann	Cornell University	X				
Hansen, Jason	NIFA	X				X
Humber, Richard	USDA-ARS	X				
Jacobson, Amanda	Dow Agro	X				X
Jensen, Annette	University of Copenhagen	X				
Klingeman, William	University of TN	X				

COLLABORATORS & OTHER AFFILIATIONS for:		John K. Moulton				
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Kwit, Charles	University of TN	X				
Lambdin, Paris	University of TN	X				
Liebherr, James	Cornell University	X				
Liebherr, Jonathon	Cornell University	X				
Maddison, David	Oregon State University			X		
Madriz, Isai	Iowa State University	X				
Marten, Paul	USDA Forest Service	X				
Michalkova, Veronika	Yale University	X				
Mireji, Paul	Egerton University	X				
O'Hara, James	ECORC	X				
O'Meara, Brian	University of TN	X				
Oliver, Jason	Tennessee State University	X				
Parker, Charles	U.S. Geological Survey	X				
Phillips, Gary	University of TN	X				
Pivar, Robert	University of TN	X				X
Pscheidt, Jay	Oregon State University	X				
Reding, Mark	USDA	X				
Robinson, Jason	Illinois Natural History Survey	X				
Schuster, Guenther	Eastern KY Univ, Retired	X				
Senatore, Gail	N/A	X				
Shelley, Roland	NC Museum Nat. History (Emeritus)	X				
Sinclair, Bradley	CFIA	X	X			
Smith, Cathe	N/A	X				
Staton, Margaret	University of TN	X				
Stireman, John	Wright State University	X				
Triagiano, Robert	University of TN	X				
Wadl, Phillip	USDA	X				
Wiegmann, Brian	NC State University	X			X	

COLLABORATORS & OTHER AFFILIATIONS for:		John K. Moulton				
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Wiggins, Gregory	University of TN	X				
Wilson, Thomas	Ohio State University	X				
Windham, Mark	University of TN	X				
Winkler, Isaac	Linfield College	X				
Zhang, Aijun	USDA-ARS Plant Sciences Institute	X				

COLLABORATORS & OTHER AFFILIATIONS for:		Margaret Staton				
Individual		Affiliation				
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Abbott, Albert	University of Kentucky	x				
Arelli, P	UTK	x				
Arumuganathan, AK	Benaroya Research Institute	x				
Bernard, Ernie	UTK	x				
Best, Teo	Penn State U	x				
Brosnan, Jim	UTK	x				
Bukles, O	Clemson U	x				
Bushakra, Jill	USDA ARS	x				
Carlson, Alanna	Clemson U	x				
Carlson, John E	Penn State U	x				
Chapman, Susan	Clemson U	x				
Chase,, Mark	Duke University	x				
Chen, CC	Clemson U	x				
Chen, Ming	University of Tennessee					x
Coggeshall, Mark	U of Missouri	x				
Cronn, Richard	USDA Forest Service	x				
Dardick, Chris	USDA ARS	x				
DeBruyn, Jennifer M.	University of Tennessee	x				
Faccoli, M	U of Padova	x				
Fang, Guang-Chen	USDA ARS	x				
Feltus, Frank	Clemson U	x				
Freese, Nowlan	UNC Charlotte	x				
Gailing, Oliver	Michigan Tech	x				
Georgi, Laura	The American Chestnut Foundation	x				
Gessler,, Damian	Semantic Options, LLC	x				
Grant, Jerome	UTK	x				
Hadziabdic, Denita	UTK	x				
Hajimorad, Reza	UTK	x				

COLLABORATORS & OTHER AFFILIATIONS for:		Margaret Staton				
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Halter, MC	UTK	x				
Hebard, Fred	The American Chestnut Foundation	x				
Hershman, DE	U of Kentucky	x				
Hewezi, Tarek	UTK	x				
Holliday, Jason	Virginia Tech	x				
Jennings, Tara	USDA ARS	x				
Jung, Sook	Washington State U	x				
Kelly, Heather	UTK	x				
Khodewkar, Sudhir	Michigan Tech	x				
Klingeman, William	UTK	x				
Koch, Jennifer	USDA Forest Service	x				
Kwit, Charles	University of Tennessee	x				
Lam, Brianna	David H. Murdock Research Institute	x				
Lambdin, Paris	UTK	x				
Lane, Thomas	UTK	x				
Leboldus, Jared	NDSU	x				
Leebens-Mack,, J	University of Georgia	x				
Lewers, Kim	USDA ARS	x				
Liang, Haiying	Clemson U	x				
Liu, Fang	University of Tennessee					x
Liu, Z	USDA ARS	x				
Main, Dorreen	Washington State U	x		x		
Mazarei, M	U of Missouri	x				
Merten, PR	USDA Forest Service	x				
Moulton, J. Kevin	UTK	x				
Nelson, Dana	USDA Forest Service	x				
Noakes, Andi	Notre Dame	x				
Olukolu, Bode	NC State	x				

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O'Meara, Brian	University of Tennessee	x				
Ownley, Bonnie	UTK	x				
Owusu, Sandra	Michigan Tech	x				
Pantalone, Vince	UTK	x				
Pires, Chris	University of Missouri	x				
Pscheidt, JW	Oregon State U	x				
Radosevich, Mark	University of Tennessee	x				
Rambani, Aditi	UTK	x				
Ranjan, Priya	ORNL	x				
Rice, Hollis	UTK	x				
Rinehart, Tim	USDA ARS	x				
Romero-Severson, Jeanne	Notre Dame	x				
Saski, Chris	Clemson U	x				
Schlarbaum, Scott	UTK	x				
Schuster, Stephan	Penn State U	x				
Shumaker, Ketia	West Alabama U	x				
Soltis, DE	University of Florida	x				
Stewart, Neal	UTK	x				
Stott, G	Clemson U	x				
Tian, Zhenkun	Beijing Forestry University	x				
Trigiano, Bob	UTK	x				
Trout, Fryxell, Rebecca	UTK	x				
Wadl, Phil	USDA ARS	x				
Wang, K-C	Clemson U	x				
Wang, Y	UTK	x				
Wegrzyn, Jill	U of Connecticut	x				
Westbrook, J	The American Chestnut Foundation	x				
Wheeler, N	Ret.	x				

COLLABORATORS & OTHER AFFILIATIONS for:		Margaret Staton				
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Wiggins, GJ	UTK	x				
Williamson, Kurt	College of William and Mary	x				
Windham, MT	UTK	x				
Xu, T	Clemson U	x				
Yu, Y	Clemson U	x				
Zhang, Xinfu	Clemson U	x				
Zhebentyayeva, T	Clemson U	x				

COLLABORATORS & OTHER AFFILIATIONS for:		Barbara P. Heath				
Individual		Affiliation				
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Antin, Parker	University of Arizona	x				
Bishop, Pamela	University of Tennessee	x				
Chappell, Carol	Lee County Public Schools	x				
Childress, Vikki	Onslow County Public Schools	x				
Cook, Jeanine	Sandia National Laboratories	x				
Curlley, Patrick	Center for Marine Sciences and Technology	x				
Dempsey, Van	University of North Carolina Wilmington	x				
Elder, Michael	Onslow County Public Schools	x				
Enis, Constance	Brunswick County Public Schools	x				
Ferner, Clayton	University of North Carolina Wilmington	x				
Folger, Beth	Onslow County Public Schools	x				
Freeman, Catherine	PPD	x				
Gordon, Christopher	University of North Carolina Wilmington	x				
Gross, Lou	University of Tennessee	x				
Holbrook, Tracy	Cape Fear Community College	x				
Hollingsworth, Jeff	University of Maryland	x				
Kern, Jackie	University of Illinois at Urbana-Champaign	x				
Kezios, Sue	University of North Carolina Wilmington	x				
Lakshmanan, Aruna	University of North Carolina Wilmington	x				
Lyons, Eric	University of Arizona	x				
Merchant, Nirav	University of Arizona	x				
Miklos, David	DNALC	x				
Morge, Shelby	University of North Carolina Wilmington	x				
Rhodes, Ginger	University of North Carolina Wilmington	x				
Rogers, Laura	ProfBLUE			x		
Stapleton, Ann	University of North Carolina Wilmington	x				
Sussman, Alan	University of Maryland	x				
Vaughn, Matthew	Texas Advanced Computing Center	x				

COLLABORATORS & OTHER AFFILIATIONS for:		Barbara P. Heath				
Individual		Affiliation				
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Ward, Charles	Retired				x	
Ware, Doreen	Cold Spring Harbor Labs	x				
Wilkinson, Barry	University of North Carolina Charlotte	x				

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./DUE DATE
NSF 16-503 **02/07/17**

☐ Special Exception to Deadline Date Policy

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NSF PROPOSAL NUMBER

1735049

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)
DGE - NSF Research Traineeship (NRT)

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626001636

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE
University of Tennessee Knoxville

AWARDEE ORGANIZATION CODE (IF KNOWN)
0035303000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE
University of Tennessee Knoxville
1 Circle Park
Knoxville, TN. 379960003

NAME OF PRIMARY PLACE OF PERF
University of Tennessee Knoxville

ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE
University of Tennessee Knoxville
1 Circle Park
Knoxville ,TN ,379960003 ,US.

IS AWARDEE ORGANIZATION (Check All That Apply)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **NRT: Next-Generation Biodiversity Training**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **2,948,586**	**60** months	**09/01/17**	

THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW
☐ BEGINNING INVESTIGATOR
☐ DISCLOSURE OF LOBBYING ACTIVITIES
☐ PROPRIETARY & PRIVILEGED INFORMATION
☐ HISTORIC PLACES
☐ VERTEBRATE ANIMALS IACUC App. Date _____
PHS Animal Welfare Assurance Number _____
☒ TYPE OF PROPOSAL **Research**

☐ HUMAN SUBJECTS Human Subjects Assurance Number _____
Exemption Subsection _____ or IRB App. Date _____
☐ INTERNATIONAL ACTIVITIES: COUNTRY/COUNTRIES INVOLVED
_____
☒ COLLABORATIVE STATUS
Not a collaborative proposal

PI/PD DEPARTMENT
Ecology and Evolutionary Biology

PI/PD FAX NUMBER
865-974-3067

PI/PD POSTAL ADDRESS
569 Dabney Hall
University of Tennessee
Knoxville, TN 37996
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Email Address
PI/PD NAME **Brian C O'Meara**	**PhD**	**2008**	**865-408-8733**	**bomeara@utk.edu**
CO-PI/PD **Susan Kalisz**	**PhD**	**1985**	**865-974-3065**	**skalisz@utk.edu**
CO-PI/PD **Charles Kwit**	**PhD**	**2000**	**865-974-9793**	**ckwit@utk.edu**
CO-PI/PD **John K Moulton**	**PhD**	**1997**	**865-974-7950**	**jmoulton@utk.edu**
CO-PI/PD **Margaret Staton**	**PhD**	**2007**	**865-974-4941**	**mstaton1@utk.edu**

CERTIFICATION PAGE

Certification for Authorized Organizational Representative (or Equivalent) or Individual Applicant

By electronically signing and submitting this proposal, the Authorized Organizational Representative (AOR) or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding conflict of interest (when applicable), drug-free workplace, debarment and suspension, lobbying activities (see below), nondiscrimination, flood hazard insurance (when applicable), responsible conduct of research, organizational support, Federal tax obligations, unpaid Federal tax liability, and criminal convictions as set forth in the NSF Proposal & Award Policies & Procedures Guide (PAPPG). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U.S. Code, Title 18, Section 1001).

Certification Regarding Conflict of Interest

The AOR is required to complete certifications stating that the organization has implemented and is enforcing a written policy on conflicts of interest (COI), consistent with the provisions of PAPPG Chapter IX.A.; that, to the best of his/her knowledge, all financial disclosures required by the conflict of interest policy were made; and that conflicts of interest, if any, were, or prior to the organization's expenditure of any funds under the award, will be, satisfactorily managed, reduced or eliminated in accordance with the organization's conflict of interest policy. Conflicts that cannot be satisfactorily managed, reduced or eliminated and research that proceeds without the imposition of conditions or restrictions when a conflict of interest exists, must be disclosed to NSF via use of the Notifications and Requests Module in FastLane.

Drug Free Work Place Certification

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent), is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Proposal & Award Policies & Procedures Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Proposal & Award Policies & Procedures Guide.

Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:
(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.
(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Proposal & Award Policies & Procedures Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:
(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:
(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

Certification Regarding Responsible Conduct of Research (RCR) (This certification is not applicable to proposals for conferences, symposia, and workshops.)

By electronically signing the Certification Pages, the Authorized Organizational Representative is certifying that, in accordance with the NSF Proposal & Award Policies & Procedures Guide, Chapter IX.B. , the institution has a plan in place to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduates, graduate students and postdoctoral researchers who will be supported by NSF to conduct research. The AOR shall require that the language of this certification be included in any award documents for all subawards at all tiers.

CERTIFICATION PAGE - CONTINUED

Certification Regarding Organizational Support

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that there is organizational support for the proposal as required by Section 526 of the America COMPETES Reauthorization Act of 2010. This support extends to the portion of the proposal developed to satisfy the Broader Impacts Review Criterion as well as the Intellectual Merit Review Criterion, and any additional review criteria specified in the solicitation. Organizational support will be made available, as described in the proposal, in order to address the broader impacts and intellectual merit activities to be undertaken.

Certification Regarding Federal Tax Obligations

When the proposal exceeds $5,000,000, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal tax obligations. By electronically signing the Certification pages, the Authorized Organizational Representative is certifying that, to the best of their knowledge and belief, the proposing organization:
(1) has filed all Federal tax returns required during the three years preceding this certification;
(2) has not been convicted of a criminal offense under the Internal Revenue Code of 1986; and
(3) has not, more than 90 days prior to this certification, been notified of any unpaid Federal tax assessment for which the liability remains unsatisfied, unless the assessment is the subject of an installment agreement or offer in compromise that has been approved by the Internal Revenue Service and is not in default, or the assessment is the subject of a non-frivolous administrative or judicial proceeding.

Certification Regarding Unpaid Federal Tax Liability

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal Tax Liability:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has no unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

Certification Regarding Criminal Convictions

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Criminal Convictions:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has not been convicted of a felony criminal violation under any Federal law within the 24 months preceding the date on which the certification is signed.

Certification Dual Use Research of Concern

By electronically signing the certification pages, the Authorized Organizational Representative is certifying that the organization will be or is in compliance with all aspects of the United States Government Policy for Institutional Oversight of Life Sciences Dual Use Research of Concern.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Stacey Wade**	**Electronic Signature**	**Feb 7 2017 11:42AM**

TELEPHONE NUMBER	EMAIL ADDRESS	FAX NUMBER
865-974-4808	**swade@utk.edu**	**865-974-2805**

PROJECT SUMMARY

Overview:

Many graduate scientific programs train Master's and Ph.D. students primarily for careers in academia; even if there is some attention paid to "alternative" tracks, the de facto system still provides little effective training for this. Programs in colleges of agriculture do have more of an applied focus, but may lack a focus on natural history of diverse environments. Yet, the US faces a key need for next-generation biodiversity researchers to work outside of academia. To understand emerging infectious diseases, detect and stop invasive species, manage natural resources, and understand how to conserve biodiversity in the face of anthropogenic change, our country needs biologists trained in a wide array of skills. The research area and theme focuses on interdisciplinary training of biologists for careers outside academia with the necessary biological, technological, and leadership skills required for success. The team merges faculty from three departments, representing both a liberal arts college and a college of agriculture. The University of Tennessee, Knoxville, is both the flagship research university and the land grant university of the state, and its key mission is to do cutting-edge research that can also translate into directly useful outcomes. This NRT will train 17 Master's and Ph.D. students directly as funded trainees, 45 other affiliate students participating in grant activities, and 60 external participants taking field courses or skills workshops developed as part of the program (a grand total of 122 students). Long-term sustainability of the program locally comes from repackaging existing courses for a new kind of audience, persistent connections between departments, and a deep connection with internship partners. More generally, the lessons learned, including both successes and failures, will be communicated through peer-reviewed publications led by our external assessment team so that others may build upon them.

The training plan covers six components. 1) Internships with private companies, NGOs, and government organizations; 2) core biological training, including field courses; 3) technology training in areas such as GIS and informatics, using existing courses and workshops; 4) leadership, management, and communication training, including regular courses and a new workshop in science communication; 5) trainee outreach at popular events to connect the public to science; and 6) Multidisciplinary Advisory Committees to train students as they work on their thesis research. Throughout the life of the grant, integration with the external partners will help to tailor training to meet key needs that are identified. This is an aspect of research-education integration within the grant, as are the assessment and the individual research projects performed by the trainees.

Intellectual Merit:

Trainee research projects will span a variety of biodiversity questions, including conservation, ecosystem services, analysis of biological communities, and development of new models. The research team, supported by the external evaluator, will also publish our findings on this traineeship model in a peer-reviewed journal assessments.

Broader Impacts:

It is increasingly recognized that graduate programs in sciences should not focus on just churning out future faculty (Nature Editorial Board 2014), however, few programs are configured for broader career outcomes. This project builds connections between graduate students and professionals outside academia while training students for a wide variety of positions focused on biodiversity. The addition of necessary practical skills such as project management and assessment will position graduates to be strongly competitive and ultimately more successful in industry or academia. The open nature of the training also pushes scientific knowledge out into the public domain where professionals can learn from it, fulfilling a classic role of land grant institutions; training of students in scientific communication will assist with this. Students will also communicate about alternative scientific careers at Darwin Day and Ag Day, two long-running events that reach hundreds of members of the public annually.

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For font size and page formatting specifications, see PAPPG section II.B.2.

