MICHIGAN STATE
UNIVERSITY

December 18, 2013

Fred Poston, Dean
Agriculture & Natural Resources
Morrill Hall of Agriculture
446 W. Circle Dr., Room 102

Re: Academic Program Review
18-Month Status Update

Dear Fred,

It has been 18 months or more since Dean Buhler met with Provost Wilcox to discuss the self-study and proposed action plan for the programs below. As you might know, the development of the action plan is the final phase of the Academic Program Review process.

Agriculture, Food, and Resource Economics
Kellogg Biological Station

Please provide a brief (no more than one page) summary of the status of the action plan for the programs above by addressing the following questions:

1. During this time, how has the action plan developed?
2. What is your assessment of the unit's progress and how are you supporting continued improvements?

Please submit your summaries for the programs electronically to Julie Harrison, harris24@msu.edu by Friday, January 17, 2014. If there are issues or concerns you would like to discuss, please feel free to schedule a time to meet with me.

Sincerely,

June Youatt
Acting Provost and
Executive Vice President for Academic Affairs

OFFICE OF THE
PROVOST

Michigan State University
Hannah Administration Building
426 Auditorium Road, Room 430
East Lansing, Michigan 48824

Phone: 517-355-6550
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c: John D. Gaboury, Associate Provost for Academic Services
Kelly Funk, Director of Assessment, Academic Program Review, and Accreditation

MICHIGAN STATE
UNIVERSITY

13 January 2013

Dean Fred Poston
College of Agriculture and Natural Resources
102 Morrill Hall of Agriculture

RE: Update on the Kellogg Biological Station Academic Program Review (18 month)

Dear Dean Poston:

I am happy to provide you with this update on the Kellogg Biological Station and what we have done – and are planning to do – to develop an Action Plan as a followup to the Academic Review. I have focused here on the three issues that were included in the Provost's response to the APR and included for each what we have done, measures of success and constraints. I apologize if this is not all that you need to prepare your report to the Provost, but I had only a week to prepare this as I am traveling.

1) *The strategies to broad participation of underrepresented groups seem to be focused on groups external to MSU. How might KBS engage underrepresented groups present at MSU?*

W.K. Kellogg Biological Station

3700 E. Gull Lake Dr.
Hickory Corners, MI 49060

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Fax: 269-671-2351
kbs.msu.edu

Progress to date: We have expanded opportunities for MSU students from under-represented groups to come to KBS as part of our efforts to enhance opportunities for all MSU students (see #3). This has included expansion of the Undergraduate Research Apprentice (URA) and summer internship opportunities programs at KBS, both of which target MSU students from under-represented groups. These programs complement the KBS REU (Research Experiences for Undergraduate) which (because of funder goals) is primarily focused on recruiting non-MSU students. Our specific activities to increase awareness of KBS programs to these students have included:

- Strengthening our relationship with the CNS DREW Program
- Working with BEACON to recruit SROP students to KBS summer programs
- Meeting with chairs, undergraduate advisors and Associate Deans in CANR and CNS to make them aware of KBS programs and coordinating efforts to increase recruitment of students from under-represented groups to majors in the colleges.

Evidence of success/progress - MSU students made up 7% of the applicant pool and 90% of the students selected for the 2013 URA program (from an applicant pool of >400). Approximately 40% of the MSU students selected for the URA program were from under-represented groups. Importantly, the KBS Academic Programs Coordinator is maintaining contacts with the MSU students who come to KBS for URA or summer field courses and working to connect them with research opportunities on campus and REU opportunities at other institutions. He is also the primary point of contact for KBS with diversity programs in CNS, CANR and BEACON.

Constraint – Our efforts to recruit MSU student to KBS, particularly those from under-represented groups depends on maintaining support for the KBS Academic Programs

Coordinator position. This position is currently supported by funding from grants and discretionary funds from the KBS Director, as a 50% time research associate, which is not sustainable. *Having recurring funding for this position (Academic Specialist) is need both to continue this trajectory of success and also to complete formal evaluations of our programs to determine which are most successful.*

2) KBS has developed partnerships with several other colleges on campus. Do opportunities exist to expand partnerships to more colleges

Progress to date and evidence of success: KBS continues to pursue research collaborations with faculty on the main campus, including those from departments outside of CNS and CANR. Recent examples include two new awards from NSF since the review involving faculty from Engineering and Social Sciences and a pending proposal to the NSF-NIH jointly funded program in Emerging Infectious Diseases, involving faculty from CANR, CNS and the Veterinary Medicine.

Awards since review:

- NSF, Coupled Natural and Human Systems Program (CNH): "A Social-Ecological Analysis of Nitrogen in Agricultural Systems of the Upper Midwest" ($1,462,073) D **Stuart** (SOC and KBS), lead PI with GP **Robertson** (KBS-PSM), B **Basso** (GLG-KBS), Zhao (Econ-ESPP) and ST Marquart-Pyatt (SOC).
- NSF Cyber-enabled sustainability science and engineering [CyberSEES]: Towards sustainable aquatic ecosystems: a new adaptive sampling and data-enabled monitoring and modeling framework ($800,000), **Litchman co-PI** with X. Tan (PI – Electrical & Computer Engineering), P. Mantha (Civil & Env Engineering), H. Radha (Electrical & Computer Engineering), G. Xing (Comp Sci & Engineering).

Pending:

- NSF-NIH Emerging Infectious Diseases: "Landscape dependent wildlife-livestock interactions and transmission dynamics of enteric pathogens in complex agro-ecosystems" ($2,477,957) K Scribner (PI, FW-ZOL), **S Utsumi** (KBS-ANS), B Maurer (FW), K Frank (Counseling, Educational Psychology and Special Education), S Manning (MMG), J Funk (Large Animal Clinical Sciences), J Owen (FWand Large Animal Clinical Sciences), J Moore (Grand Valley State University)
- USDA-AFRI Improving Feed Conversion Efficiency of Midwestern and Northeastern Pasture-Based Dairy Farms through Real Time Measurements of Enteric Carbon Emissions. ($498,930). PI **Utsumi** (KBS-ANS), co-PIs B Andre (U New Hampshire), D. Beede (ANS), K Soder(Penn State)

We are also developing research collaborations with faculty in the College of Education (specifically, Dept. of Teacher Education and CREATE4STEM) to explore the impact of field research and educational experiences (at KBS) on the training and performance of pre-service and in-service teachers. Proposals to initiate this work and provide pilot data for future external funding will be submitted to CREATE4 STEM and BEACON this spring. We are also exploring with the WK Kellogg Foundation opportunities to enhance facilities at the Kellogg Bird Sanctuary so that we can create a "Learning Laboratory" for research in science education at KBS. We are also committed to developing new collaborations in conjunction with the MSU "Water Initiative", particularly those that will

expand the research in sustainable agricultural practices for row crops (LTER and GLBRC) and animal/dairy production (KBS Pasture Dairy Research Center).

Constraint – The distance between KBS and main campus continues to be a constraint on developing new collaborations; although the growing use of video conferencing (available at KBS, but more limited on campus) is increasing the ease of scheduling meetings and promoting discussions that are critical to the development of new initiatives. *The recent decision to move the current KBS campus office to a dead end hallway in Giltner Hall is likely to decrease opportunities of collaborations with campus faculty as on-campus meetings with collaborators will be more difficult to arrange (see also below)*

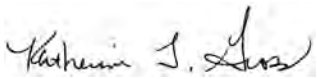
3) To what extent are the undergraduate research experiences offered by KBS utilized by MSU students?

Progress to date: The KBS Academic Programs Coordinator has increased our involvement with and connections to undergraduate advisors in CANR and CNS, including advisors in Plant Biology, Zoology, Fisheries and Wildlife and Forestry. We have also worked with chairs of FW and FOR, to offer courses that meet the needs of students majoring in these fields. We also have recruited FW faculty to teach at KBS. We see this as important to developing stronger linkage between the KBS and FW programs to engage undergraduates in research experiences.

Constraint - *As noted above the recent decision to move the current KBS campus from a central location near the main entrance of Giltner Hall (near the EEBB office) to a dead end hallway in this building will seriously reduce the visibility of KBS programs to prospective undergraduates. Also the lack of sustained recurring funding to support the Academic Programs Coordinator position will limit our ability to continue to both recruit MSU students to KBS and foster the relationships with campus departments (and advisors) to promote KBS experiences for MSU undergraduates.*

I would be happy to meet with you and Dean Kirkpatrick to discuss the progress we have made to date and the plans we are making to continue to address the issues that Provost Wilcox identified above. I would particularly like to meet with you to discuss how the constraints that I mention above might be addressed and a prioritized action plan developed. The KBS faculty are planning a retreat in Fall 2014 to lay out a vision and plan for the future that will guide our efforts in research, education and outreach in the coming 5-10 years.

Sincerely,



Dr. Katherine L. Gross
University Distinguished Professor and
Director, Kellogg Biological Station

Cc: Dean James Kirkpatrick CNS
KBS faculty

Academic Program Review of the W.K. Kellogg Biological Station, Michigan State University (March 2012)

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I. WHAT DO WE DO?

The mission of KBS is focused on research and education in ecology and evolutionary biology and its application to sustainable agriculture and conservation. KBS is jointly administered by the College of Agriculture and Natural Resources (CANR; lead) and the College of Natural Science (CNS), and has 14 year-round resident faculty members appointed in six departments in three colleges: Zoology, Plant Biology, Crop and Soil Sciences, Microbiology and Molecular Genetics, Animal Science, and Sociology.

KBS fulfills many aspects of the land grant mission of the University by integrating research, graduate and undergraduate education, and outreach. The combination of a diverse land base (over 3000 acres that includes a variety of aquatic and terrestrial ecosystems), on-site research and meeting facilities, and a highly collaborative atmosphere promotes excellence in environmental science and fosters advancement of the land grant philosophy. In this report, we summarize academic program accomplishments over the past seven years (2004-2010) and outline our vision and plans for the future.

Undergraduate and graduate programs and instruction

KBS is an academic non-degree granting unit of MSU. All KBS faculty teach on the main campus during the academic year and provide educational programming at KBS throughout the year. Teaching and graduate advising by KBS faculty supports the academic programs of home departments and several interdepartmental graduate programs. KBS faculty members advise graduate students, postdoctoral associates, and visiting scholars (both pre- and post-doctoral). Unlike a campus unit, summers are an important component of the KBS academic program and include research experiences for students of all levels (and from around the world) and teachers. The KBS Research Experience for Undergraduates (REU) program supports 10-12 students per year and is funded by the NSF Long-term Ecological Research (LTER) Program, the DOE Great Lakes Bioenergy Research Center (GLBRC), the NSF BEACON STC, and supplements to faculty grants. In 2010 we initiated an Undergraduate Research Apprentice (URA) program to provide students taking courses at KBS the opportunity to gain research experience with graduate student mentors. We support summer research experiences for K-12 teachers (RET) with funding from NSF LTER and an NSF Math and Science Partnership based in part at KBS; teachers are recruited from our K-12 Partnership (see below) schools. We also support internships that provide professional work experience for students not interested in research experiences. Additionally, since 2009 KBS faculty have participated in the CNS "SpartaNature", a freshmen seminar which brings several hundred incoming freshmen to KBS for an intensive 3-day orientation combined with introductory field and lab research

experiences. SpartaNature is designed to enhance the student experience at MSU and foster student engagement and retention.

Research and scholarship

KBS has long been recognized as supporting world-class research in ecology and evolutionary biology. The current faculty members are recognized as leaders in aquatic ecology, plant ecology and evolutionary biology, microbial ecology, and theoretical ecology (see below). Over the past 20 years, KBS also has established world leadership in agricultural ecology, the fundamental science that underpins sustainable agriculture, and is home to several large agricultural ecology projects. These include the NSF-funded Long-term Ecological Research (LTER) program in row-crop agriculture (since 1989), sustainability research of the DOE-funded Great Lakes Bioenergy Research Center (GLBRC; since 2008), and a pasture-based dairy system established with funding from the W.K. Kellogg Foundation (2008).

Outreach and engagement

Outreach programming at KBS is coordinated by three full-time academic specialists associated with the Bird Sanctuary, the LTER Program, and the Pasture-based Dairy. We have developed a strong K-12 outreach program that supports teachers and students in 13 surrounding rural school districts. The KBS K-12 program has been supported by three NSF grants in collaboration with faculty from the College of Education, including a current GK-12 award that supports nine graduate student fellows.

KBS has historically had a strong focus on public outreach that began with programming at the Kellogg Bird Sanctuary (established in 1926) and Farm (1928). These facilities continue to be an important focus for programs on conservation and sustainable agriculture. Today, outreach programming at KBS includes a tighter linkage to research with a focus on environmental science literacy. The transition of the KBS dairy to a research-based pasture system has provided opportunities for outreach on innovations in agricultural technology and supply chains related to pasture-based animal systems. We have also expanded the outreach program on cropping systems with a focus on global climate change and bioenergy, highlighting research at the KBS LTER. Our "Dessert with Discussion" program provides a unique opportunity for the public to engage informally with MSU faculty to learn more about topical research programs at MSU and KBS.

Service

KBS faculty members contribute to academic governance at all levels of the University and in professional societies. KBS faculty teach most of the core courses for the inter-

departmental graduate program in Ecology, Evolutionary Biology, and Behavior (EEBB), and contribute to the Environmental Science and Policy (ESPP) and Ecological Food and Farming Systems (EFFS) specializations. They also contribute to several cross-departmental centers and initiatives (e.g., GLBRC, Center for Water Sciences, BEACON Science and Technology Center) and serve in leadership positions in professional societies, as editors for leading journals in their fields and on a number of national and international research advisory boards (see below).

II. WHY DO WE DO IT?

Mission, Goals, and Priorities

The mission of KBS is to increase our understanding of natural and managed ecosystems and their linkages to society. This entails three main integrative activities:

- Promote and support multi-disciplinary research in ecology, agriculture, natural resources and the environment, across the continuum of basic to applied research.
- Provide MSU students with inquiry-based educational opportunities in ecology, agriculture, natural resources, and the environment.
- Provide outreach programs that bring KBS expertise to bear on environmental issues of public importance.

We fulfill this mission through:

Research

- Perform and disseminate transformative research within and across the disciplines represented at KBS.
- Promote KBS as a collaboration hub attractive to researchers from MSU and elsewhere.

Graduate Student and Post-doctoral Education

- Provide graduate student and postdoctoral training in groundbreaking research that addresses questions of national and global importance.
- Ensure that graduate students and postdoctoral researchers gain the skills needed to become future leaders in their fields.

Undergraduate Education

- Provide undergraduate students with field-based learning experiences not available on campus.
- Support a summer residential program for students from a broad range of disciplines and majors.
- Broaden participation of students from underserved and underrepresented groups.

Outreach

- Offer outreach activities that use KBS research to engage the public and working professionals such as land managers, teachers, and agency personnel.
- Expand collaborations in education and outreach with campus-based faculty, including the development of cross-cutting and integrative programs.

Roles, Needs and Impacts of KBS

KBS is unique because it is both a field station, with the attendant land base, infrastructure, and a high level of activity during the summer, and an academic unit with year-round resident faculty, staff, postdocs and graduate students. KBS is close enough to campus to allow faculty to teach and participate in campus affairs, but far enough away to create an "off campus" experience for students.

Since its inception, MSU has been a leader in catalyzing research that contributes both to societal needs and to a broader understanding of our world. KBS embodies these dual goals of fundamental and applied research, and provides unique programs that further the MSU mission. The extensive KBS land base with its diversity of habitats provides an unrivaled natural laboratory that, in combination with excellent research infrastructure and long-term experiments, provides outstanding opportunities for research and education.

KBS faculty members have an exceptional record of extramural funding for research, graduate training, and infrastructure. This includes substantial and sustained support for collaborative research in agricultural ecology supported by the NSF-funded LTER program. The track record of successful multi-disciplinary collaborations established with the KBS LTER played a significant role in DOE's funding the GLBRC, in which KBS-based faculty play a leading role in sustainability research. The tradition of research in basic ecology and growing strength in agroecology and sustainability positioned KBS for a W.K. Kellogg Foundation grant to support the recent transition of the Kellogg Dairy to a pasture-based dairy research center. This interdisciplinary project, developed in collaboration with several campus departments, is a key component of new undergraduate and graduate specializations linking sustainable agriculture and food systems.

KBS also fills a unique niche in MSU educational programs. Students at all levels can participate in research that spans a wide range of disciplines, bridging lessons learned in the classroom to the natural laboratory of field sites nearby. This juxtaposition of teaching and research provides a rich, hands-on experience that engages students in "question-driven" learning and research.

III. HOW WELL DO WE DO IT, AND WHO THINKS SO?

Instructional productivity

Class size and instructional models

KBS courses focus on hands-on inquiry in small class sizes, and include a strong field component (**Indicators 7-9**). The relatively short distance from the MSU campus (~65 miles) facilitates opportunities for students and faculty to use KBS for field trips during the academic year. Offering required and specialized courses during the summer affords students the opportunity to enhance their education with a field research experience.

Signature academic programs at KBS include Research Experience for Undergraduates (REU), Undergraduate Research Apprenticeships (URA), Enhancing Linkages between Mathematics and Ecology (ELME), and the "Eminent Ecologist" seminar series. The REU program attracts upper level undergraduates from across the US to work with KBS faculty on independent research. The URA program helps beginning and under-prepared students gain research experiences by combining a mentored research experience and a KBS summer course. Both programs are supported by grants and MSU and KBS scholarship funds. ELME provides graduate (and advanced undergraduate) students from across the nation and world with an intensive introduction to the mathematical tools that are fundamental to ecology and evolution. The "Eminent Ecologist" seminars provide a venue for outstanding ecologists to spend a week in residence at KBS during the summer; to date over 80 ecologists have participated in this program that contributes both to graduate education and the national visibility of KBS as a vibrant research community.

Retention, graduation rates, and time to degree

KBS faculty members have trained top-notch graduate students, with an emphasis on PhD students who go on to faculty positions and research/education jobs in science (**indicators 1, 3, 4**). During the past 7 years (2004-2010), 25 KBS students received PhD degrees and three received MS degrees (only one student did not graduate). Using indicators from the NRC (2010) evaluation, our graduate training program is among the best in the country (Table 1), including the number of PhDs produced per faculty member (**indicator 10**). Most KBS graduates remain in science and 40% of those graduating during this period now hold tenure-track jobs. Ninety-six percent of KBS students published their dissertation research, and on average have 3.6 refereed publications from their PhD work.

KBS has a strong tradition of hosting visiting scholars (**indicators 14, 21**). During the reporting period, we hosted a total of 14 international scholars from top-tier universities in Israel, Japan, Germany, Colombia, Taiwan, China, and Brazil. KBS faculty members

maintain or participate in research programs in South America (Colombia, Ecuador and Peru), Australia, Africa (Malawi), and Asia (Russia).

Table 1: Graduate student training at KBS: 2004-2010. Comparative data compiled from National Research Council, 2010, *A Data-Based Assessment of Research-Doctorate Programs in the United States*.

Graduate Program	Rank*	PhDs per year	Number of Faculty	% students completing PhD within 6 years	% grads in faculty or postdoc positions	% female students	% minority students
KBS	--	**4.17**	**14**	**72.0**	**64.0**	**56.0**	**4.0**
UC Davis—Ecology	1	26.4	109	51.6	61.5	55.2	11.4
Duke—Ecology	2	4.40	25	67.5	78.9	42.9	5.90
Harvard: OEB	2	10.4	33	55.1	83.3	37.6	11.6
Berkeley: IB	2	18.0	55	41.2	58.7	44.6	12.4
Cornell: EEB	14	7.20	41	45.2	81.8	55.0	6.80
Indiana: EEB	2	7.20	36	51.7	76.5	64.4	10.4
UMN: EEB	8	5.00	52	36.4	61.5	53.2	7.10
Illinois: EEB	14	5.20	47	38.5	63.2	43.6	3.20
Iowa St.: EEB	29	2.00	55	23.0	87.5	60.6	3.70
Ohio St.: EEOB	34	6.60	34	50.2	56.5	45.7	3.20

KBS also has a productive postdoctoral training program (**indicator 21**). Since 2004, KBS faculty members have mentored 27 postdocs who were supported by a combination of faculty research grants and competitive fellowships. The success of the KBS faculty in mentoring postdocs is evidenced by publications (49 peer-reviewed publications) and job placement. Over 90% of our former postdocs are employed as scientists in universities, government agencies, or the private sector.

Credit hour productivity

All KBS faculty members teach courses and mentor graduate students (**indicator 6**), but KBS is not a degree-granting program. KBS faculty teaching is done to support campus departments or inter-departmental programs. KBS faculty members primarily teach graduate courses with enrollments of 12-40. However, several teach campus courses with large undergraduate enrollments (60-250; Lennon, Getty, Lau). Courses taught by KBS faculty on campus are integral to both interdepartmental graduate (EEBB, ESPP, EFSS)

and undergraduate (Sustainable Agriculture and Food Systems) programs. Summer teaching at KBS is field and research-based and so necessarily has small class sizes (usually fewer than 15 students). As a result, credit hour productivity is not an appropriate metric for our contributions to the educational mission of MSU.

Donations and endowments

Over the reporting period, the number of endowed scholarships at KBS increased from two to six. The total value of endowed scholarships in 2010 ($770,000) reflected a 200-fold increase over the reporting period (**indicator 24**). In addition, the Conservation Legacy Fund (CLF) was established in 2009 with a deferred gift of $3.2M. The CLF will support facilities and programs at the Kellogg Bird Sanctuary and Manor House and provide funding for student internships. The number of donors to KBS has grown 8-fold over the reporting period, from 90 to over 750, and includes community members, local organizations and businesses and a growing number of KBS faculty, staff, and alumni. Total value of endowments at KBS in 2010 (Kellogg Trusts, Scholarships, and other endowments) was over $4.1million dollars (**indicator 25**)

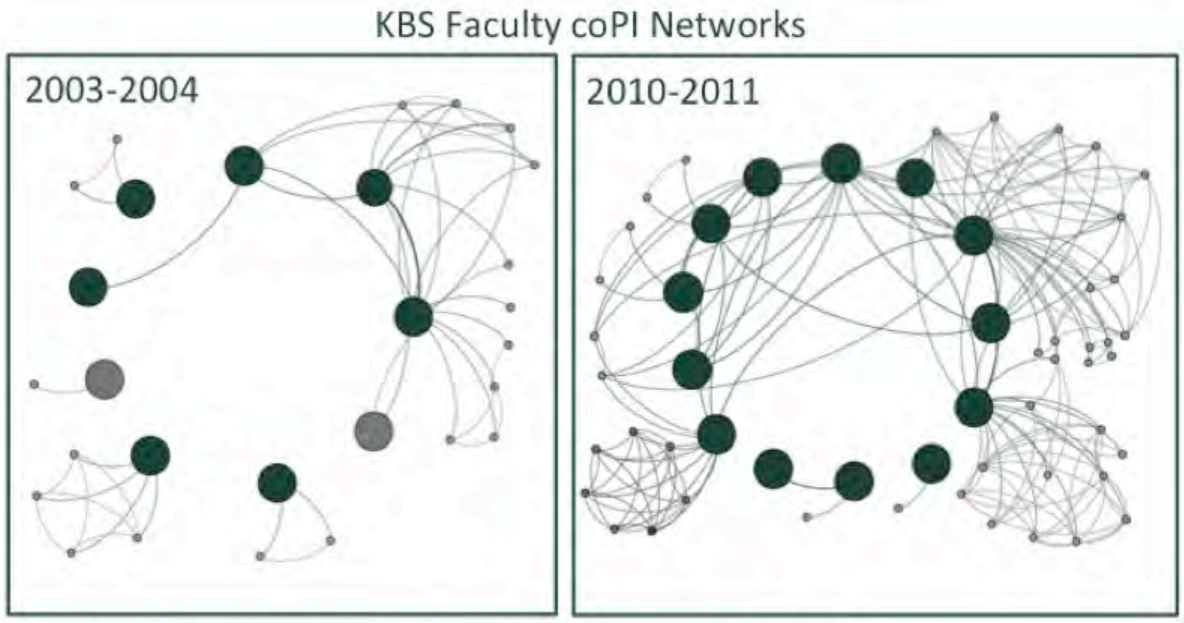
Research productivity rankings

KBS researchers excel in all measures of research productivity. Two KBS faculty—Mittelbach and Schemske—are ISI Highly Cited researchers. Total citations for the 12 KBS core faculty (defined as those hired over three years ago) exceed the top 1% threshold in Ecology (ISI Essential Science Indicators). Of the 1500+ KBS publications produced since 1959, 31% have been cited 50 or more times. KBS faculty publish in the highest impact journals in ecology/evolutionary biology, and as a group their research productivity exceeds or is on par with that at top ecology programs nationally (Table 2; **indicator 19**).

KBS researchers have been very successful in garnering extramural research funding, often taking the lead on collaborative projects that involve campus-based faculty (**indicators 15, 16, 17**). Research grants to KBS faculty generated $362,322 in F&A in FY05; by FY09 this had grown to $663,355, and in FY11 totaled $784,960. Per faculty, this averages to ~$65,000 in F&A in FY11. KBS faculty members lead sustainability research in the DOE Great Lakes Bioenergy Research Center ($2.7M in sustainability funding to MSU in FY11), the NSF LTER program ($1.0M in FY11), and play significant leadership roles in the NSF-BEACON Science and Technology Center ($5M in FY11).

Table 2: Research productivity, recognition, and composition of KBS faculty compared to programs at peer institutions. Data compiled from the NRC 2010 report for 2001-2006.

Program	NRC Rank*	Mean # pubs. per faculty per year	Mean # citations per pub. per year	% faculty with extramural grants	Mean # of faculty awards	% Female faculty
KBS faculty	**--**	**3.32**	**3.98**	**100**	**1.25**	**33**
Princeton: Ecol.	1	2.89	4.51	87.8	2.61	23
Duke: Ecology	2	2.50	3.41	69.5	3.20	5
Harvard: OEB	2	2.84	3.48	69.9	1.66	22
UC Davis: Ecol.	7	2.09	2.17	94.1	0.57	24
Berkeley: IB	13	1.77	3.44	75.6	0.47	32
Indiana: EEB	2	2.03	3.87	92.7	1.80	32
UMN: EEB	2	1.98	4.96	90.9	0.13	37
Illinois: EEB	14	1.69	2.43	79.3	1.08	28
Iowa St.: EEB	40	1.22	1.98	81.8	0.07	28
Ohio St.: EEOB	41	1.16	2.52	77.7	0.23	25



These networks are based on funded grants listed on MSU's CGA Proposal Info. website.
The large nodes are KBS faculty. Gray nodes retired and moved before 2010. Small nodes are MSU coPIs not on the KBS faculty. Internal grants not listed on the CGA site are not included.

KBS faculty members are also important collaborators in many cross-campus and national research programs, as reflected in the network diagram above. These collaborations include synthesis activities at three national centers (National Center for Ecological Analysis and Synthesis (NCEAS), National Institute for Mathematical and Biological Synthesis (NIMBioS), and National Evolutionary Synthesis Center (NESCENT)). The reputation of the KBS faculty as leaders in interdisciplinary and synthetic research is also evidenced by their success in obtaining funding for sabbatical fellowships from highly competitive sources, including the Marie Curie Foundation (Klausmeier), NCEAS (Gross and Mittelbach), Australian Commonwealth Government (Hamilton), and National Science Foundation (Robertson).

Faculty recruitment and retention success

Since 2005 eight faculty have been recruited to positions at KBS. Four of these positions are new: one to retain expertise in plant ecology (with Gross' move to the Director's position), two to support the new pasture-based dairy initiative, and one to provide agronomic expertise for the LTER program. Two of these positions promoted partnerships with Animal Science and Sociology, departments not previously associated with KBS. Another position retained expertise in microbial ecology following a KBS retirement, and another (plus spousal hire) retained expertise in aquatic ecology following a faculty move to NSF.

Table 3: Summary of KBS faculty hiring over the reporting period

New Position	Joint with	Year Hired	Faculty Name	Current Rank
Director	N/A	2005	K Gross	Univ. Dist. Prof
Aquatic Ecology	ZOL	2005	E Litchman	Assoc. Prof.
Theoretical Ecology	PLB	2005	C Klausmeier	Assoc Prof.
Microbial Ecology	MMG/MAES	2006	J Lennon	Ass't Prof.
Cropping Systems	CSS/MAES/MSUE	2006	S Snapp	Professor
Plant Ecology	PLB	2007	J Lau	Ass't Prof.
Grazing Ecology	ANS/MAES/MSUE	2009	S Utsumi	Ass't Prof.
Social Systems	SOC	2010	D Stuart	Ass't Prof.

As part of the negotiations for the renewal of the LTER project at KBS in 2010, a proposal for a senior position (Associate Professor) joint with the Department of Sociology and based on campus was developed. That search was unsuccessful, but there remains a commitment to pursuing this position (proposed for FY13). The rationale for a faculty

position in Conservation/Restoration Ecology was outlined in KBS's *Sustaining the Vision* report (2004) and requested in the startup for KBS Director Gross, but funding has not been available for this position. It too remains a priority.

National and international faculty awards

(Indicator 20) During the reporting period, KBS faculty served on 20 editorial boards for leading journals in ecology, evolution, microbiology, plant sciences, and agriculture. KBS faculty members have been elected as Fellows of four professional societies (American Association for the Advancement of Science, American Academy of Arts and Sciences, American Society of Agronomy, Soil Science Society of America) and have been recognized by professional societies with prestigious awards including the American Society of Naturalists' Young Investigator Prize, the Ecological Society of America's Distinguished Service Citation, a Fulbright Fellowship, and a Marie Curie Fellowship. Six KBS faculty have been awarded college and university awards and two are University Distinguished Professors. In addition, three faculty have been awarded NSF CAREER awards and one (Litchman) recently received the Presidential Early Career Award for Scientists and Engineers. KBS faculty members have served as elected officers in two international scientific societies (Ecological Society of America and American Society of Naturalists). Two KBS faculty currently serve on major advisory boards for NSF (Biological Directorate; Gross) and DOE (Office of Science; Robertson).

Undergraduate and graduate awards

Graduate students recruited to KBS are among the top in the nation as evidenced by the large number of national and university fellowships they are awarded. The 25 PhD students who completed their degrees in the reporting period (2004-2010) included four NSF Pre-doctoral Fellows, two EPA STAR Fellows, five University Distinguished Fellows, five CNS Recruiting Fellows, seven Plant Science Fellows and one MSU Minority Recruiting Fellow. KBS graduate students also have an excellent record of obtaining funding for their research; five NSF Doctoral Dissertation Improvement Grants (DDIGs) were received during the reporting period. KBS graduate students have gone on to receive prestigious national and societal awards; noteworthy among them is Dr. Megan Duffy (PhD 2005) who received the Mercer Award from the Ecological Society of America for a paper based on her dissertation research.

Satisfaction surveys

(Indicator 2) Feedback from students (undergraduate and graduate) about KBS summer courses or research experiences are uniformly positive and frequently speak to the unique aspects of being part of a 'living and learning' research community. SIRS metrics

comparing the campus and KBS offerings of Ecology (ZOL 355/355L), taught by the same instructor at KBS and on campus, are higher at KBS (1.4 vs. 2.0). Much of the difference comes from student rating of "Instructor Involvement" and "Instructor-Student Interactions": over 50% of KBS respondents specifically mentioned that the field-based or hands-on research aspects of the course improved their learning or enjoyment of the course.

Alumni support for KBS is also high; many return to do research after they graduate and/or send students to take courses or to do field research at KBS. We are growing an alumni base of donors, and they are important contributors to scholarship funds.

Placement rates and employer and graduate school assessments

See the *Instructional Productivity* section, above.

IV. WHAT DIFFERENCE DO WE MAKE?

KBS offers a diverse portfolio of research, education and outreach programs with a cross-disciplinary integration that is not typical of campus-based departments. The impact of KBS in the broader scientific community, to society at large, and the local community includes programs that help Michigan residents and natural resource managers understand and protect their land and water resources (**indicator 23**). Examples include: 1) Local partnerships with the Gull Lake Quality Organization that now includes summer fellowship funding for an MSU graduate student (Hamilton and Mittelbach) and 2) Assisting the US EPA and Enbridge Energy Partners LLC to develop the scientific basis for ongoing cleanup and remediation after the 2010 Kalamazoo River oil spill (Hamilton).

Agriculture is an economic mainstay for Michigan and the Midwest, and development of the bioeconomy holds good prospects for the future (**indicator 22**). The return on investment in agricultural research is high in general, and particularly so in an agricultural region like Michigan. KBS research bears on the future of agriculture, focusing on topics such as sustainable development of biofuel crops, adaptation of pasture-based dairy systems, perennialization of annual wheat, and agriculture's role in climate change including adaptation and mitigation.

Outreach is key to making research knowledge available to the full spectrum of the agricultural community. KBS outreach initiatives range from on-site activities targeting the professional development of dairy and row-crop farmers to dissemination of educational materials to teachers and policy makers. Examples of research-based outreach programs include: 1) programming to inform key Michigan legislators on how changing agricultural practices can mitigate greenhouse gas emissions (Robertson and Doll), and 2) on-site instruction on sustainable pasture-based farming, the use of robotic milking, and 3)

developing markets for products from pasture-based dairies (Utsumi, Stuart and Haan, in collaboration with the MSU Product Center).

During the reporting period, KBS received three highly-competitive NSF grants to improve facilities for freshwater and terrestrial research, demonstrating the value that NSF places on KBS as a regional ecological resource. Grants totaling ~$500,000 from NSF's Biological Field Stations and Marine Laboratories program funded the construction of a new field laboratory at the LTER site, the renovation of 10 ponds at the Experimental Pond Facility, and the construction of a new research greenhouse. These facilities support the research of faculty from around the world; nearly 40 visiting investigators used KBS for research in 2011.

V. HOW DO WE INTEND TO CHANGE?

Targets for change

Campus connectivity and collaborations: Advances in videoconferencing hold great promise for improving connectivity between KBS and campus, and recent investments in KBS videoconference facilities have reduced the need for some travel - but only for meeting with those campus colleagues who have access to compatible video-conferencing facilities. KBS video facilities are currently used mainly for collaborations with faculty from the College of Education, GLBRC, and BEACON. Until equivalent access becomes available in more buildings on campus, collaborations between KBS and campus faculty will be constrained by the need to budget ~3 hrs (round trip) for commuting to attend even a brief meeting. We are planning improvements to our video-conferencing capacity (FY13 TLE request) that will allow live transmission of seminars from KBS to off-site locations. This will be an important step in enhancing our capacity to collaborate with campus partners.

Improve Evaluation of Educational Program Impacts We have developed evaluation processes for determining the impact of our summer research experience programs and courses. Because KBS class sizes are small, we ask students to complete written evaluations of their experience, as well as SIRS forms. All students participating in research experience programs now complete an evaluation. To date, we have not had the capacity to follow up on career tracks taken by students who have participated in our programs and see a need to develop the tools (and support) that will allow us to do so. Without support for an Assistant Director for Education we will have limited capacity to do this.

Broaden Participation of Under-represented Groups We are committed to expanding the involvement of underrepresented groups in all academic programs at KBS, including summer courses, research experiences, and graduate study. We increased participation

by underrepresented minorities in our summer research and classes by partnering with HBCUs, particularly Jackson State University, as well as the University of Puerto Rico-Mayaguez, and more recently NC A&T (BEACON partner). To further expand recruitment of students from under-represented groups (graduate and undergraduate) we need to strengthen research connections to faculty at minority-serving institutions. BEACON is providing this opportunity. The URA program is another opportunity to expand the involvement of underrepresented students in research programs at KBS. Continuation and growth of these programs requires funding for an Assistant Director for Education.

Expand Research Capacity To meet our goal of expanding research and education in Conservation and Restoration Ecology, we will develop stronger connections to campus-based faculty, seek out joint departmental hires, and support their research at KBS. The development of new collaborative projects in Conservation and Restoration Ecology will no doubt strain our existing research and housing facilities by needing space for technical staff, visiting scholars and students. We will work with campus departments on the joint hiring of faculty based on campus with research programs at KBS and support this by constructing less expensive field laboratories and redesigning the Carriage House (which formerly housed MSU Extension) to provide office space for these programs.

Plans to enhance quality and competitiveness

KBS has an outstanding reputation as a center for ecological and evolutionary research, graduate and postdoctoral training and outreach programs (see Tables 1 and 2). Over the past decade we have expanded the scope of research, educational and outreach programs to include theoretical ecology (and quantitative tools) and interactions between human and natural systems. The growth of sustainable agricultural and K-12 educational programs at KBS has promoted stronger collaborations with campus faculty (see Figure 1) and enhanced the national and international reputation of KBS as a center for innovative research, education and outreach. We outline below two areas where we feel we can expand our impact, increasing our competitiveness for large interdisciplinary research and graduate awards that support the missions of KBS and MSU.

Plans for innovation and new initiatives

With its extensive and heterogeneous land base, diverse faculty, and history of successful interdisciplinary research, KBS is well positioned to catalyze new initiatives. To this end, we have identified two areas as emerging disciplines that offer excellent opportunities to further the KBS mission and expand our collaborations with campus faculty and programs: (1) Leadership in the development of a cross-college program in conservation biology and restoration ecology; (2) Partner with the Institute for Research on Mathematics and Science Education (IRMSE) to develop interdisciplinary research on how field station

research experiences can impact students' understanding and application of mathematics. We see both of these initiatives as exciting and productive ways to expand and strengthen our research activities and enhance connections with campus units that will benefit student experiences (graduate and undergraduate) and strengthen our outreach programming.

Partnering with campus units for faculty hires in Conservation and Restoration Ecology We propose a broad, interdisciplinary effort to establish MSU a leader in conservation and restoration ecology. This is an opportunity to foster interactions between KBS and multiple campus departments, with the goal of enhancing research competitiveness, strengthening graduate and undergraduate training and increasing the impact of outreach programs. There is also the potential to build collaborations with the Greening Michigan Institute of MSU Extension. The disciplines of conservation biology and restoration ecology address critical environmental challenges such as habitat loss, invasive species, and pollution, which threaten biodiversity and ecosystem services and the socioeconomic welfare of our state.

To address these issues we propose to develop a focus on conservation and restoration ecology at KBS that parallels our focus in sustainable agriculture research. This will require a commitment of new resources, including faculty hires and graduate and postdoctoral fellowships and can be pursued in collaboration with campus departments in CANR, CNS, and CSS. The benefits of such a program include greater opportunities for undergraduate and graduate training, expanded public outreach, new dimensions for seeking financial donations, and access to new sources of external funding. The latter is of particular significance. For example, federal funding agencies are increasing their emphasis on biodiversity and human dimensions of land use, exemplified by the recent NSF programs "Dimensions of Biodiversity" and "Macrosystems Biology". The growing interest in sustainable bioenergy systems has profound implications for biodiversity and ecosystems services, and will stimulate new funding opportunities from both public and private sectors.

Developing a research platform in STEM education: The KBS K-12 program has fostered connections between faculty at KBS and the College of Education (particularly Secondary Education). This has been primarily an outreach activity to develop capacity in K-12 teachers. While there have been benefits to graduate education (e.g. Fellowships and training provided by the NSF GK-12 program), there has not been an explicit research focus to these programs. We see an exciting opportunity to expand our research portfolio in partnership with the IRMSE and the College of Education, to include a focus on STEM education, particularly preparation in mathematics. The lack of preparedness of students in mathematics limits their ability to pursue majors in STEM that will prepare them for the jobs and careers of the future. Research initiatives focusing on field-station experiences in research can provide a foundation and context for strengthening student interest and

performance in mathematics. There are growing opportunities for research funding in this area including substantial potential for private or foundation support for implementation.

VII. HOW WILL WE EVALUATE OUR FUTURE PROGRESS & SUCCESSES?

Unit metrics

We will evaluate future progress of the KBS research program using NRC-based statistics along with other comparable metrics (see Tables 1 and 2). We have implemented a Site Use Request Form (SURF) system, which has been effective at tracking the researchers and funding sources that use laboratory equipment and field sites at KBS. We also are committed to assessing strengths and challenges associated with our summer undergraduate program. Currently, this is being accomplished via SIRS along with other customized evaluation forms, and we are developing surveys that will track the long-term impacts of our educational programs at both the undergraduate and graduate levels.

College metrics

KBS faculty are jointly appointed in departments in three colleges (CNS, CANR, and College of Social Science) and so we will use the metrics developed by these colleges to assess performance of individual faculty and KBS as an academic unit. Our unit metrics (described above) are consistent with those in these colleges.

University metrics

As a unit KBS has strived to meet the goals outlined in ***Boldness by Design*** and focused particularly on: *Enhancing the Student Experience* through integrated research and educational programs at the undergraduate and graduate level; *Increase Research Opportunities* through expansion of programs focusing on sustainable agriculture (row crops, biofuels and animal production); *Strengthen Stewardship* through growth in the number of endowed scholarships and donors; and *Enrich Community, Economic and Family Life* through expansion of outreach programs that highlight MSU research and through the development of partnerships with local environmental and conservation groups.

