WATERLOO INSTITUTE
for COMPLEXITY & INNOVATION

2019 ANNUAL REPORT

APRIL 1, 2020

DAWN PARKER, DIRECTOR; VANESSA SCHWEIZER, ASSOCIATE DIRECTOR;
2019 STEERING COMMITTEE MEMBERS: PETER DEADMAN, CHRIS BAUCH,
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INTRODUCTION

Waterloo Institute for Complexity and Innovation (WICI) is a member-led and member-driven organization. We strive to build networks of complex-systems researchers, not just at the University of Waterloo (UW), but across Canada. We also strive to strengthen connections with the global complex systems research community. We welcome diverse complex systems research approaches across disciplines in the sciences, arts, and humanities, striving to connect researchers with common methodological and domain interests.

WICI offerings include talks from a range of speakers, from local experts to world-renowned complex systems scholars. The majority of our talks are recorded and are available on our website. We also sponsor working groups, workshops, and small grants to support research development. We have hosted three specialist conferences on various themes. WICI membership offers an opportunity to increase the visibility of complex systems scholars and build networks for collaborative research, funding applications, scientific commentary, policy analysis, and educational initiatives.

WICI was founded in 2009 and has experienced healthy growth in membership and scope since its inception. WICI received its second Faculty Senate centre approval in 2015, and this year marks WICI's ten-year anniversary. This juncture is an appropriate time to take stock of what we envision for WICI—continue on a path of steady growth under our current mandate and scope, or potentially undergo a regime shift into a new form. Over the last year we have engaged with our membership, other research units, and University administration to explore options for a next-generation vision, identity, and support system for WICI. We have specifically gathered information and feedback in these key areas, identified in last year's report:

- What networks currently exist among WICI members in terms of trans-disciplinary scope, application areas, and methodological interests?
- To what extent are WICI members engaged in, or have the potential to engage in, external partnership research relationships?
- To what extent does WICI currently contribute towards network and capacity building, vs. support research on specific scientific problems? What should WICI's balance of these two activities be moving forward?
- What is the potential for the development of a Canadian Network for Complex Systems, with the University of Waterloo serving as the leading and founding node?

In addition, we have launched two additional scoping activities, each supported by a graduate research assistant:

- How is the published research of complex systems scholars—WICI members, all UW faculty, and Canada as a whole—characterized by output and thematic areas?
- How can WICI direct current and future resources to supporting complex systems education at UW and beyond?

We have also identified current thematic focal areas for WICI (see also the focal areas identified by the CANSEE WICI session "(The) State(s) of Complexity" on page 30):

- Complex coupled human-natural systems;
- Complex health systems;
- Complex risk and uncertainty;
- Complex systems approaches to entrepreneurship and industrial organization;

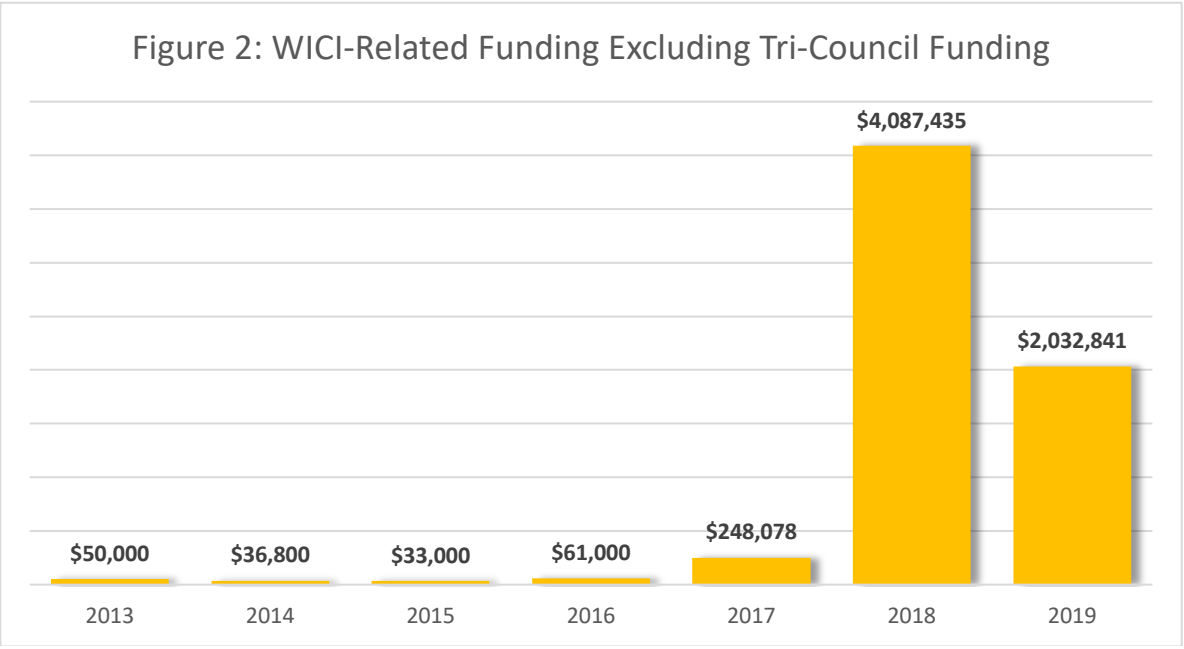
- Modelling cognition and decision-making;
- Multi-scale adaptive management and optimization of complex spatial and network problems;
- Multi-scale decision-making and governance for complex/wicked problems;
- Resilient urban environments;
- Thresholds and tipping points in social and natural systems;
- Visualization and analysis methods for complex data.

This report summarizes key information related to WICI's activities in 2019, with updates on current and planned activities. The 2018-19 Financial Report is included (page 36), as well a current update on our 2019-20 fiscal year budget (page 37). An up-to-date list of current Board, External Scientific Advisory Committee, and Steering Committee members can be found in Appendix A.

A detailed overview of activities, achievements, and plans is contained in the "Progress Toward Strategic Goals" section, starting on page 8.

The external funding awarded to WICI's core members has been included in this report as well. A full list of the awards can be found in the chart beginning on page 17. Note, in particular, the over $6,000,000 from sources other than Tri-council funding in 2018 and 2019:

Figure 2: WICI-Related Funding Excluding Tri-Council Funding



MOVING FORWARD: CENTRE RENEWAL & FUTURE DIRECTION

At the time of this report, WICI has been preliminarily approved for a one-year extension for application for centre renewal (see Extension Request: Proposed Budget and Justifications, Appendix B). The Dean of Environment and the Office of Research have offered some contributions towards operational funding, while additional funds are being sought from other faculties to enable us to continue a modest level of member-supporting activities, as well as our strategic planning. During that time, our goal is to consolidate feedback from the membership, the University of Waterloo, and the complex systems community at large to identify the best strategic direction for WICI over its next five year period.

We are excited by the current directions for interdisciplinary research at University of Waterloo, placing it squarely at the centre of the university's research vision. As a fundamentally interdisciplinary centre, we are confident that we can support this agenda, as demonstrated by our activities and accomplishments over the past decade. However, after ten years as a small, research-networking focused centre, we feel it is time to evaluate a broad range of possible future directions for WICI. Such directions include possible modifications to our current model or a substantive shift in mission and activities. In discussions with WICI members over the last 15 months, we have identified three promising directions for WICI's next stage:

1. **A substantive focus on complex-systems training,** which may include cross-university core courses, a certificate, workshops, and/or summer schools. Members have strongly emphasized that training in the science behind complex systems targeted to students, research staff, and faculty is a missing piece on campus. The Water Institute provides a possible successful interdisciplinary training model for us to emulate. Both internal members and external partners are specifically requesting training in systems thinking, description, and problem identification, as well as complex-systems appropriate methods for program evaluation. Further, new External Core members, affiliated with the emerging Canadian Network for Complex Systems, have expressed an interest in developing pan-Canadian courses as well as rotating summer school programs.

2. **Formal development of a Canadian Network for Complex Systems (CNCS):** We envision a trans-Canada network of geographical and thematic research hubs, which will create research capacity for inter-university (and international) collaboration, responsiveness, and training/employment opportunities for students. Following a summer 2019 CNCS potential member call, strong geographic nodes are developing in Cascade (led by UBC) and Montreal (led by McGill). Western University is developing as an additional node. Our call has also brought in new high-profile non-profit, government, and practitioner WICI members. We anticipate that the development of the CNCS will provide capacity for one or more *New Frontiers Transformations* grant applications in 2021.

3. "**Brand" around complex human-environment interactions:** WICI's thematic research foci are very broad, and we serve all faculties. However, a more specific focus on complex human-environment interactions would encompass the majority of current WICI scientific themes, and would retain our UW complex-systems strength in sustainable socio-ecological systems, environment and health, managing "wicked problems", and health science applications.

We would like to explore these directions and ensure we have a sustainable budget model in place prior to renewal. Specifically, these directions will provide a strong portfolio to secure external funding. To date, our inability to oversee grants and capture overhead has made it challenging for WICI to achieve financial independence. While many WICI members have strong industry partner research portfolios, with complex systems science's strong focus on novel basic science, interdisciplinarity, and high-risk/high-gain research, industry partnership funding opportunities may be lower for WICI than for other university research centres.

Our one-year extension will also allow us to work to ensure that WICI's future directions fit with and further the University of Waterloo's evolving vision for education and research, including the new Strategic Plan, as well as allowing time for new collaborative opportunities that are already emerging to more fully develop.

WICI ADMINISTRATION

Dr. Dawn Parker (School of Planning, University of Waterloo) has continued in her service as Director through April 30th 2020. Dr. Peter Deadman (Geography, University of Waterloo) served as Associate Director from September 2018 through July 2019, at which point Vanessa Schweizer (Knowledge Integration, University of Waterloo) moved into the role.

In 2019, Dr. Madhur Anand, Dr. Chris Bauch and Dr. Peter Deadman stepped down from the committee. Dr. Igor Grossmann joined the committee in July 2019. The Steering Committee currently continues with three active members, with plans to invite two more members in 2020.

Brenda Panasiak continues in the role of WICI Administrative Coordinator until May 2021.

PROGRESS TOWARD STRATEGIC GOALS THROUGH 2021

The following section is a review of our strategic goals from the 2015 annual meeting, our progress toward them, and our areas for continuing development through 2021.

At its 2015 annual meeting, the WICI Board laid out five strategic directions for 2016-2020:

1. **Strengthen core networks**
    a. Continue to actively support current core projects and members through grant writing assistance and complementary activities such as talks, workshops, and working groups.
    b. Look for existing opportunities on campus to expand core membership in the areas of network science, human-environment interactions, expanding conventional economics, complexity and non-rational drivers of behavioural change, Psychological Dynamics of Catastrophic Dehumanization; Rapid Ideological Change/Ideological Conflict; and Embodied Cognition.
    c. Work with faculty units and deans to identify opportunities for new hires whose research has a complex systems focus.
    d. Seek out particular opportunities to establish core WICI members in under-represented faculties (AHS and Science).

    Progress made in 2019:

    - Goal 1a:
        - Core member support: travel grants (8), matching SEED grant for Internal Affiliate member A. Klinkova, matching grant for Core Member D. Parker (1)
        - Other member support: student travel awards (4), other workshop funding for WICI student members (4)
        - Several members presented at WICI talks (1 Core, 3 Students and 1 External Core member, plus another scheduled for March 27)
    - Goal 1b: New Core member (1), New External Core members (4), new Affiliate members (2), new Practitioner members (2), and new Student members (6). Interactions with the Fields Institute continue; collaborations with other research institutes have been strengthened through cross-institute meetings, co-sponsored talks, and research networking sessions.
    - Goal 1c: We are not aware of any new complexity hires on campus in 2019.

- Goal 1d: Core Member Sharon Kirkpatrick joined WICI in 2018, and continues to advance the complex systems work in Health Sciences. Three of the judges for our Complex Systems Student Project Symposium were from AHS. In July 2019, we collaborated with the Faculty of Science to host a research networking session, and we hosted two science-focused complexity talks this year which both saw great turnout and engagement from the science faculty, including the most recent talk from Dr. Kate Adamala, whose visit was co-sponsored with the Waterloo Centre for Microbial Research (WCMR). An award was made to Anna Klinkova in Chemistry, with Core Member status pending.

Areas for continuing development through 2021: Goals 1a, b, and d will be areas of continual development; however, WICI's focus in the coming year will be on institution building with reduced active network building and reduced travel funding.

2. Facilitate interdisciplinary research.

a. Host talks and workshops, striving to maintain a balance between bringing in global leaders in complex systems and highlighting local complex systems scholarship.
b. Support working groups, allowing their focus and scope to evolve with the interests and needs of membership.
c. Offer support for grant development.

Progress made in 2019:

- Goal 2a: The 2019 WICI speakers included a UW faculty member, three UW graduate students, and four high-profile external scholars, including one new WICI External Core Member from UBC and another booked for March 27. WICI also promoted ongoing graduate student seminars in the spring 2019 term, and an internal Systems Design and Engineering Workshop in the fall term.
- Goal 2b: Working groups supported in 2019 were: Open Format Complexity Conversations with Dr. Bill Sutherland (held bi-weekly from May through November 2019), Graduate Student Complexity Seminars (held monthly in spring term 2019), and Complexity Networks and Organizations group organized by an affiliate member in Fall 2019. The School of Architecture has also organized a group and led a WICI-supported Design Symposium at their campus in November 2019. This was a banner year for member-led working groups and initiatives.
- Goal 2c: WICI awarded one SEED grant to A. Klinkova and promised matching funds for D. Parker's Trans-Atlantic Partnership Social Innovation grant (not funded). In 2019, it was agreed that WICI would offer grant development support as needed, if requested. We have offered mentoring, reviewing and editing support, and continue to ask members to suggest what type of support they would like to see. This question was also included in our 2019 member survey which is discussed on page 33.

Areas for continuing development through 2021: WICI is continuing to offer support (mentoring, grant reviewing, and editing) to assist junior/tenure-track members with grant development (goal 2c) as needed through the end of April 2019 (only one person requested support in 2019). Interdisciplinary collaboration will continue to be pursued as WICI continues to connect with other research institutes on campus as well as establish a national network of complex systems researchers (goals 2a-c).

3. **Enhance public engagement.**
    a. Improve WICI's web and social media presence, including the development of web pages for WICI core research projects and a set of introductory "What are complex systems?" materials.
    b. Highlight WICI work through press releases and actively engage the media when opportunities arise.
    c. Offer more public talks in the community.
    d. Continue informal receptions before talks with speakers and attendees.

    Progress made in 2019:

    - Goal 3a:
        - In 2019, the WICI website was updated extensively to improve navigation and access to information. The website (https://uwaterloo.ca/complexity-innovation/) has been averaging over **1,194** visits per month, a 7% increase from 2018;
        - Videos from core members on "What are complex systems?" have been posted on our website and viewed a total of **685** times in 2019 (up from 555 times viewed in 2018);
        - WICI's Twitter feed and Facebook page are being actively maintained. Facebook events are now being created to reflect our talks and workshops, so they may be shared more easily via social media networks.
    - Goal 3b: WICI core members contributed 18 radio and print interviews in 2018.
    - Goal 3c: While the goal of more community-based public lectures had merit, considering the new climate of fiscal restraint, WICI is prioritizing allocation of resources to activities that will directly support research. All WICI talks held on campus have been recorded and the videos have been posted on our website to share with the community at large. Community members on our mailing list regularly attend our talks.
    - Goal 3d: Receptions before WICI seminars continue and have been well attended. The fall open house continues and has been a well-attended, effective networking event.

    Areas for continuing development through 2021: WICI will continue maintaining its Twitter feed, Facebook page, and website (goal 3a). The website will be updated to reflect evolving core research projects (goal 3a). WICI will continue to encourage members to mention the role of WICI in any research that may garner media attention when notifying faculty and university press officers (goal 3b). We will also continue to highlight outstanding achievements of WICI members through our communication channels.

4. **Enhance WICI's resource base and long-term viability.**

    Prioritize efforts to obtain higher-level, external support to establish and support initiatives such as a staffed resource lab; funding for a graduate fellowship program; a competitive post-doctoral scholar program; and funding for short-term (sabbatical or study leave) positions for more senior complex systems scholars.

    Progress made in 2019: The WICI administrative team had extensive discussions with the Office of Research regarding alternative models for WICI support in its next phase. It is clear that WICI's current budget model, based on direct operating support from the Office of Research, is no longer viable moving forward. It is also still not feasible to channel grant overhead directly to WICI to

generate operating funds, as envisioned at our 2015 renewal. Alternatives are to stay small, recruiting basic operating support from several deans, or 'go big', striving to obtain University Centre status. The "go big" option would require, at a minimum, strong evidence of external partner funding relationships, and ideally, a secure external funding source such as a foundation or large tri-council operation grant. The 'go big' option was not seen as viable as of fall 2018, especially given the hold on university centers. However, it may soon be an option, following a bit more strategic assessment and planning. WICI has applied for an extension to postpone our centre renewal application process by one year, therefore WICI has until April 2021 to explore these various options to identify its next strategic goals and a path forward.

Areas for continuing development through 2021: WICI has been actively engaging its members around future vision and strategic direction, with a member survey initiated in Fall 2019 and a follow-up Visioning Session in December 2019 (page 33). Discussions have been launched about the possibility of forming of a new Canadian Network for Complex Systems as WICI's next incarnation, with the University of Waterloo as the founding and central node. The idea has been positively received by the steering committee and the Associate VP for Interdisciplinary Research. There has already been significant interest from external Core Members at University of British Columbia to form a Cascade node and from McGill University to form a Montreal node. Steps are being taken to improve our database of members and research topics, and we hope to be able to connect with additional Canadian complex systems scholars as conversations about a national network continue. We believe this network will create the needed leverage to attract substantive external funding.

5. **Raise our profile.**

   Focus on academic and media outreach to highlight WICI's unique contributions on a national and global scale.

   Progress made in 2019: Our core members made 18 media appearances in 2019, notably twelve of those by newest Core Member, Igor Grossmann. In addition, Kevin Church, a student member and fellowship awardee from Applied Mathematics, was featured on CBC Radio presenting his work on Timing of Vaccinations in Controlling Disease Outbreaks, in June 2019.

   Areas for continuing development through 2021: WICI will continue maintaining its Twitter feed, Facebook page, and website, monitoring traffic and engagements, and optimizing outreach where possible. The website will be updated to reflect new members, new projects, evolving core research projects and emerging working groups.

WICI-RELATED SCHOLARSHIP AND RESEARCH

2019 PRODUCTIVITY REPORT

WICI Core members are regular, research, or adjunct university faculty who lead a long-horizon research program under the institute's auspices. The following table summarizes the scholarly contributions made by WICI core members from January 1, 2019 to December 31, 2019. The full list of individual contributions can be found in Appendix C.