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

NRT: Next-Generation Biodiversity Training

A. List of Core Participants University of Tennessee, Knoxville (UTK); University of Tennessee Institute of Agriculture (UTIA)

Name	Project Role	Department and Institutional Affiliation	Discipline(s)
Brian O'Meara	PI	Ecology and Evolutionary Biology, UTK	Phylogenetics, macroevolution
Charles Kwit	CoPI	Forestry, Wildlife and Fisheries, UTIA Ecology and Evolutionary Biology, UTK	Conservation, wildlife-plant interactions
Susan Kalisz	CoPI	Ecology and Evolutionary Biology, UTK	Evolution, ecology, and conservation of plants
Meg Staton	CoPI	Entomology and Plant Pathology, UTIA	Plant pathology, genomic tools, and science communication
John Kevin Moulton	CoPI	Entomology and Plant Pathology, UTIA	Insect taxomomy, biodiversity, and phylogenetic relationships
Barbara Heath	Evaluator	East Main Evaluation & Consulting, LLC	STEM education assessment

B. Theme, Vision, and Goals

Understanding biodiversity is key for building workforce capacity and knowledge in many areas of national need, including the science of sustainability, conservation, ecosystem services, agriculture, wildlife management, forestry and public health. American graduate education programs in STEM do an excellent job training students for academic careers related to biodiversity science, but only 20% of students are hired in academia within five years of graduation [2]. A critical need exists to train STEM students for high-priority careers in non-governmental organizations (NGOs), government agencies, and businesses related to biodiversity, careers that are often explicitly seen as "alternate" paths by faculty mentors; however, students are not encouraged to pursue these career paths [3]. In addition, an analysis, recently published in *Proceedings of the National Academy of Sciences*, identified training students for the breadth of available careers as one of eight consensus recommendations out of 250 total recommendations [4]. It is becoming increasingly clear that the US needs a stream of well-trained students prepared for jobs outside academia, where they can have immediate, real-world impact in a different way than is possible in many academic positions. The proposed NRT seeks to train such biodiversity scientists for careers outside academia.

Motivated by the increasing interests of UTK/UTIA students in non-academic careers, the current state of relevance and marginalization of natural history knowledge [2, 5], and the importance of linking natural history knowledge with new technologies to the benefit of science and society [6], we surveyed potential employers of biodiversity STEM graduates regarding the needed skills of future employees. Repeatedly, employers indicated a desire for detailed expertise in one or more taxonomic groups, along with technical competencies (e.g., GIS, genomics, statistics, technical writing) to both gather and synthesize biodiversity data. Our regional data align with the findings of Blickley et al. [7], who analyzed job advertisements and interviewed employers in conservation nonprofits, government agencies, and private companies to find key skills needed, which included domain knowledge and project management skills.

Vision: We will capitalize on the expertise at the University of Tennessee, the combined flagship and land grant university of the state, and engage with local and national partners to provide real-world experience to students through strategic internships. By bringing together faculty and students from the UTK campus with UTIA, this NRT program will create an interdisciplinary environment for the next generation of experts in biodiversity science. Our goal is to generate a culture change, which will generate biodiversity science experts who will effectively face today's societal and scientific grand challenges.

Goals: Our project has two main goals:

1. Enhance workforce development to fill the need for biodiversity science expertise in the US.
2. Create a prototype for institutional culture change toward non-academic career paths.

Understanding the Need: Human health, food security, resource conservation and management, and recreation all rely on knowledge of biodiversity. At their intersection, many of the ecosystem services that society deems important — increased agricultural and natural resource production, water quality and fresh water abundance, and disease control [8] — are directly correlated with biodiversity in both agricultural [9] and natural [10] systems. Assessing and conserving biodiversity, especially in our current era of anthropogenic change, will require biologists trained in a wide array of skills [6] that are normally not integrated in existing, single-discipline graduate training programs.

Typical training often produces (1) researchers with deep taxonomic and evolutionary knowledge of one group but little training in how to broadly apply general biological principles, or (2) workers trained in applied details without sufficient depth of knowledge of evolutionary or ecological contexts. This leads to a lack of synergy: questions and approaches in one field, even within various fields of biology, only slowly diffuse to others. Even within the three NRT participant departments on our campus, this is the first grant incorporating all of us, and the first interaction between many of the involved faculty.

Further, traditionally narrow training paths yield graduates who lack skills in the latest technology revolutionizing their fields. Such skills include 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 allowing precise mapping and correlation of abiotic factors with responses of organisms. Moreover, potential leaders require training in business skills such as project management [7]. Students are eager for these skills; for example, a pilot course in professional development in Hawaii attracted three times as many students as expected [11].

The Next-Generation Biodiversity Solution: Our strategy is a training program for graduate students that combines interdisciplinary emphases and experiential learning to address current biodiversity-related challenges. It will pave the way for next-generation biodiversity scientists to enter careers in alternative academic paths in partner or associated organizations. The call to incorporate hands-on experiences with new technologies into the traditional realm of biodiversity research has only recently been posed [6]. However, the benefits of experiential learning are well substantiated in higher education and include increased retention [12], increased abilities to solve complex problems [13], and greater student motivation [14].

UT and its environs are the ideal location to establish such a program. For national and global biodiversity experts, we are a key destination because of the region's high biodiversity (see *Fig. 1)* and existing groundwork to map it (e.g. All Taxa Biodiversity Inventory has mapped 19,000 species locations in the Great Smoky Mountains National Park (GSMNP); Discover Life in America), research collections (TENN Herbarium housing vascular plants, bryophytes and fungi, Etnier Ichthyology Collection, UT Caddisfly Collection, McClung Museum), proximity to

two National Ecological Observatory Network (NEON) sites [15], and faculty-led field courses about fish, fungi, plants, reptiles, amphibians, birds, mammals, and invertebrates. Further, The Howard H. Baker Jr. Center for Public Policy, located at UTK, provides policy makers, citizens, scholars, and students with the information and skills necessary to work effectively within our political system and to serve our local, state, national, and global communities through a series of public lectures and programs focused on Energy & Environment, Global Security, and Leadership & Governance. We have a tradition of collaboration with and placement of graduates in federal and state agencies and NGOs such as The Nature Conservancy and the Tennessee Clean Water Network. UT also has extensive collaborations, including graduate student training, with Oak Ridge National Laboratory (ORNL), a US Department of Energy facility with research efforts on biofuels, climate and biochemical models, urban dynamics, and high-performance computing.UTK and UTIA faculty's technological skills are at the cutting edge, with expertise in environmental DNA monitoring, high-performance computing, next-generation sequencing, statistics and modeling, and use of drone, satellite imagery and spatial analyses for addressing biological questions.

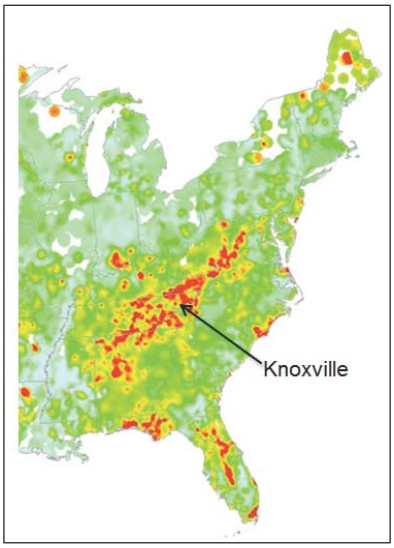

Figure 1. Heat map of areas with high species biodiversity coupled with conservation need [1].

Our proposed NRT program covers six components (*see Fig. 2):* (1) Internships; (2) Core biology training in an interdisciplinary approach including several academic disciplines, such as ecology, evolution, genetics, and natural history; (3) Technology training in remote sensing, genomics, and GIS; (4) Leadership, management and communication training; (5) Trainee outreach, and (6) Interdisciplinary thesis research projects guided by Multidisciplinary Advisory Committees (MAC), which will facilitate interdisciplinary synergy and guide trainees' research projects. Thesis committees will be comprised of three faculty from the student's home department and two committee members who are chosen from affiliated faculty *(detailed in Section D)*. Through their thesis research, NRT trainees will use skills developed in these modular areas to prepare for top jobs.

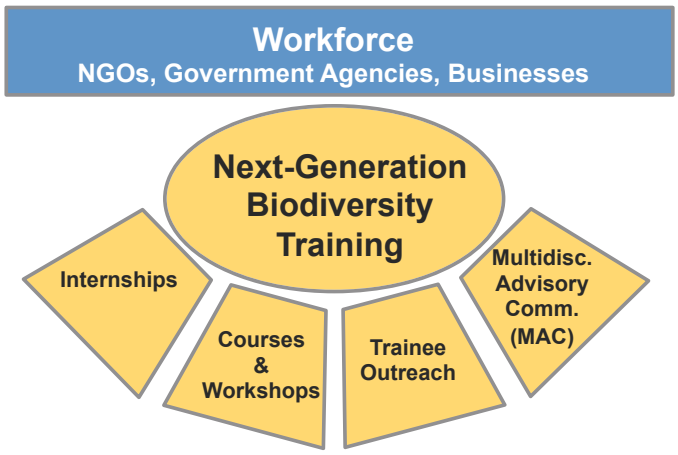

Figure 2. The Next-Generation Biodiversity Training NRT builds interdisciplinary synergy with attention to training, experiential learning and engagement, and strong mentoring/advising.

Satisfactory progress will be measured by benchmarks set in each of the students' home departments. Our model for graduate student training will be monitored and assessed as a prototype for building student awareness and faculty support for non-academic career choices by an outside consulting agency.

In brief, the core biology training builds on existing courses and features two-week intensive field courses. The technological training will largely be delivered in workshops. Faculty already offer workshops that can draw interest from hundreds of applicants; by streaming these online, we can reach many more potential trainees. For leadership and management training, we

will capitalize on relevant courses in project management and team building, including coordination with colleagues to create new courses. In modular area 4, trainees will participate in at least one internship with our partners, which will help build their professional networks and expose them to the management of concrete issues. For outreach, we will capitalize on existing programs at UT, as well others, detailed in Section C, below.

Outcomes: The overall goal is to train graduate students with Master's and Ph.D. degrees who intend to pursue careers in business, NGOs, or government. Throughout the life of the program, integration with our external partners will help us tailor training to meet their key needs and ensure student success. Because our partners have provided indications of the skills needed to address their current needs, we expect that our students will become viable candidates for careers within partner or related organizations.

Our evidence-based, interdisciplinary approach connects three departments, each with unique strengths. Ecology & Evolutionary Biology (EEB) brings a focus on ecological and evolutionary mechanisms, as well as expertise in fungi, plants, vertebrates, and some insects. Entomology & Plant Pathology (EPP) extends the taxonomic expertise to arthropods and disease organisms and has rich connections with agriculture. Forestry, Wildlife, & Fisheries (FWF) maintains a focus on harvestable natural resources (fish, timber, recreational hunting) but far less of an emphasis on biological mechanisms or question-driven science. Though these programs have seen a substantial set of students move on to careers outside academia, like most science programs across the US, we have not done enough to prepare students for this path.

Context for Added Value: We will track NRT student outcomes to assess our program's success relative to current student placement *(see Fig. 3).* All of our departments currently have a substantial proportion of graduates going on to academia, but many students *(red bars, Fig. 3)* are employed outside academia. These baseline data will help measure the effectiveness of our program in graduate placement. New data will allow us to track the integration of program participants into alumni networks, especially those outside academia. For example, EEB's placement of graduate students over the past 16 years shows that, out of the Master's students, 27 (52%) have gone on to careers outside colleges and universities and are placed in jobs ranging from the US Forest Service, to education coordinator at the Jackson Zoo in Mississippi, to program director at the New York City Parks Department, to high school biology teacher.

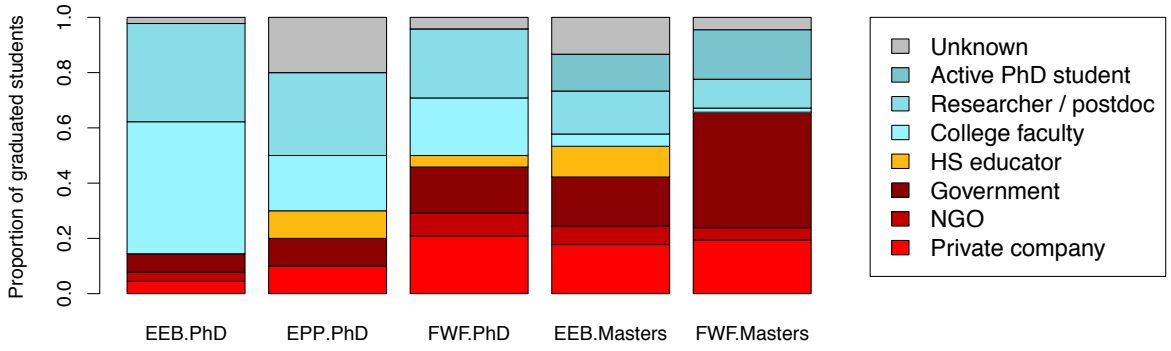

Figure 3. Graduate student placement from EEB, EPP, and FWF departments at UT. Blue areas are academic career paths, red are non-academic paths [16].

C. Education and Training

The traineeship model has six main components:

1. Internships;
2. Core biological training, including semester-long coursework in ecology, evolution, statistics and field courses focused on the natural history of organisms;
3. Technology training through coursework in GIS and informatics, and workshops in R programming language;
4. Leadership, management, and communication training, including semester-long courses in project management and workshops in science communication;
5. Trainee outreach (*see Broader Impacts*); and
6. Interdisciplinary research projects guided by Multidisciplinary Advisory Committees (MAC) that build on the synergy among faculty in EEB, FWF, and EPP.

Table 1. Trainee course requirements.

Credit Hour Instruction	Credits (total of 24)
Core Biological Training • Semester-long course credits • Field course credits	 9+ 3+
Technology Training • Semester-long course credits • Workshops	 3+
Leadership/Management/ Communications • Semester-long course credits • Workshops	 3+

We propose to use existing and new programmatic elements to enable students to select appropriate courses and experiences *(see Table 1)*. Both the Master's and Ph.D. programs across the three departments currently require 24 hours of course work (plus additional thesis or dissertation hours). All three departments offer flexible curricular choices for graduate students that will integrate with the components of this new traineeship program. This approach to graduate student training is described below, highlighting the interwoven and synergistic mechanisms for novel outcomes.

Internships: Connecting with professionals outside academia is the key component of this NRT; thus a major aspect of training is placing students in strategic internships. We already have willing partners in the National Park Service, US Fish and Wildlife Service, US Forest Service, Tennessee Department of Environment & Conservation, Tennessee Wildlife Resources Authority, Huber Engineered Woods, the Nature Conservancy, Discover Life in America, and several independent environmental consulting firms. Moreover, Dr. Thanos Papanicolaou of UTK's Tickle College of Engineering has agreed to expand current engineering student intern opportunities with the US Geological Survey to include internships for our NRT students. To further the connection between mentors and departments, at least two seminars a year will be delivered by members of partner organizations. We will continue to add more partner organizations to those that have already expressed interest in collaborating to establish a network of highly trained biodiversity professionals. As students enter the program, additional internship partners will be sought as needed, based on each student's intended career path, so that professional networks formed during internships can help students receive placement after graduation.

The team has experience facilitating intern arrangements for undergraduates that can be applied to the NRT trainee internships, and we have faculty liaisons already in place. FWF has well-established internship opportunities for its undergraduate majors. Likewise, many EEB faculty have mentored undergrads in successful internships that have opened career paths. For example, as an undergraduate intern, Stephen Nelson worked on a collaborative project between UTK and the Knoxville Zoo, assessing disease threats to amphibians. He is now head keeper in the zoo's herpetology department and continues to collaborate with his faculty advisor at UTK on conservation and biodiversity discovery (they recently discovered a new species of

mudpuppy). This NRT's internships will develop a pipeline of STEM-enabled Ph.D. and Master's students outside academia.

Coursework: Trainees will pursue courses across each of three types: core biology, technology, and management/communication/assessment. In addition to approximately 50 biological courses, this program will complement training with technology and business-related skills (*see Table 2 for examples)*. Additional targeted graduate courses, depending on trainees' needs, may also be utilized. Capitalizing on established courses helps create a sustainable program and exposes trainees to students and instructors from a variety of perspectives.

Semester-long courses utilize existing courses span three areas. Core biology courses are provided by traditional graduate student offerings across departments, spanning ecology, taxonomy, anatomy, physiology, evolution, and conservation.

Table 2. Examples of courses to supplement core biological training.

Number	Course Title	Knowledge and Skills
Technology Training Courses		
ENVE 561	Climate and Environmental Informatics	Risk management, dealing with uncertainty, extreme events
GEOG 517	Geographic Information Management and Processing	Geographic database design, manipulation, sampling and analysis
EPP 622	Bioinformatic Applications	Bioinformatics for agriculture, bash and python scripting, open source software including genomic data analysis
FWF 530	GIS for Natural Resources	Geographic information system data for forestry
EEB 5XX (planned course)	Spatial Analyses using UAVs	Use of drones to gather environmental and species distribution data
EEB 5XX (planned course)	Introduction to Molecular Techniques	Hands-on course teaching lab techniques and troubleshooting to generate genomic and genetic data
BZAN 545	Database and Big Data Technologies	Relational and non-relational databases; scripting languages, analytics in big data environments
CBE 672	Computational Bioinformatics	Modeling and analysis of DNA; algorithms; probability theory
Management and Assessment Courses		
EDAM 560	Grant Writing and Project Management	Writing grant proposals, negotiating with funding sources
ENMG 536	Project Management	Team building, conflict resolution, and contract negotiations
ENMG 541	Managing Change and Improvement in Technical Organizations	Organizational effectiveness, employee empowerment, performance measurement.
HRM 545	Compensation and Benefits	Compensation, benefits, legal compliance
ALEC 551	Servant Leadership in Agriculture and Natural Resources	Emerging philosophy of leadership in business, education, and foundations
ALEC 520	Leadership Development in Organizations and Community Nonprofit	Emphasis on leadership in agricultural professions

Field Courses: Hands-on experiences are key ways to promote learning [17] and are a central goal of the UT administration. UT faculty in our three departments currently teach field courses covering a wide variety of organisms and ecosystems that provide immersive learning environments. For example, EEB-led courses include Field Botany; Biodiversity of Fungi; Wetlands Ecology; Aquatic Insects; Herpetology; Ecology and Diversity of Fishes; and Field Ecology. New courses are being developed at the graduate level (e.g. Natural History of the Smoky Mountains and Ornithology will be newly offered for mini-term 2017) that will leverage EEB's field station just outside the Great Smoky Mountains National Park. EEB's natural history courses constitute a critical area of biodiversity training that is lacking in most graduate programs.

