ecosystem Science Center

Annual Report 2019-2020

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This document summarizes the activities of the Ecosystem Science Center for the period from July 1, 2019 ─ June 30, 2020

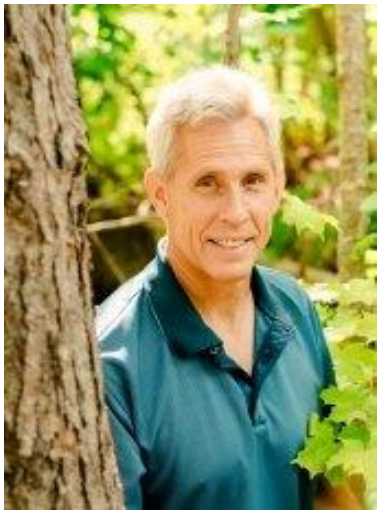
Photo on Cover: The Michigan Gradient Study: From 1994 to 2017, researchers added experimentally elevated atmospheric N deposition to four northern hardwood forests in Michigan. The four sites quickly became N saturated, with tree growth increasing, decomposition processes inhibited, and reduced seedling survival among the responses (control plot to left, N addition plot to right in the photo). The study continues now that N additions have stopped, with the objective of determining if the responses are reversible or if ambient deposition is sufficient to maintain a state of N saturation and the resultant effects.

A Message from ESC Director, Andrew Burton

The Ecosystem Science Center (ESC) has now completed its sixteenth successful year, and the third year of a renewal that continues through December 31, 2022.

During the past year, ESC members have attracted significant extramural funds for research and outreach, mentored numerous graduate and undergraduate researchers, published in high impact journals, and obtained funding for essential research equipment, as described in the Summary of Activities on the following page and the details provided throughout this report. Highlights from the past year include research awards and expenditures that rank near the top of Michigan Tech's centers and institutes and financial support for twenty numerous student research efforts. New funds obtained include National Science Foundation (NSF) support to continue the long-running predator-prey study of the wolves and moose of Isle Royale, US Department of Energy (DOE) funding to study the methane budget of an Amazonian peatland, US Forest Service funds for continued outreach and research on climate change resilience, resistance and adaptation in northern forests, US Fish and Wildlife Service support for examining red wolf ancestry in the southeast US, and NSF CAREER funds to Ericka Hersch-Green to examine the structuring of biodiversity patterns from genomes and transcriptomes to multispecies communities. ESC members also have put tremendous effort into student training, including sending twelve students to national and international scientific meetings and workshops and supporting student interactions with the speakers in the Distinguished Ecologist Lecture Series. The success of the ESC during the past sixteen years would not be possible without the hard work of our 50+ members, and I look forward to continued interaction with these outstanding ecologists during the coming year.

I hope you enjoy this report. Michigan Tech is a great place to conduct research, education and outreach in ecosystem science, and the ESC looks forward to creating new opportunities for all of these in the coming year. Please feel free to contact me if you have any questions about the report or the Center.



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Mission Statement & Summary of Activities

Mission Statement: "To promote understanding of ecosystem function through education and research at Michigan Technological University."

The Ecosystem Science Center (ESC) seeks to advance our understanding of how ecosystems function and how human activities influence ecosystem processes. The Center's two main objectives are to: (1) foster ecosystem research through the acquisition of extramural support; and (2) improve Michigan Tech's ability to educate graduate and undergraduate students in the area of ecosystem science. These two objectives are met through collaboration among faculty, staff and students interested in ecosystem science.

***Summary of Activities**:* During the past year, the ESC welcomed four new members, while four others departed, giving us a year-end membership of 54. All ESC members have worked hard to develop and submit interdisciplinary research proposals involving multiple units across campus and collaborations with government and university partners both nationally and internationally. The ESC ranked first among the twenty Centers and Institutes at Michigan Tech in terms of numbers of research awards (88) projects (160) in FY20. The ESC also ranked fifth overall in research expenditures ($3,782,119) and fifth overall in new research funds awarded ($4,627,728) for FY20. These rankings increase to 3rd and 3rd out of eighteen, when only the on-campus centers and institutes, whose members are primarily academic faculty, are considered. ESC award expenditures during FY20 generated $476,101 in facilities and administration (F&A) funds for Michigan Tech.

During the past year, the ESC continued initiatives designed to further enhance our ability to obtain external research awards. These included funding seven requests from members to support development of future medium to large proposals. These funds supported travel for collaborative proposal development, analysis of preliminary samples and satellite imagery to develop proof-of-concept information for proposals and support for field infrastructure to be used in multiple future projects. In addition, the ESC is developing: 1) a pilot pre-submission proposal review program, to ensure members submit the highest quality proposals examining novel research themes; 2) means of providing support for pre and post award support for large grant development; and 3) the ability to to support release time for the ESC members to work on large proposal development.

The ESC also supports research through equipment purchases. During the past year this included the ESC's REF-IE proposal, led by Molly Cavaleri, for a LI-6800 portable photosynthesis system and providing cost share for a REF-IE proposal by Cory McDonald (CEE) and Evan Kane (CFRES/ESC) for a high sensitivity DOC analyzer. ESC members also led a successful NSF MRI proposal for a new Isotope Ratio Mass Spectrometer, to be housed in the Microanalytical Shared Facility. The availability of this equipment will aid existing research projects and allow ESC members to propose new avenues of research.

External research funds obtained by ESC members currently help support their more than 50 graduate students. The combined efforts of our members and their students resulted in 88 peer-reviewed publications from July 2019 to June 2020. The ESC has directly enhanced graduate and undergraduate education and training by funding: 1) $17,450 in new ESC research grants to 20 students (16 graduate, 4 undergraduate) to either expand their existing research projects or perform new additional research; and 2) $9,000 in ESC travel grants for 12 students to present research results at national and international scientific conferences. In addition, the ESC has supported the Distinguished Ecologist Lecture Series, which gives our graduate and undergraduate students opportunities to discuss their research with internationally renowned experts.

ESC Financial Summary

Awards and Expenditures

In FY20, the ESC had a successful year in terms of research awards (Table 1). For FY20, the ESC amount of $4,627,728 ranked fifth among Michigan Tech's nineteen centers and institutes, trailing only APSRC, GLRC, KRC, and MTRI. ESC expenditures of $3,782,119 (Table 1) ranked fifth, trailing APSRC, GLRC, KRC and MTRI, all of which are Tier I centers.

At the time of this report, the ESC had approximately 198 active awards, with a total award value of more than $15 million. These awards came from a variety of federal, industrial, public and private sources (Table 2).

Table 1. ESC awards, projects and expenditures from FY14 through FY20.

	Number of Awards	Amount Awarded	Number of Projects	Expenditures
FY14	88	$3,095,545	189	$3,543,913
FY15	104	$3,740,245	193	$3,072,743
FY16	89	$3,279,250	187	$3,274,666
FY17	85	$5,667,434	224	$3,760,110
FY18	67	$3,550,733	182	$3,814,755
FY19	92	$3,070,691	185	$3,875,273
FY20	88	$4,627,728	160	$3,782,119

Table 2. Sponsors of ESC awards that were active as of November, 2020. The awards had a total remaining balance of $7,411,719.

Sponsor Name/Type	Award Value ($)	Remaining Funds ($)
USDA (includes Forest Service)	$6,938,255	$3,085,234
Industry (primarily wood protection group)	$3,191,773	$1,752,153
National Science Foundation	$2,690,505	$1,388,141
National Park Service	$887,888	$220,992
US Fish and Wildlife Service	$488,424	$379,546
Sub-awards from other universities (mostly federal pass-thru)	$394,791	$121,118
US Department of Energy	$314,394	$211,669
Foundations/Trusts	$274,990	$184,443
Other and Internal	$98,797	$15,884
State of Michigan	$93,000	$52,539
Total	**$15,372,817**	**$7,411,719**

Thirty ESC members served as PI on an award run through the ESC, but only 21 were PIs on awards generating IRAD income for the ESC. Nine members were PIs on awards that did not have F&A costs. In the future, we hope to further increase the number of members generating IRAD for the ESC as a PI. From FY19 to FY20, this number did increase from 17 to 21.

Use of IRAD Funds

Institutional Research and Development (IRAD) funds generated by the ESC are distributed according to University guidelines, with 18% given to the ESC, 10% to each award's PI, 9% each to the college and department of the lead PI (or 18% to the lead PI's College), and 4% to support shared facilities. During FY20, the ESC IRAD expenditures were used as follows: 11.8% to support student development through travel grants, research grants and the ESC Student Research Forum; 21.1% for staff support; 30.1% for equipment purchase or repair; 5.1% for collaboration building activities, including ESC Friday coffee and funding speakers for the Distinguished Ecologist Lecture Series; 0.3% for supplies; and 31.4% for funding requests from ESC members (Table 3). These funds supported travel to develop collaborations, certification of testing equipment used in multiple grants by the wood protection group, costs of sample analyses and data acquisition to be used as preliminary findings in support of proposals in development, and funds to help establish an oak provenance study to be used in several large proposals.

The ESC is in sound financial condition. As of June 30, 2020, the ESC IRAD account (E35288) balance was $75,159 (Table 3). This positive balance is the result of several years of reduced expenditures on equipment and member funding requests, combined with increasing IRAD income in recent years. The positive balance will enable us to support more expensive equipment purchases, to co-fund a staff member for proposal development and post-award administration, and to regularly support member requests for travel to form collaborations and costs associated with the generation of preliminary data needed to develop large, complex proposals.