OUTPUT TYPE	
PUBLICATIONS	72
PUBLICATIONS IN PRESS	18
KEYNOTE PRESENTATIONS	5
OTHER PRESENTATIONS	64
WORKSHOPS/CONFERENCES ORGANIZED	9
OP-EDS/MAGAZINE ARTICLES	2
MEDIA OUTREACH: RADIO/PRINT INTERVIEWS	18
HONOURS, DISTINCTIONS AND AWARDS	9

WICI CORE RESEARCH PROJECTS

ASSESSMENT OF AGRICULTURAL BEST MANAGEMENT PRACTICES Peter Deadman's research group continues work on the assessment of the impact of agricultural best management practices (BMPs) on water quality, with a focus on watersheds in southwestern Ontario. The research group is using hydrological models (SWAT) to simulate the impact of the frequency and spatial distribution of BMPs on key water quality parameters (nitrogen and phosphorus) in agricultural watersheds. The work includes the use of agent-based models to simulate farmer decision making around the selection and implementation of BMPs.

AUGMENTING DECISION-MAKING IN COMPLEX AND SAFETY-CRITICAL DOMAINS This project, led by Assistant Professor Mark Crowley, focuses on problems of prediction and control in the areas of forest fire management, medical imaging and autonomous driving. The work on forest fires includes two main approaches. The first uses deep neural networks to learn compact models of forest fire spread directly from data such as satellite images or computationally expensive, physics based simulations. Another, more holistic approach taken uses reinforcement learning and game theory to learn a policy for wildfire spread across a landscape based on local conditions, as if the wildfire were an agent making decisions about where to move next. This approach utilizes multi-modal satellite, weather and other data to build more robust and generalizable models for prediction and decision making. These simulations are currently being applied to forest fire management but could apply to flood management, disease modelling and urban sprawl as well. This project involves collaborations with researchers in applied fields such as sustainable forest management, ecology, automotive technology and medical imaging.

BLUE-GREEN INFRASTRUCTURE ON PRIVATE LANDS Building on previous work impacts of residential stormwater management on Potomac Gorge stream water quality and the SLUCE2 project examining linkages between residential landscaping and carbon sequestration, Dawn Parker's research group is beginning new research on residential land management in Kitchener-Waterloo and blue-green infrastructure. As climate change and urbanization accelerate, so does flood risk. Rapid urbanization and

climate change are leading to increasing stormwater (SW) runoff due to increases in paved surfaces and extreme storm events. Traditional "grey" infrastructure on public lands is proving insufficient to manage this SW increase. Green infrastructure (GI) for stormwater management on private land (such as rain barrels, rain gardens, and permeable paving) is potentially part of a hybrid system solution, since private yards occupy more than 50% of urban areas, and such decentralized infrastructure is more adaptable to changing conditions. While GI has the potential to alleviate some flood risk, a significant knowledge gap exists regarding barriers to adoption of GI on private lands, the impact of GI adoption on flood risk, and flood impacts at the watershed scale. Working with the Cities of Kitchener and Waterloo, the non-profit REEP Green Solutions, and two consulting firms, the research team seeks to co-develop policies to facilitate further resident adoption of GI for SWM on private lands. The research group is working to develop an empirical agent-based model (ABM) of resident information, attitudes, knowledge, socio-economics, and social norms to explore the potential for policies and institutional supports to catalyze GI adoption.

COMPLEX SYSTEMS SCENARIO ANALYSIS Vanessa Schweizer researches complex systems methods for scenario analysis in the context of the human dimensions of climate change (HDCC). In 2018, she began new research projects that interface her methods with other complex systems approaches, namely agent-based modelling (through hosting a WICI visiting scholar, Mr. Tristan de Wildt) and network analysis. With Mr. de Wildt, she is working on the social justice dimensions of low-carbon energy transitions. With her students, she is working on using scientometrics to perform scientific assessment of HDCC scenario studies. The latter may become increasingly important for Assessment Reports published by the Intergovernmental Panel on Climate Change. Schweizer presented at a conference in Denver in March 2019 and currently has two co-authored papers in preparation.

COMPLEXITY IN DIETARY ASSESSMENT AND NUTRITION This research is led by Sharon Kirkpatrick and supported by a team of WICI graduate student members. Understanding people's eating patterns—including what they eat and drink and the contextual factors that influence diet—is essential to better elucidating how diet influences health, as well as how to support eating patterns consistent with disease prevention. The main focus of Dr. Kirkpatrick's work is on improving and disseminating strategies for appropriately collecting, analyzing, and interpreting dietary data. Current areas of focus include novel methods for characterizing the complexity of eating patterns and their associations with health, with an emphasis on the potential for deep learning to overcome the limitations of current dietary patterns research.

Dr. Kirkpatrick's work also explores the utility of systems thinking and methods to better understand the array of factors that influence major nutrition challenges and the effectiveness of interventions to address these challenges. Together with her graduate students, she is currently examining the implications of policies such as calorie labelling for nutrition and health, with a consideration of possible unintended consequences. This work involves quasi-experimental and mixed-methods research.

COUPLED HUMAN-ENVIRONMENT SYSTEMS This core project explores the dynamics of coupled human-environment systems and the implications of these dynamics for environmental health and sustainability. A coupled human-environment system involves a two-way interaction between human systems and our environment: what humans do influences the environment, but the resulting changes in the environment in turn influence our perceptions and behaviour. Humans and their environment together thus form a single, coupled nonlinear system.

Professors Chris Bauch and Madhur Anand have been moving this core project forward in 2019 through the initiation of new projects as well as the fruition of existing projects. This work has been spearheaded

by their co-supervised graduate students, some of which started in 2018. The core project was also supported by seed funding from the WICI Grant Challenges in 2017-18.

Projects with co-supervised students continued concerning developing new types of early warning signals for tipping points in complex systems; spatial ecosystem mosaic dynamics; human-environment dynamics of forest pest outbreaks; human feedbacks on invasive versus native grasslands; mining social media data for clues about dynamics of climate change; the effects of globalization and interconnectedness on socio-ecological population collapse; and further development of their long-standing collaboration on forest-grassland mosaics. Papers were accepted or published concerning dynamics of coupled forest-harvester populations and early warning signals in complex coupled networks, among other topics.

DiD MIRACLE PROJECT Dawn Parker received funding from the Social Sciences and Humanities Research Council (SSHRC) via the Digging into Data Challenge (DiD) from 2013-2016. The international DiD program was established to advance the use of computational methods to explore, analyze and visualize the rapidly expanding pool of crowd-sourced and remotely sensed "big data" from real-world systems. Unique among her year's awards, Parker's research team developed tools to analyze output from computerized simulation models and compare that output to real-world "big data."

MIRACLE created a prototype community platform to support complex systems research across research communities, providing creates access to sample output from computational models, as well as the algorithms used for analysis. Building on this project, Parker continues to collaborate with the CoMSES project at Arizona State University, hosting the current CoMSES platform on Compute Canada via a Portals and Platforms award. (This work is also supported by the US NSF BD Spokes: Spoke: West: Accelerating and Catalyzing Reproducibility in Scientific Computation and Data Synthesis (Michael Barton, ASU, PI). Expanding on the scope of MIRACLE and CoMSES, Parker and Piereder have been exploring new bibliometric tools (see Piereder's GRA Report on page 24) for keyword and scholar community identification, including Gargantext, and open-source tool developed and hosted through the Complex Systems Institute of Paris Ile-de-France (ISC-PIF). They have proposed to implement a Gargantext implementation through CoMSES, which could be available for WICI scholars for specific projects.

ECONOMICS FOR THE ANTHROPOCENE Through WICI, Stephen Quilley has been a partner on the *Economics for the Anthropocene* project – an international partnership between McGill, Vermont and York. Working closely with Prof. Peter Brown at McGill (including being on the committee for one of his students), Quilley has helped to create an opening for Katie Kish, who is now playing a leading role in the Canadian Society for Ecological Economics (CANSEE). In consequence, Quilley was on the scientific committee of the CANSEE 2019 conference that was held in Waterloo where he gave a keynote presentation with Paul Gregory, Director of Outreach for the Green Party (personal capacity).

FOLK THEORIES OF SOUND JUDGEMENT This project, led by Igor Grossmann, concerns exploration of a theoretical framework accommodating the notion of rationality advocated in neoclassic economics and political science with the Aristotelian notion of practical wisdom, as well as the notion of reasonable judgment discussed by legal philosophers such as Rawls. The core question is how lay people understand these concepts and whether their intuitive understanding corresponds to any of the distinct philosophical positions. Over many studies involving linguistic analyses of large-scale text corpora, behavioral experiments, and surveys, Grossmann's team has observed that people represent intellectual virtues by accommodating two distinct standards of judgmental competence: a standard of rationality that corresponds to economists' definition of decontextualized rational self-interest, and a standard of reasonableness that corresponds to philosophical traditions encouraging context-specific balance of self-interest with fairness. For instance, experiments show that concerns for rationality and reasonableness lead people to different conclusions about what constitutes good judgment in dilemmas that pit self-

interest against fairness: Rationality is absolute and self-maximizing, whereas reasonableness pays attention to particulars and fairness. Currently, the team aims to expand this framework theoretically, providing the first synthesis of ideas from distinct streams of behavioral and decision sciences, and to test implications of this framework in real life (e.g., by developing intergroup hostility reduction techniques via framing other party's actions as irrational vs. unreasonable).

NAVIGATORS OF THE ANTHROPOCENE RESEARCH GROUP Since 2015 Stephen Quilley has worked with Dan McCarthy to develop a broad cluster of doctoral projects under the WISIR Umbrella, working with Barb Davy, Katherine Zywert (with Jennifer Lynes) and most recently Anna Beresford. In different ways these students are developing projects that share a theoretical framework that combines a complex systems approach to social and economic change, radical political economy and an emphasis on the significance of ontology and non-rational drivers of behaviour in process of cross-scale systems change. Specific foci include: neo-paganism and ritual, ecological conscience formation and environmental politics (Barb Davy); communitarian experiments in health care and post-capitalist, post-growth health/welfare systems (Zywert); peer-to-peer production and the reMaker society (Kish); and social capital formation and sustainable community in traditional music culture (Beresford).

Continuing over the last two years, students Perin Ruttonsha, Katie Kish, Barb Davy, Anna Beresford and Katherine Zywert have all been dealing with very theoretical problems which draw upon literatures far removed from the centre of gravity of an albeit interdisciplinary department. This work is highly intensive, often rewarding for both parties and absolutely critical, though it takes a great deal of time. This is a necessary transaction cost of interdisciplinarity. Katie Kish defended her dissertation in 2019. She is currently finishing a post-doc with the E4A project and she and Dr. Quilley are working on an Insight Grant application as well as a book for Routledge looking at the UN Sustainable Development Goals through the lens of ecological economics.

PROTOTYPING LAB PROJECT Stephen Quilley with Marcel O'Gorman were awarded a CFI-JELF grant to support the work of students and researchers who are investigating the social, psychological, and environmental impacts of contemporary technologies. The equipment purchased through this grant has been used to train HQP in the creation of digital interfaces, apps, and small electronics that serve as "objects-to-think-with." More specifically, in the past year 15 graduate students have been trained in 3D modelling and printing, physical computing, Internet of Things design, big data analysis, and visualization. The training has paid off in the form of research papers presented, hardware projects showcased in design exhibitions, and Mitacs funded positions for students at Deloitte and North (formerly Thalmic Labs). This project builds on the ongoing work in relation to Stephen Quilley's (Metcalf Funded) reMaker Society and represents quite a unique interdisciplinary collaboration.

RAPID IDEOLOGICAL CHANGE (RIC) PROJECT Tad Homer-Dixon was awarded a 3-year SSHRC Insight Grant for *Ideological Conflict Project (ICP), Methods field testing* in the spring of 2018. In 2019, the research team continued the development of its methods for modeling the emotional content of ideologies as complex systems into practical tools for data gathering and conflict resolution. Pilot exercises simulating conflict resolution negotiations were conducted with volunteers in the Waterloo region as well as with student volunteers at Bilkent University in Ankara, Turkey, under the supervision of Prof. Esra Cuhadar. Consultations were also held at a workshop in at the Potsdam University of Applied Sciences with German researchers using ICP methods as data gathering tools in psychology research, to further the development of standardized research materials. Drawing from these consultations, a beta version of new software for drawing Cognitive-Affective Maps will be made available online for testing and public use in April 2020.

RETROSPECTIVE PHOTOGRAMMETRY AND VIRTUAL REALITY

Peter Deadman is beginning work on the use of historical photographs and survey data to construct 3D models of archeological sites for visualization using virtual reality technologies.

THE URBAN GROWTH AND CHANGE RESEARCH GROUP

Dawn Parker's research group is conducting long-term, highly empirical research to explore interactions between residential location and transportation decisions, using Kitchener-Waterloo and the natural experiment of its light rail implementation as a living laboratory case study.

The outward growth of cities after the Second World War and associated urban sprawl has created extensively documented negative impacts. As a result, contemporary planning policy and investments promote intensification–concentration of activities in vibrant urban cores and nodes and corridors that support accessibility and more efficient municipal expenditures. Rapid transit (RT) has potential to catalyze intensification, assuming that it causes intensification and economic vitality. However, while numerous studies have demonstrated correlation between these factors, due to data and methodological limitations, causality has not been established. Establishing causality is challenging, as some relationships may be direct–new RT investments may make adjacent lands more desirable–producing direct changes in property values. Yet, some impacts may be indirect, as RT investment might increase the density of complementary land uses, creating positive agglomerative feedbacks. Confounding the identification challenge, such feedbacks can occur independent of, and may themselves induce, RT investments. Further, RT investments often occur with complementary physical investments, higher land values, or policy changes to achieve planning goals.

The team's research responds to a natural experiment to explore the causal dynamics between the just-implemented Ion light rail transit (LRT), core-area intensification, residential land use and markets, and transportation behavior in Kitchener-Waterloo, Ontario, working with local government and industry partners. Research in the UGC research group has two streams: data gathering/analysis and modeling. Working in partnership with the Region of Waterloo, they are gathering and analyzing qualitative and quantitative information from the pre-build stage through completion of the LRT construction. To date they have surveyed residential land owners, renters, and developers, buyers, sellers, and real estate agents, with results reported in four completed student theses. A just-approved PhD thesis combines survey, land transaction, and assessment data for an in-depth, multi-method statistical examination of space-time price trends and their relationship to demographic buyer cohorts. In-progress research is chronicling retail changes along the LRT corridor to assess any retail gentrification trends. An additional study for the Region and cities examines property value impacts of cycling infrastructure. The team will be using these data to build a series of agent-based models that model the joint evolution of residential land-use change and transportation behaviour. In addition to the partnership with Municipal Property Assessment Corporation and Teranet that facilitated their most recent research, the research team is exploring new collaborative partnerships with the Canadian Mortgage and Housing Corporation and the Bank of Canada.

WISDOM OF KNOWING THE DIFFERENCE: UNPACKING KNOWLEDGE OF STRATEGY-SITUATION FIT AND ITS RELATIONSHIP TO CONTEXT-SENSITIVE META-COGNITION

At least since Aristotle, the notion of practical wisdom has focused on the ability to discern the best action for the different situations people encounter in their lives. For Aristotle and many scholars after him, practical wisdom concerned both knowledge of which strategies fit which situations and application of such knowledge in daily life. In contrast, current psychological wisdom research has largely focused on individual characteristics attributed to wise persons. Igor Grossmann proposes to bring together these two approaches in a process model linking characteristics attributed to wise persons with knowledge of Strategy-Situation Fit (SSF) and its application in meaningful daily life situations. He hypothesizes that a

"wise" meta-cognitive ability to discern the features of a situation, often attributed to wise people, affords greater SSF knowledge and facilitates its application in daily life. His goal is to provide a unified SSF framework encompassing an ecologically-derived set of cognitive, emotional, motivational and behavioural strategies, to assess their applicability across typical daily life situations, and to test the role of wisdom-related meta-cognitive processes for SSF development. Specifically, in this ongoing program of research he:

1. Develops tools to assess knowledge of Strategy-Situation Fit, with a focus on cognitive, emotional, motivational and behavioural strategies across different situations;
2. Explores the utility of Strategy-Situation Fit knowledge for performance in daily life;
3. Examines how wise meta-cognition and SSF influence each other over time.