The value of our courses to training next-generation biodiversity science experts is clear from the participation by NGO and government agencies employees. For example, in the last two semesters, a total of nine students attended three EEB courses (Ecology and Diversity of Fishes; Environmental Toxicology; Aquatic Insects) and are current employees of the Tennessee Valley Authority (2), Tennessee Department of Environment and Conservation, Conservation Fisheries, Oak Ridge National Laboratory (ORNL) (3), and private consulting firms (2). New and existing grad courses in this NRT program will further stimulate interaction across agencies and UT.

Workshops: Each year, trainees will have access to workshops organized as two to three days of intensive learning involving both lecture and practical exercises. The workshops will cover areas of technology training, communication, and modeling/analysis.

For example, O'Meara will offer two technology workshops based on his prior tutorials: "High Performance Computing for Phylogenies" and "Computing in the Cloud: What Every Computational Life Scientist Should Know." Co-PI Staton will sponsor and co-teach a Data Carpentry workshop each year as well as continuing to offer her two-day next-generation sequencing and bioinformatics workshop on RNASeq. Staton is a certified instructor in Data Carpentry (Teal 2015), a vetted two-day training curricula utilized worldwide for teaching data analysis and reproducibility principles. Customized curricula are available for ecology, genomics, and geospatial data approaches. Additional workshops on the use of drones and LiDAR for spatial data collection and remote sensing will be held in the new Spatial Analysis Lab of EEB/NIMBioS (National Institute for Mathematical and Biological Synthesis) led by new EEB/NIMBioS faculty, M. Papes.

A communications workshop, taught in conjunction with UTK's School of Journalism and Electronic Media, will tap into the expertise of Dr. Mark Littmann. It will focus on written and verbal communication necessary to convey complicated scientific topics to the general public or government officials. In the process, NRT trainees will learn how to craft press releases about their research, how to write a query letter to pitch their story to the media, and gain a basic understanding of how the mainstream media communicates scientific topics. Additional communications workshops will focus on skills for the range of information presentations employed outside academia, as well as report development and web design.

Trainees at the Master's level will participate in at least one workshop prior to graduation, and Ph.D. level trainees will participate in a minimum of two. Topics will either be updated yearly or replaced with new relevant material to reflect state-of-the-art approaches in biodiversity and the particular research needs of the trainees. Materials from all workshops will be available online through live streaming and posting all teaching materials (slides, exercises, scripts) to an open access website. This successful model is used by PI O'Meara for several NIMBioS tutorials on computing, phylogenetics, R, and genetics, as well as an NSF CAREER grant-sponsored course and will be the standard for all workshops. Assessment of domain knowledge at the beginning, completion, and a year after each field course and skills workshop will help highlight effective strategies and long-term impact.

Table 3. Expected timeline for participation of funded trainees, affiliated students and external participants in this Next-Generation Biodiversity NRT.

Participants	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Number of new NRT trainees admitted annually	4	5	4	4	0	**17**
Second-year funded trainees	0	4	5	4	4	
Cumulative number of Master's trainees graduating	0	0	2	4	6	8
Cumulative number of PhD trainees post 2-yr funding (to graduate in years 6-9)	0	0	2	5	7	9
New affiliate students per year (estimate)	5	7	9	11	13	**45**
New external participants per year (minimum estimate)	10	15	15	15	15	**70**

STEM Graduate Populations to Be Served: This grant will serve four audiences:

- Trainees (funded students): Seventeen Ph.D. or Master's students who fulfill the full slate of program components in our core NRT program and who receive stipends (plus tuition and benefits) for two years each. Based on available information from 54 NRT-eligible students admitted over the last five years, 74% identify as female, 5.6% identify as Hispanic, 5.6% identify as African-American, and 1.9% identify as American Indian. The majority of our graduate students are recruited from the national pool, only 24% graduated from UTK (usually as undergraduates) before enrolling in our graduate program. The timeline for admission of trainees is presented in Table 3. We expect an even mix of Master's and Ph.D. students. Master's students should graduate in two years, while the Ph.D. students are expected to graduate in five. Given a higher affinity for non-academic careers in some underrepresented groups [18], we anticipate greater participation from those groups.
- Affiliate students: Other degree-seeking graduate students in EEB, FWF, and EPP, as well as students in related UTK departments and institutes such as Earth and Planetary Sciences, Genome Sciences and Technology, and Geography. Affiliate students can participate in one or more of the field courses or skills workshops. We expect the affiliate student numbers to grow per year; conservatively, we estimate a minimum of 45 affiliate students over the course of the NRT award.
- External participants: Graduate students from other institutions, land managers, biocontrol workers, agency employees, or other non-academics who attend a field course or skills workshop. These experiences will deepen connections between the program and the broader community, and importantly expose students to professionals outside academia. We conservatively estimate 70 external participants over the life of the grant, though given current interest in our field courses and skill workshops, we expect the actual number to be far higher.
- Remote participants: A broad range of students who access online teaching and training materials. NIMBioS experiences reveal that online video tutorials draw hundreds of views, and O'Meara's course website for his NSF-sponsored flipped phylogenetics methods course, launched in January, 2016, has supported 6,677 visitors from 94 countries to date.

D. Major Research Efforts

This project will catalyze and advance two types of research: thesis research performed by students while studying at the university and research based on assessments of the

program's success *(discussed in Section H: Performance Assessment / Project Evaluation)*. This research will address current research needs, recognizing that 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 agriculture in the US alone [19]), and the skills to identify critical species are being lost [20]. NRT trainees will pursue research-based dissertations in areas relating to modern biodiversity issues. Thesis research will be shaped by the overlap in interest between the student and their potential advisor (*Table 4)*, guided by each student's MAC. This innovative process will provide student access to top scholars, such as Dr. Dan Simberloff, a member of the National Academy of Sciences, and many other world-renowned scholars on campus. Anticipated thesis research projects will revolve around the following themes.

Table 4. Biodiversity science capacity of departmental faculty.

Department	Field skills / taxonomic knowledge	Conservation / invasion / biodiversity / policy	GIS / spatial analysis	Modeling / Statistics	Ecological & evolutionary theory & principles
EEB	16	8	2	7	28
FWF	13	13	1	4	29
EPP	10	6	2	1	20
Total	**39**	**27**	**5**	**12**	**77**

Conservation of Biodiversity: Several research groups focus on topics related to biodiversity, conservation, and policy. For example, Buehler, C. Harper, Keyser, and Kwit (FWF) have all worked on management of disturbed systems and restoration, with aims driven toward increasing abundance and diversity of wildlife species. Wildlife diseases and their impacts constitute a main research area in the Alford, Eda, Gray, Hickling, D. Miller, Muller and Willcox labs (FWF). Projects in these labs have links with federal and state agencies and NGOs. In EEB, the Bailey, Kalisz, Fordyce, Schweitzer, Sheldon, and Simberloff labs investigate forces that shape individual phenotypes and genomes, drive population-level fitness and speciation, and alter standing levels of biodiversity within native communities. In addition, the Armsworth, Echternacht, Giam, Gaoue, Kalisz, McCracken, Simberloff and Schussler labs focus on invasion biology, conservation, and policy. Identifying biodiversity is an important first step for conserving it, and departmental members have described new species of hexapods [21-24], plants [25, 26], fungi [26, 27], and other organisms. Possible graduate projects could investigate mechanistic hypotheses and develop theory centered on how anthropogenic factors (e.g. habitat disturbance disease, invasive species) alter species interactions and drive native species declines. Current efforts focus on mechanisms underpinning invasive species disruption of native plant mutualisms (i.e. mycorrhizae and pollination), physiological, life history, and demographic responses of native biodiversity and invaders. These projects leverage long-term databases from NEON, GSMNP, and other field sites to address conservation and management issues at national and regional scales, creating links to careers in government, conservation NGOs, and state and national parks.

Sustainability & Ecosystem Services: Research interests include plant-animal interactions and bioenergy sustainability. Connections with partner organizations include common interests in assessing landscape change and silvicultural practices on pollination and seed dispersal. Graduate students could learn skills ranging from field identification of pollinators or seed dispersers, pollen or seeds, to the application of DNA sequencing approaches to quantify pollination and seed dispersal effectiveness. Graduate students with prior DNA sequencing skills could identify organisms providing ecosystem services. These students could move on to careers in federal or state agencies, NGOs, or agricultural

businesses. Kwit (FWF) Kalisz, Armsworth (EEB) and Grant (EPP) work in this area; Buehler, Gray (FWF) and McCracken (EEB) could also contribute to this area.

Analysis of Biodiversity Relationships and Communities: Research in phylogenetic methods and the analysis of community structure address key questions in macroevolution and ecology. Notably, one focus of O'Meara, Moulton, and several faculty (Fitzpatrick, Hughes, Matheny, Budke, Williams, Small (all EEB), and Bernard (EPP)) has been the development and/or use of approaches to delimit species [28], including fungi, bryophytes and vascular plants, cave fishes of the Eastern US [29], North American bats [30], salamanders, springtails [21], and midges [23, 24]. In addition, empirical and statistical approaches addressing the role of genetic and phenotypic variation within species on community composition (Bailey, Fordyce, Riechert, Schweitzer (EEB)) are also currently being developed. These skills and approaches are necessary for delimiting biodiversity, rapid radiation, hybridization, and especially cryptic biodiversity that is of grave conservation concern. Students working on such projects could pursue careers in conservation, at NGOs or in state or federal conservation agencies.

Technology and Model Development: Developing software and statistical and mathematical models for biology are major research goals for the Staton (EPP), and O'Meara, Gross, Fefferman, Gavrilets, Gilchrist, and Fordyce (all EEB) lab groups. For example, the Staton group builds software for developing websites that store genotype and phenotype data (the open source Tripal project), and is currently funded to expand this software base to a mobile device application and online website interface for ecological data sampling. The software will enable scientists to develop an ontology-driven data collection schema, deploy this across mobile devices for field data collection, upload their data to the cloud, and return to the lab to filter, sort, and share data from an intuitive map interface. O'Meara's group develops software for understanding evolution using phylogenetic trees. Graduate students interested in programming could help with software development, while field courses and student research projects could be used as test beds for its application. These students could move onto careers identifying genes of potential agricultural significance. Papeş (EEB), Trout, Fryxell (EPP), and Zobel (FWF) work extensively on GIS data analysis, which is of growing interest for careers in agriculture, invasive species management, and conservation.

E. Broader Impacts

Science graduate programs must train students for a broad array of careers [Nature Editorial Board 31]. However, few graduate programs are configured for broad career outcomes. By design, our program itself is a broader impact in that it builds connections between graduate students and professionals outside academia and trains students for a wide variety of positions focused on biodiversity. Practical skills including project management, science communication, and program assessment will position our NRT graduates to be competitive and successful in industry or academia. The open nature of the training pushes scientific knowledge into the public domain where professionals can learn from it, fulfilling a national need and a classic role of land grant institutions. Sponsored student research projects will span a variety of biodiversity questions, likely ranging from alpha taxonomy, to modeling population movement with projected climate, to studies of urban ecology. Our approach is radically different. With this program, the "alternate" career is academia – our goal is to get our students out into the world working with real world biodiversity science questions. The triumphs and failures of this program, which will be assessed and communicated throughout the life of the award, will help create a prototype that other programs can adopt to bring equal rigor and attention to non-academic and academic career paths in STEM.

A key aspect of broadening participation in science is showing the various career paths one can take. For example, a traditional academic path often requires a scientist to make multiple moves around the world, receive low financial rewards, and experience great

uncertainty. Alternative paths may offer better options, while posing other tradeoffs (fewer opportunities to affect students through teaching, limited access to research, etc). To showcase the career opportunities in STEM, we will leverage existing UT events to reach both undergraduates and the broader public. First, we will participate in creating research and career path displays at our university's Ag Day event, a way to connect the local community with the UT Institute of Agriculture. Strategically scheduled on the same day as a UTK football game (which draws over 100,000 attendees) and featuring an insect petting zoo, farm animals, departmental displays, free food, and other activities, this well-liked outreach event is designed to draw in a broad swath of the community. Trainees will create a display and talk to visitors about their chosen career paths and options in science. Additionally, we will partner with Darwin Day Tennessee (PI O'Meara is the faculty advisor), a group founded 20 years ago to educate the public about evolution. It has grown to feature nearly a week of events, ranging from keynote speakers like Neil Shubin who draw hundreds of visitors plus media coverage, to teacher workshops, to birthday parties for Darwin at the local museum (McClung Museum of Natural History & Culture). Trainees will run a panel on careers involving evolution outside academia, targeted at local teachers and guidance counselors. These efforts will help inform the local community about the importance of evolution (in areas ranging from antibiotic resistance to invasive species) as well as give educators the information and tools to direct students into science-based careers other than academia.

Finally, this is an unprecedented time of threats to biodiversity. Our country desperately needs more research on threats and how to mitigate them, but we also need muddy boots on the ground to implement best practices. Students from our program will have deep knowledge of biodiversity, ecology, and evolution, while also having skills in project management and communications and contacts with NGOs and private companies required to effect real change.

F. Organization and Management

The faculty involved in this grant as PIs and Co-PIs will comprise the Leadership Team. They already are well-connected (for example, Kwit has appointments in both EEB and FWF; O'Meara has served on committees for Ph.D. students of Moulton and Kalisz; and Staton, Kalisz, and O'Meara are all affiliated with NIMBioS). An organizational chart is included in Fig. 4, outlining responsibilities.

As PI, O'Meara will oversee the program to ensure NextGen Biodiversity NRT goals are met. His management experience includes being an Associate Director for NIMBioS, filling leadership positions in the Society of Systematic Biologists, codirecting the annual iEvoBio conference for three years, mentoring 11 postdocs through his lab, and managing over $2.2 million in grants. O'Meara will oversee the Project Coordinator, a half time staff position based in EEB. Together, they will be responsible for tracking student progress, matching students with internship opportunities, coordinating scheduling and space requirements for workshops, and the day-to-day tasks required in managing a set of students.

Kwit will serve as a bridge between the various academic communities, both on and off campus. Kwit's research spans areas from warbler winter habitat management in the Bahamas, to bioenergy sustainability of switchgrass as a biofuel crop, oak savanna restoration, and animal-mediated seed dispersal, much of which is collaboratively supported from state and federal agencies and NGOs. He has a joint appointment in FWF in UTIA's College of Agricultural Sciences & Natural Resources and EEB in UTK's College of Arts and Sciences. He is an ideal resource for students in this program and will receive support to enable his time to be used for this. Kwit will oversee steady progress of the students and handle connections between them and internship opportunities.

Staton will lead the development of tutorials and workshops, assisted by O'Meara. Moulton and Kalisz will help foster MAC faculty for thesis work by onboarding affiliate faculty

chosen by students to be part of their MAC. They will also help ensure that data generated are deposited appropriately.

Evaluations will be handled by East Main Evaluation & Consulting, LLC; Dr. Barbara Heath will lead this group, assisted by staff or interns within her group.

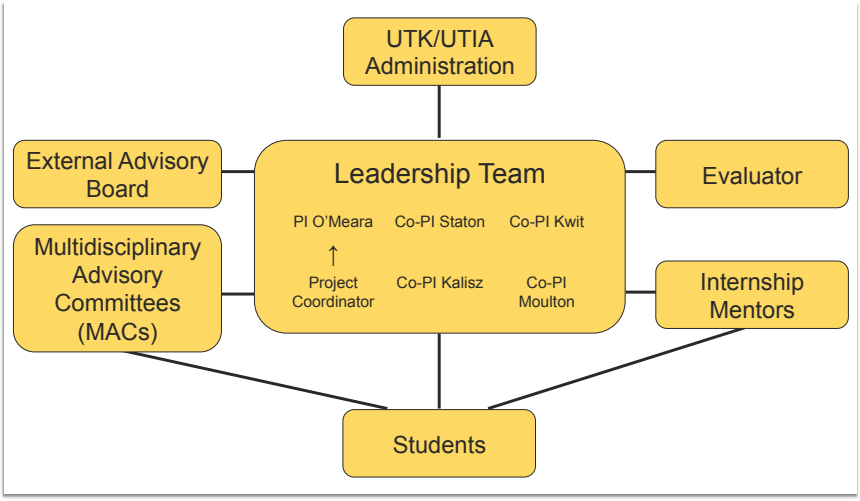

Figure 4. Next-Generation Biodiversity NRT organizational chart.

Each trainee will be housed in the lab of a member of one of the three participating departments (faculty mentors will be approved to advise students after receiving training in cross-cultural mentoring), but will have at least two faculty from any of the following departments on their committee (*Table 5*). Students will thus be mentored by faculty with a wide variety of knowledge and experiences. This structure also serves as a way to infuse the idea of non-academic jobs as a major focus of a graduate program to a wider audience within this university, as affiliate faculty will be introduced to this idea through their participation.

Table 5. Interdisciplinary Affiliate Faculty Departments

Department for Affiliate Faculty	College
Agricultural & Resource Economics	Agriculture & Natural Sciences, UTIA
Agricultural Leadership, Education & Communications	Agriculture & Natural Sciences, UTIA
Animal Science	Agriculture & Natural Sciences, UTIA
Anthropology	Arts & Sciences, UTK
Biochemistry & Molecular Biology	Arts & Sciences, UTK
Biosystems Engineering & Soil Science	Agriculture & Natural Sciences, UTIA
Business Analytics & Statistics	Business, UTK
Civil and Environmental Engineering	Engineering, UTK
Earth & Planetary Sciences	Arts & Sciences
Ecology & Evolutionary Biology	Arts & Sciences
Entomology & Plant Pathology	Agriculture & Natural Sciences, UTIA
Food Science & Technology	Agriculture & Natural Sciences, UTIA
Forestry, Wildlife, & Fisheries	Agriculture & Natural Sciences, UTIA
Geography	Arts & Sciences, UTK
Management	Business, UTK
Mathematics	Arts & Sciences, UTK
Microbiology	Arts & Sciences, UTK
Plant Sciences	Agriculture & Natural Sciences, UTIA

A sense of community will be fostered organically through overlapping courses and workshops taken by students and taught by faculty. Two social gatherings per year will be scheduled: one in February at the time of recruiting and one at the end of the academic year. These will feature core students and their families, recruited applicants (annually in Feb.), the Leadership Team, and other members of involved departments. We will also create a website

and chat room for the project. The chat room will allow participants to discuss issues as they arrive, share information, celebrate successes, and ask for advice. The technology we will use is a service such as Slack or Gitter. Given the anticipated start date for the grant approximately 1.5 years in the future, these particular services may have been replaced; we will use the best available at that time.