W. K. KELLOGG BIOLOGICAL STATION
CHRONOLOGY

1927	Kellogg Bird Sanctuary and Kellogg Farm established by W.K. Kellogg
1928	Kellogg Bird Sanctuary and Kellogg Farm conveyed to Michigan State College of Agriculture and Applied Science
1930	Kellogg Experimental Forest conveyed to Michigan State College of Agriculture and Applied Science
1930-1941	Summer instructional program in field biology centered on summer flora, ornithology and wildlife – discontinued during World War II
1941-1952	Manor House served as an annex to Percy Jones Veterans Hospital, Battle Creek
1948	Kellogg Company contract with Michigan State University – small animal nutrition research; Kellogg Feed Research Laboratories established
1952	Kellogg Estate deeded to Michigan State University and establishment of the W.K. Kellogg Station by MSU President John Hannah
1954	Kellogg Biological Station Summer Teaching Program reestablished
1959	W.K. Kellogg Foundation Award – capital improvements to support Summer Teaching Program and Conference Center
1962	W.K. Kellogg Foundation Award – capital improvements and renovation of Bird Sanctuary to support environmental educational programs
1964	A Resident Director, G.H. Lauff, appointed to further develop summer program and initiate a year-round research activity
1978	National Science Foundation grant to support research facility development at Kellogg Biological Station and designation as a national Experimental Ecological Reserve.
1981	W.K. Kellogg Foundation Award to Michigan State University to support the Rural Resources Education Program
1986	Academic Building Dedication and Special Symposium (June 1986)
1987	National Science Foundation funded Long Term Ecological Research (Agricultural Ecology) Site Established
1990	Lux Arbor Reserve (LAR) deeded to MSU to support research, education and outreach program of KBS
1998	W.K. Kellogg Foundation grant for Manor House and Carriage House restoration
2000	Restored Manor House Dedicated
2008	W.K. Kellogg Foundation grant for establishment of Pasture Dairy Center at Kellogg Farm

KBS FACULTY
2017

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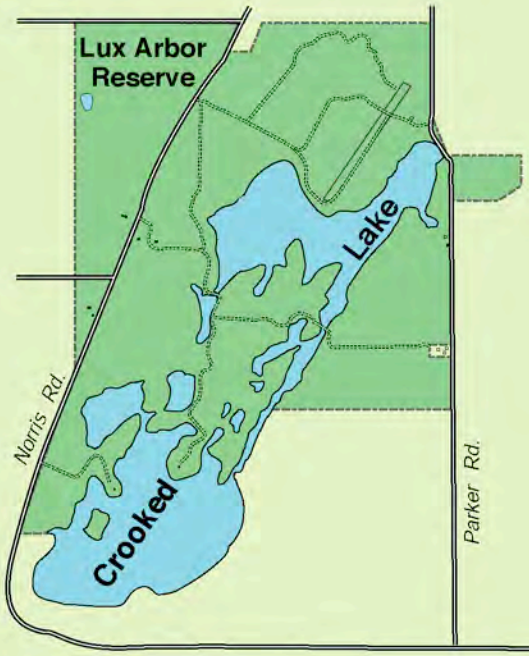
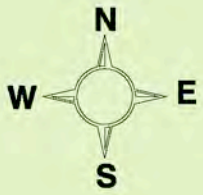
Stump, Simon	Klausmeier	stumpsim@msu.edu
West, William	Evans	westwill@msu.edu

Visiting Scholars and Grad Students

Name	Status	Lab/Project
Gjhuvan Grimaud	Visiting Scholar	Klausmeier Lab
Zepeng Sun	Visiting Scholar	Klausmeir Lab





MICHIGAN STATE UNIVERSITY

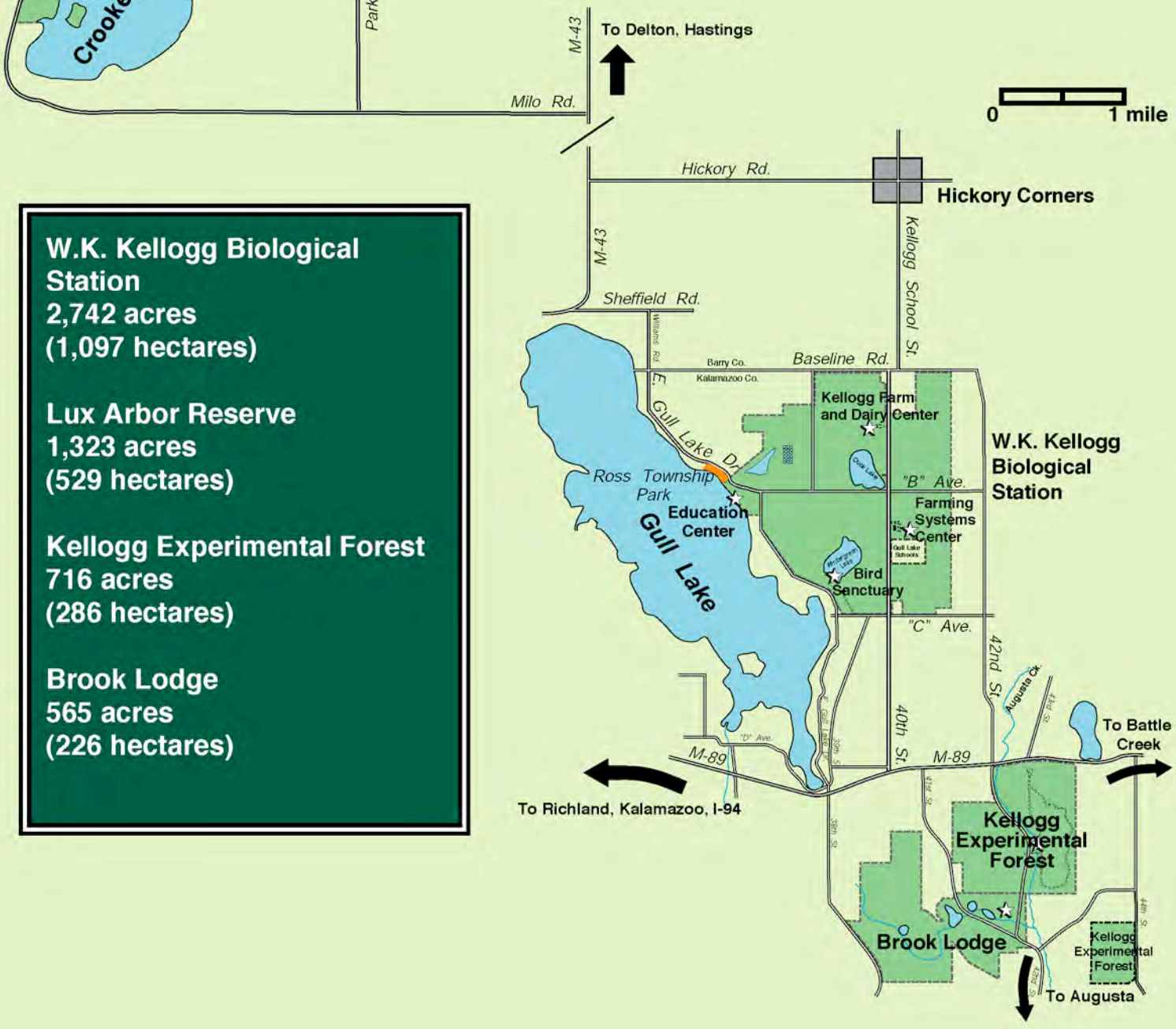
W.K. Kellogg Biological Station and adjacent MSU lands

W.K. Kellogg Biological Station
2,742 acres
(1,097 hectares)

Lux Arbor Reserve
1,323 acres
(529 hectares)

Kellogg Experimental Forest
716 acres
(286 hectares)

Brook Lodge
565 acres
(226 hectares)



Kellogg Biological Station

aerial photo date: 12 August 2011

N

0 0.5 1 km

Map numbers:

1. Academic & Conference Center
2. Experimental Pond Lab
3. Terrestrial Field Lab
4. Pasture Dairy Center
5. Kellogg Farm Office
6. LTER Main Site
7. Farming Systems Center
8. GLBRC Intensive Site
9. KBS Physical Plant
10. Bird Sanctuary

Map prepared by Suzanne Sippel Oct. 2014

KBS property border

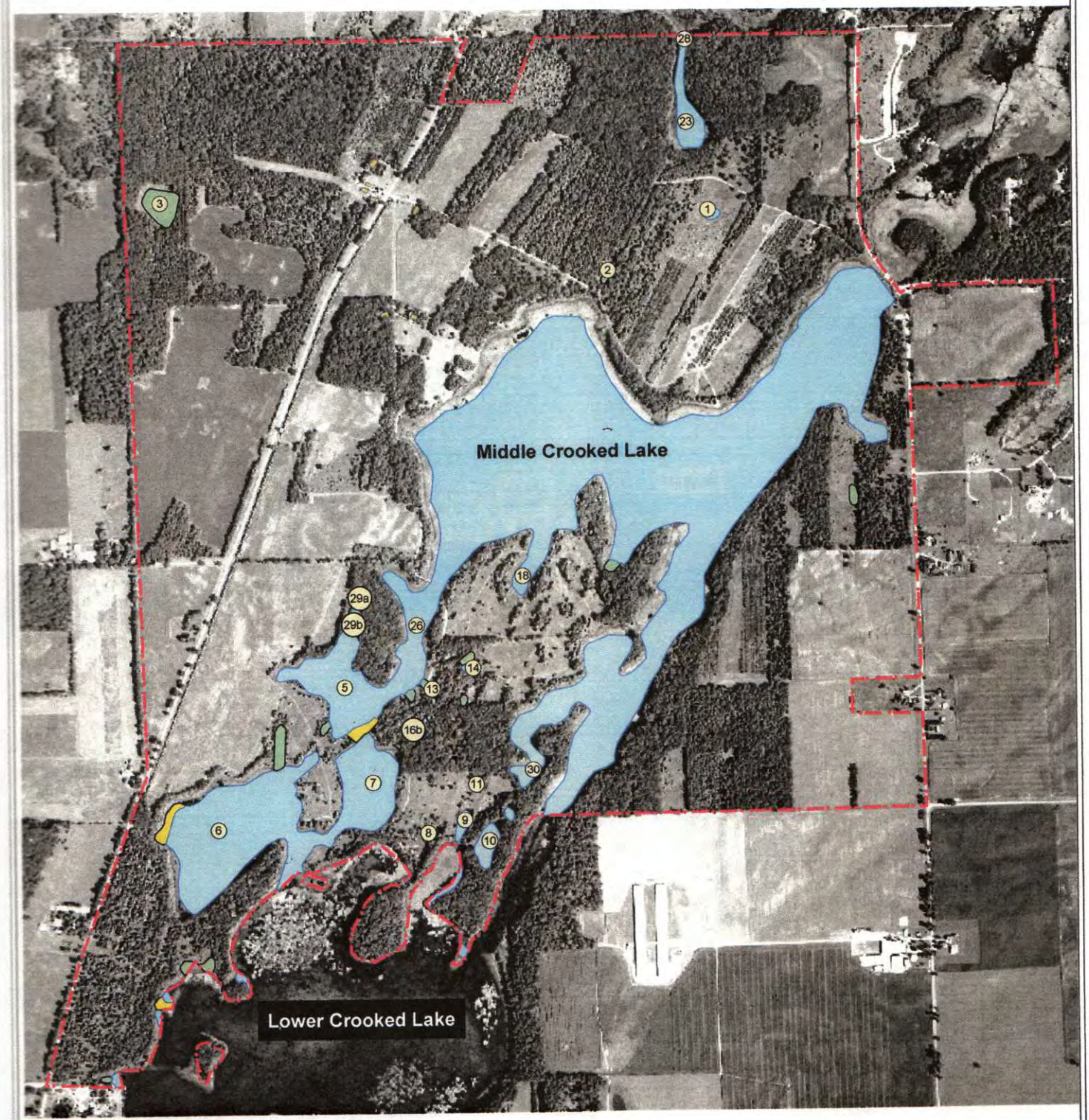
MSU buildings

Kellogg Biological Station

Field and Forest Names

Map prepared by KBS GIS Lab,
Michigan State University, May 2008

Lux Arbor Reserve - Lakes and Wetlands



N

0 0.25 0.5 1 km

Source: National Wetland Inventory photo, August 2005

LAR border
LAR pond number
Emergent wetland
Open water
Forested wetland

Map prepared by Suzanne Sippel, KBS, Dec. 2005

Figure 11

Michigan State University

W.K. Kellogg Biological Station

Mission Statement

The mission of the W.K. Kellogg Biological Station (KBS) is to increase our understanding of natural and managed ecosystems and their linkages to society. This entails three main integrative activities:

- Facilitate and conduct fundamental and applied research in ecology, evolution, agriculture, and conservation biology
- Provide MSU students with inquiry-based educational opportunities in ecology, evolutionary biology, agriculture, and conservation biology.
- Provide outreach programs that bring KBS expertise to bear on environmental issues of public importance.

We fulfill this mission through:

Research

- Perform and disseminate transformative research within and across the disciplines represented at KBS.
- Promote KBS as a collaboration hub attractive to researchers from MSU and elsewhere.

Graduate Student and Postdoctoral Education

- Provide graduate student and postdoctoral training in groundbreaking research that addresses questions of national and global importance.
- Ensure that graduate students and postdoctoral researchers gain the skills needed to become future leaders in their fields.

Undergraduate Education

- Provide undergraduate students with field-based learning experiences not available on campus.
- Support a summer residential program for students from a broad range of disciplines and majors.
- Broaden participation of students from underserved and underrepresented groups.

Outreach

- Offer outreach activities that use KBS research to engage the public and working professionals such as land managers, teachers, and agency personnel.
- Expand collaborations in education and outreach with campus-based faculty, including the development of cross-cutting and integrative programs.

Administrative Overview: W.K. Kellogg Biological Station

Andrew Widner, Assistant Director for Finance and Operations
Katherine Gross, Director

The KBS administrative team supports all of the staff of KBS, except the Physical Plant which is also managed by the MSU Land Management Office. The team members and key responsibilities of the Admin team have changed over the past three years as a result of staff retirements that allowed us to reassess needs, responsibilities and roles and develop new positions that allow us to function more effectively. We worked closely with human resources staff in the College of Agriculture and Natural Resources in making these changes and feel we now have in place an administrative structure and reporting system for KBS that works effectively and efficiently and promoted cooperation among units and alignment with campus partners (CANR,CNS, and MABR in particular). Included in this realignment has been a stronger collaboration with LMO regarding the management of the KBS Physical Plant, Farm and Lux Arbor Reserve.

Key to this change was the establishment of the Assistant Director for Finance and Operations position and hiring of A Widner, who had the finance, management and business experience that are important to overseeing the complexity of operations and budgetary sources at KBS. He has also fostered a team approach among the staff, resulting in an adaptable, cross-trained team who are adaptable to change and able to wear multiple hats. These changes in reporting have also freed up the Director's time to focus on academic (research and educational partnerships), development and outreach to the community. Key to the team approach is the recognition that while the research and educational programs led by the KBS faculty are the primary focus of KBS, everyone contributes to the value of KBS as an important part of MSU.

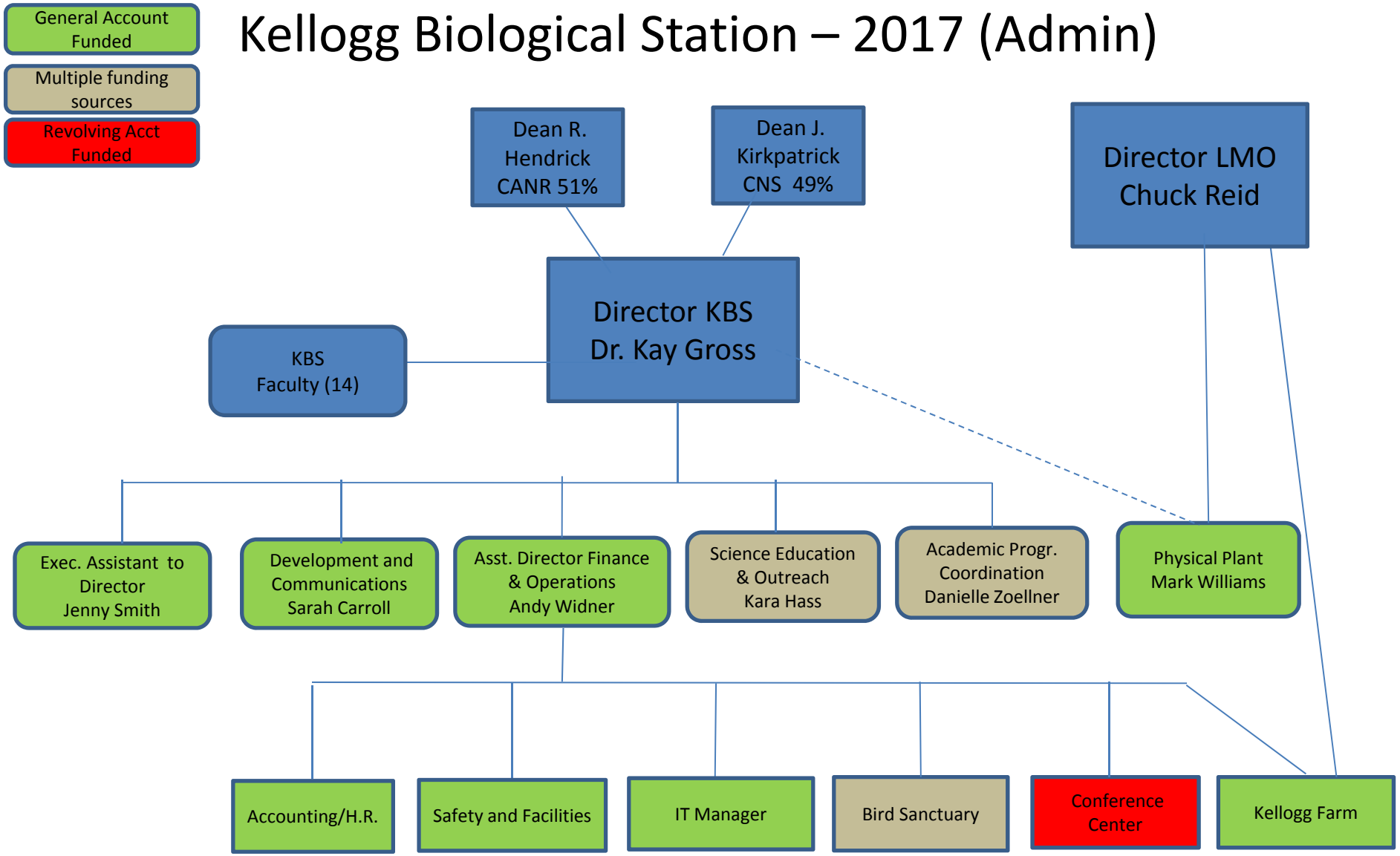
The Director heads the Administrative team of KBS (see table) and shares responsibility with Department chairs for recruiting, evaluating and making teaching and related assignments for faculty. Others reporting to the Director are the Coordinators for Academic Programs (primarily summer undergraduate, but expanding to graduate programs), Science Education and Outreach, and Development & Community Relations (community connections, communications). These are the key programmatic areas of the KBS and so having their reporting to the Director helps align and coordinate our efforts and investments. An Executive Assistant supports the work of the Director and handles all academic appointments (graduate student, postdocs, visiting scholars and faculty), allocates fellowship and scholarship funds, arranges travel and reimbursements for all academic personnel, oversees the academic sections of the KBS website, tracks alumni, and supports the work of the Coordinators (especially Academic Programs).

The AD for Finance and Operations has primary responsibility for managing finances of KBS and works with the KBS Director on budgets and long term strategic plans. He oversees the Finance manager who manages KBS grant accounts, tracks purchasing and other expenditures, handles hiring of full-time non-academic staff, oversees hiring of temporary and on-call staff, and handles 'ad hoc' questions about MSU policies and practices particularly in regard to benefits (over 20+ years of experience at MSU). Also reporting to the AD for Finance and Operations are KBS IT and Operations staff; the former supporting IT and connectivity across all unis of KBS, including a station-wide wireless network and several video conferencing facilities.

In addition, managers of the three support units – Farm, Bird Sanctuary, and Conference Center and Manor House also report to the AD for Facilities and Operations.

The administrative staff at KBS is lean, but efficient. Recent hires have allowed us to hire information experts who can take on the challenging issues associated with changes at MSU in financial compliance and reporting, hiring and overtime reporting, and health care eligibility. We are making strides in this area and the team is better positioned for this than any time in the past four years. Efforts to hire and empower stronger staff within the units are capable helping the central Admin team stay lean and focused on more global KBS administrative support needs and questions are key to our success.

Kellogg Biological Station – 2017 (Admin)



MICHIGAN STATE UNIVERSITY
W.K. Kellogg Biological Station
For the Years Ended June 30, 2012 to 2016

Budgeted

		FY 11-12 30-Jun-12	FY 12-13 30-Jun-13	FY 13-14 30-Jun-14	FY 14-15 30-Jun-15	FY 15-16 30-Jun-16
CANR	**GA011061**	**$ 377,256**	**$ 371,176**	**$ 398,767**	**$ 387,607**	**$ 371,798**
CNS	**GA013831**	**$ 1,126,079**	**$ 1,210,701**	**$ 1,133,581**	**$ 1,302,809**	**$ 1,354,309**
Ag Bio	**Multiple Accts**	**$ 311,922**	**$ 289,360**	**$ 365,643**	**$ 403,709**	**$ 398,707**
MSU Extension	**Multiple Accts**	**$ 208,235**	**$ 65,862**	**$ 80,849**	**$ 65,712**	**$ 38,549**
LTER Agronomic	**GA012791**	**$ 322,880**	**$ 315,458**	**$ 312,152**	**$ 336,877**	**$ 318,622**
KBS General Funds	**Total**	**$ 2,346,372**	**$ 2,252,557**	**$ 2,290,992**	**$ 2,496,714**	**$ 2,481,985**
Maintenance - Salary	**GA015101**	**$ 655,254**	**$ 675,211**	**$ 662,463**	**$ 689,673**	**$ 720,906**
Maintenance - Utilities	**GU015363**	**$ 701,952**	**$ 814,000**	**$ 632,000**	**$ 793,390**	**$ 843,287**
Maint. General Funds	**Total**	**$ 1,357,206**	**$ 1,489,211**	**$ 1,294,463**	**$ 1,483,063**	**$ 1,564,193**
Gifts/Endow	**Multiple Accts**	**$ 396,048**	**$ 461,996**	**$ 472,482**	**$ 713,478**	**$ 535,441**
Business Accts	**Multiple Accts**	**$ 2,389,426**	**$ 2,663,233**	**$ 2,621,638**	**$ 2,679,342**	**$ 2,491,105**
Grants*	**Multiple Accts**	**$ 3,652,330**	**$ 2,774,050**	**$ 2,195,198**	**$ 2,319,212**	**$ 2,797,770**
Other Accounts	**Total**	**$ 6,437,804**	**$ 5,437,283**	**$ 4,816,836**	**$ 4,998,554**	**$ 5,288,875**
Grand Total KBS Funding	**Total**	**$ 10,141,382**	**$ 9,179,051**	**$ 8,402,291**	**$ 8,978,331**	**$ 9,335,053**

***Large drop in Grant spending from 12 to 13 driven by completion of large dairy project ($375K) and Extension Grant ($200K)**

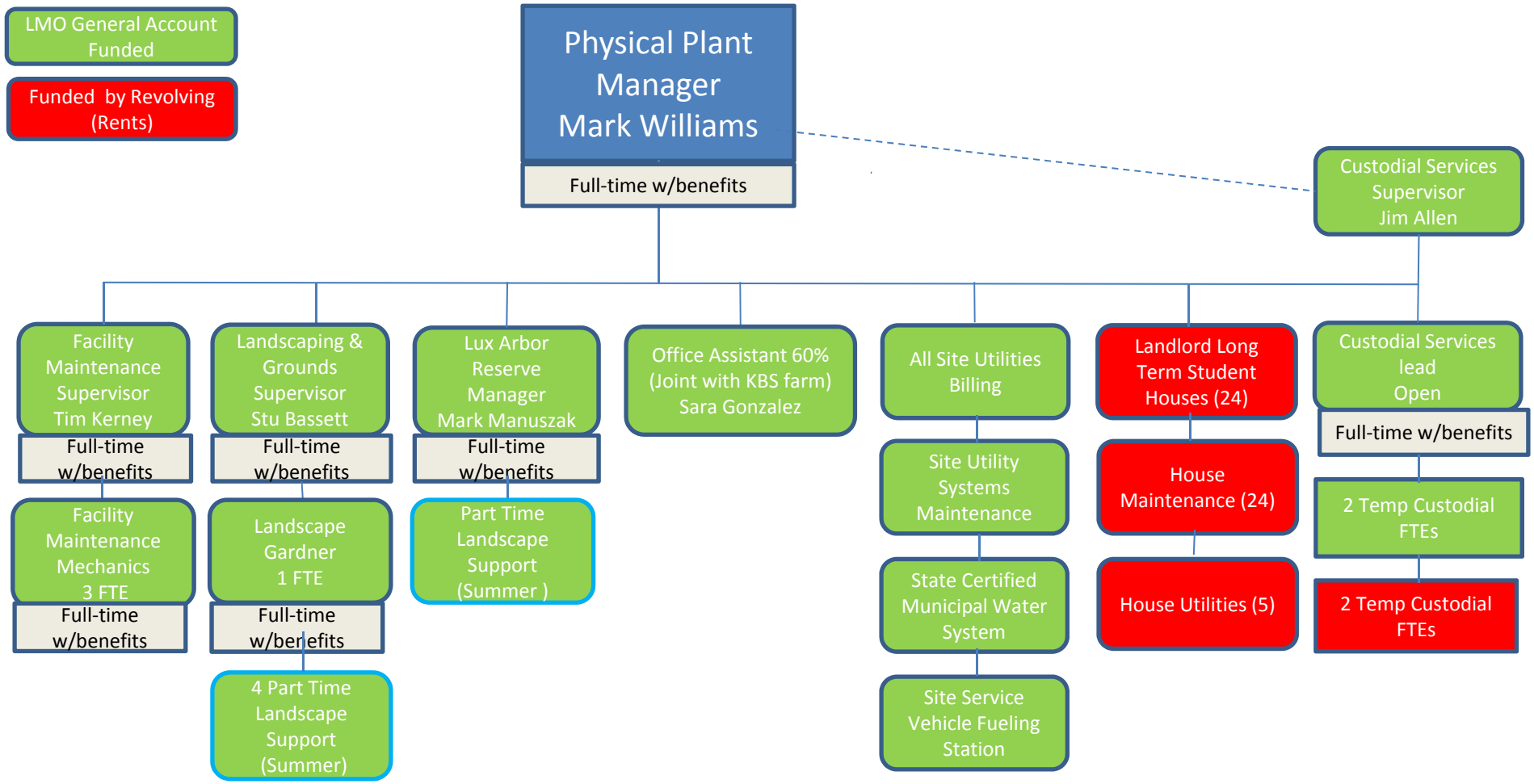
MICHIGAN STATE UNIVERSITY
W.K. Kellogg Biological Station
For the Years Ended June 30, 2012 to 2016

Business Acct Income Detail

Business Accts	**FY 11-12 30-Jun-12**	**FY 12-13 30-Jun-13**	**FY 13-14 30-Jun-14**	**FY 14-15 30-Jun-15**	**FY 15-16 30-Jun-16**
Conference Center*	$ 995,867	$ 1,108,330	$ 1,183,514	$ 1,136,168	$ 1,083,925
Bird Sanctuary	$ 74,224	$ 76,634	$ 81,169	$ 83,015	$ 77,911
KBS Farm	$ 799,033	$ 895,071	$ 911,715	$ 1,087,812	$ 916,405
Rental Housing	$ 137,004	$ 131,761	$ 158,359	$ 144,703	$ 162,353
Maintenance Service	$ 295,973	$ 280,402	$ 198,646	$ 154,986	$ 147,565
Management	$ 87,324	$ 171,035	$ 88,235	$ 72,660	$ 102,946
Revolving Total	**$ 2,389,426**	**$ 2,663,233**	**$ 2,621,638**	**$ 2,679,342**	**$ 2,491,105**

*Conf. Center Accounting reclass effects have been removed - was creating false revenue.

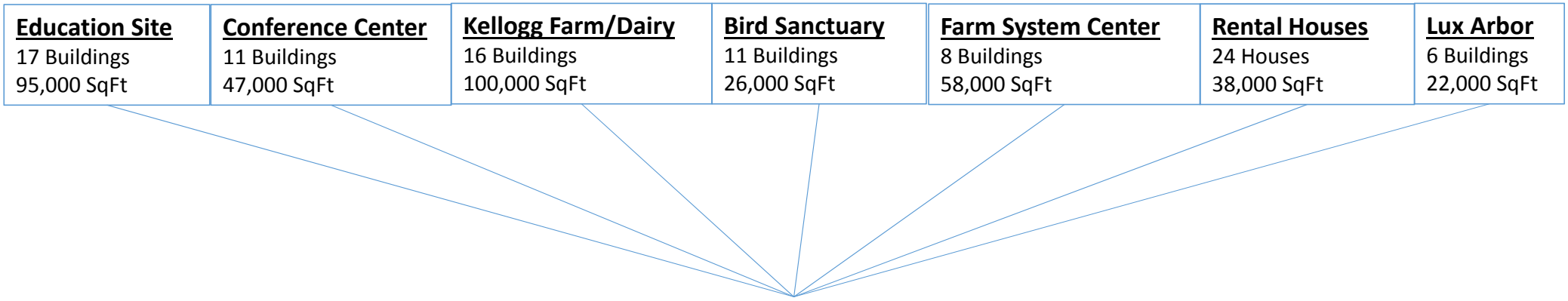
KBS Physical Plant – 2017



Kellogg Biological Station

3200 Acres
140 Buildings
386,000 SqFt

Education Site	**Conference Center**	**Kellogg Farm/Dairy**	**Bird Sanctuary**	**Farm System Center**	**Rental Houses**	**Lux Arbor**
17 Buildings	11 Buildings	16 Buildings	11 Buildings	8 Buildings	24 Houses	6 Buildings
95,000 SqFt	47,000 SqFt	100,000 SqFt	26,000 SqFt	58,000 SqFt	38,000 SqFt	22,000 SqFt



KBS Physical Plant

Building Maintenance & Site Utilities	Facility Maintenance (4 FTE)
Landscaping & Grounds Maintenance	Landscaping & Grounds (2 FTE, 4 PartTime Seasonals)
Lux Arbor Site & Research Support	Lux Arbor Farm Manager (1FTE, 1 Part Time Seasonal)
Custodial Services	Janitorial (3 FTE = 1full time + 4 PartTime)
Site Administration & Support Services	Administration (1.6 FTE)
Housing Landlord, MDEQ Water System,	
Gas station, Pest Control,LAN/Cell phones, waste pick up	

Age Class of Facilities

- 55% > 40 years old
- 40% 25-40 years old
- 5% < 25 years old

- Facility Maintenance Budget = $690,000/yr
- 280,848 gsf of HVAC conditioned spaces
- $2.87/Gsf Maintenance budget

KBS Physical Plant Services for the Kellogg Biological Station - 2017

Provide maintenance, repair and improvements to the infrastructure, facilities, physical assets and building equipment to ensure they are meeting the needs for Education, Research and Outreach activities at KBS.

Ensure the Landscaping & Grounds are maintained to provide a positive exemplary image to the students, guests and public.

Ensure utility systems and services supporting the facilities at KBS are reliable and meeting the operational needs of the businesses and operations housed within them.

Provide housing for long term Graduate student residents of KBS

Provide emergency 24/7 response for unplanned facility and utility failures and repairs

Coordinate Site Infrastructure and support services with multiple local area service providers.

GENERAL FUND BUDGETS

Site Facility Maintenance, Landscaping & Grounds, Custodial and Lux Arbor Reserve FY16/17 $696,700

Site Utilities, Nat. Gas, Propane, Electricity, Water, Sewer, Telephones & Misc Services FY16/17 $718,600

KBS Faculty (January 2017)									
Name	**Title/Rank**	**PhD awarded**	**Hired MSU**	**%KBS**	**Tenure Appt**	**College**	**% MABR**	**%MSUE**	**AY or AN**
Katherine Gross***	University Distinguished Professor/Director, KBS	1980	1987	100	Plant Biology	CANR/CNS	1 month SS	1 month SS	AY
Stephen Hamilton	Professor/Associate Director, KBS	1994	1995	100	Int. Biology	CNS	No	No	AY
Gary Mittelbach**	Professor	1980	1987	85	Int. Biology	CNS	No	No	AY
Elena Litchman	Foundation Professor	1997	2005	85	Int. Biology	CNS	No	No	AY
Christopher Klausmeier	Foundation Professor	2000	2005	80	Plant Biology	CNS	No	No	AY
Jennifer Lau	Associate Professor	2005	2007	80	Plant Biology	CNS	20%(PLB)	No	AY
Sarah Evans	Assistant Professor	2012	2014	80	Int. Biology	CNS	No	No	AY
Jeffrey Conner	Professor	1988	1996	80	Plant Biology	CNS	No	No	AY
Santiago Utsumi	Assistant Professor	2008	2009	75	Plant Biology	CANR	30%(KBS)	20%	AN
Sarah Fitzpatrick	Asst Prof	2016	2017	75	Int. Biology	CNS	No	No	AY
G. Philip Robertson	University Distinguished Professor	1980	1987	40	Plant, Soil and Microbial Sciences	CANR/CNS	38%(PSM)	No	AY
Douglas Schemske*	Hannah Distinguished Professor	1977	2001	25	Plant Biology	CNS	10%(PLB)	No	AY
Thomas Getty	Professor/Chair, Dept. of Zoology	1980	1986	20	Int. Biology	CNS	No	No	AY
Bruno Basso	Professor	2000	2012	20	Earth & Environ Sciences	CNS	25%(KBS)	No	AY

To Be Named Ecologist	Professor			80	IBIO or PLB	CNS	tbd	tbd	AY

* Retiring Feb 2017

** Retiring May 2018

*** Retiring as Director Aug 2018

KBS Faculty Awards				
Name	**Title/Rank**	***Significant Awards***		
		College/University	**National**	**International**
Bruno Basso	Professor	MSU Innovation of the Year (2016)	Fellow Amer Soc Agron (2013); Soil Sci Soc Amer (2015)	
Jeffrey Conner	Professor	CNS Graduate Advisor (2003)	Walton Lecturer, Mt. Lake Biological Station (2004); Fellow, AAAS (2011); Distinguished Sabbatical Scholar NESCent (2013-14)	
Sarah Evans	Assistant Professor		Grinnell College Alumni Scholar (2013); ESA Best Student Presentation (Biogeo; 2011)	Young Scientists' Fellowship, Int. Inst for Appl. Systems Analysis (2012)
Sarah Fitzpatrifk	Asst Prof	CSU Excellence in Undergraduate Mentoring (2014)	2015); ASN Young Investigator Award (2017)	
Thomas Getty	Professor/Chair, Dept. of Zoology	CNS Graduate Academic Advisor Award (2009)		
Katherine Gross	University Distinguished Professor/Director, KBS	CNS and MSU Outstanding faculty (2005); Univ Dist. Professor(2005)	ESA Fellow; ESA Distinguished Service Award	

Name	Title/Rank	*Significant Awards*		
Stephen Hamilton	Professor/Associate Director, KBS	MSU Civic Engagement Award (2014)	Fellow Soc. Freshwater Sci. (2017); Soc. Freshwater Sci. Environmental Stewardship (2015); Michigan Env Council Petoskey Prize (2014)	Commonwealth Envir. Res. Fellowship (Australia) (2008-09)
Christopher Klausmeier	Foundation Professor	MSU Foundation Prof (2016)		NSF CAREER (2009); EU Marie Currie Fellowship (2011-12)
Jennifer Lau	Associate Professor	CNS Teacher Scholar (2010); CNS Teacher Excellence (2012)	ESA Buell Award (honorable mention 2004); ASN Young Investigator Award (2008); Kavlie Fellow, National Academy of Sciences (2013)	
Elena Litchman	Foundation Professor	MSU Foundation Prof (2016)		NSF CAREER (2009); Presdidential Early Career Award for Scientists and Engineers (2011); Peterson Award, Kiel Germany (2016)

Name	Title/Rank	*Significant Awards*		
Gary Mittelbach	Professor	CNS (2016) and MSU Beal (2017) Outstanding Faculty Award	ESA Fellow (2015); ISI Highly Cited Researcher	
G. Philip Robertson	University Distinguished Professor	Univ Dist. Professor(2005)	Fellow AAAS (2015); Soil Sci Soc (003)	
Douglas Schemske	Hannah Distinguished Professor	CNS (2010) and MSU (2010) Distinguished Faculty Award	ISI Highly Cited Researcher; EO Wilson Naturalist Award (2002)	
Santiago Utsumi	Assistant Professor			

KBS Faculty Service					
		Service and Leadership (2012-2016)			
Name	**Title/Rank**	**KBS**	**Home Dept/MSU**	**National**	**International**
Bruno Basso	Professor		Member MSU Global Water Initiative (2014-16); GLG Search Comm Chair, Hydrogeology (2013), Geomicrobiology (2013);Member Grad Studies Committee (2013)	USDA Panel Chair (2013); Editorial Boards European J Agron (2008-), Agricul Systesm (2008-), Agron Journal (2008-12)	Consultant Sci Adv Comm UN-FAO;Member UN 68th Anniversary Conference(2013); Editorial Board Ital J Agron (2010-),
Jeffrey Conner	Professor	Greenhouse and Molecular Lab Liaison (2012-16); Faculty Adv Comm (2014-17; chair, 2015-17); Academic Programs Comm., Chair (2011-12 and 2014-15); Seminar	EEBB Quantitative Biology Search Comm. (2014-15); Plant Biology Departmental Advisory Comm. (2016-18); Plant Biology Promotion and Tenure Comm. (2012-13, 2014-16); Evolution Curriculum Comm. (2016-)	Handling Editor, *Evolution* (2013-2015); Steering Committee *Micromorph RCN (2010-)* ; NSF panels (2012, 2015); Editor, Special issue on measuring natural selection , *Methods in Ecology and Evolution* (2016-17); Editorial Board, *International Journal of Plant Sciences* (2010-12)	
Sarah Evans	Assistant Professor	Faculty Adv Comm (2016-); Chair Seminar Comm (2014-2016)	Terrestrial Ecologist search comm. (2016-17); KBS seminar comm., chair (2014-16); KBS grad. affairs comm., chair (2014-present); KBS faculty advisory comm. (2015, 2016-present)	Panelist: NSF Doctoral Disseration Improvement Grant (DDIG), DEB Ecosystems Panel, 2015	
Thomas Getty	Professor/Chair, Dept. of Integrative Biology	PI and Director, NSF GK-12 Bioenergy Sustainability Project (2009-2016); KBS K-12 Partnership Comm. (2014-)	Chair, IBIO (2012-); BEACON Exec. Comm. (2009-); BEACON EHRD Steering Comm. (2009-); Chair, EEBB Graduate Comm. (~2000-); Chair, EEBG Curriculum Comm. (2012-); MSU Biology Initiative Executive Comm. (2013-); MSU Museum Academic Advisory Comm. (2014-)		
Katherine Gross	University Distinguished Professor/Director, KBS	Director, KBS (2005-)	EEBB Executive Committee (2016-); PLB Chair Seach Committee (2015-16)	NSF BIO Advisory Committee (2011-); Chair 2014-); Editor in Chief *Oecologia* (2007-); SYSENC Adv Board (2013-16); NEON Educ Adv Comm (2009-12); Member Director Search Comm (2013-15)	
Stephen Hamilton	Professor/Associate Director, KBS	PI KBS LTER; Assoc Director KBS	IBIO	LTER Exec Board (2010-13); National Acad Comm on Effects of Diluted Bitumen (2014-15), Science advisor to International Joint Commission for the Great Lakes (2017)	Adjunct at Australian Rivers Inst.; co-advising PhD students in Australia and Brazil; ongoing research in Brazil and Kenya

Name	Title/Rank	KBS	Home Dept/MSU	National	International
Christopher Klausmeie	Foundation Professor	Chair Grad Committee(2013- ; Chair 2016-); Faculty Adv Committee (2013-15); Search Comm. Microbial Ecology(2012-2013)	Plant Bio RPT Committee (2016-); EEBB Quant Ecology Search Committee (2104-15); CNS FAC (2010, 2011) Plant Science Fellows Recruitment (2014-)	Assoc.Editor *Amer. Nat.(2014-),* J Theor Biology(2008-2015)	Adv Board Danish Center for Excellence (2011-);
Jennifer Lau	Associate Professor	Faculty Adv Comm (2015-) Search Comm. GII Ecology (2016-); Coor Terr Ecology Lab (2015-)	EEBB Seminar Committee (2010-)	Handling Editor Oecologia (2013-), J Ecology (2013-), Am J Bot (2017-) ; Am Soc Nat Secretary (2016); ESA Awards Buell/Braun (2008-), Mercer (2016-)	
Elena Litchman	Foundation Professor	Space Comm (2014-); Grad Committee (2012-2016; Chair 2014 -2016); Chair Seminar Comm (2017)	IBIO Fac Adv Committee (2016-), Grad Adv Comm (2015-); CNS Fac Adv Committee (2013-)	Handling Editor *Oecologia (2010-14),* J Plankton Res (2010-); Adv Board NCEAS (2010-14)	Adv Board Danish Center for Excellence (2011-16); Science Adv Board WasserClutz, Austria (2012-)
Gary Mittelbach	Professor	Coor KBS Expt Pond Lab (1987-); Search Commiittees - Microbial Ecol (2012-13), GII Terrestrial Ecologist, Chair (2016 17); Space Comm (2005; Chair 2014 -); Grad Affairs (2005-12; 2016 -)	EEBB Exec. Comm. (2000-2016); EEBB Curr. Comm. (2006-12); ZOL/IBIO Advisory Comm. (2012-13, Chair); EEBB Rereat Planning Comm. (2015-16)	Assoc. Editor Glob. Ecol. & Biogeog. (2009-15); ESA MacArthur Award Comm. (2014-present); ESA Eminent Ecologist Award Comm. (2013-17); NSF Panelist (2014, 2016)	
G. Philip Robertson	University Distinguished Professor	PI KBS LTER (1988-2017); Web IT Committee Chair (2013-); Faculty Adv Comm (2015-16); Outreach Comm (2015-16); Kellogg Farm Research Adv Comm (2014-)	GLBRC Mgmnt Team- (2008-); Science CoDirector (2017-); MSU Provost RPT Comm. (2015-); Search Committee MSU Provost (2013-14); Chair CANR Dean Search (2012-13); PSM Adv Comm (2011-13; Chair 2012-13); PSM Soil Biology Search Comm (2013-14); Chair, PSM Cropping Systems Agron Search (2016-17)	LTER Science Council, Member (1988-2016), Chair (2008-2012); US National Climate Assessement Lead Author (2013-14); NSF COV BIO Dir 2014), Ecosystems panels (2012-16); DOE Office of Science Biology and Environ Res Adv Comm (2010-);Research Comm LTAR (2014-); NEON Science & Educ Adv Comm (2009-12); USDA Wheat CAP science advisory board (2008-2016)	

Name	Title/Rank	KBS	Home Dept/MSU	National	International
Douglas Schemske	Hannah Distinguished Professor		EEBB Quan Biol Search (2012-14); EEBB Director; PLB Long Range Planning (2013-14); Plant Bio Search, Chair (2012-14)	Amer Soc Nat EO Wilson Award Committee (Chair); Editor Selection Committee (Chair); Young Inv Award Selection	
Santiago Utsumi	Assistant Professor	Coord. Pasture Dairy (2009-); Space Comm (2014-); Outreach Comm (2014-16)	Steering Comm. SAFS (2011-14)	USDA SARE Panel (2013-15); Member Technical Comm. North Central Region SARE (2013-15)	
Sarah Fitzpatrick	Assistant Professor	Space Comm (2016-); Outreach Comm (2016-)			

KBS Faculty Teaching
Academic Year (FS, Sp) and Summer (US)
Fall 2012 - Summer 2017

Name	Course Number	Course Title	Credits	Semesters Taught	Total # of Semesters	Campus or KBS?
Basso, Bruno	CSS 442	Agricultural Ecology	3	FS 14, FS 15, FS 16	3	Campus
	ISP 203	Global Change	3	Sp14, Sp15	2	Campus
	GLG 446	Water and Food	3	FS16	1	Campus
	GLG 893	Biological Modeling	2	S13, US15	2	KBS
Conner, Jeffrey	PLB 802	Evolution Discussion Group	1	Sp 12, Sp 13, Sp 15, Sp 16, Sp17	5	Campus
	PLB 849	Evolutionary Biology	3	Sp 12, Sp 13, Sp 15, Sp 16, Sp 17	5	Campus
	IBIO 440	Field Ecology and Evolution	4	US 12, US 13, US 15	3	KBS
Evans, Sarah	IBIO 357	Global Change Biology	3	Sp 16, Sp17	2	Campus
	PLB 809	Pathways to Success Seminar	1	Sp 15	1	KBS
	IBIO 890	Topics in Microbial Ecology and Evolution	1	Sp 15	1	
Fitzpatrick, Sarah	IBIO 357	Global Change Biology	3	Sp17	1	Campus
	PLB 849	Evolutionary Biology	3	Sp 16	1	Campus
Getty, Tom	IBIO 895	GK-12 Professional Development Seminar	1	Sp 12, FS 13, Sp 14, FS 14, Sp 15	5	KBS
	BS 182H	Honors Organismal Biology	3	FS 12, FS 13, FS 14, FS 15, FS 16	5	Campus
Gross, Katherine	IBIO 891	Eminent Ecologists Seminar	1-2	US 12, 13, 14, 15, 16	5	KBS

	PLB 809	Pathways to Success Seminar	1	Sp 16	1	KBS
Hamilton, Stephen	PLB 809	Pathways to Success Seminar	1	Sp 13, Sp14	1	Campus
	MMG 426	Biogeochemistry	3	US 12	1	KBS
	IBIO 897	Ecosystem Ecology & Global Change	4	Sp 13, Sp 15	2	Campus
	FW 417	Wetland Ecology & Management	3	US 14, US 15, US 16,US17	4	KBS
Klausmeier, Christopher	PLB 898	Population and Community Ecology Theory Lab	1	FS 12, FS 13, FS 14, FS 15, FS 16, FS 17	6	Campus
	PLB 809	ELME: Metacommunity Ecology & Evolution	1	US 13	1	KBS
	PLB 803	Integrative Topics in Plant Biology	2	FS 13	1	Campus
	PLB 802	Contemporary Concepts in Ecology	1	Sp 14	1	Campus
	IBIO 890	Quantitative Microbial Ecology & Evolution	1	Sp 15	1	KBS& Campus
	IBIO 896	Population and Community Ecology	4	FS 15, FS 16	2	Campus
Lau, Jennifer	PLB 802	Writing: Crafting Compelling Stories	1-4	Sp 12, Sp 14	2	KBS
	IBIO 355	Ecology	3	FS 12, FS 13	2	Campus
	IBIO 355	Ecology	3	US 13, US 15, US 16,	3	KBS (US)
	PLB 803	Integrative Topics – Plant Biology	2	FS 13	1	Campus
	PLB 801	Foundations of Plant Biology	3	FS 16	1	Campus
	IBIO 440	Field Ecology & Evolution	4	US 14, US17	1	KBS
Litchman, Elena	PLB 424	Algal Biology	4	US 13, US 15	2	KBS

	IBIO 896	Population & Community Ecology	4	FS 12, FS 13, FS 14, FS 15, FS16	5	Campus
	IBIO 890	Topics in Microbial Ecology and Evolution	1	Sp 15	1	Campus
Mittelbach, Gary	IBIO 895	Scientific Writing: Crafting Compelling Stories	1	Sp 12	1	KBS
	IBIO 440	Field Ecology & Evolution	4	US 12, US 13	2	KBS
	IBIO 896	Population & Community Ecology	4	FS 12, FS 13, FS 14, FS 15, FS 16	5	Campus
	IBIO 895	Seminar: Communication Science	1	Sp 13, Sp 14	2	Campus
	IBIO 895	Seminar: Evolution Discussion Group	1	Sp 14	1	Campus
Robertson, Phil	CSS 442	Agricultural Ecology	3	FS 12, FS 13, FS 14, FS 15, FS 16	5	Campus
Schemske, Doug	PLB 803	Integrative Topics: Plant Biology	2	Sp 12	1	Campus
	PLB 849	Evolutionary Biology	3	Sp 12, Sp 13, Sp 14, Sp 15	4	Campus
	PLB 802	Evolution Discussion Group	1	Sp 14	1	Campus
	PLB 801	Foundations of Plant Biology	3	FS 15	1	Campus
	PLB 804	Frontiers in Plant Biology	2	Sp 16	1	Campus
Utsumi, Santiago	PSM 424	Sust. Ag & Food Systems	3	FS11, FS12, FS13, FS15, FS16	5	Campus
	ANS 432	Alternative Dairy Systems	2	Sp14	1	Campus

Descriptions for Courses Taught by KBS Faculty

Academic Year and Summer

Fall 2012-Summer 2017

Animal Sciences

ANS 432: Advanced Dairy Cattle Management (Alternative Dairy Systems)
Management techniques for operating a dairy herd. Mastitis control, reproductive and nutrition management, records and general herd health. (Guest Lecturer)

Earth and Environmental Sciences

GLG 446: Ecosystems Modeling, Water and Food Security
Impacts of climate variability and change on water availability, food security and global environmental change. Integrated models to identify adaption and mitigation strategies to such changes and to enhance the efficiency of natural resources use.

Fisheries & Wildlife

FW 417: Wetland Ecology and Management
Biological, physical and chemical processes controlling wetland structure and function. Utilization, mitigation and conservation of wetlands on a sustainable basis.

Integrative Biology

IBIO 355: Ecology
Plant and animal ecology. Interrelationships of plants and animals with the environment. Principles of population, community, and ecosystem ecology. Application of ecological principles to global sustainability.

IBIO 357: Global Change Biology
Causes and consequences of modes of contemporary global change that are caused by biological systems or impact biological systems. Theories, evidence, and predictions in global warming, ocean acidification, desertification, eutrophication, food security and mass extinction.

IBIO 440: Field Ecology and Evolution
Solving conceptual and practical research problems in ecology and evolution under field conditions.

ZOL 895: GK-12 Professional Development Seminar
Graduate seminar on current research topics in zoology.

*ZOL 896: Population and Community Ecology
Population dynamics of animals and plants utilizing life tables and projection matrices. Species interaction. Life history theory. Structure and dynamics of communities. Succession.

*ZOL 897: Ecosystem Ecology and Global Change
Structure and function of natural ecosystems and their responses to global environmental change. Biogeochemical cycles, food webs, energy flow, nutrient cycling, and ecosystem management and restoration.