Table 3. ESC expenses, income and IRAD account (E35288) balances from FY16 to FY20.

	FY16	FY17	FY18	FY19	FY20
Expenditures					
S&W & Fringes	$21,337	$12,565	$11,606	$16,958	$18,801
Supplies & Fees	$331	$252	$3,262	$5,176	$332
Equipment	$16,750	$13,400	$7,671	$6,307	$26,850
Student Support*^	$16,602	$27,716	$18,777	$34,420	$10,550
Collaboration Building**	$5,763	$5,455	$4,703	$5,932	$4,582
PI requests	$7,814	$41,810	$24,601	$8,346	$28,031
Total	**$68,597**	**$101,198**	**$70,619**	**$77,138**	**$89,146**
Income					
Incentive Transfers	$61,397	$92,157	$92,020	$92,369	$90,161
Other Transfers In	$10,733	$10,935	$4,962	$10,056	$0
Total	**$72,131**	**$103,092**	**$96,982**	**$102,425**	**$90,161**
Carry Forward	**$17,067**	**$20,600**	**$22,495**	**$48,858**	**$74,144**
Year End Balance[1]	**$20,600**	**$22,495**	**$48,858**	**$74,144**	**$75,159**

[1]Year End Balance excludes encumbrances at year end
**Student support includes student travel awards, research awards, and Research Forum*
***Collaboration Building includes DELS, ESC coffee, meetings*
^Student support does not include $11,000 in student research awards from spring 2020 that were funded in FY21

Progress toward FY22 Goals

Activity 1: *Fostering quality ecosystem science through the acquisition of extramural grants and contracts.*

Goal 1.1. Increase funding from extramural grants and the IRAD return generated.

Evaluation Criteria. The ESC will increase the value of annual research awards by approximately 30% and F&A funds generated by 40% during the renewal period, relative to the values for FY17. Thus, the targets will be $7,350,000 for grants awarded and $685,000 in F&A generation by the ESC by the end of the renewal period. The ESC also will implement a pre-submission review program that is voluntary for smaller submissions and mandatory for larger submissions. Finally, ESC will fund staff to support proposal development, with approximately 20% of ESC funds devoted to this effort during the renewal period.

Progress. ESC awards increased to $4,627,728 in FY20. The ESC is on pace for even higher awards in FY21, with awards through late-November 2020 at $4.3 million, compared to $3.1 million and $1.7 million at the same point in FY19 and FY20, respectively.

ESC research expenditures decreased slightly from FY19 to FY20 (Table 1), temporarily halting an increasing trend in F&A generation (Figure 1). A total of $476,101 in F&A funds were generated by ESC expenditures in FY20. Through March, 2020, we were on pace to exceed FY19 F&A, but the shutdown of many research activities due to the COVID-19 pandemic caused fourth quarter FY20 expenditures and F&A generation to be much lower than would normally occur. The fourth quarter typically has the highest values for these each fiscal year. As research activity has resumed, the first quarter of FY2021 had greater expenditures and F&A generation that the same quarter in FY2021, and ASPIRE projects that up to $770,000 in F&A will be generated in FY21 (Figure 2). We typically achieve about 80 to 85% of the ASPIRE projection, but even that would suggest over $615,000 to $655,000 in F&A. Thus, the ESC appears to be on track to achieve our FY22 goal for F&A generation.

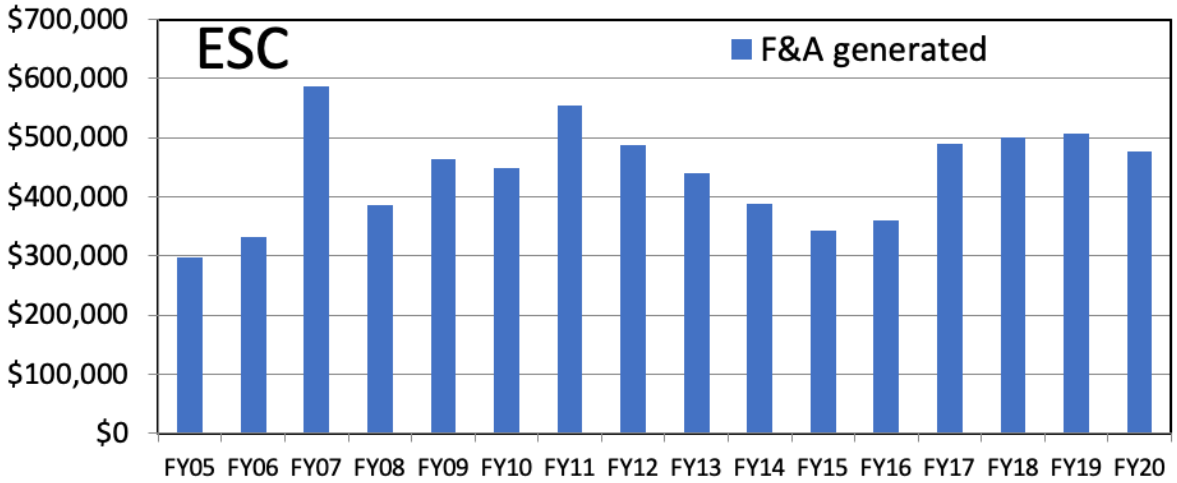
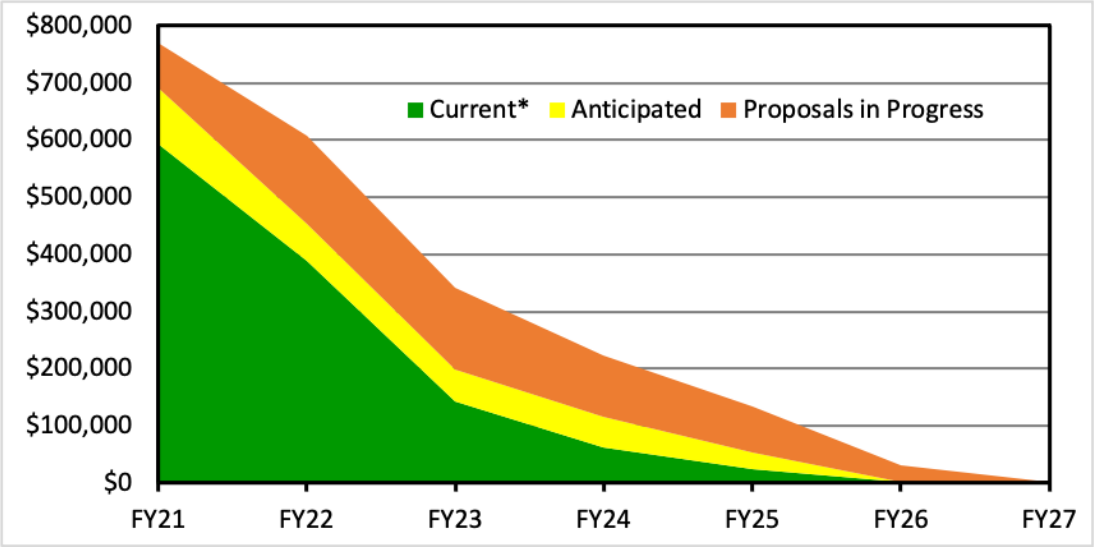


Figure 1. F&A generated by ESC grants from FY05 through FY20.



	FY21	FY22	FY23	FY24	FY25	FY26	FY27
Current	$594,036	$387,710	$142,670	$62,274	$24,648	$787	$0
Anticipated	$98,265	$65,112	$55,158	$54,458	$28,137	$0	$0
Proposals in Progress	$77,546	$153,760	$143,526	$107,159	$80,527	$29,169	$2,359
Total	$769,847	$462,076	$252,972	$118,534	$82,445	$57,453	$8,073

Figure 2. Aspire projections for ESC F&A generation from existing awards, anticipated award increments and proposals in review for FY21 through FY27.

We intended to hire a staff person to support proposal development and post-award administration for large grants during FY20, with the position co-funded by the Tech Forward NRW&E Initiative. The University was unable to fund several Tech Forward initiatives, including NRW&E for FY21, and it is not known what their funding will be for FY22. This, combined with a hiring freeze associated with the COVID-19 pandemic in spring of 2020, has delayed this hiring. Our intent now is to hire a 75% FTE person in the second half of FY21 using ESC funds. Our current budget surplus will enable us to do this and to continue funding such a person for several years. Future co-funding from NRW&E would enable us to increase the person's percent effort and give us additional time before ESC IRAD generation has to increase to the point that the position can be entirely funded by the ESC. In FY21, we anticipate devoting up to $31,500 for the person's salary and fringe, equivalent to about 28% of our anticipated expenditures for FY21. Our pilot pre-submission review program will be fully developed when this person is on-board, as they will coordinate the activities involved. Director Burton worked with two groups preparing large proposals in FY20, helping coordinate of completion of all required documents from multiple investigators and the preparation of data and project management plans, equipment and other resources descriptions and budgets and budget justifications.

Goal 1.2. Seek and obtain large, high-value, competitive grants that require the interdisciplinary teams and capabilities that a center can provide.