Students in our program will be full members of one of the three collaborating departments. Our plan is that each department receives at least 25% of all students. Admitted students will be assured of funding until graduation (as long as they meet adequate progress guidelines). After their NRT funding is completed, EEB Masters and Ph.D. students will continue on guaranteed TA or RA lines until graduation, a model used for trainees in our NIH PEER program. For EPP and FWF students, most admitted students will be seeking Master's degrees and are expected to graduate in two years.

External Advisory Board: Collaborating with external partners is essential, both as members of the External Advisory Board and as internship hosts. The advisory board will consist of one representative, each, from an NGO, a government agency, and a private company, plus one graduate of each department with a career outside of academia. The board will meet annually to discuss program progress and will provide guidance on emerging training and skills needs. Our external partners will also provide internship opportunities and mentoring.

Coordination with Administrators: A training grant will fail without institutional support. At the level of department heads, we have one department head as a Co-PI on the grant, an associate head as PI, and have had frequent contacts in developing it with heads of the other two departments (with particular concern for how participation in this grant affects tenure considerations for Co-PIs who are junior faculty). We have also met with Associate Dean Ernest Brothers in the Graduate School and will continue to consult with him moving forward.

We will coordinate with higher level administrators in two ways. The first is informal: we will invite them to our two annual social events so they can form connections with our students and our external partners. The second is through an annual joint meeting with heads of the three collaborating departments, grant personnel, the Dean of the Graduate School, the Associate Dean for Academic Programs at the College of Arts and Sciences, and the Associate Dean at the College of Agricultural and Natural Resources. One week before the meeting, the involved parties will receive a written report listing grant goals for the previous year, delivery of those goals, goals for the next year, and university, college, and department policies or procedures that have helped or hindered the achievement of those goals.

An important aspect of sustainable programmatic capacity is aligning with broader university directions. The university has recently implemented its VolVision 2020 strategic plan, which includes goals as well as assessment metrics. It notes that "doctorate recipients are more likely to pursue nonacademic careers than in the past, which relates to the need for additional career development for doctoral students." Assessment goals include career placement, and specific recommendations include improved career coaching and career placement support. Our project, with its robust assessment model (*see below)*, will provide a prototype that other academic units can adopt, and its dovetailing with the overall university direction will lead to institutionalization of those training elements shown to be effective. The College of Arts and Sciences is preparing a strategic plan in response to the university's overall goals. It will be completed in Spring 2017, and its current draft includes increasing recognition of non-academic careers and strategies to enhance non-academic career options, as well as assessment tools for what aspects prepared graduates for their careers. Concrete metrics include whether a unit participates in career development opportunities, the number of non-academic career workshops or other opportunities, and more. Our proposed NRT will create incentive for other departments to encourage affiliate students.

Sustainment Plan: Sustaining the program after the conclusion of NSF funding is a primary goal, and UT has committed to funding four students' tuitions for the four years following the grant period. The long-term vision is that this new traineeship becomes integrated into regular graduate training: as faculty and students see the benefits of biodiversity training for careers outside academia, cultural expectations of the programs will shift. In the same way training for academic careers is currently the default, and which thrives despite lack of NSF funding explicitly for this, we expect our training model to diffuse through the relevant programs. Similarly, tasks that will be initially undertaken by the Project Coordinator will transition to the graduate coordinators of each department. Similarly, the paradigm shift in training approach, including partnerships with potential employers through internships, will be continued as faculty, students, and partners experience the benefits. Cross-disciplinary mentorship of students will foster research projects and grant proposals spanning the included departments (and this will be measured as part of the assessment process). Seminars featuring partner organizations will continue past the life of the award.

G. Recruitment, Mentoring, and Retention

This NRT has a two-fold strategy to recruitment and retention: providing student access to the program and ensuring that potential graduate students from all walks of life are aware of the opportunity to apply, and creating an environment of inclusion with mentoring and enrichment experiences to maintain retention and facilitate attainment of students' goals.

Recruitment: This NRT program will work closely with UT's Graduate School, which supports 55 doctoral degree and 76 Master's degree programs, to recruit a diverse population of students. We will join Graduate School representatives as they participate annually in graduate school fairs across the Southeast and at national conferences such as the annual Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) conference, which has 3,600 attendees from a wide variety of backgrounds, as well as professional conferences. In addition, we will provide printed and online promotional materials about the NRT Traineeship, which will be disseminated in these venues and others.

We will coordinate our graduate student recruitment activities to increase underrepresented students by partnering with UT's Office of Graduate Training and Mentoring (OGTM) and PEER. Working with existing undergraduate diversity programs at UT (e.g. Tennessee Louis Stokes Alliance for Minority Participation *(*TLSAMP*)* program) and other institutions will expand our existing diversity recruiting pipeline. We will also leverage the Graduate School's recruitment activities that focus specifically on underrepresented students, such as campus visits from TRIO, McNair, and NSF LSAMP programs throughout the region. Finally, we will work with colleges throughout UT that engage in decentralized recruitment activities taking place at the departmental level. Each year, we will sponsor two major events for students and prospective students, one during a graduate recruitment weekend in early spring, focused on prospective students, and the other at the end of the spring semester, focused on celebrating graduate students' progress.

Institutional support will come from Associate Dean of the Graduate School Dr. Ernest Brothers (*see letter of support)*, who is an expert in graduate student diversity and mentoring. He recently presented a workshop, "Diversity and Mentoring in Academia," to ORNL and a workshop, "Strategies for Mentoring Diverse Graduate Students and Faculty" to UT's Psychology Department. He will present similar workshops for NRT faculty, to set the stage for a welcoming environment upon NRT Trainees' arrival in Knoxville. Brothers is on several advisory boards related to diversity and graduate student training, including the TLSAMP, and serves as a CoPI on UT's NIH-funded Program for Excellence and Equity in Research (PEER). The Graduate School also sponsors a diversity job fair and training in teaching, presentations, and research conduct.

Mentoring and Retention: Mentoring and retention will build on the strengths of our programs. Trainees will be mentored through their MACs but also through annual meetings with the Project Coordinator (one of the core faculty). Students will be further mentored through the informal networks fostered by their internships in first summer year of grant funding. The EEB department has created its own tracking software to monitor grad student progress toward degree and to automatically highlight potential issues while building up a long-term, secure, database of progress and outcomes.

Co-PI Kwit will oversee trainees' mentoring activities and coordinate collaboratively with Dr. Brothers, who also oversees the Office of Graduate Training and Mentorship (OGTM) within the Graduate School. One of these activities is a weekly discourse session, modeled on a NIH-funded PEER initiative to increase the number of exceptional underrepresented students graduating with doctoral degrees in STEM disciplines at UT. This session will create cohesion for our students (the funded trainees and those affiliate students who opt in) within and between cohorts. These will provide opportunities for students to discuss current challenges and solutions, professional and scientific skills, plans for outreach, and experiences during internships. Students will develop an individual development plan (IDP) in their first semester and monitor their progress toward accomplishing their goals. This plan will help keep their focus on the skills needed for their chosen career and ensure timely graduation. It will also be crucial in helping to identify whether they want to intern at one of our existing external partners or whether Co-PI Kwit and the Program Coordinator should reach out to a new potential partner so the student will have an appropriate placement in her or his first summer. IDPs for graduate students are now a requirement for NIH grantees [32] based on best practices in training.

We will create a community of scholars within NRT cohorts and connect students with other programs at UT. The goal is to create experiences that further each student's professional aspirations. We will make use of existing resources, such as UT's Multi-Cultural Graduate Student Organization, which connects members of underrepresented groups across campus, to help students form meaningful relationships with others. Working with the Graduate School's new customer relationship management system, we will be able to identify where students were recruited and when they applied, were accepted, enrolled, and matriculated. Such a system enables the NRT program to automatically respond to students, providing immediate feedback.

H. Performance Assessment / Project Evaluation

Process evaluation seeks to answer two main questions. First: Are the services and support functions consistent with the program design? Second: Are the services reaching the target population? This approach was selected as the most appropriate method for measuring the processes related to the NRT program activities. The program impact theory (*Fig. 3*) guides the evaluation team in establishing the links between program services and the overall benefits or effects of the program. This approach provides the most appropriate means for measuring the intermediate effects of the target populations.

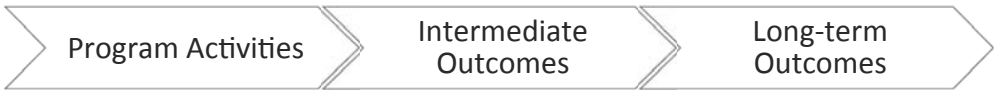

Figure 3: *Program Impact Theory.*

Our NRT program evaluation will be conducted by East Main Evaluation & Consulting (EMEC), LLC of Wilmington, NC. EMEC provides consulting and evaluation services with expertise in science and mathematics education and technology. This effort will be managed by Barbara P. Heath, Ph.D., with implementation support from additional staff. Dr. Heath founded EMEC in 2004 and has evaluated over 30 STEM focused programs including CyVerse (formerly iPlant), multiple Math and Science Partnerships, and various informal education efforts.

The evaluation of this NRT will follow a process-and-outcome framework, which provides a comprehensive model to analyze the project activities while gathering data on the program effects. Within this framework, a logic model (*Table 6*) is used to represent the sequence of steps between program services and outcomes [33]. The outputs and outcomes (*Table 6*) include identified performance measures and expected competencies that are anticipated effects of the project activities. An evaluation timeline is provided in Table 7.

The evaluation will use a mixed methods approach to gather both qualitative and quantitative data. Data collection for the external evaluators will include document review, surveys, interviews, and observations. Project documents will be collected and reviewed with assistance from the Project Coordinator. Documents will include (but are not limited to) rosters, student data, course descriptions, and university policies. Document review will provide the opportunity to generate program outputs as well as track the project implementation and related changes. Surveys will be developed and deployed to trainees to collect data for satisfaction and knowledge and skill gains. Trainee surveys will be deployed each semester, post-workshop, post-internship, and post-graduation. Trainee surveys will be deployed to all participant students regardless of their funding status within the project. Additional surveys will be deployed to faculty and administrators to collect satisfaction, course or departmental changes, and suggestions for improvements. A trainee exit interview will be developed and instituted as trainees complete the program of study to collected final impressions of their experiences. Last, observations will occur when evaluators visit the site. This will include observing courses and field experiences. Regular observation will also occur during Leadership Team (LT) meetings.

The data collected will be analyzed, and results will be provided to the Leadership Team through formative reports and committee meetings. The formative process will enable the LT to make data-informed shifts to the project implementation plan if warranted. An annual report will be produced for Years 1-4. All results will be provided to the LT and disseminated as appropriate to participants, faculty, and administrators. The summative evaluation process will occur during the final phase of program implementation and will result in a summative report at the conclusion of Year 5. This report will include all data analyses and results for the full program implementation. It will be the basis for a peer-reviewed manuscript that describes the program model and effects on the target populations.

Table 6. Logic model for evaluation and assessment of trainee progress and placement.

Goal 1: Enhance workforce development to fill the need for US biodiversity science expertise.

Strategy	Output	Outcome	Data Method
Course work w/ two week field course	# and description of courses offered pre/post program # and description of field courses # students enrolled in each course each semester # students completing each course each semester # trainees completing comprehensive examination # completed theses # completed dissertations # of students graduating from the program # of faculty teaching program courses # of departments collaborating	• Trainees are satisfied with program • Trainees gain a understanding of biodiverse concepts • Trainees gain professional skills • Trainees successfully defend their thesis or dissertation • Increase graduate student retention rate • Trainees secure related career post-graduation • Trainees are satisfied with field course • Trainees gain understanding of field methods	• Document review • Trainee survey (semester) • Trainee exit interview • Trainee follow-up survey

		• Faculty and institution undergo paradigm shift • Increase in departmental collaboration	
Workshops	# and description of workshops offered # of streamed workshops # of workshop participants # of workshop views # workshop instructors	• Trainees are satisfied with workshops • Trainees gain technological skills • Trainees gain leadership, management, and/or communication skills • Trainees gain domain knowledge • Expand program reach through streaming	• Document review • Pre, post, knowledge measure • Post workshop survey
Internships	# students accept internship # students complete internship # students placed in internship companies # companies offering internships # interns hired	• Trainees increase professional network • Trainees gain skills needed for career outside academia • Program develops pipeline of STEM-enabled students outside of academia	• Document review • Intern survey • Leadership Team interviews
Outreach	# and description of outreach events # trainee participants per event # trainee displays per event # non-academic publications	• Connect trainees with undergraduates and targeted community members (e.g. teachers) • Disseminate findings to broad audience	• Document review

Goal 2: Create a prototype for institutional culture change toward non-academic career paths.

Strategy	Output	Outcome	Data Method
Document program implement-ation over 5 years (including revisions)	# leadership team meetings Timeline Leadership meeting minutes # significant revisions made to program Description of rationale for changes Updated timeline # and description of external advisory board # advisory board meetings Advisory board meeting minutes # of faculty teaching program courses # of departments collaborating	Narrative description of program implementation Faculty and institution undergo paradigm shift Increase in departmental collaboration	• Document review • Leadership Team interviews • Meeting attendance • Faculty survey (semester) • Department Chair survey or interview
Dissemin-ate program results via publications and presen-tations	# and description of presentations # and description of publications	Prepare and submit publication for peer review Prepare and present results at conferences	• Document review

Table 7. Evaluation timeline.

Activity	Year 1			Year 2			Year 3			Year 4			Year 5		
	Fall	Spr	Sum	Fall	Spr	Sum	Fall	Spr	Sum	Fall	Spr	Sum	Fall	Spr	Sum
Baseline data															
Document review															
Student survey, post															
Trainee exit interview															
Trainee follow-up															
Workshop survey, post															
Workshop, knowledge measure															
Internship survey															
LT interviews															
Meeting attendance															
Faculty survey, post															
Dept chair interview															
Observation															
Annual report															
Summative report															
Manuscript prep															

I. Recent Student Training Experiences

Over the past five years, PI O'Meara has had four graduate students. All are still currently enrolled: two are on schedule to receive their Ph.D. in ecology and evolutionary biology as well as a Master's in Statistics this semester, another recently received a DDIG award, and a fourth recently took his Ph.D. qualifying exam. The two students planning to finish this semester have decided to pursue careers outside of academia, and enrolled in and successfully completed a program to earn a Master's degree in statistics while in a Ph.D. program with this intention. They both had internships at the Tennessee Valley Authority (one received an offer of a job once she graduated), and one has also interned with our athletic department analyzing academic progress of athletes. Half of O'Meara's students identify as women, and one identifies as Hispanic. O'Meara serves on approximately one-third of graduate student committees in EEB and has also served on student committees in EPP, Earth & Planetary Sciences, Microbiology, and Genome Sciences and Technology. O'Meara has served on EEB's Graduate Admission Committee and now is Associate Head for Graduate Affairs in the department; as part of this, he has run training for graduate students in grant writing. As Associate Director for Postdoctoral Training for NIMBioS, he has also organized training sessions for postdocs pursuing careers in biology, math, and statistics.

Co-PI Kwit has had four graduate students in his lab over the past five years. All are still currently enrolled: two are on schedule to receive their Ph.D. in EEB, another is a co-advised

natural resources Ph.D. candidate in FWF, and a fourth is pursuing a Master's degree in Wildlife and Fisheries Science in FWF. The latter is pursuing a career outside of academia, and is about to participate in an internship with the National Parks Conservation Association. Three of Kwit's graduate students identify as women. Over the past two years, Kwit and one of his EEB graduate students have served as undergraduate mentors at the University of Virginia's Mountain Lake Biological Station, an NSF-funded Research Experience for Undergraduates program. Kwit currently serves on graduate student committees in FWF, EEB, Plant Sciences, and at other universities.

Over the past three years, Co-PI Staton has trained three graduate students in her lab. One graduated with a Master's degree in EPP; the other two are currently enrolled and on schedule to receive Ph.D.s; one in EPP, the other in Genome Science and Technology. The graduated Master's student is currently working as a staff scientist at ORNL. Two of the three students self-identify as female and two are foreign nationals. Staton serves on 14 graduate student advisory committees across five departments: EPP, EEB, Energy Science and Engineering, Genome Science and Technology, and Animal Science. Co-PI Staton's position is unique in that her appointment specifies 50% time devoted to providing bioinformatic and data analysis expertise and consulting for faculty, staff, and students. This positions her to successfully build interdisciplinary programs spanning multiple departments and to focus on developing and running workshops and courses for broadly needed data analysis techniques.

Over the past five years, Co-PI Kalisz has mentored seven Ph.D. students. Three have defended and graduated (from the University of Pittsburgh), three are current students in EEB at UTK, and one continues in the Ph.D. program at Pittsburgh. Of the seven students, five self-identity as female. Of the current three female students in the Kalisz lab at UTK, and one self identifies as African-American. Kalisz serves as faculty mentor in the Program for Excellence and Equity in Research (PEER), an effective recruiting and graduate training program that offers students from underrepresented minority groups a framework of training and other support activities. Kalisz serves on five additional graduate student committees at UTK and is the sole faculty advisor for Pipeline: Vols for Women in STEM, a Committee of UTK's Commission for Women. This student organization provides a campus-wide support system that fosters an environment of interdisciplinary engagement while providing networking and professional development opportunities in STEM fields. Additionally, Kalisz is the Head of EEB at UTK since Aug 2015.