Integrative Studies in Physical Science

ISP 203: Global Change
Science as a way of knowing about natural and anthropogenic global change. Implications for societies.

Microbiology and Molecular Genetics

MMG 426: Biogeochemistry (Summer Only)
Integration of the principles of ecology, microbiology, geochemistry and environmental chemistry. Societal applications of research in aquatic and terrestrial habitats.

Plant Biology

PLB 424: Algal Biology
Algal taxonomy, systematics, physiology, ecology and environmental assessment. Lab focus on identification of freshwater algal genera collected from regional habitats.

PLB 801: Foundations of Plant Biology
An introduction to the history and current status of major research questions in plant biology, and approaches used to answer them.

PLB 802: Selected Topics in Plant Biology (Evolution Discussion Group)
Recent developments in plant biology.

PLB 803: Integrative Topics in Plant Biology
Integrative topics in plant biology. Molecular, physiological, ecological and evolutionary perspectives. Proposal writing and presentation.

PLB 804: Frontiers in Plant Biology
Introduction to new and emerging research directions in the plant sciences, and provide tools needed for professional development.

*PLB 849: Evolutionary Biology
Major conceptual, theoretical and empirical questions in evolutionary biology. Readings and lectures are synthesized in student discussions and papers.

PLB 898: Population and Community Ecology Theory Laboratory
Practical experience designing and analyzing mathematical models in ecology from single species to communities, food webs and ecosystems.

Plant, Soil and Microbial Sciences

PSM 424: Sustainable Agriculture and Food Systems: Integration and Synthesis
Biogeochemical and socio-economic aspects of food, fiber and fuel production. Environmental impacts and social context. Experiential learning projects.

PSM 442: Agricultural Ecology
Ecological principles in the design and management of agricultural ecosystems. Integration of ecological factors regulating crop and rangeland productivity.

*Courses are part of the Ecology, Evolutionary Biology and Behavior (EEBB) curriculum.

PLB Teaching Schedule

	Semester/ Frequency	Title	course #	# credits	# students	Proportion of course or # lectures	Notes
Courses not covered currently	FS every year	Tropical Biology	IBIO 485				Co-instruct with C. Lindell
Brandizzi, Federica	SS every year	Eukaryotic Cell Biology	MMG 409	3	150 to 200	1/3 course	
Brudvig, Lars	FS even years	Organisms and Populations	BS 162	3	150 to 200	all	
	FS odd years	Restoration Ecology	PLB 443	3	25 to 35	all	
Robin Buell	FS every year	Plant Genomics	PLB 812	3	8 to 20	all	
Conner, Jeff	SS every year	Selected Topics in Plant Biology	PLB 802	1 to 4			EDG
	SS every year	Evolutionary Biology	PLB 849	3	25 to 25	half of course	SS
Ding, Shiyou	FS every year	Introductory Plant Physiology	PLB 301	3	20 to 25	all	FS
Ebert-May, Diane	FS even years	Organisms and Populations	BS 162	3	150 to 200	all	FS
	FS every year	Biology of Plants	PLB 203	3	19	all	FS
	FS every year	Selected Topics in Plant Biology	PLB 802	1	14	all	FS
Farre, Eva	SS every year	Plant Physiology Laboratory	PLB 416L	1	7		SS
	Fall & Spring	Plant Biology Laboratory	PLB 106				Lab coordinator.

PLB Teaching Schedule

	Semester/ Frequency	Title	course #	# credits	# students	Proportion of course or # lectures	Notes
Friesen, Maren	FS every year	Evolution	ZOL 445	3	80 to 100	all	
Gross, Kay	US every year	Current topics in Ecology & Evolution	IBIO/PLB 891	1 or 2	25- 30	all	
He, Sheng Yang	SS every year	Plant Molecular & Omic Biology	PLB 856	3	15 to 20	1/3 of course	
Hu, Jianping	SS every year	Senior Seminar	PLB 499	2	5 to 15	all	
	FS even years	Plant Growth and Development	PLB 865	3	5 to 10	half	
Jarosz, Andrew	FS odd years	Organisms and Populations	BS 162	3	150 to 200	all	
	SS odd years	Epidemiology of Plant Diseases	PLP 812	3	5 to 15	all	
Klausmeier, Chris	FS every year	Pop & Com Ecol Theory Lab	PLB 898	1	5 to 10	all	Ended Fall 2016
	FS every year	Pop & COM (EEBB)	IBIO/PLB 896	4	20 to 30	half	Starting in 2017
	SS every second year	Grad seminar	Various		10 to 15	Half	
Last, Rob	SS every year	Plant Molecular & Omic Biology	PLB 856	3	10 to 20	two-thirds of course	Course organizer
	FS even years	Sel Topics in Biochemistry I	BMB 960	1	10 to 15	one-third of course	Course organizer
	SS odd years	Frontiers in Biochemistry	BMB 101	1	125	1 lecture	

PLB Teaching Schedule

	Semester/ Frequency	Title	course #	# credits	# students	Proportion of course or # lectures	Notes
Lau, Jennifer	FS every year	Foundations of Plant Biology	PLB 801	3	5 to 15	1 of 5 modules	
	SS every year	Frontiers in Plant Biology	PLB 804	2	5 to 15	co-instructor	
	FS & SS	Coordinator	801 & 804	2 + 3	5 to 15		coordinates course with Yair Shachar-Hill
	US even year	Intro to Ecology	ZOL 355	3	9	all	
	US odd years	Field Ecology and Evolution	ZOL 440	4	12	50%	
Long, Tammy	FS odd years	Organisms and Populations	BS 162	3	150 to 200	all	
	FS even years	Plants of Michigan	PLB 218	3	40 to 50	all	
Lowry, David	FS of even years	Plant Structure & Function	PLB 434	4	15 to 25	all	
	FS of odd years	Fundamental Genetics	IBIO 341	4	150 to 220	half	
Malmstrom, Carolyn	FS every year	Plant Ecology	PLB 441	3	25 to 35	all	
Osteryoung, Kathy	SS every year	Cells and Molecules	BS 161	3	250 to 300	co-instructor	
	SS every year	Plant Systematics	PLB 418	3	40 to 55	all	
Prather, Alan	FS every year	Foundations of Plant Biology	PLB 801	3	8 to 15	1 of 5 modules	
Shachar-Hill, Yair	SS even years	Hnrs Cell Molecular Biology	BS 181H	3	80 to 110	all	

PLB Teaching Schedule

	Semester/ Frequency	Title	course #	# credits	# students	Proportion of course or # lectures	Notes
	FS every year	Foundations of Plant Biology	PLB 801	3	5 to 15	1 of 5 modules	
	SS every year	Frontiers in Plant Biology	PLB 804	2	5 to 15	co-instructor	
	FS & SS	Coordinator:	PLB 801 & 804	2 + 3	5 to 15		coordinator with Jen Lau
Shiu, Shinhan	FS even years	Introduction to Bioinformatics	PLB 400/810	3	12	all	
	FS odd years	Fundamental Genetics	ZOL 341	4	150 to 220	half	
	FS every year	Foundations of Plant Biology	PLB 801	3	5 to 15	1 of 5 modules	
Telewski, Frank	SS odd year	Environmental Plant Physiology	PLB 863	3	5 to 15	one-third	
Trail, Frances	SS odd year	Hnrs Cell Molecular Biology	BS 181H	3	80 to 110	all	
	FS odd years	Biology of Fungi	PLB 402	4	20 to 30	all	
Walton, Jonathan	SS every year	Plant Physiology	PLB 415	3	25 to 35	all	
Weber, Marjorie	FS every year	Stat Methods in Ecology & Evolution (EEBB)	IBIO 851	3	25 to 35	half	Begins Fall 2017; course will be revised in future so course number likely to change
	FS every year	Ecology	IBIO 355	3	150 to 200	half	Begins Fall 2018
Wilkerson, Curtis	SS every year	Cells and Molecules	BS 161	3	250 to 300	co-instructor	

PLB Teaching Schedule

Semester/ Frequency	Title	course #	# credits	# students	Proportion of course or # lectures	Notes
FS every year	Foundations of Plant Biology	PLB 801	3	5 to 15	1 of 5 modules	
FS every year	Plant Biochemistry	BMB 864	3	5 to 15	3, 1.5 hour lectures	
[redacted]						

RESUME

Bruno Basso, PhD

University Foundation Endowed Professor
Dept. Earth and Environmental Sciences and W.K. Kellogg Biological Station
Michigan State University

Summary

Research interests:

- Precision Agriculture and Crop Modeling
- Water, carbon and nitrogen cycling and modeling
- Agricultural Systems and Environmental Sustainability

Dr. Basso has participated as PI and Co-PI in several international projects. He is the author of more than 150 technical publications.

Professional Preparation

PhD.	2000	Michigan State University, - Crop and Soil Sciences
Laurea	1992	University of Naples- Federico II, Italy - Agricultural Sciences

Appointments

2017 – present	University Foundation Professor, MSU
2015- 2017	Full Professor, Dept. Earth and Environmental Sciences, and W.K. Kellogg Biological Station, Michigan State University, USA
2012- present	Tenure Assoc. Professor, Dept. Geological Sciences and W.K. Kellogg Biological Station, Michigan State University, USA
2005 - 2012	Assoc. Professor, Dept. Crop Systems, Forestry and Environ. Science, University of Basilicata, Italy
2000 - 2005	Assistant Professor, Dept. Crop Systems, Forestry and Environ. Sciences, University of Basilicata, Italy
2008 - present	Adjunct Professor, Queensland University of Technology, Ist. Future Environment , Brisbane, Australia
1997	Visiting Research associate CIMMYT – Mexico DF. Mexico,
1998	Visiting Research associate -ICRISAT – Andra Pradesh,. India
1993	Research assistant - CRC, CISRO- Waite Inst. Adelaide - Australia

Honors and Awards

2016	MSU Innovation of Year for Precision Agricultural Systems Analysis Software
2015	Fellow Soil Science Society of America
2013	Fellow of the American Society of Agronomy
2010	Pierre Robert Precision Agriculture Award - International Society of Precision Agriculture
2008	L. Frederick Lloyd Soil Teaching Award - Soil Science Society of America
2007	L.R. Ahuja Agricultural System Modeling Award - Soil Science Society of America

Recent Selected Publications

Chenu, J.PR. Porter, B. **Basso** et al., 2017. Contribution of crop models to adaptation in wheat. Trends in Plant Sciences in press

Liu, B., et al., 2016. Similar estimates of temperature impacts on global wheat yield by three independent methods. In print in **Nature Climate Change**

Jones, JW. et al.. 2016. Brief history of agricultural systems modeling. **Agricultural Systems** http://dx.doi.org/10.1016/j.agsy.2016.05.014

Albarenque, SM., **B. Bass**o, OP Caviglia, RJM Melchiori. 2016. Spatio-Temporal Nitrogen Fertilizer Response in Maize: Field Study and Modeling Approach. 2016. **Agronomy Journal** Vol. 108, Issue 5 1-13

Basso, B., et al.. 2016. Environmental and economic benefits of variable rate nitrogen fertilization in a nitrate vulnerable zone**. Science of The Total Environment** Vol. 545–546, 1

Basso, B., Liu, L., Ritchie, J.T. 2016. A Comprehensive Review of the CERES-Wheat, -Maize and-Rice Models' Performances. **Advances in Agronomy**. Pages 1-106 http://dx.doi.org/10.1016/bs.agron.2015.11.004

Basso, B., et al.,. 2016. Tradeoffs between maize yield and nitrate leaching in a Mediterranean nitrate-vulnerable zone under current and projected climate scenarios. **PLOS ONE** DOI: 10.1371/journal.pone.0146360

Basso B., et al.. 2015. Can Impacts of Climate Change and Agricultural Adaptation Strategies Be Accurately Quantified if Crop Models Are Annually Re-Initialized? **PLOS ONE**, Vol 10, 6. DOI: 10.1371/journal.pone.0127333

Asseng, S., et al, 2015. Rising temperatures reduce global wheat production. 2015. **Nature Climate Change** Doi:10.1038/nclimate2470

Stuart D., **Basso, B**. S. et al.. 2015. Coupled Human-Natural Systems Understanding of Agricultural Nitrogen Loss. **Bioscience** 65,6, 571-578

Dumont, B., **Basso, B**. et al., 2015. A comparison of within season yield prediction algorithms based on crop model behaviour analysis. **Agricultural and Forestry Meteorol**. Vol 204, 10-21

Bassu, S. et al., 2014. How do various maize crop models vary in their responses to climate change factors? **Global Change Biology** Volume: 20 Issue: 7 Pages: 2301-2320

Basso B. and J. T. Ritchie. 2014. Temperature and drought effects on maize yield. **Nature Climate Change** 4, 233 (2014) doi:10.1038/nclimate2139

Basso, B. A.D. Kendall, D.W. Hyndman. 2013. The future of agriculture over the Ogallala Aquifer: Solutions to grow crops more efficiently with limited water. Earth's Future. 10.1002/2013EF000107

Asseng, S. F. et al., 2013. Quantifying uncertainties in simulating wheat yields under climate change. **Nature Climate Change**. June 2013 | doi: 10.1038/nclimate1916

Biographical Sketch - JEFFREY CONNER

a. Professional Preparation

Harvard College	Cambridge, MA	Biology	B.A. *cum laude*, 1979
Cornell University	Ithaca, NY	Behavioral Ecology	Ph.D., 1987
Cornell University	Ithaca, NY	Evolutionary Genetics	Postdoctoral, 1987-1990

b. Appointments

2003 – present: Professor, Michigan State University
Kellogg Biological Station (KBS) and Department of Plant Biology
Programs: Ecology, Evolutionary Biology, and Behavior; Beacon STC; Genetics

1997-2003: Associate Professor, KBS, Dept. of Plant Biology, Michigan State University
1996-1997: Assistant Professor, KBS, Dept. of Plant Biology, Michigan State University
1990-1996: Assistant Professor, Dept. of Ecology, Ethology, and Evolution, Univ. of Illinois.

c. Products (available at www.msu.edu/~connerj)

Closely related products (indicates undergraduate co-author):*

Royer, A.M., C. Kremer, K. George*, S.G. Pérez, D.W. Schemske, and J.K. Conner. 2016. Incomplete Loss of a Conserved Trait: Function, Latitudinal Cline, and Genetic Constraints. Evolution 70: 2853-2864 (DOI: 10.1111/evo.13121).

Roles, A.J., M.T. Rutter, I. Dworkin, C.B. Fenster, and J.K. Conner. 2016. Field measurements of genotype by environment interaction for fitness caused by spontaneous mutations in *Arabidopsis thaliana*. Evolution 70: 1039-1050.

Moghe, G. D., D. E. Hufnagel*, H. Tang, Y. Xiao, I. Dworkin, C. D. Town, J. K. Conner, and S.-H. Shiu. 2014. Consequences of whole-genome triplication as revealed by comparative genomic analyses of the wild radish *Raphanus raphanistrum* and three other Brassicaceae species. The Plant Cell 26:1925-1937.

Rutter, M.T., A. Roles, J.K. Conner, R.G. Shaw, F.H. Shaw, K. Schneeberger, S. Ossowski, D. Weigel, C.B. Fenster. 2012. Fitness of *Arabidopsis thaliana* mutation accumulation lines whose spontaneous mutations are known. Evolution 66: 2335-2339.

Sahli, H. and J.K. Conner. 2011. Testing for conflicting and non-additive selection: floral adaptation to multiple pollinators through male and female fitness. Evolution 65: 1457-1473.

Other significant products:

Dittmar, E.L., C.G. Oakley, J.K. Conner, B.A. Gould, and D.W. Schemske. 2016. Factors influencing the effect size distribution of adaptive substitutions. Proceedings of the Royal Society B 283:20153065. (F1000 Prime recommended)

terHorst, C.P., J.A.Lau, I.A.Cooper, K.R.Keller, R.J. La Rosa, A.M. Royer, E.H. Schultheis, T. Suwa, and J.K. Conner. 2015. Quantifying non-additive selection caused by indirect ecological effects. Ecology 96:2360-2369

Conner, J. K., I. A. Cooper, R. J. La Rosa, S. G. Pérez, and A. M. Royer. 2014. Patterns of phenotypic correlations among morphological traits across plants and animals. Philosophical Transactions of the Royal Society B: Biological Sciences 369:20130246

Conner, J.K., Karoly, K., Stewart, C., Koelling, V.A., Sahli, H.F., and Shaw, F.H. 2011. Rapid Independent Trait Evolution Despite a Strong Pleiotropic Genetic Correlation. American Naturalist 178: 429-441. (lead article)

Conner, J. K. 2002. Genetic mechanisms of floral trait correlations in a natural population. Nature 420: 407-410. (Summarized, in Futuyma, D. J. 2005. *Evolution*. Sinauer.)

d. Synergistic Activities

Elected Fellow, American Association for the Advancement of Science (AAAS), 2011.

Mentor for high school interns (17 to date; two teams qualified for National Intel Science Fair) and undergraduate research students (over 180 to date) including many REU; at least 7 have gone on to Ph.D programs in ecology/evolution, and 4 have faculty positions. Ten former undergraduates are authors (two as first author, one African-American) on 11 published papers. Three have presented posters at the Annual Biomedical Research Conference for Minority Students (ABRCMS) and two at the OPT-ED Leadership Conference. These students are mostly women, including two with disabilities, 17 African-American, one Latina, one Pacific Islander, and one Native American. I have ongoing collaborations with Greg Goins at North Carolina A&T, Aditi Pai at Spelman College (both HBCUs), and Matt Rutter at College of Charleston in which they identify excellent undergraduates to do summer research in my lab. I was a co-PI on an NSF GK-12 grant, and have two RETs in my lab each summer (11 to date) who work in collaborative teams with the REUs. I have also done an in-service workshop for teachers, school visits, and volunteer consulting in informal education.

Outstanding Graduate Advisor, College of Natural Science, Michigan State University, 2003.

Textbook: Conner, J. K. and D. L. Hartl. 2004. *A Primer of Ecological Genetics*. Sinauer Associates, Sunderland, MA. (Second printing; translated into Italian and Lithuanian)

National and international service: Editor, Special Feature on measuring natural selection, *Methods in Ecology and Evolution,* 2017; Distinguished Sabbatical Scholar, National Evolutionary Synthesis Center, 2013-2014; Handling Editor, *Evolution*, 2013-2015; Editor, special issue on natural selection, *International Journal of Plant Sciences,* 2009-2010; Editorial Boards: *International Journal of Plant Sciences,* 2010-2012; *Oecologia,* 2007-08; *J. Evolutionary Biology*, 2004-07, *Evolution*, 1999-2001; Member, NSF Evolutionary Processes Panels, 1996, 2004, 2010, 2012; NSF Plant Genome Panel 2015; Ecological Society of America, Plant Population Ecology Chair, 1998-99. Member, NSF Beacon STC and NSF microMorph RCN, 2010-present. Reviewer for 32 journals, 6 funding agencies, and 5 publishers.

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MICHIGAN STATE UNIVERSITY
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(i) PROFESSIONAL PREPARATION:

Grinnell College	Biology	B.A., May, 2005
Colorado State University	Ecology	PhD Ecology, May 2012
University of California Irvine	Ecology	Postdoctoral Fellow 2012-2014

(ii) APPOINTMENTS:

Date(s)	Appointment
Aug. 2014-	Assistant Professor, Kellogg Biological Station, Michigan State Univ.
2012-2014	NSF Postdoctoral Fellow, University of California, Irvine
2012 summer	International Institute for Applied Systems Analysis (IIASA) Summer Fellow
2009-2012	NSF GRFP Fellow, CSU Natural Resource Ecology Lab
2007-2008	Teaching Assistant, CSU Warner College of Natural Resources
2008-2009	Research Assistant, CSU / Shortgrass steppe LTER
2008	NSF EAPSI Fellow, Chinese Academy Sciences, Beijing, China
2005-2006	GrinnellCorps Fellow, Gobabeb Desert Research Station, Namibia

(iii) PRODUCTS:

(i) 5 products most closely related to the proposed project

Evans, SE, J. Martiny, S. Allison. 2016. Effects of dispersal and selection on stochastic assembly in microbial communities. *International Society for Microbial Ecology Journal (ISMEJ).* doi:10.1038/ismej.2016.96

Evans, SE, U Dieckmann, O Franklin, K Kaiser. 2015. Synergistic effects of diffusion and microbial physiology reproduce the Birch effect in a micro-scale model. *Soil Biology and Biochemistry* 93: 28-37.

Rocca, JD, EK Hall, JT Lennon, **SE Evans,** MP Waldrop, JB Cotner, DR Nemergut, EB Graham, MD Wallenstein. 2015. Relationships between protein-encoding gene abundance and corresponding process are commonly assumed yet rarely observed. *ISMEJ* 9**:** 1693–1699

Evans, SE, MD Wallenstein. 2014. Climate change alters the ecological strategies of soil bacteria. *Ecology Letters* **17**(2): 155-164.

Evans, SE, MD Wallenstein, IC Burke. 2014. Is bacterial moisture niche a good predictor of shifts in community composition under long-term drought? *Ecology* 95(1): 110-122. http://dx.doi.org/10.1890/13-0500.1

(ii) Other significant products

Jacobson, KM, A van Diepeningen, **SE Evans**, R. Fritts, P Gemmel, C Marsho, MK Seely, A Wenndt, X Yang, PJ Jacobson. 2015. Non-rainfall moisture activates fungal decomposition of surface detritus in the Namib Sand Sea. *PLOS One***.** 10(5): e0126977.

Evans, SE, IC Burke. 2013. Carbon and nitrogen decoupling under an 11-year drought in the shortgrass steppe. *Ecosystems*, **16**(1) 20-33. doi: 10.1007/s10021-012-9593-4

Evans, SE and MD Wallenstein. 2012. Soil microbial community response to drying and rewetting stress: does historical precipitation regime matter? *Biogeochemistry* **109:**101-116. doi: 10.1007/s10533-011-9638-3

Evans, SE , KM Byrne, IC Burke and WK Lauenroth. 2011. Defining the limit to resistance in a drought tolerant grassland: long-term severe drought significantly reduces the dominant species and increases ruderals. *Journal of Ecology* **99**: 1500-1507. doi: 10.1111/j.1365-2745.2011.01864.x.

Conant, RT, MG Ryan, GI Ågren, HE Birge, EA Davidson, PE Eliasson, **SE Evans**, SD Frey, CP Giardina, F Hopkins, R Hyvönen, MUF Kirschbaum, JM Lavallee, J Leifeld, WJ Parton, JM Steinweg, MD Wallenstein, JÅ Martin Wetterstedt, and MA Bradford. 2011. Temperature and soil organic matter decomposition rates – synthesis of current knowledge and a way forward. *Global Change Biology* **17**: 3392–3404. doi: 10.1111/j.1365-2486.2011.02496.x

(iv) SYNERGISTIC ACTIVITIES:

Undergraduate mentoring (targeting women and minority groups):

2015-2016. At KBS, have mentored 4 undergraduates, 3 of which are minority students: Hepsiba Chepengo, Kelechi Ukachukwu, Kathryn Bloodworth, and Ben Dougherty.

2014. ESA SEEDS mentor (Strategies for Ecology Education, Diversity, & Sustainability), ESA annual meeting, Sacramento, CA

2008-2009. Mentored 3 female students on independent projects during PhD

Working Group leadership and participation (those relevant to project):

Session Organizer and moderator, ESA Annual Meeting. IGNITE session "Put a number on it: quantitative microbial ecology for deeper and broader scientific impact. Portland, OR, 2017.

Leader, LTER All Scientists Meeting Working Group: "LTER-based perspectives on analyzing microbial structure, function, and process". Estes Park, CO, 2015.

Invited participant, FOGLIFE collaboration between meteorologists and biologists to assess changes in climate and biotic responses in the Namib Desert and other deserts, 2014-2016

Participant and co-grant writer, "Next Generation of Microbial Ecological Indicators", USGS Powell Center, 2012-2015:

Participant, "Prioritizing directions for long-term ecological research in the U.S." (NSF award to Lau and Bradford), 2015

Reviewer and Panelist:

Journals reviewed: *Nature Climate Change, Ecology Letters, Global Change Biology, Soil Biology and Biochemistry, New Phytologist, Environmental Management, Soil Biology and Biochemistry, Soil Science Society of America Journal, Acta Oecologica*

DEB Ecosystems Panel, NSF Doctoral Dissertation Improvement Grant (DDIG), 2015

Leader in Professional development and Symposium organization

Instructor, Professional Development Seminar, Kellogg Biological Station. 2015. 19 students and postdocs currently enrolled to enhance academic and non-academic career skills

Organizing Committee and Secretary, Front Range Student Ecology Symposium, Colorado State University, 2009-2012.

Graduate Student Representative, Natural Resource Ecology Lab, Colorado State University, 2010

BIOGRAPHICAL SKETCH

SARAH W. FITZPATRICK

Department of Integrative Biology
W.K. Kellogg Biological Station
Michigan State University
Hickory Corners, MI 49060

Telephone: (970) 491-3289
Fax: (269) 671-2104
email: sfitz@msu.edu

1. EDUCATION AND TRAINING

Cornell University	Ecology & Evolutionary Biology	B.S., 2008
Colorado State University	Zoology	Ph.D., 2015
Michigan State University	Biology	Research Associate, 2015-2018

2. RESEARCH AND PROFESSIONAL EXPERIENCE

Date(s)	Appointment
2017-present	Assistant Professor, Kellogg Biological Station, Michigan State University
2015-2016	Research Associate, Kellogg Biological Station, Michigan State University
2014-2015	Edward & Phyllis Reed Fellow, Colorado State University
2010-2014	NSF GRFP Fellow, Colorado State University
2012	Global Sustainability Leadership Fellow, Colorado State University
2008-2009	Research Assistant, Colorado State University
2007-2008	Research Assistant, Cornell University
2007	Howard Hughes Undergraduate Research Fellow

3. PUBLICATIONS

(i) Five Most Closely Related to the Proposed Project

Kronenberger JA, Funk WC, Smith JW, **Fitzpatrick SW**, Angeloni LM, Broder ED, Ruell EW (2017) Testing the demographic effects of divergent immigrants on small populations of Trinidadian guppies. ***Animal Conservation***, in press.

- Highlighted in ***Animal Conservation*** with three commentaries written about it by Dave Tallmon, L. Scott Mills, and Catherine Grueber

Fitzpatrick SW, Gerberich JC, Angeloni LM, Bailey LL, Broder ED, Torres-Dowdall J, Handelsman CA, López-Sepulcre A, Reznick DN, Ghalambor CK, Funk WC (2016) Gene flow from an adaptively divergent source causes rescue through genetic and demographic factors in two wild populations of Trinidadian guppies. ***Evolutionary Applications*** 9:879-891.

- Invited contribution to special issue on '*Gene Flow and Applied Evolutionary Biology'*

Havird JC, **Fitzpatrick SW**, Kronenberger J, Funk WC, Angeloni LM, Sloan DB (2016) Sex, mitochondria, and genetic rescue. ***Trends in Ecology and Evolution*** 31:96-99.

Fitzpatrick SW, Gerberich JC, Kronenberger J, Angeloni LM, Funk WC (2015) Locally adapted traits maintained in the face of high gene flow. ***Ecology Letters*** 18, 37-47.

- Recommended as having high significance in the field by F1000

Whiteley AR*, **Fitzpatrick SW***, Funk WC*, Tallmon DA* (2015) Genetic rescue to the rescue. ***Trends in Ecology and Evolution*** 30, 42-49.
*All authors contributed equally.

- Featured on the cover of ***Trends in Ecology and Evolution***
- Designated a **"Highly Cited Paper"** by ***Web of Science***

(ii) Five Other Significant Products

Funk, WC, RE Lovich, PA Hohenlohe, CA Hofman, SA Morrison, TS Sillett, CK Ghalambor, JE Maldonado, TC Rick, MD Day, NR Polato, **SW Fitzpatrick**, TJ Coonan, KR Crooks, A Dillon, DK Garcelon, JL King, CL Boser, LM Lyren, EE Boydston, N Gould, WF Andelt. (2016). Drift drives

divergence: genomic analysis of the evolutionary mechanisms causing genetic differentiation in the island fox (*Urocyon littoralis*). ***Molecular Ecology*** 25:2176-2194.

- Featured in the ***The New York Times*** (Zimmer, Carl, ***The New York Times***, April 21, 2016)

Fitzpatrick, SW, H Crockett, WC Funk (2014). Water availability strongly impacts population genetic patterns of an imperiled Great Plains stream fish. ***Conservation Genetics*** 15:771-788.

Fitzpatrick SW, Torres-Dowdall J, Reznick RN, Ghalambor CK, Funk WC (2014) Parallelism isn't perfect: Could disease and flooding drive a life history anomaly in Trinidadian guppies? ***American Naturalist*** 183, 290-300.

Fitzpatrick, SW, CA Brasiliero, CFB Haddad, KR Zamudio (2009). Geographic variation in genetic structure of an Atlantic Coastal Forest endemic reveals regional differences in habitat stability. ***Molecular Ecology*** 18 (13):2877-96.

D. Synergistic Activities

K-12 education and teacher training. I participate in the K-12 partnership at W.K. Kellogg Biological Station. In Fall 2016 I gave the plenary talk to 45 teachers attending the KBS Fall Workshop. I am working with 4th grade teachers to bring guppies into their classroom as a tool for teaching evolution, animal behavior, and data collection techniques.

Advising natural resource managers and policy makers. I have advised natural resource managers and policy makers on population genetic results relevant to conservation and management of native fishes and other threatened wildlife. For example, I briefed the Native Plains Fishes team in Colorado Parks and Wildlife on results from our Arkansas darter population genetics study. I was also asked to share these results with US Fish and Wildlife during their review of the species as a candidate for listing under the Endangered Species Act. I was also asked to lead a conservation genetics workshop for the American Fisheries Society Colorado/Wyoming division.

Organizer of grassroots conservation efforts in Northern Range, Trinidad. In 2013 I organized a group of biologists from University of West Indies in Trinidad, local educators, and international researchers to discuss top threats and conservation priorities for the biodiversity of the Northern Range mountains. We have followed up on these priorities and have launched the first long-term wildlife monitoring study using motion-sensing cameras donated by the NGO *Panthera.*

Co-leader of 'Trinidad Evolution Education Workshop'. In 2013 I was asked to participate in the NESCent Ambassador Program and co-lead a workshop for providing high school biology teachers in Trinidad with resources for teaching evolution. More than 60 teachers participated in the workshop and I have since visited several of their classrooms to present about our evolution research in Trinidad.

Mentor for undergraduates participating in research. I am strongly committed to advising undergraduate students in research, as demonstrated by my track record of mentoring 10 women and 4 men during graduate school (2010-2015). In 2014 was awarded the Colorado State University Excellence in Undergraduate Research Mentoring Award at both departmental (Biology) and college (College of Natural Sciences) levels.

NSF Biographical Sketch: Thomas Getty

Professor & Chair, Department of Integrative Biology
Professor, W.K. Kellogg Biological Station
Michigan State University
https://www.msu.edu/~getty
getty@msu.edu

Professional Preparation

University of Michigan	Science Engineering	B.S.E. 1972
University of Michigan	Biology	Ph.D. 1980
Oxford University	NATO Postdoctoral Fellow	1981-82
University of British Columbia	NATO Postdoctoral Fellow	1981-82
University of Georgia	NSF Postdoctoral Fellow	1984-86

Appointments

2013 -	Chair, Department of Integrative Biology, MSU
2010-2011	Acting Director, W.K. Kellogg Biological Station
1986-present	Assistant, Associate, and Full Professor Department of Zoology and W.K. Kellogg Biological Station Michigan State University
1984-1986	Research Associate, University of Georgia
1983-1984	Lecturer, Biology, University of Michigan
1981-1982	NATO Postdoctoral Fellow, Oxford, UK and U.B.C., Canada
1980-1981	Lecturer, Biology, University of Michigan
1972-1980	TA & RA, Biology, University of Michigan

Primary Research Interests Evolution and ecology of behavior, communication, sociality, sexual selection.

Five Publications Most Closely Related to Proposed Work

Gering, E, M Johnsson, P Willis, T Getty and D Wright. 2015. Mixed ancestry and admixture in Kauai's feral chickens: invasion of domestic genes into ancient Red Junglefowl reservoirs. Molecular Ecology 24: 2112–2124.

Getty, T. 2014. GEIs when Information Transfer is Uncertain or Incomplete. In J. Hunt and D.J. Hosken (Eds.) Genotype-by-Environment Interactions and Sexual Selection (Chapter 2). Oxford, UK: Wiley-Blackwell.

Abbot, P. et al. 2011. Inclusive fitness theory and eusociality. Nature 471, E1.

Getty, T. 2006. Sexually selected signals are not similar to sports handicaps. Trends in Ecology and Evolution 21:83-88.

Getty, T. 2002. Signaling health versus parasites. American Naturalist 159:363-371.

Five Other Significant Publications

Cooper, I. A., Brown, J. M. and Getty, T. 2015. A role for ecology in the evolution of colour variation and sexual dimorphism in Hawaiian damselflies. Journal of Evolutionary Biology. doi: 10.1111/jeb.12796

Kuczynski, M. C., Gering,G. and Getty, T. 2015. Context and condition dependent plasticity in sexual signaling in gray treefrogs. Behavioural Processes 124: 74-79. DOI: 10.1016/j.beproc.2015.11.020

Kuczynski, M. C., Bello-DeOcampo, D. and Getty, T. 2015. No Evidence of Terminal Investment in the Gray Treefrog (Hyla versicolor): Older Males Do Not Signal at Greater Effort. Copeia:530-535. DOI: 10.1643/CE-14-156.
Olendorf, R., T. Getty, K. Scribner & S.K. Robinson. 2004. Male red-winged blackbirds distrust unreliable and sexually attractive neighbours. Proceedings: Royal Society London B. 271:1033-1038.
Olendorf. R, T. Getty & K. Scribner. 2004. Cooperative nest defense in red-winged blackbirds: reciprocal altruism, kinship or by-product mutualism? Proceedings: Royal Society London B 271:177-182.

Synergistic Activities

1. coPI, NSF DRL: Sustaining Responsive and Rigorous Teaching Based on Carbon: Transformations in Matter and Energy.
2. PI, NSF GK-12: The KBS GK-12 Bioenergy Sustainability Project.
3. NSF STC: BEACON Evolution in Action (Chair of the Education & HR Steering Committee)
4. Chair, MSU's Ecology, Evolutionary Biology & Behavior (EEBB) Graduate Committee.

Teaching and Training Activities:

Teaching: My regular rotation is Honors Introductory Organismal Biology (BS148h) in the fall, with a typical enrollment of 90 freshmen and sophomores. On occasion I contribute to the Enhancing Linkages between Mathematics and Ecology (ELME) summer courses at KBS. I co-directed educational activities in the NSF GK-12 Project: Ecological Literacy in the K-12 Classrooms of Rural Michigan. I currently lead graduate training and K-12 outreach activities for the KBS GK-12 Bioenergy Sustainability Project. I Chair the Graduate Committee for MSU's EEBB Interdisciplinary Graduate Program and I serve on the EEBB Curriculum Committee. I Chair the BEACON EHRD Steering Committee and serve as coPI on several BEACON-funded education projects.

Katherine L. Gross
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Professional Preparation

Iowa State University	Ames, IA	Biology	B.S. 1975
Michigan State University	E Lansing, MI	Zoology	Ph.D. 1980

Appointments

2005 -	Director, W. K. Kellogg Biological Station, Michigan State University
2005 -	University Distinguished Professor, Michigan State University
2004 -2005	Acting Director, W. K. Kellogg Biological Station, Michigan State University
1995-	Professor, Dept. of Plant Biology (formerly Botany and Plant Pathology) and W.K. Kellogg Biological Station, Michigan State University
1987-95	Associate Professor, W.K. Biological Station, Michigan State University (jointly appointed in Zoology and Botany/Plant Path. Depts)
1980-87	Assistant/Associate Professor, Botany Department, Ohio State University Columbus, Ohio

Publications

Five publications most closely related to proposed project (total 100+)

Gelfand, I, S. Ritvik, X. Zhang, R.C. Izaurralde, **K.L. Gross**, and G. P. Robertson. 2013. Sustainable bioenergy production from marginal lands in the US Midwest. Nature 493: 514-517.

Robertson, GP, **KL Gross**, SK Hamilton, DA Landis, TM Schmidt, SS Snapp, and SM Swinton. 2014. Farming for Ecosystem Services: An Ecological Approach to Row-crop Agriculture. BioScience 64: 404-415

Hallett, LM, JS Hsu, EE Cleland, SL Collins, TL Dickson, EC Farrer, LA Gherardi, **KL Gross**, RJ Hobbs, L Turnball, KN Suding. 2014. Biotic mechanisms of ecosystem stability change with precipitation variability. Ecology 95: 1693-1700

Gross, K.L. S. Emery, A.S. Davis, R.G. Smith, T.M.P. Robinson. 2015. Plant community dynamics in agricultural and successional fields. Pages 158-187, *in* S. K. Hamilton, J. E. Doll, and G. P. Robertson, editors. The Ecology of Agricultural Landscapes: Long-term Research on the Path to Sustainability. Oxford University Press, New York, New York, USA.

Dickson, TL and **KL Gross**. 2015 Can results of biodiversity-ecosystem productivity studies be translated to bioenergy production? PLoS ONE 10: e0135253. doi:10.1371/journal.pone.0135253

Five other significant publications

Grman, E., J Lau, D Schoolmaster, **KL Gross** Mechanisms contributing to stability in ecosystem function depends on the environmental context. 2010. Ecology Letters 13: 140-1410

Dickson, TL and **KL Gross**. 2013. Plant community responses to long-term fertilization: Changes in functional group abundance drive changes in species richness. Oecologia 173: 1513-1520.

Cleland, EE, SL Collins, TL Dickson, EC Farrer, **KL Gross**, LA Gherardi, LM Hallett, RJ Hobbs, JS Hsu, KN Suding, and LTurnbull. 2013. Sensitivity of grassland plant community composition to spatial versus temporal variation in precipitation Ecology 94: 1687-169

Dickson, TL, GG Mittelbach, H Reynolds**, KL Gross**. 2015. Height and clonality traits determine plant community responses to fertilization. Ecology 95:2443-2452

Stahlheber, KA, B Watson, TL Dickson, R Disney, **KL Gross** 2016. Balancing biofuel production and biodiversity: Harvesting frequency effects on production and community composition in planted tallgrass prairie. Biomass and Bioenergy 92: 98-105

Synergistic Activities

2015- PI NSF REU Site program, W.K. Kellogg Biological Station, MSU; developed proposal and work with Academic Program Coordinator to both recruit a diverse applicant pool and provide training in mentorship for graduate student and post-doctoral associates who work directly with students

2011- NSF Biological Sciences Directorate (BIO) Advisory Committee Member; Chair, beginning July 2014; worked with BIO Director and staff to revitalize the AC and provide more opportunities for discussion of scientific issues and potentials; co-organized a working group that developed a report on the future of NEON for the NSF Board

2013-2016 Synthesis Center for Social-Ecological Research (SYSENC), Advisory Board Member – met with staff and students and provided feedback on developing programs and new collaborations; provided editorial comments and advise on the development of annual reports and a successful renewal proposal

2008- Research Scientist and Education Programs DOE- Great Lakes Bioenergy Research Center, W.K. Kellogg Biological Station, MSU; developed an Undergraduate Research Apprentice (URA) program to provide early career students with a research experience in bioenergy

2007- Editor in Chief, *Oecologia* (Plant Population and Community Ecology) review and handle ~ 150 papers per year; recruit Handling Editors and provide technical editing on all accepted papers (~40% of those submitted)

2015- PI and faculty liaison, “Teaching Science Outdoors” a science-math professional development program for elementary teachers (funded by EPA Environmental Education, KBS LTER and private donations)

Collaborators and other affiliations – list attached

Thesis advisor: - see collaborators list 5 MSc; 11 PhD

Graduate Advisor (PhD): Patricia Werner (CSIRO Australia, retired)
Postdoc Advisor - None

Recent Postgraduate scholars (20 total): A Golubski (Kennesaw State University, Atlanta); A Eilts (U Minnesota); D Schoolmaster (USGS), T Dickson (Univ Nebraska-Omaha), K Stahlheber (U Wisconsin – Green Bay)

Stephen K. Hamilton
Kellogg Biological Station, Michigan State University,
Hickory Corners, MI 49060. 269/671-2231;
hamilton@kbs.msu.edu

(a) PROFESSIONAL PREPARATION:

Michigan Technological University	Biological Sciences	B.S. 1981
University of Colorado, Boulder	Biological Sciences	M.A. 1985
University of California, Santa Barbara	Biological Sciences	Ph.D. 1994

(b) APPOINTMENTS:

1995-now	Assistant, Associate, and full Professor (since 2007), Kellogg Biological Station and Dept. of Integrative Biology, Michigan State University. Associate Director of Kellogg Biological Station.
2009-now	Adjunct faculty at Australian Rivers Institute, Griffith University
2008-09	Commonwealth Environmental Research Facilities Fellow, Griffith University
2002	Visiting professor at Griffith University, Brisbane, Queensland, Australia.

(c) PRODUCTS:

(i) 5 products most closely related to the proposed project

Kinsman-Costello, L.E., J.O. O'Brien, and S.K. Hamilton. 2015. Natural stressors in uncontaminated sediments of shallow freshwaters: The prevalence of sulfide, ammonia and reduced iron. Environmental Toxicology & Chemistry. doi: 10.1002/etc.2801

Hamilton, S.K. S.J. Sippel, J.P. Chanton, and J.M. Melack. 2014. Plant-mediated transport and isotopic composition of methane from shallow tropical wetlands. Inland Waters 4: 369-376. doi 10.5268/IW-4.4.734

Kinsman-Costello, L.E., J.O. O'Brien, and S.K. Hamilton. 2014. Re-flooding a historically drained wetland leads to rapid sediment phosphorus release. Ecosystems 17: 641-656. Doi 10.1007/s10021-014-9748-6

O'Brien, J.O., S.K. Hamilton, L. Kinsman-Costello, J.T. Lennon, and N.E. Ostrom. 2012. Nitrogen transformations in a through-flow wetland revealed using whole-ecosystem pulsed ^{15}N additions. Limnology and Oceanography 57(1): 221-224. doi: 10.4319/lo.2012.57.1.0221

Hamilton, S.K. 2012. Biogeochemical time lags may delay responses of streams to ecological restoration. Freshwater Biology 57 (Suppl. s1): 43-57. doi: 10.1111/j.1365-2427.2011.02685.x

(ii) 5 other significant products

Hamilton, S.K., M.Z. Hussain, A.K. Bhardwaj, B. Basso, and G.P. Robertson. 2015. Comparative water use by maize, perennial crops, restored prairie, and poplar trees in the U.S. Midwest. Environmental Research Letters 10 (2015) 064015. doi: 10.1088/1748-9326/10/6/064015

Hamilton, S.K., J.E. Doll, and G.P. Robertson (eds.). 2015. The ecology of agricultural landscapes: long-term research on the path to sustainability**.** Oxford University Press, New York. http://lter.kbs.msu.edu/synthesisbook/

Beaulieu, J.J., J.L. Tank, S.K. Hamilton, et al. 2011. Nitrous oxide emission from denitrification in stream and river networks. Proceedings of the National Academy of Sciences of the U.S.A. 108: 214-219. doi: 10.1073/pnas.1011464108

Burgin, A.J. and S.K. Hamilton. 2008. NO_3^- driven SO_4^{2-} production in freshwater ecosystems: implications for N and S cycling. Ecosystems 11: 908-922. doi: 10.1007/s10021-008-9169-5

Mulholland, P.J., A.M. Helton, G.C. Poole, R.O. Hall, Jr., S.K. Hamilton, B.J. Peterson, J.L. Tank, L.R. Ashkenas, L.W. Cooper, C.N. Dahm, W.K. Dodds, S. Findlay, S.V. Gregory, N.B. Grimm, S.L. Johnson, W.H. McDowell, J.L. Meyer, H.M. Valett, J.R. Webster, C. Arango, J.J. Beaulieu, M J. Bernot, A.J. Burgin, C. Crenshaw, L. Johnson, B.R. Niederlehner, J.M. O'Brien, J.D. Potter, R.W. Sheibley, D.J. Sobota, and S.M. Thomas. 2008. Stream denitrification across biomes and effects of anthropogenic nitrate loading. Nature 452: 202-206. doi:10.1038/nature06686

(d) SYNERGISTIC ACTIVITIES:

(1) Co-PI on the KBS Long-Term Ecological Research program and the DOE Great Lakes Bioenergy Research Center, providing many opportunities for outreach on agriculture and natural resources.

(2) Regularly assist local governmental and non-governmental organizations concerned with water resources, including state and federal environmental officials, local governments, and NGOs. International activities have recently involved Ecuador, Peru, Brazil, Australia. In 2014 received the Petoskey Prize from Michigan Environmental Council and the MSU Service and Civic Engagement Award; in 2015 received the Environmental Stewardship Award from Society for Freshwater Science.

(3) Since 2006 served as President of the Kalamazoo River Watershed Council, a local NGO that plays a key role in Superfund and other river issues while building public understanding of and appreciation for the river. Activities include public informational meetings, paddling trips, and serving as liaison between the community and state and federal environmental agencies.

(4) Independent advisor to the US EPA on the cleanup and remediation of the Kalamazoo River following the 2010 Enbridge pipeline release of oil sands crude, the largest oil spill in the Midwest U.S. This has included extensive media coverage in US and Canada and many public presentations. Served on the National Academy of Science, Engineering and Medicine's *Committee on the Effects of Diluted Bitumen in the Environment* (2014-15).