Evaluation Criteria. During the next five years the ESC will identify two to three large interdisciplinary grant topics and funding agencies and submit at least one proposal for each. To aid proposal development, the ESC will work with the lead investigators' home academic units to reduce that persons teaching and service load, including funding a portion of that person's effort if needed.

The ESC will also continue collaborating with other centers and institutes on campus to obtain such grants, as has been done successfully with SFI, GLRC and MITRI.

Progress. In FY19, ESC members submitted two large proposals (circa $1.6 million) to the NSF CNH2 program and a $1.3 million proposal as a sub-award on an NSF CZCN proposal. None of these were successful, but their content is leading to additional proposal efforts and the further development of collaborations with researchers outside of Michigan Tech. Members also continue to collaborate with other centers and institutes at Michigan Tech. In FY20, several ESC members were working on a potentially very large effort (circa $3 to $5 million to Michigan Tech) in collaboration with multiple other universities, but this effort has been temporarily put on hold, as the funding entity postponed the solicitation due date indefinitely during the COVID-19 pandemic. This effort is expected to resume later in FY21 with a potential proposal early in FY22. ESC members now do have the opportunity to request funds to reduce teaching load to work on large proposals, but none have done so to date.

Goal 1.3. Ensure wide participation of ESC members in obtaining grants and generating IRAD and ensure that the ESC is not dependent on a few large grants for generating IRAD needed to sustain the center.

Evaluation Criteria. We will continue the indicators that: 1) no more than four ESC members will generate greater than 10% of ESC IRAD each; and 2) ten or more ESC members will generate at least 3% of ESC IRAD. We also will add two additional criteria: 3) at least 50% of ESC members will generate IRAD in any given year (it was 40% in FY17), and 4) the ESC members will design and implement a research funding mentoring program for junior members during the 2018/2019 academic year.

Progress. Our first two criteria were met in FY20. For criteria three, 41% of ESC members were PIs on F&A generating grants in FY20 (58% were PI on an active award). Mentoring of junior members is still informal, but the Director continues to meet with several such members to gather information on their research interests and experience, as a first step toward formalizing mentoring and enabling ESC staff to help guide members to opportunities.

Activity 2: *Improving educational opportunities.*

Goal 2.1. Seek and obtain extramural funds for graduate and undergraduate education and research, professional training and public outreach and education.

Evaluation. The ESC will investigate the possibility of pursuing an NSF NRT proposal or similar effort with other agencies, as described previously. The ESC will set up formal meetings for interested members with USFS NIACS personnel to improve our working relationship with this important group. ESC members will continue to seek funding for outreach activities, such as those currently conducted in conjunction with NIACS and KISMA. The ESC will also support travel of ESC members to potential international collaborators (such as those in China) to facilitate development of both collaborative research and student training and exchange programs.

Progress. This goal is being somewhat deemphasized during the current five-year renewal, as the ESC's primary efforts will focus on increasing our overall success rate in research proposals and award $ under Activity 1. Increasing sponsored research awards will in turn create funds needed for student education and public outreach. The ESC director met with NIACS in FY19 to discuss collaborations on potential future USDA proposals. Virtually all ESC grants to NIACS-associated members (Leopold, Schmitt, Zermeno and Ontl as PI) directly fund public and professional outreach and education, as do grants to KISMA (Resh as PI). In FY20, the ESC supported travel by Dr. John Vucetich to the United

Kingdom, which led to a successful proposal ($130,000) to the Issachar Fund entitled "Science, religion, and purpose in life as meaning-making systems for coexisting with biodiversity". In addition, a 12-person team from ESC, led by Dr. Chris Webster, sought $500,000 in funding from USDA's Research and Extension Experiences for Undergraduates program, for which the proposal is still pending. The themes in the proposal also could serve as a foundation for NSF REU or NRT proposals.

Activity 3: Promoting Ecosystem Science and Education at Michigan Tech

Goal 3.1. Continue supporting the Distinguished Ecologist Lecture Series (DELS)

Evaluation Criteria. Annual continuation of this existing, successful lecture series for course credit, with participation by at least 15 students per year.

Progress. ESC provided $2,000 to support the DELS speaker series. Five students took the DELS course, but 15 graduate students typically attended the meetings and lunches with the DELS speakers, and 20 to 30 students were among the 50+ persons attending the lectures.

Goal 3.2. Support graduate attendance at national and international scientific meetings.

Evaluation Criteria. The ESC will help support meeting attendance for at least 20 graduate or undergraduate students per year. The ESC will also continue sponsoring the ESC Student Research Forum each spring, where students have a chance to prepare posters and present research to ESC faculty and their peers, gaining important skills that will improve their presentation skills for national/international meetings and position interviews.

Progress. In FY20 the ESC supported the travel of 12 students to present at meetings and conferences. This included 9 travel grants in the fall, but only 3 in the spring, when the COVID-19 pandemic caused many meetings to be postponed or switched to a virtual format. The 16th annual ESC Student Research Forum was not held as scheduled in spring 2020, due to closure of campus buildings during the COVID-19 pandemic.

Goal 3.3. Support internal graduate and undergraduate research grants.

Evaluation. The ESC will spend at least $20,000 per year supporting graduate and undergraduate research grants.

Progress. In FY20, the ESC selected 14 graduate research awards and 4 undergraduate research awards for total funding of $15,700. Due to COVID-19 related delays in students being able to start their summer research, $11,000 of this support will be funded in FY21, rather than FY20. The total amount of funding requested was likely reduced by COVID-19, as several students felt they would be unable to conduct their planned research in 2020 and thus delayed requesting funding to 2021.

Goal 3.4. Obtain multi-user advanced instrumentation to support the research of ESC members and other researchers at Michigan Tech and to enable training of graduate students in state-of-the-art analytical techniques.

Evaluation. The ESC will apply annually for REF-IE funds to obtain equipment needed to support the research of ESC members and to enhance their ability to obtain research funding. We will lead large equipment initiatives (such as NSF MRI) as needed to benefit our members and will annually assess potential future use for our aging Isotope Ratio Mass Spectrometer (IRMS), to determine whether or not it should be replaced. The ESC will help support maintenance and repairs for instruments the ESC helped purchase.

Progress. Dr. Molly Cavaleri led the ESC's successful REF-IE proposal in October 2019 to obtain a LI-COR LI-6800 portable photosynthesis system. The ESC provided $22,350 in cost share for this purchase. In addition, the ESC provided $500 in cost share for an REF-IE request from non-member Cory McDonald for an ultra-low DOC analyzer (ESC member Evan Kane was a co-PI on the proposal). The ESC and Microanalytical shared Facility (MAF) initiated an effort to replace the IRMS through the NSF MRI program. The proposed project was funded for $327,067 plus $140,172 in cost share. The ESC is providing $12,648 of this cost share in FY21. The new IRMS will enable analysis of isotopes of additional elements beyond those 20-year-old IRMS it is replacing can analyze, as well as analysis of isotopes in a wider variety of sample types, greatly expanding the types of ecological questions that can be addressed with stable isotopes and supporting the research thrusts of several newly hired faculty.

Future Plans

The ESC was reauthorized in June of 2018 for a five-year period from January 2018 through December, 2022. During the renewal process, several opportunities to improve the ESC's abilities to achieve its goals and support both the ESC and Michigan Tech visions were identified. As described above, we have made continuing progress toward our goals in FY20. Going forward, the Director will continue efforts to:

1. Fully develop and institute mentoring programs for early and mid-career members;
2. Identify very large, collaborative proposal topics and funding sources;
3. Institute a successful pre-submission proposal review program; and
4. Work with existing and new ESC staff and directly with PIs to provide proposal development support to ESC members.

As the ESC refocuses its efforts, we will continue adjusting our spending priorities to help achieve our goals. Relative to our initial spending goals for the renewal period (Table 4), we will likely spend a greater proportion on staff salary and PI requests and less on release time, in order to optimize our ability to help members prepare successful proposals. FY2020 values for some categories are lower than normal, due to impacts of COVID-19 on student support activities (no Research Forum, less travel, fewer/delayed research grants). Spending priorities include:

1. Funding a portion of the Director's annual salary to support efforts described above.
2. Increasing funds allocated to staff as new and/or retrained staff begin supporting proposal development and post-award project management for large proposals.
3. Funding member requests likely to lead to successful proposals, such as preliminary data generation, travel for collaborative proposal development, help in purchasing needed equipment and repair/refurbishment of existing essential research capabilities.
4. Funding release time from teaching for ESC members who are developing and preparing large ($1 to $10 million), collaborative proposals (lower priority).

Table 4. Comparison of renewal goals and recent allocation of ESC IRAD expenditures.