J. Results from Prior NSF Support

B. O'Meara DEB-1257669: Collaborative Research: *Phylogeographic Inference Using Approximated Likelihoods,* $340,000, 2/28/13 – 2/28/17. Intellectual Merit: This project developed, implemented, and tested models for examining phylogeographic structure of populations or species. These models can allow for gene flow between populations, speciation events, and population size changes. Models were created to allow inference about species delimitation (whether a set of populations should be treated as one species or multiple species). Broader Impacts: Workshops were run in Ohio and Louisiana with travel support for students to train them in phylogeography, and students are already using this software in their research. To aid in communication and outreach, this software allows creation of 3D models, which can be embedded in presentations or even 3D printed using an output file from the open source software R. The postdoc involved in the grant chose to take a position in cancer research outside academia. A website and discussion group were created to promote long-term use of the software, which is open source. Products: Results include publications of two papers about this approach [30, 34], two more in press, and a general review paper currently being developed about model comparison in phylogeography.

S. Kalisz, NSF DEB 0958676, $619,208, (includes equipment [NSF DEB 144552] and REU supplements) 5/1/2009 – 4/30/2015, *LTREB: The population dynamics of forest understory*

invasion: mechanistic experiments with generalist herbivores, natives, and invaders, LTREB RENEWAL DEB 1457531 $520,383 (included REU supplements) 5/1/2015 – 4/30/2020. Intellectual Merit*:* This decadal project investigates long-lived herbaceous species experiencing disrupted species interactions through exotic invasion and overabundant deer. Results demonstrate the deer facilitate invader success and native decline. The allelopathic invader suppresses the AMF-native plant mutualism, essentially turning the AMF fungal mutualist into a parasite that suppresses native plant species' physiological function and vital rates. Broader Impacts*:* Kalisz presented 12 lectures to the public and state, local, and national officials on this work. Results were highlighted in 10 popular press articles and 64 radio spots. Kalisz advises the Fox Chapel Borough on stewardship, management, and conservation of their land holdings, served as Science Advisor on "Virtual Trillium Trail" game software, an interactive K-12 educational tool for exploring biodiversity built on Kalisz's database. The game is free to any educator for classroom use and fits the State of PA STEM guidelines for middle school students. Products*:* 11 publications [35-45], six papers in review, and a virtual *Trillium* trail website.

J. K. Moulton, DEB-0933218; *MIDGEPEET: A Collaborative Effort to Increase Taxonomic Expertise in Understudied Families of Nematoceran Diptera;* $750,000, 09/1/2009 – 08/31/2015. Intellectual Merit: Morphological and molecular systematic studies were conducted on a number of understudied dipteran families, resulting in new species descriptions, identification keys, phylogenetic inferences, and increased basic knowledge of the families and the order. Broader Impacts: This multi-institutional collaboration of researchers provided mentoring to the next generation of taxonomic specialists (i.e., systematists) for several families of lower Diptera identified as being in need of young specialists capable of providing taxonomic expertise for the next several decades. These new systematists received hands-on training in field research and traditional morphology-based and molecular systematics, including phylogenetics. This award provided training to nine international visiting scholars, one technician, three postdoctoral researchers, 10 graduate students (7 Ph.D. & 3 M.S.), nine undergraduate students, and one high school student. Synergistic activities through the Iowa State University Insect Zoo (e.g., development of outreach programs focused on the role of aquatic Diptera in medical entomology and in the biomonitoring of aquatic ecosystems) and the Iowa State Insect Collection (e.g., collection-improvement projects, initiation of a database system, and digitization of slide- and fluid collections) further enhanced the impact of the project. Lucid keys to Chironomidae have been improved, increasing our ability to identify this important group of freshwater indicators of water quality. A molecular workshop conducted at UT provided experiential learning to PEET- and non-PEET-supported participants. Products: Outputs include traditional and web-based products, six book chapters, and nearly four dozen peer-reviewed articles [24, 46-89]. Improvements to existing assets were made, including improvements to LUCID keys for Chironomidae, and the Taxonomic Inventory of Simuliidae. Several repositories have and will continue to receive primary types and voucher specimens of all Dipteran families studied. Numerous genetic sequences have been and will continue to be deposited in GenBank.

M. Staton, NSF DIBBS-1443040, *Tripal Gateway, a Platform for Next-Generation Data Analysis and Sharing,* $1,485,021, 1/1/2015 – 12/31/2017. Intellectual Merit: This award supports expansion and new functionality of Tripal, an open source software package for building community genomic and biological websites and databases. Broader Impacts: This work establishes exciting new cyberinfrastructure resources for biological science communities that opens new data analysis opportunities for scientists through faster and more powerful online resources. Products: papers [90-92], software products: BDSS v1.0.1b2 [93]; Tripal v3 alpha [94]; blend4php [95]; Docker Images with Tripal and Galaxy [96, 97] ; Tripal elastic search [98], NGS data Galaxy workflows [99].

C. Kwit, no prior NSF support over the past five years.

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77. Senatore, G.L., E.A. Alexander, P.H. Adler, and J.K. Moulton, *Molecular systematics of the Simulium jenningsi species group (Diptera: Simuliidae), with three new fast-evolving nuclear genes for phylogenetic inference.* Molecular Phylogenetics and Evolution, 2014. **75**: p. 138-148.
78. Sinclair, B.J., *Rediscovered at last: a new enigmatic genus of Axymyiidae (Diptera) from western North America.* Zootaxa, 2013. **3682**(1): p. 143.
79. Sinclair, B.J., *A New Species of Afrothaumalea Stuckenberg, 1960 (Diptera: Thaumaleidae) from the Western Cape (South Africa) and First Description of the Pupa of this Genus.* African Invertebrates, 2015. **56**(1): p. 161-166.
80. Sinclair, B.J. and H. Huerta, *A new species of Androprosopa from Mexico (Diptera: Thaumaleidae).* The Canadian Entomologist, 2010. **142**(05): p. 443-447.
81. Swanson, D.A. and W.L. Grogan, *A New Predaceous Midge in Brachypogon (Brachypogon) from Alabama and Florida, U.S.A. and New Distibution Records for Brachypogon woodruffi Spinelli and Grogan (Diptera: Ceratopogonidae).* Proceedings of the Entomological Society of Washington, 2011. **113**(4): p. 531-540.
82. Swanson, D.A. and W.K. Reeves, *New records of biting midges (Diptera: Ceratopogonidae) from Guam Island, USA.* Check List, 2016. **7**(3): p. 313.
83. Teles, C.B.G., R.A. Freitas, A.F.J. De Oliveira, G.M. Ogawa, E.A.C. De AraÚJo, J.F. Medeiros, F.A.C. Pessoa, and L.M.A. Camargo, *Description of a new phlebotomine species (Diptera: Psychodidae, Phlebotominae) and new records of sand flies from the State of Acre, northern Brazil.* Zootaxa, 2013. **3609**(1).

84. Wihlm, M.W. and G.W. Courtney, *The Distribution and Life History of Axymyia furcata McAtee (Diptera: Axymyiidae), a Wood Inhabiting, Semi-Aquatic Fly.* Proceedings of the Entomological Society of Washington, 2011. **113**(3): p. 385-398.
85. Wihlm, M.W., R.B. Sam, and G.W. Courtney, *Morphology of Axymyia furcata (Diptera: Axymyiidae), including scanning electron microscopy of all life stages.* The Canadian Entomologist, 2012. **144**(02): p. 273-290.
86. Wipfler, B., G.W. Courtney, D.A. Craig, and R.G. Beutel, *First μ-CT-based 3D reconstruction of a dipteran larva-the head morphology of protanyderus (tanyderidae) and its phylogenetic implications.* Journal of Morphology, 2012. **273**(9): p. 968-980.
87. Farnsworth, E.J., M. Chu, W.J. Kress, A.K. Neill, J.H. Best, J. Pickering, R.D. Stevenson, G.W. Courtney, J.K. VanDyk, and A.M. Ellison, *Next-generation field guides.* BioScience, 2013. **63**(11): p. 891-899.
88. Huang, Y.T., P.H. Adler, and H. Takaoka, *Polytene chromosomes of Simulium arakawae, a pest species in the Simulium venustum group (Diptera: Simuliidae) from Japan.* Tropical biomedicine, 2011. **28**(2): p. 376-381.
89. Curler, G.R. and J.K. Moulton, *Descriptions of three new species of Psychodidae (Diptera) from the southeastern United States.* Zootaxa, 2010. **2524**: p. 51-62.
90. Mills, N., F. Feltus, and W. Ligon, *Maximizing the Performance of Scientific Data Transfer by Optimizing the Interface Between Parallel File Systems and Advanced Research Networks.* Future Generation Computer Systems, 2016. **Preprint**.
91. Watts, N.A. and F.A. Feltus, *Big Data Smart Socket (BDSS): a system that abstracts data transfer habits from end users.* Bioinformatics, 2016.
92. Wytko, C., B. Soto, and S.P. Ficklin, *blend4php: a PHP API for galaxy.* Database-the Journal of Biological Databases and Curation, 2017.
93. Watts, N. and A. Feltus, *BDSS*. 2017.
94. Developers, *Tripal.* 2017.
95. Soto, B. and S. Ficklin, *blend4php*. 2017.
96. Chen, M. and M. Staton, *Tripal Docker.* 2017.
97. Chen, M. and M. Staton, *Tripal Galaxy Workflows.* 2017.
98. Chen, M. and M. Staton, *Tripal Elasticsearch Module*. 2017.
99. Cheng, M. and M. Staton, *Docker Galaxy dibbs*. 2017.

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Professional Preparation:

Harvard University	Cambridge, MA	Biology	B.A. 2001
University of California, Davis	Davis, CA	Population Biology	Ph.D. 2008

Appointments:

2015-present	Associate Professor, Department of Ecology and Evolution University of Tennessee, Knoxville TN
2009-2015	Assistant Professor, Department of Ecology and Evolution University of Tennessee, Knoxville TN
2007-2009	Postdoctoral Fellow, National Evolutionary Synthesis Center

Five Products Most Relevant to Proposal:

1. Beaulieu, J. M. and B. C. **O'Meara** (2015). "Extinction can be estimated from moderately sized molecular phylogenies". *Evolution* 69.4, pp. 1036-1043.
2. **O'Meara, B.C.** 2012. Evolutionary inferences from phylogenies: A review of methods. Annual Review of Ecology, Evolution, and Systematics. 43(1)
3. Beaulieu, J. M., D.-C. Jhwueng, C. Boettiger, and **B. C. O'Meara**. 2012. Modeling Stabilizing Selection: Expanding The Ornstein-Uhlenbeck Model Of Adaptive Evolution. Evolution 66: 2369-2383.
4. **O'Meara**, B. C. and J. M. Beaulieu (2016). "Past, future, and present of state-dependent models of diversification". In: *American Journal of Botany*. 10.3732/ajb.1600012.
5. **O'Meara, B.C.,** C. Ané, M.J. Sanderson, and P.C. Wainwright. 2006. Testing for different rates of continuous trait evolution using likelihood. Evolution 60: 922-933.

Five Other Signification Products:

1. Smith, S.A., and **B.C. O'Meara**. 2009. Morphogenera, monophyly, and macroevolution. PNAS: 106:E97-E98
2. Stotzfus, A, **B.C. O'Meara,** J. Whitacre, R. Mounce, E. Gillespie, S. Kumar, D. Rosauer, R. Vos. 2012. Sharing and re-use of phylogenetic trees (and associated data) to facilitate synthesis. BMC Research Notes 5(1): 574
3. Smith, S.A. and **B.C. O'Meara**. 2012. "treePL: Divergence time estimation using penalized likelihood for large phylogenies. Bioinformatics.
4. **O'Meara, B. C**. 2010. New Heuristic Methods for Joint Species Delimitation and Species Tree Inference. Systematic Biology 59:59-73.
5. Driskell, A. C., C. Ané, J. G. Burleigh, M. M. McMahon, **B. C. O'Meara**, and M. J. Sanderson. 2004. Phylogenetic utility of large sequence databases for building the tree of life. Science 306: 1172-1174

Synergistic Activities:

1. Darwin Day Tennessee advisor
2. Curator of Phylogenetics task view for R
3. Organizer in Women in Science activities for Society of Systematic Biologists & at UT Knoxville
4. Organizer of multiple hackathons
5. Associate director for the National Institute for Mathematical and Biological Synthesis (NIMBioS)

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Professional Preparation:

University of Michigan	Ann Arbor, MI	Botany	B.Sc. 1977
University of Chicago	Chicago, IL	Evolutionary Biology	M.Sc. 1982
University of Chicago	Chicago, IL	Evolutionary Biology	Ph.D. 1985

Appointments:

2015-present	Professor and Head, Department of Ecology & Evolutionary Biology, University of Tennessee, Knoxville
2001-2015	Professor, Department of Biological Sciences, University of Pittsburgh
2009-2010	Program Director, DEB, National Science Foundation
1995-2001	Associate Professor, Department of Biological Sciences, University of Pittsburgh
1993-1995	Associate Professor Department of Botany and Plant Pathology & Kellogg Biological Station, Michigan State University
1987-1993	Assistant Professor Department of Botany and Plant Pathology & Kellogg Biological Station, Michigan State University
1985-1987	Research Assistant Professor Kellogg Biological Station, Michigan State University

Five Products Most Relevant to Proposal:

1. Kalisz, S., R.B. Spigler and C.C. Horvitz. 2014 In a long-term experimental demography study, excluding ungulates reversed invader's explosive population growth rate and restored natives. PNAS: doi/10.1073/pnas.1310121111
2. Hale A.N., L. Lapointe and S. Kalisz. 2016. Invader disruption of a mycorrhizal-plant mutualism reduces carbon acquisition, allocation and growth in a native forest herb. New Phytologist. 10.1111/nph.13709.
3. Heckle, C.D. and S. Kalisz. 2016. Life history trait divergence among populations of a non-palatable species reveals strong non-trophic indirect effects of an abundant herbivore. Oikos Doi: 10.1111/oik.03658
4. N.L. Brouwer, A.N. Hale and S. Kalisz. 2015. Invader disruption of a belowground mutualism drives carbon starvation and vital rate declines in a native forest perennial herb. AoB Plants. doi: 10.1093/aobpla/plv014
5. Cantor*, A., J. Aaron*, A. Hale, B. Traw, and S. Kalisz. 2011. Low allelochemical concentrations detected in garlic mustard-invaded forest soils inhibit fungal growth and AMF spore germination. Biological Invasions: doi: 10.1007/s10530-011-9986-x

Five Other Signification Products:

1. Hale, A.N. and S. Kalisz. 2012. Perspectives on allelopathic disruption of plant mutualisms: An exploration of potential mechanisms and consequences. Plant Ecology 213: 1991-2006, Special Issue: Invited review. (doi: 10.1007/s11258-012-0128-z).
2. Burke, D.J., M.N. Weintraub, C.R. Hewins* and S. Kalisz. 2011. Relationship between soil enzyme activities, nutrient cycling and soil fungal communities in a northern hardwood forest. Soil Biology and Biochemistry 43: 795-803.
3. Heckle, C.D., N.A. Bourg, W.J. McShea and S. Kalisz. 2010. Non-consumptive effects of a generalist ungulate herbivore drive decline of unpalatable forest herbs. Ecology 91: 319–326. doi:10.1890/09-0628.
4. Hale, A.N., S.J. Tonsor, and S. Kalisz. 2011. Testing the mutualism disruption hypothesis: a physiological mechanism for invasion of intact perennial plant communities. Ecosphere 2:110. doi:10.1890/ES11-00136.1.
5. Knight, T.M., H. Caswell, and S. Kalisz. 2009. Population growth rate of a common understory herb decreases non-linearly across a gradient of deer herbivory. Forest Ecology and Management 257:1095-1103.

Synergistic Activities:

1. Outreach: Since 2009, I have presented 12 lectures to the public and/or applied audiences including Sleeping Bear and Indiana Dunes National Parks, national, state and local officials regarding deer, forest health, and invasive species management. Publications from this LTREB project were highlighted in 10 popular press articles including Nature News, & radio spots, including 64 public radio stations in the northeast US and Canada.

   I served as the Science Advisor on the development of "Virtual Trillium Trail" game software. This is an interactive K-12 educational tool for exploring biological diversity in the eastern deciduous forest. The virtual forest is built on my database derived from long-term field data at Trillium Trail in Fox Chapel, PA, which is the site of the Kalisz lab's NSF funded long-term research. The game is freely distributed to teachers and other education professionals for classroom use and fits the State of Pennsylvania STEM guidelines for middle school students. Maria Harrington PhD, software developer. Website: virtualtrilliumtrail.com
2. Public-science interface: Our research is a powerful example of public-scientist partnership for research and knowledge exchange. The Fox Chapel Borough allows the Kalisz lab to conduct research at Trillium Trail and provides some logistical support. Kalisz functions as an advisor to the Fox Chapel Borough government regarding stewardship, management and conservation of their land holdings. Kalisz regularly attend FCB council meeting, and members of the Kalisz lab write pieces highlighting our research at Trillium Trail for the Borough's newspaper.
3. Science Community Service: I served as Editor for The American Naturalist (2012-2015) and as a member of the Botanical Society of America Merit Awards Committee 2011-2014.

   I co-led a NESCent Working Group (Nov 2013-Dec 2015) entitled "Linking self-fertilization, dispersal and distribution traits of species: Is Baker's law an exception to the rule?"

   I serve as a member of the NSF Microevolutionary Molecular & Organismic Research in Plant History (microMORPH): Research Coordination Network Steering Committee 2010-2014.