Christopher A. Klausmeier
Kellogg Biological Station & Dept. of Plant Biology
Michigan State University
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(a) PROFESSIONAL PREPARATION:

Harvey Mudd College	Claremont CA	Mathematics	B.S. 1995
University of Minnesota	St. Paul MN	Ecology	Ph.D. 2000
EAWAG	Kastanienbaum Switzerland	Limnology	Postdoc 2000-1
Princeton University	Princeton NJ	Theoretical ecology	Postdoc 2001-2

(b) APPOINTMENTS:

Date(s)	*Appointment*
2016–	MSU Foundation Professor, *Michigan State University*, Dept. of Plant Biology & Kellogg Biological Station
2015–2016	Professor, *Michigan State University*, Dept. of Plant Biology & Kellogg Biological Station
2011–2012	Visiting Scientist, *Technical University of Denmark*, DTU Aqua
2009–2015	Associate Professor, *Michigan State University*, Dept. of Plant Biology & Kellogg Biological Station
2005–2009	Assistant Professor, *Michigan State University*, Dept. of Plant Biology & Kellogg Biological Station
2003–2005	Assistant Professor, *Georgia Institute of Technology*, School of Biology

(c) PRODUCTS:

(i) 5 products most closely related to the proposed project

Kremer CT, Klausmeier CA. 2013. Coexistence in a variable environment: eco-evolutionary perspectives. *Journal of Theoretical Biology* 339: 14–25

Klausmeier CA, Litchman E. 2012. Successional dynamics in the seasonally forced diamond food web. *American Naturalist* 180: 1–16

Norberg J, Urban MC, Vellend M, Klausmeier CA, Loeuille N. 2012. Eco-evolutionary responses of biodiversity to climate change. *Nature Climate Change* 2: 747–751

Klausmeier CA. 2010. Successional state dynamics: a novel approach to modeling nonequilibrium foodweb dynamics. *Journal of Theoretical Biology* 262: 584–595.

Litchman E, Klausmeier CA. 2008. Trait-based community ecology of phytoplankton. Annual Review of Ecology, Evolution, and Systematics 39: 615–639.

(ii) 5 other significant products

Thomas MK, Kremer CT, Klausmeier CA, Litchman E. 2012. A global pattern of thermal adaptation in marine phytoplankton. Science 338: 1085–1088

Duffy MA, Ochs JH, Penczykowski RM, Civitello DJ, Klausmeier CA, Hall SR. 2012. Ecological context influences epidemic size and parasite-driven evolution. *Science* 335: 1636–1638

Klausmeier CA, Litchman E, Daufresne T, Levin SA. 2004. Optimal nitrogen-to-phosphorus stoichiometry of phytoplankton. *Nature* 429: 171–174.

Klausmeier CA, Tilman D. 2002. Spatial models of competition. pp. 43–78 in eds. U. Sommer and B. Worm, *Competition and Coexistence*, Springer-Verlag

Klausmeier CA. 1999. Regular and irregular patterns in semiarid vegetation. *Science* 284: 1826–1828

(d) SYNERGISTIC ACTIVITIES:

Editorial Board: American Naturalist

JENNIFER A. LAU

Kellogg Biological Station & Department of Plant Biology
Michigan State University
Hickory Corners, MI 49060

tel: 269-671-2107
fax: 269-671-2104
e-mail: jenlau@msu.edu

(a) Professional Preparation:

Duke University	Durham, NC	Biology	B.S. 1999
Univ. California, Davis	Davis, CA	Population Biology	Ph.D. 2005
Univ. Minnesota	Minneapolis, MN	Plant Biology	Post-doc 2005-2007

(b) Academic Appointments:

June 2013 – present: Associate Professor, Michigan State University, Kellogg Biological Station and Department of Plant Biology

June 2007 – 2013: Assistant Professor, Michigan State University, Kellogg Biological Station and Department of Plant Biology

(c) Publications (10 significant)

Klinger, C. K., Lau, J. A., and Heath, K. D. 2016. Ecological genomics of mutualism decline in nitrogen-fixing bacteria. Proceedings of the Royal Society B 283: 20152563

Schultheis, E. H. and Lau, J. A. 2015. No release for the wicked--enemy release is dynamic and not associated with invasiveness. Ecology 96:2446-2457.

Weese, D. J., Heath, K. D., Dentinger, B. T. M., and Lau, J. A. 2015. Long-term nitrogen addition causes the evolution of less cooperative mutualists. Evolution 69:631-642.

Lau, J. A. and terHorst, C. P. 2015. Causes and consequences of failed adaptation to biological invasions: the role of ecological constraints. Molecular Ecology 24:1987-1998.

Colautti, R. I. and Lau, J. A. 2015. Contemporary evolution during invasion: evidence for differentiation, natural selection, and local adaptation. Molecular Ecology 24:1999-2017.

terHorst, C.P., Lau, J. A., Cooper, I. A., Keller, K. R., La Rosa, R. J., Royer, A. M., Schultheis, E. H., Suwa, T., and Conner J. K. 2015. Quantifying non-additive selection caused by ecological indirect effects. Ecology 96:2360-2369.

Lau, J. A., Shaw, R. G., Reich, P. B. and Tiffin, P. 2014. Indirect effects drive evolutionary responses to global change. New Phytologist 201:335-343.

terHorst, C. P., Lennon, J. T. and Lau, J. A. 2014. The relative importance of rapid evolution for plant-soil feedbacks depends on ecological context. Proceedings of the Royal Society B 281: doi: 10.1098/rspb.2014.0028

Lau, J. A. and Lennon, J. T. 2012. Rapid responses of soil microorganisms improve

plant fitness in novel environments. Proceedings of the National Academy of Sciences USA 109:14058-14062.

Lau, J. A. and Lennon, J. T. 2011. Evolutionary ecology of belowground-aboveground interactions: soil microbial structure alters selection on plant traits. New Phytologist 192:215-224.

(d) Synergistic/Leadership Activities:

1. I integrate research and teaching in undergraduate ecology courses. Students have presented posters at national meetings (Ecological Society of America annual meeting), and a paper (7 undergraduate co-authors) was published in Acta Oecologica. For these efforts, I have been awarded two teaching awards from Michigan State University and was selected to chair the revision of the ecology curriculum at MSU.
2. My lab members and I have mentored dozens of undergraduate student researchers over the past 9 years. Several projects have resulted in undergraduate authored publications and/or presentations at national (ESA), regional (Midwest Ecology and Evolution Meeting), or local (MSU Undergraduate Research and Arts Forum) meetings, with three students winning "best poster" awards for their work.
3. I serve as an associate editor for three ecology journals, *Oecologia, Journal of Ecology,* and *American Journal of Botany* handling ~12 papers for each journal each year.
4. I am the current secretary for the American Society of Naturalists, past chair of the American Society of Naturalists student research awards committee, and serve on the Ecological Society of America Buell/Braun student awards committee and the Mercer award committee.

(e) Current grant support of research

2017	National Science Foundation Doctoral Dissertation Improvement Grant. *The role of rapid adaptation in population establishment* (Role: PI, on behalf of PhD candidate). $15,261 (recommended)
2016	National Science Foundation, DEB: LTER & LTREB. *LTER: The ecology of row crop ecosystems and landscapes at the KBS LTER Site* (Role: Co-PI with 5 others, G. P. Robertson PI). $2.64M
2015	National Science Foundation, DEB: LTER & LTREB. *Collaborative Research: RAPID: Linking population and community ecology in restored communities: Interactions between species diversity and genetic diversity* (Role: PI, with 2 Co-PIs). $105,297
2014	National Science Foundation, DEB: LTER & LTREB. *Collaborative: Workshop: Identifying and prioritizing research questions for long-term ecological experiments* (Role: Co-PI, M. Bradford of Yale PI). $40,807
2014	National Science Foundation Doctoral Dissertation Improvement Grant. *The role of resource mutualisms in plant adaptation to abiotic environments* (Role: PI, on behalf of PhD candidate). $19,953
2013	National Science Foundation, DEB: Population and Community Ecology. *Evolution in LTER experiments: Ecological and evolutionary consequences of long-term nitrogen addition for the legume-rhizobium mutualism* (Role: PI, with one Co-PI). ($355,000).

Elena Litchman
W.K. Kellogg Biological Station and Department of Integrative Biology
Michigan State University
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Hickory Corners, MI 49060
litchman@msu.edu

Professional Preparation

Moscow State University, Russia	Diploma in Biology		1990
University of Minnesota	Ecology	Ph.D.	1997
Smithsonian Institution	Marine Biology	postdoc	1998-2000
Swiss Federal Institute of Technology, Switzerland	Limnology	postdoc	2000-2001
Rutgers University	Oceanography	postdoc	2001-2002

Appointments

2016-	MSU Foundation Professor
2015-2016	Professor, MSU
2011-2012	Visiting scientist (sabbatical), Danish Technical University
2010-2015	Associate Professor, MSU
2005-2010	Assistant Professor, Michigan State University
2003-2005	Research Scientist II, Georgia Institute of Technology
2001-2002	Postdoctoral Associate, Institute of Marine and Coastal Sciences, Rutgers University
2000-2001	Postdoctoral Associate, EAWAG, Switzerland
1998-2000	Postdoctoral Fellow, Smithsonian Environmental Research Center, Smithsonian Institution

Five Most Relevant Products (* denotes supervised students or postdocs)

Thomas MK*, CT Kremer* and E Litchman. 2016. Environment and evolutionary history determine the global biogeography of phytoplankton temperature traits. ***Global Ecology and Biogeography*** 25: 75-86.

Litchman E, KF Edwards and CA Klausmeier. 2015. Microbial resource utilization traits and trade-offs: implications for community structure, functioning and biogeochemical impacts at present and in the future. ***Frontiers in Microbiology*** 6: 254. doi: 10.3389/fmicb.2015.00254.

Thomas MK*, CT Kremer*, CA Klausmeier and E Litchman. 2012. A global pattern of thermal adaptation in marine phytoplankton. ***Science*** 338: 1085-1088.

Litchman E., K.F. Edwards*, CA Klausmeier and MK Thomas*. 2012. Phytoplankton niches, traits and eco-evolutionary responses to global environmental change. ***Marine Ecology Progress Series*** 470: 235-248.

Litchman E and CA Klausmeier. 2008. Trait-based community ecology of phytoplankton. ***Annual Review of Ecology, Evolution and Systematics***, 39: 615-639.

Five Other Relevant Products

Thomas, MK*, M Aranguren-Gassis*, CT Kremer*, MR Gould*, K Anderson*, CA Klausmeier and E Litchman. Temperature-nutrient interactions exacerbate sensitivity to warming in phytoplankton. ***Global Change Biology***. Accepted.

Litchman E**,** P de Tezanos Pinto*, KF Edwards*, CT Kremer*, CA Klausmeier, MK Thomas*. 2015. Global biogeochemical impacts of phytoplankton: a trait-based perspective. ***Journal of Ecology*** 103: 1384-1396.

Edwards KF*, E Litchman and CA Klausmeier. 2013. Functional traits predict variation in phytoplankton community structure across lakes of the United States. ***Ecology*** 94: 1626–1635.

Edwards KF*, CA Klausmeier and E Litchman. 2013. A three-way tradeoff maintains functional diversity under variable resource supply. ***American Naturalist*** 182: 786-800.

Litchman E., P. de Tezanos Pinto*, C.A. Klausmeier, M.K. Thomas* and K. Yoshiyama*. 2010. Linking traits to species diversity and community structure in phytoplankton. ***Hydrobiologia*** 653: 15-38.

Select Synergistic Activities (last 5 years)

2015 Co-organizer of the Phytoplankton Traits session at the European Ecological Federation Meeting

2012- Advisory Board, WasserCluster Lunz, Austria

2011- Advisory Board, Danish Centre of Excellence “Centre for Ocean Life”

2010- Editorial Board of *Journal of Plankton Research*

Biographical Sketch: Gary G. Mittelbach

Professor - Department of Integrative Biology and W.K. Kellogg Biological Station
Michigan State University, Hickory Corners, MI 49060, (269) 671-2216

Professional Preparation:

University of Iowa	Zoology	B.A. (honors) 1974
Michigan State University	Zoology	Ph.D. 1980

Appointments:

1987-present	Assistant, Associate, and Full Professor, Kellogg Biological Station and Integrative Biol. Dept., Michigan State University
2010-2011	Sabbatical Fellow, NCEAS, Santa Barbara, CA; Visiting Scientist, EAWAG Centre for Ecology, Switzerland
1995	Visiting Scholar, Dept. of Animal Ecology, University of Umeå, SWEDEN
1994-1995	Visiting Scholar, Ecology and Evol. Biology Dept., University of Arizona
1980-1987	Senior Research Assoc. and Adj. Asst. Prof., Zoology Dept., Ohio State Univ.

Publications:

Five recent publications:

Ballew, N.G., **G.G. Mittelbach** and K.T. Scribner. 2017. Fitness consequences of boldness in juvenile and adult largemouth bass. American Naturalist 189(4): in press.

Hanly, P.J., **G.G. Mittelbach** and D.W. Schemske. 2017. Speciation and the latitudinal diversity gradient: insights from the global distribution of endemic fish. American Naturalist 189: in press.

Mittelbach, G.G. and D.W. Schemske. 2015. Ecological and evolutionary perspectives on community assembly. Trends in Ecology and Evolution 30:241-247.

Mittelbach, G.G., N.G. Ballew, and M.K. Kjelvik. 2014. Fish behavioral types and their ecological consequences. Canadian Journal of Fisheries and Aquatic Sciences 71:927-944.

Mittelbach, G.G. 2012. *Community Ecology*.16 chapters, 400 pp, Sinauer Associates.

Five highly-cited publications:

Schemske, D. W., **G. G. Mittelbach**, H. V. Cornell, J. M. Sobel, and K. Roy. 2009. Is there a latitudinal gradient in the importance of biotic interactions? Annual Review of Ecology, Evolution, and Systematics 40:245-269.

Mittelbach, G. G., D. Schemske, H. V. Cornell, A. P. Allen, J. M .Brown, M. B. Bush, S. P. Harrison, A. H. Hurlbert, N. Knowlton, H. A. Lessios, C. M. McCain, A. R. McCune, L. A. McDade, M. A. McPeek, T. J. Near, T. D. Price, R. E. Ricklefs, K. Roy, D. F. Sax, D. Schluter, J. M. Sobel, and M. Turelli. 2007. Evolution and the latitudinal diversity gradient: speciation, extinction, and biogeography. Ecology Letters 10:315-335.

Currie, D. J., **G. G. Mittelbach**, H. V. Cornell, R. Field, J-F. Guégan, B. A. Hawkins, D. M. Kaufman, J. T. Kerr, T. Oberdorff, E. O'Brien, and J. R. G. Turner. 2004. Predictions and tests of climate-based hypotheses of broad-scale variation in taxonomic richness. Ecology Letters 7:1121-1134.

Hawkins, B. A., R. Field, H. V. Cornell, D. J. Currie, J. Guegan, D. M Kaufman, J. T. Kerr, **G. G. Mittelbach**, T. Oberdorff, , E. M. O'Brien, E. E. Porter, and J. R. G. Turner. 2003. Energy, water, and broad-scale geographic patterns of species richness. Ecology 84:3105-3117.

Mittelbach, G. G., C. F. Steiner, S. M. Scheiner, K. L. Gross, H. L. Reynolds, R. B. Waide, M. R. Willig, S. I. Dodson, and L. Gough. 2001. What is the observed relationship between species richness and productivity? Ecology 82:2381-2396.

Current grant support:
NSF (DEB), "OPUS: Ecological and evolutionary perspective on the origins of community diversity" $189,000 (D. Schemske, Co-PI)

Honors and Awards:
2002 Original member, ISI Highly Cited Researchers in Ecology and Environmental Sciences
2015 Fellow of the Ecological Society of America
2016 College of Natural Science, Beal Outstanding Faculty Award
2017 Michigan State University, Beal Outstanding Faculty Award

Synergistic Activities:
1) Participant; National Center for Ecological Synthesis (NCEAS) working group on Species-energy relationships (2001-2003); PI: NCEAS working group on "Gradients in Biodiversity and Speciation" (H. Cornell and D. Schemske, Co-PI's); (2005-2008); NCEAS Sabbatical Fellow (2010-2011)
2) NSF panelist: Ecology of Infectious Diseases (2004), Ecological Biology (2004-2007), Animal Behavior DDIG panel (2014), Population and Community Ecology (2016)
3) Editorial board: Ecological Society of America (1993-1997), American Society for Limnology and Ocenaography (1998-2001) and (2003-2004), Global Ecology and Biogeography (2009-2016)
4) Co-PI; NSF grant, "Ecological literacy in the K-12 classrooms of rural Michigan", $1,558,000, (G.P. Robertson lead PI; four other co-PI's)
5) Published a graduate-level textbook in *Community Ecology*, 2012, Sinauer Associates.

Students and Postdocs
Past Graduate Students (12 total): Craig Osenberg (co-advisor with E. Werner) (faculty, U. Georgia), Mark Olson (faculty, Franklin and Marshall College), Andrew Turner (faculty, Clarion U.), Casey Huckins (faculty, Michigan Tech. U.), Jessica Rettig (faculty, Dennison University), Christopher Steiner (faculty, Wayne State U.), Nathan Dorn (faculty, Florida Atlantic U.), Jeremy Wojdak (faculty, Radford U.), Tara Darcy-Hall (lecturer, Indiana Univ.), Erica Garcia (research scientist, Charles Darwin Univ.), Melissa Kjelvik (Postdoctoral, MSU BEACON), Nick Ballew (NRC postdoctoral fellow, NOAA Southeast Fisheries Science Center)
Current Ph.D. Graduate Student (1): Patrick Hanly (MSU Integrative Biology Dept).
Postdoctoral (2): Anthony Golubski (faculty, Kennesaw State U.), Alex Eltis (researcher, U. Minnesota)

G. PHILIP ROBERTSON
University Distinguished Professor, W.K. Kellogg Biological Station and Dept. of Plant, Soil & Microbial Sciences, Michigan State University, Hickory Corners, MI 49060. 269 760-8364; robert30@msu.edu

Professional Preparation

Hampshire College	Biology	B.A. 1976
Indiana University	Ecol. & Evol. Biol. (P.M. Vitousek)	Ph.D. 1980
Royal Swedish Academy of Sciences	A.W. Mellon Fellow (T. Rosswall)	Postdoc. 1980–81
Michigan State University	Microbiology (J.M. Tiedje)	Postdoc. 1981–85

Appointments

1985–now *Assistant, Associate, Full, and University Distinguished Professor*, Dept. of Plant, Soil and Microbial Sciences and W.K. Kellogg Biological Station, Michigan State University
2017-now Science Co-director, DOE Great Lakes Bioenergy Research Center, University of Wisconsin and Michigan State University
2001–2002 *Visiting Scholar*, CRC in Greenhouse Accounting, University of Queensland
1993–1994 *Visiting Scholar*, CSIRO, University of Adelaide, Australia

Current Research Awards

current NSF (Division of Environmental Biology): Long Term Ecological Research in Field Crop Ecosystems. PI with co-PIs K.L. Gross, S.K. Hamilton, D.A. Landis, T.M. Schmidt, S. Snapp, S.M. Swinton; and 34 Co-I's; $5.9M; (2010-2017).

current DOE Office of Science (Biological and Environmental Sciences Division): Great Lakes Bioenergy Research Center; co-PI with T. Donohue (PI), K. Keegstra, B. Dale, J. Ralph, R. Landick; and ~50 co-I's. $125M (2012-2017) [Research Leader for Sustainability, $20M].

current NSF (BCS Coupled Natural-Human Systems): A Social-Ecological Analysis of Nitrogen in Agricultural Systems of the Upper Midwest. Co-PI with D. Stuart (PI), D. Basso, S.T. Marquart-Pyatt, J. Zhao. $1.5M (2013-2017).

current NSF (DEB): EAGER: Development of a New Technique to Measure Ecosystem-level Soil Nitrous Oxide Fluxes using Micrometeorological Towers. co-PI with I. Gelfand (PI), M. Zondlo (Princeton); $150,000 (8/2014-7/2016).

current USDA (ARS): Collaborative Long-term Agricultural Research (LTAR): Ecosystem services from row-crop agriculture; $97,182 (9/2015 – 9/2020)

Selected Recent Publications (>150 at kbs.msu.edu/people/faculty/robertson)

Kravchenko, A. N., S. S. Snapp, and **G. P. Robertson**. 2017. Field-scale experiments reveal persistent yield gaps in low-input and organic cropping systems. *PNAS* (in press)

Ruan, L. and **G.P. Robertson**. 2016. Reduced snowfall accelerates wintertime nitrous oxide (N_2O) fluxes from an agricultural soil in the upper U.S. Midwest. *Ecosystems* doi: 10.1007/s10021-016-0077-9

Paustian, K., J. Lehmann, S. Ogle, D. Reay, **G.P. Robertson**, and P. Smith. 2016. 'Climate-smart' soils: A new management paradigm for global agriculture. *Nature* 532:49-57. 10.1038/nature17174

Gelfand, I., I. Shcherbak, N. Millar, A. N. Kravchenko, and **G. P. Robertson.** 2016. Long-term nitrous oxide fluxes in annual and perennial agricultural and unmanaged ecosystems in the upper Midwest USA. *Global Change Biology* 22:3594-3607.

Gelfand, I. and **G. P. Robertson**. 2015. A reassessment of the contribution of soybean biological nitrogen fixation to reactive N in the environment. *Biogeochemistry* 123:175-184. 10.1007/s10533-014-0061-4

Stuart, D., B. Basso, S. Marquart-Pyatt, A.P. Reimer, **G.P. Robertson**, and J. Zhao. 2015. The need for a coupled human and natural systems understanding of agricultural nitrogen loss. *BioScience* 65:571-578.

Kravchenko, A. N. and **G. P. Robertson**. 2015. Statistical challenges in analyses of chamber-based soil CO_2 and N_2O emissions data. *Soil Science Society of America Journa*l 79:200-211.

Robertson, G.P. and P. Groffman. 2015. Nitrogen transformations. Pages 421-446 in E.A. Paul, ed. *Soil Microbiology, Biochemistry, and Ecology, 4th Edition*. Elsevier Academic Press, Oxford, UK. 10.1016/B978-0-12-415955-6.00014-1

Hamilton, S. K., J. E. Doll, and **G. P. Robertson**, eds. 2015. *The Ecology of Agricultural Landscapes: Long-Term Research on the Path to Sustainability*. Oxford University Press, NY.

Shcherbak, I. and **G. P. Robertson**. 2014. Determining the diffusivity of nitrous oxide in soil using in situ tracers. *Soil Science Society of America Journal* 78:79-88. 10.2136/sssaj2013.05.0181

Shcherbak, I., N. Millar, and **G. P. Robertson**. 2014. A global meta-analysis of the nonlinear response of soil nitrous oxide (N_2O) emissions to fertilizer nitrogen. *PNAS* 111:9199–9204. 10.1073/pnas.1322434111

Ruan, L. and **G.P. Robertson**. 2013. Initial nitrous oxide, carbon dioxide and methane costs of converting CRP land to row crops under conventional tillage vs. no-till. *Global Change Biology* 19:2478-2489. 10.1111/gcb.12216

Robertson, G. P., K. L. Gross, S. K. Hamilton, D.A. Landis, T.M. Schmidt, S.S. Snapp, and S M. Swinton. 2014. Farming for ecosystem services: An ecological approach to production agriculture. *BioScience* 64:404-415. 10.1093/biosci/biu037

Gelfand, I., R. Sahajpal, X. Zhang, C. R. Izaurralde, K. L. Gross, and **G. P. Robertson**. 2013. Sustainable bioenergy production from marginal lands in the US Midwest. *Nature* 493:514-517. 10.1038/nature11811

Robertson, G.P., T.W. Bruulsema, R. Gehl, D. Kanter, D.L. Mauzerall, A. Rotz, and C. Williams. 2013. Climate-nitrogen interactions in agriculture. *Biogeochemistry* 114:41-70. 10.1007/s10533-012-9802-4

Gelfand, I., T. Zenone, P. Jasrotia, J. Chen, S.K. Hamilton, and **G.P. Robertson**. 2011. Carbon debt of a CRP grassland converted to bioenergy production. *PNAS* 108:13864-13869. 10.1073/pnas.1017277108

Selected Synergistic Activities

Ongoing: DOE Biological and Environmental Research Advisory Committee (BERAC; from 2010); Science Advisory Board for USDA Wheat Climate Change Center (from 2011); Research Committee for USDA Long-term Agroecosytem Research Network (LTAR; from 2012); direct sustainability research in the DOE Great Lakes Bioenergy Research Center (GLBRC; from 2008)

1989-2016: Member of US Long-term Ecological Research (LTER) Science Council (1989-2016; Chair 2009-2012).

2012-2015: Member, NSF Ecosystems Program grants panel

1988–2016: Directed the KBS LTER Program.

1996-2015: Led the KBS K-12 Partnership for Science Literacy (provides inquiry-based learning workshops for regional science teachers and hosted an NSF GK-12 and MSP program).

2013-2014: Lead author, 2014 National Climate Assessment (Midwest section) and review editor; member, Agricultural Indicators team (on-going).

Various times: Editor for *Biogeochemistry*, *Ecology* and *Ecological Monographs*, *Plant and Soil*, *PNAS* (guest editor)

Douglas W. Schemske

(a) Professional Preparation

University of Illinois, Urbana	Biology	B.S. 1970.
University of Illinois, Urbana	Evolutionary Ecology	M.S. 1972.
University of Illinois, Urbana	Evolutionary Ecology	Ph.D. 1977.
Smithsonian Tropical Research Institute	Postdoctoral Fellow	1977 – 1978.

(b) Appointments

Michigan State University, Professor. *2001-present.*
University of Washington, Assoc. Prof. *1989-1992*, Professor *1992-2001*.
University of Chicago, Asst. Prof. *1979-1985*, Assoc. Prof. *1985-1989.*
Amherst College, Asst. Prof. *1978-1979.*

(c) Products

i) *Five recent publications in evolutionary biology*

Ågren, J., C. Oakley, J. McKay, J. Lovell and D. W. Schemske. 2013. Genetic mapping of adaptation reveals fitness tradeoffs in *Arabidopsis thaliana*. Proceedings of the National Academy of Sciences 110: 21077–21082.

Baskett, C. A. and D. W. Schemske. 2015. Evolution and genetics of mutualisms. pp. 77-92, *In* Mutualism, ed. by J. L. Bronstein, Oxford Univ. Press.

Dittmar, E. L., C. G. Oakley, J. K. Conner, B. A. Gould and D. W. Schemske. 2016. Factors influencing the effect size distribution of adaptive substitutions. Proceedings of the Royal Society of London B 283: 20153065.

Mittelbach, G. G., D. W. Schemske, H. V. Cornell et al. 2007. Evolution and the latitudinal diversity gradient: speciation, extinction, and biogeography. Ecology Letters 10:315-331.

Schemske, D. W. 2010. Adaptation and *The Origin of Species*. American Naturalist 176, No. S1: S4-S25.

ii) *Five recent publications in ecology*

Hanly, P. J., G. G. Mittelbach and D. W. Schemske. Global distribution of endemic fish links speciation rate to the latitudinal diversity gradient. (in press, American Naturalist).

Mittelbach, G. G. and D. W. Schemske. 2015. Ecological and evolutionary perspectives on community assembly. Trends in Ecology and Evolution 30: 241-247.

Schemske, D. W. 2009. Biotic interactions and speciation in the tropics. pp. 219-239, *In* Speciation and patterns of diversity, R. K. Butlin, J. R. Bridle and D. Schluter (eds.). Cambridge University Press, Cambridge.

Schemske, D. W., H. V. Cornell, G. G. Mittelbach, K. Roy and J. M. Sobel. 2009. Is there a latitudinal gradient in the importance of biotic interactions? Annual Review of Ecology, Evolution and Systematics 40: 245-269.

Sobel, J M., G. F. Chen, L. R. Watt and D. W. Schemske. 2010. The biology of speciation. Evolution 64: 295-315.

(d) Synergistic Activities

1. Led research modules for MSU SpartaNature program in which freshman conduct ecological research prior to their first year of college (http://spartanature.natsci.msu.edu/). 2013.

2. Co-supervised an undergraduate student from Puerto Rico as part of the MSU Summer Undergraduate Research Experience in Plant Genomics program (www.plantgenomics.msu.edu). 2012.

3. NSF, National Center for Ecological Analysis and Synthesis (NCEAS). Working group on: Gradients in biodiversity and speciation. co-PI with G. Mittelbach and H. Cornell. 2005-2008. Examples of products:

Mittelbach, G. G., D. W. Schemske, H. V. Cornell et al. 2007. Evolution and the latitudinal diversity gradient: speciation, extinction, and biogeography. Ecology Letters 10:315-331. (508 citations).

Schemske, D. W., H. V. Cornell, G. G. Mittelbach, K. Roy and J. M. Sobel. 2009. Is there a latitudinal gradient in the importance of biotic interactions? Annual Review of Ecology, Evolution and Systematics 40: 245-269. (289 citations)

4. NSF Ecology—Frontiers of Ecology Advisory Group, 2006. This NSF-sponsored workshop was established to identify future research directions in ecology, as summarized in:

Agrawal, A. A. et al. 2007. Filling key gaps in population and community ecology. Frontiers in Ecology and the Environment. 5:145-152. (239 citations)

5. Associate Editor— American Naturalist, 1996-1999; Annual Review of Ecology, Evolution and Systematics, 2002-2006.

6. Symposium (co-organized with G. Mittelbach). Latitudinal Gradients in Species Diversity: 50 years since Pianka. American Society of Naturalists. 2016, Asilomar CA.

S A N T I A G O A . U T S U M I
Department of Animal Science & W.K. Kellogg Biological Station
Michigan State University
3700 E. Gull Lake Drive, Hickory Corners, MI 49060
E-mail: utsumi@msu.edu; Phone (269) 671-2230

PROFESSIONAL PREPARATION

1998 B.S., Agronomy, Universidad Catolica Argentina, Argentina.

2003 M.S., Animal Sciences, University Nacional de Mar del Plata, Argentina.

2008 Ph.D., Rangeland & Animal Sciences, New Mexico State University, Las Cruces, NM, USA.

PROFESSIONAL APPOINTMENTS

2009-present: Assistant Professor jointly appointed with the W.K. Kellogg Biological Station and Department of Animal Science, Michigan State University.

2008-2009: Associate Research Specialist, Department of Animal & Rangeland Sciences, New Mexico State University.

2005-2008: Research Assistant , Department of Animal & Rangeland Sciences, New Mexico State University.

2001-2003: Research Assistant, Universidad Nacional de Mar del Plata, Instituto Nacional de Tecnologia Agropecuaria, Argentina

PUBLICATIONS (Peer-Reviewed)

*Li, Q.F., Rowntree J.E., **Utsumi S.A**., Xu S., and Carmichael D.E.. In Press. Case study: irrigation and stocking rate influence on Northern Michigan beef cow-calf and forage production. Professional Animal Scientist.

*Mora, J., Nelson[2], N, Fauchile[2], A., & **Utsumi, S. A**. 2016. Application of GPS and GIS to study foraging behavior of dairy cattle. Agronomía Costarricense 40:81-88.

*Watt[2], L.J., G.L. Krebs, C.E. Petzel, C.E.F. Clark, S. Nielsen and S.A. Utsumi. 2015. Rumination patterns and methane production by dairy cows in a pasture-based automatic milking system. Journal of Dairy Science 98:7248-7263.

*Nieman[1], C.C., K.M. Steensma[1], J.E. Rowntree, D.K. Beede, and **S.A. Utsumi**. 2015. Differential response to stocking rates and feeding by two genotypes of Holstein-Friesian cows in a pasture-based automatic milking system. Animal 9:2039-2049.

*Pereira[1], A.B.D, **S.A. Utsumi**, C.D. Dorich and A.F. Brito. 2015. Estimation of dry matter intake of lactating Holstein cows using an open circuit portable automated gas quantification system. Journal of Dairy Science 98:8913-8925.

*Huhtanen, P., E. Cabezas-Garcia[1], **S. Utsumi**, and S. Zimmerman. 2015. Comparison of methods to determine methane emissions from dairy cows in farm conditions. Journal of Dairy Science 98:3394-3409.

Wesley[1], R., A. Cibils, C. Rubio[1], E. Pollak[1] and **S. Utsumi**. 2014. Maternal influence on feeding site selection of male and female lambs. Animal 8:991-999.

Utsumi, S.A., A.F. Cibils, R.E. Estell, S.A. Soto-Navarro, L. Cheng, and D.M Hallford. 2013. Effects of adding protein, condensed tannins, and polyethylene glycol to diets of sheep and goats fed one-seed juniper and low quality roughage. Small Ruminant Research 112:56-68.

Utsumi, S.A., A.F. Cibils, R.E. Estell, T.T., Baker, and J.W., Walker. 2010. One-seed juniper sapling use by goats in relation to stocking density and mixed grazing with sheep, Rangeland Ecology and Management 63: 373-386.

Utsumi, S.A., C.A. Cangiano, J.R. Galli, M.B. McEachern, M.W. Demment, and E.A. Laca. 2009. Resource heterogeneity and foraging behavior of cattle across spatial scales. BMC Ecology 9, 9. Open Access: http://www.biomedcentral.com/1472-6785/9/9

CONTRACTS, GRANTS AND GIFTS

2010-2013. C-Lock Technology Inc. Development, implementation and testing of an automatic system to continuously monitor enteric gas emissions from dairy cattle. Co-PIs: D.K. Beede, and S.A. Utsumi, $ 75,000.

2011-2012. "A new crop for a variable climate: intermediate wheatgrass biology and forage potential. MSU-GREEN, Culman, S. (PI), S. Snapp, S.A. Utsumi, T. Dietz, and R. Leep. $ 57,769.

2012-2014. "Forage Brassicas as a complementary forage ". PGG Seeds, $ 3,500.
2012. "Success factors for robotic milking in grazing dairy farms". DeLaval Inc, USA, $2,000.

2016-2017. Evaluation of forage brassicas for extended grazing in Michigan. PGG Wrightson, PI Utsumi, $9,768.

KBS Resident Graduate Students- 2012-2016: Fellowships, Grants and Current Positions

Name	Dept./Program or Institution	Advisor	Finished?	Degree	Recruiting	Continuing or Grant	Current Position
Bassett, Tyler	Plant Biology/EEBB	Lau	2017	PhD	PS	CNS, GK12;NIFA	Postdoc, MSU (Brudvig)
Krieg, Cara	Integrative Biology/EEBB	Getty	2016	PhD		BEACON, GK12	Postdoc MSU (Wade/Getty)
Kuczynski, Michael	Zoology/EEBB	Getty	2016	PhD		GK12	Visiting Ass't Prof, Truman State
Miller, Elizabeth	Plant Biology/EEBB	Klausmeier	2016	PhD	PS		Postdoc, U Oregon
Nalley, Jakob	Integrative Biology/EEBB	Litchman	2016	PhD	PS	GK12	Educ. Specialist, NWU
Keller, Kane	Plant Biology/EEBB	Lau	2015	PhD	NSF, PS	CNS, GK12	Postdoc, U Minnesota
Kjelvik, Melissa	Zoology/EEBB	Mittelbach	2015	PhD	MSU	LTER, BEACON;DDIG	Postdoc, BEACON (Mead)
LaRosa, Raffica	Plant Biology /EEBB	Conner	2015	PhD	NSF, PS	CNS, GK12	Postdoc, U Colorado
Schultheis, Elizabeth	Plant Biology/EEBB	Lau	2015	PhD	PS	TER, CNS, GK12, BEACON; DDI	Postdoc, BEACON (Mead)
Sprunger, Christine	Plant, Soil & Microbial Science	Robertson	2015	PhD	MSU	Mott, GK12, Ford;SARE	Postdoc, Columbia Univ
Suwa, Tomomi	Plant Biology/EEBB	Lau	2015	PhD	PS	CNS, GK12,BEACON; DDIG	Editorial Ass't *Oecologia;* Field Museum, Chicago
Ballew, Nicholas	Zoology/EEBB	Mittelbach	2014	PhD	MSU	CNS, GK12;DDIG	Research Scientist, Duke Medical School
Celi, Jorge	Zoology/EEBB	Hamilton	2014	PhD		CNS	Ass't Professor, IKIAM Regional Univ, Equador
Kremer, Colin	Plant Biology/EEBB	Klausmeier	2014	PhD	NSF, MSU		NSF Postdoc, Yale U
Royer, Anne	Plant Biology/EEBB	Conner	2014	PhD	PS	CNS, GK12	Postdoc, U Oregon
Ruan, Leilei	Plant, Soil & Microbial Science	Robertson	2013	PhD		GK12, LTER	Graduate Student, Wayne State
Shcherbak, Iurii	Plant, Soil & Microbial Science	Robertson	2013	PhD		GK12; DDIG; LTER	Data scientist, CiBO Technology, Boston
Thomas, Mridul	Plant Biology/EEBB	Litchman	2013	PhD		CNS	Postdoc, EAWAG
Bird, Kali	Microbiology & Molecular Genetics	Lennon	2012	MS			Education Spec IES, NY
Kinsman-Costello, Lauren	Zoology/EEBB	Hamilton	2012	PhD		CNS	Ass't Professor, Kent State University
Nieman, Christine	Animal Science	Utsumi	2012	MS		Mott, GK12	PhD Program, U Wisconsin
Steensma, Kate	Animal Science	Utsumi	2012	MS		Mott, GK12	Staff Scientist, DeLavel
Chicoine, Tayler	Integrative Biology/EEBB	Evans		PhD	NSF, PS	Mott, CNS	
Garnett, Sara	Integrative Biology/EEBB	Getty		PhD	MSU	BEACON, GK12	
Garrison, Ava	Plant Biology/EEBB	Conner		PhD	PS	BEACON	
Glanville, Kate	Plant, Soil & Microbial Science	Robertson		PhD	MSU	NSF CNH, DOE GLBRC	
Hanly, Patrick	Integrative Biology/EEBB	Mittelbach		PhD	NSF	CNS, GK12	
Kincaid, Dustin	Integrative Biology/EEBB	Hamilton		PhD		LTER, GK12	
Kittredge, Heather	Integrative Biology/EEBB	Evans		PhD		GK12	
Liang, Di	Plant, Soil & Microbial Science	Robertson		PhD		GK12, DOE GLBRC	
Logan, Robert	Integrative Biology/EEBB	Evans		PhD	NSF		
Magnoli, Susan	Plant Biology/EEBB	Lau		PhD	PS	LTER, GK12; DDIG	

Name	Dept./Program or Institution	Advisor	Finished?	Degree	Recruiting	Continuing or Grant	Current Position
McGill, Bonnie	Integrative Biology	Hamilton		PhD	NSF		
O'Donnell, Daniel	Integrative Biology/EEBB	Litchman		PhD	NSF		
Ranjan, Ravi	Plant Biology/EEBB	Klausmeier		PhD	MSU	BEACON	
Wilburn, Paul	Integrative Biology/EEBB	Litchman		PhD			
Zettlemoyer, Meredith	Plant Biology/EEBB	Lau		PhD	UDF, CNS, PS		

Key: Recruiting
CNS: College of Natural Sciences
MSU: College or University Fellowship
NSF: GRFP
PS: Plant Sciences

Key: Continuing or Grants
Mott: Predoctoral
Ford: Predoctoral
NIFA: USDA predoc
GK12: NSF or Grad School
LTER: Summer or year
BEACON: semester or annual
DDIG: NSF dissertation research
SARE: USDA dissertation research

KBS Postdoctoral Reseach Associates, 2012-2016

Name	Lab	Appointment	Funding	Status	Current Position/Institution
Michael Abraha	Hamilton	2013-present	GLBRC	Current	
Sarah Bodbyl Roels	Getty	2012-2015	NSF K-12	Research Assoc	Teacher Education, MSU
Idelle Cooper	Getty	2010-2013	NSF K-12	Faculty	Assistant Professor, James Madison University
Steve Culman	Snapp	2009-2012	USDA	Faculty	Assistant Professor, Ohio State University-Wooster
Timothy Dickson	Gross	2011-2014	MSU/LTER	Faculty	Assistant Professor, University of Nebraska - Omaha
Kyle Edwards	Klausmeier	2011-2013	NSF	Faculty	Assistant Professor, University of Hawai'I at Manoa
Sarah Fitzpatrick	Mittelbach	2015-2016	MSU	Faculty	Assistant Professor, KBS/IBIO, MSU
Ilya Gelfand	Robertson	2008-present	GLBRC	Current	
Eben Gering	Getty	2013-2016	BEACON	Current	Research Associate, Getty Lab, IBIO, MSU
Mike Grillo	Gross	2013-2014	MSU	Postdoc	NSF Plant Genome postdoctoral fellow, University of Illinois
Ghjuvan Grimaud	Klausmeier	2016-present	DARPA	Current	
Mir Zaman Hussain	Hamilton	2013-present	GLBRC	Current	
Melissa Kjelvik	BEACON	2016-present	BEACON	Postdoc	BEACON MSU - NSF funded DRK-12
Neville Millar	Robertson	2007-present	LTER	Research Coordina	KBS LTER
Karen Nikolakakis	Gross	2014-2016	MSU/LTER/GLBRC	Faculty	Ass't Professor, U Wisconsin -Green Bay
Ariane Peralta	Lennon	2011-2012	USDA	Faculty	Assistant Professor, East Carolina University
Brian Petersen	Gross	2010-2014	MSU	Faculty	Assistant Professor, Northern Arizona University
Sarah Placella	Lennon/Hamilton	2011-2013	NSF	Postdoc	INRA Eco&Sols, Montpellier, France
Rachel Prunier	Lau	2010-2012	NSF	Faculty	Assistant Professor, Western Connecticut State University
Adam Reimer	Stuart/Robertson	2013-present	NSF	Current	
Sarah Roley	Robertson	2012-present	GLBRC	Current	
Ben Roller	Robertson	2015	Self	Postdoc	Center for Adaptation to a Changing Environment, ETH Zurich
Maria Stockenreiter	Litchman	2013-2014	NSF	Faculty (TS)	Assistant Professor, University of Munich
Simon Stump	Klausmeier	2015-present	DARPA	Current	
Zepeng Sun	Klausmeier	2016-present	DARPA	Current	
Casey terHorst	Lau	2011-2013	NSF	Faculty	Assistant Professor, University of California - Northridge
Robin Tinghitella (Hibbs)	Getty	2010-2012	NSF K-12	Faculty	Assistant Professor, University of Denver
Kaito Umemura	Klausmeier	2016-present	Simons Foundation	Current	
Dylan Weese	Lau	2010-2012	NSF	Faculty	Assistant Professor, St. Ambrose University
Will West	Evans	2015-present	NSF	Current	
Sabine Wollrab	Klausmeier	2013-2014	NSF	Faculty	Leibniz-Institute for Freshwater Ecology and Inland Fisheries
Terenzio Zenone	Robertson	2009-2013	GLBRC	Faculty	University of Antwerp
Joanthan Bauer	Brudvig/Lau	2016-2017	USDA Fellow	Current	

Use of the Kellogg Biological Station field sites and laboratories by MSU and external researchers

Having excellent research facilities and access to field sites is important not only for the success of KBS resident faculty, but also allows us to support the research of others. Especially important for this is the diversity of field sites that are relatively protected, allowing for secure long-term experiments and observation programs. Also, the availability of large-scale field experiments (e.g. the LTER, GLBRC and Pasture Dairy) and field laboratories (e.g. the Pond Lab) provide unique research opportunities that are not available on campus or other institutions.

Important to the success of KBS in hosting and supporting external research is that there is a ***resident faculty*** who have established and maintain these research sites and facilities and have historical information on the systems that are important for establishing field research. For example, having historical data (and samples) from the LTER has been important in attracting researchers to this site. Because field research in agriculture, ecology and evolutionary biology often requires access to laboratory, greenhouse, growth chamber or similar facilities, we have establish these as shared facilities at KBS that are available to both KBS and other researchers.

To better track research use of KBS we have developed a Site Use Request Form (SURF) and process that allows us to know what is being done and where (history and legacy), what impacts this may have for future use of KBS resources (space and land), to avoid conflicts of use (occasional), and importantly, to document the research use of KBS to support grant requests (e.g., NSF FSML). Individuals interested in pursuing research at KBS contact the Director, KBS Facilities Coordinator or individual responsible for a specific facility who can help in identifying research sites and lab facilities and (if needed) negotiating the support from KBS to establish the research. Once details and challenges have been worked out the SURF form is easy to complete and approval process is relatively quick. We charge non-resident researchers modest fees for lab/office and other research space to help cover the costs of maintaining these facilities. In some cases we also charge a fee if the use of a KBS facility or site by a project will preclude its use by others, reduce (or impact) future use, or (as can be the case for agricultural lands) result in lost income or reduced management flexibility by the Farm (including the Dairy).

The tables below summarizing the recent research use of KBS (2012-2016) by non-resident faculty reveals several important things: 1) there is a strong interest in establishing research at KBS by both MSU and non-MSU faculty – close to 200 projects have been based here over the past five years and (data not shown) this interest is growing; 2) Half of the SURF requests from MSU come from faculty in CANR Departments; 3) MSUE research specialists also make significant use of KBS; 4) the agricultural lands and experiments at KBS are used by both MSU and non-MSU researchers; 5) the field labs (plant ecology, pond and LTER) are particularly well utilized by outside researchers; 6) the Lux Arbor Reserve (LAR) is a big draw for non-MSU researchers to KBS; and 6) many outside researchers are setting up longer term studies (more than one year).

Importantly (and not yet documented here), we are seeing increasing use of KBS as a primary field research site by newly hired campus based faculty in CNS [Lowry (PLB), Weber (PLB), Brudvig (PLB)] and CANR [Zarnetsky (FOR/FW), and Wetzel (ENT)], whose projects involve

graduate students, technicians, postdocs and undergraduates – as well as the faculty member – in residence for part or all of the summer. In fact some technical and postdoctoral staff for these campus-based researchers are now maintaining year-round residence at KBS. These investigators are a great addition to our community but are beginning to strain our capacity to provide appropriate laboratory space and housing. It is a good problem to have and one that can be addressed by a combination of reallocation of space and investments into laboratories and housing.