	FY18-22 goal $	FY18-22 goal %	FY22 goal $	FY22 goal %	FY20 $	FY20 %	FY21 (proj) $	FY21 (proj) %
S&W & Fringes[1]	$32,000	29.5	$36,000	29.2	$18,801	21.1	$49,500	43.7
Supplies	$1,500	1.4	$1,500	1.2	$332	0.4	$1,500	1.3
Equipment	$15,000	13.8	$22,800	18.5	$26,850	30.1	$12,648	11.2
Student Support*	$26,000	24.0	$30,000	24.3	$10,550	11.8	$26,000	23.0
Collaboration Building**	$6,000	5.5	$6,000	4.9	$4,582	5.1	$3,500	3.1
Member requests[2]	$20,000	18.4	$15,000	12.2	$28,031	31.4	$20,000	17.7
Release time	$8,000	7.4	$12,000	9.7	$0	0.0	$0	0.0
Total	$108,500	100.0	$123,300	100.0	$89,146	100.0	$113,148	100.0

1Increases over time to fund Director and staff to support proposal development/project management.
2Funds will be used largely for preliminary data generation & travel for collaborative proposal development
**Student travel and research awards, Research Forum, increase is based on increasing student numbers*
***DELS, ESC coffee, meetings*

ESC members 2019-2020 academic year

During the 2019-2020 academic year, ESC participants included 58 members from 5 academic units, including 29 T/TT faculty, 9 research professors, 13 research staff of various ranks, 4 US Forest Service scientists, and 3 academic unit and university administrators. Andrew J. Burton, Professor and Associate Dean, CFRES, serves as Director of the ESC, under a four-year term that commenced on January 1, 2017. Patricia Burton serves as the ESC staff assistant in charge of accounting. In addition to the members listed below, there are over 60 graduate student members, who were advisees of ESC members during the 2019-2020 academic year.

New members joining during 2019-2020 included Drs. Mickey Jarvi, Carsten Külheim, Colin Tucker and Tristy Vick-Majors. Several ESC members left during the academic year, including Dr. Alex Mayer and Paula Zermeno, who left Michigan Tech for positions at other institutions, and Drs. Peter Laks and Dana Richter, who have retired. As a result, the ESC had only 54 members at the end of FY20.

Name	Rank/Academic Unit	Areas of Expertise
Tara Bal	Research Assistant Professor, CFRES	Forest Health Management and Monitoring, Earthworm Invasion Ecology, Wood Decay Testing, Insect, Fungi, and Environmental Education, Wild Foods
Kristin Brzeski	Assistant Professor, CFRES	Conservation genetics, Canid genomics, Noninvasive methods in wildlife management, Wildlife immuno- & epi- genetics, Applied conservation in Central Africa
Andrew Burton	Director, Ecosystem Science Center, Professor/Associate Dean, CFRES	Forest responses to global change factors, Below ground processes, Carbon and nutrient cycling, Physiological ecology of tree roots, Undergraduate involvement in research
Patricia Burton	ESC Financial Manager	Accounting and ESC student grant administration
Angie Carter	Assistant Professor, Social Sciences	Environmental sociology, Rural sociology, Community-based and participatory research, Social movements and social change
Molly Cavaleri	Associate Professor, CFRES	Forest canopy structure and function, Forest response to global change, Carbon and water cycling through forests, Tree ecophysiology, Stable isotope ecology, Invasive tree species
Rod Chimner	Professor, CFRES	Peatland and wetland restoration, Peatland and wetland carbon cycling, Mountain wetlands, Tropical peatlands, Ecosystem carbon cycling, Wetland ecohydrology
Yvette Dickinson	Assistant Professor, CFRES	Applied forest ecology and silviculture, Stand- and landscape-scale forest structure, Forest restoration
Paul Doskey	Professor, CFRES	Environmental Biogeochemistry, Biogeochemistry of Surface-Atmosphere Exchange, Atmospheric Organic Chemistry, Environmental Analytical Chemistry
Jennifer Eikenberry	Assistant Research Scientist, CFRES	Stable isotopes, Forest ecology, Mass spectrometry

Name	Rank/Academic Unit	Areas of Expertise
David Flaspohler	Professor, CFRES	Conservation biology, Avian ecology and reproduction, Cascading effects of deer overbrowse, Island ecology
Robert Froese	Associate Professor, CFRES Director, Ford Center and Forest	Forest inventory, mensuration, and biometrics; Silviculture, quantitative silviculture, and growth & yield; Empirical, process and hybrid forest modelling; Biomass and carbon inventory, management, and life cycle assessment
Kathleen Halvorsen	Associate Vice President for Research Development Professor Social Sciences/CFRES	Woody bioenergy, Climate change, Natural resource policy, Biodiversity policy, Bioenergy policy
Erika Hersch-Green	Associate Professor, Biological Sciences	Plant evolutionary ecology, Ecological genetics, Eco-evolutionary dynamics
Kathryn Hofmeister	Post-doctoral Research Fellow, CFRES	Watershed hydrology and biogeochemistry, Forest and wetland hydrology, Geographic Information Systems (GIS), Science outreach and communication
Casey Huckins	Professor, Biological Sciences	Ecology of lakes, streams, and riparian interface with terrestrial systems, Fish ecology, biology, functional morphology, Effects of land use on ecological systems, Biomonitoring for research and restoration, Effects of invasive species
Mike Hyslop	Principal Lecturer, CFRES; Master of GIS Program Director	Geographic information systems, Cartography, Global positioning systems, Great Lakes Quaternary (glacial) geomorphology
Maria Janowiak	NIACS Deputy Director, USFS Northern Research Station	Translating science related to climate change and carbon into usable information, resources, and tools for forestry and conservation professionals
Mickey Jarvi	Lecturer, CFRES	Forest ecology, Use of multispectral and hyperspectral imagery attached to unmanned aerial vehicles investigate forestry and natural resource issues
Chandrashekhar Joshi	Department Chair and Professor, Biological Sciences	Cellulose and lignin biosynthesis in trees, Wood formation, Tree growth and development, Engineering trees, Forest bioinformatics
Martin Jurgensen	Research Professor, CFRES	Forest soil productivity, management and sustainability, Global climate change impact on soil biology, Organic matter decomposition and ecosystem nutrient cycling
Evan Kane	Associate Professor, CFRES	Soil carbon, Plant/soil relationships, Decomposition, Dissolved organic carbon, Wildfire, Black carbon
Matthew Kelly	Assistant Professor, CFRES	Forest operations, Forest and natural resource management, Human dimensions of natural resources, Watershed management, Natural resources policy

Name	Rank/Academic Unit	Areas of Expertise
Carsten Külheim	Associate Professor, CFRES	Genetic basis of trait variation, Plant adaptation to local environment, Plant secondary metabolism, Functional genomics of plant defenses
Peter Laks	Research Professor, CFRES	Fungal and insect resistance of wood-based composites, Preservative systems for solid and composite wood products. Field-testing of wood products for biodegradation resistance
Nancy Langston	Professor, Social Sciences	Toxics, forested watersheds, and northern lakes, Environmental history, Watershed change and water quality, Mining history
Glenn Larkin	Senior Research Scientist I, CFRES	Wood protection and composites, Forest natural products
Patricia Leopold	Research Scientist I, CFRES Climate Change Outreach Specialist, NIACS	Ecosystem response to climate change, Climate change adaptation and management strategies, Outreach and technical transfer of climate change tools and resources
Erik Lilleskov	Research Ecologist and Director's Representative, USFS Northern Research Station Adjunct Professor, CFRES	Forest ecology, Ecosystems ecology, Physiological ecology, Community ecology, Fungal ecology, Mycorrhizal fungi, Molecular ecology, Soil ecology, Global environmental change impacts on forest ecosystems, Invasive species impacts, Biogeography of invasive soil organisms
Fengjing Liu	Associate Professor, CFRES	Ecohydrology in forests, Watershed hydrology in montane and lake-dominated catchments, Biogeochemistry in snow-dominated, agricultural and forested catchments, Numerical modeling in watershed hydrology, Forensic hydrology with natural geochemical and isotopic tracers
Ann Maclean	Professor, CFRES	Remote sensing, Digital image processing, Geographic information systems, Spatial modeling
Carol Maclennan	Research Professor, Social Sciences	Environmental anthropology/political ecology, Anthropology of industry (mining, sugar), Hawai`i and the Pacific, Anthropology of public policy
Amy Marcarelli	Associate Professor, Biological Sciences	Limnology, Ecosystem ecology of streams and rivers, Biogeochemistry
Alex Mayer	Professor, Civil and Environmental Engineering/ Geological and Mining Engineering and Sciences	Numerical and experimental investigations of contaminant transport in groundwater vadose zones, Mathematical optimization of groundwater remediation systems, Surfactant-enhanced dissolution of nonaqueous phase liquids in subsurface systems
Audrey Mayer	Associate Professor, CFRES	Landscape ecology, Conservation biology, Environmental and natural resources policy, Sustainability science
Todd Ontl	USDA Northern Forests Climate Adaptation Specialist, NIACS	Understanding the motivations for and implementation of climate adaptation actions on forests across the Midwest and Northeast region