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Professional Preparation:

University of Wisconsin-Madison	Madison, WI	Wildlife Ecology	B.S. 1992
Louisiana State University	Baton Rouge, LA	Plant Biology	Ph.D. 2000
University of Florida	Gainesville, FL	Ecology	Postdoc 2000-2003
University of Georgia	Athens, GA	Ecology	Postdoc 2003-2005

Appointments:

2013-present	Assistant Professor, The University of Tennessee
2011-2013	Research Assistant Professor, The University of Tennessee
2009-2011	Research Scientist, The University of Tennessee
2008-2009	Assistant Professor, Wittenberg University
2005-2008	Visiting Assistant Professor, Miami University
2005-present	Adjunct Assistant Professor, Miami University, Department of Botany
2002-present	Clemson University, Department of Forestry and Natural Resources

Five Products Most Relevant to Proposal:

*undergraduate student, **graduate student, ***postdoctoral fellow

1. Connell, R.K.*, A.A. Pfennigwerth, A.T. Classen, and **C. Kwit**. 2016. Incorporating redispersal microsites into myrmecochory in eastern North American forests. Ecosphere 7: e01456.
2. Nageswara-Rao, M.***, M. Hanson*, S. Agarwal, C.N. Stewart, and **C. Kwit**. 2014. Genetic diversity analysis of switchgrass (Panicum virgatum L.) populations using microsatellites and chloroplast sequences. Agroforestry Systems 88: 823-834.
3. Nageswara-Rao, M.***, **C. Kwit**, S. Agarwal, M.T. Patton*, J.A. Skeen*, R.M. Manshardt, J.S. Yuan, and C.N. Stewart. 2013. Sensitivity of real-time PCR for the detection of transgenic papaya (Carica papaya L.) seeds. BMC Biotechnology 13:69.
4. Larkin, C.C.**, **C. Kwit**, J.M. Wunderle, Jr., E.H. Helmer, M.H.H. Stevens, M.T.K. Roberts*, and D.N. Ewert. 2012. Disturbance type and plant successional communities in Bahamian dry forests. Biotropica 44: 10-18.
5. **Kwit, C**., G. J. Marcello, J. Laboy Gonzalez*, A.C. Shapiro*, and R.D. Bracken*. 2012. Advantages of seed dispersal for a myrmecochorous temperate forest herb. American Midland Naturalist 168: 9-17.

Five Other Signification Products:

1. **Kwit, C.**, M. Swanson, D. King, and B. Collins. 2014. Conservation importance of early post-disturbance temperate forests. (Special Section Preface). Forest Ecology and Management 324: 158-159.

2. Greenberg, C.H., D.J. Levey, **C. Kwit**, J.P. McCarty, S.F. Pearson, S. Sargent, and J. Kilgo. 2012. Long-term patterns of fruit production in five forest types of the South Carolina Upper Coastal Plain. Journal of Wildlife Management 76: 1036-1046.
3. **Kwit, C.**, H.S. Moon, S.I. Warwick, and C.N. Stewart. 2011. Transgene introgression in crop relatives: molecular evidence and mitigation strategies. *Trends in Biotechnology* 29: 284-293.
4. **Kwit, C.**, D.J. Levey, and C.H. Greenberg. 2004. Contagious seed dispersal beneath heterospecific fruiting trees and its consequences. Oikos 107: 303-308.
5. **Kwit, C.**, C.C. Horvitz, and W.J. Platt. 2004. Conserving slow-growing, long-lived species: input from the demography of a rare understory conifer, *Taxus floridana*. *Conservation Biology* 18: 432-443.

Synergistic Activities:

1. Faculty advisor, University of Tennessee's Naturalist Club, 2015-present
2. Faculty mentor, University of Virginia's Mountain Lake Biological Station REU Program, 2015
3. Guest editor, Forest Ecology and Management Special Issue: Conservation importance of early post-disturbance temperate forests. 2013-2014
4. Board of Editors, Ecosphere, 2010-2016
5. Teach: University of Tennessee, 'Plant-animal Interactions,' 'Wildlife Vegetation and Habitat,' 'Introductory Botany,' 'Rare Species Management'

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Professional Preparation:

Clemson University	Clemson, SC	Entomology	B.S.	1989
Clemson University	Clemson, SC	Entomology	M.S.	1992
The University of Arizona	Tucson, AZ	Entomology	Ph.D.	1997
The University of Arizona	Tucson, AZ	Entomology	Postdoc	1997–2001
North Carolina State University	Raleigh, NC	Molecular Systematics	Postdoc	2010

Appointments:

2009-present	Associate Professor, The University of Tennessee
2003-2009	Assistant Professor, The University of Tennessee
2001-2002	Postdoctoral Research Associate, NC State University
1997-2001	Extension Associate, The University of Arizona
1992-1997	Graduate Research Assistant, The University of Arizona
1990-1992	Graduate Research Assistant, Clemson University

Five Products Most Relevant to Proposal:

1. Pivar, R.J., **J.K. Moulton**, B.J. Sinclair. 2016. A new species of Austrothaumalea Tonnoir from Australia (Diptera: Thaumaleidae). Zootaxa 4132(4): 594–597.
2. Curler, G.R., **J.K. Moulton** and R.I. Madriz 2015. Redescription of *Aposycorax chilensis* (Tonnoir) (Diptera, Psychodidae, Sycoracinae) with the first identification of a blood meal host for the species. *Zootaxa* 4048 (1): 114–126.
3. Greenwalt, D.E., **J.K. Moulton**. 2016. The first fossil New World Dixidae with a critical discussion of generic definitions. *Palaeontologia Electronica* 19.3.55A: 1–32.
4. **Moulton, J.K.** 2016. The *Dixa inextricata* Dyar & Shannon (Diptera: Dixidae) species group, with two new cryptic species from the eastern Nearctic Region. *Zootaxa* 4121(4): 458–472.
5. **Moulton, J.K.** 2017. The true identity of *Dixa modesta* Johannsen (Diptera: Dixidae) resolved: synonymy of *Dixa similis* Johannsen, designation of the *Dixa ubiquita* species group, and description of three new eastern Nearctic species. *Zootaxa* 4216 (3): 247–260.

Five Other Signification Products:

1. Curler, G.R., **J.K. Moulton**. 2012. A review of Nearctic *Clytocerus* (Diptera, Psychodidae, Psychodinae). *Canadian Entomologist* 144: 186–195.
2. Curler, G.R. and **J.K. Moulton**, 2008. A review of the Nearctic species of the genus *Eurygarka* Quate (Diptera: Psychodidae). *Zootaxa* 1740: 28–36.
3. Winkler, I.S., J.D. Blaschke, D.J. Davis, J.O. Stireman, J.E. O'Hara, P Cerretti, **J.K. Moulton**. 2015. Explosive radiation or uninformative genes? Origin and early diversification of tachinid flies (Diptera: Tachinidae). *Molecular Phylogenetics and Evolution* 88*:* 38–54.

4. Senatore, G.L., E.A. Alexander, P.H. Adler, **J.K. Moulton**. 2014. Molecular systematics of the *Simulium jenningsi* species group (Diptera: Simuliidae), with three new fast-evolving nuclear genes for phylogenetic inference. *Molecular Phylogenetics and Evolution* 75: 138–48.
5. Smith, C, **J.K. Moulton**, E.C. Bernard. 2015. Multiple invasions of the Nearctic Region by the springtail *Orchesella cincta* (Entomobryidae). *The Great Lakes Entomologist* 48(3–4): 103–110.

Synergistic Activities:

1. Editorial Work. Subject Editor (Diptera): Zootaxa (2006–2012) and (2015–present)
2. *Ad Hoc* Reviewer of manuscripts in 7 international journals
3. Co-organizer of symposium at 63nd Annual Meeting of the Entomological Society of America. 11/2016
4. Co-organizer of symposum at 25th International Congress of Entomology, 9/2016

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Professional Preparation:

Clemson University	Clemson, SC	Computer Science	B.S. 2003
Clemson University	Clemson, SC	Plant and Environmental Science	Ph.D. 2007

Appointments:

2014-present: Assistant Professor, Department of Entomology and Plant Pathology
Adjunct Appointment in Genome Science and Technology Program
University of Tennessee
2007-2014: Bioinformatics Research Scientist at Clemson University Genomics Institute

Five Products Most Relevant to Proposal:

1. **Staton** M*, Zhebentyayeva T, Olukolu B, Fang GC, Nelson D, Carlson JE, Abbott A. (2015) Substantial genome synteny preservation among woody angiosperm species: comparative genomics of Chinese chestnut (*Castanea mollissima*) and plant reference genomes. BMC Genomics 16:744. *corresponding author
2. **Staton** M*, Best T, Khodewkar S, Owusu S, Xu T, Yu Y, Jennings T, Cronn R, Arumuganathan AK, Coggeshall M, Gailing O, Liang H, Romero-Severson J, Schlarbaum S, Carlson JE. Genomic characterization of ten hardwood tree species from multiplexed low coverage whole genome sequencing. PLOS One 10(12):e0145031. *corresponding author
3. Lane T, Best T, Zembower N, Davitt J, Henry N, Xu Y, Koch J, Liang H, McGraw J, Schuster S, Shim D, Coggeshall M, Carlson J, **Staton** M. (2016). The green ash transcriptome and identification of genes responding to abiotic and biotic stresses. BMC Genomics. 17:702.
4. Ficklin SP, Sanderson LA, Cheng CH, **Staton ME**, Lee T, Cho IH, Jung S, Bett KE, Main D. 2011 Tripal: a construction toolkit for online genome databases. Database bar044.
5. Wegrzyn JL, Main D, Figuero B, Choi I, Yu J, Neale, DB, Jung S, **Staton** M, Zheng P, lee T, Ficklin S, Cho I, peace C, Evans K, Volk G, Oraguzie N, Chen C, Gmitter FG, and AG Abbot. 2012. Uniform Standards for Genome Databases in Forest and Fruit Trees. Tree Genetics and Genomes. 8(3):549-557.

Five Other Signification Products:

1. Rambani A, Rice JH, Liu J, Lane T, Ranjan P, Mazarei M, Pantalone V, Stewart CN, **Staton** M, Hewezi T. (2015) The methylome of soybean roots during the compatible interaction with the soybean cyst nematode, *Heterodera glycines*. Plant Physiology 168(4):1364-77.
2. Liang H, **Staton** M, Xu Y, Xu T, Leboldus J. 2014. Comparative expression analysis of resistant and susceptible *Populus* clones inoculated with *Septoria musiva*. Plant Sci. 223:69-78.
3. Khodwekar S, **Staton** M, Coggeshall MV, Carlson JE, Gailing O. 2015. Nuclear microsatellite markers for population genetic studies in sugar maple (*Acer saccharum*

Marsh.). Annals of Forest Research, [S.l.], p. 1-12, apr. 2015. ISSN 20652445. doi:10.15287/afr.2015.360.
4. Zhang X, Carlson A, Tian Z, **Staton** M, Schlarbaum SE, Carlson JE, Liang H. 2015 Genetic characterization of *Liriodendron* seed orchards with EST-SSR markers. Journal of Plant Science & Molecular Breeding. 4 (1), doi: 10.7243/2050-2389-4-1
5. Chen CC, Xu Y, Xu T, **Staton** M, Stott G, Bukles O, Schlarbaum SE, Carlson JE, Liang H. 2015 Diversity level of genomic microsatellites in redbay (*Persea borbonia* L.) generated by Illumina sequencing. Journal of Plant Science & Molecular Breeding. 4 (2), doi: 10.7243/2050-2389-4-2

Synergistic Activities:

1. Software Carpentry and Data Carpentry Instructor. Each summer offers a 2-day training workshops for learners of all ages, backgrounds and prior experience to develop computational skills including Linux command line, writing code, and contributing to open source software projects.
2. RNASeq workshop instructor. Each summer offers a 2-day training workshop open to all University of Tennessee-affiliated students, staff and faculty to learn about processing RNASeq data using our local high performance cluster and state of the art open source software.
3. Instructor for 3 hour graduate credit course, Bioinformatic Applications (Entomology and Plant Pathology 622). Fundamental bioinformatics concepts, principles and techniques with a focus on the application of bioinformatics to problems in agriculture. Laboratory practical is taught within a LINUX computational environment where students gain basic skills in bash and python scripting and construction open source-software based workflows to analyze genomic data.
4. Co-PI for grant, "Abiotic stress response and adaptive phenology in fruit and forest trees" (1008660) funded by USDA NIFA and headed by Albert Abbott (University of Kentucky). This research seeks to decipher the molecular links between cold stress response and control of the endodormancy-ecodormancy transition. PI Staton is responsible for RNASeq and metabolite data, including quality filtering and using statistical methodology to identify genes and metabolites differentially expressed between tree genotypes bred for various climatic zones.
5. Co-PI for grant, "CIF21 DIBBS: Tripal Gateway, a Platform for Next-Generation Data Analysis and Sharing" (1443040) funded by the NSF and headed by Stephen Ficklin (Washington State University). Tripal (http://tripal.sourceforge.net/) is a custom open source framework that integrates the content management system Drupal and the GMOD standard molecular biology database schema, chado. This grant will develop and implement new functionality for the Hardwood Genomics Web, including ability for users to build and execute Galaxy workflows.

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Professional Preparation:

University of Pittsburgh	Pittsburgh, PA	Physics/Astronomy	BS	1994
University of North Carolina	Wilmington, NC	Science Education	MAT	1998
North Carolina State University	Raleigh, NC	Science Education	PhD	2001
University of North Carolina	Wilmington, NC	Chemistry Education	Postdoc	2001-2003

Appointments:

2004–Present	Managing Member and Lead Consultant, East Main Evaluation & Consulting, LLC. Wilmington, NC
2003-2004	Secondary Science Facilitator, University of North Carolina. Chapel Hill, NC. North Carolina Partnership for the Improvement of Mathematics and Science
2001-2003	Visiting Assistant Research Professor, Chemistry Department, University of North Carolina at Wilmington
1995-1997	Science Teacher, Planetarium Assistant Director, South Robeson High School, Public Schools of Robeson County. Rowland, NC..

Five Products Most Relevant to Proposal:

1. Heath, B.P., & Freeman, C.M. (2015). Pathway: Guiding Complex Efforts from Inception to Achievement. Poster presentation at the Science of Team Science (SciTS) 2015 Conference. National Institutes of Health. June 3-5, 2015.
2. C. Ferner, B. Wilkinson, B. Heath, "Toward using higher-level abstractions to teach Parallel Computing", in the proceedings of the *Third NSF/TCPP Workshop on Parallel and Distributed Computing Education (EduPar-13)*, held in conjunction with *the 27th IEEE International Parallel & Distributed Procession Symposium (IPDPS 2013)*, Boston, MA, May 20, 2013.
3. Davis, L., Heath, B.P., & Lakshmanan, A. (2012, October). Deploying a multivariate methodology for evaluating professional develoment programs. Paper presented at the American Evaluation Association Annual Confernece. October 22 - 27, 2012. Minneapolis, MN.
4. Lakshmanan, A., Heath, B.P., Elder, M., & Perlmutter, A. (2011) The impact of science content and professional learning communities on science teaching efficacy and standards-based instruction. Journal of Research in Science Teaching. 48(5), 5-11.
5. Heath, B.P., Lakshmanan, A., Perlmutter, A., & Davis, L.B. (2010). Measuring the impact of professional development on science teaching: A review of survey, observation, and interview protocols. International Journal of Research & Method in Education. 33(1), 3-20.

Five Other Signification Products:

1. Heath, B.P., Lakshmanan, A., Freeman, C.M. (2013). The Systems-Highlights-Patterns (SHP) Framework: A New Framework for the Evaluation of Complex Projects.

Demonstration presented at the American Evaluation Association Annual Conference. October 14-19, 2013. Washington, D.C.

2. Heath, B.P., & Lakshmanan, A. (2012, October). iPlant as Example: Promoting discussion of the relationship between systems and strategy evaluation. Roundtable presented at the American Evaluation Association Annual Conference. October 22 - 27, 2012. Minneapolis, MN.
3. Heath, B.P. (2010). Using system concepts to evaluate the iPlant Collaborative: Quality, implications, and benefits. Paper presented at the American Evaluation Association Annual Conference. November 10-13, 2010. San Antonio, TX.

Synergistic Activities:

1. Developer, Pathway: A process to guide complex efforts from inception to achievement. 2013-present.
2. Grantor, The EMEC, LLC Scholarship in Science and Mathematics at UNCW. 2013-present.
3. Grantor, NC Regional Science Fair Special Award for Excellence. 2017.
4. Coach, Science Olympiad, 2013-present.