User Group	***# SURFs***	***%***
Other MSU	133	67%
Non-MSU	65	33%
TOTAL	198	

MSU Unit	***# SURFs***	***%***
CANR (FW, ENT, FOR)	65	49%
CNS (IBIO, PLB, MM)	42	32%
MSUE	21	16%
CVM (LAS)	3	2
CAL (PHL)	1	1
SSC (GEO)	1	1

Agricultural Facilities (# SURFs using)				
User Group	***LTER***	***GLBRC***	***FSC***	***Dairy***
Other MSU	28	28	47	8
Non-MSU	21	15	4	1

Non-Agricultural Facilities (# SURFs using)				
User Group	***Old-fields***	***Field Labs***	***LAR***	***Pond Lab***
Other MSU	15	32	12	2
Non-MSU	2	2	3	8

Study duration			
User Group	1 year	2-3 years	>3 years
Other MSU	42	55	36
Non-MSU	35	24	5
Total	77	79	41
%	39%	40%	21%

"Top 10" KBS papers based on number of citations (ISI; March 2017). Only papers listed as KBS contributions are included in this analysis; bold indicates KBS faculty or graduate student

Citations (#)	Year Published	Authors, year, title, journal
1900	1984	**Werner, E. E**., and **J. F. Gilliam**. 1984. Ontogenetic niche and species interactions in size-structured populations. *Annual Review of Ecology and Systematics* 15: 393-425
1588	1996	J. Zhou, M. A. Bruns and J. M. Tiedje. 1996. DNA recovery from soils of diverse composition. *Applied and Environmental Microbiology* 62: 316-322
1124	2002	J. Six, R. T. Conant, E. A. Paul and **K. Paustian**. 2002. Stabilization mechanisms of soil organic matter: Implications for C-saturation of soils. *Plant and Soil* 241: 155-176
1101	1983	**Werner, E. E**., **J. F. Gilliam, D. J. Hall, and G. G. Mittelbach**. 1983. Experimental test of the effects of predation risk on habitat use in fish. *Ecology* 64: 1540-1548.
977	2000	D. A. Landis, S. D. Wratten and G. Gurr. 2000. Habitat management to conserve natural enemies of arthropod pests in agriculture. *Annual Review of Entomology* 45: 175-201
950	2003	Hawkins BA, R Field , HV Cornell , J. Currie, J. F. Guegan, D. M. Kaufman, J. T. Kerr, **G. G. Mittelbach,** T. Oberdorff, E. M. O'Brien, E. E. Porter and J. R. G. Turner. 2003. Energy, water, and broad-scale geographic patterns of species richness *Ecology* 84: 3105-3117
873	1982	Crowder, L. B., and W. E. Cooper. 1982. Habitat structural complexity and the interaction between bluegills and their prey. Ecology 63: 1802-1813
826	2001	**Mittelbach, G.G., C. Steiner, K. Gross, H. Reynolds**, S. Scheiner, R. Waide, M. Willig, S. Dodson. 2001. What is the observed relationship between species richness and productivity. *Ecology* 82: 2381-2396
818	1979	**Cummins, K. W., and M. J. Klug**. 1979. Feeding ecology of stream invertebrates. *Annual Review of Ecology and Systematics* 10: 147-172.
794	1974	**Cummins, K. W**. 1974. Structure and function of stream ecosystems. *BioScience* 24: 631-641

Externally funded Research Projects at the WK Kellogg Biological Station

Active 2011-2016

***** *indicates Graduate Student or Postdoc as PI or coPI*

KBS faculty as PI or coPI; (Managed at KBS)

Barazani, O., J. Ziffer-Berger, ***J.K. Conner***, A. Al-Oqla Daradkah, T. Hijawi, N. Samara, and I. Dworkin***.*** 2014-2016. Establishing a germplasm collection of East Mediterranean crucifer plant genetic resources. Multinational Agricultural Research and Development Program (Israel), $50,000.

*Basset, T.J. and ***J.A. Lau.*** 2013-2016. Can Diversity Deliver Multiple Ecosystem Services in Grassland Restoration? USDA-NIFA (Pre-doctoral Fellowship), $79,900.

Bradford, M. and ***J.A. Lau***. 2014-2017. Collaborative: Workshop: Identifying and prioritizing research questions for long-term ecological experiments NSF DEB (LTER & LTREB), $40,807

Conner, J.K., I. Dworkin, and S-H. Shiu. 2009-2016. Genetic mechanisms of rapid adaptive evolution in an outbred natural population. NSF DEB, $940,000.

Conner, J.K., K. Childs, and P. Edger. 2016-2019. Origins and adaptations of weedy and crop radish. Rackham Foundation, $90,000.

Evans, S.E., L. Tiemann, M. Friesen, and J. Cole. 2015-2020. Connecting nitrogen transformations mediated by the rhizosphere microbiome to perennial cropping system productivity in marginal lands. DOE: $5,771,832.

Evans, S.E. 2016-2017. Microbial transport in the Namib Desert: From ocean to desert, via fog. National Geographic Society Waitt Grant, $11,400.

Fitzpatrick, S. 2016-2017. Using population genomics to evaluate the conservation status and population viability of the Arkansas darter (*Etheostoma cragini).* Kansas Dept Wildlife, Parks, and Tourism/USFWS, $121,802.

*Gelfand, I. and ***G.P. Robertson***. 2014-2016. EAGER: Collaborative Research: Development of a new technique to measure ecosystem-level soil nitrous oxide fluxes using micrometeorological towers. NSF; $150,000.

Hamilton, S.K. 2016-2017. Effects of increased reservoir drawdown on resource dynamics in Willamette Basin Reservoirs and implications for salmonid rearing capacity. U.S. Forest Service, $20,000.

Hamilton, S.K. 2016-2017. Lower Muskegon River restoration project. NOAA, Grand Valley State University, $14,987.

Hamilton, S.K. 2012-2015. Application of high precision isotope tracer measurements to resolve rates of aquatic denitrification. NSF-EAGER; $82,876.

Hamilton, S.K., D. Hyndman***, B. Basso, and G.P. Robertson***. 2015-2017. FEW Supplement to KBS LTER: Implications of expanding irrigation and changing climate for terrestrial water balances in the agricultural Midwest. NSF; $386,130.

Hamilton, S.K, S.E. Evans, D.A. Landis***, J.A. Lau,*** S.T. Marquart-Pyatt, ***G.P. Robertson,*** S.M. Swinton. 2017-2018. LTER: The ecology of row crop ecosystems and landscapes at the KBS LTER Site. NSF DEB (LTER), $2.254M.

Klausmeier, C.A, and E. Litchman. 2015-2017. Trait-Based Models for Complex Microbial Communities, $801,210. DARPA (Biological Robustness in Complex Settings).

Klausmeier, C.A, and E. Litchman. 2015-2018. Microscopic Foundations for Macroecological Patterns. $599,583 Simons Foundation (Mathematical Models in the Life Sciences).

Klausmeier, C.A. 2009-2014. CAREER: Modeling complexity in plankton communities. NSF Ecology program; $835,660.

Klausmeier, C.A. 2011-2013. Trait-based ecosystem models for deep-sea chemosynthetic microbial communities. Gordon and Betty Moore Foundation; $51,000 direct costs.

Lau, J.A. and K.T. Heath***.*** 2013-2016. Evolution in LTER experiments: Ecological and evolutionary consequences of long-term nitrogen addition for the legume-rhizobium mutualism. NSF-DEB $470,000 ($355,000 MSU portion).

Lau, J., E. Grman (Collaborative PI's), and L.A. Brudvig (co-PI). 2015-2016. National Science Foundation. Collaborative Research: RAPID: Linking population and community ecology in restored communities: Interactions between species diversity and genetic diversity. $137,766 ($105,297 to MSU; plus $8500 in supplements to MSU)

Lennon J, D. Schoolmaster, ***C. Klausmeier***. 2008-2012. Moisture variability as a 'master regulator' of microbial diversity and soil respiration across an agricultural landscape. USDA NRI, Soil Processes; 2008-2012. $324,000.

Lennon, J. 2011-2014. Microbial seed banks: patterns and mechanisms of bacterial dormancy in soils. USDA-AFRI; $499,956.

Litchman, E., C.A. Klausmeier, D.A. Hutchins (USC) and T. Rynearson (URI). 2016-2020. Collaborative Research: Genetic, functional and phylogenetic diversity determines marine phytoplankton community responses to changing temperature and nutrients ($2,000,000). NSF OCE (Dimensions of Biodiversity).

Litchman, E., X. Tan, P. Mantha, H. Radha, G. Xing (MSU)***.*** Towards sustainable aquatic ecosystems: A new adaptive sampling and data-enabled monitoring and modeling framework. NSF (Cyber-enabled sustainability science and engineering [CyberSEES]; $800,000.

Litchman, E., C.A. Klausmeier, S. Hampton (UCSB), L. Yampolsky (ETSU), M. Moore (Wellesley), E. Theriot (Texas). 2011-2016. Lake Baikal Responses to Global Change: The role of genetic, functional and taxonomic diversity in plankton. NSF Dimensions of Biodiversity; $2,000,000 total; $599,941 MSU.

Litchman, E., C.A. Klausmeier. 2011-2015. Experimental and theoretical trait-based approaches to optimizing algal biofuel polycultures. NSF Division of Chemical, Bioengineering, Environmental, and Transport Systems; $328,537.

Litchman, E., C.A. Klausmeier. 2009-2015. Phytoplankton traits, functional groups and community organization: A synthesis. NSF Biological Oceanography Program; $544,871.

Litchman, E., X. Tan (MSU***).*** 2009-2014. AquaSWARM: Small wireless autonomous robots for monitoring of aquatic environments. NSF (Information & Intelligent Systems); $409,999.

Litchman, E. 2009-2015. Mechanisms of phytoplankton community reorganization under global change. NSF CAREER (Ecology); $529,626.

*Millar, N. and ***G.P. Robertson***. 2016. Nitrous oxide quantification and mitigation in Mexican grain crops under different nitrogen management practices. USDA-FAS; $18,032

Mittelbach, G. G. and D. W. Schemske. 2015-2017. Ecological and evolutionary perspectives on the origins of community diversity. NSF DEB (Opus program), $189,286.

****Robertson, G.P.*** and C. Sprunger. 2014-2015. Biodiversity effects on soil carbon gain in annual vs. perennial cropping systems. NCR SARE Graduate Student Grant; $6,382.

****Robertson, G.P.*** and I. Shcherbak. 2011-2013. Dissertation Research: Denitrification in subsurface soils. NSF-DEB $9,832.

Robertson, G.P. and S.K. Hamilton. 2015-2020. Collaborative Long-term Agricultural Research (LTAR): Ecosystem services from row-crop agriculture. USDA; $97,182.

Robertson, G.P., R. Gehl, P. Grace, 2007-2010. Reducing nitrous oxide gas emissions in agricultural crop production. EPRI – Electric Power Research Institute; $800,000.

Robertson, G.P. 2010-2014. Developing greenhouse gas emission offsets by reducing nitrous oxide emissions in agricultural crop production. EPRI – Electric Power Research Institute; $406,000.

****Robertson, G.P***. and B. O'Neill. 2014-2015. Linking soil testing with farmer decision making—an interdisciplinary approach. NCR SARE Graduate Student Grant; $6,853.

Robertson, G.P., K.L. Gross, S.K. Hamilton, D.A. Landis, ***T.M. Schmidt***, S.S. Snapp, ***S.M. Swinton***. 2010-2016. LTER: The KBS LTER: Long Term Ecological Research in Row Crop Agriculture, NSF DEB, $5.6M.

Schultheis, E. and ***J.A. Lau***. 2012. Dissertation Improvement Grant. The dynamic role of natural enemies during plant invasions. NSF $14,943.

Shiu, S-H., ***J.K. Conner***, and P. Krysan. 2017-2021. Collaborative Research: Fitness effects of loss-of-function mutations in duplicate genes (recommended for funding), NSF DEB $884,000.

Snapp, S. 2010-2012. Fostering complex soil food webs and building soil fertility with organic production of perennial wheat. The Ceres Trust; $155,000.

Snapp, S. 2011-2013. Mycorrhizal role in organic row crop production long-term experimentation. The Ceres Trust; $120,000.

Snapp, S. 2011-2013. Organic management effects on individual species of mycorrhizal fungi and the consequences on plant performance and soil health. The Ceres Trust; $200,000.

Snapp, S. and S. Swinton. 2009-2013. Practical perennials: Partnering with farmers to develop a new wheat crop. CSREES USDA-AFRI; $1.05M

*** Snapp, S. (PI),*** S.M. Emery, and C.B. Gottshall. 2012-14. Organic management effects on individual species of mycorrhizal fungi, and the consequences for plant performance and soil health. Ceres Trust. ($119,197 total; $41,479 to U Louisville).

Stuart, D., ***B. Basso***, S. T. Marquart-Pyatt, ***G.P. Robertson***, and J. Zhao. 2013-2017. CNH: A social-ecological analysis of nitrogen in agricultural systems of the upper Midwest. NSF-DEB; $1.46M. diversity and genetic diversity NSF DEB (LTER & LTREB), $1.5M.

*Suwa, T. and ***J.A. Lau***. 2014-2016. DDIG: The role of resource mutualisms in plant adaptation to abiotic environments NSF DEB, $19,953.

*Culman, S., ***S. Snapp, SA Utsumi,*** T. Dietz, R, Leep. 2010-2012. A new crop for a variable climate: intermediate wheat grass biology and forage potential. MSU- GREEEN, $57.769.

KBS appointed faculty (project not managed by KBS***)***

Basso, B. (PI) withJ Butler, N Brozovic, J Hatfield, D Hyndman, J Andresen, ***GP Robertson***, P Parker, J Price, J Zhao.. 2015-2019. Developing and promoting water-, nutrient-, and climate-smart technologies to help agricultural systems adapt to climate and societal changes. USDA-NIFA; $5M.

Basso, B, 2014-2016., Quantifying the spatial and temporal changes in San ClememteIsland Veetation between 1985 and present, using historical imagery and dynamic plant modelin. US Army Corps of Engineers, $214,381

****Schemske, D***., C. Oakley, M. Thomashow, J. McKay (co-PIs). 2016-2019. Evolutionary genetics of adaptation in natural populations of *Arabidopsis thaliana*. NSF, $980,000.

Schemske, D. (co-PI), H.SD. Bradshaw Jr. (PI). 2010-2015. Genetics of prezygotic reproductive isolation in natural populations of monkeyflowers (mimulus). NIH, $296,000.

Schemske, D., M.F. Thomashow (co-PI). 2010-2014. Ecological genomics of adaptation to the environment. NSF, $1,866,138.

*Other MSU faculty as PI (*MSU campus unit manages grant);

Aoda, M., A. Smucker and ***G.P. Robertson***. 2011-2015. Technology to improve vegetable production among highly permeable soils under water scarcity and dry climate conditions in Iraq. NSF-NAS PEER; $150,000.

*Bahlai, C., D. Landis, and Z. Szendrei. 2015-2016. Exploiting the landscape of fear as an insect control tactic. Projet GREEEN; $37,900.

Bauer, J.T. 2016-2017. Ecosystem services and plant diversity in re-established grasslands: A study of restoration chronosequences. USAD AFRI competitive grant; $144,000.

Chilvers, M. 2015. Improving management of SDS through detection, germplasm and fungicides. Michigan Soybean Promotion Committee; $45,000.

Chilvers, M. 2016. Improving management of wheat diseases, short and long term solutions. Michigan Wheat Program; $40,000

Donohue, T., K. Keegstra, B. Dale, R. Amasino, R. Landick, J. Ohlrogge, and ***G.P. Robertson***. 2008-2012. Great Lakes Bioenergy Research Center. DOE Office of Science (Biological and Environmental Sciences Division); $132M. Renewed 2013-2018; $125M. (U Wisconsin and MSU

co-manage: KBS LTER hosts sustainability research,; ca. $20M).

Hyndman, D., R.L. Van Dam, A. Kendall. 2009-2012. Multi-scale monitoring and modeling of land use and climate change impacts on the terrestrial hydrologic cycle: Implications for the Great Lakes basin. NSF-EAR; $243,552.

*Isaacs, R., D.A. Landis, J. Tuell, A. Fiedler, and M. Gardiner. 2007-2011. Maximizing arthropod mediated ecosystem services in agricultural landscapes. USDA NRI Integrative Biology of Arthropods and Nematodes; $342,000.

Kirk, W., N. Rosenzsweig, and K. Steinke. 2013-2014. Development of baseline soil data as an ecological foundation to reverse yield decline in Michigan potatoes. MDARD; $40,000.

Kravchenko A. (PI). 2010-2015. The chemical and physical nature of particulate matter affecting air, water and soil quality. USDA-NIFA; funding unspecified.

Kravchenko , A. N. and T. Marsh. 2014-2016. N2O production at micro-scale: understanding microbiological mechanisms. Discretionary Funding Initiative, MSU; $50,000.

Kravchenko, A. N., A. K. Guber, T. Marsh, and N. Ostrom. 2016-2019. Micro-scale mechanisms of N2O production in soil. NSF Geobiology Program; $550,000.

Kravchenko, A. N., K. Renner, and A. K. Guber. 2016-2017. Topographically diverse landscape influences on cover crop establishment. Project GREEEN; $39,500

Kravchenko, A., et al. 2008-2013. Quantitative methods for analyzing spatial variability of soil properties and crop yields. USDA-NIFA; funding unspecified.

Kravchenko, A., S. Snapp, ***B. Basso***., A. Grandy, J. Winkler, and J. Andresen. 2010-2014. Row crop ecosystems in a changing climate: enhancing ecosystem services at field farm and watershed scales. USDA-NIFA ES; $475,400.

Kravchenko, A.N., J. Rose, and A.J.M. Smucker. 2009-2011. Transport and survival of Escherichia coli within soil aggregates. USDA-Water and Watersheds Program; $260,269.

Kravchencko A and ***B Basso.*** 2011-2015. Climate Change, Mitigation, and Adaptation in Corn-based Cropping Systems, $891,401. USDA NIFA

Kravchenko, A.N., T. Marsh and A.J.M. Smucker. 2012-2013. Mechanisms of carbon storage in conventional and cover-crop-enhanced row crop agro-ecosystems at micro-scales. Project GREEEN; $30,000.

*Landis, D and J.M. Woltz. 2010-2012. The effects of field size and cropping pattern on carabid population dynamics in agricultural landscapes. Pioneer Hi-Bred International Graduate Student Fellowship; $25,000

*Landis, D. A., B. Wills and A. Myers. 2016-2017. Developing highly productive monarch butterfly habitats for Michigan's agricultural landscapes. Project GREEEN and MSU Entomology Discretionary; $30,000.

Lowry, D.B. Switchgrass Using Maize as a Model Discovery Engine. Great Lakes Bioenergy Research

Center (DOE). $18,789. 2015-2016

Lowry, D.B. Switchgrass Using Maize as a Model Discovery Engine. Great Lakes Bioenergy Research Center (DOE). $50,000. 2016-2017

Malmstrom, C.M., D.A. Landis, and R. Isaacs. 2011-2016. Control and mitigation of generalist pests in perennial grass-dominated bioenergy landscapes. USDA-NIFA; $991,219.

Malmstrom, CM and Z Szendrei, 2016 – 2017. Assessing the importance of local and distant sources of aster yellows phytoplasma to improve control strategies in Michigan agriculture. Project GREEEN. $40,000.

Maurer, B. 2012. Effects of grazing on plant and avian community structure in an experimental grazing system. KBS Farm Pasture Dairy; $14,000.

Mutch, D. and ***G.P. Robertson***. 2011-2014. Effect of cover crops on N2O emissions, N availability and C accumulation in organic versus conventionally managed systems. USDA-AFRI (Organic Transitions Program); $749,000.

Ostrom, N. 2014-2016. Collaborative Research: High-precision triple-isotopologue analysis of N2. NSF Geobiology and Low Temperature Geochemistry; $90,071.

Sarnelle,O and ***S Hamilton***. 2009-2014. Consequences of consumer adaptation for ecosystem responses to fertilization and food-web perturbation. $391,000 NSF (DEB)

Schmidt, T.M., U. Levine, Z. Lee, D. Reznik, C. Waldron, R. Sloup, A. Killinger. 2007-2010. Genomics of terrestrial microbial communities associated with the production and consumption of greenhouse gases. NSF/USDA-CSREES Microbial Genome Sequencing Program; $1.7M.

Scribner, K. and J. Moore. 2011. The importance of natural and anthropogenic features on deer forage use and movements: implications for disease spread and transmission to livestock. W.K. Kellogg Foundation; $14,000.

Simic, A. 2015. Monitoring the impact of agricultural chemicals on soil and crop parameters using satellite images. Bowling Green State Univ.; $10,000

Smith, N. and J. Dukes. 2013-2014. Improving earth system models via incorporation of temperature acclimation of plant carbon exchange. NASA-ESSF; $30,000 (Purdue).

Smith, R. and D. Foran. 2012-2013. Developing guidelines for the application of multivariate statistical analysis to forensic evidence. NIJ Forensic Sciences; $272,220.

Snapp, S. 2013-2016. Fostering complex soil food webs and building soil fertility with organic production of perennial wheat: Phase II. The Ceres Trust; $180,000.

Snapp,S, ***B Basso,*** J Messina, L Smith-Olabisi, R Richardson. 2013-15. Perennial grain crops for African smallholder farming systems. Bill and Melinda Gates Foundation, $1.5M

Swinton, S.M., F. Lupi, and ***G.P. Robertson***. 2005-2010. HSD-AOC: Ecosystem services from low-input cropping systems: Incentive to produce them and value of consuming them. NSF (Agents of Change Program); $400,000.

Swinton, S.M., J. Kerr and R. Richardson. 2012-2015. Great Lakes watershed ecological sustainability strategy Phase II: Payments for ecosystem services. The Nature Conservancy (via Great Lakes Protection Fund): $263,182 .

Thomashow, M., L. Sepulveda, J. Tiedje, D. Lubman, S. Kathariou, J. McGrath, D. Gilichinsky, R. Goldstein, E. Branscomb. 2007-2012. Biodiversity and biogeography of Exiguobacterium sp. and Psychrobacter sp. NASA Astrobiology Institute; $5.4M.

Thompson, A., ***B. Basso,*** M. Fienen, D. Hyndman, R. Jackson, K.G. Karthikeyan, A. Kendall, and B.J. Lepore. 2010-2013. Implications of climate change and biofuel development for Great Lakes regional water quality and quantity. USGS; $247,000.

Tiemann, L. 2015-2016. How does cover crop chemistry regulate the soil microbes, SOM dynamics and plant available N? MSU AgBioResearch Project GREEEN; $69,489

Trail, F. 2014-2015. The interaction of microbial soil communities with *Fusarium graminearum*. Michigan Wheat Program; $35,000.

Non-MSU PI, co-PI: (account not managed by MSU)

Bonan, G. (PI), et al. 2014-2017. Decadal prediction of sustainable agricultural and forest management-Earth system prediction differs from climate prediction. NSF-USDA; $500,000 UNH portion.

*Brewer, P. 2013-2015. Uncovering the mechanisms of reduced tillage effects on nutrient cycles and greenhouse gas flux: how anoxic microsites and other soil structures mediate critical cycles in agriculture. USDA-NIFA AFRI Predoctoral Fellowship. $65,000 (Colorado State U).

Dick, R. (PI). 2013-2015. Enzyme activities as dynamic properties to detect soil changes within a human time scale. Natural Resources Conservation Service (NRCS); $158,000 (Ohio State U).

*Dukes, J. and N. Smith. 2013-2015. Dissertation Research: Acclimation of photosynthesis and respiration to temperature under climate change: Understanding variation among species and biomes to improve climate models. NSF-DEB; $19,903 (Purdue).

Eichorst, S. 2009-2012. Unraveling complex microbial community processes. Los Alamos National Lab, (LDRD Program); $567,000.

Emery, S. 2015-2017. Can soil biodiversity increase biofuel feedstock production and ecosystem services on marginal lands? USDA AFRI: Agroecosystem Priority Area; $149,960 (Univ. Louisville).

Emery,SM and C.B. Gottshall. (with Snapp,MSU) 2012-14. Organic management effects on individual species of mycorrhizal fungi, and the consequences for plant performance and soil health. Ceres Trust. ($119,197 total; $41,479 to U Louisville).

Gonzalez-Andujar, J.L. and A.S. Davis. 2013-2015. Comparative time series analysis of non-crop plant biomass in two long-term cropping systems experiments. Spanish Ministry of Economy and Competitiveness; $120,000 (Univ. Illinois).

Grandy A.S. and M. Daly. 2013-2016. NSF Graduate Research Fellowship: Linking microbial community structure with nitrogen cycling in response to priming. NSF; $108,000 (UNH).

Grandy, A.S. and A. Jilling. 2014-2017. NSF Graduate Research Fellowship: Effects of nitrogen

management on nitrogen availability to plants. NSF; $108,000 (UNH).

Grandy, A.S. and C. Kallenbach. 2013-2014. Dissertation Research: Linking microbial ecophysiology to soil organic matter abundance and stabilization. NSF-DEB; $19,000 (UNH).

Grandy, A.S., E. Marin-Spiotta, and T. Schmidt. 2009-2014. Multi-scale consequences of rotational diversity on Midwestern agricultural soils. USDA-AFRI Soil Processes; $450,000. (UNH)

Grandy, A.S., R. Smith, K. Broders, and E. Hobbie. 2013-2017. Nitrogen synchrony at the crop-soil interface: optimizing root-microbe interactions to minimize environmental nitrogen losses. USDA-NIFA; $493,388 (UNH).

Gratton, C., D. A. Landis, and R. Isaacs. 2012-2015. Developing sustainable perennial bioenergy crop management for birds and pollinators: effects of harvest, refuges and landscape context. USDA-NIFA AFRI; $496,053.(U Wisconsin)

Grman, E. (Collaborative PI's) with ***J Lau*** and L.A. Brudvig (co-PI). 2015-2016. National Science Foundation. Collaborative Research: RAPID: Linking population and community ecology in restored communities: Interactions between species diversity and genetic diversity. $137,766 ($30,000 to Eastern Michigan ;plus $8500 REU supplement)

*Hess, L. and P.A. Matson. 2015. The effects of changing rainfall patterns on nitrogen leaching from agroecosystems. McGee/Levorsen Grant; $4,000 (Stanford).

*Hess, L. and P.A. Matson. 2015. The effects of changing rainfall patterns on nitrogen leaching from agroecosystems. NSF-DEB Doctoral Dissertation Improvement Grant; $16,536 (Stanford).

*Hess, L. and P.A. Matson. 2015-2016. The effects of changing rainfall patterns on agroecosystem nitrogen cycling and losses. Stanford University; $120,000 (Stanford).

*Hestrin, R. 2015-2016. Microbial contributions to plant nitrogen uptake: Arbuscular mycorrhizal fungi and soil bacterial communities. NSF IGERT and Cornell ACSF; $4,000 (Cornell).

*Hestrin, R. 2016-2017. Rethinking soil nitrogen cycling: Can the movement of nitrogen from ammonia point sources through soil contribute to plant and fungal nitrogen nutrition? NSF IGERT and Cornell ACSF; $4,000 (Cornell).

*Hockaday, W. and Z. Valdez. 2013-2018. NSF Graduate Research Fellowship: Effects of management practices on soil carbon storage in switchgrass bioenergy agrisystems. NSF DGE; $456,000 (Baylor).

Honroth, S. and A. McCall. 2016. Disruption of the legume-rhizobia relationship by N-addition and its effect on pollinator behavior and herbivory. Denison University Batelle Fund; $5,188 (Denison).

Jordan, N., K. Spokas, A. Davis, G. Sims, A. Yannarell, A. Grandy, S. Snapp, R. Mortensen, and R. Smith. 2011-2015. Precision zonal management systems for resilient cereal yields and ecosystem services under variable climates. USDA Climate Change; $4.1M (MSU portion: $986,464).

Kallenbach, C. 2013-2015. Microbial ecophysiology as an explanation for observed differences in soil carbon concentrations between an organic and conventional agricultural system. USDA-NIFA AFRI; $79,000 (UNH).

Lennon, J., K. Locey and S. Jones. 2014-2019. Microbial seed banks: Processes and patterns of dormancy-driven biodiversity. NSF; $1.9M (Indiana Univ.)

Masiello, C. and W. Hockaday. 2011-2013. Effects of nitrogen management on biofuel crop biogeochemistry and soil carbon stocks. USDA AFRI Biofuels; $443,541 (Rice Univ.).

Miller, W.R., B. Adams, C. Johansson, and P. Morris. 2007-2011. Tardigrades of the LTER sites: A framework for the distribution and phylogeny of North American Tardigrada. NSF; $600,000 (Baker Univ.).

Nelson, D (PI). 2009-2011. Metagenomic analysis of spatial and temporal variation in the composition of soil microbial communities. USDOD NGIA. $239,651 (Univ. Maryland).

*Quigley, M.Y. 2015-2017. Using stable isotopes and computed tomography to determine mechanisms of soil carbon protection in cover crop based agricultural systems. USDA-NIFA AFRI ELI Predoctoral Fellowship; $79,000

Paul, E. (PI). 2013-2015. OPUS: Soil organisms, carbon and nitrogen interact in the control of soil organic matter dynamics in ecosystem functioning. NSF-DEB; $142,626 (CSU).

Peralta, A.L., J.T. Lennon, and L.A. Hoagland. 2012-2016. Land use legacies in soils: Effects of crop diversity on plant-soil-microbial interactions. USDA-NIFA; $125,991

Philips, R., L.W. Morton, L.W. Morton, A.N. Kravchenko and >15 co-PIs from multiple states. 2010-2014. Climate and sustainable corn-based systems. USDA-NIFA: $1.12M (MSU's portion).

Radosevich, M., S. Pfiffner, E. Wommack, and S. Williamson. 2007-2011. Microbial Observatory for phage in soil: Influence of land management practices on virus-host interactions. NSF/USDA Microbial Observatories; $1.35M (Univ. Tennessee).

Ribes, D., T. Finholt, S. Jackson. 2008-2011. VOSS: Delegating organizational work to virtual organization technologies: Beyond the communicational paradigm. NSF; Office of CyberInfrastructure (OCI), $395,685 (Univ. Michigan).

Steiner, CF 2013-2014. The causes and consequences of clonal diversity in spatially and temporally varying meta-populations. $250,000 ($7500 REU Supplement) NSF DEB (Wayne State)

Steiner, CF. 2013-2017.The impacts of dispersal and genetic diversity on the stability of environmentally forced meta-communities $639,214 NSF DEB (Wayne State)

Triplett, E., N. Fierer, D. Arp, R. Knight. 2008-2012. How are archaeal diversity, abundance, and function regulated in soil? USDA-CSREES; $1.5 M (Univ. Colorado).

Weigel, D. 2014-2016. Evolution in action: a 200-year experiment of adaptation in a clonal lineage of Arabidopsis thaliana. Max Planck Institute for Developmental Biology; funding unspecified.

Zhou, J., W. Liyou, K. Sanghoon, H, Jiang. 2008-2011. GeoChip analysis of responses of microbial communities to plant diversity, nutrient addition. USDA; $800,000 (Univ. Oklahoma).

Externally funded Education/Outreach Projects at the WK Kellogg Biological Station

Active 2011-2016

*KBS faculty/staff as PI or co-PI (*account managed at KBS)

Doll, J.E., C. Currell, P. Gross, and M. Thelen. 2014-2015. Sustaining Michigan's soil amidst changes in the climate: curriculum for a rainfall simulator. MSU Extension AABI; $3,600.

Doll, J.E., C. Currell, P. Gross, and M. Thelen. 2014-2015. Climate change and soil health curriculum. MI SARE; $1,500.

Doll, J.E., C.L. Layman, and G.P. Robertson. 2010-2012. Michigan agriculture and climate change: deliberating toward stewardship. EPA Environmental Education Grant; $48,264.

Getty, T.R., C.W. Anderson, ***K.L. Gross, G.P. Robertson***, and ***J.A. Lau***. 2010-2015. GK-12 Pre-doctoral Fellowship Program: Biofuel sustainability in K12 classroom of rural Michigan. NSFEHR; $2.7M.

Gross, K.L. (PI). 2015. REU Site: Ecological and evolutionary dynamics in a changing world: A scaffolded undergraduate research experience. NSF; $320,000.

Gross KL, K Haas, I Bayer. 2015-2018 "Teaching Science Outdoors: A pathway to enhancing K-5 teacher and student environmental education" EPA Environmental Education, $91,000

Haan, M., ***J.E.Doll,*** and D. Pennington. 2010. 2nd Annual upper midwest food, fuel, and fiber network tour. NCR SARE Professional Development Grant; $3,500.

Other MSU PI: (account managed by other MSU or institution)

Amasino, R., H.B. Lauffer, J. Greenler, J. Grignon, M. Cook, W. van Lopik, and C.W. Anderson. 2011-2015. Place-based opportunities for sustainable outcomes and high-hopes (POSOH). USDA-AFRI program; $4.7M (U Wisconsin Lead: MSU portion: $236,916).

Anderson, C.W, D. Gallagher, K. Schwille and M. Wilson 2010-2015. A learning progression-based system for promoting understanding of carbon-transforming processes. National Science Foundation DRK-12 Program; $3.5M.

Anderson, C.W., D. Gallagher, S. Spiegel, ***T. Getty,*** and B. Covitt. 2014-2019. Sustaining responsive and rigorous teaching based on carbon: Transformations in matter and energy. NSF DRL; $6,968,640.

Covitt, B., K. Gunckel, and C.W. Anderson. 2010-2013. Reasoning tools for understanding water systems. NSF DRK-12 Program; $450,000

Landis, D.A., R. Ahern, A. Ziegler, and P. Higman. 2008-2011. The Michigan Invasive Species Information Network (MISIN): engaging stakeholders in invasive species detection and management. Sustainable Michigan Endowed Project Integrative Project Grants (IPG) program; $75,000.

Layman, C.L., ***J.E. Doll, and G.P. Robertson***. 2010-2013. Preparing Michigan plant industries for the changing physical and policy climates. Project GREEEN; $29,620.

Layman, C.L., W. Beyea***, J.E. Doll,*** M. Skidmore, and D. Solomon. 2012-2013. Adapting to climate change and variability: Planning tools for Michigan communities. Great Lakes Integrated Sciences and Assessments Center GLISA; $49,500.

Layman, C.N., W. Beyea***, J.E. Doll***, M. Skidmore, and D. Solomon. 2012-2013. Adapting to climate change and variability: planning tools for Michigan communities. GLISA; $49,500.

Mead, L.S. 2015-2019. Collaborative Research: Scientific data in schools: Measuring the efficacy of an innovative approach to integrating quantitative reasoning in secondary science. Collaborators: M. Stuhlsatz (PI) and J Taylor; Biological Sciences Curriculum Study. NSF-HER; $2.3M ($1,147.500 to MSU)

Moore, J.C., C.W. Anderson, A.R. Berkowitz, R.L Tschillard, and A.C. Whitmer. 2009-2014. Targeted Math and Science Partnership: Culturally relevant ecology, learning progressions and environmental literacy. NSF-EHR; $12.5M (Colorado State lead: MSU portion: $3.33 M).

Pathak, T. and ***J.E. Doll***. 2012-2013. Ensuring the sustainability of agriculture in the face of a changing climate. USDA NCR-SARE Professional Development Program Grant; $74,286 ($18,113 to MSU)

KBS Visiting Scholars, 2012-2016

Name	Title	Home Institution	Dates at KBS	Sponsoring Lab/Programs
Nalini Nadkarni	Director	Center for Science and Mathematics Education, Utah State University	October 2012	Gross/K-12 Partnership
Kathryn Cottingham	Professor	Dept. of Biological Sciences, Dartmouth College	Feb-April 2011	Hamil/Litchman
Bryan Foster	Professor	Dept. of Ecology and Evolutionary Biology, University of Kansas	Sept.-Oct 2013	Gross
Leonilde Roselli	Postdoc	University of Salento (Italy)	Feb -Aug 2014	Robertson
Shumin Li	Professor	Northeast Agricultural University (China)	Feb 2014	Robertson
Julio Galli	Agronomy Engineer	College of Agricultural Sciences, Universidad Nacional de Rosario (Argentina)	July 1 - Sept. 15, 2014	Utsumi
Mark McCarthy	Postdoc	The University of Texas at Austin, Marine Science Institute		Hamilton
Mike Jones	Professor	Dept. of Fisheries & Wildlife, MSU	October 2014	Gross
Alexey Ryabov	Postdoc	University of Oldenburg (Germany)	Oct-Nov 2014	Klausmeier
Karel Jacobs	Associate Professor	Chicago State University	Sept- Dec 2015	Gross/K-12 Partnership
Art Stewart	Professor	Oak Ridge National Laboratories	July 2016	Science Ed & Outreach
Veera Norros	Researcher	Finnish Environment Institute (SYKE)	February- September 2016	Litchman
Juan Ramon Insua	Assistant Professor	Universidad Nacional de Mar del Plata, Department of Animal Production	March - October 2016	Utsumi
Carol Shennan	Professor	Department of Environmental Studies, University of California - Santa Cruz	August- October 2016	Robertson

W. K. Kellogg Biological Station Academic Programs

Danielle C. Zoellner, PhD, Academic Programs Coordinator

The Kellogg Biological Station offers a variety of education and training opportunities for graduate and undergraduate students. These opportunities be divided in three broad categories: 1) courses and seminars (both); 2) research and professional internships (undergraduates); and 3) mentoring (both). Below we describe these programs in more detail. Additional information about KBS Education/Academic programs is on the website

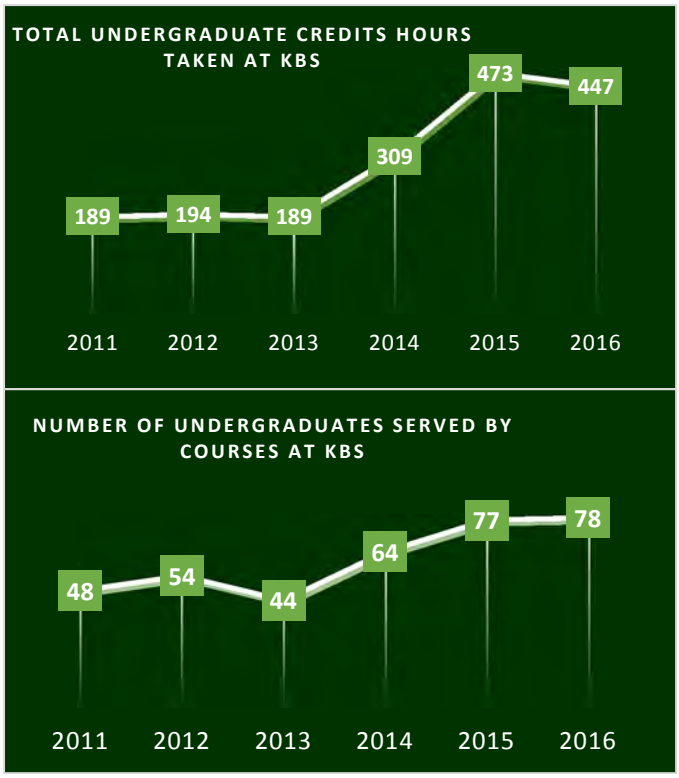

Figure 1: Total undergraduate credit hours taken at KBS from 2011 to 2016, and the total number of undergraduates taking courses at KBS from 2011 to 2016.

Undergraduate and Graduate Courses: We offer a wide variety of undergraduate field-based courses at KBS in the summer and have made a concerted effort to coordinate with departments in both College of Natural Sciences (CNS) and the College of Agriculture and Natural Resources (CANR) to offer undergraduate courses that both help student fulfill requirements of their major and enrich their educational experience. Important to KBS courses is the small size, focus on field experiences, and in many courses a research experience. The number of undergraduates enrolled in courses and KBS and the number of student credit hours earned here have both increased over the past five years; importantly we cancel very few courses and have developed a stable curriculum that allows students to plan on taking a summer (or two) at KBS as part of their MSU educational experience. We have also developed course sequences that allow students to spend a full term – or summer- at KBS and gain a variety of experiences. For example in 2015, we initiated the "Launch Your Major" program that required students to take three courses together – Organismal Biology and Lab (BS 162/172) and an introductory course in statistics (STT/FW 224) –taught 5 days/wk (M-F) for 5 weeks. The intent was to provide early career (Freshmen) and transfer students the opportunity to complete courses that were required for many STEM majors, that can be difficult to schedule. It also provided students the opportunity to see the importance of quantitative skills in biology. Student reviews for this offering were encouraging and we have continued it; in 2016 we had 18 students enrolled and a waiting list. Several of the students that enrolled in LYM stayed on to take courses in the second term, and many from the first cohort returned to take courses the next summer.

Increasingly students are electing to be in residence (vs. commuting from campus) when taking KBS courses. This has helped to create a sense of community that is very important for student retention, especially for under-represented or first generation students. We keep student expenses for a KBS summer experience to a minimum by providing all students who are in residence with scholarships to cover at least 50% of their room and board at KBS which keeps room and board rates slightly lower than those on campus. The Conference Center has contributed directly and indirectly to this by providing $15-$20,000 in direct scholarship support to KBS summer students, reducing rates (or fully covering) costs for Resident Mentors, and setting costs for summer students considerably lower than what they charge other conference groups.

KBS courses provide students with research and learning experiences that are not possible (or very difficult) to provide on the MSU campus. Some are only offered at KBS. This includes ENT 461 "Ecology of Insects as Vectors of Disease" and IBIO/PLB 440 "Field Ecology and Evolution". ENT 461 is targeted for students interested in health profession (pre-Vet, pre-Med) and provides field and research experiences that can broaden students options for professional careers. The IBIO440 course takes students through the full cycle of a research project: starting with reading the literature, to designing and conducting experiments to test hypotheses, analyzing the data, presenting the results and (as a final project) writing a research proposal. Wetland Ecology and Management (FW417) is also offered on campus, but at KBS students spend a majority of class time whereas on campus it is primarily a lecture course. The co-teaching by Steve Hamilton (KBS) and Todd Lossee (wetland scientist with Niswander Environmental Consulting) provides students the opportunity to see the connections between ecological principles and management challenges.

Having summer courses at KBS benefits our graduate students in several ways: 1) some enroll in the 400-level course (e.g. PLB 418 - Field Plant Systematics; PLB 424 – Algal Biology; or those listed above) to get an introduction to systems at KBS; 2) summer school funds include support for Teaching Assistants, providing summer support and the opportunity to teach in a unique (and relevant) course setting, and 3) having specific courses for graduate students. This includes the long running "Eminent Ecologist" course and short courses in mathematical-statistical ecology the "ELME" program (Enhancing Linkages between Math and Ecology). The ELME courses attracts students from across the US (and sometimes internationally) and provides them advanced training in analytical methods used in ecology and the opportunity to apply them to their own data.

Graduate seminars on special topics led by KBS faculty are offered during the academic year – both for students in residence and based on campus by using video technology. Each spring we offer a seminar, "Career Pathways" that is designed to introduce graduate students and postdocs to skills and opportunities to pursue careers in and outside the academy. This seminar is presented at KBS, live-streamed and recorded for future online viewing. The focus of the seminar differs each year, but always includes sessions on communicating science and mentoring as these are both critical skills to develop in any profession. It is also important to the success of our undergraduate research programs as these students are often co-mentored by graduate students or postdocs with the faculty in the lab.

Research and Professional Experiences: We recognized the importance and value that research and professional internships can have for undergraduates and over the past 5 years have increased the number of internships offered at KBS by 30% (Figure 2). We offer two types of research experiences: the URA (Undergraduate Research Apprentice) for MSU students with little or no prior research experience and REU (Research Experiences for Undergraduates) for more advanced students and targets students from small liberal arts colleges, community colleges and universities with limited research opportunities. The REU (Research Experience for Undergraduates) program is funded by a NSF site grant and supplements to faculty grants and each year we have 12-15 REUs in residence at KBS for 11-12 weeks. The URA program is funded by a variety of sources, included grants from GLBRC and BEACON, scholarship funds from CANR, CNS programs that target under-represented students (DREW and DOW STEM scholars) departments (FW and IBIO), and KBS scholarship funds. Students are paid a stipend ($2500 for URAs, $5775 for REUs), have free room and board and research funds; we also provide travel funds for REUs as they are not from Michigan.

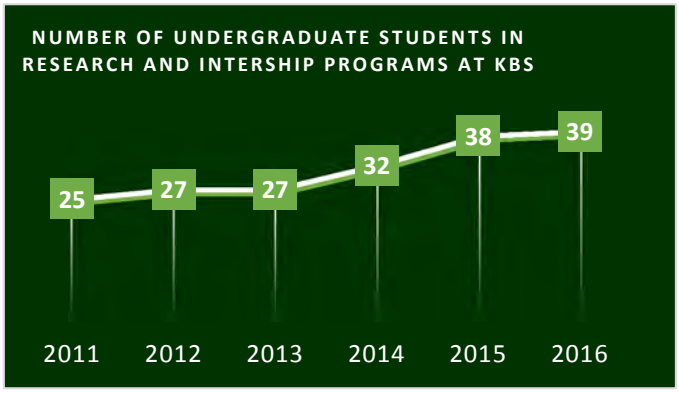

Figure 2: Total number of undergraduates served with KBS Internship, REU and URA programs from 2011 to 2016.

KBS staff, faculty, post-docs and graduate students are actively involved as mentors for KBS undergraduate programs, and are integral part of undergraduate training (Table 1). Mentors are expected to work with their mentees to develop a research and learning plan and we offer a comprehensive Professional Development for the undergraduates to complement this. Topics in the weekly PD program include keeping data records, statistical tools, preparing and presenting posters, science communication, authorship and publication. We also introduce them to a variety of careers – and the education needed for these – thorough panel discussions, presentations by scientists in different careers and a visit to MSU organized in collaboration with the MSU Graduate School. Both URA and REU students are encouraged to present a poster at the end of summer Undergraduate Symposium; we also encourage them to blog about their KBS experiences. To encourage students to present their research at a professional meeting we provide funding for both the undergraduate and their graduate mentor to attend a national meeting.