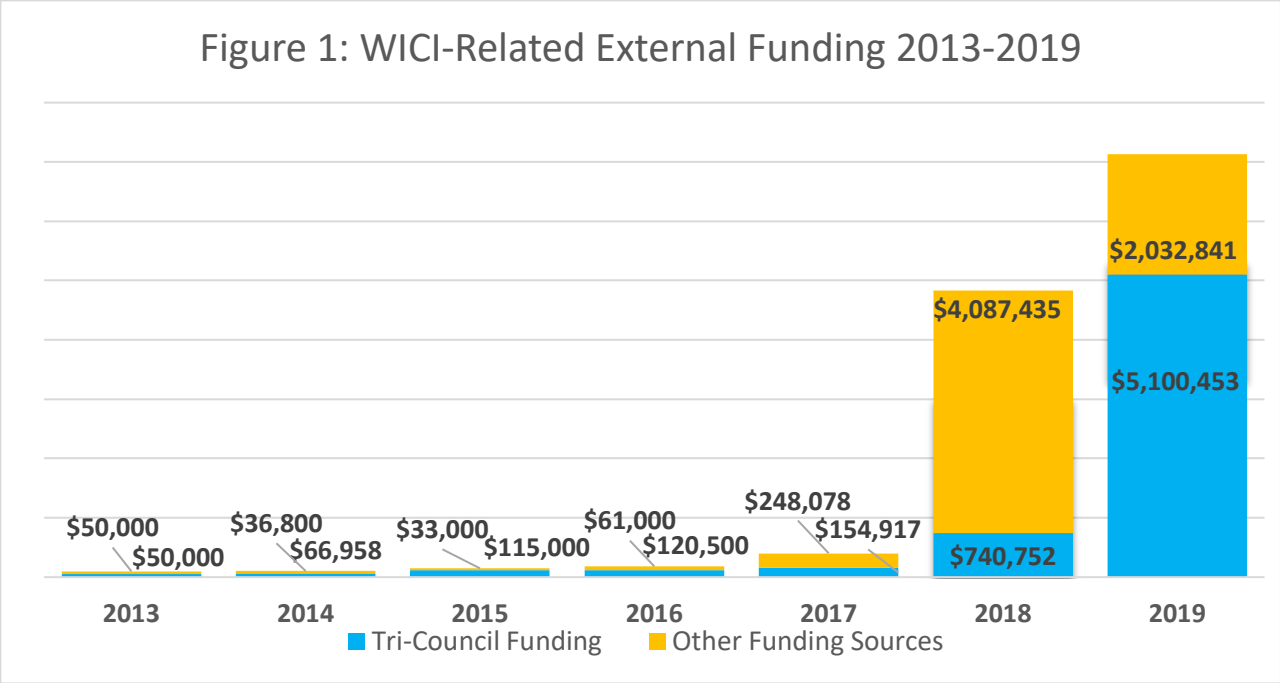
NEW RESEARCH FUNDING

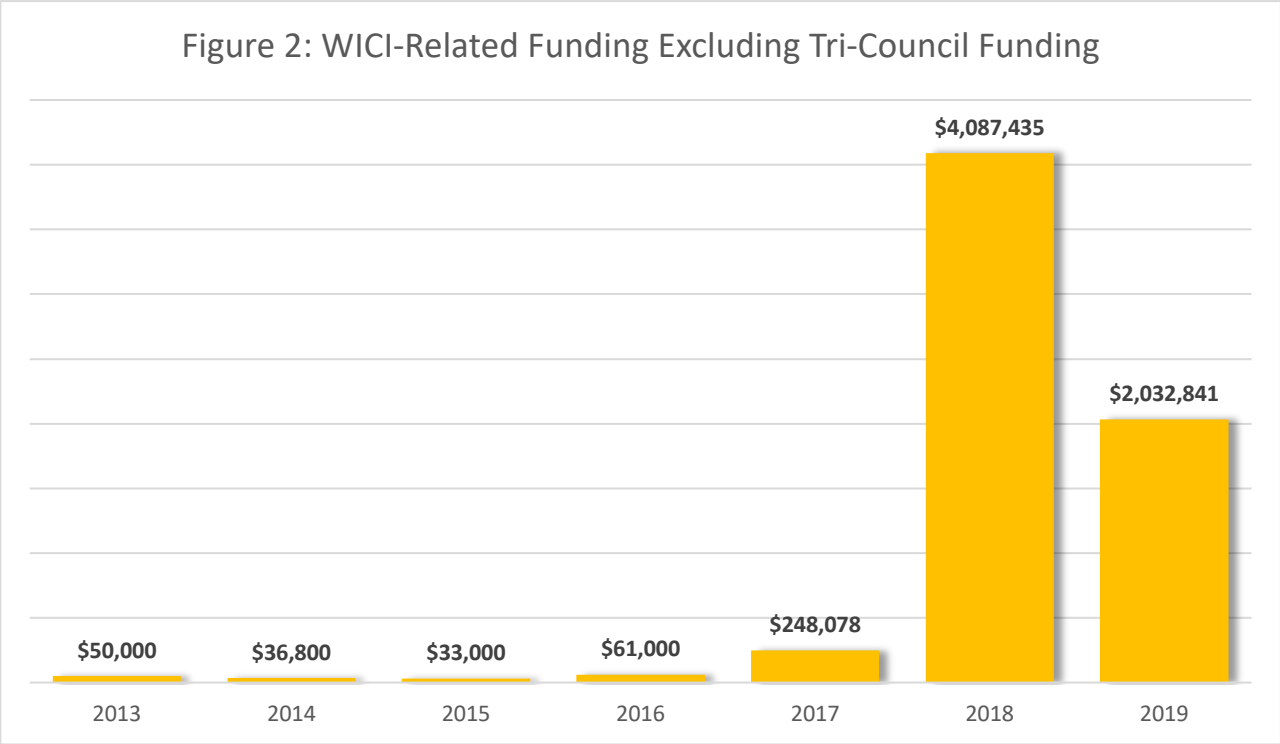
Researcher	Project	Awarded By	Amount
M. Crowley (Co-Investigator, 15%)	"Computational Peer Review through Identification and Captioning of Gigapizel Digital Pathology Scans"	Ontario Research Funds – Research Excellence (ORF-RE) (2018-2024)	$620,000
M. Crowley (Co-PI, 50%)	"Driver Behaviour Learning" (2018-2021)	NSERC Collaborative Research and Development (CRD)	$164,000
M. Crowley	"Integration of Scientific Workflows in Geoscience"	Mitacs Globalinks Research Travel Award	$6,000
M. Crowley (Co-PI, 33%)	"Trace Analysis for Safety Assurance of Critical Software Systems"	NSERC Collaborative Research and Development (CRD)	$120,000
M. Crowley	"Automated Material Synthesis Using Deep Reinforcement Learning"	National Research Council – UW Collaboration Centre for AI/Cybersecurity/IoT	$90,000
M. Crowley (Co-PI, 50%)	"Artificial Intelligence and Wildland Fire Management"	Waterloo Artificial Intelligence Institute – Microsoft - AI for Social Good	$50,000
P. Deadman	"GIS based virtual and augmented reality tools"	Canada Foundation for Innovation & Ontario Research Fund (CFI-ORF)	$212,659

I. Grossmann (Co-PI)	"Measuring and developing the character strengths of wisdom in low-security contexts: Testing new approaches in Sri Lanka and the Philippines"	Global Innovations in Character Development Grant from Templeton World Charity Foundation	$299,919
I. Grossmann	"Wisdom to know the difference: Unpacking knowledge of strategy-situation fit and its relationship to context-sensitive cognition"	SSHRC Insight Grant	$239,703
S. Kirkpatrick	"Accelerating methods for characterizing dietary patterns"	Canadian Institutes of Health Research	$15,000
S. Kirkpatrick	"Measuring cardio-vascular Outcomes in Depression in referred Youth (MODIFY)"	Canadian Institutes of Health Research	$914,175
S. Kirkpatrick	"International food policy study: Evaluating the impact of food labelling, marketing, and fiscal nutrition policies"	Canadian Institutes of Health Research	$2,994,975
S. Kirkpatrick	"Accuracy and cost-effectiveness of technology-assisted dietary assessment"	Australian Research Council Discovery Grants	$288,103 AUD
S. Kirkpatrick	"Measurement error in self-report dietary intake data"	US National Cancer Institute	$10,000 USD (contract)
C. Nehaniv	"Automatic Computational Understanding and Manipulation of Finite Discrete-Event Dynamical Systems throughout Natural Sciences and Engineering"	NSERC Discovery Grant	$205,000

C. Nehaniv (Co-PI)	"Infrastructure for Social & Intelligent Robotics"	Canada Foundation For Innovation - John R. Evans Leaders Fund (CFI-JELF) and Ontario Research Fund (ORF) (with other funding source(s))	$930,812
C. Nehaniv	"Novel Computational Methods for Predicting Transitions in Spatiotemporal Neurodynamics between Attention and Mind-wandering"	US Air Force Office of Scientific Research (awarded via University of Hertfordshire)	$81,000 USD
D. Parker (Co-PI)	"Artificial Intelligence-based Tools for Fresh Produce Procurement Price Decisions as Applied to Canadian Distribution Centers"	Natural Sciences and Engineering Research Council of Canada (NSERC) CRD	$600,000
D. Parker (Co-PI)	"Residential Property Values and Active Transportation Infrastructure"	Cities of Kitchener	$18,750
S. Quilley	"A Pattern Language for Traditional Music and Sustainable Communities"	Global Mitacs	$6,000
V. Schweizer	"Scientometric tools and complex systems modelling for solution-oriented assessment"	UW/SSHRC RIF	$10,000

Figures 1 and 2 below illustrate the overall WICI-related external funding, as well as the WICI-related funding excluding TriCouncil awards, from 2013 through 2019.



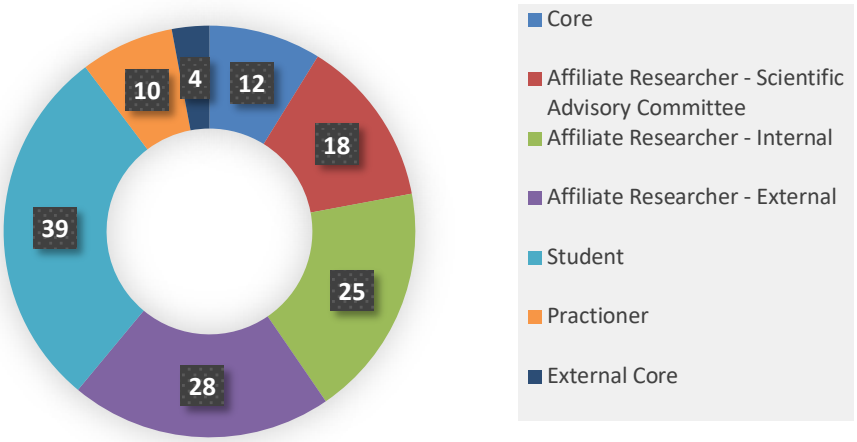


COMMUNICATION AND COMMUNITY ENGAGEMENT

MEMBERSHIP

As of February 2020, WICI had a total of 136 members, which represents an 8% growth in membership over the past year. Student and affiliate membership has dropped slightly, as some members have moved on, and others have changed to Practitioner membership status. Figure 3 provides a breakdown of the number of members in each membership category (note the new category: External Core).

Figure 3: WICI Membership By Category



In 2019 WICI welcomed the following members:

NAME	POSITION	MEMBERSHIP CATEGORY
Igor Grossmann	Professor, Psychology, University of Waterloo	Core Member
Mary O'Connor*	Associate Professor, Zoology, University of British Columbia	External Core Member
Liane Gabora	Associate Professor, Psychology, University of British Columbia	External Core Member
Raja Sengupta*	Associate Professor, Geography, McGill University	External Core Member
Roger White	Professor, Geography, Memorial University	External Core Member
Anna Klinkova	Assistant Professor, Chemistry, University of Waterloo	Affiliate Researcher
Rebecca Saari	Assistant Professor, Civil and Environmental Engineering, University of Waterloo	Affiliate Researcher

Naresh Singh	Senior Vice President, Global Partnerships, Global Development Solutions Canada	Practitioner
Robert Cutler	Complex Organization and Decision Specialist, Canadian Energy Research Institute	Practitioner Member
Adrienne Mason	PhD candidate, School of Environment, Resources and Sustainability, University of Waterloo	Student Member
Nicholas Palaschuk	PhD candidate, School of Environment, Enterprise and Development, University of Waterloo	Student Member
Christopher Greyson	PhD candidate in Integrative Biology, University of Guelph	Student Member
Lesley Andrade	PhD candidate, School of Public Health and Health Systems, University of Waterloo	Student Member
Majid Mirza	PhD candidate, School of Environment, Enterprise and Development, University of Waterloo	Student Member
Simon Leroux	Masters of Architecture student, University of Waterloo	Student Member

*Mary O'Connor and Raja Sengupta are leading development of nodes for a Canadian Network for Complex Systems in British Columbia and Montreal, respectively. Their External Core member applications are included as Appendix D and Appendix E.

Figure 4 illustrates WICI membership by Faculty in 2019.

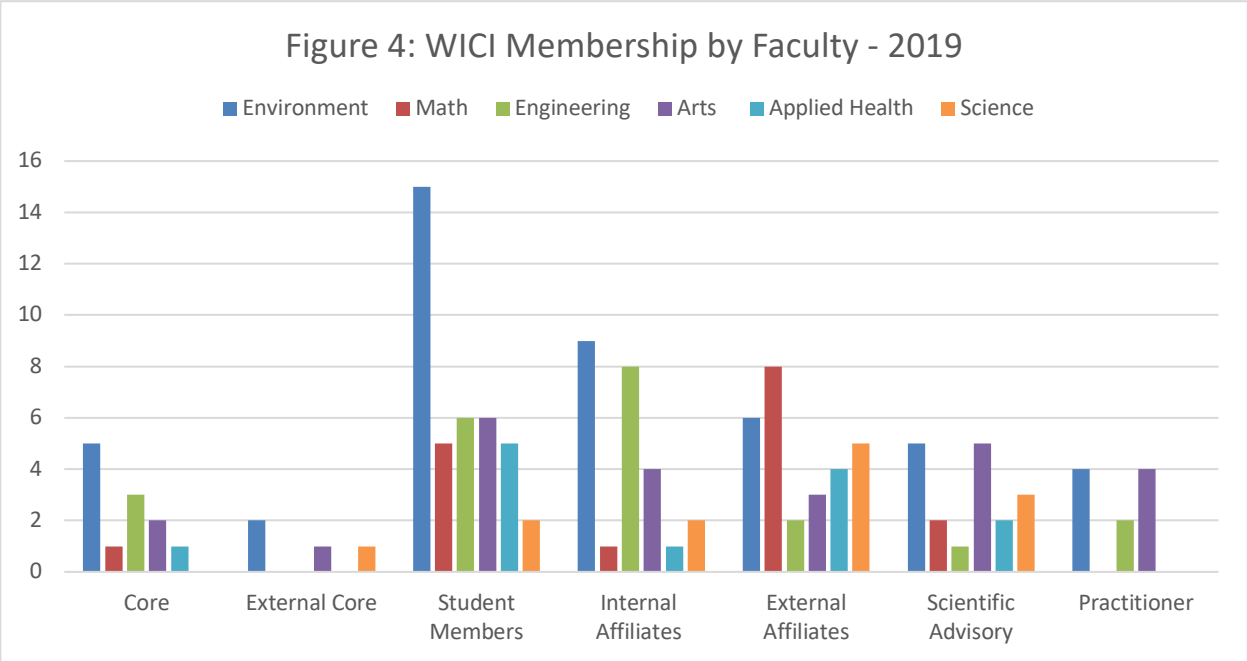
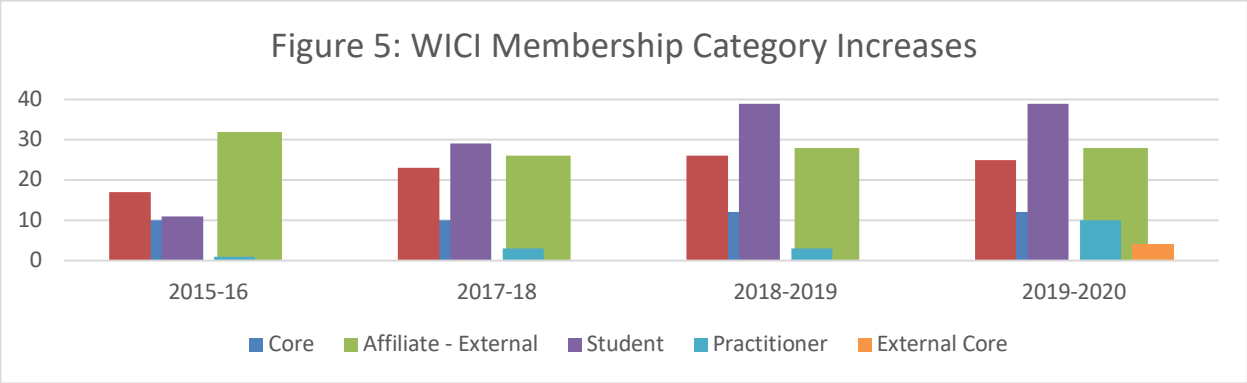


Figure 5 illustrates the representation of the different faculties over the past four years.



DIVERSITY REPORT

Approximately twenty percent of WICI's membership is visible minorities, and approximately thirty percent are women. Half of our guest speakers in 2019 were women. The WICI leadership is currently more than half women. (These numbers are not based on self-reporting. All diversity statistics will be updated for our renewal document following the university standard of self-reporting.)

ONLINE ENGAGEMENT

WICI launched its University of Waterloo WCMS website (uwaterloo.ca/complexity-innovation) in September 2017, and it continues to be the primary source for information relating to the Institute. It is used to share news about upcoming events, profile WICI members, and recruit researchers and staff. In 2019, the WICI website has been averaging over **1,194** visits per month, which is up 11% from the average monthly visits in 2018, and more than double the monthly average of 533 per month in our first year.

Currently, WICI has **554** active subscribers on its Mail Chimp mailing list (a 7% growth from last year). The Institute has also continued to maintain three social media accounts to share news and events: a Facebook page, a Twitter feed and a LinkedIn company page. We currently have **578** followers of our Facebook page, and **700** followers of our Twitter page; both numbers reflect an increase of 9% from last year. Our LinkedIn page has a total of **107** followers (a 12% increase from 2018).

In addition, videos of WICI talks on our Vimeo page were viewed a total of **1817** times in 2019 (up 2% from last year).

WICI STUDENT GRA REPORTS

KIRSTEN WRIGHT - STUDENT ENGAGEMENT INITIATIVE

For the winter 2019 term, WICI hired PhD student Kirsten Wright as a graduate research assistant (10 hours per week) to lead organization of student engagement activities. Graduate student activities in winter 2019 included a graduate student "Complexity Café," research working group activities, and a graduate and undergraduate student project symposium.

The graduate student "Complexity Café" was designed to facilitate interaction between WICI student

members around complex systems challenges of mutual interest. These sessions involved connecting students working on applied problems with students with particular methodological skills, connecting groups of students to brainstorm a problem of general interest, and supporting working groups. Smaller graduate research groups emerged focusing on health in complex systems, climate, risk, and frameworks for understanding the relationships among applied complex systems challenges.

K. Wright also took a leadership role in organizing the WICI Complex Systems Student Project Symposium in April 2019 (page 30) with over 20 participants and 10 judges from across multiple faculties.

K. Wright's efforts to engage the student community made a notable impact on WICI-related student activities in 2019. Graduate students later formed a "Student Complexity Seminar" series held monthly from May through July. Four presenters volunteered to share their work with other students and members of the WICI community for feedback and networking. Wright also encouraged Dr. Bill Sutherland to explore and host ongoing informal mentorship sessions in complexity thinking that were held over the Summer and Fall terms (page 31). She co-led two special sessions at the CANSEE 2019 conference titled 'Agent-based modeling of social innovation, resilience, and opinion dynamics' and '(The) State(s) of Complexity' (page 30). Finally, Wright encouraged Simon Leroux to organize a WICI chapter at the School of Architecture campus in Cambridge, which later led to a successful symposium event at that site (page 32).

JINELLE PIEREDER – MAPPING CANADIAN COMPLEX SYSTEMS SCHOLARSHIP

Mapping exercises are increasingly important for organizational positioning, strategy, and assessing impact beyond just scholar productivity. Fortunately, new bibliometric and informetric tools are helping researchers answer questions around emerging topic clusters and epistemic communities, potential collaborations, research trends and gaps, state-of-the-art assessments, and alternative perspectives. With these questions in mind, WICI brought on a research assistant (WICI Student Member, Jinelle Piereder) in September 2019 to map the network of complex systems scholars at the University of Waterloo, and across Canada. The goal of this mapping exercise was to:

1. evaluate the research activities of WICI members;
2. increase our awareness of complex systems scholars and research;
3. help us better understand how scholars situate themselves as complex systems researchers;
4. enable more collaboration across institutions, with the eventual goal of establishing a Canadian Complex Systems Network.

The project consisted of several simultaneous and iterative research activities. We (1) conducted a survey of existing WICI members, (2) identified important keywords and tags related to the disciplines, methods, and application areas of complex systems research, (3) developed a comprehensive search query based on our keyword database, and (4) conducted bibliometric analysis of search results using several cutting-edge tools (Elsevier's SciVal (https://www.elsevier.com/solutions/scival), VOSViewer (https://www.vosviewer.com/), and Gargantext (https://gargantext.org/).

Initial findings point to, among other things, the high level of multi- and inter-disciplinarity among WICI members, an increasing amount of international collaboration by WICI members, more frequent collaboration between WICI members, clusters of complex systems work being done at UW, the most common sources of research funding, and the top publication destinations for complex systems scholarship. More detailed insights and metrics will be included in a forthcoming comprehensive WICI report. An additional important finding is that much of the complex systems literature is less visible in traditional bibliometric analysis because scholars tend not to emphasize complex systems language in

their article abstracts or keyword lists. This suggests the need for better cross-discipline and cross-institution mechanisms to encourage research communication and knowledge accumulation, perhaps in the form of a Canadian complex systems network.

Keywords Survey summary and results are attached as Appendix F.

EXTERNAL COLLABORATION OPPORTUNITIES

As planned for this year, WICI has actively engaged with key other research centres on campus to explore areas of complementarity and identify future joint activities. With the help of ADR Shirley Tang, we have also pursued multiple channels to better engage with the Science faculty. We have also had key communications with groups external to the university, the majority of whom have reached out to WICI directly, either from our web presence, internal referrals, or in response to our call for members of the new Canadian Network for Complex Systems. This level of external engagement is very positive for WICI.