Name	Rank/Academic Unit	Areas of Expertise
Judith Perlinger	Professor, Civil and Environmental Engineering	Air and water quality, Atmosphere-biosphere exchange of chemicals, Micrometeorology, Environmental analytical chemistry, Sustainability
Rolf Peterson	Research Professor, CFRES	Mammalian ecology, Predator-prey relationships, Ecology and behavior of gray wolves
Sigrid Resh	Research Assistant Professor, CFRES Coordinator, Keweenaw Invasive Species Management Area	Forest carbon dynamics, Soil sustainability, Invasive species education/outreach, control, and research
Dana Richter	Research Scientist II, CFRES	Forest mycology, pathology, fungal ecology; Tree and forest disease diagnosis and assessment; Wood decay: mold/stain testing; Fungal isolation & identification
Mark Rudnicki	Professor of Practice, CFRES	Forest Biomaterials, Tree biomechanics, Wind and trees, Dendrochronology, Extension and Outreach
Kristen Schmitt	Research Scientist I, Climate Change Outreach Specialist, NIACS	Ecosystem response to climate change, Climate change adaptation in natural resource management, Science synthesis and communication
Terry Sharik	Research Professor, CFRES	Academic leadership in natural resources, Educational reform in natural resources, Trends in natural resource enrollments, Regeneration ecology of forests
Andrew Storer	Dean and Professor, CFRES	Forest insect ecology, Insect/fungus/plant interactions in forest ecosystems, Impacts of exotic species on forest ecosystems, Interactions among fire, insects and disease in forests, Urban forest health
Christopher Swanston	Research Ecologist USFS and Director, Northern Institute of Applied Climate Science (NIACS) Adjunct Professor, CFRES	Soil organic carbon stabilization and cycling, Radiocarbon analysis and interpretation, Forest response and adaptation to climate change, Landscape scale conservation
Stephen Techtmann	Assistant Professor, Biological Sciences	Environmental microbiology, Next-generation sequencing technology and bioinformatics, Microbial physiology and biochemistry, Microbes as sensors for the environmental impacts of oil and gas production, Microbial-mediated remediation of crude oil contamination
Colin Tucker	Ecologist/Lab manager, USFS Northern Research Station	Analysis of environmental samples for understanding carbon cycling and potential impacts of climate change on ecosystems

Name	Rank/Academic Unit	Areas of Expertise
Noel Urban	Professor, Civil and Environmental Engineering	Environmental cycles of major and trace elements, Sediment diagenesis and stratigraphy, Chemistry of natural organic matter, Wetland biogeochemistry, Environmental impact and fate of pollutants, Influence of organisms on the chemical environment, Role of chemical environment in controlling populations
Trista Vick-Majors	Assistant Professor, Biological Sciences	Microbial ecologist who studies the reciprocal relationships between microbial communities and biogeochemical processes in aquatic ecosystem
Ken Vrana	Director, Isle Royale Institute	Wildland experiential outreach
John Vucetich	Professor, CFRES	Demographic and genetic elements of population biology, Ecology of wolves and moose, Environmental ethics
Leah Vucetich	Research Assistant Professor, CFRES	Isle Royale wolf genetics, Field research methods
Christopher Webster	Professor, CFRES	Gap dynamics and disturbance ecology, Invasion biology of exotic species, Landscape ecology, Plant community response to herbivory, Restoration silviculture, Wildlife habitat relationships
Hairong Wei	Professor, CFRES	Identification of genes regulating complex traits via systems biology approaches, Gene expression data analysis, Gene network construction and decomposition, Developing software for mining large-scale biological data, Genomics of wood formation
Richelle Winkler	Associate Professor, Social Sciences	Rural sociology, Population and environment, Environmental sociology, Community engaged scholarship, Internal migration, GIS and spatial analysis
Jared Wolfe	Research Assistant Professor, CFRES	Wildlife conservation in working landscapes, Temperate and tropical avian ecology, Demographic modeling, Avian molts and plumage
Xinfeng Xie	Assistant Professor, CFRES	Carbon materials derived from wood, lignin, and cellulose; Integrated thermochemical conversion and fractionation of lignocellulosic biomass; Carbon-polymer composites and hybrid materials; Wood protection and preservation; Wood properties, quality, and modification
Paula Zermeño	Research Scientist, CFRES Manager, Carbon, Water and Soils Research Lab, USFS	Preparing environmental samples for radiocarbon analysis, as a component of the Radiocarbon Collaborative

ESC Major Research Thrusts

ESC members have been able to develop a number of research thrusts that involve multiple collaborators within and outside Michigan Tech (Table 5). These research areas have typically been developed by mid-career investigators, and have been able to regularly obtain medium to large grants that have helped create steady to increasing research funding for the ESC, with each generating $1 million or more in awards during the past several years, and all receiving additional funds in FY19 and/or FY20. None of these research thrusts have been funded by the single very large interdisciplinary grants of the type envisioned in our evaluation criteria (one to several million-dollar grants).

Several younger investigators have started building programs as well, such as ***Kristin Brzeski***, who received a $318,024 grant from the US Fish and Wildlife Service entitled "Rediscovering Red Wolf Ancestry in the Southeastern United States" in June 2020 and several smaller grants ($56,538 total) on related topics. In February, 2020, ***Erika Hersch-Green*** received an NSF Career award with a total potential five-year value of $1,127,287, entitled "CAREER: Can material costs contribute to the structuring of biodiversity patterns from genomes and transcriptomes to multispecies communities?".

The following are examples of recent large and/or collaborative research thrust led by ESC members. As the ESC members have developed their research areas, they have been able to obtain multiple supporting grants, including funds from agencies (NSF, NASA, DOE) with high F&A rates (26 to 55%). Other agencies and institutions collaborating with the Michigan Tech investigators are indicated, but funding shown is only that awarded to Michigan Tech.

Research Thrust: Black Ash Wetlands

Principal Investigator(s): F. Liu, A. Storer, and J. Wagenbrenner (with USFS collaborators)

Sponsor	Amount	Duration	Title
USFS	$463,439	9/14- 9/19	Future of Black Ash Wetlands
USFS	$432,987	9/17-9/20	Black Ash Wetland Ecosystem Processes
USFS	$141,322	3/11-9/15	Future of Black Ash Wetlands in the Northern Great Lakes Region (only Yr 4 increment from 2013 is shown)

Planting candidate replacement species in a black ash wetland to assess options for dealing with emerald ash borer invasion.

Research Thrust: TRACE (Puerto Rico warming project)

Principal Investigator(s): M. Cavaleri (with USFS, USGS and DOE collaborators)

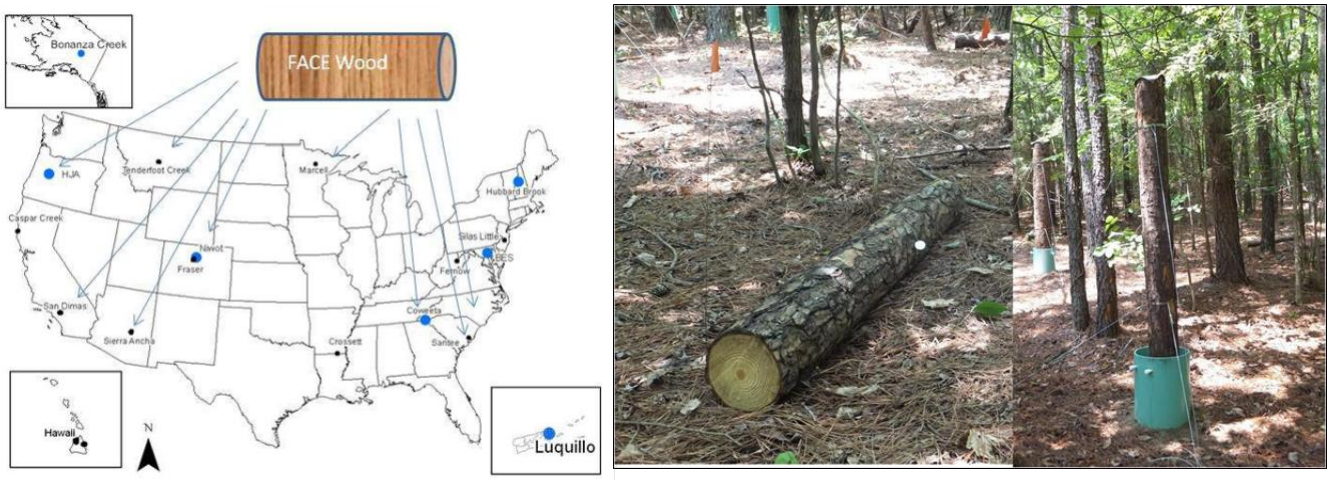
Sponsor	Amount	Duration	Title
USFS	$110,359	8/13-8/17	Temperature Sensitivity of Photosynthesis in a Puerto Rican Wet Tropical Forest; Investigating variation with Tree Age and within-crown Environmental Gradients
USGS	$28,895	1/14-4/15	Integrating Modeling and Empirical Approaches to Improve Predictions of Tropical Forest Responses to Global Warming
DOE	$776,935	7/14-6/18	Effects of warming on tropical forest carbon cycling: investigating temperature regulation of key tropical tree and soil processes
DOE	$314,394	9/18-8/21	Effects of hurricane disturbance and increased temperature on carbon cycling and storage of a Puerto Rican forest: a mechanistic investigation of above- and belowground processes
Ciudadanos del Karso (NSF pass-thru)	$98,797	5/19-4/22	Into the Deep: Temperature effects on coupled biogeochemical cycles in deep soil\profiles of a wet tropical forest

TRACE (Tropical Tropical Responses to Altered Climate Experiment) project principal investigator, Tana Wood takes preliminary leaf temperature data from a canopy access tower in Puerto Rico (Photo by Molly Cavaleri).