The KBS Internship Program is designed to attract students who are not necessarily interested in research, to come to KBS to take courses and have a professional learning experience. These are also paid (part-time) positions and include free room and board. Internships are targeted to MSU students and we use MSU's Internships@State to advertise and recruit students and develop learning plans for each student. Mentors for the interns include KBS staff from the Sanctuary, Farm, Outreach, Communications, Development and Grounds and internships are offered in avian care, marketing, communications, science/environmental education and landscaping. Interns also participate in the Professional Development program and are expected to present a poster or project summary at the Undergraduate Symposium.

Table 1: Number of undergraduate students mentored in KBS faculty labs during summers 2014-2017.

KBS Faculty Lab	Total # of undergraduate researchers mentored
Connor	3
Evans (2015-2017)	5
Fitzpatrick (2017)	1
Getty	5
Gross	7
Hamilton	8
Lau	16
Litchman	10
Mittelbach	3
Robertson	17
Utsumi	1
Visiting Faculty	
Brudvig/Gross (2015-2017)	6
Grman/Gross (2015-2016)	1
Landis (2017)	1
Lowry/Gross (2016-2017)	2
Steiner (2015-2016)	2
Wetzel (2017)	1
Zarnetsky/Lau (2016-2017)	4
Total # of undergraduate researchers hosted from 2014-2017	**96**

Broadening Participation: One goal of these programs is to increase opportunities for students from under-represented groups to have a research and professional experiences off campus that can help define their career goals, increase their competitiveness for other research or related internships, and for REUs and URAs, retain these students in STEM. We also want to provide opportunities for first generation students to explore career options, gain skills and develop the professional networks that are important to their success in graduate school or a career. We have set as a goal to have 50% of interns students from either under-represented groups or first generation and have been reasonably successful in meeting these goals. For example, in 2016 60% of URAs were female, and 1 student self-identified as non-binary; 30% self-identified as an under-represented racial or ethnic group in STEM, 30% were first-generation college student and 30% were community college transfers. Of the 17 REUs in 2016, 13 provided demographic data: 70% self-identified as women, 70% as from underrepresented racial or ethnic group in STEM; 61% were from Historically Black Colleges and Universities

(HBCU) or Hispanic Serving Institutions (HIS); 23% were first generation; 46% were from schools <10K students. The pool from which interns are selected does not provide a lot of racial diversity, but we have been successful in recruiting first generation (30%) and transfer students from community colleges (20%) to this program. We are continuing to seek ways to better identify (and recruit) students from more diverse backgrounds to our internship program.

Undergraduate Program Evaluation: A recent survey of former KBS undergraduates shows that many of our internship and research program students have gone on to obtain advanced internship or research positions, or admittance to graduate school, at MSU and across the nation. We are gaining a reputation on-campus for preparing URAs well for both advanced course work and research positions in faculty labs. Faculty have particularly noted the level of professionalism and research skills that KBS URA students have.

Table 2: Career pathways of recent KBS Program Students (as of December 13, 2016). A total of 214 students were sent this survey and we had 71 respondents.

Interns, REUs and URAs (2009-2016 cohorts, 71 responses)	**Total**
Still enrolled as undergraduate	36 (51%)
Currently enrolled as graduate student	21 of 35 (60%)
Enrolled in MS or PhD Program	14 of 35 (40%)
Obtained another REU/STEM intern position following KBS experience	39 of 71 (55%)
Currently working in a STEM-related field	42 of 71 (59%)

We fully recognize that in order to have a superior STEM workforce we must recruit students from diverse backgrounds. We are committed to increasing diversity in the STEM workforce, and our recruitment track record demonstrates that we have been successful in meeting this goal. In addition, we have successfully 'scaffolded' many students to further STEM-related experiences and careers (see Table 2). While the majority of our past program students from 2009 forward are still undergraduates (51%), most obtained additional experiences in STEM following their time at KBS (55%). Moreover, of the 35 survey respondents that had completed their undergraduate degree, 60% indicated they have pursued an advanced degree.

Participating in the NSF BIO-REU program has also given KBS access to use the URSSA (Undergraduate Research Student Self-Assessment) evaluation tool. Data from this survey indicates that KBS has done an excellent job of mentoring undergraduates in research experiences. When students were asked to rate their gains with regard to "Thinking and Working Like a Scientist", the KBS program scored a mean of 4.46/5 for the entire section, with nearly 65% of the student participants indicating they made "great gains" in answer to 7 of the 8 questions within this section. KBS students expressed higher than average scores in the section focused on "Personal Gains", with many students indicating they made "great gains" in every area (mean = 4.44/5). The KBS program is also having a particularly important impact on student perceptions of what research is like, with 71% of students indicating they made "great gains" in "understanding what everyday research work is like".

In the section of the tool focused on "Changes in Attitudes or Behaviors as a Researcher", 83% of student respondents felt that they were able to engage "a great deal" in real-world scientific research, with all of our student respondents feeling very much a part of a scientific community (mean = 4.40/5). More than 95% of respondents "agreed" or "strongly agreed" that their REU and URA experiences have prepared them for graduate school, and 58% of students indicated they are "much more likely" to "extremely more likely" to pursue a PhD in STEM.

We are also exploring ways to evaluate the impact of taking summer courses on students learning, perception of science and ability to apply what they learned/experienced at KBS to other courses. While the MSU SIRS (Student Instructional Rating System) scores for KBS courses are consistently high (4 and above out of 5), it is difficult to determine if this is due to having selected highly motivated students, or having motivated them by

being here. We are partnering with faculty interested in evaluating student learning to develop an appropriate tool to do this and have had discussions with others in the OBFS (Organization of Biological Field Stations) about how best to do this type of analysis.

Funding and costs: The KBS summer programs - course work and research/professional experiences are expensive on a per student bases. Class sizes are necessarily small (12-18 students), instructor:student ratios high due to the intensive research and field focus of most classes and teaching requires use of vans, boats and sampling equipment that most campus based courses (even labs) do not. We cover the instructional costs through funding from the Provost's Office (requested via the Colleges) and to date they have been supportive of KBS continuing to offer courses. It also costs students to come here – tuition is the same, having to pay room and board and the loss of summer income can be a deterrent. We attempt to offset the costs by providing scholarships (50% or more) toward room and board and having all of our research experiences and internships paid. Fortunately grants, gifts, scholarships and endowment income help to offset this: in 2016 we provided over $260,000 in scholarship and/or stipend or room and board support to the students at KBS. We hope that this can/will continue and are committed to pursuing grants (e.g. the NSF REU site), increasing endowment funds for scholarships, and pursuing partnerships with campus units whose students attend, participate and benefit from the diverse learning experiences at KBS

Future Directions: Classroom size and number and the focus on field research experiences limits the capacity of KBS to offer many more courses or enroll more students in our current summer courses. There is also some limitation of housing – especially if we want to continue to attract students into both course work and research experiences at KBS. However, there may be opportunities to provide MSU students with research experiences at KBS during the academic year. A recent NRC report has outlined the importance of Course-work based Undergraduate Research Experiences (CURE) for retention of students in STEM, particularly those from for under-represented and first generation students. The distance KBS is from main campus can be a challenge, but low cost on-site lodging (cabins that sleep 16 -20) is available and we could work with the conference center to provide a low cost meal plan as well (the cabins do not have cooking facilities). We would like to see more opportunities for KBS learning experiences incorporated into courses, for example, as weekend field trips (which are currently part of the PSM 424 and 422 courses taught by KBS faculty). We also envision that we could develop hybrid courses in collaboration with campus faculty that include both on-line and KBS learning experiences. To develop this type of program would require a large amount of coordination among mentors, student schedules and the KBS Conference Center to provide additional experiential learning opportunities for undergraduates at KBS. We are also exploring with faculty/chairs of Math and Statistics opportunities to offer under-prepared students enrolling at MSU pre-college experiences ("math camps") that would better prepare them for the academic rigors of a STEM major at MSU. Funding (to support the program) and time (for the faculty involved) are both important constraints to this, but we feel it is worthwhile to pursue.

Kellogg Biological Station Summer 2017 Field Courses

www.kbs.msu.edu

Session 1 (May 22-June 23)

- Organisms & Population Biology (BS 162+BS172*) & Stats for Ecologists (STT224*)

*Launch Your Major courses are integrated and must be taken together

- Field Ecology of Arthropod Disease Vectors (ENT461)
- Plant Systematics (PLB418)
- Nature & Environmental Writing (WRA341)
- Algal Biology (PLB424)
- Ecology (IBIO355+IBIO355L)

A LEGACY OF CONSERVATION
90 YEARS
W.K. Kellogg Biological Station

Session 2 (July 3 – August 4)

- Wetland Ecology & Management (FW417)
- GIS Applications in Natural Resources (FW419)
- Restoration Ecology (FW443)
- Ecology (IBIO355+IBIO355L)
- Advanced Field Ecology & Evolution (IBIO440)

Graduate Courses & Workshops

- ELME Advanced Stats Courses (PLB809 Sec 431-433)
  - Maximum Likelihood, July 10-14
  - Structural Equation Modeling, July 17-21
  - Stochastic Modeling July 24-28
- Eminent Ecologist Seminar Series (IBIO891)
- EDAMAME Workshop: Metagenomic Advances in Microbial Ecology (August 6-12)

**Housing scholarships are available to all students

SUMMER STUDY.
LIFETIME IMPACT.

WANT TO GAIN VALUABLE EXPERIENCE, EARN COURSE CREDITS, AND HAVE THE MOST LIFE-CHANGING SUMMER EVER?

APPLY TO W.K. KELLOGG BIOLOGICAL STATION'S SUMMER PROGRAMS!

Whether you're looking for a hands-on internship, research experience, or the best possible way to tackle your summer courses, KBS is for you.

Our **INTERNSHIPS** are paid professional experiences for students in a variety of disciplines. Interns assist with KBS programs, take a KBS course, and complete a portfolio-worthy project.

Our **UNDERGRADUATE RESEARCH APPRENTICESHIP (URA)** program offers paid part-time research positions to students. URA students assist in a research lab and take a course.

Our **SUMMER COURSES** are a great chance to earn credits outside of a traditional classroom setting. KBS summer courses are hands-on learning experiences with extensive field work.

Summer students live and learn at MSU's W.K. Kellogg Biological Station in Hickory Corners, Michigan on beautiful Gull Lake. For more information, visit our website or contact us with your questions.

VISIT US ONLINE TO LEARN MORE
kbs.msu.edu/education/undergraduate-program/

EMAIL **KBSSummer@kbs.msu.edu**
PHONE **(269)671-2171**

W.K. Kellogg Biological Station
MICHIGAN STATE UNIVERSITY

LAUNCH YOUR MAJOR COURSES

SESSION 1: MAY 22 - JUNE 23, 2017

- Population & Organismal Biology (BS162)
- Population & Organismal Biology Lab (BS172)
- Statistics for Biologists (STT224)

SESSION 2: JULY 3 - AUGUST 4, 2017

- Ecology (IBIO355)
- Ecology Lab (IBIO355L)
- Field Ecology & Evolution (IBIO440)
- Wetland Ecology & Management (FW417)
- GIS Applications in Natural Resource Management (FW419)
- Restoration Ecology (PLB443)

LAUNCH YOUR MAJOR

AT W.K. KELLOGG BIOLOGICAL STATION!

We offer a set of **integrated introductory biology and statistics courses** (BS162/BS172/STT224) that are prerequisites for many upper-division courses. Because the courses are integrated, you will learn how biologists use statistical tools to study organisms and populations, plus **you will gain 8 credit hours in just 5 weeks**! You can then choose from a portfolio of upper division courses in the second 5-week term, and end up **an entire semester ahead** by the end of the summer! We offer small (capped at 18 students), hands-on, field-based courses that provide a truly unique learning experience. **Courses fill fast, so apply early**!

ELME 2017

Enhancing Linkages between Mathematics & Ecology

A LEGACY OF CONSERVATION 90 YEARS W.K. Kellogg Biological Station

Applications Due March 15, 2017

To apply today, visit: kbsmsu.wufoo.com/forms/zp1dxrq11j8dch/

Come learn about the interface of ecology and mathematics on the campus of MSU's beautiful W.K. Kellogg Biological Station! Each week-long course combines lectures, hands-on computer activities using [R], literature discussions, and group projects, emphasizing applications of quantitative techniques to ecology and evolution. Course topics are complementary, but can be taken singly or in any combination. Housing and travel scholarships are available; non-MSU students enrolled in Universities that are part of the Big 10 Academic Alliance can enroll through the Traveling Scholars program.

Maximum Likelihood Estimation
Dr. Colin Kremer, Yale University

July 10-14 (M-F, 1 cr.)
PLB 809, Section 431

Structural Equation Modeling
Dr. Don Schoolmaster, USGS

July 17-21 (M-F, 1 cr.)
PLB 809, Section 432

Stochastic Modeling
Dr. Kevin Gross, NC State University

July 24-28 (M-F, 1 cr.)
PLB 809, Section 433

Questions? For more info & full course descriptions, go to www.kbs.msu.edu/education/courses/#grad or email KBSsummer@kbs.msu.edu

W.K. KELLOGG BIOLOGICAL STATION

UNDERGRADUATE RESEARCH APPRENTICESHIPS

Summer 2017

Want to gain research experience and earn credits toward your major this summer?

APPLY FOR THE KBS URA PROGRAM!

Our goal is to provide students with quality research experiences that will jumpstart their careers. KBS faculty, post-docs and graduate students are passionate about mentoring undergraduates.

The KBS Undergraduate Research Apprenticeship (URA) Program features part-time research positions that are geared for early career students with little to no previous research experience.

In addition to their research, URA students also take KBS courses, which combine classroom and field experiences for a unique and truly engaging learning environment.

Each summer, undergraduates from across the country live at KBS for courses, research & internships.

WILL YOU BE ONE OF THEM THIS YEAR?

Please check our website for position descriptions and application materials starting on December 15!

MAY 22 - AUGUST 4, 2017
APPLICATIONS DUE FEBRUARY 15, 2017

The KBS URA program compensation package is a $2500 stipend + FREE room and board at KBS.

KBS is Michigan State University's largest off-campus education complex and biological research station. KBS is the academic home to MSU professors with research expertise in Ecology, Evolution and Sustainable Agriculture.

KBS is located on beautiful Gull Lake in Hickory Corners, Michigan, about 65 miles from MSU's main campus in East Lansing.

W.K. Kellogg Biological Station
MICHIGAN STATE UNIVERSITY

VISIT US ONLINE TO LEARN MORE
kbs.msu.edu/education/undergraduate-program/

EMAIL KBSSummer@kbs.msu.edu **PHONE** (269) 671-2171

W.K. KELLOGG BIOLOGICAL STATION

RESEARCH EXPERIENCES *for* UNDERGRADUATES

Summer 2017

MAY 22 - AUGUST 4, 2017
APPLICATIONS DUE FEBRUARY 15, 2017

The KBS REU program compensation package is a $5775 stipend + FREE room and board at KBS+ up to $300 in research funds + up to $500 to cover travel expenses.

KBS is Michigan State University's largest off-campus education complex and biological research station. KBS is the academic home to MSU professors with research expertise in Ecology, Evolution and Sustainable Agriculture.

KBS is located on beautiful Gull Lake in Hickory Corners, Michigan, about 65 miles from MSU's main campus in East Lansing.

Do you think you may want to pursue science as a career?

APPLY FOR THE KBS RESEARCH EXPERIENCE FOR UNDERGRADUATES (REU) PROGRAM!

KBS faculty, post-docs, graduate students and staff are passionate about mentoring undergraduates. Our goal is to advance student learning with a quality independent research experience that will jump start your career!

The KBS REU program provides a full-time research experience under an experienced mentor. You will participate in professional development seminars and develop a research poster.

Each summer, undergraduates from across the country live at KBS for courses, research & internships.

WILL YOU BE ONE OF THEM THIS YEAR?

Please check our website for position descriptions and application materials starting on December 15!

W.K. Kellogg Biological Station
MICHIGAN STATE UNIVERSITY

VISIT US ONLINE TO LEARN MORE
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EMAIL **KBSSummer@kbs.msu.edu** PHONE **(269) 671-2171**

Undergraduate Student Important Dates, Enrichment, and Professional Development
Summer 2016 Kellogg Biological Station

Date	Time	Location	Topic/Event	Presenter
May 22	5:00 pm	KBS Auditorium	Orientation & Welcome BBQ in McCrary Dining Hall	Various
May 23	7:30 pm	KBS Auditorium	**PD:** Eminent Ecologist Seminar Series	Dr. Hopi Hoekstra, Harvard University
May 24	7:15 pm	KBS Auditorium	**PD:** Undergraduate Program Logistics & Professionalism	Dr. Danielle Zoellner, KBS Academic Programs
May 25	10:00 am	GLBRC Field Site	GLBRC Field Tour: Sustainability of Biofuels (REUs required, others welcome!)	Dr. Sarah Roley, KBS/GLBRC
May 25	7:30 pm	KBS Auditorium	**PD:** Eminent Ecologist Seminar Series	Dr. Hopi Hoekstra, Harvard University
May 26	2:00 pm	Conference Room 327	REU Meeting with the Eminent Ecologist (REUs required, others welcome!)	Dr. Hopi Hoekstra, Harvard University
May 27			**Interns Submit I@S Learning Agreement to Bill Morgan**	
May 31	7:15 pm	KBS Auditorium	**PD:** Your Resume Will Get You in the Door, but Your APC's Will Separate You!	Dr. William Moseley, Zoetis
June 1	10:00 am	KBS Auditorium	What You Need to Know About Ticks & Lyme Disease	Dr. Jean Tsao, MSU-F&W
June 2	9 am-12pm	Pierce Cedar Creek	Invasive Species Removal: Garlic Mustard (12 student limit)	
June 2	7:15 pm	KBS Auditorium	**PD:** Excel Tips, Tricks, and Time Savers	Dustin Kincaid, KBS PhD Candidate
June 3	1:30 pm	LTER Field Site	LTER Field Tour: Agroecology...What Have We Learned (REUs required, others welcome!)	Dr. Julie Doll, KBS/LTER
June 3			**REUs & URAs Submit Learning Plan to Program Coordinator**	
June 7	7:15 pm	KBS Auditorium	**PD*:** Responsible Conduct of Research & Keeping a Lab Notebook (1 RCR Credit)	Dr. Steve Hamilton, KBS/MSU-Int. Bio
June 9	7:15 pm	KBS Auditorium	**PD:** Communicating Science (1 RCR Credit)	Dr. Julie Doll, KBS/LTER
June 10			**REU Research Proposal Due to Coordinator: Must include budget if you are planning to use research funds**	
June 13	7:30 pm	KBS Auditorium	**PD:** Eminent Ecologist Seminar Series	Dr. Sarah Hobbie, University of Minnesota
June 14	7:15 pm	KBS Pasture Dairy	**PD:** KBS Pasture Dairy Tour (& ice cream!)	Dr. Brook Wilke & Misty Klotz
June 15	7:30 pm	KBS Auditorium	**PD:** Eminent Ecologist Seminar Series	Dr. Jacques Finlay, University of Minnesota
June 16	2:00 pm	Conference Room 327	REU Meeting with the Eminent Ecologist (REUs required, others welcome!)	Dr. Sarah Hobbie & Dr. Jacques Finlay, University of Minnesota
June 21	7:15 pm	KBS Auditorium	**PD:** Mosquitos and Disease	Dr. Mike Kauffman, MSU-ENT
June 24			**LAST DAY OF KBS SESSION 1 COURSES**	

Date	Time	Location	Topic/Event	Presenter
June 25-26		Muskegon State Park	Undergraduate Weekend Camping Trip	Resident Mentors
June 27	7:30 am	MSU Main Campus	REU Trip to MSU Main Campus; Info Session with MSU Graduate School; Lunch with campus-based REUs; Meet with MSU Professors (**ALL DAY**)	Various; (REUs only)
June 28	7:15 pm	KBS Auditorium	**PD**: Blogging for the Public & Your Boss	Kathryn Houghton, MSU Professional Writing Program
June 30	6:30 am	Chicago Botanical Gardens	Trip for KBS Undergrads to Chicago Botanical Gardens Tour, and behind the scenes look at Research (**ALL DAY**)	Dr. Jeremie Fant, Chicago Botanical Gardens
July 1	9:00 am	Pierce Cedar Creek	Massasauga Rattlesnake Sampling Day (**ALL DAY** – 6 student limit)	
July 5			**FIRST DAY OF SESSION 2 COURSES**	
July 7	7:15 pm	KBS Auditorium	**PD***: Evolution and Conservation	Dr. Sarah Fitzpatrick, Mittelbach & Connor Labs
July 8	1-4 pm	Zoetis Farm	Tour of Zoetis Farm Facility (12 student limit)	Dr. Dr. William Moseley
July 12	7:15 pm	KBS Auditorium	**PD**: Creating a Stand Out Resume & Leveraging Your KBS Experience	Chris Sell, MSU/CNS, Academic Student Affairs Internship Coordinator
July 14	7:15 pm	KBS Auditorium	**PD***: Creating an Effective Scientific Poster	Dr. Arthur Stewart, Oak Ridge National Lab (& Science Poet!)
July 15	9:00 am	Pierce Cedar Creek	Massasauga Rattlesnake Sampling Day (**ALL DAY** – 6 student limit)	
July 19	7:15 pm	KBS Auditorium	**PD**: KBS Symposium Specific Abstract/Summary and Poster Preparation	Dr. Danielle Zoellner, KBS Academic Programs
July 21	7:15 pm	KBS Auditorium	**PD***: Authorship and Publication (1 RCR Credit)	Dr. Kay Gross, KBS Director
July 23	10:00 am		MSU Main Campus SROP Students Visit and Tour KBS + Late Afternoon Student BBQ on Windmill Island (**ALL DAY**)	
July 25	7:30 pm	KBS Auditorium	**PD**: Eminent Ecologist Seminar Series	Dr. Alan Hastings, University of California, Davis
July 26	7:15 pm	KBS Auditorium	**PD**: JOBS Panel Discussion (professionals discuss their non-PhD career paths)	Various
July 27	7:30 pm	KBS Auditorium	**PD**: Eminent Ecologist Seminar Series	Dr. Alan Hastings, University of Cali, Davis
July 28	2:00 pm	Conference Room 327	REU Meeting with the Eminent Ecologist (REUs required, others welcome!)	Dr. Alan Hastings, University of Cali, Davis
August 3	**3:30 pm–5:30 pm**	**KBS Auditorium**	**KBS Undergraduate Internship and Research Symposium**	**KBS Summer Program Undergraduates**
August 5			**LAST DAY OF KBS SESSION 2 COURSES & KBS SUMMER PROGRAMS**	
August 6			Students Depart KBS	

PD = Professional Development (**all** program students must attend); **PD*** = only URAs & REUs are required to attend

W.K. Kellogg Biological Station
Science Education and Outreach Overview
Prepared for External Review: March 26-28, 2017

Kara Haas, Science Education & Outreach Coordinator;
Misty Klotz, Outreach Educator and Volunteer Coordinator
Dr. Julie Doll, LTER Education & Outreach Coordinator

Science Education and Outreach are an important component of the KBS mission. While there are relatively few KBS staff assigned to this (listed above) faculty, students, postdoctoral associates and support staff contribute time, expertise and other resources to support outreach programs at KBS. An "outreach team" that includes representatives from both academic and support units of KBS works together to identify unifying themes, set priorities for programs and identify partners (at MSU and locally) that can support KBS outreach programs.

The success of outreach programs at KBS is attributable to the willingness of KBS students, staff and faculty (also from MSU) to contribute 'science content' to them. Also, by using the CANR events programming for registration and fee collection we have simplified the logistics of offering these programs and, importantly, developed email contacts that we can include in our database.

Focus and Impact: The focus of outreach programs at KBS is on the research done here, but also highlights relevant research by other MSU faculty that relate to our mission. We have identified three core groups to whom we target outreach programming at KBS, reflecting both our expertise and available funding. For each we have identified specific goals, and as funding opportunities emerge (or end), we evaluate what we can do most effectively to ensure that our work supports the mission of KBS and MSU. Sustainability of programming and the support of partners (MSU and community) are also important considerations. Our primary programming focus area are:

- Enhance the ***public/community*** understanding of science and the natural world and how to steward these resources;
- Increase the capacity of ***K-12 teachers*** to teach science and to better utilize the outdoor environment;
- Share our research with ***professionals*** and help translate it to improving what they do.

We measure the impact of our outreach programs by tracking visitation, program attendance and memberships. In the past year we have developed a centralized database to track participation across KBS units and programs. This effort will allow us to have better data for grant writing and strategic decision making about future programs. We also monitor website use and social

media engagement, please reference the KBS Development and Communications Report for details. At a minimum programs are evaluated through participant surveys – this gives us feedback on satisfaction and input for future programming. Some programs such as Grazing School and K-12 Partnership programs, have more thorough evaluations; most of our grant funded programs involve an outside evaluator that focused on changes in professional practice/behavior.

Public and Community

Public outreach programming at KBS provides educational experiences that increase public understanding of science and the natural environment; where possible, we incorporate into these programs KBS and MSU research. Most of these programs occur at the Bird Sanctuary (Table 1) – though some are held at the Farm and Manor House. Public programming at KBS includes formal (short courses, workshops), informal (evening presentations, tours) and casual (self-guided trails) opportunities.

There is a strong connection between public/community outreach and our development activities. We intentionally promote connections between events to increase awareness of the opportunities here and to scaffold the visitor learning experience. For example, we host open houses at the Manor, Farm/Dairy and Sanctuary each year – there is cross promotion of units at these events. We have also streamlined communications to a single 'events brochure' that lists all events and volunteer opportunities. At the Manor House, the lead docent has strengthened the tour to not only tell the story of Mr. Kellogg and the construction of the house, but the impact of his gift to MSU on our community and the scholarship that comes from KBS. These connections have been intentional and help visitors to understand the importance and impact of KBS. The Development and Communications Report shows an increase in donations and donation amounts which is a product of telling the KBS story.

Programming at the Sanctuary targets both adults and young families Over the past 5 years we have worked to increase programs that meet the needs and interests of adult learners while still supporting access by young families, the primary visitors to the Sanctuary. This includes a *Field Ornithology* short course (first offered in 2007) and more recently programs focused on native plant communities that build on KBS research in restoration ecology and ecosystem services (ex. *Field Botany* and *Winter Tree ID*). Families tend to be drop in/casual visitors and adults flock to programs. The majority of Sanctuary memberships (78%) are household or grandparent level memberships and 30% of Sanctuary visitors are children (Figure 2). For casual visitors, mainly young families, we have expanded access to trails (around the lake and through the front prairie restoration) and added educational signage along the trail to provide more information about the birds, ecology and history of the Sanctuary.

The *Dessert with Discussion* (*DwD*) program at KBS is specifically designed to promote public understanding of research being done at MSU – including KBS – and how it can/does impact them. Initially funded by a grant from the WK Kellogg Foundation, the program is now funded by contributions from community partners and grants to KBS faculty. Each event includes relevant sponsors who have booths set up in the lobby to share what they do. *DwD* provides an important avenue for development: we target a small group (invited by the Advisory Board) to a pre- or post-event "meet and greet" with the speaker and KBS faculty. Typically we have 60-75 people in attendance (sometimes as high as 100), and we now offer a 'live stream' of the talk which expands the audience both locally and regionally.

The *DwD* program can be scaffolded to engage the public with the underlying science. For example, following presentations in 2016 by Drs. Jack Liu (FW) and Jeff Andresen (Geography) who spoke about the impact of climate change locally (Michigan) and globally (pandas in China), we organized a panel discussion "Climate Change Conversations" in collaboration with LTER scientists (Robertson, Hamilton) and outreach coordinator (Doll). An upcoming DwD on aquatic invasive species (April) will be done in partnership with a local lake association, Barry Conservation District and the CISMA (Cooperative Invasive Species Management Area) in several surrounding counties. These examples showcase how we could better partner with MSU Extension to promote environmental awareness and action by community members.

K-12 Teachers

The KBS K-12 Partnership started in 1999 with modest funds from the LTER to develop a 'schoolyard' outreach program. This funding was foundational to our obtaining NSF and other funding for multiple grants (total 5; >$10M) in collaboration with faculty in the MSU College of Education and CREATE for STEM Institute to develop a unique professional development program for teachers – that also supported research on the effectiveness of these programs. The KBS K-12 partnership has grown to include 100 teachers in 20 local (primarily rural) districts and is now expanding to include teachers in urban districts, specifically as part of a new program (Teaching Science Outdoors) that supports elementary teachers.

There are two components to the KBS K-12 partnership. The largest is the professional development we provide teachers. Teachers participate in school year (one day) and summer (3-5 day) workshops at KBS that focuses on both ecological science, pedagogy and effective use of technology. Important to the success of the KBS K-12 partnership has been the involvement of graduate students as 'Fellows' supported primarily by NSF grants, but also by MSU Graduate School and KBS. Critical to the continuing success of this program is to have funding for graduate students as they provide the science expertise that makes this program valuable and unique for teachers; the program also provides valuable professional experiences for graduate students in teaching and communicating their science to non-scientific audiences.

We have recently expanded the teacher professional development to provide specific training for elementary (K-5) teachers through our *Teaching Science Outdoors* (TSO) program. The program includes a one-week summer workshop that introduces teachers to how they can use the outdoor environments at (or near) their school as part of their classroom. TSO is currently funded by a grant from EPA and private donations and we are developing partnerships with MSU Extension (Tollgate Farm and Education Center) to expand the program to SE Michigan to support teachers in Detroit.

A second component of our K-12 outreach is coordinated with research experiences for teachers funded by faculty grants, BEACON and GLBRC. We typically support 2 to 9 teachers per year as RETs (Research Experiences for Teachers) and have developed a professional development focused on curriculum design that complements the research mentoring offered by their host labs. Increasingly we are having RETs also develop (and lead) sessions in the K12 partnerships workshops so they can share their experiences – research and curricular – with other teachers.

Professionals

Providing professionals with up to date information about the ecology of natural and agricultural landscapes remains a priority for our programming. For much of our outreach we employ a "train the trainer" approach, working to empower professionals to include relevant science in their work with farmers, landowners, and others, as they have a wide reach across the state and region and access to hundreds or thousands of community members.

Much of our outreach to professionals is done in collaboration with Michigan State University Extension (MSUE) and other extension staff from across the North Central Region (NCR). Programming spans the spectrum of producing peer-reviewed and other fact sheets and bulletins, to technical trainings, to creating curriculum, to hosting in-depth discussion sessions on pressing topics in agricultural ecology. Specific recent examples include:

- **Ecology and pasture management**: For the past 3 years we have worked with MSUE Forage Team to provide science–based information on production practices for pasture-based dairy systems through Grazing Schools and have developed a standardized Grazing School curriculum for the state of Michigan. A unique aspect of the KBS Grazing School is that we have been able to extend its reach state-wide by using video technology to link three MSU research stations, thus doubling attendance and providing a 'local experience' for grass-based farmers.

- **Climate change**: Over the past 5 years we have worked with MSUE to develop a Climate Outreach Team; the team now includes educators from all program areas of Extension. In 2012 and 2013 we partnered with MSU's Knight Center for Environmental Journalism and the Society for Environmental Journalists to host two climate change

communication workshops at KBS. Over 50 journalists and scientists from across the country participated in these workshops and had the opportunity to tour the LTER and GLBRC research sites, learn about the research (from scientists), challenges in communicating science (from journalists), and together explore ways of connecting climate science to the general public. Important products from our Climate Outreach Team have been a series of Extension bulletins on topics focusing on climate change in general and climate change and agriculture that are available free and used in Extension programs state-wide and across the NCR.

- **Sustainable use of nitrogen**: In collaboration with LTER scientists we hosted a workshop on sustainable nitrogen use in cropping systems for 40 crop consultants and Extension educators from across the Midwest. The meeting included presentations by scientists and sessions to foster dialogue between the scientists and these stakeholders. Results of these discussions were published in the Journal of Soil & Water Conservation (Reimer, A., et al. 2017. J Soil and Water Conservation 72:5A-9A.

Volunteers

Volunteers play a critical role in the success of KBS outreach programs and we have seen an increase in both the number and engagement of volunteers over the past 3 years, largely due to the efforts of volunteer coordinator Klotz to coordinate recruitment, training and recognition of KBS volunteers. Volunteers are particularly important for programs at the Sanctuary and Manor House where they lead tours, provide administrative support and help maintain gardens and trails. The Farm has more limited—but very engaged—volunteers who help with calving and research activities. Recently we have been recruiting volunteers to help with research, and this has led to discussions about how to increase opportunities for 'Citizen Science' at KBS; unfortunately we do not have the staff or funds to develop these programs beyond a few. We currently participate in established Citizen Science programs to monitor butterflies and birds at the Sanctuary, but would like to expand this type of outreach to include projects that support the research of KBS faculty. The Lau/Brudvig prairie restoration project and the Fitzpatrick Salamander project are both areas that citizen science programs could be incorporated. In 2016, we had over 180 volunteers at KBS who contributed over 5,000 hours to the outreach and related programs – a financial value of $ 65,994.

Funding

Funding for the Science Education and Outreach programs at KBS come from a variety of sources, including CANR general, LTER, grants and gifts. Currently, the budget for these programs is around $100,000, and supports a full-time coordinator (Haas) and an assistant (currently temporary, search underway for a permanent staff) as well as student interns (summer). We currently have funding to support two graduate student fellows to assist with K-12 partnership (ending in August 2017), and have grants pending with BEACON to support

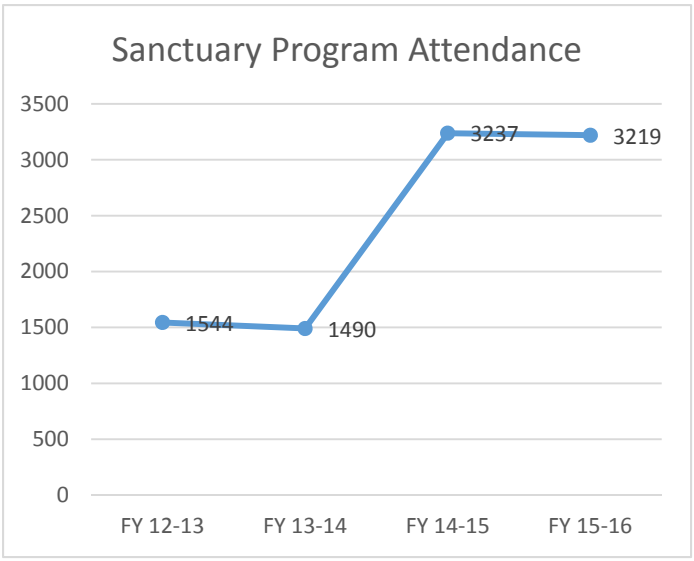
expansion of the RET program. We are also working with faculty Teacher Education and CREATE for STEM on grants (NSF and other) to build a stronger, more research-focused, program in teacher education. While we have funding to continue to offer workshops for teachers, we need to identify support for maintaining the involvement of graduate students as Fellows in this program.

Until ~5 years ago MSUE was an important contributor to outreach programs at KBS; however constraints and a reorganization of MSUE resulted in reassignment of staff from KBS and a significant reduction in budget allocations. There are currently only two KBS faculty with MSUE appointments: Utsumi (20%) and Gross (1 month summer salary). MSUE also provides partial funding for Doll's salary (match to the LTER) and some support to the Dairy Manager. While we work very closely with MSUE staff on outreach programs for professionals, including collaborations on fact sheets and workshops (see above); however there is great deal of potential to expand this collaboration if funding were available.

There is also a need for upgrade facilities at the Bird Sanctuary that will enhance the visitor experience (particularly for school groups), to increase accessibility, and more effectively include technology in outreach programming. We have included a major upgrade and renovation of the Sanctuary as part of the current MSU Capital Campaign. We are currently in the silent funding phase of this effort and are working with Development offices in both CANR and CNS to identify donors (individuals, foundations and corporations) who can support these improvements so that we can continue to grow programs both on-site and off-site, utilizing technology to reach broader audiences.

Type of Event or Number of Participants	**Bird Sanctuary**	**Manor House**	**LTER**	**Farm & Dairy**	**TOTAL**
Scheduled Events					
Programs*	50	54	7	4	**115**
Tours	47	45	32	53	**177**
Number of Participants					
Programs	2,134	2,019	329	422	**4,904**
Tours	1,698	1,377	980	1,431	**5,486**
Self-guided/Walk-in	10,786	481	30	722	**12,019**
Total	**14,618**	**3,132***	**1,339**	**2,632**	**22,409***
% of total	**65%**	**14%**	**6%**	**12%**	

Table 1: Summary of visitation to KBS in 2016 to various venues, separated by type of event. *Not included in these data are participants in private events held at the Manor House and Conference Center.



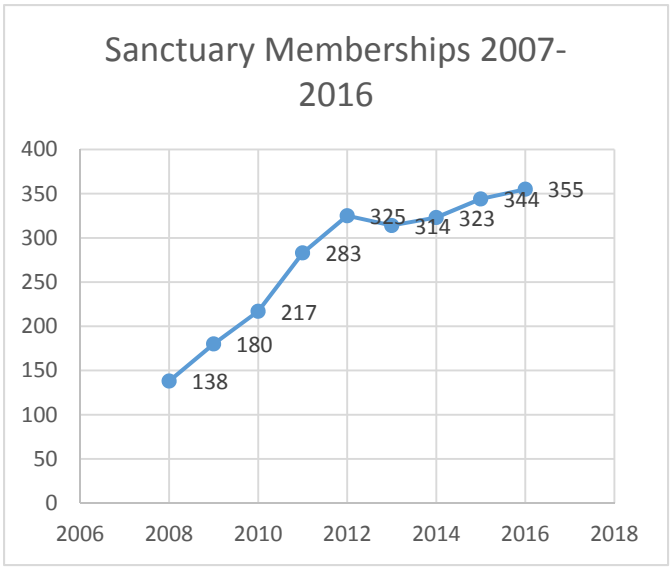


Figure 1: Increased participation in Sanctuary programs (top) and memberships (fee paid annually) over time.

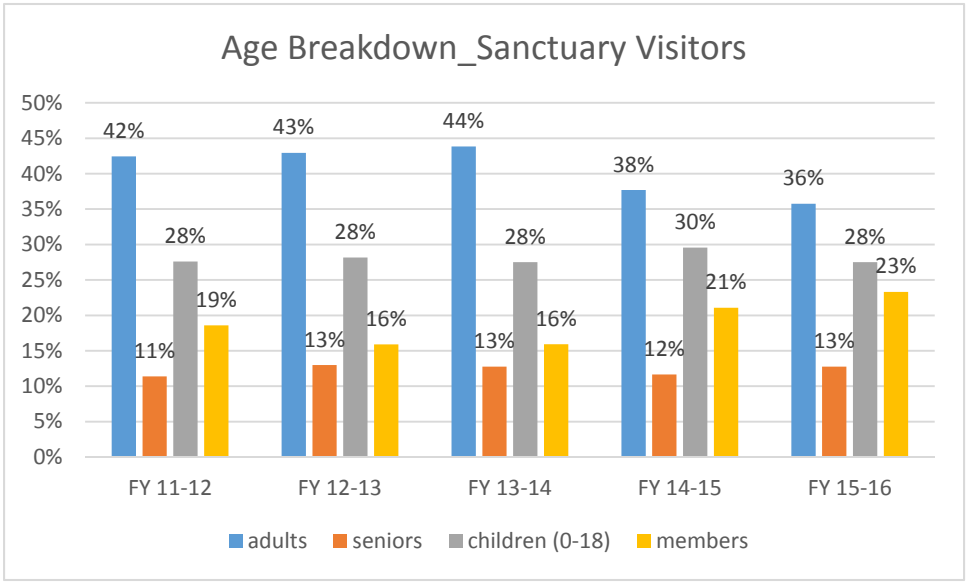


Figure 2: Age breakdown of Sanctuary visitors

Development and Communications

Sarah Carroll, Development and Community Relations Coordinator

Important to the success of the Kellogg Biological Station is having an effective means for communicating what we do and why to our constituents and supporters. Increasingly this involves a more diverse community – the public, current and future donors, alumni and stakeholders at MSU and in the community. In 2014, the role of Development & Community Relations Coordinator was created to allow us to develop more effective mechanisms of communication (including expansions in social media), better align our marketing and communications with MSU standards and policies, and create a more coordinated and consistent message. Importantly, this coincided with the start of the University's Empower Extraordinary Capital Campaign and so our development interests and targets were included with those of both CANR and CNS, and we were able to take advantage of marketing efforts for the campaign to develop KBS specific materials. This change also has streamlined our communications and marketing efforts, develop means for assessing the impact of different efforts and make strategic decisions about the mechanisms we use to share what we do here.

This office is led by Sarah Carroll (MPA) and supported by a full time assistant (Bethany Bohlen); the office contributes to the educational mission of KBS by supporting 2-3 interns in the summer. We target for these positions, MSU students with expertise (or strong interest in) marketing, communications and development for non-profits. The past two years we have hired students with experience in videography and worked with them to develop videos that capture the KBS experience for undergraduates, graduate students and that share the value of the "Lands of KBS" for supporting our research and educational programs.

The primary areas of focus for KBS Development and Communications are:

- Enhancing **communication efforts** to increase the community understanding of KBS science and experiences
- **Strengthening connections** between KBS, the local community and campus partners
- Developing materials and coordinating fund (and friend) raising efforts with MSU's **Empower Extraordinary** Capital Campaign

Communication Efforts

Recognizing that web-based and social media are an increasingly important ways to stay connected with supporters of all ages, we have devoted considerable effort to reorganizing and redesigning the KBS website so that it can share information in a variety of ways, including video and blogs. The redesign of the KBS website (now three separate sites) was led by Ms. Carroll. Her office manages the main site pages for KBS and works with faculty and staff to update content on specific pages. They also monitor the analytics of what pages and events are most actively accessed electronically. This office also coordinates the development and distribution of the monthly 'E-station to station', an alumni newsletter (three times/yr) and the KBS Annual Report; all of which are maintained on the KBS Media Center page.

e-Station to Station newsletter: For over a decade KBS has distributed a newsletter to the local community. In 2012 we switched to a digital format for the e-Station to Station newsletter, continuing to reach to the local Gull Lake community, but expanding to audiences on campus and around the world. Over the last five years, subscriptions to the e-Station to Station has

increased 156%, with over 2,500 subscribers. We are continuing to review analytics to reformat the e-newsletter based on user feedback. Reader engagement analytics show that the KBS Annual Report and Science Spotlight articles are the most popular sections of the newsletter (Table 1). An *unexpected challenge* to our communications efforts is the recent implementation at MSU of a spam blocker that seems to be blocking the Vertical Response mailing of our newsletters. We are working with the KBS IT and campus communications to determine ways to avoid this block that are consistent with new efforts at MSU to increase cyber-security.

%	Year-Month	Link	# of clicks
22.21%	16-Jan	KBS : 2015 in Review	533
6.68%	16-May	Dr. Phil Robertson publishes on climate-smart soils	117
4.35%	17-Jan	KBS Annual Report Highlights the Unique Lands of KBS	106
4.20%	14-Dec	Annual Report	105
2.04%	16-Mar	Science Spotlight: KBS Climate Change and Agriculture	56
1.57%	13-Feb	Science Spotlight: KBS Biofuels Study Featured in Nature (MSU Today link)	17
1.30%	15-Jul	Generosity of local farmer creates national impact (MSU Today link)	32
1.18%	16-Oct	Science Spotlight: Pandas, Bamboo, and Climate Change	32
1.15%	13-Apr	KBS Science Spotlight: Liz Schulties	13

Table 1: *Top e-Station to Station articles of user engagement*

KBS Website: In January 2016, KBS launched our new three part website. The KBS websites consist of a Research & Education site, a Bird Sanctuary site, and a Conference Center & Manor House site. Analytical data showed that our audience was large enough to support these three sites that work collaboratively. For communication purposes, our new website template includes a highlighted Blogs and News webpage. For donor relations the KBS Support webpage highlights the best that KBS has to offer and the opportunities to support these activities.

Strengthening Connections

The communication efforts described above have been important in increasing the public awareness of what is done at KBS and its impact. Important as these electronic and print communications are, it is also important to foster more direct connections with the local community as they can provide feedback on how we are perceived, help identify partners who will support our programming (particularly in education and outreach), and support our development activities directly and by facilitating connections to other donors.

The *KBS Director's Advisory Board* was established in 2006 to foster this community connection and it has become a very important for making connections to, and sharing the message of, what we do at KBS locally (Gull Lake, Kalamazoo and Battle Creek area). The KBS Director's Advisory Board serves a number of important functions; specifically: 1) facilitate the exchange of information between KBS and its alumni and friends; 2) offer advice

concerning public programming and how this can be used to effectively communicate to alumni and friends the academic programs and research at KBS; 3) be an effective advocate of KBS to the surrounding communities, the Gull Lake area and regionally, and when needed to the University; and 4) assist the KBS Director in the identification and solicitation of external support, both financial and otherwise.

Board members are selected from the community to reflect different interests and experiences who can help us communicate the message of what KBS is and does. Members agree to an initial 3 year term (renewable); several have been on the board since its inception. New members are selected by the Director in consultation the Advisory Board, the coordinators for Development and Community Relations, and MSU development staff. The Board meets~ 3 times a year: twice for Board meetings and once for a "Behind the Scenes" tour where specific aspects of KBS research and outreach programs are shared. These tours have turned out to be very effective in engaging the Board as they enjoy and appreciate the access to the research and researchers at KBS and come away with a better understanding of what is done here. The current Board members and their affiliations are in Table 2.