Meeting with Dean of Science April 10, 2019
Vanessa Schweizer (Associate Director of WICI), Dawn Parker (Director of WICI), and WICI member Kirsten Wright met with Bob Lemieux (Dean of Science), Shirley Tang (ADR of Science) and Brian McNamara (Chair of Physics) on April 10th, 2019. The objective of the meeting was to raise awareness of WICI's mission and scope and identify scholars in the Science faculty who could benefit from WICI involvement. Surprisingly, although the Science fields dominate in most complex systems institutes, Science is currently underrepresented in WICI membership. It was a positive meeting with good discussions. As a result of feedback from this meeting, the WICI website was updated so the "What is Complex Systems" tab is more accessible from the main page, and Shirley Tang agreed to help circulate communications from WICI within the Science research community. Some names of faculty who are interested and/or working in complex systems were provided for outreach. There was a brief discussion about a complex systems/physics link with the Perimeter Institute. While it appears Perimeter does not currently house a substantive group of complex systems researchers, we agreed to periodically revisit the potential for stronger links with Perimeter in the future.

An additional meeting with Shirley Tang and Dawn Parker resulted in a faculty networking session for the Frontiers grant, organized on short notice by WICI and the Faculty of Science, with an interest in connecting Science faculty with Arts and/or Environment researchers in particular. There was also interest in having another networking session in the fall; however, WICI administration was not able to support an additional session due to time constraints.

The improved linkages with Science have led to increased participation of Science faculty and staff in WICI activities. In particular, we connected with Anna Klinkova (Chemistry) who has joined as an Internal Affiliate member and was awarded a WICI SEED grant, complexity researcher Michael Gingras (Physics), and Trevor Charles from Waterloo Centre for Microbial Research (WCMR). Further, a number of biology scholars attended a WICI talk with Mary O'Connor in November 2019.

Santa Fe Institute June 2019
Dawn Parker (WICI Director) visited the Santa Fe Institute for consultation and strategic advice. She met with Susan Carter, SFI's incoming Research Development Director. Ms. Carter offered helpful perspectives on prospects for foundation funding and the current shift towards interdisciplinary funding in Canada's tri-councils. She advised that funding opportunities are available at the intersection of medicine and complex systems. Parker and Carter also discussed prospects for collaboration and joint funding applications to the US National Science Foundation through SFI collaborators. Parker also discussed summer schools with Scott Page and John Miller (Computational Social Science summer school)

and Dave Feldman (General SFI summer schools), including format, audience, and funding models. A main take-home message was the importance of team-project-based summer schools.

Visit with Dean Toonen (University of Twente) June 17 & 18, 2019

Several meetings around a "resilient cities" theme were held over a two-day visit with Dean Theo Toonen from University of Twente on June 17-18, 2019. WICI organized meetings between Toonen and the Dean of Environment, the INTACT Centre, the Canadian Water Network, the Water Institute, and several groups of Environment faculty members. As a result of these meetings, two research questions appropriate for large-scale grant applications were developed, and a connection was made with Bernadette Conant (CEO of the Canadian Water Network), who later scheduled a collaboration meeting with WICI and the Interdisciplinary Centre on Climate Change (IC3) in September 2019. Dawn Parker (Director, WICI) and Prof. Dr. T. Filatova at the University of Twente have tentative plans to cohost a summer 2020 workshop at University of Waterloo as a follow-up to these research questions and discussions, with the goal of identifying a large collaborative cross-university grant proposal around participatory modeling and policy analysis for water policy. Subsequently, Professor Michael Drescher has developed a blue-green infrastructure working group with the School of Planning and has initiated discussions with the leaders of the Water Institute and IC3 around a potential Frontiers grant application. WICI has offered to coordinate further discussions. We see the summer 2020 workshop as a possible opportunity to bring all these players together.

Meeting with Waterloo Institute for Nanotechnology (WIN) July 3, 2019

Dawn Parker (Director) and Brenda Panasiak (Administrative Coordinator) met with Sushanta Mitra (Executive Director, WIN), Lisa Pokrajac (Assistant Director of Research, Programs), and Oleg Stukalov (Business Development Manager, WIN) of the Waterloo Institute for Nanotechnology. The common themes of multi-scale adaptive management and optimization of complex spatial and network problems were identified. Following the meeting, WICI and WIN issued a joint speaker invitation to Andrew Maynard at Arizona State; unfortunately he was unable to accept the invite.

Meeting with Paul Heidebrecht, Director, Kindred Credit Union Centre for Peace Advancement July 18, 2019

Paul Heidebrecht contacted WICI in July 2019 to discuss co-sponsorship of the 2020 Map the System Challenge. The Centre for Peace Advancement at Conrad Grebel University College coordinated the participation of University of Waterloo students in Oxford University's 2019 Map the System Challenge. Map the System is a competition that challenges participants to thoroughly research a specific social or environmental issue in order to fully comprehend its underlying components. Participants are then expected to compellingly articulate their findings in a way that engages audiences and promotes understanding. It was agreed that co-sponsoring this challenge would help extend the reach among faculty and students in 2020. WICI agreed to sponsor up to $500 and assist with promoting and mentoring student teams wishing to participate in the challenge.

Meeting with Canadian Water Network (CWN) & Interdisciplinary Centre on Climate Change (IC3) September 18, 2019

Bernadette Conant (CEO, Canadian Water Network) called a meeting with Dawn Parker (Director, WICI), Daniel Scott (University Research Chair & Executive Director, IC3) and Simon Glauser (Managing Director, IC3). The purpose of the meeting was to share what each group is doing in the areas of Climate Adaptation, Resilience and more effective structuring of Innovation and Knowledge Mobilization in the governance/management decision worlds. Some strong overlap and collaboration opportunities were identified and strategic collaboration opportunities were discussed. The IC3 administration expressed an interest in having a follow-up meeting with WICI to continue these discussions. In particular, WICI was identified as potentially serving a bridging role to better connect IC3 with the Water Institute.

Complex Systems Institute of Paris Ile-de-France (ISC-PIF) October 2019
In addition to strategic discussions to understand this Institute's growth, Dawn Parker (WICI Director) met with researchers who had developed Gargantext, a bibliographic data mining program developed in house, and Open Mole, a system to facilitate conducting sensitivity analysis for large computational models. Parker later connected PhD GRA Piereder with this group to facilitate her use of Gargantext to map complex systems scholarship at UW (see GRA Report section on page 24). She also connected the Open Mole group with her CoMSES.net collaborators to discuss common interests in model archiving and analysis.

Meeting with Waterloo Centre for Microbiology Research (WCMR) October 28, 2019
In a meeting between WICI and WCMR, both centres discussed their mission and main areas of focus and agreed there is a connection to complexity theories. WCMR agreed to co-sponsor our guest speaker, Dr. Kate Adamala, on Thursday February 6th, and provided names of complex systems scholars who could be contacted, including Professor Laurette Dube from McGill who is now collaborating with our External Core Member and potential Montreal node leader, Raja Sengupta. Further, Professor Dube subsequently reached out to Dawn Parker, WICI director, with an invitation to participate as a collaborator on a CIHR Smart Health Cities training grant, with WICI potentially playing a major role in the development of complex systems educational components. The proposal made it past the LOI stage, and preparation of the full proposal is in progress.

Connecting with Naresh Singh November 2019
Following the call for external members of a Canadian Network for Complex Systems (CNCS), WICI was contacted by Naresh Singh, Senior Vice President of Global Development Solutions Canada, who has a distinguished record as an international development expert (https://www.gdsc.ca/about https://sustainable-livelihoods.com and https://sustainable-livelihoods.com). While here as a visiting professor in the Faculty of Environmental Studies in 2001, Dr. Singh called for establishment of a complex systems research centre at University of Waterloo, which did not materialize at that time due to the loss of a key collaborator from campus. Dr. Singh is highly enthused to join the new CNCS and as a practitioner member of WICI. Dawn Parker also connected Dr. Singh with Paul Heidebrecht, Director of Kindred Credit Union Centre for Peace Advancement.

CMHC Campus Visit November 2019
In fall 2019, Environment faculty personnel forged connections between CMHC's Innovation group and UW researchers, including WICI. Through these contacts, Dawn Parker was able to engage CHMC as a partner in her Open Research Area international grant application "Exploring housing policy complexity: Cross-scale modelling of housing markets drivers, interactions, and impacts," which also engages collaborators from the Bank of Canada, Bank of England, and UK and French academic researchers. At the time of this report, this grant application has proceeded to the second stage of evaluation. Parker further represented WICI during the on-site visit of CHMC staff, hosted by the Faculty of Environment. Many areas of common interest for future research were identified, including development of qualitative models to explore systems dynamics in housing markets.

Robert Cutler Campus Visit December 2019
Robert M. Cutler is a Senior Research Fellow for Energy Security, NATO Association of Canada; Senior Fellow in Energy Geo-economics, Canadian International Council; and Fellow, Canadian Energy Research Institute. He found WICI through the Research Institutes page on the University of Waterloo website, and joined WICI as a Practitioner member. On December 3, Cutler visited campus to participate in the WICI Visioning Session. During his visit, he met with Ann Fitz-Gerald at the Balsillie School of International Affairs, as well as John Ravenhill, Chair of Political Science. He was able to further connect WICI with Ann

Fitz-Gerald to discuss strategic directions for complex systems. He will also be working closely with Raja Sengupta in the establishment of a CNCS node at McGill University in Montreal.

Meeting with Tamer Özsu for a Waterloo Data Science Institute Application December 17, 2019
Dawn Parker (Director, WICI) met with Professor Tamer Özsu (Computer Science) to discuss potential synergies and joint activities between WICI and the developing Watdata Institute. They identified a series of potential collaborative activities, the most significant of which being the development of a proposal for a funded, staffed laboratory to assist Waterloo scholars with computational modelling and analysis. WICI subsequently provided a letter of support for Watdata's application.

Cascade Institute, Royal Roads University (BC)
WICI Core Member Thomas Homer-Dixon has recently relocated and has been setting up the Cascade Institute at Royal Roads University in British Columbia. The Cascade Institute is designed to address critical questions to trigger a fundamental positive and rapid change in humanity's trajectory in the current and projected global climate. The Institute's work is to be conducted by a team of the world's best complex-systems scientists, and the Institute will act as a network hub and catalyst among scientifically aligned research Institutes around the world. WICI has already been established as a Targeted Affiliated Institute for Cascade Institute, in the Institute's founding document.

UNIVERSITY OF WATERLOO COLLABORATION

In July 2019, Dawn Parker (Director, WICI) participated in the Office of Research Strategic Research Plan Update consultation session and provided written feedback, sharing WICI's collaboratively developed list of thematic areas, her perspective on areas of strength on campus in complex systems, and a summary of complex systems science as an emerging global field.

A key theme identified during these consultations led to establishment of the Task Force on Interdisciplinary, Inter-Faculty Research, Academic Programming and Training. Parker met with committee member Jean Andrey (Dean, Environment) on December 4, 2019, and subsequently provided a short memo to the committee with comments on facilitators and barriers to interdisciplinary scholarship in the areas of teaching and scholarship, advising, faculty appointments, and research funding and administration. A copy of Parker's submitted feedback is attached in Appendix G.

WICI SPEAKER SERIES

2018-2019 SPEAKER SERIES

Wisdom in a Complex World: Measurement, Utility, and Interventions
Dr. Igor Grossman
Associate Professor of Psychology, University of Waterloo
November 13, 2018

Demystifying Language and Breaking Down Barriers in Complexity Science and Methods
Dr. Sharon Kirkpatrick, *University of Waterloo, School of Public Health & Health Systems*
Dr. James Shelley, *Western University, Research and Knowledge Translation Coordinator, Health Sciences*
Dr. William Sutherland, *Founder and Director of the Institute for Complexity and Connection Medicine*
January 29, 2019

Graduate Fellowship Awardees: Research Symposium
Amanda Raffoul *(School of Public Health and Health Sciences):* Are we (unintentionally) doing more harm than good? Systems Approaches to the Prevention of Eating-and-Weight-Related Disorders
Kevin Church *(Applied Math):* The Hidden Geometry of Complex Dynamics and How to Exploit It
Katharine Zywert *(School of Environment, Resources and Sustainability*): Social-Ecological Systems Change and the Future of Human Health
February 26, 2019 (Snow date)

Systems Approaches to Sustainability: Climate, Air Pollution, and Toxic Substances
Dr. Noelle Selin-Eckley
Associate Professor in the Institute for Data, Systems and Society and the Department of Earth, Atmospheric and Planetary Sciences at Massachusetts Institute of Technology (MIT)
Director of Technology and Policy Program, MIT
March 26, 2019

2019–2020 SPEAKER SERIES

Origins: How the Earth Shaped Human History
Dr. Lewis Dartnell
Professor, Life Sciences, University of Westminster, London, UK
September 17, 2019

How and Why do Cultures Change?
Dr. Michael Varnum
Associate Professor of Psychology at Arizona State University (ASU)
October 9, 2019

Toward a Unified Science of Ecological Change: Advances in Metabolic Scaling and Biodiversity Science
Dr. Mary O'Connor
Associate Professor of Zoology, Associate Director of the Centre for Biodiversity, University of British Columbia (UBC)
November 15, 2019

Life, but not Alive (co-hosted with Waterloo Centre for Microbiology Research)
Dr. Kate Adamala
Assistant Professor of Genetics, Cell Biology and Development at University of Minnesota
February 6, 2020

It's Complex: Future of Modelling and Simulation in a Changing Geospatial Environment
Dr. Raja Sengupta
Associate Professor, Geography at McGill University
March 27, 2020 – Cancelled due to Coronavirus pandemic (to be rescheduled for 2020/2021)

SPONSORED EVENTS/WORKSHOPS

WICI RESEARCH NETWORKING EVENT – FEBRUARY 28, 2019

WICI held a faculty networking event on February 28th, 2019, with the goals of connecting faculty members across campus who share common research interests, to which complex systems methods might be usefully applied; and preliminary visioning for a "Canadian Network for Complex Systems".

Participants reported up to three disciplines, application areas, and methods represented in their work and then broke into groups to play "Cooperative Research Question Boggle," where they worked to identify, in a short time, as many common research questions that the group could address as possible. In the second half of the session, participants were asked to brainstorm around aspects of a potential new organization with a national network, identifying potential goals, structure and activities, mission, members and funding models. A full report of the outcomes of this brainstorming session was included in the WICI 2018 Annual Report.

WICI COMPLEX SYSTEMS STUDENT PROJECT SYMPOSIUM – APRIL 4, 2019

The WICI Complex Systems Student Project Symposium was a cross faculty, juried complex systems research competition that took place Thursday, April 4, 2019. There were awards of $250 for first place, $150 for second place, and $100 for third place for each of the graduate and undergraduate competitions. All entries judged "Outstanding" received a certificate with tailored comments of support from judges. All participants received a confidential summary of judge's ranking and comments.

Submissions for poster presentations were invited from all students, including graduate and undergraduate students, with 21 entries received. Each presenter was scheduled a window to give a three-minute talk about their poster to judges and audience members. Posters described research and/or design projects related to complex systems, and/or the application of systems thinking and/or methods to complex challenges more generally.

(THE) STATE(S) OF COMPLEXITY WORKSHOP – CANSEE MAY 2019

In the winter of 2019, the Waterloo Institute for Complexity and Innovation (WICI) began to strategize how it might expand its programming and engagements through the establishment of a Canadian Network for Complex Systems (CNCS). As part of this, a small group of graduate students took initiative to frame opportunities for present and future collaborations, with the intention of ultimately scaling this work out through research grants, special publications, curriculum development and other events.

They started by formulating a conceptual framework, through an informal and cursory review of the research interests of WICI's graduate student and faculty membership. Through this, they recognized that WICI members already have a strong foothold in research related to sustainability, resilience and transition, and especially as these translate into practical applications. As such, this framework outlines seven thematic categories by which to apply complex systems thinking to address complex challenges for global transition, as follows:

- Sensemaking Amidst Complexity;
- Human Ecologies-and-Environmental Interactions;
- Metabolism, Scale and Growth;
- Systems Thresholds and Risk Mitigation;

- Processes and Phases of Change Over Time;
- Social Networks, Institutions and Human Development;
- Emergent Sciences, Innovations and Technologies.

Acknowledging that the analyses of complex systems will entail both methodological and substantive considerations, the workshop title carries a double meaning: (The State of Complexity) how increasing global pressures are necessitating the advancement of new tools by which to effectively analyse and intervene within dynamic social and ecological systems; and (States of Complexity), how the variant parameters of complex systems states will have different implications for sustainability, resilience and transition, which should be analysed in detail. The framework was presented at the Canadian Society for Ecological Economics' (CANSEE) 12th Biennial Conference, in May 2019, and again at a local WICI workshop. Participants identified "big questions" that frame transition from the perspective of global systems complexities, and considered how to analyse related complex systems dynamics and structures.

The team used case studies from their own research to introduce the subject and approach, as follows: Truzaar Dordi (School of Environment, Enterprise and Development), Market Risks of Climate Change; Jonathan Hui (Balsillie School of International Affairs), Automated Economies; Kirsten Wright (Systems Design Engineering), Social Decision Models; Katharine Zywert (School of Environment, Resources and Sustainability), Low-Growth Healthcare. Through small group discussions, participants examined the topics of (Group 1, facilitated by Katharine Zywert) complex human factors of transition; (Group 2, facilitated by Truzaar Dordi) complex human-environment relationships; (Group 3, facilitated by Kirsten Wright) dynamics of and strategies for complex systems change; and, (Group 4, facilitated by Jonathan Hui) sustainable systems planning. Between two events, more than thirty (30) people were involved in the activities.

The related complex systems framework is being developed as a working paper, which might be influential in helping stimulate interdisciplinary research collaborations in the future.

OPEN FORMAT CONVERSATIONS ON COMPLEXITY – MAY TO NOVEMBER 2019

Dr. William Sutherland (WICI Scientific Advisory Committee member) volunteered to host an emergent 'curriculum/seminar' on campus, occurring every two weeks in the Summer term and twice monthly in the Fall term. Through models of mentorship and facilitation, conversations emerged and continued over the two terms, utilizing the framework of systems and complexity thinking, in the direction of creating a common language and shared experience of community. An interesting mix of 8 to 10 WICI members, students, staff and community members came forward to participate in these engaging discussions. Through these sessions, some new WICI memberships were developed, and some networking occurred. Although there was no credit or reward for participation, feedback from participants was quite positive and those who participated enjoyed the shared experience. The informal success of these sessions has reinforced that a training/education model would be well-received in the future.

2019 RESEARCH NETWORKING LUNCH FOR NEW FRONTIERS AND NSERC ALLIANCE – JULY 2019

Shirley Tang, (ADR of Science), approached WICI to co-host a networking event between the Arts, Environment and Science faculties, which WICI organized and cohosted on July 17, 2019. There were close to forty participants at this event, and a few promising connections made. WICI graduate students helped to harvest keywords on self-identified methods, application areas, and disciplines, and WICI student Perin Ruttonsha subsequently broke participants into thematic research clusters based on areas of focus, a list of which (see Appendix H), including harvested keywords, were shared with the Office of Research,

Faculty of Science, WICI and event participants. Luis Sandoval (University Research Chair II & Associate Professor, Chemical Engineering, connected through WIN) offered to provide advice/feedback to Frontiers applicants, as he was on the Frontiers panel in previous years. At the event, WICI also found out about and attempted to reach out to the Calgary Complex Systems Centre.