Research Thrust: Decomposition Studies and C cycle modeling

Principal Investigator(s): A. Burton, M. Jurgensen, S. Resh, A. Storer, Z. Dai (w/ USFS, U Minnesota, and U Georgia collaborators)

Sponsor	Amount	Duration	Title
USFS-DOE pass through	$219,896	8/16-6/19	Wood Decomposition: Understanding Processes Regulating Carbon Transfer to Soil Carbon Pools Using FACE Wood at Multiple Scales
USFS	$87,877	9/13-12/17	Assessment of the Microbiome During Early Stages of Wood Decomposition
DOE	$149,397	9/11-8/14	Interactive effects of climate change and decomposer communities on the stabilization of wood-derived carbon in soils: Catalyst for a new study
NSF	$710,776	1/19-12/21	Collaborative Research: Impact of microbial and termite communities on transfer of decaying wood C to stable and protected mineral soil C pools
USFS	$199,410	2/19-5/21	Application of MCAT in Estimating Total Ecosystem Carbon in Blue Carbon Ecosystems

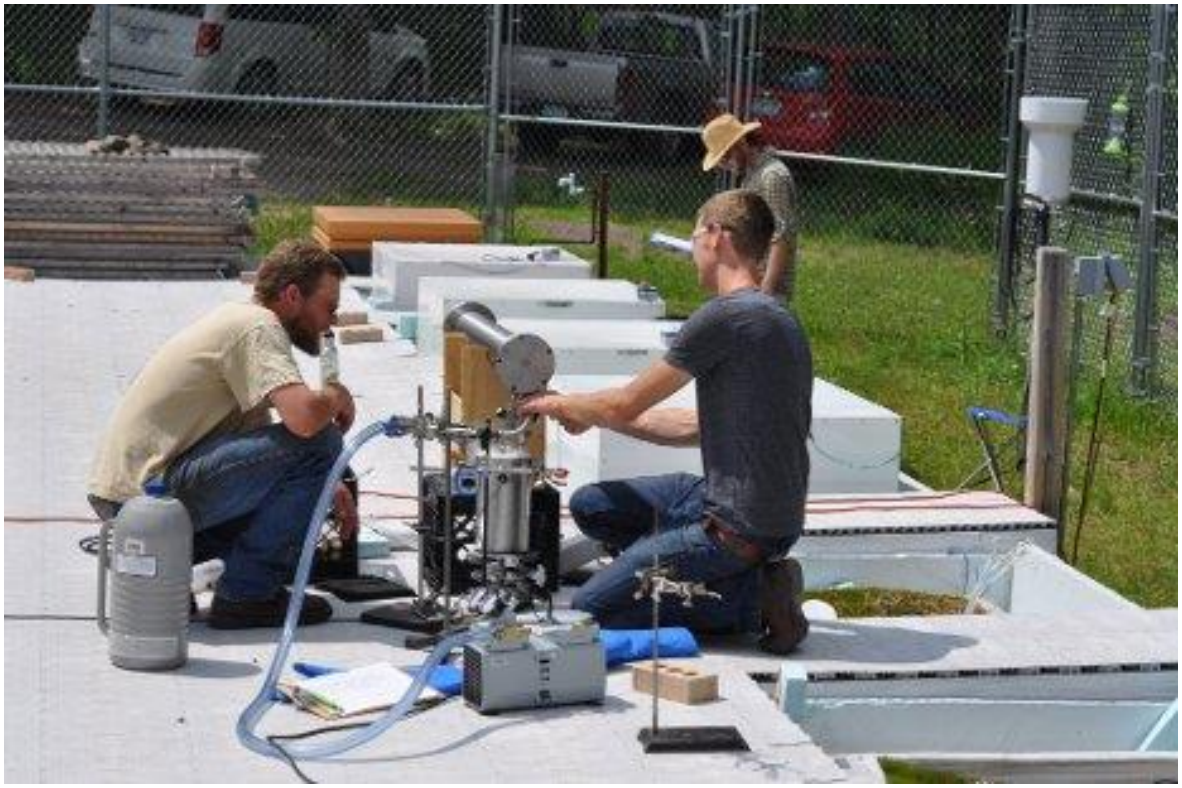


The FACE-Wood Decomposition Experiment (FWDE) is a continental-scale study using isotopically labeled wood, harvested from FACE experiments, to determine the processes governing the movement of carbon from decaying wood into soil carbon pools.

Research Thrust: PEATcosm

Principal Investigator(s): E. Kane, R. Chimner, E. Lilleskov (with USFS and University of Indiana collaborators)

Sponsor	Amount	Duration	Title
NSF	$541,330	5/12-8/16	Collaborative Research: PEATcosm: Understanding the Interactions of Climate, Plant Functional Groups and Carbon Cycling in Peatland Ecosystems
USFS	$598,291	8/12-7/16	Response of Forest and Peatland Ecosystems to Environmental Change
NSF	$283,119	8/14-7/19	Collaborative Research: Long-term Changes in Peatland C Fluxes and the Interactive Roles of Soil Climate, Vegetation, and Redox Supply in Governing Anaerobic Microbial Activity
USFS	$424,909	6/17-5/22	Response of forest and peatland ecosystems to environmental change: a continuation
USFS	$76,073	6/17-5/21	Peat accumulation rates in Lake States forested wetlands



In 2018, a second-generation peatcosm experiment, “TreePeat”, began manipulating intact peat monoliths with trees to examine potential impacts of community composition and climate-induced water table changes on peatland carbon cycling and greenhouse gas emissions.

Research Thrust: Forest Climate Change Assessment, Adaptation and Outreach

Principal Investigator(s): P. Leopold, K. Schmitt, T. Ontl (with USFS NIACS collaborators including ESC members C. Swanston & M. Janowiak)

Sponsor	Amount	Duration	Title
USFS	$88,186	5/15-4/20	Climate change science assessment, synthesis, and science delivery
USFS	$250,800	6/15-5/20	Forest Adaptation to Climate Change: Science, Planning, and Implementation
USFS	$400,000	6/17-4/22	Climate Change, Forests, and Water: Adaptation Resources, Tools, and Demonstrations
USFS	$45,000	6/17-9/18	Web Development for the USDA Climate Hubs
USFS	$448,660	5/15-4/20	Science Delivery for Climate Change and Ecosystem Management
USFS	$110,000	6/16-6/21	Support of the USDA Northern Forest Climate Hub
USFS	$214,750	6/16-6/22	Web Development for Climate Change Science Delivery
USFS	$138,152	6/17-5/22	Responding to Climate Change Risks: Services for the USDA Northern Forests Climate Hub
USFS	$261,682	3/18-9/19	Adapting Forested Watersheds to Ecosystem and Climate Stressors
USFS	$292,000	6/18-6/20	Climate Change Resource Center Development and Support
USFS	$45,000	11/18-12/19	Land and Climate Program Implementation Midwest Region
USFS	$104,000	5/19-5/24	Ecosystem Adaptation in the Great Lakes Region
USFS	$224,500	7/19-6/23	Web Development for the Climate Change Resource Center
USFS	$95,000	8/19-7/24	Collaborative Adaptation through the Climate Change Response Framework
USFS	$119,271	9/19-8/24	Digital Science Communication
USFS	$125,000	6/20-6/22	Developing a Great Lakes Coastal Climate Adaptation Menu
USFS	$30,000	11/19-10/21	Great Lakes State Climate Change Summaries for Agriculture

Research Thrust: S. American Peatlands

Principal Investigator(s): R. Chimner, S. Resh, E. Lilleskov (with USFS, Colorado State and South American University collaborators)

Sponsor	Amount	Duration	Title
USFS	$758,299	7/13-7/18	Collaboration for Research and Capacity Building in Wetland Carbon Cycling in Tropical Ecosystems
USFS	$278,867	1/17-8/21	Collaboration for Research and Capacity Building in Wetland Carbon Cycling in Tropical Ecosystems
Colorado State (NSF pass thru)	$65,921	8/16-7/21	CNH-RCN: Andes Bofedales and Cattle: The Impacts of Changing Hydrology and Glacial Retreat on Community Livelihoods in Peru's Cordillera Blanca
Univ of Minnesota (DOE pass thru	$117,126	9/19-8/22	Biophysical Processes and Feedback Mechanisms Controlling the Methane Budget of an Amazonian Peatland

Peatlands cover just 3 percent of the Earth's land, but store approximately 30 percent of the Earth's soil carbon. The high-altitude peatlands of Colombia, Ecuador, Peru, and Bolivia do more than act as carbon sinks. They also purify water, cycle nutrients, and provide grazing areas for native camelids. *"No one ever thought these mountains would have this much carbon. They have some of the highest storing capabilities in the world."* R. Chimner.

Research Thrust: Isle Royale and Yellowstone Wolves

Principal Investigator(s): J. Vucetich, R. Peterson

Sponsor	Amount	Duration	Title
NSF	$448,003	3/15-2/20	LTREB: Instability, Contingency, and Global Change in a Terrestrial Food Chain
NPS	$184,629	1/16-12/20	Wolf-Moose Population Monitoring, Isle Royale National Park
NPS	$165,000	9/18-6/21	Wolf moose study collection cataloging and specimen preservation
NSF	$474,003	4/20-3/25	LTREB Renewal: Instability, contingency and global change in a terrestrial food chain

The longest continuous study of any predator-prey system in the world has persisted for more than 50 years on Isle Royale, a remote wilderness island isolated in Lake Superior. The island's wolves and moose, as predator and prey, are linked in a drama that is timeless and historic.

ESC Member Publications for Calendar Year 2019

ESC members (bold) and their students and postdocs (bold italacs) published 88 total refereed journal articles in Web of Science Core Collection.