Dr. David Dvorak	Ophthalmologist (Retired)
Becky Eldridge	Gull Lake Community School Foundation Board Member, Trustee
Betsi English	Citizen-at-large
Mike Gallagher	President of Gallagher Uniforms (Retired), Member of Gull Lake Quality Organization
Dr. William Maxey	Director of Animal Health at Pharmacia (Retired)
Dr. Gene McKay	President at Strategic Research Associates, LLC
Carole Mendez	Legal Counsel at Stryker, Gull Lake Community Schools Board President
Sarah Sandell	Gull Lake Community School Foundation Board Member, Trustee
Christopher Tracy	Partner at Honigman, Miller, Schwartz and Cohn, LLP Michigan Natural Resources Commission Member
Dr. William Uggen	Orthopedic Surgeon (Retired) –

Table 2: *Current KBS Director's Advisory Board Members*

Beginning in 2013, we have developed a more focused effort to maintain and strengthen connections with *KBS Alumni*; primarily graduate students, postdocs, former faculty and visiting scholars, but more recently undergraduates. The goal of establishing a formal KBS alumni communication program is to build a strong relationship between KBS and alumni. Establishing a solid relationship between KBS and the alumni will help in undergrad, graduate and faculty recruitment, while alumni donations to KBS funds will help bring future students to KBS for an experience of a lifetime. The Alumni Relations program includes a 3x/year Alumni e-newsletter, newly designed KBS Alumni webpage, and the continuation of hosting a KBS alumni gathering at Ecological Society of America (ESA) annual meetings.

The program has had a measurable success on developing connections to alumni many of whom are now making financial contributions to KBS. Since its launch, the KBS alumni e-newsletter has had a higher than industry standard open rate (34% vs. 22%); the most popular links being

information of KBS summer courses, the Annual Report, blog postings, and information about the KBS alumni gatherings at ESA. Links to financial support for KBS are approximately the industry average (2% vs. 2.63%); however, the conversion rate for those that click onto the KBS giving page was nearly 100%.

Empower Extraordinary Campaign

Campaign goals and status: KBS has worked diligently with CANR, CNS and MSU Advancement team to establish fundraising goals for KBS as part of the University's Empower Extraordinary capital campaign. The goal is ambitious ($8.2M) and is designed to both align with College priorities and needs of KBS (Figure 1). As of March 2017 KBS has reached 44% of our fundraising goal for the campaign (Table 3). Efforts have included the creation of donor communication pieces (KBS Empower Extraordinary Case Statement), newly designed KBS Support webpage, and donor events (Dessert with Discussion Meet & Greet receptions, Behind the Scenes tours, Alumni gatherings).

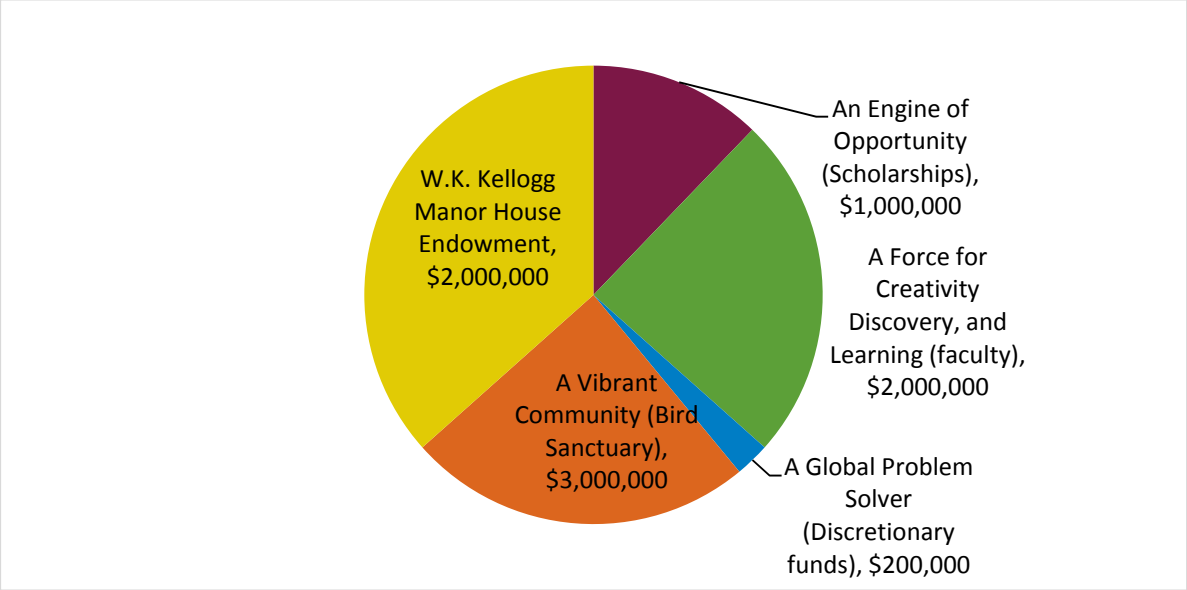


Figure 1: *KBS Empower Extraordinary Campaign Goals*

An Engine of Opportunity (Scholarships)	$1,000,000	$817,038	82%
A Force for Creativity, Discovery, and Learning (Faculty)	$2,000,000		0%
A Global Problem Solver (Discretionary funds)	$200,000	$539,956	270%
A Vibrant Community (Bird Sanctuary)	$3,000,000	$739,295	25%
W.K. Kellogg Manor House Endowment	$2,000,000	$1,491,817	75%
	$8,200,000	$3,588,106	44%

Table 3: *KBS Capital Campaign Goal Status (March 7, 2017)*

Campaign Highlights:

- The establishment of the *KBS Graduate Student Research Fellowship Fund* (Interest generated from a Behind the Scenes Tour), supporting graduate students performing research with preference given to those doing aquatic or bird research.
- The establishment of the *James Larson W.K. Kellogg Biological Station Endowment for Graduate Research in Climate Change and Environmental Sciences* (interest generated from KBS Annual Report). A planned gift supporting future graduate students conducting research that contributes to the sustainability and enhancement of natural and managed ecosystems.
- The creation of the *Richard A. Brunt Family Scholarship at KBS,* an expendable scholarship for undergraduate students conducting research and/or enrolled in courses.
- KBS took part in *MSU's 2016 Day of Giving Campaign*, setting a goal of $1,000. Three funds were targeted (Lauff Scholarship, Joe Johnson Endowment, and Manor House Endowment). $3,045 was donated to KBS during the 24 hour campaign.

The number of individual donors has increased since 2014 (Figure 2) , partially attributed to both increased communication channels, incorporating best practices by continuing to analyze our data, and collaborating with MSU for a cohesive message.

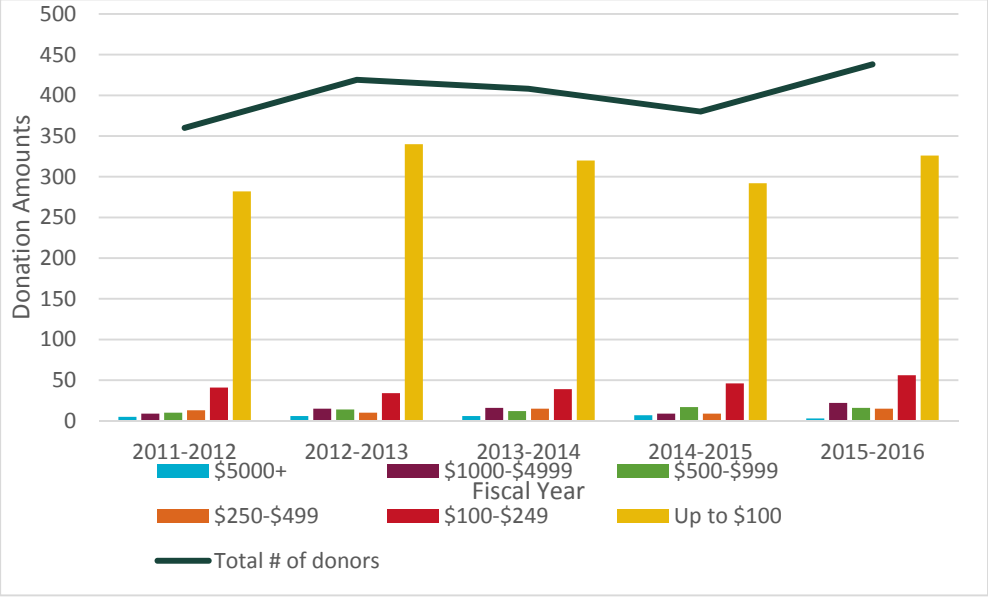


Figure 2: *Number of individual donors to KBS*

Future Plans: Development will focus on the capital campaign goals, specifically the Sanctuary facility project. We are at a point in time where in order to continue the long standing tradition of conserving native habitat and helping people gain environmental awareness we must make necessary upgrades to the outdated facilities that are over fifty years old.

Our goal is to raise $3M to support the renovation of the Sanctuary's current welcome center, auditorium, and offices which were built in the 1960's. In order to accommodate today's visitors it is important that our welcome center reflect just that – a warm and welcoming environment to learn more about the natural world (Figure 3). Facility upgrades are necessary to support our K-

12 Partnership programming and requests from area school systems for educational opportunities (Figure 4).

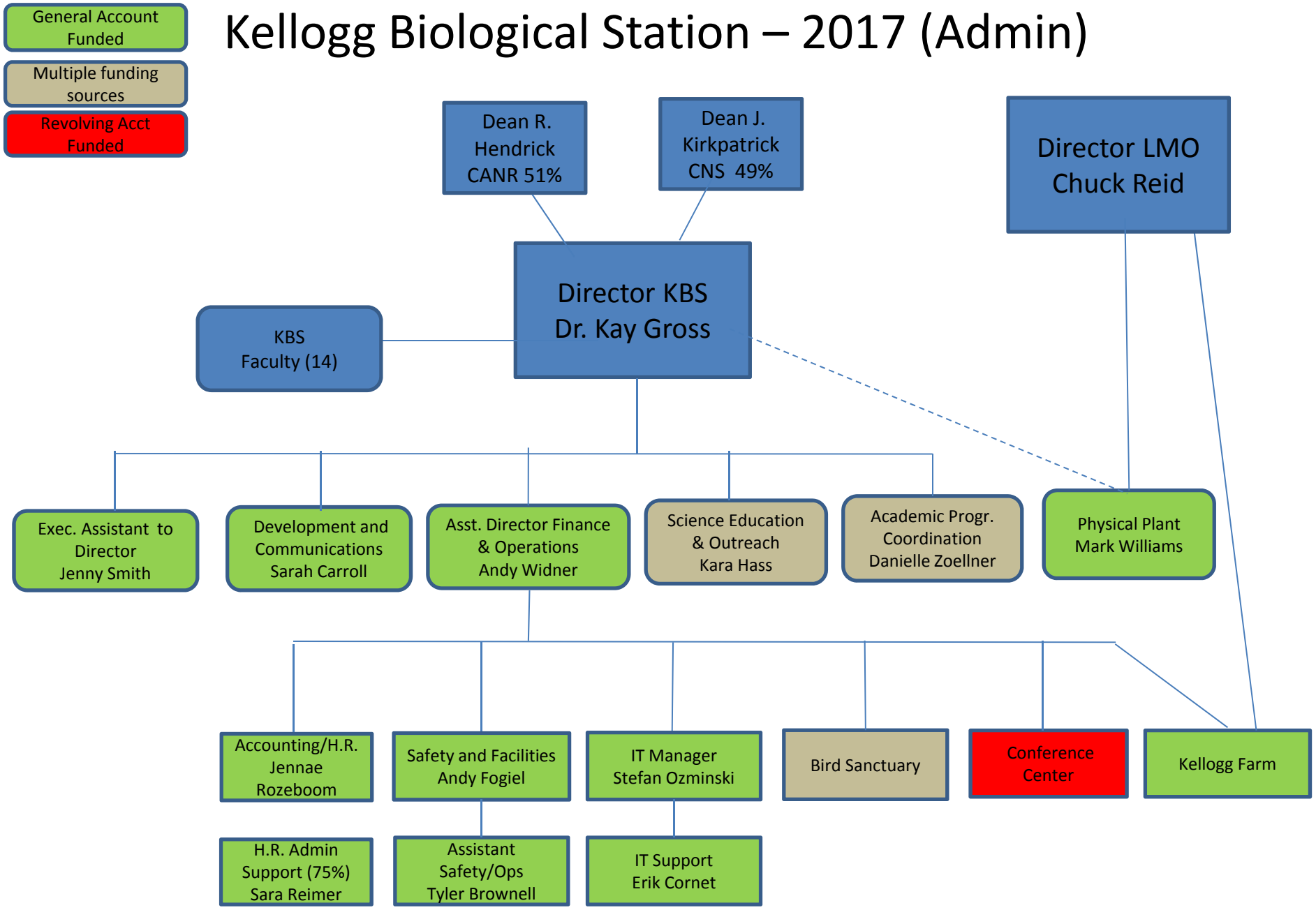
Figure 3: *Architectural rendering of Sanctuary Welcome Center and Auditorium upgrades proposed in the capital campaign*

Figure 4: *Architectural rendering of Outdoor Classroom and Meeting Space proposed in the capital campaign*

Resources needed: Continued support for Advancement staff on campus to make the connections that we are unable to begin here at KBS. KBS staff can foster those connections, leading to the success of the current MSU Capital Campaign, more specifically the Sanctuary facility project, allowing KBS to continue to grow programs both on-site and utilizing technology to reach broader audiences.

Increased utilization from campus departments and colleagues of both KBS facilities and on-going research to attract major donors and gifts. MSU Advancement has sporadically utilize KBS to host alumni and donor events, a more coordinated and routine effort in this area will benefit highlighting KBS and our research to those unaware of KBS and its impact.

Kellogg Biological Station – 2017 (Admin)



KBS Administrative Team Job Descriptions

AD Finance and Ops (Widner) –	Supervision of KBS operations team. Financial management, strategic planning, staffing and resource deployment. Unit level strategic planning. Special projects and funding requests.
H.R./Accountant (Rozeboom) –	Grant support for P.I.'s. Development of job descriptions and interfacing with campus human resources (for full-time positions). Financial reporting and accounting support for all units of KBS. Invoicing, purchase orders, bids, and all matters of financial compliance. Fiscal officer for KBS.
Admin. Assistant (Reimer) –	Primary human resource support of the part-time staff of KBS. Hiring and payroll as well as onboarding process. Preparation and creation of financial reporting packages. Support of accounting and finance areas as needed. General office support. Position 75% level appointment.
Executive Assistant (Smith) –	Supports the Director managing calendar travel and projects. Faculty appointments and summer program support, travel reimbursement, academic data tracking, and website support.
I.T. Manager (Ozminski) –	Charged with maintaining the infrastructure, equipment and software necessary for KBS staff, faculty, students, and guests to meet their respective technology needs. Information expert on technology upgrades and equipment investment. Handle daily customer support needs.
Safety and Operations (Fogiel) –	Key responsibilities are working with faculty and research partners on lab safety, equipment, supplies, and scheduling. Critical partner in the success of summer academic program coordinating venues, labs, classrooms. Main liaison with campus for chemical management, safety training and various inspections.
Dev. & Communications (Carrol)	Plans, coordinates and implements fundraising activities and programs across KBS to increase donor engagement and support. Oversees and coordinates the development and distribution of communications materials that broaden the community understanding of KBS programs and events. Supervises paid and volunteer staff, providing strategic oversight for KBS communications related to research, educational programs and outreach events.

Academic Programs (Zoellner) – Core responsibility is the administration and execution of the KBS summer academic program. Works with KBS and campus partners to facilitate the effective deployment of limited resources to maximize academic output and participation.

Education and Outreach (Haas) – Coordinates and evaluates science education and community outreach programming across all units of KBS. Works with KBS partners to identify potential funding sources for outreach and science education programs. Supervises and mentors outreach staff, graduate student outreach positions and undergraduate interns to provide programming on a variety of natural and scientific themes to diverse audiences.

Phys. Plant Manager (Williams) - Charged with ongoing daily management of the buildings and grounds of KBS. This includes maintenance (both preventative and reactive). Manages the maintenance and grounds team. Phys. Plant budget owner and key partner with the KBS Administrative team. Has dual reporting to the Director and to land management. Landlord for 24 rental houses, Financially responsible (General Fund Account) for all Site Utilities and providing maintenance and repair to owner portions serving the site including State certified Municipal Water Drinking Water System, a gasoline fueling station with fuel card tracking and user charge back system serving KBS business fleet of vehicles, managing service provider

Kellogg Farm Overview

Brook Wilke, Farm Manager
Howard Straub, Dairy Manager

Overview and Facilities

The Kellogg Farm was established by WK Kellogg in 1928 as a site for demonstrating "… *a most modern system of farm management so that it may serve as an object lesson to the people of the region…*" Clearly, what constitutes "most modern" in agriculture has evolved over the past 90 years and by supporting research by faculty on agriculture management and ecology and communicating this to farmers, students and other professionals, we are able to continue to fulfill the intent of the trust that was made to support this Farm.

Embedded within the W.K. Kellogg Biological Station (KBS) in Southwest Michigan, the Kellogg Farm includes 526ha (1300 acres) of managed agricultural lands the majority of which is used cropping system and dairy research / extension (see maps that follow). The agricultural lands are located at the Gull Lake site, Lux Arbor Reserve and Marshall Farm, and include row crops, fenced pasture (100 ha) and a small plots research (100 ha; Farm Systems Center, FSC). Both the pasture and FSC have irrigation facilities that can be used to support research activities. The Pasture Dairy Center utilizes rotational grazing and milks up to 155 cows using Lely A3 Automated Milking Systems. There are also several field laboratories associated with the Farm, including the Pasture Agroecology and LTER Field Labs. Two heated shops are available to work on equipment.

Research and Related Activities

Over the past 8 years, the focus of the Farm has shifted to be primarily on research with outreach programs targeted to professionals. This conversion has allowed us to more strategically utilize personnel and to better support the research of KBS and campus-based faculty involved in both long and shorter term research projects involving the agricultural land base of KBS. The large amount of land and diversity of holdings allows the Farm to support research at a variety of spatial scales (plot, field and landscape scale). The opportunity to conduct research that integrates multiple scales is rare for university facilities. We also have certified organic land for crop and horticulture research, and that can be expand if needed. The robotic milking and intensively managed rotational grazing systems are unique combination of facilities that makes KBS nationally and internationally recognized as a leader in the industry. Importantly, our dairy facility and management allows for both grazing based research/extension and confinement based research/extension, depending on the season.

The LTER (established in 1988) and GLBRC (established in 2008) are clearly a central focus of much of the research on agricultural systems at KBS, and while the design, planting and crop management of the experiments for these projects are managed by LTER PIs and staff, the Farm harvests the plots, manages the scale up fields for both projects, and provides equipment and other resources. The Pasture Dairy Center (also established in 2008), is also managed as a research facility (jointly by the Farm and Dairy Manager, in consultation with a faculty advisor, Utsumi). Use of this facility for research has not grown as much as we have anticipated, due to the lack of funds to leverage and/or attract new projects here.

Both the LTER and GLBRC provide opportunities for shorter duration experiments (approved by the Project PIs) but there is also an increasing demand for short to medium term experiments on agricultural systems that involve commitment of land or personnel by the Kellogg Farm. Some of these are based at the FSC (also managed by the Farm), but others are done on crop and/or pasture lands that are managed to provide feed and forage for the Dairy. There continue to be short term – both agricultural and ecological – studies at the FSC and a growing commitment to providing larger tracts of land to address ecological questions within agricultural landscapes. Important to the success of managing what can be the conflicting demands for research and cash crop production has been the hiring of a Farm Manager (Wilke) in 2013, who has both a research and farm systems background and could better communicate (and support) the opportunities for research at the Kellogg Farm. As a result we have seen a significant increase in the number of research projects done at/on the Kellogg Farm. In addition to projects contained within the LTER, GLBRC and Pasture Dairy, 32 new research projects have been established at the Kellogg Farm since 2014: 2014 (3 new, 14 continuing); 2015 (11 new, 11 continuing); 2016 (18 new, 12 continuing). The full list of these projects is provided at the end of this report.

Education and Outreach

The Farm is able to support the educational and outreach missions of KBS by providing sites for classes, workshops or programs to learn about different types of agricultural management and cropping systems. It also classroom/meeting space equipped with video technology. The Outreach programs at the Farm are part of the overall KBS Outreach program and supported in part by income from the Kellogg Trust. The LTER also provides some support for outreach programs on cropping systems research. A number of outreach programs on technology in agriculture (including cover crops), novel crops (barley production for malting), and pasture practices (Grazing Schools and Pasture Walks) are done in collaboration with MSU Extension. The Farm also supports 1-2 interns each summer who work in collaboration with Farm and Extension personnel on farm management, animal care and communications.

Funding

The Kellogg Farm is supported by a combination of funding from MSU (primarily MABR, some MSUE), income from a Trust established by WK Kellogg, and crop/milk sales to business/revolving accounts. Because of the reliance on revolving accounts, it can be a challenge to balance the sometimes competing interests to support research (which ties up the land to particular crops, rotations and management), the need to produce forage and feed for the dairy herd (when they are not on pasture), and also provide opportunities for research on non-cash crops to be supported. Also the facilities and equipment of the Farm are aging and while specific projects (e.g. GLBRC and LTER) can provide some funding for this, having the cash flow to cover needed investments is a challenge.

Long Term Research Projects / Facilities by the Kellogg Farm

- Long Term Ecological Research (LTER) (1988-Present)
    - Utilizes 160 acres for main site research
- Great Lakes Bioenergy Research Center (GLBRC) (2008-Present)
    - Utilizes 50 acres for main site and 192 acres for scale-up research
- Pasture Dairy Center; Dairy Grazing Innovations for the Upper Midwest (2009-Present)
    - 225 acres pasture plus 150 acres for feed production
- Farming Systems Center and Agroecology Research Facility (1985-Present)
    - 75 acres of agricultural fields divided into one to five acre plots

Recent newly established research projects Kellogg Farm (2014- 2016)

2014

- The Role of Plant Functional Traits in Restoration: Community Assembly and Ecosystem Function (Lars Brudvig, Plant Biology, NSF)
- Apple Flower Microbiome (Ashley Shade, MMG)Impact of Differential Corn Feeding on Methane Production and Rumination Time in Pasture Fed Dairy Cows (Santiago Utsumi, Animal Science/KBS)
- Sustainable Switchgrass: Pest Interactions (Carolyn Malmstrom, Plant Biology, Funding from USDA NIFA Sustainable Biofuels)

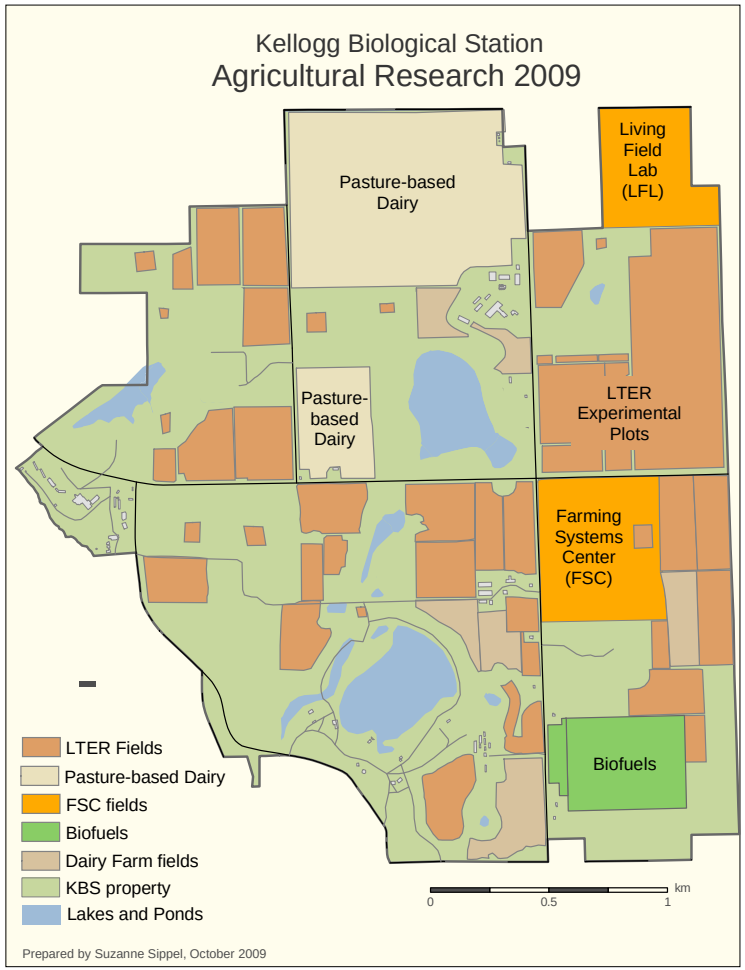
2015

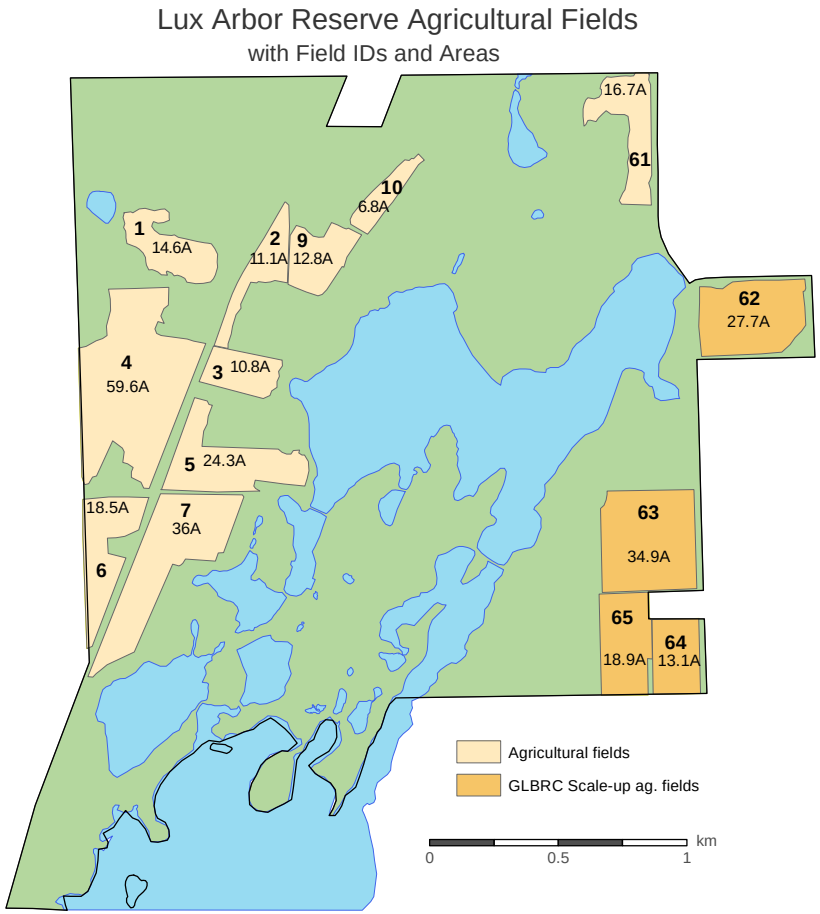
- Masters Choice Corn Comparison Trial (Brook Wilke, KBS, Funding from Byron Seeds / Masters Choice)
- The Genetic Basis of Adaptation Across a Latitudinal Gradient in Switchgrass (David Lowry, Plant Biology, Funding from NSF Plant Genome)
- Barley Variety Trials and Demonstration (Dean Baas, MSUE, Funding Info Unavailable)
- Building Pollinator-Supportive Landscapes for Michigan's Diverse Agriculture (Lars Brudvig, Plant Biology, Funding from GREEEN)
- Exploiting the Landscape of Fear as an Insect Control Tactic (Doug Landis, Entomology, Funding from GREEEN)
- Soybean Nitrogen Fixation Across a Diverse Topographical Landscape (Kate Glanville / Robertson, KBS/PSMS)
- Comparing Small Grains as Cover Crops (Dean Baas, MSUE,)
- The Use of Remote Sensing to Assess Climate Variability Impacts on Livestock (Rojas-Downing)
- BLV "Super Shedder" Intervention Study (Paul Bartlett, Vet Med, Funding from USDA)
- β-Lactam Antibiotic Mastitis Treatment in Dairy Herds: A Potential Public Health Risk (Martina Johnson, MSU Public Health)
- Preliminary Drone based remote sensing in Pastures (Bruno Basso/Santiago Utsumi, KBS/PSMS/Animal Science)

2016

- Consequences of Changing Rainfall Patterns on Nitrous Oxide Fluxes in Agricultural Landscapes (Kate Glanville / Phil Robertson, KBS LTER/GLBRC))
- Combining Integrated Pest Management with Climate Change, Mitigation, and Adaptation in Soybean-Corn Cropping Systems (Andrey Guber / Sasha Kravchenko, PSMS,United Soybean Board)
- Topographically Diverse Landscape Influences on Cover Crop Establishment and Ecosystem Services in Corn and Wheat Cropping Systems (Sasha Kravchenko, PSMS, Project GREEEN)
- Interseeding Cover Crops in Corn: Timing Influences Ecosystem Services (Karen Renner, PSMS, Corn Marketing Program)
- Spring Barley Variety Trials (Dean Baas, MSUE, Craft Maltsters Guild)
- Wheat as a Cover Crop (Dean Baas, MSUE)
- *Stachyus byzantina* (Lamb's Ear) Test Plot (Brook Wilke, KBS, Ernst Conservation Seeds)
- Pilot Malt House Barley Variety Trial (Dean Baas, MSUE, Pilot Malt House)
- Perennial Wheat and Intermediate Wheatgrass (Sieg Snapp, PSMS, Ceres Trust)
- Optimizing Oilseed Radish and Oats Seeding Rates for Mixed Cover Crop Planting (Erin Hill, PSMS)
- Greenhouse Gases Dissolved in Groundwater used for Irrigation (Steve Hamilton, KBS/Integrative Biology, LTER)
- Lab to Farm: Integrating Organic Cucurbit Science and Production in the Midwest (Dan Brainard / Szofia Szendrei, Horticulture/Entomology, USDA-NIFA)
- Exploring Winter Malting Barley Production in Michigan (Dean Baas / Ashley McFarland, MSUE, Project GREEEN)
- Oilseed Radish Cultivar Investigation (Dean Baas / Jeff Conner, MSUE / KBS, NSF
- PSNT and Corn Stalk Nitrate Test Mini-Study (Eric Anderson, MSUE)
- Environmental Pathway of Antimicrobial Resistance in Agricultural Lands (Jade Mitchell, Engineering)
- Comparison of Brassica Forage Crops (Santiago Utsumi, Animal Science/KBS, Funding from PGG Wrightson Seeds)
- Relationship Between Residual Height, Pasture Regrowth and Forage Nutritive Value in Different Seasons (Juan Insua/Utsumi, Visiting Research Scientist)

Figure 1: KBS Agricultural Land Base Research Commitments: Oversight for all Agricultural Land base is responsibility of KBS Farm Manager (Brook Wilke, hired October 2013)





KBS Main Site 2017 – 892 Total Acres

Project	***% of Agricultural Land Base***
LTER - Main Site	17%
LTER Scale Up/LTAR -	27%
GLBRC	6%
Pasture Dairy	25%
FSC	13%
Other	4%
TOTAL RESEARCH	***92%***

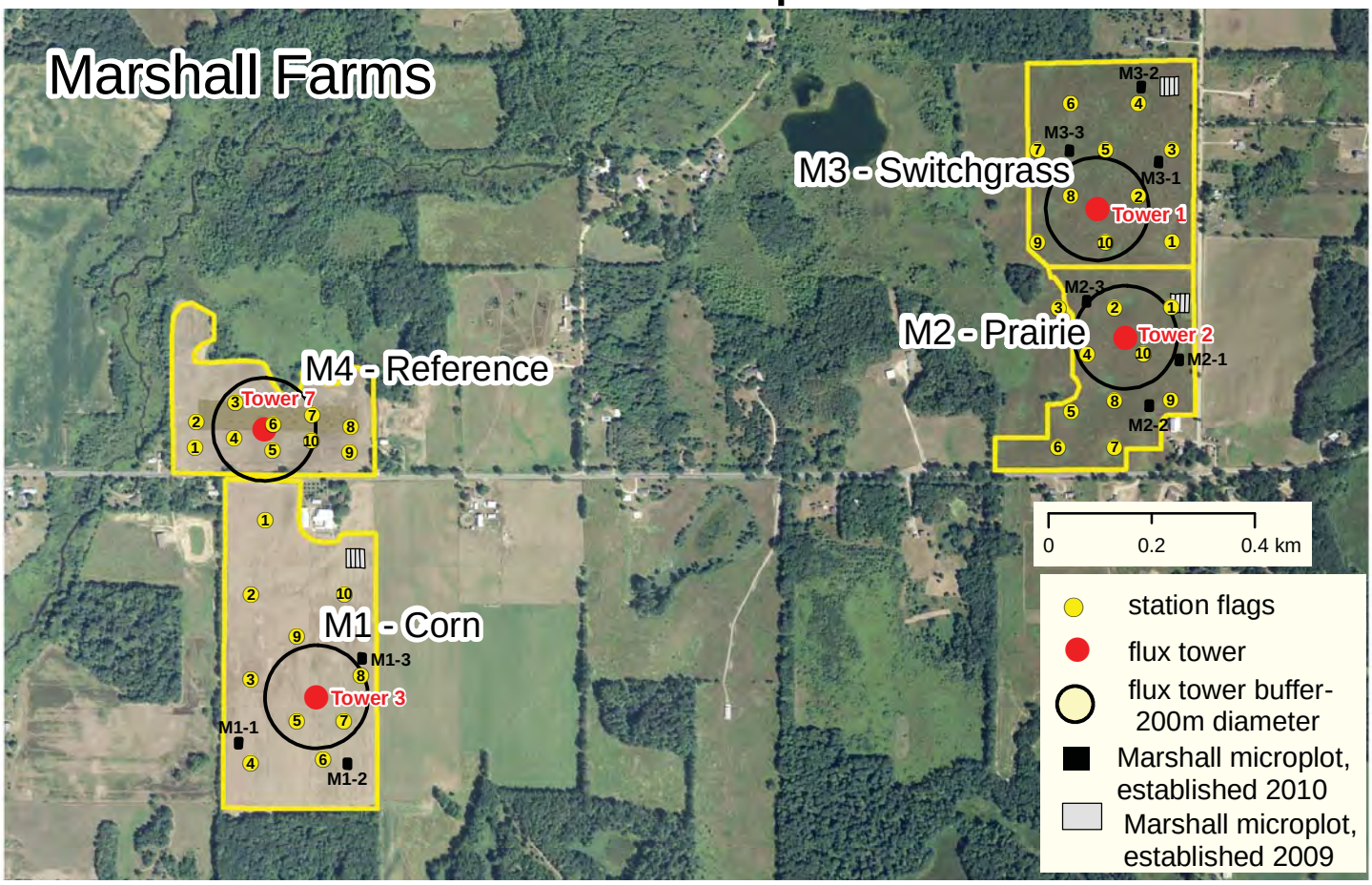
Lux Arbor Reserve 2017 – 331 Total Acres

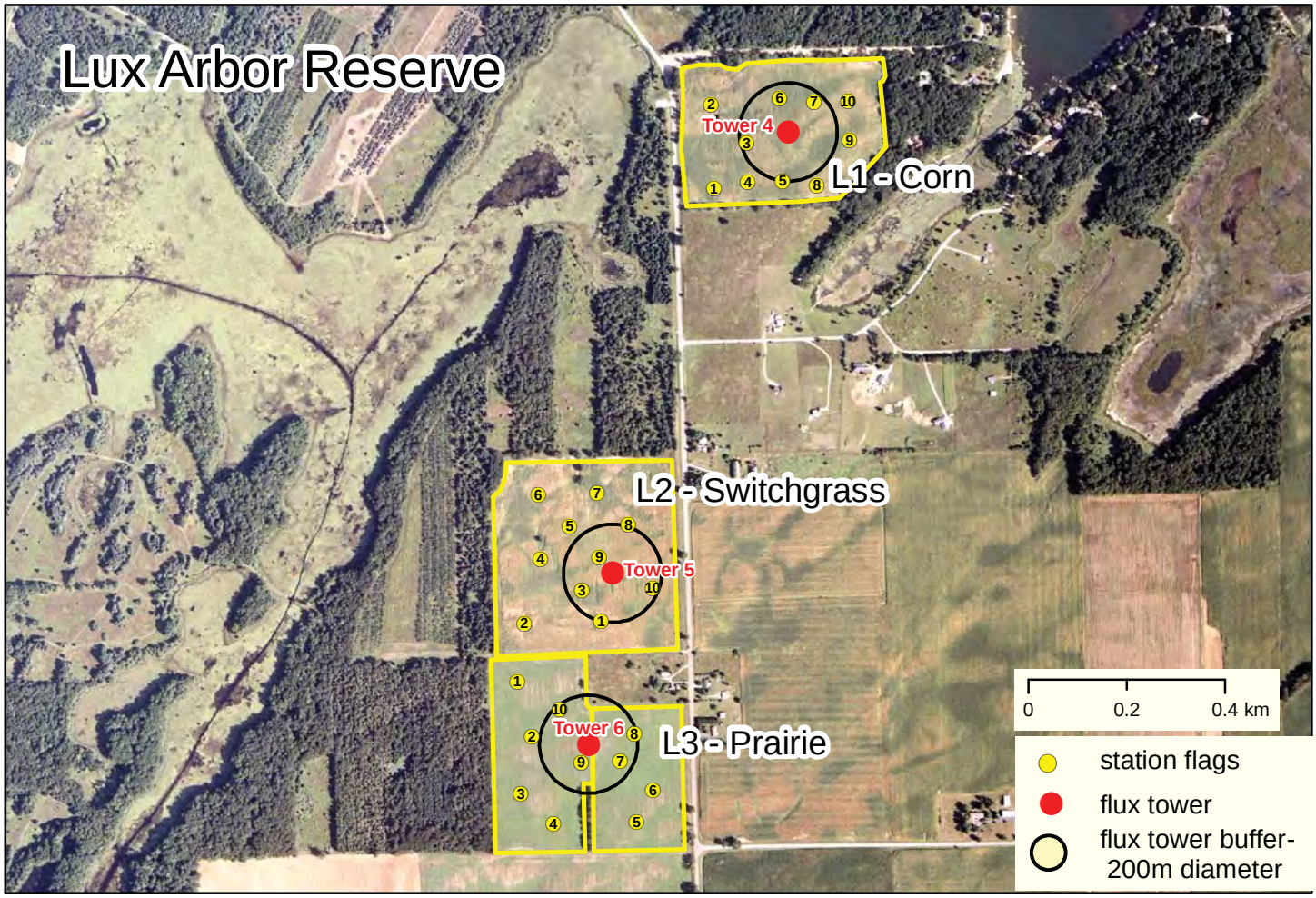
Project	***% of Agricultural Land Base***
GLBRC Scale up	28%
TOTAL RESEARCH	***28%***

Kellogg Farm Pasture Dairy Center

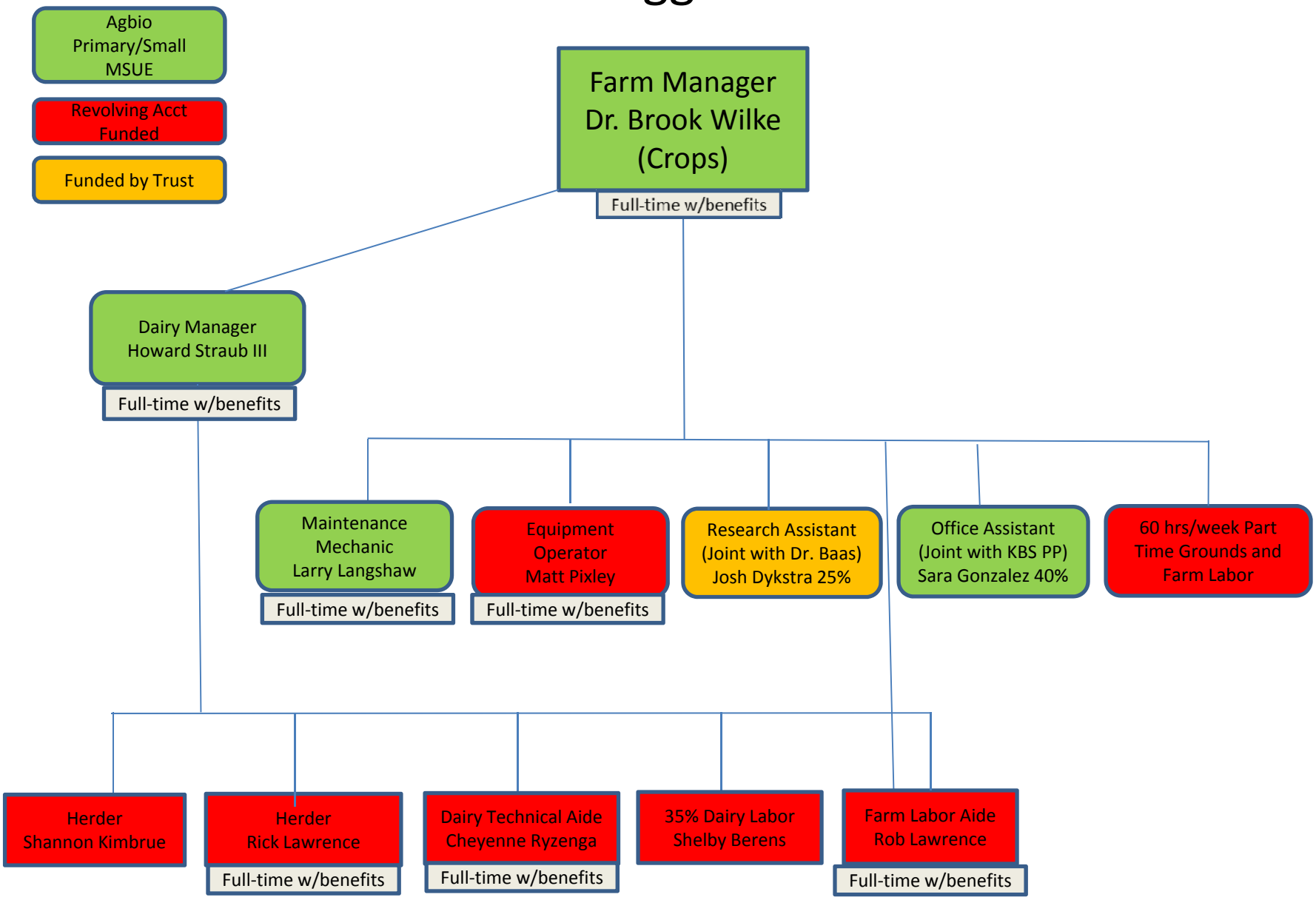
air photo date: 11 July 2013
Prepared by Suzanne Sippel

GLBRC Scale-up Fields





W.K. Kellogg Farm – 2017



MICHIGAN STATE UNIVERSITY
W.K. Kellogg Farm
Comparative Statement of Revenues and Expenses
For the Years Ended June 30, 2012 through June 2016

	30-Jun-12	30-Jun-13	30-Jun-14	30-Jun-15	30-Jun-16
REVENUES:					
General Funding Budget (AgBio Primary)	$ 86,147	$ 82,657	$ 255,505	$ 206,314	$ 211,203
Trust Account Funds	$ 59,610	$ 57,769	$ 78,935	$ 66,532	$ 65,602
Revolving Account					
Admin/Operations	$ 799,033	$ 44,541	$ 46,390	$ 42,536	$ 26,047
Research Fees	$ -	$ 27,968	$ 24,000	$ 27,677	$ 25,723
Animal Operations	$ -	$ 598,545	$ 635,700	$ 763,276	$ 605,164
Cropping Operations	$ -	$ 224,016	$ 205,625	$ 254,322	$ 259,471
Farming System Center	$ -	$ -	$ -	$ -	$ -
Total Revenues	**$ 944,789**	**$ 1,035,497**	**$ 1,246,154**	**$ 1,360,657**	**$ 1,193,210**
EXPENSES:					
Salaries General Fund	$ 83,344	$ 163,115	$ 253,545	$ 205,151	$ 208,185
Salaries Trust Fund	$ -	$ 1,292	$ 7,751	$ 7,416	$ 17,958
Salaries Revolving Account	$ 157,248	$ 259,692	$ 201,967	$ 272,832	$ 292,626
Operations					
Admin/Operations	$ -	$ 297,100	$ 198,832	$ 104,184	$ 95,527
Animal Operations	$ -	$ 232,792	$ 250,443	$ 254,404	$ 259,557
Cropping Operations	$ -	$ 70,657	$ 138,193	$ 122,485	$ 149,927
Farming System Center	$ -	$ 3,382	$ 21,026	$ 7,153	$ 6,255
Machinery Operations	$ -	$ -	$ 156,187	$ 304,859	$ 245,555
Miscellaneous	$ 573,797	$ -	$ 1,960	$ 1,163	$ 3,018
Total Expenses	**$ 814,388**	**$ 1,028,030**	**$ 1,229,903**	**$ 1,279,646**	**$ 1,278,608**
REVENUE OVER (UNDER) EXPENSES	**$ 130,401**	**$ 7,466**	**$ 16,251**	**$ 81,011**	**$ (85,397)**
Fund Ledger Balance June 30 (usable funds) (includes General, Trust and Revolve)	**$ 15,606**	**$ 119,168**	**$ 127,719**	**$ 219,861**	**$ 112,889**
Plus: Livestock Inventory	$ 242,700	$ 290,700	$ 394,700	$ 415,300	$ 388,900
Account Balance June 30 - Accrual Basis	$ 258,306	$ 409,868	$ 522,419	$ 635,161	$ 501,789

Prepared by:
A. Widner, Kellogg Biological Station, Administration

W.K. Kellogg Bird Sanctuary
Lisa Duke, Manager

Founded in 1927 as a sanctuary for the (then) threatened Canada Goose, the W.K. Kellogg Bird Sanctuary today serves as the hub for public outreach program at KBS. The primary focus of Sanctuary programs is on the importance of habitat for migratory and resident birds, but over the past ten years programming has broadened to include programs that increase awareness native plant communities, pollinators and birds from a variety of habitats. The Sanctuary is open year round and offers outreach programs (modest fee) for adults, families and youth as well as several free open houses.