2019 FALL OPEN HOUSE – SEPTEMBER 2019

WICI's fall open house on September 15, 2019 welcomed a balance of new and current members and led to several important network connections. A prospective post-graduate student was connected with a potential supervisor, some new names were added to the mailing list, and an affiliate member was able to reach out to establish a new Working Group. By holding the event in the lobby of the Environment 3 building, WICI Administration was able to promote the Institute and its activities/events to a large group of students and staff, and possibly influence several new PhD students to enroll in Environment graduate studies.

COMPLEXITY, NETWORKS AND ORGANIZATIONS WORKING GROUP

WICI Member Jon Mackay contacted WICI to establish a working group as a forum to bring graduate students and interested faculty together to share knowledge and experience around complex systems scholarship and methods. Interests of participants included ecology, sustainability, network science, new approaches to business, and economics.

Meetings were organized around research presentations, journal paper discussions, and workshops around new methodologies. The group gathered to discuss how a complex systems reading/learning group might be organized and what the goals might be. Student member Jonathan Hui presented his work titled "Return of the Empires: China and the US as world ecologies" to this group on November 18, 2019.

SYNERGIES CROSS-DISCIPLINARY DESIGN COLLOQUIUM AT SCHOOL OF ARCHITECTURE

WICI graduate student Simon Leroux organized a symposium at the School of Architecture on November 21st, 2019, between the Waterloo Institute for Complexity and Innovation and University of Waterloo's School of Architecture. Graduate students from a diverse range of academic backgrounds gathered at the Cambridge campus to share related thesis topics through both formal and informal activities. The event began with a graduate research colloquium, where 14 students from the University of Waterloo and Balsillie School of International Affairs presented thesis work, followed by moderated discussions. The panels were presented in three categories: Land-use and ecologies, Narrative and System Re-Design, and Humanizing Design. Following the colloquium, a social mixer was held in the school's loft area, where food and casual conversations were had alongside showcased undergraduate and graduate projects. This 2-part event was fortunate to accommodate over 60 attendees, which included a range of faculty members, graduate and undergraduate students from Environment, Engineering, International Affairs, and Architecture. A copy of the event report is attached as Appendix I.

Since the colloquium, there have been ongoing efforts from various parties to foster stronger links across disciplines. Two Waterloo-Cambridge campus socials have been organized by the Graduate Students Association, namely "Cambridge GSA visits the Graduate House" on November 29th, 2019 and "Cambridge goes to Winter Blast: Grad Student Party" on January 31st, 2020. Regarding research opportunities, more cross-campus activities are on the horizon as the student body in Architectural Engineering grows and with the potential future expansion of the Cambridge campus. Closer engagement with multidisciplinary

initiatives such as the Collaborative Water Program and the Certificate in Structural Engineering could also bring new and exciting academic projects to fruition.
The Synergies colloquium was organized by the Design chapter of Waterloo Institute for Complexity and Innovation, WICI: Design. Due to changing cohorts following the Winter term, the branch is currently seeking new leadership.

2019 WICI MEMBER SURVEY AND VISIONING SESSION

In fall 2019, WICI sent a survey to all current members and several event participants to gage their past interaction with the Institute and solicit their thoughts on our direction moving forward. Thirty-five people completed the survey. Feedback from the survey identifies interdisciplinarity as WICI's comparative advantage, encourages WICI to strengthen our position as a Complex Systems networking hub, with a focus on training and education opportunities for students and faculty in the future. The full results from the survey (Appendix J) will be evaluated and taken into consideration when preparing our next five-year plan.

On December 3rd, 2019, WICI held a Visioning Session with open invitation for members of WICI to attend. We had 7 participants with representation from student membership (1), Core and Steering Committee members (3), Internal Affiliate members (2) and external Practitioner membership (1).

Brainstorming focused on ways to approach funding opportunities and shift WICI's direction in a way that better supports training/education/credentials and moves in a direction that expands networking and collaboration opportunities (including a national network, interdisciplinary grant applications and big research questions).

2020 MAP THE SYSTEM CHALLENGE

WICI was approached by the Kindred Credit Union Centre for Peace Advancement to co-sponsor and help promote the 2020 Map the System Challenge. Information was disseminated through WICI's membership as well as through social media accounts. Four WICI student members are registered at the time of this report, including two projects focusing on Kitchener-Waterloo rental markets and gentrification. This annual challenge is an excellent opportunity for WICI to establish a regular, recurring sponsorship that may further its institutional goals in the future.

WICI SPONSORED STUDENT RESEARCH AND TRAVEL

Kevin Church: Attendance and presentation at "SIAM Conference on Applications of Dynamical Systems" in Snowbird, Utah, May 19-23, 2019

Yu Huang: Attendance and presentation at "Canadian PhD and Early Career Workshop in Environmental and Resource Economics", Calgary, AB, June 3-4, 2019

Thomas Bury: Attendance and presentation at "CAIMS Annual Meeting" in Whistler, BC, June 9-13, 2019

Kristen Lee: Attendance and presentation at "Canadian Student Health Research Forum (CSHRF)" in Winnipeg, MB, January 10-14, 2019

2019 WICI SEED FUNDING AWARDS

ASSESSMENT-GUIDED DEVELOPMENT OF ELECTROORGANIC CO2 FIXATION TO VALUE-ADDED CHEMICALS

In April 2019, WICI awarded Anna Klinkova, University of Waterloo Assistant Professor in Chemistry, a SEED grant in the amount of $8,000, for her project "Assessment-guided development of electroorganic CO_2 fixation to value-added chemicals.

Negative carbon emission technologies are at the forefront of addressing climate change at the source. Electroorganic CO_2 fixation to produce a variety of value-added carboxylic acids (e.g., ibuprofen and other NSAED drugs, precursors for Nylon synthesis, etc.) offers a sustainable carbon utilization strategy while simultaneously providing a solution to long-term storage of renewable electricity surplus in chemical bonds. This approach has the potential to develop into a versatile technology capable of replacing current industrial processes associated with low atom economy, toxic reagents, and harsh reaction conditions with sustainable alternatives. Because such complex and versatile carbon upgrading technology is desperately needed for climate change mitigation and sustainable economic development, there is an urgent need to accelerate the transition from ideation and academic research to industrial implementation. Currently, this emerging area of research relies on a few test chemicals to validate new reactor or catalyst systems. However, it is essential to (1) rationally target industrially relevant carboxylic acids with the highest feasibility for industrial implementation and (2) rationally prioritize performance metrics goals for making the process commercially and environmentally competitive with current non-sustainable production routes.

Professor Klinkova's team proposed to develop technoeconomic and environmental assessment-guided framework for targeting of products and process performance metrics from both perspectives of feasibility and environmental benefits associated with technology transition. In the field of direct CO_2 electroreduction with a big focus on fuel production, assessment of the industrial potential of the involved technologies and their economic viability has become a part of this research movement. Even though it has never been done before, similar preliminary assessment with appropriate corrections could be applied to electrocarboxylation and other developing processes. Specifically, the novelty of this proposal is in performing such assessments early on and using them for guidance in the selection of development targets for electrocarboxylation technology.

The funding from the WICI seed grant was used to support a part-time postdoctoral fellow, Rachelle Choueiri, working on developing an early stage technoeconomic assessment method for evaluating resource, market, and technical potentials for attainable products of electrocarboxylation process (electroorganic coupling of carbon dioxide). The first iteration of the application-specific gross-margin model for defining technoeconomic benchmarks has been developed, and preliminary results for the CO_2-based syntheses of ibuprofen have been obtained to guide further method refinement. The input data was based on the experimental results obtained by the team at Waterloo (Klinkova lab) and the Sommerfeld's cost estimation method for specialty chemicals. The preliminary assessment results enabled the research team to stir the experimental efforts in the direction that maximizes the process cost efficiency. The continuation of this project has been enabled by awarded Trailblazer funding ($60,000), that allowed the team to hire a life cycle analysis postdoc, co-supervised with Robert Gibson and Goretty Dias (SEED, Faculty of Environment, University of Waterloo), who will continue developing the model and finalizing a publication on the assessment method and the results of its application. In addition, WICI seed funding partially covered the travel costs for a research visit to Monash University for developing joint efforts in the electrolyser optimization, and preparations for Australian Research Council

International Research Collaboration funding are underway. The approach applied in this work has also been partially used in preparing a funding proposal for 2020 NFRF Transformation grant by an extended team in collaboration with the University of Alberta.

TRANSATLANTIC PARTNERSHIP (TAP) SOCIAL INNOVATION PROPOSAL (WICI SEED MATCH FUNDING)

Dawn Parker (Canadian PI) received a WICI matching grant to fund a kick-off workshop for her Transatlantic Partnership Social Innovation proposal, submitted in January, 2019. The proposed work sought to investigate how social innovations (SIs) can emerge and adapt to achieve resilient housing in countries with different historical, political and cultural contexts, using agent-based social simulations (ABSSs) to compare various forms of housing-related SI. The proposed models sought to capture relevant aspects of (a) the actors involved in housing resilience projects and (b) the cross-scale dynamics and emergence of such interactions in time and space, across different environmental, cultural and historical contexts to generate insights into the leverage points that foster SI under different contextual conditions. The project engaged research partners from the UK (lead), France, Germany, the Netherlands, and Brazil. While recommended for funding, the project was not ranked highly enough to be funded given budgetary constraints. Parker's proposed case study, 'The blue-green infrastructure and residential land management' (described in detail in the 'WICI Core Research Projects' section of this report on page 12), was subsequently submitted as a Trailblazer application, with additional collaborators from Environment and Engineering. While also ranked highly, it did not qualify for funding, but resubmission was encouraged.

FINANCIAL REPORT (MAY 1, 2018 - APRIL 30, 2019)

FINANCIAL REPORT 2018-2019	BUDGETED 2018-19	Actuals 2019-20	Variance
Anticipated income			
2017-2018 Carryforward	$21,136.00	$21,136.00	$0.00
Requested UWaterloo funding	$75,000.00	$75,000.00	$0.00
TOTAL INCOME	**$96,136.00**	**$96,136.00**	**$0.00**
Anticipated expenses			
SALARIES			
Admin Assistant	$19,000.00	$19,638.66	($638.66)
IT Technician – Research Group Websites	$1,000.00	$0.00	$1,000.00
Research Assistant (GRA)	$7,988.24	$7,806.69	$181.55
SPEAKERS SERIES, WORKSHOPS AND OTHER EVENTS			
Catering for Speakers Series and Meetings	$2,000.00	$1,079.86	$920.14
Travel, Accommodation and Meals for Speakers Series	$10,000.00	$3,166.11	$6,833.89
Sponsored Workshops	$0.00	$0.00	$0.00
Promotion and Marketing	$500.00	$532.37	($32.37)
2018 Conference - Modelling Complex Urban Environments	$0.00	$11,017.41	($11,017.41)
GRANT SUPPORT EXPENSES			
Academic Stipend for WICI Director Dawn Parker	$10,000.00	$10,000.00	$0.00
OTHER RESEARCH FUNDING			
Core Members Travel for Conferences and Networking	$7,000.00	$4,384.60	$2,615.40
WICI Student Membership Initiative	$3,000.00	$780.05	$2,219.95
Student Research and Travel Grants	$5,000.00	$3,530.96	$1,469.04
WICI Awards for Student Project Symposium	$0.00	$750.00	($750.00)
WICI Partnership Match: SEED Grants	$16,000.00	$8,000.00	$8,000.00
WICI Partnership Match: Matching Grants	$15,000.00	$0.00	$15,000.00
OTHER			
IT Maintenance/Subscriptions	$1,500.00	$812.99	$687.01
Contracted Services (*including editing of publications*)	$500.00	$263.90	$236.10
Telephone Service	$240.00	$239.68	$0.32
Miscellaneous	$500.00	$292.20	$207.80
TOTAL EXPENSES BUDGETED	**$99,228.24**		
TOTAL EXPENSES TO DATE		**$72,295.48**	
PROJECTED VARIANCE AVAILABLE FOR CARRYOVER			**$26,932.76**

Notes

[1] *1016.91 in Jan for Vacation payout and training overlap

[2] Research assistantship GRA - 7,681 x 1.04 VAC for 4 months

[3] Airfare for Ricard Solevicente (April 2018) reimbursed January 10 2019

[4] paid with carryforward as originally budgeted in 2017-18

[5] $2000 carryover committed for next year; $1500 approved for V. Schweizer for 2018-19

[6] $510 for poster printing support; $720 for CANSEE registrations

[7] $500 committed for next year for a student in May

[8] One Grant awarded - $8,000 counted in carry-over projection

[9] One TAP Grant approved; $10,000 for projected carryover

WICI BUDGET 2019-20

FINANCIAL REPORT 2019-2020	BUDGETED 2019-20	Actuals May 1, 2019 - present	Committed Funds to April 2020	Variance
Anticipated income				
Carryforward from FY 2018-19	$18,413.79	$34,932.76		$16,518.97
UWaterloo funding for 2019-20	$75,000.00	$75,000.00		
TOTAL INCOME	**$93,413.79**	**$109,932.76**		**$16,518.97**
Anticipated expenses				
SALARIES				
Administrative Coordinator	$19,200.00	$15,771.41	$12,343.00	($8,914.41)
Graduate Research Assistant - Summer Student Engagement	$2,000.00	$0.00	$0.00	$2,000.00
Graduate Research Assistant - Educational Resource Development	$8,000.00	$0.00	$0.00	$8,000.00
Graduate Research Assistant - Canadian Complex Systems Mapping	$8,000.00	$8,844.50	$1,155.50	($2,000.00)
SPEAKERS SERIES, WORKSHOPS AND OTHER EVENTS				
Catering for Speakers Series and Meetings	$2,000.00	$1,442.69	$400.00	$157.31
Travel, Accommodation and Meals for Speakers Series	$5,000.00	$2,935.19	$0.00	$2,064.81
External Core Member Visits	$10,000.00	$1,869.86	$2,500.00	$5,630.14
Promotion and Marketing	$500.00	$197.80	$393.70	($91.50)
Sponsorship for Map the System 2020 Challenge	$0.00		$500.00	($500.00)
GRANT SUPPORT EXPENSES				
Research Honorarium for WICI Director Dawn Parker	$10,000.00	$0.00	$7,500.00	$2,500.00
OTHER RESEARCH FUNDING				
Core Members Travel for Conferences and Networking	$7,000.00	$3,967.80	$1,000.00	$2,032.20
Student Research and Travel Grants	$5,000.00	$2,327.59	$0.00	$2,672.41
Additional travel support for Vanessa Schweizer (as Asc. Director)	$2,000.00	$0.00	$2,000.00	$0.00
OTHER				
IT Development and Maintenance	$1,500.00	$916.61	$583.39	$0.00
Contracted Services (*including editing of publications*)	$3,000.00	$0.00	$0.00	$3,000.00
Telephone Service	$240.00	$179.55	$60.45	$0.00
Miscellaneous	$500.00	$763.75	$0.00	($263.75)
ORGANIZATIONAL DEVELOPMENT				
Institutional Development	$9,473.79	$1,337.71	$5,000.00	$3,136.08
TOTAL BUDGETED EXPENSES	**$93,413.79**			
TOTAL EXPENSES TO DATE		**$40,554.46**		
TOTAL PROJECTED EXPENSES			**$33,436.04**	
Total Budgeted Expenses Less Total Actual Expenses				$52,859.33
PROJECTED CARRY-FORWARD FOR 2020-2021				$19,423.29

Notes

[1] Uncommitted $5,000 funds from this year will be carried over.

[2] Admin hours increased from 14 to 18 effective Nov 1st

[3] Unused Summer funds applied to 2 Fall term GRA positions

[4] Jinelle being paid in Winter term to finish project and report

[5] 200 ea committed for Raja and board mtg

[6] 2,500 committed for Raj's visit in winter term

[7] Amount is prorated down from Sept 1/18 to May 31/20 (ending prior to Aug 31)

[8] $1,000 to be carried over for Grossmann and Nehaniv ($500 ea)

[9] $3000 unused funds to be carried over

[10] Student poster printing, conference supplies and student awards paid in May

[11] $5,000 committed for CARA, Complex Systems Paris, Ottawa

APPENDIX A: WICI GOVERANCE COMMITTEES

WICI BOARD

Charmaine	Dean	UW VP, University Research
James	Rush	UW VP, Academic and Provost
Deans	(or their representatives) from the primary participating faculties	
Keith	Hipel	Professor, System Design Engineering, UW
Monica	Cojocaru	Professor, Mathematics, University of Guelph
Anna	Lawniczak	Professor, Department of Mathematics & Statistics, University of Guelph
Sarah	Tolmie	Associate Professor, Department of English Language and Literature
William	Sutherland	MD, Assistant Clinical Professor (Adjunct), Family Medicine, McMaster University, and Founder and Director of the Institute for Complexity & Connection Medicine

SCIENTIFIC ADVISORY COUNCIL

W. Brian	Arthur	External Professor, Santa Fe Institute
Robert	Axtell	Professor and Chair, Dept. of Computational Social Science, George Mason University
Yaneer	Bar-Yam	President, New England Complex Systems Institute
Michael	Batty	Professor of Planning, Director, Center of Advanced Spatial Analysis, University College London
Eric	Beinhocker	Executive Director, Institute for New Economic Thinking at the Oxford Martin School, University of Oxford
Monica	Cojocaru	Associate professor, Department of Mathematics & Statistics, University of Guelph
J. Doyne	Farmer	Professor of Mathematics and Director of Complexity Economics, Institute for New Economic Thinking at the Oxford Martin School, University of Oxford
Carl	Folke	Science Director, Stockholm Resilience Centre
Ian	Goldin	Director, Oxford Martin School, Oxford University
Matthew	Hoffman	Associate professor of political science, University of Toronto
Eric	Lambin	Professor, Dept. of Geography, University of Louvain; Professor, School of Earth Sciences, Stanford University
Jukka-Pekka	Onnela	Assistant Professor of Biostatistics, Department of Biostatistics, Harvard School of Public Health
Felix	Reed-Tsochas	Co-Director of the CABDyN Complexity Centre University of Oxford
Marten	Scheffer	Professor, Aquatic Ecology, Wageningen University
Lee	Smolin	Perimeter Institute; Adjunct Professor, Dept. of Physics, UW
William	Sutherland	MD, Assistant Clinical Professor (Adjunct), Family Medicine, McMaster University, and Founder and Director of the Institute for Complexity & Connection Medicine
Leigh	Tesfatsion	Professor of Economics, Mathematics, and Electrical & Computer Engineering, Dept. of Economics, Iowa State
Jan	Wouter Vasbinder	Director of the Complexity Program at the Nanyang Technological University at Singapore

STEERING COMMITTEE

Dawn	Parker	WICI Director, Professor, School of Planning, Faculty of Environment, University of Waterloo
Igor	Grossmann	Professor, Psychology, University of Waterloo (from July 2019)
Sharon	Kirkpatrick	Associate Professor, School of Public Health & Health Systems, University of Waterloo
Chrystopher	Nehaniv	Professor, Systems Design Engineering, University of Waterloo
Stephen	Quilley	WICI Director of Development; Associate Professor, SiG, Department of Environment and Resource Studies, University of Waterloo
Vanessa	Schweizer	Assistant Professor in Knowledge Integration, University of Waterloo

APPENDIX B: PROPOSED BUDGET AND JUSTIFICATIONS FOR ONE YEAR EXTENSION OF CURRENT WICI MANDATE

UNIVERSITY OF WATERLOO | WATERLOO INSTITUTE for COMPLEXITY & INNOVATION

WATERLOO INSTITUTE FOR COMPLEXITY & INNOVATION
519-888-4567, ext. 31813
info@wici.ca | uwaterloo.ca/complexity-innovation

To: Charmaine Dean, VP research
Cc: Bernard Dunker Associate VP, Interdisciplinary Research; John Thompson (Associate VP, University Research)
From: Dawn Parker, WICI director
12 Dec. 2019
re: One-year extension request for the Waterloo Institute for Complexity and Innovation

The Waterloo Institute for Complexity and Innovation (WICI) is a cross-university research centre, founded in 2009. WICI houses UW and external faculty, practitioner, and student members. WICI received Faculty Senate approval in 2010 and was renewed in 2015. Historically, WICI has received funding from the Office of Research, with annual support from the Provost and Office of Research offices ranging from $50k to $78k. WICI is due to renew again by April, 2020. We are proposing a one-year extension of our current mandate, postponing renewal until April 2021, based on the following justification:

First, in accordance with items 4 and 5 in the Task Force for Interdisciplinarity memo, the role and assessment criteria for university research centres and institutes is under review. Consistent with the memo, in Dec. 2018 we were informed by the Office of Research that approval of any new university research centres is on hold. Second, the implications of the "new budget model," which devolves research overhead primarily to Deans, is currently under evaluation. Third, there is substantial political uncertainty under the current Provincial government, which translates into substantive budget uncertainty for Deans.