Aguilar FX, and **Kelly MC**. US family forest management coupling natural and human systems: Role of markets and public policy instruments. LANDSCAPE AND URBAN PLANNING Volume: 188 Pages: 43-53 DOI: 10.1016/j.landurbplan.2019.01.004 Published: AUG 2019

Alian S, **Mayer A**, **Maclean A**, Watkins D, and Mirch A. Spatiotemporal Dimensions of Water Stress Accounting: Incorporating Groundwater-Surface Water Interactions and Ecological Thresholds. ENVIRONMENTAL SCIENCE & TECHNOLOGY Volume: 53 Issue: 5 Pages: 2316-2323 DOI: 10.1021/acs.est.8b04804 Published: MAR 5 2019

Bal TL, and **Sharik TL**. Image Content Analysis of US Natural Resources-Related Professional Society Websites with Respect to Gender and Racial/Ethnic Diversity. JOURNAL OF FORESTRY Volume: 117 Issue: 4 Pages: 360-364 DOI: 10.1093/jofore/fvz023 Published: JUL 2019

Bal TL, and **Sharik TL**. Web Content Analysis of University Forestry and Related Natural Resources Landing Webpages in the United States in Relation to Student and Faculty Diversity. JOURNAL OF FORESTRY Volume: 117 Issue: 4 Pages: 379-397 DOI: 10.1093/jofore/fvz024 Published: JUL 2019

Bales AL, and **Hersch-Green EI**. Effects of soil nitrogen on diploid advantage in fireweed, Chamerion angustifolium (Onagraceae). ECOLOGY AND EVOLUTION Volume: 9 Issue: 3 Pages: 1095-1109 DOI: 10.1002/ece3.4797 Published: FEB 2019

Baziari F, Henquinet KB, and **Cavaleri MA**. Understanding farmers' perceptions and the effects of shea (Vitellaria paradoxa) tree distribution in agroforestry parklands of Upper West Region, Ghana. AGROFORESTRY SYSTEMS Volume: 93 Issue: 2 Pages: 557-570 DOI: 10.1007/s10457-017-0150-1 Published: APR 2019

Boyes KN, Hietala-Henschell KG, Barton AP, **Storer AJ**, and Marshall JM. Linking tree growth rate, damage repair, and susceptibility to a genus-specific pest infestation. JOURNAL OF FORESTRY RESEARCH Volume: 30 Issue: 5 Pages: 1935-1941 DOI: 10.1007/s11676-019-00896-y Published: OCT 2019

Brooks CN, Grimm AG, **Marcarelli AM**, and Dobson RJ. Multiscale collection and analysis of submerged aquatic vegetation spectral profiles for Eurasian watermilfoil detection. JOURNAL OF APPLIED REMOTE SENSING Volume: 13 Issue: 3 Article Number: 037501 DOI: 10.1117/1.JRS.13.037501 Published: AUG 27 2019

Bruskotter JT, **Vucetich JA**, Dietsch A, Slagle KM, Brooks JS, and Nelson MP. Conservationists' moral obligations toward wildlife: Values and identity promote conservation conflict. BIOLOGICAL CONSERVATION Volume: 240 Article Number: 108296 DOI: 10.1016/j.biocon.2019.108296 Published: DEC 2019

Bunce A, Volin JC, Miller DR, Parent J, and **Rudnicki M**. Determinants of tree sway frequency in temperate deciduous forests of the Northeast United States. AGRICULTURAL AND FOREST

METEOROLOGY Volume: 266 Pages: 87-96 DOI: 10.1016/j.agrformet.2018.11.020 Published: MAR 15 2019

Burkett EM, and **Winkler RL**. Recreational fishing participation trends in Upper Great Lakes States: an age-period-cohort analysis. HUMAN DIMENSIONS OF WILDLIFE Volume: 24 Issue: 1 Pages: 95-97 DOI: 10.1080/10871209.2018.1526352 Published: JAN 2 2019

Butler TM, Wilhelm AC, Dwyer AC, Webb PN, Baldwin AL, and **Techtmann SM**. Microbial Community Dynamics During Lake Ice Freezing. SCIENTIFIC REPORTS Volume: 9 Article Number: 6231 DOI: 10.1038/s41598-019-42609-9 Published: APR 17 2019

Campa MF, **Techtmann SM**, Ladd MP, Yan J, Patterson M, Amaral AGD, Carter KE, Ulrich N, Grant CJ, Hettich RL, Lamendella R, and Hazen TC. Surface Water Microbial Community Response to the Biocide 2,2-Dibromo-3-Nitrilopropionamide, Used in Unconventional Oil and Gas Extraction. APPLIED AND ENVIRONMENTAL MICROBIOLOGY Volume: 85 Issue: 21 Article Number: e01336-19 DOI: 10.1128/AEM.01336-19 Published: NOV 2019

Campa MF, Wolfe AK, **Techtmann SM**, Harik AM, and Hazen TC. Unconventional Oil and Gas Energy Systems: An Unidentified Hotspot of Antimicrobial Resistance? FRONTIERS IN MICROBIOLOGY Volume: 10 Article Number: 2392 DOI: 10.3389/fmicb.2019.02392 Published: OCT 18 2019

Carter A, "We Don't Equal Even Just One Man": Gender and Social Control in Conservation Adoption. SOCIETY & NATURAL RESOURCES Volume: 32 Issue: 8 Pages: 893-910 DOI: 10.1080/08941920.2019.1584657 Published: AUG 3 2019

Carter A, Wells BL, and Kruzic A. Social Justice, Corporate Influence, and Development: Defending the Public Interest at a State University. THEORY IN ACTION Volume: 12 Issue: 1 Pages: 54-85 DOI: 10.3798/tia.1937-0237.1902 Published: JAN 2019

Chimner RA, Bourgeau-Chavez LL, Grelik SL, ***Hribljan JA***, Clarke AMP, Polk MH, **Lilleskov EA**, and Fuentealba BD. Mapping Mountain Peatlands and Wet Meadows Using Multi-Date, Multi-Sensor Remote Sensing in the Cordillera Blanca, Peru. WETLANDS Volume: 39 Pages: 1057–1067 DOI: 10.1007/s13157-019-01134-1 Published MAR 2019

Chimner RA, Cooper DJ, Bidwell MD, Culpepper A, Zillich K, and Nydick K. A new method for restoring ditches in peatlands: ditch filling with fiber bales. RESTORATION ECOLOGY Volume: 27 Issue: 1 Pages: 63-69 DOI: 10.1111/rec.12817 Published: JAN 2019

Cladas KL, **Bal TL**, and **Storer AJ**. Is success in detection of Agrilus planipennis related to forest edges? JOURNAL OF APPLIED ENTOMOLOGY Volume: 143 Issue: 3 Pages: 214-224 DOI: 10.1111/jen.12591 Published: APR 2019

Coals P, Burnham D, Johnson PJ, Loveridge A, Macdonald DW, Williams VL, and **Vucetich JA**. Deep Uncertainty, Public Reason, the Conservation of Biodiversity and the Regulation of Markets for Lion Skeletons. SUSTAINABILITY Volume: 11 Issue: 18 Article Number: 5085 DOI: 10.3390/su11185085 Published: SEP 2019

Coble AA, **Marcarelli AM**, and **Kane ES**. Year-round measurements reveal seasonal drivers of nutrient uptake in a snowmelt-driven headwater stream. FRESHWATER SCIENCE Volume: 38 Issue: 1 Pages: 156-169 DOI: 10.1086/701733 Published: MAR 2019

Danhoff BM, and **Huckins CJ**. Modelling submerged fluvial substrates with structure-from-motion photogrammetry. RIVER RESEARCH AND APPLICATIONS Volume: 36 Issue: 1 Pages: 128-137 DOI: 10.1002/rra.3532 Early Access Date: AUG 2019 Published: JAN 2020

DeCandia AL, **Brzeski KE**, Heppenheimer E, Caro CV, Camenisch G, Wandeler P, Driscoll C, and, vonHoldt BM. Urban colonization through multiple genetic lenses: The city-fox phenomenon revisited. ECOLOGY AND EVOLUTION Volume: 9 Issue: 4 Pages: 2046-2060 DOI: 10.1002/ece3.4898 Published: FEB 2019

Demissie F, Yeshitela K, Rouleau M, **Flaspohler D**, and Kindu, M. Socio-economic importance of forest resources and their conservation measures in Ethiopia: the case of area closure in South Gonder of Ethiopia. ENVIRONMENTAL MONITORING AND ASSESSMENT Volume: 191 Issue: 7 Article Number: 437 DOI: 10.1007/s10661-019-7569-y Published: JUL 2019

Deng C, Zhang SG, Lu YC, **Froese RE**, Ming AG, and Li QF. Thinning Effects on the Tree Height-Diameter Allometry of Masson Pine (Pinus massoniana Lamb.). FORESTS Volume: 10 Issue: 12 Article Number: 1129 DOI: 10.3390/f10121129 Published: DEC 2019

Dickinson YL, Battaglia MA, and Asherin LA. Evaluation of the FVS-CR diameter growth model in structurally-heterogeneous ponderosa pine (Pinus ponderosa Douglas ex C. Lawson) stands in the Southern Rockies, and potential modifications. FOREST ECOLOGY AND MANAGEMENT Volume: 448 Pages: 1-10 DOI: 10.1016/j.foreco.2019.05.031 Published: SEP 15 2019

Fang Y, Chen LF, Lin KD, Feng YL, Zhang PY, Pan XC, Sanders J, Wu YF, Wang XE, Su Z, Chen CY, **Wei HR**, and Zhang WL. Characterization of functional relationships of R-loops with gene transcription and epigenetic modifications in rice. GENOME RESEARCH Volume: 29 Issue: 8 Pages: 1287-1297 DOI: 10.1101/gr.246009.118 Published: AUG 2019

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Hedrick PW, Robinson JA, **Peterson RO**, and **Vucetich JA**. Genetics and extinction and the example of Isle Royale wolves. ANIMAL CONSERVATION Volume: 22 Issue: 3 Pages: 302-309 DOI: 10.1111/acv.12479 Published: JUN 2019

Heidari A, **Mayer A**, and Watkins D. Hydrologic impacts and trade-offs associated with forest-based bioenergy development practices in a snow-dominated watershed, Wisconsin, USA. JOURNAL OF HYDROLOGY Volume: 574 Pages: 421-429 DOI: 10.1016/j.jhydrol.2019.04.067 Published: JUL 2019

Herndon EM, Kinsman-Costello L, Duroe KA, Mills J, **Kane ES**, Sebestyen SD, Thompson AA, and Wullschleger SD. Iron (Oxyhydr)Oxides Serve as Phosphate Traps in Tundra and Boreal Peat Soils.