The Sanctuary staff works with the Education and Outreach team to share with the community what is happening in their backyard from a scientific and natural standpoint. Outreach programs are organized by Sanctuary staff who enlist MSU faculty, conservation biologists and wildlife experts, and KBS staff as speakers and programs leaders. Although there is interest and opportunity to offer more public programming at the Sanctuary, the lack of staff to organize, develop and coordinate these activities limits what we can do. We have been making strategic decisions based on visitor and member feedback to focus on programs that best highlight the unique features of the Sanctuary and KBS (including the research done here) and that we can find funding and community partners to support. The growing interest in the natural resource and environmental programs at the Sanctuary suggest that there would be opportunities to develop more programming in these area (especially for adults) in partnership with MSU Extension.

Attendance and Membership:
Visitors come to the Sanctuary from around the world, though most are from the SW Michigan area, particularly Battle Creek. The Sanctuary has been a destination for the general public since established in 1927. It is wonderful to hear people say "I visited here when I was a child and now I bring my grandchildren." Along with the Manor House the Sanctuary is the public face of the Kellogg Biological Station and has an average of 11,000 visitors annually.
In 2008, the Sanctuary started a membership program to encourage visitors to support and participate in Sanctuary programs as well as come as casual visitors. While the total number of visitors to the Sanctuary had not changed appreciably over the past 10 years, we have seen an increase in participation in programs (20%) over the past five years. Memberships are renewed annually (and most do) get free admission to the Sanctuary, discounted fees for programs, and 10% off merchandise. SEeral different membership levels are available and the 'Grandparents' level is among the most popular. Funds from memberships are used to support projects that fall outside of the normal operations budget.

Education and Research Contributions: The Sanctuary also contributes to the research and educational mission of KBs by supporting access to habitats for sampling (including Wintergreen Lake), providing sites for mist netting songbirds and small mammal trapping (research and courses) and more recently supporting the establishment of a grassland restoration project funded by the MDNR and faculty grants from NSF. The Sanctuary also hosts two or more interns each year who learn about avian care, and contribute to environmental education and wildlife conservation programs of the Sanctuary. The avian care intern's work includes daily husbandry,

veterinary care, exhibit maintenance, and handling techniques. The environmental education intern helps the Sanctuary staff deliver and develop public outreach programs for youth and adults. Tangible and practical experience in informal education for important components of both internships. The Sanctuary is also a destination for MSU group tours including the AIMS, SROP, and MAP programs.

Programming at the Sanctuary includes:
Adult Short Courses - Field Ornithology (established in 2006) teaches participants to identify birds, provides lectures on bird behavior and ecology and introduces participants to birding habitats in the area; Field Botany (started summer 2016) focused on plant identification and natural habitats in the area.

Workshops are typically one day (or less) experiences for adults or families interested in learning more about natural habitats or how to expand native species in their gardens and are becoming more popular. Recent topics include native pollinators and wild edibles.

Family Programs - are usually 1.5 to 2 hours long and designed to allow families with young children to have a fun learning experience. One of the most popular programs is Birds of Prey – LIVE! Includes information on raptors, their adaptations, and includes a glove-trained introduction to Barred Owl, Great Horned Owl, and Red-tailed Hawk.

Youth Programs at the Sanctuary target K-8 and preschool children and are offered throughout the year and are aligned with NGSS. In summer "Wild Wednesdays" – a programs for preschoolers that involves activities based on a nature themed topics. Until recently we have been offering a science focused summer camp (3 one week sessions) "**K**ids **B**eing **S**cientists" at the Sanctuary for children in 3rd- 8th grade. However, the staff time and energy to market and conduct this program was not sustainable and so we have dropped our own program and instead are cooperating with camp programs at the Kalamazoo Nature Center and Sherman Lake YMCA to provide science focused programs for them.

Open Houses are offered at the Sanctuary throughout the year and offered varied activities to attract both adults and families. The "Fall Migration Celebration" was introduced in 2014 and participation has doubled over the past two years. At this event staff and volunteers help visitors ID migratory waterfowl, provide live birds presentations, and a decoy carving demonstration. We also participate in the "Arts and Eats Tour", a self-driving tour of Allegan and Barry counties. In 2016, the Sanctuary hosted 9 artists and attracted almost 600 visitors.

Educational School Tours
The Sanctuary has a long history of hosting student groups and providing educational programs for teachers about the natural environment. We have reduced the number of tour options offered to two that are/have been popular with school groups and showcase the unique features of the Sanctuary.

Bird Adaptations touches on the history of the Sanctuary and highlights adaptations of birds of prey, waterfowl and upland game birds. Seasonal highlights include spring nesting behavior,

summer care of young, fall migration and winter survival. This is our most popular tour option and we can adapt it for preschool to high school students.

Agriculture and Ecology is a more recent program/tour developed at the Sanctuary in collaboration with outreach educators (and interns) affiliated with the LTER. It includes an activity trail (appropriate for 1st to 4th graders) and introduces students to how agriculture and ecology are both needed to enjoy a bowl of Kellogg's cereal. Students engage in hands-on activities and gain an understanding of how agricultural ecosystems function and integrates finding from KBS researchers on how production of crops and livestock influence air, water, climate, and wildlife.

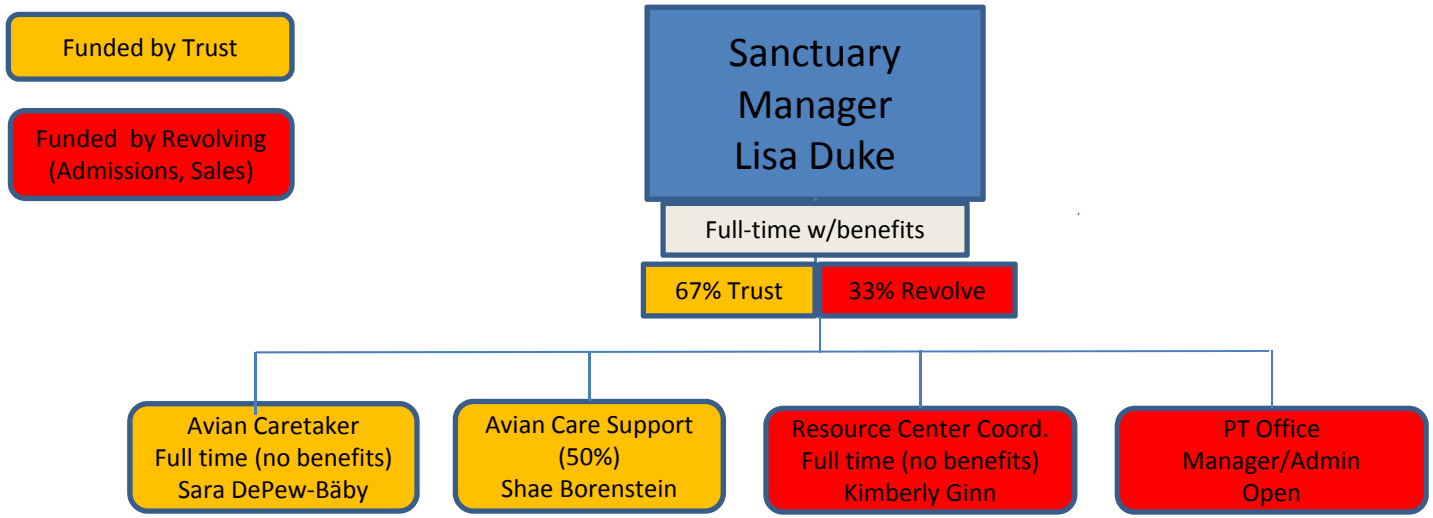
Funding and Facilities:

Currently, the Sanctuary Manager is the only full-time benefitted position at the Sanctuary; the salary and benefits of this position are paid by a trust established by Kellogg for a "man to care for the birds". There is also a full time (temporary) animal care staff and part-time office support. Volunteers obviously play an important role in supporting the educational programs and operations of the Sanctuary. A second trust established by Kellogg supports some of the operational costs of maintaining the sanctuary, educational programs and some part-time staff. Income from the Bookstore, memberships and gifts for specific programs provide a significant portion of the Sanctuary operating budget. While it is a goal to have more (at least 3) benefitted positions at the Sanctuary, the operating budget cannot currently support benefits for the rest of the staff.

The KBS Development office is in the middle of fundraising for a capital campaign to explore a project to update the main entry buildings of the Sanctuary. The buildings on the property were constructed in the 1960's or before and are in need of updating so that they can better support educational programs and the visitor experience, including having more accessible trails and bathroom facilities. The Sanctuary is not currently ADA accessible and the lack of air conditioning in Auditorium limits its use for educational programs in the summer.

In cooperation with the KBS Grounds department and using funds from donors, we have recently updated the Entrance and Overlook areas, improved the view and allowing us to better showcase native plantings and gardens in these areas. These aesthetic improvements have had a significant impact on visitor impressions of the Sanctuary and will hopefully serve as a focal point for future fund raising to improve Sanctuary facilities

Kellogg Bird Sanctuary – 2017



MICHIGAN STATE UNIVERSITY
W.K. Kellogg Bird Sanctuary
All Accounts

Comparative Statement of Revenues and Expenses
For the Years Ended June 30, 2012 to 2016

	FY 11-12 30-Jun-12	FY 12-13 30-Jun-13	13-14 30-Jun-14	14-15 30-Jun-15	15-16 30-Jun-16
REVENUES:					
Admissions - Revolving	**$29,804**	**$27,109**	**$27,913**	**$36,457**	**$35,931**
Bookstore Retail Sales - Revolving	**$26,879**	**$26,302**	**$27,563**	**$27,098**	**$32,465**
Programs and Tours - Revolving*	**$15,465**	**$14,170**	**$21,324**	**$19,459**	**$9,515**
Miscellaneous - Revolving	**$2,076**	**$9,053**	**$4,368**	**$0**	**$0**
Trust Income (Comerica + Harris)**	**$85,040**	**$84,569**	**$137,539**	**$97,031**	**$140,816**
Donations - Capital Improvements***	**$2,709**	**$29,471**	**$9,754**	**$12,154**	**$5,871**
Donations - Memberships***	**$2,865**	**$5,705**	**$12,598**	**$12,028**	**$14,223**
Donations - Memorials***	**$500**	**$0**	**$250**	**$315**	**$200**
Total Revenues	**$165,338**	**$196,379**	**$241,309**	**$204,542**	**$239,020**
EXPENSES:					
Salaries and Fringe	**$145,764**	**$154,242**	**$132,103**	**$119,187**	**$162,778**
Administrative/Operational	**$9,619**	**$11,758**	**$9,748**	**$7,981**	**$9,943**
Supplies and Printing	**$10,042**	**$8,249**	**$6,285**	**$14,223**	**$13,383**
Resale for Store	**$10,168**	**$12,163**	**$11,483**	**$10,764**	**$17,476**
Bird Care Supplies and Feed	**$7,714**	**$9,625**	**$12,097**	**$13,003**	**$10,380**
Capital Projects	**$9,508**	**$0**	**$7,072**	**$10,929**	**$32,376**
Misc.	**$2,253**	**$2,345**	**$1,124**	**$967**	**$191**
Total Expenses (see note below)	**$195,068**	**$198,382**	**$179,912**	**$177,054**	**$246,527**
REVENUE OVER (UNDER) EXPENSES	**($29,730)**	**($2,003)**	**$61,397**	**$27,488**	**($7,507)**
Fund Ledger Balance July 1 - all accounts	$59,269	$23,465	$21,462	$82,859	$110,346
Fund Ledger Balance June 30 - all accounts	$29,539	$21,462	$82,859	$110,347	$102,839
Plus Bookstore Inventory (Retail Value)	$ 14,754	$ 16,369	$ 5,419	$10,843	$8,300
Account Balance June 30 - Accrual Basis	$44,293	$37,831	$88,278	$121,190	$111,139

*Timing of MSU payments pushed about $11K into the next fiscal year

** Depending on Trust payment timing some years have 3 some have 5 (Dec vs. Jan pmts)

***Gift account no subaccounts until 2012. Revenue and expense from the gift account not included in FY 11-12.

Prepared by:
Sarah Reimer, Kellogg Biological Station

Conference Center and Kellogg Manor House: Operations Summary

Jim Allen, Conference Center- Manor House Manager
Andy Widner, Assistant Director

Overview:

The Conference Center and Manor House are the public face of the Kellogg Biological Station, and support the mission of KBS by providing: 1) food and housing for summer students and visiting researchers, 2) a professional venue for meetings and conferences, 3) an elegant space (the Kellogg Manor House) for hosting donor events, and 4) scholarship support. The grounds of the Kellogg Estate also provide an outdoor classroom that can be used for K12 education programs. Many in the community enjoy the grounds and gardens of the Estate (especially in the summer) and value the historical role of the Estate in community. Private and public events (meetings, celebrations, dinners, etc.) provide both income that can be used for scholarships, maintenance and improvements to facilities, and sustain the employment of the professional staff year round (or nearly so).

Facilities and Operations:

The Conference Center manages meeting spaces and housing for conference guests and summer students and operates a kitchen and dining room (McCrary Hall) where meals are served cafeteria-style. Several of the historical buildings of the Kellogg Estate are also managed by the Conference Center staff, including the Manor House, Carriage House (with two meeting rooms and the Lakeside Cottage), and Caretaker's Cottage. The Boathouse Laboratory and Greenhouse/Head House are managed by KBS Facilities and faculty. Maintaining historical buildings and features of the Estate, including the grounds and gardens, are responsibility of the KBS Physical Plant, although Manor House staff is responsible for updates and minor repairs to the interior of the House.

Maintaining the historical features (buildings and grounds) of the Kellogg Estate can be a challenge and expensive. The Manor and Carriage House were updated with funds from the WK Kellogg Foundation in 1998 ($3.5M) and as part of this renovation a commitment was made to make the facilities open and available to the public. Some funding was committed by MSU to maintain the House and grounds, and there was also an expectation that the business operations of the Manor House and Conference Center would both provide income and foster a donor base to support the maintenance of the Manor House and Estate. Unfortunately that was more of a challenge than first envisioned, and in 2012 the Kellogg Foundation made a generous grant ($1M) to establish an endowment for the maintenance of the historical buildings and grounds of the Kellogg Estate. They challenged KBS to match that donation ($500,000) within five years and that goal has been met. The Manor House Endowment now generates ~ $75,000 annually, most of which is used to update, repair and maintain the Estate; approximately $15,000 is used to support summer interns who assist with the maintenance of the estate and do special projects to share the legacy of the Estate and Kellogg family.

Finance and Staffing:

The Conference Center and Manor House are operated entirely (except for income from the Endowment) as a business account. This means that they are highly reliant on the seasonal of the conference business and the peak season for conference business conflicts with that of the KBS

academic program (May-August). In 2015, the Conference Center management completed a financial analysis of past and prospective business and implemented revised labor scheduling, closer tracking of finances, revised opening/closing dates and accounting protocols to reduce costs. They have also established comprehensive financial tracking to identify financial winners and losers developed better cost estimates for events and meals. Pricing tables have also been established that help the staff meet profitability goals for events.

In 2015, KBS obtained a liquor license allowing us to serve alcohol at public and private events providing more control over this service and some financial advantage by having additional income at these events (previously it was contracted out to private vendors). We have put in place operational and tracking procedures to ensure appropriate compliance with rules and regulations and are beginning to see positive impacts on conference business.

There are six full-time benefitted staff and the majority of the staff are seasonal. Over the past three years, the Conference Center has implemented policies and procedures to assure consistent (and excellent) service, manage costs and increase staff training and performance. The staff are expected to be flexible and adaptable to the changing needs of the Conference Center business. There is now coordination of finances (Conference Center and Manor House), but also clarity in the responsibilities of the Manor House Event Manager and Conference Manager, with appropriate support personnel. There also has been a concerted effort to improve the operational efficiency of the Conference Center and Manor House. A number of procedural changes have been implemented to build a sustainable business model that can handle the challenges of the seasonal nature of the business cycle, aged facilities and distance from campus or a large city.

Challenges and Opportunities:
The Conference Center is challenged by having outdated facilities, a strongly seasonal business, having to avoid competition with the KBS academic program, and lack of funds and personnel to invest in exploring marketing and new business opportunities. While the historical buildings managed by the Conference Center have been updated, the other housing facilities – apartments, dorms and cabins – need to be updated (or replaced). They are adequate for student and research groups (and some conference groups), but not appropriate for a higher end business or professional clientele that could be attracted to this facility given our location, meeting room capacity, and availability of video technology. Without central MSU support – or identification of major donors – to fund upgrades to these facilities, it will continue to be a challenge for the Conference Center to develop the financial stability it needs to be sustainable.

Facilities and Meeting Rooms Managed by the Conference Center

Meeting Rooms

Auditorium (academic) —	up to 120 people
Terrace Room (academic) —	up to 50 people
Carriage House —	up to 40 people
(6) Classrooms —	up to 15 people
Spruce Lodge - *(Sanctuary)*	up to 50 people

Lodging — KBS campus

(12) Orchard Dorms	48 twin beds
(30) Apartments	79 twin beds with sofa sleepers
Cabin A —	sleeps 6, twin beds
Cabin B —	sleeps 16, bunk beds
Cabin C —	sleeps 20, bunk beds
Lakeside Cottage	(4) bedrooms, kitchen, dining room, living room, 2 bathrooms, large 2 story, sleeps 9pp
Caretaker's Cottage	(2) bedroom, kitchen, dining room, living room, bathroom, sleeps 4-5 pp

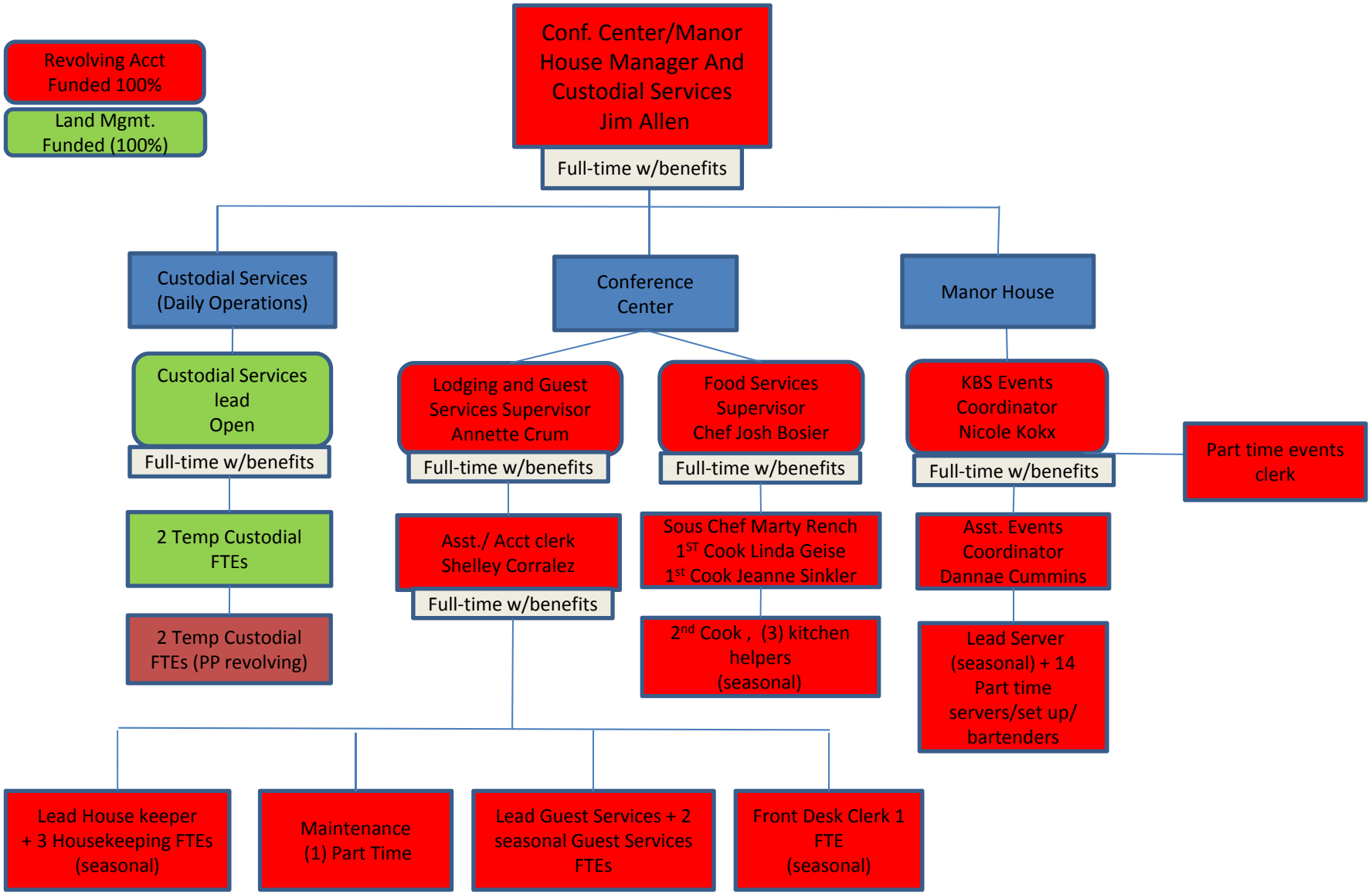
Lodging — off campus

Bergner House —	2 story farm house, sleeps 10
Hayes House —	2 story, full house, sleeps 7 pp
Dairy Apartment —	2 bedrooms, 2 bathrooms, sleeps 4 pp
Bird Sanctuary Apt. —	2 bedrooms, sleep 2 pp
*Kellogg Forest House —	2 bedrooms open (summer or yearly rental)
*Helen's House —	4 bedrooms, sleeps 8 pp

Subleased from Kellogg Center by KBS

McCrary Dining Hall — seating for up to 130 people; with an additional 40 on the deck

Kellogg Biological Conference Center & Manor House– 2017



W.K. Kellogg Biological Station Conference Center and Manor House
Combined Accounts
Comparative Statement of Revenues and Expenses
For the Years Ended June 30, 2012 through June 2016

	30-Jun-12	30-Jun-13	* 30-Jun-14	* 30-Jun-15	* 30-Jun-16
REVENUES:					
Fac Fees/deposits:	$148,869	$132,495	$472,926	$286,888	$122,155
Housing	$382,622	$460,038	$428,300	$326,915	$309,118
Meals, catering, food	$363,787	$371,687	$214,327	$311,732	$432,351
Miscellaneous	$8,701	$29,480	$1,586	$3,122	$3,759
Tours, Weddings, Special Events	$91,888	$114,631	$66,376	$207,511	$216,542
Total Revenues	**$995,867**	**$1,108,331**	**$1,183,514**	**$1,136,168**	**$1,083,925**
EXPENSES:					
Salaries	$408,471	$408,820	$464,825	$485,585	$506,915
Fringes	$113,231	$111,871	$143,663	$155,509	$142,304
Food	$215,609	$216,811	$205,002	$205,192	$187,755
Other operating expenses	$292,589	$292,898	$297,574	$352,353	$288,815
Total Expenses	**$1,029,900**	**$1,030,400**	**$1,111,064**	**$1,198,638**	**$1,125,789**
REV. OVER (UNDER) EXPENSES/TRANSFERS	**($34,033)**	**$77,931**	**$72,450**	**($62,470)**	**($41,864)**
Fund Ledger Balance June 30	**$35,784**	**$113,715**	**$186,165**	**$123,695**	**$81,831**

Prepared by:
J. Allen, Kellogg Biological Station

*Change in accounting methods between fiscal 14 and 15.

REPORT IN BRIEF

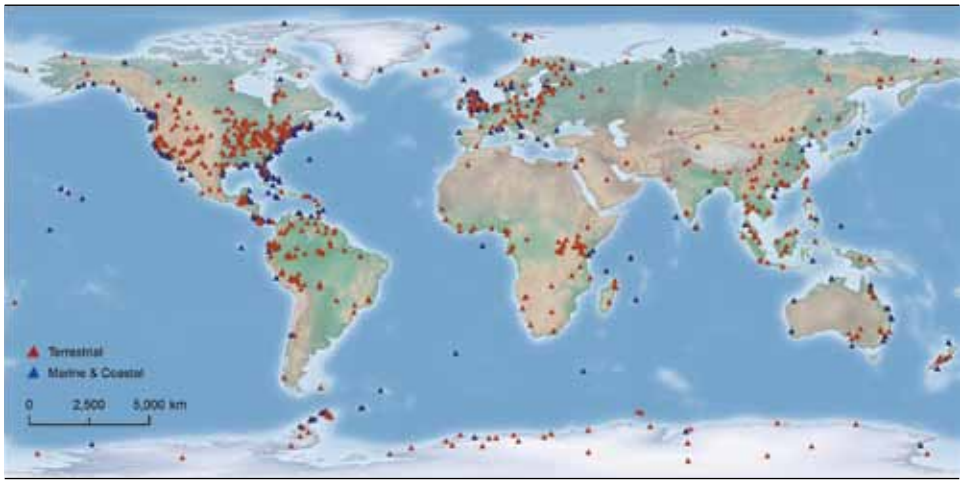
NATIONAL ACADEMY OF SCIENCES
NATIONAL ACADEMY OF ENGINEERING
INSTITUTE OF MEDICINE
NATIONAL RESEARCH COUNCIL

BOARD ON LIFE SCIENCES
JULY 2014

Enhancing the Value and Sustainability of Field Stations and Marine Laboratories in the 21st Century

AMID RAPID ENVIRONMENTAL CHANGE, a strong understanding of the natural world is more important than ever. Field stations and marine laboratories place scientists on the front lines of the changing Earth so they can better understand shifting climate and ecosystems and make robust projections of future conditions. Field stations are a critical part of the scientific infrastructure that bring the basic tools of science into the field and connect scientists, educators, and communities to their environments. But to fulfill their vital roles, field stations and their leadership must continue to evolve. This report explores strategies to harness the power and potential of field stations to address complex challenges, by developing stronger networks, establishing more entrepreneurial leadership and planning, and documenting their impacts in science and society.

To understand the workings of our planet—from how a forest responds to wildfire to how climate change is affecting biodiversity—there is no substitute for directly observing the natural world. Field stations and marine laboratories provide the tools to help make those observations possible in almost every environment, from city to mountain, prairie to desert, to forest, river, and ocean.



There are more than 900 field stations and marine labs worldwide.

Although they range in size, scope, and complexity, all field stations are windows into ecosystems that provide unique educational and research opportunities. Field stations engage local communities in observing the natural world and help connect their observations with decision making.

Away from the hustle and bustle of everyday life, field stations foster collaborations among scientists from different disciplines. But the separation that enables focused research and allows creativity to flourish can also mean that field stations are overlooked by their parent institutions and other funding organizations. In challenging economic times, some field stations—especially remote or small ones—are vulnerable to budget cuts and even closure.

If field stations are to thrive in the 21st century and beyond, they will need to become better able to adapt to changing technologies, economic situations, and societal and scientific needs At the request of the National Science Foundation, the National Research Council convened an expert committee to review and assess the roles field stations play in supporting research, education, and public outreach; and to identify strategies to help enhance those vital roles in sustainable ways.

SCIENCE FOR AN UNPREDICTABLE WORLD

In an era of rapid climate change, overexploitation of natural resources, and instabilities in food production, field stations provide vital links to the environment

Box 1 ***An Unexpected Research Opportunity***

Native to South America, red fire ants are invasive pests that cost the United States an estimated $8 billion each year in control, damage mitigation and medical treatment. In 1981, red fire ants invaded the Brackenridge Field Laboratory in Austin, Texas, and inadvertently giving researchers the opportunity to launch an invasive species research program. Today, the Brackenridge Field Laboratory is an international hub for fire ant research that has generated more than $10 million in research funds and more than 80 publications over 20 years.

Photo credit: John & Kendra Abbott/Abbott Nature Photography

through research, education and community engagement. These connections are more important than ever in understanding, predicting, and modifying the changing relationship of humans with Earth to make them more resilient.

The long-term environmental data gathered at field stations help scientists better understand current changes in ecosystems and climate. Over many years, observations on the timing of leaf budding or the arrival of migratory species allow researchers to document shifting conditions and identify the environmental drivers of change. This historical record allows more robust projections of future change and that can inform policy decisions.

Field stations also foster cross-disciplinary research communities. Field stations stimulate convergence among the various branches of science as well as engineering, humanities, and arts that can help tackle pressing scientific and societal challenges.

PREPARING THE NEXT GENERATION OF SCIENTISTS

Field stations enable hands-on, discovery-based learning for students of all ages and backgrounds. Early research experiences in the field help students build skills such as learning how to develop research questions and gathering data to answer them. Research experiences early in life promote a lifelong interest in science, technology, engineering, and mathematics (STEM) and have been shown influence career choices. Active learning has been shown to help students retain, recall, and apply information. Universities should seek to expand opportunities for student participation in research and active learning programs at field stations, which could boost student interest in science and the environment, and encourage their persistence in STEM fields.

EMPOWERMENT THROUGH PUBLIC ENGAGEMENT

Many field stations have programs that engage the public in science, for example through lectures, workshops, science cafes, citizen science, volunteer opportunities. These engagement activities help connect local communities with their environment and promote stewardship of the natural world.

Technological advances allow citizen scientists to collect field data in unprecedented ways, from relatively simple observational programs, such as eBird or iNaturalist, to coordinated, training-intensive water quality monitoring programs. As well as helping to strengthen public understanding, appreciation, and support of science, citizen science initiatives also contribute much-needed data to researchers. Advances in mobile technologies and geographic information tools allow citizens across the globe to pool data to reveal patterns of change.

Each field station should continue to explore and expand a range of approaches to engage the public in science, tailoring its programs to reflect its unique assets and environmental and societal challenges. Each station should take advantage of empirical knowledge of science communication and informal education research to develop effective public engagement programs. New technologies and networking initiatives provide opportunities to recruit and engage the public in the nation's scientific enterprise as citizen scientists.

NETWORKING FOR DISCOVERY AND INNOVATION

Linking field stations and other organizations to enable data pooling could greatly enhance our understanding of the impacts of a regional drought, an extreme storm, or longer-term environmental change resulting from human activities. More expansive and robust networks would make it easier to share these data in a timely way and transform them into information and knowledge that could aid decision-making. In a time of budget constraints, networking could help field stations share resources to make investments in expensive infrastructure such as tools for data storage and analysis. Networking also promotes the coordination of research and education programs to enhance effectiveness and reduce redundancies.

By providing incentives for networking, universities and funding organizations could encourage collaborations that make scientific, educational, and business

sense. For example, funding agencies could state in program announcements and in requests for proposals that they will give preference to proposals that link multiple field stations.

Networking of field stations can also help build convergence among scholars from different scientific disciplines to foster creativity and innovation, and to fuel more rapid scientific and societal advances. Field-station leaders can facilitate this convergence by organizing research around common scientific and societal challenges, and by embracing the social sciences, the arts and the humanities.

MEASURING PERFORMANCE AND IMPACT

The value of field stations is documented unevenly and, for the most part, anecdotally. There is a dearth of empirical evidence on the contributions that field stations make to research, education, and community engagement. In the absence of aggregated and empirical documentation of their value, field stations are vulnerable to budget cuts. Field stations need to document the roles they play in science and society with better metrics individually and as a community. One way of doing this could be to track the publications based on research from a particular field station using a field-station–specific digital object identifier, or DOI. A digital object identifier is a character string (a "digital identifier") that is used to uniquely identify content and provide a persistent link to its location on the Web. If each future publication based on research at a particular field station cited this DOI, publications from the field station could be easily tracked. In times of shrinking budgets and increased demands for accountability, demonstrating outputs and outcomes is essential to securing long-term funding.

Field stations should work together to develop a common set of metrics of performance and impact that can be aggregated across regions and the entire nation. New mechanisms and funding are needed to collect, aggregate, and synthesize these data.

MODERN INFRASTRUCTURE FOR A NETWORKED WORLD

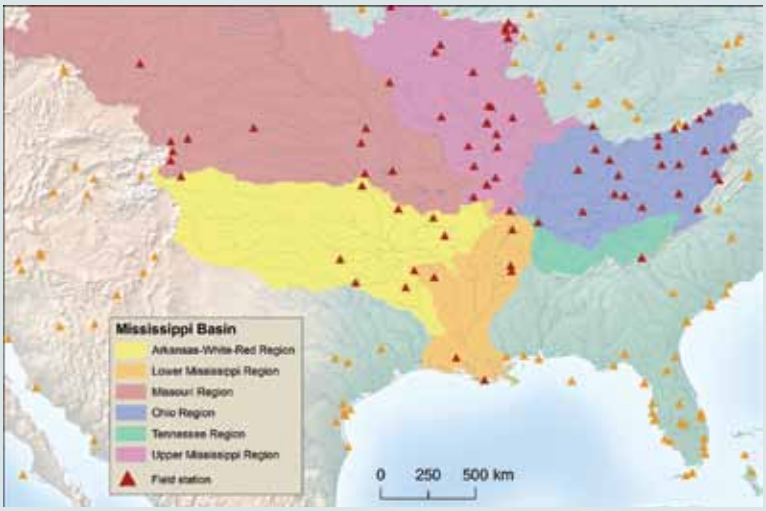
Maintaining and upgrading field station infrastructure—from laboratory space to scientific equipment—is essential to ensuring field stations are equipped to provide scientists with the tools needed for research and education in the 21st century.

Field stations vary greatly in size, scope, complexity, and mission, and therefore each field station needs to assess and define its own infrastructure needs. However the infrastructure needed for data management and internet connectivity, known as cyber-infrastructure, is essential to allow all field stations to build networks and more easily share data. In particular, the process of archiving "dark data"—data that are not currently stored in digitally accessible formats—is critical.

FINANCIAL SECURITY FOR A MODERN INFRASTRUCTURE

Aging infrastructure, the need for current technology and cyber-infrastructure, and evolving safety regulations place increased financial demands on field stations. To be sustainable, many field stations will need to place greater emphasis on good business practices. A business plan that includes a clear, compelling, and comprehensive value proposition is crucial both to secure continuing support from host institutions

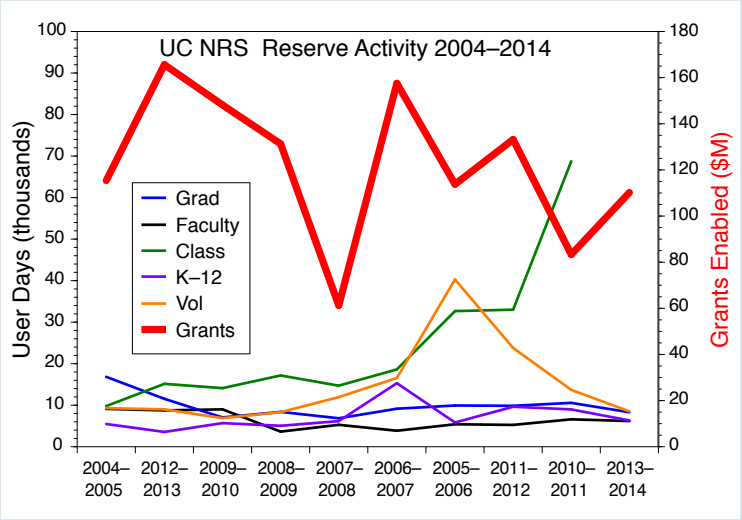
Box 2 ***A Network to Study the "Dead Zone" in the Gulf of Mexico***



In the Gulf of Mexico there lurks a "dead zone"—an area of water so low in oxygen that it is lethal to many of the organisms that live on or beneath the ocean floor. This dead zone is caused by excess nutrients from agricultural lands that runoff into the Mississippi River and are carried to the Gulf, where they cause algal blooms. As the algae decompose, they remove oxygen from the water column. Runoff from agricultural land is exacerbated by the loss of forests and wetlands that help retain sediments and absorb nutrients. Building a network among the many field stations located in the Mississippi River Basin and along the coast could help scientists gather and share data to better understand the connections between the region's freshwater and marine systems.

Box 3 ***University of California Natural Reserve System: Gathering Metrics***

Created in 2000, the Reserve Application Management System (RAMS) helps track the use of the University of California Natural Reserve System's 39 field stations for easier reporting to funders such as campus administrators, and private sector, state, and federal agencies. Before they are granted access to the reserves, researchers are asked to provide information such as the project, an abstract, and funding amounts. Data from the RAMS system show that from January 2010 to January 2013, 26,600 people used the reserves, generating 683 peer-reviewed journal articles, books, and book chapters and $386.4 million. in research grants. These metrics could, when combined with outcome metrics, more effectively demonstrate field stations' contribution to research and education.



and to develop new and diverse sources of funding. Furthermore, station leaders should be recruited and evaluated not only for their scientific credentials, but also for their leadership, management and entrepreneurial skills. Mentoring of field-station leaders would help them develop and hone management, business planning, and fundraising skills.

LOOKING FORWARD

Field stations play a critical role in science and society by connecting researchers, students, and communities with each other and with the environment. These valuable resources are poised to help scientists better understand the shifting climate and nature's responses, and to create the information and knowledge we need to conserve our ecosystems and quality of life. But in an era of budget constraints, reaching these goals will take business acumen as well as scientific expertise. Through networking, incorporating more entrepreneurial leadership and developing new metrics of performance and impacts, field stations can meet the challenges of a rapidly changing world.

Locate additional information, including related reports, at http://dels.nas.edu/bls
Read, purchase, or download a free PDF of this report at http://www.nap.edu

Committee on Value and Sustainability of Biological Field Stations, Marine Laboratories, and Nature Reserves in 21st Century Science, Education, and Public Outreach: Jerry R. Schubel (*Chair*), Aquarium of the Pacific, Long Beach, CA; **Felicia C. Coleman,** Florida State University Coastal and Marine Laboratory, St. Teresa; **Cathy Conrad,** Saint Mary's University, Halifax, Nova Scotia, Canada; **Diane Debinski,** Iowa State University, Ames; **Peter M. Kareiva,** The Nature Conservancy, Seattle, WA; **George I. Matsumoto,** Monterey Bay Aquarium Research Institute, Moss Landing, CA; **Diane M. McKnight,** University of Colorado Boulder; **Camille Parmesan,** Plymouth University, Plymouth, UK, and University of Texas, Austin; **Robert Plowes,** University of Texas Brackenridge Field Laboratory, Austin; **Alison G. Power,** Cornell University, Ithaca, NY; **Mary E. Power,** Angelo Coast Range Reserve, University of California, Berkeley; **Mark R. Stromberg,** University of California Natural Reserve System (*retired*), Sonora, AZ; **Keegan Sawyer** (*Study Director and Program Officer*), **Claudia Mengelt** (*Senior Program Officer*), **Laurence Yeung** (*Christine Mirzayan Science & Technology Policy Fellow, until April 2014*), **Lauren Soni** (*Senior Program Assistant*), **Norman Grossblatt** (*Senior Editor*), National Research Council

The National Academies appointed the above committee of experts to address the specific task requested by the National Science Foundation. The members volunteered their time for this activity; their report is peer-reviewed and the final product signed off by both the committee members and the National Academies. This report brief was prepared by the National Research Council based on the committee's report.

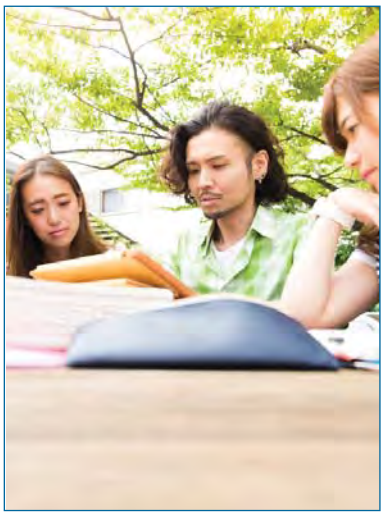
For more information, contact the Board on Life Sciences at (202) 334-3514 or visit http://dels.nas.edu/bls. Copies of *Enhancing the Value and Sustainability of Field Stations and Marine Laboratories in the 21st Century* are available from the National Academies Press, 500 Fifth Street, NW, Washington, D.C. 20001; (800) 624-6242; www.nap.edu.

Report

February 2017

HIGHLIGHTS

Undergraduate Research Experiences for STEM Students: Successes, Challenges, and Opportunities



Many ongoing efforts to improve undergraduate education in science, technology, engineering, and mathematics (STEM) fields focus on decreasing traditional lecture-based teaching and increasing the active participation of students. Engaging students in research experiences has been proposed as a way to increase students' interest and persistence in STEM and to broaden participation in these disciplines. Efforts are currently underway to increase both the number and the diversity of students participating in undergraduate research experiences (UREs).

Undergraduate Research Experiences for STEM Students: Successes, Challenges, and Opportunities (2017), a report from the National Academies of Sciences, Engineering, and Medicine, examines what is known about the effectiveness of UREs. The initial research that has been conducted so far suggests that participation in UREs is beneficial for students and increases their persistence in STEM, the report concludes. It recommends ways that researchers, institutions, and funders can both improve and strengthen the evidence base on these experiences.

A WIDENING RANGE OF UNDERGRADUATE RESEARCH EXPERIENCES

UREs are a meaningful opportunity for students to learn about the work and perspectives of researchers in STEM fields. Attention to UREs has grown significantly in the last few years as policy actions have promoted their expansion.

While the classic image of a URE is a student spending the summer working directly with a faculty member on a project related to that faculty member's research, UREs have diversified beyond this traditional apprentice model. Course-based UREs are becoming increasingly common. Students also participate in research through internships and co-ops, where they do academically relevant work outside of academia.

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

The students at undergraduate institutions are increasingly diverse as well, including more historically underrepresented students, first-generation college students, and part-time and other nontraditional students. Many private and publicly funded programs have focused specifically on providing UREs to historically underrepresented minorities, women, and first-generation students because members of these groups are less likely to persist in STEM fields.

WHAT IS KNOWN ABOUT UNDERGRADUATE RESEARCH EXPERIENCES

Research on the effectiveness of UREs is still in the early stages of development compared with other interventions to improve undergraduate STEM education. Most studies of UREs are case studies or use correlational designs, and many of these studies report positive outcomes from participation in a URE. For example, studies focused on students from historically underrepresented groups indicate that participation in UREs improves their persistence in STEM and helps them to feel part of the research community.

Only a small number of studies have used research designs that can support inferences about causation, and many questions remain for research—for example, the ways UREs lead to benefits for students, and the aspects of these experiences that are most powerful.

RECOMMENDATIONS

The report offers eight recommendations to improve UREs and to strengthen the research base on these experiences.

Recommendation 1: Researchers with expertise in education research should conduct well-designed studies in collaboration with URE program directors to improve the evidence base about the processes and effects of UREs. This research should address how the various components of UREs may benefit students. It should also include additional causal evidence for the individual and additive effects of outcomes from student participation in different types of UREs. Not all UREs need be designed to undertake this type of research, but it would be very useful to have some that are designed to facilitate these efforts to improve the evidence base.

Recommendation 2: Funders should provide appropriate resources to support the design, implementation, and analysis of some URE programs that are specifically designed to enable detailed research establishing the effects on participant outcomes and on other variables of interest such as the consequences for mentors or institutions.

Recommendation 3: Designers of UREs should base their design decisions on sound evidence. Consultations with education and social science researchers may be helpful as designers analyze the literature and make decisions on the creation or improvement of UREs. Professional development materials should be created and made available to faculty. Educational and disciplinary societies should consider how they can provide resources and connections to those working on UREs.

Recommendation 4: Institutions should collect data on student participation in UREs to inform their planning and to look for opportunities to improve quality and access.

Recommendation 5: Administrators and faculty at all types of colleges and universities should continually and holistically evaluate the range of UREs that they offer. As part of this process, institutions should

- consider how best to leverage available resources (including off-campus experiences available to students and current or potential networks or partnerships that the institution may form) when offering UREs so that they align with their institution's mission and priorities;
- consider whether current UREs are both accessible and welcoming to students from various subpopulations across campus (historically underrepresented students, first generation college students, those with disabilities, non-STEM majors, prospective K-12 teachers, etc.); and
- gather and analyze data on the types of UREs offered and the students who participate, making this information widely available to the campus community and using it to make evidence-based decisions about improving opportunities for URE participation. This may entail devising or implementing systems for tracking relevant data.

Recommendation 6: Administrators and faculty at colleges and universities should ensure that all who mentor undergraduates in research experiences (this includes faculty, instructors, postdoctoral fellows, graduate students, and undergraduates serving as peer mentors) have access to appropriate professional development opportunities to help them grow and succeed in this role.

Recommendation 7: Administrators and faculty at all types of colleges and universities should work together within and, where feasible, across institutions to create a culture that supports the development of evidence-based, iterative, and continuous refinement of UREs, in an effort to improve student learning outcomes and overall academic success. This should include the development, evaluation, and revision of policies and practices designed to create a culture supportive of the participation of faculty and other mentors in effective UREs. Policies should consider pedagogy, professional development, cross-cultural awareness, hiring practices, compensation, promotion (incentives, rewards), and the tenure process.

Recommendation 8: Administrators and faculty at all types of colleges and universities should work to develop strong and sustainable partnerships within and between institutions and with educational and professional societies for the purpose of sharing resources to facilitate the creation of sustainable URE programs.

COMMITTEE ON STRENGTHENING RESEARCH EXPERIENCES FOR UNDERGRADUATE STEM STUDENTS

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For More Information . . . This Report Highlights was prepared by the Board on Science Education based on the report, *Undergraduate Research Experiences for STEM Students: Successes, Challenges, and Opportunities* (2017). The study was sponsored by the National Science Foundation. Any opinions, findings, conclusions, or recommendations expressed in this Report Highlights are those of the authors and do not necessarily reflect the views of any organization or agency that provided support for the project. Copies of the report are available from the National Academies Press, (800) 624-6242; http://www.nap.edu or via the DBASSE page at http://nas.edu/STEM_Undergraduate_Research.

Division of Behavioral and Social Sciences and Education