We are excited by the current directions for interdisciplinary research at UW, placing it squarely at the centre of the university's research vision. As a fundamentally interdisciplinary centre, we are confident that we can support this agenda, as demonstrated by our activities and accomplishments over the past decade. However, after ten years as a small, research-networking focused centre, we feel it is time to evaluate a broad range of possible future directions for WICI. Such future directions include possible modifications to our current model or a substantive shift in mission and activities. In discussions with WICI members over the last 15 months, we have identified three promising directions for WICI's next stage:

1. **A substantive focus on complex-systems training,** which may include cross-university core courses, a certificate, workshops, and summer schools. Members have strongly emphasized that training in the science behind complex systems targeted to students, research staff, and faculty is a missing piece on campus. The Water Institute provides a possible successful interdisciplinary training model for us to emulate.
2. **Formal development of a Canadian Network for Complex Systems (CNCS).** We envision a trans-Canada network of geographical and thematic research hubs, which will create research capacity for inter-university (and international) collaboration, responsiveness, and training/employment opportunities for students. Following a summer 2019 CNCS potential member call, strong geographic nodes are developing

EV3, 200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1

in Cascadia (led by UBC) and Montreal (led by McGill). Our call has also brought in new high-profile non-profit, government, and practitioner WICI members. We anticipate that the development of the CNCS will provide capacity for one or more *New Frontiers Transformations* grant applications in 2021.

3. **"Brand" around complex human-environment interactions:** WICI's thematic research foci are very broad, and we serve all faculties. However, a more specific focus on complex human-environment interactions would encompass the majority of current WICI scientific themes, and would retain our UW complex-systems strength in sustainable socio-ecological systems, environment and health, managing "wicked problems", and health science applications.

We would like to explore these directions and ensure we have a sustainable budget model in place prior to renewal. Specifically, these directions will provide a strong portfolio to secure external funding. To date, our inability to oversee grants and capture overhead has made it challenging for WICI to achieve financial independence. While many WICI members have strong industry partner research portfolios, with complex systems science's strong focus on novel basic science, interdisciplinarity, and high-risk/high-gain research, industry partnership funding opportunities may be lower for WICI than for other university research centres.

An extension will also allow us to work with OR and the Provost's office to ensure that WICI's future directions fit with and further the University's evolving vision for education and research, including the new Strategic Plan. It will allow full exploration of WICI participation in a CIHR training grant (LOI submitted), a potential new research collaboration with Canadian Mortgage and Housing Corporation, and collaboration with the developing Cascadia and Montreal complex systems nodes.

We are requesting, with this extension, a one-year (slightly reduced) budget award for FY 2020-21 of $70k. A justification follows, referring to the enclosed proposed budget spreadsheet:

Carry-over: The substantive carry-over anticipates we have the opportunity to take time to investigate the new directions outlined above. Specifically, we budgeted for four external core member visits this year, but have so far had only one, with another one anticipated in winter or spring term. We are moving a GRA to work on educational resource development to Spring Term so that incoming Associate Director Vanessa Schweizer (Knowledge integration) can supervise the GRA. We further budgeted for institutional development activities (Parker visit to the Canadian Associate of Research Administrators, visits to additional international complex systems centres, and a kick-off meeting for CNCS), which would more rationally take place during FY 2020-21. Our external speaker costs are lower than anticipated, as we managed to do cost sharing for 3 talks, and decided not to bring in a 4th speaker. The carry-over further includes a $5000 grant match, for a grant that was not awarded. Finally, we budgeted $10k for the director honorarium, but only $7500 was awarded, due to Parker's pro-rated term.

Administrative Coordinator: As member-lead initiatives and invitations to co-host speakers and events have increased, we found our original 14 hours per week was not

adequate. Thus, we propose to continue with Brenda Panasiak in an 18 hour per week administrative role.

GRAs: The first rolled-over educational GRA will inventory WICI's ten-year archive to curate our taped lectures into learning modules, take stock of the university's in-house capacity for training in complex systems, and develop a strategy for the delivery of educational resources. Our current GRA is using advanced text and network analysis bibliometric tools to map the network of UW and Canadian complex systems scholars, identify thematic areas, and map the evolution of communities through time. We expect the results will identify the depth of complex systems scholarship on campus and demonstrate he potential contributions of CNCS. From a research methods standpoint, the project will demonstrate cutting-edge complex systems "big data" bibliometric analysis. We seek additional resources to see this task through. We seek an additional GRA to harness our growing pan-Canada CNCS network to organize readings courses, workshops, and summer schools, drawing upon inter-university talent.

Speaker Series/Colloquia: Although the administrative burden of hosting talks is high, our members consistently rate these activities as a source of value. To reduce costs and administrative time, we propose to streamline our events:

- Host up to two co-sponsored talks with other centres or units, splitting expenses and administrative support. For instance, in the last year, we extended a joint invitation with WIN to Andrew Maynard from ASU (unfortunately not accepted due to his prior commitments), will co-sponsor a talk with the Waterloo Center for Microbiology, and are co-sponsoring the Map the System challenge with the Centre for Peace Advancement;
- Carry over two planned external core member visits (which include public talks);
- Continue to provide administrative support and catering for one-off or regular member-lead events (such as the recent Synergies colloquium at the School of Architecture, or William Sutherland's Complexity Conversations.)

Other research funding:

- We plan to continue the director's $10k honorarium and the AD's $2k travel award. We receive no direct benefits, financial or modified appointment split, for our administrative contributions. These funds allow us both to continue to advance our individual research programs in complex systems.
- We have cut our core member travel (formerly $500 a year), and instead are giving $500 to the steering committee members other than the Director and AD (3)
- We would like to maintain our student travel funding. Uptake for these funds are high, as is impact, measured through training benefits, conference papers and media exposure. Previous recipients have also presented as WICI speakers.

Organizational Development: The proposed carry-over is intended for planned activities including Parker's attendance at the Canadian Network for Research Administrators, a possible visit to Ottawa, possible visits to other national complex systems network in other countries (e.g., the Netherlands), and a possible match for a

kick-off workshop for the CNCS/grant development workshop for *New Frontiers Transformation* grant. We would also like to reserve $2500 for ad-hoc support requests, such as Fields Institute workshop matches, student initiatives, small internal matches. Historically it has been very useful to leverage WICI funds for these purposes.

Other has been adjusted according to expenses in recent years, but remains somewhat unchanged.

BUDGET 2020-2021

Anticipated income	
Anticipated 2019-20 Carryforward	$18,950.00
UWaterloo requested funding for 2020-2021	$70,000.00
TOTAL INCOME	**$88,950.00**
Anticipated expenses	
SALARIES	
Administrative Coordinator	$25,055.96
Graduate Research Assistant - Educational Capacity/Resource Development	$8,000.00
Graduate Research Assistant - Network mapping	$8,000.00
Graduate Research Assistant - Educational Capacity/Resource Development	$8,000.00
SPEAKERS SERIES, WORKSHOPS AND OTHER EVENTS	
Catering for Speakers Series and Meetings	$2,000.00
Travel, Accommodation and Meals for Speakers Series	$3,000.00
External Core Member Visits	$4,000.00
Promotion and Marketing	$250.00
GRANT SUPPORT EXPENSES	
Research Honorarium for WICI Director Dawn Parker	$10,000.00
OTHER RESEARCH FUNDING	
Steerinig committee Members Travel for Conferences and Networking	$1,500.00
Student Research and Travel Grants	$5,000.00
Additional travel support for Vanessa Scheweizer (as Asc. Director)	$2,000.00
OTHER	
IT Development and Maintenance (*includes yearly account subscriptions, software, etc.)*	$1,250.00
Contracted Services (*including editing of publications*)	$1,500.00
Telephone Service	$240.00
Miscellaneous	$750.00
ORGANIZATIONAL DEVELOPMENT	
Institutional Development	$4,500.00
DP -- ad-hoc event support requests	$2,500.00
TOTAL EXPENSES	**$87,545.96**

Variance $1,404.04

APPENDIX C: 2019 PRODUCTIVITY REPORT - DETAILS OF INDIVIDUAL CORE WICI-RELATED ACTIVITIES

NAME	CONTRIBUTIONS
Chris Bauch	***Publications*** V.A. Thampi, **C.T. Bauch**, M. Anand (2019). `Socio-ecological mechanisms for persistence of native Australian grasses under pressure from nitrogen runoff and invasive species'. ECOLOGICAL MODELLING, **413:**108830. [PDF]  M.C. Fitzpatrick, **C.T. Bauch**, J.P. Townsend, A.P.Galvani (2019). `Modelling microbial infection to address global health challenges'. NATURE MICROBIOLOGY, **4(10):**1612-1619. P.V.S. Souza, R. Silva, D. Girardi, **C.T. Bauch** (2019). `Cooperation in a generalized age-structured spatial game'. JOURNAL OF THEORETICAL BIOLOGY, **109995**.  R. Sigdel, M. Anand, **C.T. Bauch** (2019). `Convergence of socio-ecological dynamics in disparate ecological systems under strong coupling to human social systems'. THEORETICAL ECOLOGY, **12(3):**285-296. T. Bury, **C.T. Bauch**, M. Anand (2019). `Charting pathways to climate change mitigation in a coupled socio-climate model'. PLOS COMPUTATIONAL BIOLOGY, **15(6)**: e1007000.  S. Nowack, **C.T. Bauch**, M. Anand (2019). `A local optimization framework for addressing conservation conflicts in mosaic ecosystems'. PLOS ONE, **14(5)**:e0217812. S. Bhattacharyya, A. Vutha, **C.T. Bauch** (2019). `The impact of rare but severe vaccine adverse events on behaviour-disease dynamics: a network model'. SCIENTIFIC REPORTS, **9(1)**: 7164.  M.A. Andrews, **C.T. Bauch** (2019). `Parameterizing a dynamic influenza model using longitudinal versus age-stratified case notifications yields different predictions of vaccine impacts'. MATHEMATICAL BIOSCIENCES AND ENGINEERING, **16(5)**: 3753-3770. B. Morsky, **C.T. Bauch** (2019). `The impact of truncation selection and diffusion on cooperation in spatial games'. JOURNAL OF THEORETICAL BIOLOGY, **466**: 64-83.  Z. Dockstader, **C.T. Bauch**, M. Anand (2019). `Interconnections accelerate collapse in a socio-ecological metapopulation'. SUSTAINABILITY, **11(7)**: 1852.
Mark Crowley	***Publications*** Sushrut Bhalla, Matthew Yao, Jean-Pierre Hickey and Mark Crowley (presented). “Compact Representation of a Multi-dimensional Combustion Manifold Using Deep

Neural Networks", *European Conference on Machine Learning (ECML-19)*. 8 pages. Wurzburg, Germany. September, 2019.

Juan Carrillo, Mark Crowley, Guangyuan Pan, Liping Fu. "Comparison of Deep Learning models for Determining Road Surface Condition from Roadside Camera Images and Weather Data". In *The Transportation Association of Canada and Intelligent Transportation Systems Canada Joint Conference (TAC-ITS)*. 17 pages. Halifax, Canada, July 2019.

Benyamin Ghojogh, Fakhri Karray, Mark Crowley. "Locally Linear Image Structural Embedding for Image Structure Manifold Learning (LLISE)". *16th International Conference on Image Analysis and Recognition (ICIAR-19)*. 12 pages. Waterloo, Canada, August 27-29, 2019.

Benyamin Ghojogh, Fakhri Karray, Mark Crowley. "Principal Component Analysis *on Image Analysis and Recognition (ICIAR-19)*. 12 pages. Waterloo, Canada, August 27-29, 2019.

Benyamin Ghojogh , Fakhri Karray, Mark Crowley. "Image Structure Subspace Learning Using Structural Similarity Index (SSIM-M)". *16th International Conference on Image Analysis and Recognition (ICIAR-19)*. 12 pages. Waterloo, Canada, August 27-29, 2019.

Sushrut Bhalla, Sriram Ganapathi Subramanian, Mark Crowley. "Learning Multi-Agent Communication with Reinforcement Learning". In *Conference on Reinforcement Learning and Decision Making (RLDM-19)*. 4 pages. Montreal, Canada, July 2019.

Publications in Press

Colin Bellinger, Rory Coles, Mark Crowley and Isaac Tamblyn. "Reinforcement Learning in a Physics-Inspired Semi-Markov Environment". To appear in *Canadian Conference on Artificial Intelligence*. 12 pages. Ottawa, ON, Canada, May 12-15, 2020.

Sushrut Bhalla, Sriram Ganapathi Subramanian and Mark Crowley. "Deep Multi Agent Reinforcement Learning for Autonomous Driving". To appear in *Canadian Conference on Artificial Intelligence*. 12 pages. Ottawa, ON, Canada, May 12-15 2020.

Benyamin Ghojogh, Fakhri Karray and Mark Crowley. "Anomaly Detection and Prototype Selection Using Polyhedron Curvature". To appear in *Canadian Conference on Artificial Intelligence*. 12 pages. Ottawa, ON, Canada, May 12-15 2020.

Keynote Presentations

'Automated Material Synthesis using Deep Reinforcement Learning'. **AI for Design Challenge Conference, National Research Council, Ottawa, October 17, 2019.**

Other Presentations

'Machine Learning for Modelling and Decision Making in Complex Physical Domains '. Centre for Artificial Intelligence Decision-making and Action (CAIDA) Seminar Series, University of British Columbia, Vancouver, Nov 4, 2019.

'Automated Material Synthesis using Deep Reinforcement Learning'. AI for Design Challenge Workshop, National Research Council, Ottawa, October 17, 2019.

'Machine Learning for Modelling and Decision Making in Complex Physical Domains'. Insight Centre for Data Analytics, University College Dublin, Dublin, Ireland, Sep 25, 2019.

'Artificial Intelligence on Fire!'. Waterloo Artificial Intelligence Institute Seminar Series, University of Waterloo, Sept 12, 2019.

'The Economics of Artificial Intelligence'. Panelist: Waterloo Symposium on Technology and Society, Centre for Security and Governance. May 19, 2019.

'Artificial Intelligence on Fire!'. EECS Department Invited Seminar Series, York University, Toronto, Sept 12, 2019.

'Adaptation Through Learning : Using Machine Learning to Improve Forest Wildfire Management'. Re-Work Deep Learning Summit, San Francisco, Jan 24-25, 2019.

Workshop/Conference Organization

Local Organizer for the annual conference on **Image Analysis and Recognition (ICIAR 2019)**. This conference was held at the University of Waterloo in August 2019. I am working with the programming committee to co-ordinate the local arrangements for the conference including acting as the main host of proceedings during the technical program.

Media Outreach

The Waterloo Record - https://www.therecord.com/news-story/9766881-waterloo-professor-says-artificial-intelligence-is-a-useful-tool-to-help-fight-wildfires/

The Scientist magazine - https://www.the-scientist.com/features/artificial-intelligence-tackles-a-world-of-images-65793

Wired Magazine - https://www.wired.com/story/how-supercomputers-can-help-fix-our-wildfire-problem/

ITU AI for Good Summit - https://uwaterloo.ca/stories/waterloo-innovation-summit-addresses-climate-change

Honours, Distinctions and Awards

Best paper ward: The paper with my student Juan Manuel Carrillo Garcia "Integration of roadside camera images and weather data for monitoring winter road surface conditions." Won the best paper award at the *Canadian Association of Road Safety Professionals (CARSP)* conference in Calgary, Alberta in May of 2019.

Peter Deadman	***Publication in Press*** Y. Dou, P. Deadman, M. Berbes, Pathways out of poverty through the lens of development resilience : an agent-based simulation. Submittted to Ecology and Society ***Presentations*** Mirnasl N., P. Deadman, A. Frank. Does crop rotation have significant impact on water quality? GWF 2ndAnnual Open Science Meeting, May 15 – 17 2019, Saskatoon, SK. Frank A., P. Deadman, D. Robinson, R. de Loe, R. Brouwer. Science for decision making: are we set to provide it? GWF 2ndAnnual Open Science Meeting, May 15 – 17 2019, Saskatoon, SK.
Igor Grossmann	***Publications*** **Grossmann, I**., Eibach, R. P., Koyama, J., & Sahi, Q. (2020). Folk standards of sound judgment: Rationality vs. Reasonableness. *Science Advances, 6*(2), eaaz0289. doi: 10.1126/sciadv.aaz0289 **(12.80)** **Grossmann, I.**, Dorfman, A., & Oakes, H. (2020). Wisdom is a social-ecological rather than person-centric phenomenon. *Current Opinion in Psychology*, *20*, 66-71. doi: 10.1016/j.copsyc.2019.07.010 **(SJR 1.61)** Huynh, A. C. & **Grossmann, I.** (2020). A pathway to wisdom-focused education. *Journal of Moral Education, 49*, 9-29. doi: 10.1080/03057240.2018.1496903 (**1.02**) Ko, A., Pick, C., Kwon, J. Y., Barlev, M., Krems, J. A., Varnum, M. E. W., Neel, R., Peysha, M., Boonyasiriwat, W., Brandstätter, E., Vasquez, J. E. C., Galindo, O., Pereira de Felipe, R., Crispim, A. C., Fetvadjiev, V. H., Fischer, R., Karl, J., David, D., Galdi, S., Gomez-Jacinto, L., **Grossmann, I**. ... & Kenrick, D. T. (2020). Family Matters: Rethinking the Psychology of Human Social Motivation. *Perspectives on Psychological Science, 15*, 173-201. doi: 10.1177/1745691619872986 (**7.51**) Dorfman, A., Oakes, H., Santos, H. C. **& Grossmann, I.** (2019). Self-distancing promotes positive emotional change after adversity: Evidence from a micro-longitudinal field experiment. *Journal of Personality*. doi: 10.1111/jopy.12534 (**3.08)** Na, J.*, **Grossmann, I**.*, Varnum, M. E.W., Karasawa, M., Cho, Y., Kitayama, S., & Nisbett, R. E. (2019). Culture and personality revisited: Behavioral profiles and within-person stability in interdependent (vs. independent) social orientation and holistic (vs. analytic) cognitive style. *Journal of Personality.* doi: 10.1111/jopy.12536 (**3.08)** *****corresponding authors Ferrari, M., **Grossmann, I**., Grimm, S., & Staffel, J. (2019). A process model of wisdom from adversity. *The Journal of Value Inquiry*, *5*, 471-473. doi: 10.1007/s10790-019-09711-7.