JOURNAL OF GEOPHYSICAL RESEARCH-BIOGEOSCIENCES Volume: 124 Issue: 2 Pages: 227-246 DOI: 10.1029/2018JG004776 Published: FEB 2019

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Hoy SR, MacNulty DR, Smith DW, Stahler DR, Lambin X, **Peterson RO**, Ruprecht JS, and **Vucetich JA**. Fluctuations in age structure and their variable influence on population growth. FUNCTIONAL ECOLOGY Volume: 34 Issue: 1 Pages: 203-216 DOI: 10.1111/1365-2435.13431 Early Access Date: AUG 2019 Published: JAN 2020

Hupperts SF, **Dickinson YL**, **Webster CR**, and Kern CC. Promoting structural and species diversity in Great Lakes northern hardwoods: a conceptual model and its application. FORESTRY Volume: 92 Issue: 1 Pages: 16-25 DOI: 10.1093/forestry/cpy026 Published: JAN 2019

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Distinguished Ecologist Lecture Series – Fall 2019

Each fall the Distinguished Ecologist Lecture Series (DELS) is co-sponsored by the ESC and the College of Forest Resources and Environmental Science and is a one credit graduate level course. Students read papers, meet the guest ecologists in pre- and post-lecture meetings to review their research and discuss its impact on the field of ecology. Students, faculty and staff from across campus who are interested in Ecosystem Science are invited to attend the seminars and socials.

Dr. Ann Bartuska

V.P. for Land, Water, & Nature of Resources for the Future and the former USDA Deputy Under Secretary for Research, Education, and Economics as well as chief scientist and Deputy Chief of Research & Development at the U.S. Forest Service

Thursday, September 12, “Right place, right time... When it helps to be an ecologist”

Dr. Merritt Turetsky

Associate Professor & Canada Research Chair, University of Guelph.

Thursday, October 3, “Mega-fires, thawing permafrost and loss of ecological legacies in Canada's north”

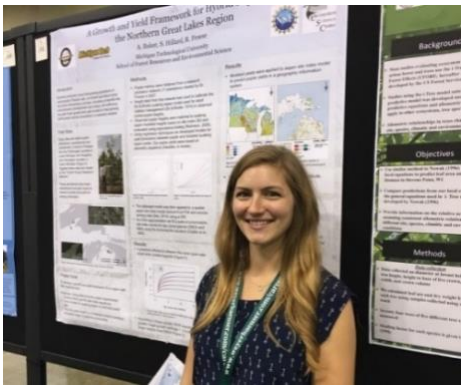
Dr. Diane McKnight

Professor at the University of Colorado Boulder and a Fellow at the Institute of Arctic & Alpine Research and the Association of Environmental Engineering and Science Professors (AEESP) Distinguished Lecturer for 2019-2020.

Wednesday, November 6, “A biogeochemical perspective on the reactivity of dissolved organic matter in natural waters: from Antarctica to the Arctic”

Student Travel Grants 2019–2020

The ESC helped 11 graduate students attend national and international scientific meetings, where they presented their research. This allowed them to receive feedback on their research results and future research ideas and to begin developing a network of scientific colleagues and potential future collaborators. In addition, one graduate student received funding to attend a short course that provided training on techniques and instruments not available at Michigan Tech. Meetings in the spring of 2020 were switched from in-person to virtual, due to the COVID-19 pandemic.



Student	Advisor	To Attend	Location & Date	Amount	Purpose
Tanner Barnes	Kristin Brzeski	Wildlife Soc Natl Conference	Reno NV, Oct 2019	750	Poster
Breanna Gusick	Jared Wolfe	Wildlife Soc Natl Conference	Reno NV, Oct 2019	750	Talk
Andrea Myers	Tara Bal	North Central Pest Workshop	Morton Arboretum, Sep, 2019	750	Talk
Rafia Rahman	Matt Kelly	SAF Annual Convention	Louisville, KY, Nov 2019	750	Talk
Veronica Porter	Fengjing Liu	AGU Fall Meeting	San Francisco, CA, Dec 2019	750	Poster
Joseph Shannon	Fengjing Liu	AGU Fall Meeting	San Francisco, CA, Dec 2019	750	Talk
Cory Burkwald	Fengjing Liu	AGU Fall Meeting	San Francisco, CA, Dec 2019	750	Talk
Bethel Tarekegne	Roman Sidortsov	Inter. Conf. on Energy Research and Social Science	Virtual, Aug 2020	750	Talk
Michelle Kelly	Amy Marcarelli	Fundamentals course at Cary Institute of Ecosystem Studies	Millbrook, NY, Jan 2020	750	Training
Zachary Merrill	Chris Webster	ESA Annual Meeting	Virtual, Aug 2020	750	Talk
Tiffany Degroot	Kristin Brzeski	National Wildlife Society Conference	Virtual, Oct 2020	750	Talk
Samuel Hervey	Kristin Brzeski	National Wildlife Society Conference	Virtual, Oct 2020	750	Talk
Total				$9,000	

Student Research Grants 2019-20

The ESC supported twenty student research grants during the year. To obtain these grants, students submitted proposals for peer review by a panel of ESC members, and if requested, revised their proposal based on panel feedback. These efforts enhanced the students' ability to write concise, well-designed, proposals with high scientific merit. The funds are for additional research beyond the scope of that funded by their advisor. Projects often result in preliminary data for new research thrusts and lead to the development of proposals to funding agencies such as NSF, DOE and USDA.

Student	Level	Research Topic	Advisor(s)	$
Katherine Schneider	undergrad	iDNA tool for sampling small mammal biodiversity	Brzeski & Bal	750
Victoria Peck	undergrad	Comparison of drought stress ecophysiology between mature Quercus rubra and Q ellipsoidalis	Cavaleri & Kulheim	750
Liam Krause	grad	Assessing carbon mass loss in ditched peatlands	Lilleskov & Kane	1000
Samuel Lopes Oliveira	grad	The role of easements in the conservation of wood thrush (Hylocichla mustelina) in Costa Rica	Wolfe	1000
Tony Lammers	grad	Identifying winter range expansion of bird communities in North America	Wolfe	200
Tanner Barnes	grad	Red wolf ancestry in wild canids	Brzeski	1000
Maeve Draper	grad	Evaluating long-term growth and financial yield in Great Lakes northern hardwoods	Froese	1000
Heidi Harmala	grad	Species and age distribution of saplings across multiple silviculture treatments in N hardwoods	Froese	1000
Ian Pope	grad	Single tree detection from LiDAR in boreal forests	Froese	500
Rob Tunison	grad	Heat-shock and temperature acclimation transcriptional responses of a tropical shrub	Cavaleri	1000
Matthew Vander Molen	grad	Comparing drivers of terpene production in Tsuga canadensis	Webster	1000
Cory Burkwald	grad	Seasonal variations in hydrologic pathways	F Liu	750
Angela Walczyk	grad	Effects of whole genome duplication on phenotypic plasticity	Hersch-Green	1000
Joseph Shannon	grad	Changes in hydrologic connectivity following shift from forested to non-forested wetland	F Liu	1000
Lindsey Dolinski	grad	Impacts of native wood decomposing fungi on regrowth of invasive buckthorns	Resh	1000
Seth Finkel	grad	Forest management effects on ruffed grouse densities and sex ratios	Wolfe & Flaspohler	1000
Sam Hervey	grad	Genetic monitoring of the Isle Royale wolves	Brzeski	1000
Madeline Peterson	grad	Enzymatic capabilities and organic soil degradation potential of peatland fungi	Kane & Lilleskov	1000
Rebecca Rooney	undergrad	Intra-crown variation in leaf morphology and anatomy of two species in the genus Quercus	Cavaleri	750
Alayna Merten	undergrad	Exploring the effects of emerald ash borer on C stocks in MI wetlands	F Liu	750
Total				17,450

16th Annual ESC Student Research Forum

The ESC was unable to hold the sixteenth Student Research Forum in April 2020, due to the COVID-19 pandemic. Our hope is to provide a forum in April 2021, even if it needs to be a virtual event.