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Tennessee Knoxville

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Brian C O'Meara

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Brian C O'Meara - PI**	0.00	0.00	0.50	**5,833**	
2. **Charles Kwit - Co-PI**	0.00	0.00	1.00	**8,900**	
3. **Margaret Staton - Co-PI**	1.00	0.00	0.00	**7,130**	
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**3**) TOTAL SENIOR PERSONNEL (1 - 6)	1.00	0.00	1.50	**21,863**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**2**) OTHER				**31,969**	
TOTAL SALARIES AND WAGES (A + B)				**53,832**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**16,602**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**70,434**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**6,915**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **136,000**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **62,060**					
TOTAL NUMBER OF PARTICIPANTS (**4**) TOTAL PARTICIPANT COSTS				**198,060**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**72,000**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**72,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**347,409**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC - UTIA (Rate: 44.0000, Base: 21053) (Cont. on Comments Page)**					
TOTAL INDIRECT COSTS (F&A)				**74,694**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**422,103**	
K. SMALL BUSINESS FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**422,103**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Brian C O'Meara

ORG. REP. NAME*
Stacey Wade

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 1

**** I- Indirect Costs**
MTDC - UTK (Rate: 51.0000, Base 128296)

SUMMARY PROPOSAL BUDGET

YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Tennessee Knoxville

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Brian C O'Meara

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Brian C O'Meara - PI**	0.00	0.00	0.50	**6,008**	
2. **Charles Kwit - Co-PI**	0.00	0.00	1.00	**9,167**	
3. **Margaret Staton - Co-PI**	1.00	0.00	0.00	**7,343**	
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**3**) TOTAL SENIOR PERSONNEL (1 - 6)	1.00	0.00	1.50	**22,518**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**2**) OTHER				**32,928**	
TOTAL SALARIES AND WAGES (A + B)				**55,446**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**17,100**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**72,546**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**5,877**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **312,120**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **148,015**					
TOTAL NUMBER OF PARTICIPANTS (**9**) TOTAL PARTICIPANT COSTS				**460,135**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**72,000**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**72,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**610,558**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC - UTIA (Rate: 44.0000, Base: 23639) (Cont. on Comments Page)**					
TOTAL INDIRECT COSTS (F&A)				**75,061**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**685,619**	
K. SMALL BUSINESS FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**685,619**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Brian C O'Meara

ORG. REP. NAME*
Stacey Wade

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Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 2

**** I- Indirect Costs**
MTDC - UTK (Rate: 51.0000, Base 126784)

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Tennessee Knoxville

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Brian C O'Meara

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Brian C O'Meara - PI**	0.00	0.00	0.50	**6,189**	
2. **Charles Kwit - Co-PI**	0.00	0.00	1.00	**10,387**	
3. **Margaret Staton - Co-PI**	1.00	0.00	0.00	**8,320**	
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**3**) TOTAL SENIOR PERSONNEL (1 - 6)	1.00	0.00	1.50	**24,896**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**2**) OTHER				**33,916**	
TOTAL SALARIES AND WAGES (A + B)				**58,812**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**18,147**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**76,959**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**5,877**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **318,364**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **156,896**					
TOTAL NUMBER OF PARTICIPANTS (**9**) TOTAL PARTICIPANT COSTS				**475,260**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**72,000**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**72,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**630,096**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC - UTIA (Rate: 44.0000, Base: 24569) (Cont. on Comments Page)**					
TOTAL INDIRECT COSTS (F&A)				**77,246**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**707,342**	
K. SMALL BUSINESS FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**707,342**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Brian C O'Meara

ORG. REP. NAME*
Stacey Wade

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 3

**** I- Indirect Costs**
MTDC - UTK (Rate: 51.0000, Base 130267)

SUMMARY PROPOSAL BUDGET

YEAR 4

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Tennessee Knoxville

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Brian C O'Meara

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Brian C O'Meara - PI**	0.00	0.00	0.50	**6,374**	
2. **Charles Kwit - Co-PI**	0.00	0.00	1.00	**10,698**	
3. **Margaret Staton - Co-PI**	1.00	0.00	0.00	**8,570**	
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**3**) TOTAL SENIOR PERSONNEL (1 - 6)	1.00	0.00	1.50	**25,642**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**2**) OTHER				**34,934**	
TOTAL SALARIES AND WAGES (A + B)				**60,576**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**18,691**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**79,267**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**5,877**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **288,649**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **147,831**					
TOTAL NUMBER OF PARTICIPANTS (**8**) TOTAL PARTICIPANT COSTS				**436,480**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**72,000**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**72,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**593,624**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC - UTIA (Rate: 44.0000, Base: 27262) (Cont. on Comments Page)**					
TOTAL INDIRECT COSTS (F&A)				**78,235**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**671,859**	
K. SMALL BUSINESS FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**671,859**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Brian C O'Meara

ORG. REP. NAME*
Stacey Wade

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 4

**** I- Indirect Costs**
MTDC - UTK (Rate: 51.0000, Base 129882)

SUMMARY PROPOSAL BUDGET

YEAR 5

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Tennessee Knoxville

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Brian C O'Meara

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Brian C O'Meara - PI**	0.00	0.00	0.50	**6,566**	
2. **Charles Kwit - Co-PI**	0.00	0.00	1.00	**11,019**	
3. **Margaret Staton - Co-PI**	1.00	0.00	0.00	**8,827**	
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**3**) TOTAL SENIOR PERSONNEL (1 - 6)	1.00	0.00	1.50	**26,412**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**2**) OTHER				**35,981**	
TOTAL SALARIES AND WAGES (A + B)				**62,393**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**19,252**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**81,645**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**3,921**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **147,212**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **78,350**					
TOTAL NUMBER OF PARTICIPANTS (**4**) TOTAL PARTICIPANT COSTS				**225,562**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**72,000**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**72,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**383,128**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC - UTIA (Rate: 44.0000, Base: 26065) (Cont. on Comments Page)**					
TOTAL INDIRECT COSTS (F&A)				**78,535**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**461,663**	
K. SMALL BUSINESS FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**461,663**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Brian C O'Meara

ORG. REP. NAME*
Stacey Wade

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 5

**** I- Indirect Costs**
MTDC - UTK (Rate: 51.0000, Base 131501)

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Tennessee Knoxville**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Brian C O'Meara**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Brian C O'Meara - PI**	0.00	0.00	2.50	**30,970**	
2. **Charles Kwit - Co-PI**	0.00	0.00	5.00	**50,171**	
3. **Margaret Staton - Co-PI**	5.00	0.00	0.00	**40,190**	
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**3**) TOTAL SENIOR PERSONNEL (1 - 6)	5.00	0.00	7.50	**121,331**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**10**) OTHER				**169,728**	
TOTAL SALARIES AND WAGES (A + B)				**291,059**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**89,792**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**380,851**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)				**28,467**	
2. INTERNATIONAL				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **1,202,345**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **593,152**					
TOTAL NUMBER OF PARTICIPANTS (**34**) TOTAL PARTICIPANT COSTS				**1,795,497**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**360,000**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**360,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**2,564,815**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**383,771**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**2,948,586**	
K. SMALL BUSINESS FEE				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**2,948,586**	

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Brian C O'Meara**

ORG. REP. NAME*: **Stacey Wade**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Budget Justification
The University of Tennessee

Senior Personnel:

PI Dr. Brian O'Meara will oversee the project. We request salary calculated at half a summer month per year ($30,970 total).

Co-PI Margaret Staton will plan, organize and teach in skills workshops, as well as identify curricular holes that will need to be filled with new courses and facilitate the organization and teaching of those courses. We request salary calculated at 1 calendar month per year ($40,190 total).

Co-PI Charles Kwit will serve on the Leadership team for the program and will be the key contact person for students and external members of the program. We request salary calculated at 1summer month per year ($50,171 total).

Other Personnel:

For the project coordinator, we request salary of $30,000 per year ($159,274).

Dr. Mark Littmann will do a workshop in communications, requiring four days of time per year ($10,454 total).

All salaries include a 3% annual salary increase. Dr. Staton and Dr. Kwit both include a 10% increase in Year 3 for tenure.

Fringe Benefits:

Fringe benefits are based on each member's actual fringe benefits. Fringe benefits for PI O'Meara are calculated at 19% of salary ($5,885); Co-PI Staton are calculated at 36% of salary ($14,468); Co-PI Kwit are calculated at 27.6% of salary ($13,847); and Dr. Littman are calculated at 29% of salary ($3,032). For the project coordinator, fringe benefits are estimated at 33% ($52,560 total).

Travel:

The travel budget includes trips for the PI to meet with NSF at an orientation meeting (year 1), travel to the SACNAS conference (years 1-4), and at a regular NRT meeting (years 1-5).

Purpose of Travel	Depart From	Destination (if known)	No. of Days	No. of Travelers	Conference Reg. Fees	Airfare	Lodging (per night)	Per Diem	Total
Domestic Travel									
Meet with sponsor (Years 1-5)	Knoxville	Washington DC	3	3	$0	$500	$200	$69	$3,921
Orientation Meeting with Sponsor (Year 1)	Knoxville	Washington DC	2	1	$0	$500	$200	$69	$1,038
Conference travel (Years 1-4)	Knoxville	TBD	4	1	$400	$600	$175	$64	$1,956

Participant Support Costs:

A total of 17 students will be recruited to participate for 2 years each (34 student-years).

Student stipends in year 1 will be $34,000 and includes an increase of 2% per year ($1,202,345 total). Tuition is calculated in year 1 at $13,658 per student and includes an increase of 6% per year ($522,154 total). Health insurance is calculated in year 1 at $1,857 per year includes an increase of 6% per year ($70,998 total).

Other Direct Costs:

East Main Consulting, LLC, the external assessor for the grant, bases its cost on the size of the grant and the amount of work required. Given the substantial assessment and follow-up planned for this grant their cost is 12% of the overall grant size, thus $360,000.

Indirect Costs (F&A):

Indirect costs are calculated at 44% MTDC - the University's federally-audited rate for on-campus research under UTIA AgResearch. Total amount of indirect costs is $53,938.

Indirect costs are calculated at 51% MTDC – the University's federally-audited rate for on-campus research under the University of Tennessee, Knoxville. Total amount of indirect costs is $329,833.

Participant support costs are excluded from the calculations.

Total Direct and Indirect Costs:

The total direct and indirect costs requested for the project period is $2,948,586.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Brian O'Meara	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: DISSERTATION RESEARCH: Morphological consequences of trophic evolution

Source of Support: NSF

Total Award Amount: $ 19,630 Total Award Period Covered: 07/01/17 - 06/30/19

Location of Project: The University of Tennessee, Knoxville

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Population genetics-based codon models

Source of Support: NSF

Total Award Amount: $ 520,000 Total Award Period Covered: 09/14/14 - 09/15/17

Location of Project: The University of Tennessee, Knoxville

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 1.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative Research: Phylogeographic inference using approximated likelihoods

Source of Support: NSF

Total Award Amount: $ 34,000 Total Award Period Covered: 03/01/13 - 12/31/16

Location of Project: The University of Tennessee, Knoxville

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 1.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative research: ABI Development: An open infrastructure to disseminate phylogenetic knowledge

Source of Support: NSF

Total Award Amount: $ 148,101 Total Award Period Covered: 07/01/15 - 07/01/18

Location of Project: The University of Tennessee, Knoxville

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.50

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: CAREER: Reducing barriers for comparative methods

Source of Support: NSF

Total Award Amount: $ 738,298 Total Award Period Covered: 08/01/15 - 07/31/20

Location of Project: The University of Tennessee, Knoxville

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Summ: 1.00

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Brian O’Meara

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: NRT: Next-Generation Biodiversity Training

Source of Support: NSF
Total Award Amount: $ 2,948,586 Total Award Period Covered: 09/01/17 - 08/31/22
Location of Project: The University of Tennessee
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Susan Kalisz	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: LTREB RENEWAL: The population dynamics of forest understory invasion: mechanistic experiments with generalist herbivores, natives, and invaders

Source of Support: NSF

Total Award Amount: $ 620,383 Total Award Period Covered: 06/01/15 - 05/30/20

Location of Project: Pennsylvania

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 1.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Dissertation Research: Selection, niche breadth and mating system evolution: Are wider niche breadths of selfing species shaped by water limitation?

Source of Support: NSF

Total Award Amount: $ 19,630 Total Award Period Covered: 05/01/17 - 04/30/19

Location of Project: The University of Tennessee, Knoxville

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Preliminary Proposal: Testing a novel plant invasion hypothesis: Aboveground food web structure alters in-vader plant-soil feedback

Source of Support: NSF

Total Award Amount: $ 0 Total Award Period Covered: 01/01/00 - 01/01/00

Location of Project: The University of Tennessee, Knoxville

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Preliminary Proposal: Collaborative Research: Testing the equivalency of pathways to the selfing syndrome using experimental evolution and transcriptomics

Source of Support: NSF

Total Award Amount: $ 0 Total Award Period Covered: 01/01/00 - 01/01/00

Location of Project: The University of Tennessee, Knoxville

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: NRT: Next-Generation Biodiversity Training

Source of Support: NSF

Total Award Amount: $ 2,948,586 Total Award Period Covered: 09/01/17 - 08/31/22

Location of Project: The University of Tennessee

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Summ: 0.00

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Charles Kwit	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Multi-scale Assessment of Wildlife Sustainability in Switchgrass Biofuel Feedstock Production in the Eastern US

Source of Support: USDA AFRI Sustainable Bioenergy

Total Award Amount: $ 498,366 Total Award Period Covered: 01/15/13 - 01/14/17

Location of Project: Tennessee, Kansas, Pennsylvania

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Effectiveness of Joint Fuel Treatments and Vegetation Management in Restoring Eastern Upland Oak Savannas

Source of Support: DOI-BLM Joint Fire Sci. Pgm.

Total Award Amount: $ 241,530 Total Award Period Covered: 09/20/13 - 08/30/17

Location of Project: Tennessee, North Carolina, Kentucky

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Redirecting Directed Dispersal: Incorporating Disperser Seed Treatment in an Ant Seed Dispersal System

Source of Support: NSF DEB Pop & Comm Ecol

Total Award Amount: $ 376,106 Total Award Period Covered: 05/01/17 - 04/30/20

Location of Project: Tennessee, Virginia

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: NRT: Next-Generation Biodiversity Training

Source of Support: NSF

Total Award Amount: $ 2,948,586 Total Award Period Covered: 09/01/17 - 08/31/22

Location of Project: The University of Tennessee

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 1.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: John Moulton	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: The Sequatchie Caddisfly, Glyphopsyche sequatchie (Trichoptera: Limnephilidae): Bionomics, Genetic Diversity, and Gene Flow

Source of Support: USFWS

Total Award Amount: $ 45,071 Total Award Period Covered: 08/01/14 - 07/31/17

Location of Project: The University of Tennessee, Institute of Agriculture

Person-Months Per Year Committed to the Project. Cal: 2.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Preproposal: Phylogenetics, evolution, and classification of the meniscus midges (Dixidae), an understudied, quasi-orphaned group of mosquito-like lower Diptera

Source of Support: NSF-DEB

Total Award Amount: $ 0 Total Award Period Covered: 01/01/00 - 01/01/00

Location of Project: The University of Tennessee, Knoxville

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Preproposal: Testing phylogenetic relationships of net-winged midges (Diptera: Blephariceridae) at taxonomic levels

Source of Support: NSF-NRT

Total Award Amount: $ 0 Total Award Period Covered: 01/01/00 - 01/01/00

Location of Project: ISU/UTK

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: NRT: Next-Generation Biodiversity Training

Source of Support: NSF

Total Award Amount: $ 2,948,586 Total Award Period Covered: 09/01/17 - 08/31/22

Location of Project: The University of Tennessee

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Margaret Staton	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: ABR-PG Standards and CyberInfrastructure That Enable "Big-Data" Driven Discovery For Tree Crop Research

Source of Support: NSF Plant Genome Research Program
Total Award Amount: $ 623,586 Total Award Period Covered: 07/15/16 - 07/14/19
Location of Project: The University of Tennessee, Institute of Agriculture
Person-Months Per Year Committed to the Project. Cal: 1.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Comparative Genomics of Rabbiteye Blueberry

Source of Support: USDA ARS
Total Award Amount: $ 170,000 Total Award Period Covered: 08/01/15 - 07/31/20
Location of Project: The University of Tennessee, Institute of Agriculture
Person-Months Per Year Committed to the Project. Cal: 1.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Genomics of Woody Ornamentals

Source of Support: USDA ARS
Total Award Amount: $ 125,000 Total Award Period Covered: 08/01/16 - 07/31/21
Location of Project: The University of Tennessee, Institute of Agriculture
Person-Months Per Year Committed to the Project. Cal: 0.50 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: CIF2 DIBBS: Tripal Gateway, a platform for next-generation data analysis and sharing

Source of Support: NSF Data Infrastructure Building Blocks Program
Total Award Amount: $ 94,632 Total Award Period Covered: 01/01/15 - 12/31/17
Location of Project: The University of Tennessee, Institute of Agriculture
Person-Months Per Year Committed to the Project. Cal: 1.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Abiotic stress response and adaptive phenology in fruit trees

Source of Support: USDA NIFA Foundational Program
Total Award Amount: $ 82,672 Total Award Period Covered: 12/01/15 - 11/30/18
Location of Project: The University of Tennessee, Institute of Agriculture
Person-Months Per Year Committed to the Project. Cal: 1.00 Acad: 0.00 Summ: 0.00

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Margaret Staton	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Identification of genes and alleles for blight resistance in Castanea spp.

Source of Support: USDA NIFA Foundational Program

Total Award Amount: $ 10,999 Total Award Period Covered: 10/01/15 - 09/30/17

Location of Project: The University of Tennessee, Institute of Agriculture

Person-Months Per Year Committed to the Project. Cal: 1.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: NRSP010: Database Resources for Crop Genomics, Genetics and Breeding Research

Source of Support: USDA National Institute of Food and Agriculture Multi-State

Total Award Amount: $ 0 Total Award Period Covered: 10/01/14 - 09/30/19

Location of Project: The University of Tennessee, Institute of Agriculture

Person-Months Per Year Committed to the Project. Cal: 0.50 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Exploring the role of soil bacteria in the health of soybeans through manipulation of strigolactones

Source of Support: Tennessee Soybean Promotion Council

Total Award Amount: $ 10,000 Total Award Period Covered: 01/01/00 - 01/01/00

Location of Project: The University of Tennessee, Institute of Agriculture

Person-Months Per Year Committed to the Project. Cal: 0.50 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative Research: ABI Innovation: Enabling association mapping and landscape genomics through the advanced integration of genotype, phenotype, and geospatial data

Source of Support: NSF Advances in Biological Informatics Program

Total Award Amount: $ 236,880 Total Award Period Covered: 01/01/00 - 01/01/00

Location of Project: The University of Tennessee, Institute of Agriculture

Person-Months Per Year Committed to the Project. Cal: 0.50 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Rocky Mountain Spotted Fever and environmental, host and microbial factors in tick vectors

Source of Support: NIH

Total Award Amount: $ 1,439,281 Total Award Period Covered: 01/01/00 - 01/01/00

Location of Project: The University of Tennessee, Institute of Agriculture

Person-Months Per Year Committed to the Project. Cal: 0.62 Acad: 0.00 Summ: 0.00

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Margaret Staton	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: NRT: Next-Generation Biodiversity Training

Source of Support: NSF

Total Award Amount: $ 2,948,586 Total Award Period Covered: 09/01/17 - 08/31/22

Location of Project: The University of Tennessee

Person-Months Per Year Committed to the Project. Cal: 1.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Preliminary proposal: Population dynamics and diversity of bacteriophages of US Alfisols

Source of Support: NSF Division of Environmental Biology

Total Award Amount: $ 0 Total Award Period Covered: 01/01/00 - 01/01/00

Location of Project: The University of Tennessee, Institute of Agriculture

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Barbara Heath

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: NRT: Next-Generation Biodiversity Training

Source of Support: NSF
Total Award Amount: $ 2,948,586 Total Award Period Covered: 09/01/17 - 08/31/22
Location of Project: The University of Tennessee
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Facilities

University of Tennessee, Knoxville: The EEB department has office space and equipment for the Program Coordinator. Students coming to EEB through an NRT award will be allocated offices in shared student spaces and conduct reseach in their advisor's lab space. Research facilities in EEB/Division of Biology are state-of-the-art and include high performance computing clusters, a genomics core facility (including Sanger sequencing, SNP/fragment analysis, and Next Generation DNA Sequencing using Illumina's MiSeq platform), the Advanced Microscopy and Imaging Center (including Optical, Transmission Electron, Scanning Electron, Focused Ion Beam, and Atomic Force Microscopy), HPLC and total carbon analyzers, reseach greenhouse and growth chamber facilities associated with Hesler and Senter Halls, a field station in the Smoky Mountains, and research boats. Currenly, EEB, NIMBioS, the College of Arts and Sciences, and Dept of Geography are creating a new Spatial Analysis Lab that will feature an unmanned aerial system (a drone) with multispectral and LiDAR capabilities, a terrestrial laser scanner, key software, and more.