Grossmann, I., Oakes, H. & Santos, H. C. (2019). Wise reasoning benefits from emodiversity, irrespective of emotional intensity. *Journal of Experimental Psychology: General, 148*(5), 805-823. doi: 10.1037/xge0000543 (**5.78**)

Huh, M., **Grossmann, I.**, & Friedman, O. (2019). Children show reduced trust in confident advisors who are partially-informed. *Cognitive Development*, 50, 49-55. doi: 10.1016/j.cogdev.2019.02.003 (**2.00)**

Varnum, M. E. W. & **Grossmann, I.** (2019). The wealth→life history→innovation account of the Industrial Revolution is largely inconsistent with empirical time series data. *Behavioral and Brain Sciences, 42*, e212. [commentary] (**14.20**) doi: 10.1017/S0140525X19000086

Publications in Press

Grossmann, I., Weststrate, N. M., Ardelt, M., Brienza, J. P., Dong, M., Ferrari, M., Fournier, M. A., Hu, C. S., Nusbaum, H. C. & Vervaeke, J. (in press). Wisdom Science in a Polarized World: Knowns and Unknowns. *Psychological Inquiry.* [target article] **(10.27)**

Presentations

Invited Webinar for the *European Society for Research in Adult Development*, UK (2019, October)

Grossmann, I. & Dorfman, A. (2019, August). *Wisdom, self-distance, and adversity.* Paper presented at the capstone conference of the Pathways to Character Initiative at Wake Forest University, Winston-Salem, North Carolina.

School of Psychology, Higher School of Economics, Moscow, Russia (2019, June)

University-wide lecture, Moscow Psychological Pedagogical University, Russia (2019, June)

Grossmann, I., Dorfman, A., Oakes, H., Santos, H. C. & Scholer, A. (2019, June). *Wisdom training: Self-distancing training promotes growth in wise reasoning and emodiversity.* Paper presented in the symposium "A process view on wisdom: Antecedents, mechanisms, and consequences" chaired by A. Dorfman at the biennial conference of the Association for Research in Personality, Grand Rapids, Michigan.

Dorfman, A., Oakes, H. & **Grossmann, I.** (2019, June). *Wisdom in conflict: How rejection sensitivity and power positions influence wise-reasoning.* Paper presented in the symposium "A process view on wisdom: Antecedents, mechanisms, and consequences" chaired by A. Dorfman at the biennial conference of the Association for Research in Personality, Grand Rapids, Michigan.

Turpin, M. H., Walker, A. C., Białek, M., Fugelsang, J. A., & **Grossmann, I.** (2019, June). *Why we hate utilitarians: The search for predictable moral partners.* Paper presented in the symposium "Decision Making" chaired by J. Fugelsang at the 29th Annual Meeting of the Society for Canadian Brain, Behaviour, and Cognitive Science, Waterloo, Ontario.

Invited workshop at the "Tabula Rasa: Neuroscienze e culture" conference of the Intercultura Foundation in Florence, Italy (2019, April)

Invited flash talk at the Sixth Annual Conference of the Society for Affective Science, Boston, USA (2019, March)

Grossmann, I. & Varnum, M. E.W. (2019, February). *Can we foresee the future? Challenges in explaining and predicting social cultural change.* Paper presented in the symposium "The promise and limits of long-term social change" chaired by T. Charlesworth at the 20th Annual Society for Personality and Social Psychology Conference, Portland, Oregon.

Huynh, A. C. & **Grossmann, I.** (2019, February). *Explaining and discussing your political views to others: Does it encourage inclusive reasoning?* Paper presented in the symposium "Understanding civil discourse: Predictors, outcomes, and indicators of intellectual humility" chaired by B. Meagher (Chair) at the 20th Annual Society for Personality and Social Psychology Conference, Portland, Oregon.

Grossmann, I. & Brienza, J. P. (2019, January). *Wisdom and social class.* Paper presented at the Jubilee Centre for Character and Virtues, Oriel College, Oxford, UK.

Invited talk at The Jubilee Centre for Character and Virtues, University of Birmingham, UK (2019, January)

Workshops Organized

Organizing Committee of the *Cultural Psychology Pre-Conference* at the 20th and 21st Annual Conference of the Society for Personality and Social Psychology

Organizer of the *First Pan-Asian Summit on Wisdom, Morality and Character IN the Polarized World*, to take place in Colombo, Sri Lanka (2020)

Organizer of the Toronto Wisdom Task Force Meeting
Small conference of leading empirical scholars to identify the core components of wisdom in empirical sciences

Op-Eds/Magazine Articles

Grossmann, I., & Eibach, R. P. (2020, January). When "Reasonable" Trumps "Rational." *Scientific American*. https://blogs.scientificamerican.com/observations/when-reasonable-trumps-rational/

Grossmann, I., Dorfman, A., & Moscovitch, D. (2019, January). A pathway to wisdom in the face of adversity: Type of self-reflection matters. *Pathway to Character Project.* http://pathwaystocharacter.org/a-pathway-to-wisdom-in-the-face-of-adversity-type-of-self-reflection-matters/

Media Outreach: Radio/Print Interviews

	https://scienceadvances.altmetric.com/details/73763246/news https://www.sciencemag.org/podcast/squeezing-two-people-mri-machine-and-deciding-between-what-s-reasonable-and-what-s-rational https://kitchener.ctvnews.ca/spock-versus-yoda-waterloo-researchers-determine-who-is-more-wise-1.4274129 https://digest.bps.org.uk/2019/12/11/why-fear-of-rejection-prevents-us-from-making-wise-decisions/ https://www.abc.net.au/radionational/programs/allinthemind/why-smart-people-do-stupid-things/11747416 https://aeon.co/ideas/why-speaking-to-yourself-in-the-third-person-makes-you-wiser https://www.mnn.com/lifestyle/arts-culture/stories/who-wiser-spock-or-yoda-actual-scientific-study-weighs https://www.dailymail.co.uk/sciencetech/article-6641573/The-secret-wise-better-Yoda-Spock-researchers-say.html https://thriveglobal.com/stories/how-the-concept-ubuntu-can-teach-you-3-ways-to-take-better-care-of-yourself-wisdom-wellness-connection/ https://247wallst.com/media/2019/08/15/referring-to-yourself-in-the-third-person-might-be-a-good-thing/ https://gulfnews.com/world/europe/why-smart-minds-get-it-wrong-1.62481844 https://lifehacker.com/talk-to-yourself-in-the-third-person-for-improved-clari-1837084747 ***Honours, Distinctions and Awards*** Joseph B. Gittler Award from the American Psychological Foundation *The Gittler Award recognizes the most scholarly contribution to the philosophical foundations of psychological knowledge* SAGE Young Scholars award from the Society for Personality and Social Psychology *The Sage Young Scholar Awards recognize outstanding achievements by young scholars who are early in their research careers, recognizing their accomplishments and potential*
Keith Hipel	***Publications*** Zhao, S., Xu, H., Hipel, K.W., and Fang, L., “Mixed Stabilities for Analyzing Opponents’ Heterogeneous Behavior within the Graph Model for Conflict Resolution”, European Journal of Operational Research, DOI: 10.1016/j.ejor.2019.02.043, Vol. 277, No. 2, pp. 621-632, 2019.

Silva, M.M., Hipel, K.W., Kilgour, D.M., and Costa, A.P.C.S., "Strategic Analysis of a Regulatory Conflict Using Dempster-Shafer Theory and AHP for Preference Elicitation", Journal of Systems Science and Systems Engineering, DOI: 10.1007/s11518-019-5420-1, Vol. 28, No. 4, pp. 415-433, 2019.

Zhao, J., Xu, H., Hipel, K.W., and Yang, B., "Theory and Implementation of Sensitivity Analyses Based on their Algebraic Representation in the Graph Model", Journal of Systems Science and Systems Engineering, DOI: 10.1007/s11518-019-5412-1, Vol. 28, No. 5, pp. 580-601, 2019.

Aljefri, Y., Fang, L., Hipel, K.W., and Madani, K., "Strategic Analyses of the Hydropolitical Conflicts Surrounding the Grand Ethiopian Renaissance Dam", Group Decision and Negotiation, DOI: 10.1007/s10726-019-09612-x, Vol. 28, No. 2, pp. 305-340, 2019.

Wang, J., Hipel, K.W., Fang, L., Xu, H., and Kilgour, D.M. "Behavioral Analysis in the Graph Model for Conflict Resolution", IEEE Transactions on Systems, Man, and Cybernetics: Systems, DOI: 10.1109/TSMC.2017.2689004, Vol. 49, No. 5, pp. 904-916. 2019.

Garcia, A., Hipel, K.W., and Obeidi, A., "Classifying Metarational Stabilities in Conflicts", Journal of Systems Science and Systems Engineering, DOI: 10.1007/s11518-019-5408-x, Vol. 28, No. 3, pp. 265-284, 2019.

Sabtan, B., Kilgour, D.M., and Hipel, K.W, "Assessing the Effectiveness of Economic Sanctions", EURO Journal of Decision Processes, DOI: 10.1007/s40070-019-00096-3, Vol. 7, No.1-2, pp. 69-82, 2019.

Langenegger, T.W. and Hipel, K.W., "The Strategy of Escalation and Negotiation: The Iran Nuclear Dispute", Journal of Systems Sciences and Systems Engineering, DOI: 10.1007/s11518-019-542-1, Vol. 28, No. 4, pp. 434-448, 2019.

Aljefri, Y., Fang, L., Hipel, K.W., and Madani, K., "Strategic Analyses of the Hydropolitical Conflicts Surrounding the Grand Ethiopian Renaissance Dam", Group Decision and Negotiation, DOI: 10.1007/s10726-019-09612-x, Vol. 28, No. 2, pp. 305-340, 2019.

Talukder, B. and Hipel, K.W., "Diagnosis of Sustainability of Trans-Boundary Water Governance in the Great Lakes Basin", World Development, DOI: 10.1016/j.worlddev2019.104855. Accepted for publication on December 18, 2019. 12 pp.

Zhang, X., Hipel, K.W., Ge, B., and Tan, Y., "A Game-theoretic Model for Resource Allocation with Deception and Defense Efforts", Systems Engineering, DOI: 10.1002/sys.21479, Vol. 22, No. 3, pp. 282-291, 2019.

Publications in Press

	Hipel, K.W., Fang, L., and Kilgour, D.M., "The Graph Model for Conflict Resolution: Reflections on Three Decades of Development", Group Decision and Negotiation, DOI: 10.1007/s10726-019-09648-z, published online on December 20, 2019, 50 pp. Zhao, S., Xu, H., Hipel, K.W., and Fang, L. "Mixed Coalition Stabilities with Full Participation of Sanctioning Opponents within the Graph Model for Conflict Resolution", IEEE Transactions on Systems, Man, and Cybernetics: Systems, DOI: 10.1109/TSMC.2019.2950673, published online on November 16, 2019, 15 pp. Yu, J., Hipel, K.W., Kilgour, D.M., Fang, L., and Yin, K., "Graph Model under Unknown and Fuzzy Preferences", IEEE Transactions on Fuzzy Systems, DOI: 10.1109/TFUZZ.2019.2905222, 14 pages, accepted for publication on March 7, 2019. He, S., Kilgour, D.M., and Hipel, K.W., "A Three Level Hierarchical Graph Model for Conflict Resolution", IEEE Transactions on Systems, Man, and Cybernetics: Systems, DOI: 10.1109/TSMC.2019.2897176, accepted for publication on January 18, 2019. Zhang, X. Hipel, K.W., and Tan, Y., "Project Portfolio Selection and Scheduling under a Fuzzy Environment", Memetic Computing, DOI: 10.1007/s12293-019-00282-5 accepted for publication on February 25, 2019. ***Workshops/Conferences Organized*** One of the Conference General Chairs for the *8th International Conference on Water Resources and Environment Research (ICWRER 2019)*, which was held in Nanjing, China, from June 14 to 18, 2019. ***Media Outreach*** 5 top researchers granted the 2019 Killam Prize – considered 'Canada's Nobel' award, Ideas, CBC Radio, September 6, 2019. https://www.cbc.ca/radio/ideas/5-top-researchers-granted-the-2019-killam-prize-considered-canada-s-nobel-award-1.5273788 ***Honours, Distinctions and Awards*** *Killam Prize in Engineering* from the Canada Council for the Arts (2019) *China Friendship Award*, People's Republic of China (2019) *IEEE Life Fellow*, from José J.F. Moura, IEEE President and CEO (2019)
Thomas Homer-Dixon	***Publication in Press*** *Commanding Hope: The Power We Have to Renew a World in Peril* (Toronto: Knopf Canada, 2020).
Sharon Kirkpatrick	***Publications*** de Vlieger NM, Weltert M, Molenaar A, McCaffrey TA, Rollo ME, Truby H, Livingstone B, **Kirkpatrick SI**, Boushey CJ, Kerr DA, Collins CE, Bucher T**.** A systematic review of

recall errors associated with portion size estimation aids in children. Appetite, Epub ahead of print. PubMed.

Lee KM*, Marcinow ML*, Minaker LM, **Kirkpatrick SI**. The healthfulness of eateries at the University of Waterloo: A comparison across two time points. Canadian Journal of Dietetic Practice and Research, Epub ahead of print. PubMed.

Solbak NM, Rajabi AA, Akawung AK, Lo Siou G, **Kirkpatrick SI**, Robson PJ. Strategies to address misestimation of energy intake based on self-report dietary consumption in examining associations between dietary patterns and cancer risk. Nutrients, 2019, 11(11). pii: E2614. doi: 10.3390/nu11112614. PubMed.

Jones A, **Kirkpatrick SI**, Hammond D. Beverage consumption and energy intake among Canadians: analyses of 2004 and 2015 national dietary intake data. Nutrition Journal, 2019, 18(1):60. doi: 10.1186/s12937-019-0488-5. PubMed.

Kirkpatrick SI, Baranowski T, Subar AF, Tooze JA, Frongillo EA. Best practices for conducting and interpreting studies to validate self-report dietary assessment methods. Journal of the Academy of Nutrition and Dietetics. 2019, 119(11):1801-1816. doi: 10.1016/j.jand.2019.06.010. PubMed.

Kirkpatrick SI, Vanderlee L, Dias GM, Hanning RM. Can food-based dietary guidelines support transformation of the food system to foster human and planetary health? UNSCN Nutrition, 2019. View.

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Publications in Press

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Keynote Presentations

Kirkpatrick SI. Measurement error in dietary intake data: Considerations and mitigation strategies. Norwegian Association of Dietitians 2019 Annual Conference. Bergen, Norway. 2019.

Other Presentations

Kirkpatrick SI. Food literacy. Standing Senate Committee on Agriculture and Food. 2019.

Kirkpatrick SI. The centrality of measurement error modelling to advances in nutritional epidemiology. 2019 Joint Statistical Meetings. Denver, Colorado. 2019.

Kirkpatrick SI. Measurement needs (discussant). Advancing Measurement of Individual Behaviors Related to Childhood Obesity. National Collaborative on Childhood Obesity Research. Washington, DC. 2019.

Kirkpatrick SI. Elucidating the complexity of dietary patterns. Artificial Intelligence and Health Sciences. University of Waterloo-Université de Bordeaux Joint Workshop. Bordeaux, France. 2019

Kirkpatrick SI. Dietary assessment: Challenges and future directions. Centre for Nutrition, University of Bergen. Bergen, Norway. 2019.

Samuels A, **Kirkpatrick SI**. Towards improved measurement of individual diet behaviors and food environment exposures: Resources from the National Collaborative on Childhood Obesity Research. Healthy Eating Research Grantee Meeting, Detroit, MI. 2019.

Raffoul A*, Hammond D, Kelly A, **Kirkpatrick SI**. Beyond the numbers: Young adults' lived experiences of calorie labelling in relation to disordered eating. Body Peace Virtual Conference, 2019.

Korczak DJ, Perruzza S, Chandrapalan M, **Kirkpatrick SI**, Tracey M, Cost K, Cleverley K, Birken C, McCrindle BM. A comparative analysis of dietary quality assessed using different measures in relation to depression among children and adolescents. International Society of Nutritional Psychiatry Research, 2019, London, UK.

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Raffoul A*, Rynard V, Goodman S, Hammond D, **Kirkpatrick SI**. Are weight management intentions and weight perceptions related to dietary quality among young adults? An analysis of the Canada Food Study. International Society of Behavioral Nutrition and Physical Activity Annual Meeting, 2019, Prague, Czech Republic.

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understanding of diet quality. International Society of Behavioral Nutrition and Physical Activity Annual Meeting, 2019, Prague, Czech Republic.

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Sharpe I, Smith B, Anderson LN, **Kirkpatrick SI**. Measuring intake of sugars and sugar-containing beverages among young children: A pilot study evaluating the use of the Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24) for administration to parents. Canadian Society for Epidemiology and Biostatistics, 2019, Ottawa, ON.

Lee KM*, Marcinow M*, Minaker LM, **Kirkpatrick SI**. Campus food environments require improvements to foster healthy eating among students. Canadian Nutrition Society Annual Meeting, 2019, Niagara Falls, ON.

Andrade L*, Lee KM*, Stapleton J, **Kirkpatrick SI**. Is increasing use of low-calorie sweeteners a cause for concern? A rapid review of systematic reviews. Canadian Nutrition Society Annual Meeting, 2019, Niagara Falls, ON.

Price M*, Ferro MA, Raffoul A*, Meyer SB, Hanning R, Hammond D, **Kirkpatrick SI**. Evidence for a holistic approach to conceptualizing weight loss behaviours: Going beyond the healthy versus unhealthy dichotomy. Canadian Nutrition Society Annual Meeting, 2019, Niagara Falls, ON.

Bhawra J, **Kirkpatrick SI**, Hammond D. Correlates of food insecurity among Canadian youth and young adults: Results from the Canada Food Study. Public Health 2019, 2019, Ottawa, ON.

Raffoul A*, Hammond D, Rynard V, Goodman S, **Kirkpatrick SI**. Exploring the relationship between weight management, weight perception, and dietary quality among Canadian young adults. Canadian Obesity Summit 2019, 2019, Ottawa, ON.

Workshop/Conference Organization

Kirkpatrick SI. Enhancing the measurement of dietary behaviours and food environments in research with children. Canadian Nutrition Society Annual Meeting, 2019, Niagara Falls, ON.