EEB is home to two significant research collections. The nationally-recognized University of Tennessee Herbarium (TENN) resides in EEB and houses over 600,000 accessioned specimens of vascular plants (ferns, cone-bearing, and flowering plants), bryophytes (mosses and liverworts), and fungi (including lichens). Our collection is the primary repository of the native and naturalized plants and fungi of Tennessee. It is the largest collection from the southern Appalachians and has a strong emphasis on the eastern US, Mexico, and Central America. The Etnier Ichthyological Collection houses over 450,000 specimens of fishes. The collection is the primary repository of the native fishes of Tennessee and houses the most important collection in the world of fishes from the southern Appalachians, and has a strong emphasis on collections from the eastern U. S., Mexico, and Central America.

University of Tennessee Institute of Agriculture (UTIA): The FWF and EPP departments will offer students office and laboratory space. Students will have access to a number of UTIA facilities. The 1500 square-foot UTIA Genomics Hub, located in the Plant Biotechnology Building, houses equipment needed for DNA isolation, amplification, and purifications. The UTIA Genomics Hub has computers with software that can assemble data (de novo and template) from Illumina and other NGS platforms. The University of TN Insect Museum is a regional repository of chiefly voucher and other non-primary type specimens that are representative of the southeastern U.S. and, more particularly, the Appalachian fauna. The UTIA Greenhouses comprise three large, state-of-the-art greenhouse facilities on the UTIA campus. A total of 22,000 square feet is dedicated to growing space. The UTIA greenhouse space is designed for the containment of pathogens, has an automated watering system and a Priva environmental system for temperature and light control. The greenhouse is maintained using only biological control agents as pesticides. EPP's microscope facility contains modern microscopy capabilities. In addition, UTIA has 10 research and education centers located across the state of Tennessee, ranging from managed forests to agricultural fields.

Data Management Plan

This project will generate three kinds of data: 1) assessment data on the students and the training, 2) materials generated for teaching in workshops, and 3) data generated in the course of research by grant participants.

Assessment Data

The external evaluator, Principal Investigator, and Project Coordinator will meet early in the first year of the grant to establish a written plan for assessment data protocols, including compliance with the policies of the Institutional Review Board (IRB) at the University of Tennessee, Knoxville. The Project Coordinator will receive training regarding student data and research data management policies.

Assessment Instruments. All data collection instruments will be saved in commonly used formats (Word, PDF, Excel) to facilitate ease of use among team members. Instruments will additionally be publicly shared to facilitate reuse in the manner described for research data (below).

Digital Assessment Data. Assesssment data will be collected confidentially with permission from the participants and stored securely with the external evaluator (EMEC). Assessment data will be saved in commonly used formats (Word, PDF, Excel) to facilitate ease of use among team members. The external evaluator will share the data with the PI and program coordinator, and the data will be stored on a password protected computer in secure location under the control of the lead PI with additional long term archival storage in Office 365 OneDrive. This cloud based storage solution is offered by UTK in partnership with Microsoft, and features include: up to 1Tb per faculty member; secure transfer of data; group sharing within UTK; encryption of data at rest, on the server side and in transit; and certification for storage of HIPAA/PHI, FERPA and PII data.

Paper Assessment Data. Any data collected via pen and paper and consent forms will be stored in a locked cabinet of the Project Coordinator.

Teaching materials

Teaching materials will be distributed during or immediately after instruction under the open access Creative Commons 0 (CC0) license allowing for educational reuse. Materials will be available via dedicated training websites but also deposited on GitHub, with citable DOIs provided by Zenodo. As best practices change, we will adapt to ensure the materials are reusable and available without any registration or login barriers. Teaching materials will include slides, exercises, notes and videos. Staton and O'Meara have a significant record of doing this already using the GitHub platform.

Research data

All team members (faculty, staff and students) will take the CITI training in Responsible Conduct of Research. Research data will be placed in appropriate repositories for each kind of data at the time of publication. Possible research products:

- Genetic data will be deposited in NCBI's GenBank or Sequence Read Archive, which maintains long-term storage and free reuse.
- Phylogenetic trees will be placed in both the TreeBase and Open Tree of Life repositories under a Creative Commons Zero (CC0) license allowing free reuse.

- GIS data will be pushed to the Global Biodiversity Information Facility (GBIF), also under a CC0 license. The only exception would be for species of conservation concern where disclosure of locations could lead to their targeting by collectors or other bad actors.
- Research software created will be published via GitHub and language-specific repositories (such as CRAN for the R language) under an open source license.
- Specimen vouchers will be deposited in appropriate repositories. For example, primary types of any new insect species described would go to either the United States National Museum (Smithsonian) or the preferred repository of the agency that issued the collecting permit. Non-type insect specimens would be placed in the University of Tennessee Insect Museum and other important collections as deemed appropriate by the research leader. Ethanol-preserved specimens suitable for DNA analysis and DNA vouchers would be stored in the PI's laboratories but will be made available to interested researchers upon request. Plant specimens will be obtained and submitted as vouchers to either the University of Tennessee Herbarium or to an appropriate national herbarium. All deposited plant specimens will be digitized; all collections from the southeastern U.S. and all relevant metadata will be provided to the Southern Regional Network of Expertise and Collections (SERNEC).

In addition to the specialized types of data above, data for all publications resulting from this grant will be available via Dryad, a journal and society-sponsored repository that maintains data long term and allows its citation and reuse. All data deposited on Dryad are CC0 licensed.

THE UNIVERSITY OF
TENNESSEE
KNOXVILLE

Feb. 6, 2017

National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Selection Committee:

The University of Tennessee (UT) is pleased to provide the institutional support to enable the success of a novel graduate training program, "NRT: Next-Generation Biodiversity Training." UT has worked with NSF on two successful IGERTs: SCALE-IT (focused on scalable computing) and STAIR (focused on sustainable energy). We seek to build on that expertise, along with an NIH-funded graduate traineeship program, Program for Excellence and Equity in Research, which has been funded for 10 years.

This NRT proposal, led by Dr. Brian O'Meara, brings together two UT campuses, UT Knoxville and the UT Institute of Agriculture, to present a cross-disciplinary approach that will leverage resources while enhancing students' capabilities and job readiness. By focusing on students whose career aspirations focus on biodiversity but look outside academia, I believe this traineeship program will enhance our university's ability to serve the workforce needs of the future.

As Tennessee's flagship, research-intensive university, UT is engaged in an ever-growing research portfolio, reaching nearly $174 million in fiscal year 2016. Increasingly, the future of research depends on a broad, interdisciplinary network between our researchers and beyond. Programs such as this NRT, which contribute greatly to the research enterprise, help to bring graduate students into this paradigm at UT.

During the grant period, UT will support the research training program by providing the needed laboratory and office space for students, access to travel funds, and assistance with publication

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527 Andy Holt Tower Knoxville, TN 37996-0184
865-974-3265 *fax* 865-974-4811 chancellor@utk.edu

costs. Our department heads represent the three distinct disciplines: Ecology and Evolutionary Biology; Entomology and Plant Pathology; and Forestry, Wildlife and Fisheries, which have collaborated in this novel approach to training the next generation of biodiversity researchers.

Following the grant period, these three departments will build upon the internship network created by this NRT initiative and continue to encourage students to pursue such opportunities. The University of Tennessee, Knoxville will provide out of state graduate tuition for each of four traineeships for a four year period after the federal award period to support program sustainability. This support is estimated to total approximately $308,216. Stipends for these traineeships will be covered by the relevant department of the trainee recipient. Stipend support over the four year period is estimated to total approximately $618,880.

In addition, by building upon a stronger relationship with the UT Graduate School and the UT Center for Career Development, a more diverse set of students in the biological sciences will have access to broader career choices in the biological sciences. We expect a lasting cultural change to result within the three departments, as well, leading to an expectation of more diverse career placements.

Such achievements are aligned perfectly with UT's VolVision 2020, our strategic plan that seeks to increase the quality of education, develop research strengths, and expand our contribution to economic development.

Thank you for the opportunity to reflect UT's commitment to this NSF National Research Traineeship program. If further information is needed, please contact the Office of Sponsored Programs at osp@utk.edu or 865-974-3466.

Sincerely,

Jimmy G. Cheek
Chancellor

THE UNIVERSITY OF
TENNESSEE
KNOXVILLE

Feb. 3, 2017

National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

To whom it may concern:

On behalf of the UT College of Arts and Sciences, I offer my support for the interdisciplinary research traineeship program for graduate students in biodiversity, "NRT: Next-Generation Biodiversity Training."

This NRT program will create a novel approach to graduate student training by focusing on the skills needed for careers outside of academia. Our college enjoys strong relationships with many corporations, non-government agencies, and non-profit agencies that seek students with advanced science degrees. The College of Arts and Sciences will support the NRT's team of faculty who will collaborate on interdisciplinary research projects, innovative curriculum delivery, and external internships. For example, we look forward to involving this NRT's graduate students in our annual Darwin Day, which shares scientific knowledge with our local community. In addition, I will work directly with the PI, Brian O'Meara, to identify administrative changes that will be required for this shifting paradigm toward broader career options.

As our college works to fulfill the university's mission toward diversity, we will also engage this team of NRT researchers in our annual recruitment efforts to ensure students from all walks of life have the opportunity to compete for these prestigious and effective traineeship opportunities.

Thank you for this opportunity.

Sincerely,

Charles Collins
Associate Dean for Academic Programs

College of Arts and Sciences
1403 Circle Drive
Knoxville, TN 37996-1330
865-974-5332 865-974-4352 fax artsci.utk.edu

COLLEGE OF AGRICULTURAL SCIENCES & NATURAL RESOURCES

Office of the Dean
126 Morgan Hall
2621 Morgan Circle
Knoxville, TN 37996-4500
phone: 865-974-7493
fax: 865-974-9329
www.casnr.utk.edu

Feb. 3, 2017

National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

To Whom It May Concern:

On behalf of the UT College of Agricultural Sciences and Natural Resources (CASNR), I offer my support for the interdisciplinary research traineeship program for graduate students in biodiversity, "NRT: Next-Generation Biodiversity Training."

This NRT program will create a novel approach to graduate student training by focusing on the skills needed for careers outside of academia. Our college has placed students in internships at many corporations, non-government agencies, and non-profit agencies that seek students with advanced science degrees. We look forward to extending this access to students who seek careers in the area of biodiversity. CASNR will support the NRT's team of faculty who will collaborate on interdisciplinary research projects, innovative curriculum delivery, and external internships.

For example, we look forward to involving this NRT's graduate students in our annual Agriculture Day, a popular event on a football Saturday that showcases the many programs and research projects at the UT Institute of Agriculture (UTIA). In addition, our college staff will work directly with the PI, Brian O'Meara, the UT Center for Career Services, and other parties as needed to collect and assess employment data of the students in the program and their employers. The project will be useful to us as it should help us develop long-term best practices to help build the workforce of the future.

Through its mission of research, teaching and extension, UTIA provides real-life solutions. As our college works to bring a diverse population of graduate students to biodiversity research, we will also engage this team of NRT researchers in our annual recruitment efforts to ensure students from all walks of life have the opportunity to compete for these prestigious and effective traineeship opportunities.

Thank you for this opportunity.

Sincerely,

John C. Stier
Associate Dean
College of Agricultural Sciences and Natural Resources
University of Tennessee, Knoxville
126 Morgan Hall, 2621 Morgan Circle
Knoxville, Tennessee 37996-4500
jstier@utk.edu

THE UNIVERSITY OF
TENNESSEE
KNOXVILLE

3 February 2017

National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear NRT Program Directors:

If the proposal submitted by Prof. Brian O'Meara titled, "NRT: Next-Generation Biodiversity Training" is selected for funding, the Department of Ecology and Evolutionary Biology (EEB) will provide support by providing office and laboratory space, access to travel funds, and assistance with publication costs. In addition, we will work closely with the UT Graduate School to recruit top students into this graduate research traineeship program and with the UT Center for Career Development to help students identify desirable career options. EEB will also collaborate with the NRT team to encourage and coordinate NRT trainees' involvement in outreach during our annual Darwin Day events, a weeklong set of activities that seeks to inform the public about evolution and its importance as a unifying concept in all of biology. Finally, EEB will fund one seminar per semester where the invited speaker will be from one of the NRT's partner government, non-government or business affiliates. All NRT related students and faculty will be encouraged to attend these seminars.

Thank you for this opportunity.

Sincerely,

Susan Kalisz

Professor and Department Head
Ecology and Evolutionary Biology Department
1416 Circle Drive
569 Dabney Hall
University of Tennessee, Knoxville
Knoxville, Tennessee 37996
865-974-3065 telephone
skalisz@utk.edu

UTIA INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

Feb. 3, 2017

National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear NRT Program Directors:

We enthusiastically support the proposal submitted by Prof. Brian O'Meara titled, "NRT: Next-Generation Biodiversity Training". If the proposal is funded, the two departments in the UT Institute of Agriculture (UTIA), the Entomology and Plant Pathology Department and the Forestry, Wildlife, and Fisheries Department, will participate fully in implementing the proposed program and in training biodiversity graduate students. Both of us commit to providing biodiversity program students in our respective departments with office and laboratory space, access to travel funds, and assistance with publication costs. In addition, we will work closely with the UT Graduate School to recruit top quality students into this graduate research traineeship program and with the UT Center for Career Development to help our students identify desirable career options and internship opportunities. Finally, we will collaborate with the NRT team to encourage and coordinate NRT trainees' involvement in our annual Ag Day, a popular event on a home football Saturday that highlights the many endeavors underway at UTIA.

Thank you for this opportunity.

Sincerely,

Dr. Dewayne Shoemaker, Department Head
Entomology and Plant Pathology
College of Agricultural Sciences and Natural Resources

Dr. Keith Belli, Department Head
Forestry, Wildlife, and Fisheries
College of Agricultural Sciences and Natural Resources

THE UNIVERSITY OF
TENNESSEE
KNOXVILLE

Feb. 3, 2017

National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear NRT Program Directors:

If the proposal submitted by Prof. Brian O'Meara titled, "NRT: Next-Generation Biodiversity Training" is selected for funding, it is my intent to collaborate by providing workshops on diversity and mentoring to NRT faculty, by helping NRT trainees access a broad range of decentralized graduate student training opportunities available on campus, and by working closely with the NRT PI and Project Coordinator to recruit from the broadest possible population of students, with special attention given to students from underrepresented populations. This includes taking NRT faculty along on some of our recruitment trips throughout the Southeast US.

Sincerely,

Ernest L. Brothers

Ernest L. Brothers, PhD
Associate Dean, The Graduate School
Associate Director for Diversity Enhancement,
National Institute for Mathematical & Biological Synthesis, NIMBioS

The Graduate School
111 Student Services Building 1331 Circle Park Drive Knoxville, TN 37996-0211
office 865-974-2475 *fax* 865-946-1090 http://gradschool.utk.edu

TENNESSEE WILDLIFE RESOURCES AGENCY

ELLINGTON AGRICULTURAL CENTER
P. O. BOX 40747
NASHVILLE, TENNESSEE 37204

Feb. 2, 2017

National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear NRT Program Directors:

If the proposal submitted by Prof. Brian O'Meara titled, "NRT: Next-Generation Biodiversity Training" is selected for funding, it is my intent to collaborate by logistically supporting one or more of the NRT trainees as an intern. I see this as an amazing concept that will assist us with projects we never seem to be able to tackle and provide real-world training and education for high achieving students.

Sincerely,

Bill

Bill Reeves
Chief of Biodiversity
Tennessee Wildlife Resources Agency
P.O. Box 40747
Nashville, TN 37204

The Nature Conservancy
Protecting nature. Preserving life.™

210 25th Ave N
Suite 810
Nashville, TN 37203

Tel (615) 383-9909
Fax (615) 383-9717

nature.org/tennessee

Feb. 3, 2017

National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear NRT Program Directors:

If the proposal submitted by Prof. Brian O'Meara titled, "NRT: Next-Generation Biodiversity Training" is selected for funding, it is my intent to collaborate by logistically supporting the NRT trainee internship program.

Sincerely,

Sally Palmer
Director of Science
The Nature Conservancy, Tennessee

Feb. 3, 2017

National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear NRT Program Directors:

If the proposal submitted by Prof. Brian O'Meara titled, "NRT: Next-Generation Biodiversity Training" is selected for funding, it is my intent to collaborate by logistically supporting one or more of the NRT trainees as an intern.

Sincerely,

Todd P. Witcher
Executive Director
Discover Life in America
1316 Cherokee Orchard Road
Gatlinburg, TN 37738
865-430-4757 (Business)
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todd@dlia.org
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