Kirkpatrick SI. Demystifying language and breaking down barriers in complexity science and methods. University of Waterloo, 2019, Waterloo, ON.

Honours, Distinctions and Awards

	Highly Cited Researcher (ranking in the top 1% by citations for field and publication year in the Web of Science) Outstanding Reviewer, Journal of the Academy of Nutrition and Dietetics
Chrystopher Nehaniv	***Publications*** Förster, F., Saunders J., Lehmann, H., Nehaniv, C. 'Robots Learning to Say "No" Prohibition and Rejective Mechanisms in Acquisition of Linguistic Negation', *ACM Transactions on Human-Robot Interaction (THRI)* 8 (4), 1-26, Dec. 2019. Broz, F., Nehaniv, C., Kose, H., Dautenhahn, K., 'Interaction Histories and Short-Term Memory: Enactive Development of Turn-Taking Behaviours in a Childlike Humanoid Robot', *Philosophies: Special Issue Frontiers of Embodied Artificial Intelligence: The (r-)evolution of the embodied approach in AI*, 4(2), June 2019. Nehaniv, C. (2019). 'Constructive Biology of Emotion Systems: First-and Second-Person Methods for Grounding Adaptation in a Biological and Social World', In : *Cognitive Architectures*, Springer Verlag Robu, A., Salge, C., Nehaniv, C., Polani, D. 'Measuring Time with Minimal Clocks', *Artificial Life* 25(4) : 383-409. November 2019. Foerster, F., Nehaniv, C., Saunders, J., Lehmann, H., 'Example recordings of human-robot interactions in the rejection and prohibition experiments', University of Hertfordshire Research Archive, 29 August 2019. [Dataset] ***Publications In Press*** Frank Förster, F., Dautenhahn, K., Nehaniv, C. 'Toward Scalable Measures of Quality of Interaction: Motor Interference', *ACM Transactions on Human-Robot Interaction (THRI)* 9(2), 1-25, February 2020. ***Keynote Presentation*** 'Time's Multiple Arrows: Navigating the Complexity of Discrete Event Dynamical Systems', Second Northeast Regional Conference on Complex Systems (NERCCS), Binghamton, NY, April 3-5, 2019. http://coco.binghamton.edu/nerccs/ ***Other Presentations*** 'Models of Time : Complexity of Discrete Event Dynamical Systems', Vision and Image Processing (VIP) Research Group Seminar, University of Waterloo, 29 March 2019. 'Structure and Development of Aspects of Self in Human and Humanoid Cognitive Architectures', International Workshop on Mapping the Self: infants, Robots, and Modeling , IEEE Epirob-ICDL, Oslo Norway, August 2019.

Peter C. Jentsch and Chrystopher L. Nehaniv, 'Exploring Tetris as a Transformation Semigroup', 5th Applied Mathematics, Modelling and Computational Science (AMMCS) International Conference, Canada, August 2019

Saptarshi Pal and Chrystopher L. Nehaniv, 'Algebraic Structure and Complexity of Bootstrap Percolation with External Inputs', 5th Applied Mathematics, Modelling and Computational Science International Conference, Canada, August 2019

Jason d'Eon and Chrystopher L. Nehaniv, 'Algebraic Structure of the Varikon Box', 5th Applied Mathematics, Modelling and Computational Science International Conference, Canada, August 2019

Ágnes Bonivárt, Shabnam Kadir, Chrystopher L. Nehaniv, Catherine St.-Pierre, 'Natural Subsystems in a Biochemical Reaction System with Multiple Steady States and Hysteresis', 5th Applied Mathematics, Modelling and Computational Science International Conference, Canada, August 2019.

Isaiah Fararbaksh and Chrystopher L. Nehaniv, 'Spatial Iterated Prisoner's Dilemma as a Transformation Semigroup', 5th Applied Mathematics, Modelling and Computational Science International Conference, Canada, August 2019

Samin Riasat, Andrew Hryniowski, Chrystopher L.Nehaniv, Catherine St.-Pierre, 'Collatz Approximation Semigroups', 5th Applied Mathematics, Modelling and Computational Science International Conference, Canada, August 2019

Frank Foerster (Keynote), 'Motor resonance, quality of interaction, and their relationship to entrainment and rapport' at IEEE ICDL Workshop on Naturalistic Non-verbal and Affective Human-Robot Interactions, 19 August 2019, Oslo, Norway. (joint work with Chrystopher L. Nehaniv & Kerstin Dautenhahn)

Ágnes Bonivárt, Chrystopher L. Nehaniv, Shabnam Kadir, 'Computational Dynamics of Biochemical Systems', Doctoral Student Symposium, University of Hertfordshire, Hatfield, U.K. 19 April 2019.

Workshops/Conferences Organized

Special Double Session 'Algebraic Structure of Discrete-Event Dynamical Systems' at Applied Mathematics, Modelling and Computational Systems (AMMCS) 2019, 25 August 2019), co-organized with Prof. Attila Egri-Nagy (Akita International University, Japan).

'Workshop on Naturalistic Non-Verbal and Affective Human-Robot Interactions', at IEEE International Conference on Cognitive and Developmental Systems, 19th August 2019, Engineer's House Conference Centre, Oslo, Norway,
co-organized with Nicolás Navarro-Guerrero (Aarhus University) and Robert Lowe (University of Gothenburg)

Honours, Distinctions and Awards

	External evaluator for Centre for Collective Dynamics of Complex Systems at Binghamton University, State University of New York, April 2019.
Dawn Parker	***Publications*** Dawn Cassandra Parker, Michael J. Barton, Tatiana Filatova, J. Gary Polhill, Xiongbing Jin, Allen Lee, Ju-Sung Lee, Kirsten Robinson (Wright), and Calvin Pritchard. (2019). Final white paper: MIRACLE project (MIning Relationships Among variables in large datasets from CompLEx systems). Digging into Data grant program. Huang, Y., Parker, D., & Anglin, P. (2019). Identifying heterogeneous preferences of homebuyers for a new Light-Rail Transit line: Application of a two-stage hedonic model. *Presented at the 5th Canadian PhD and Early Career Workshop in Environmental and Resource Economics. University of Calgary, Calgary. June 3-4, 2019*. Dawn Cassandra Parker, Adrian Carro, Claudio Detotto, Tatiana Filatova, Jiaqi Ge, Yu Huang, Corinne Idda, Nicholas Magliocca, J. Gary Polhill, and Dominique Prunetti. (2019). MR POTATOHEAD: Property market edition-development of a common description template and code base for agent-based land-market models. Social Simulation conference Short Paper (peer reviewed) ***Publications in Press*** Arika Ligmann-Zielinska, Peer-Olaf Siebers, Nick Maglioccia, Dawn Parker, Volker Grimm, Eric Jing Du, Martin Cenek, Viktoriia, Radchuk, Nazia Arbab, Sheng Li, Uta Berger, Rajiv Paudel, Derek T. Robinson, Piotr Jankowski, Li An, Xinyue Ye (In Press) 'One size does not fit all': a roadmap of purpose-driven mixed-method pathways for sensitivity analysis of agent-based models. Journal of artificial societies and social simulation. ***Keynote Presentations*** Invited panelist, Fields Institute Workshop on Borders in Public Health and Mathematical Epidemiology, Oct. 24, 2019. ***Workshop/Conference Organization*** Invited panelist and co-organizer, "Modelling human-environment interactions in land systems: Current status, challenges and ways forward" Innovative/Immersive session, 4th Open Science Meeting of the Global Land Project, Bern, Switzerland, 24-26th April, 2019.
Steve Quilley	***Publications*** Quilley, S. and Zywert, K. (2019) 'Livelihood, market and state: What does a political economy predicated on the 'individual-in-group-in-place' actually look like?' in the 30th anniversary issue *of Ecological Economics* on the future of the discipline Ed. Kish, K. and Farley, J.

	Quilley, S. (2019). Smithsonian Reflections on the Age of Humans*:* A review of *Living in the Anthropocene: Earth in the Age of Humans* by Kress, W.J. and Stine, J.K. (Eds) 2017 Washington DC: Smithsonian Institute. Quilley, S. (2019) 'Liberty in the Near Anthropocene: State, Market and Livelihood. What the changing I/We balance means for feminism, nationalism, liberalism, socialism and conservatism' in in *Liberty and the Ecological Crisis Freedom on a Finite Planet,* 1st Edition Edited by **Christopher J. Orr**, **Kaitlin Kish**, **Bruce Jennings** (London Routledge) Quilley, S. (2019) 'Liberty in the (Long) Anthropocene: The 'I' and the 'We' in the Longue Duree ' in *Liberty and the Ecological Crisis Freedom on a Finite Planet,* 1st Edition Edited by **Christopher J. Orr**, **Kaitlin Kish**, **Bruce Jennings** (London Routledge) Kish, K. and Quilley, S. (2019). 'Livelihood and the Individual: New Ecological Economic Development Goals'. In: *BSIA-10: Reflections on the Sustainable Development Goals*. By: Dalby, S. University of Toronto Press: Toronto, ON. Kish, K. and Quilley, S. (2019). Labour and Regenerative Production. In: *A Research Agenda for Ecological Economics.* By: Costanza, B., Farley, J., and Kubiszewski, I. Edward Elgar: New York, NY. ***Publications in Press*** Zywert, K. and Quilley, S. (Eds) (2019). *Health in the Anthropocene: Living well on a finite planet* (Toronto University Press). (In press) Quilley, S. (2020, forthcoming). Elias in the Anthropocene: Human Nature, Evolution and the Politics of Great Acceleration. In J. C. Pereira & A. Saramago (Eds.), *Non-Human Nature in World Politics: Theory and Practice*. Cham: Springer International Publishing. Alesandros Glaros; Stephen Quilley; Steffanie Scott: "Relocalization: A two-pronged trajectory for food system transformation" *Agriculture and Human Values - submitted* ***Keynote Presentation*** 'When Rednecks, Mennonites and Petrol-Heads vote green' CANSEE, May 25th, 2019 (Plenary speaker) ***Media Outreach*** CTV Interview with Michael Raletic: 'Why don't North Americans use bidets and how might they be persuaded'. Wed Oct 16th 2019 **'**A 2020 Wishlist for Boris Johnson' in British Intelligence, https://www.british-intelligence.co.uk/feb-2020-articles-7
Vanessa Schweizer	***Publications***

Schweizer, V. (2019) Scenarios and Decision Support for Security and Conflict Risks in the Context of Climate Change. *Current Climate Change Reports*, 5, 12-23. Part of a Topical Collection on "Climate Change and Conflict," doi:10.1007/s40641-019-00123-0

Sharma, A.*, Hipel, K.W., **Schweizer, V.** (2019) Cauvery River Dispute: Strategic insights using Graph Model for Conflict Resolution (GMCR) with Fuzzy Preferences. In: K.W. Hipel, H. Wang, L. Fang, J. Chen and Y. Xiao (Eds.), Proceedings of the 8th International Conference on Water Resources and Environment Research, 14-18 June 2019, Nanjing, China, 284-286. 2 pp.

Schweizer, V. Development as a determinant of climate risk (2019). Book chapter in S. Dalby and S. Horton (Eds.), *Achieving the Sustainable Development Goals: Global Governance Challenges*, Routledge.

Kurniawan, J.H.* and **Schweizer, V.** (2019) Extending Shared Socio-economic Pathways: Developing multi-scale internally consistent scenarios for Canada's energy futures. 7th Annual Meeting of the Society for Decision Making under Deep Uncertainty, 7 November 2019, Delft, The Netherlands.

Schweizer, V., Power, A.*, Kurniawan, J.* Scientometrics for systematic review of academic literature related to the Shared Socioeconomic Pathways. Scenarios Forum 2019: Forum on Scenarios for Climate and Societal Futures, 11 March 2019, Denver.

Keisler, J.M., Collier, Z.A., Ayyub, B.M., Dempwolf, C.S., MacDonald Gibson, J., Porter, A.L., **Schweizer, V.J.**, Thorisson, H., Wang, L., Ye, M. (2019) Modeling and Analytics to Identify Emerging International Innovation Partnerships. Breakout Group Report for the workshop, "Signals and Metrics Identifying Partnerships for Innovation", Washington, DC, May 2019, 18 pp.

Publications in press

Schweizer, V. (in press) The promise of systematically constructed socio-technical scenarios for climate change research: Experiences with global scenarios, *Climatic Change* for a Special Issue on "Integrated scenario building in energy transition research".

Presentations

Kurniawan, J.H.* and **Schweizer, V.** (2019) Extending Shared Socio-economic Pathways: Developing multi-scale internally consistent scenarios for Canada's energy futures. 7th Annual Meeting of the Society for Decision Making under Deep Uncertainty, 7 November 2019, Delft, The Netherlands.

Schweizer, V. (2019) Scenario development and use outside the IPCC: AR6 as an opportunity to provide guidance. Invited remarks at the session, "Use of scenarios in IPCC's 6th Assessment cycle (AR6)." Scenarios Forum 2019: Forum on Scenarios for Climate and Societal Futures, 11 March 2019, Denver. (**Invited Panelist**)

	Schweizer, V., Power, A.*, Kurniawan, J.* Scientometrics for systematic review of academic literature related to the Shared Socioeconomic Pathways. Scenarios Forum 2019: Forum on Scenarios for Climate and Societal Futures, 11 March 2019, Denver. ***Honours, Distinctions and Awards*** Inducted into the Global Young Academy (GYA) on April 30, 2019. Membership is competitive, with only 43 young scientists in the world invited in 2019. The mission of the GYA is to "empower young researchers to lead international, interdisciplinary, and inter-generational dialogue with the goal to make global decision making evidence-based and inclusive". GYA receives core funding from the German Federal Ministry of Education and Research and is hosted by the German National Academy of Sciences Leopoldina.

APPENDIX D: EXTERNAL CORE MEMBER APPLICATION – MARY O'CONNOR (UBC)

THE UNIVERSITY OF BRITISH COLUMBIA

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July 15 2019

Dear Dawn,

I have attached here an application for consideration as a Waterloo Institute for Complexity and Innovation (WICI) External Core Member. This application follows the call for applications made June 25th, 2019.

I understand WICI is exploring a Canadian Centre for Complex Systems (CNCS). I think this is a promising idea and would be an exciting and timely development for complexity science in Canada. As an ecologist working on global change issues, science today seems to be rapidly increasing in urgency, scale, scope and interdisciplinary collaboration required to solve big problems of basic and applied nature. Canada is home to many of the world's leaders in this kind of scholarship, yet we are surprisingly poorly networked and organized. A CNCS could fill this void and catalyze collaboration and progress at a time when we Canadian policy and society is ready for bid advances.

I have substantial experience working in international and interdisciplinary collaborations. I have been a resident scholar at the US National Centre for Ecological Analysis and Synthesis (2009-2010), UBC's Peter Wall Institute for Advanced Studies (2016), Switzerland's Socio-Ecological-Technological-Synthesis Centre (2017-2018), and now a recently appointed external faculty at the Santa Fe Institute (2019-2022). I have also led or participated in numerous working groups focused on the causes and consequences of biodiversity change – a problem relating to complex natural systems and human-natural coupled systems. Additionally, I chaired the 2018 Gordon Research Conference on Unifying Ecology Across Scales, a meeting dedicated to integrating information science and metabolic science to identify new perspectives on the biosphere. I note these activities to emphasize that I value networking and collaboration, I believe it needs institutional support, and I am dedicated to increasing such support in Canada.

I am happy to begin this conversation with your group and I look forward to meeting others interested in complexity science in Canada! Below, you will find my application and CV.

Sincerely,

Mary O'Connor

Mary I. O'Connor, Associate Professor, Department of Zoology
Associate Director, Biodiversity Research Centre
University of British Columbia, Vancouver, BC, Canada
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1. Prior background and scholarship in complex systems.

Through my research I aim to understand how diverse living systems function and adapt in a changing world. I am trained as a community ecologist, and I have studied causes and consequences of biodiversity in marine ecosystems for nearly 20 years. I use experimental approaches to test theoretical models of how ecological systems change, and how they respond to changes in physical properties such as temperature. I have emphasized two theoretical approaches – biodiversity science, and metabolic scaling theory. These two approaches take different perspectives on living systems. Biodiversity science is first and foremost an information-based theory, and emphasizes how information is generated and maintained in non-human systems through evolutionary and ecological processes, emphasizing and valuing diversity. Metabolic scaling theories stress the physical constraints on living systems, and highlight general responses to environmental warming, minimizing the importance of diversity for function. I now am pursuing a more unified approach to living systems that integrates information theories and metabolic theories, to foster an integrated perspective on our changing biosphere.

Achieving this will require a highly interdisciplinary approach and team. This goal is drawing me toward complex systems thinking and literature. Living systems are complex systems, existing across multiple interacting scales, from subcellular systems to the biosphere. Ecology struggles to understand these systems, and I am deeply interested in finding connections among ecological theories and theories from other disciplines that help us understand and model our biosphere. I believe a perspective on the biosphere that includes humans as elements of the living system, not outside it, is essential. This trajectory is evident in my own contributions to scholarship, which began in biodiversity science, and then expanded to include metabolic scaling theory, and not most recently, information theory. Moving forward, I'm very interested in learning from and collaborating with complex system thinkers in computer science, human-ecological systems, and artificial intelligence.

2. Vision for a local CNCS node: Understanding Change in Complex Living Systems Across Scales

My vision for a CNCS node in Cascadia (the region including UBC, SFU and UVic) would focus on environmental change, and living systems adapt and respond to change across scales. This theme would harness world class ecological, evolutionary and conservation research led by teams working in this region. Many of the challenges associated with global change problems involve complex systems and coupled human-ecological systems. In our region, we have untapped potential for collaboration across disciplines. I envision a node that would catalyze collaborations and projects by providing support for working groups, seminars, and project development.

UBC provides an excellent environment for a CNCS node. UBC is uniquely positioned to catalyze collaboration on the topic of changing living systems across scales, from subcellular systems to ecosystems. I would envision one goal of our CNCS node, and in my participation in WICI, to be *elevating the profile of complexity science and its relevance to ecology, biodiversity and conservation issues*. I would like to do this through working groups and seminars, and networking activities. I share the goals of the CNCS that networking is needed to be ready for interdisciplinary funding opportunities, and that these networking opportunities have been too limited to date.

I will list three initiatives – two established and one ongoing – that I would draw up on to form a CNCS node:

1. The Biodiversity Research Centre (BRC). The biodiversity research centre is a community of more than 60 researchers from across departments and faculties dedicated to the study of biodiversity and its causes and consequences. Strengths include speciation research, species interaction research, evolutionary transitions, and climate change ecology. The BRC is one of UBC's identified Research Excellence Clusters, and as such, has access to financial support from the University for annual working groups and workshops aimed to catalyze new partnerships and collaborations. The deadline each year for proposals is October 31st. *I will submit a proposal to fund one workshop dedicated to developing a CNSC node at UBC.* These funds could cover one multi-day workshop with UBC participants and external participants from SFU, UVic, Waterloo and other universities. One or more of these visitors could also give a seminar open to the UBC community, and we could promote this to attract a large audience. I expect, based on past experience with these funding opportunities, that such a proposal has a high chance of success.

2. The Peter Wall Institute for Advanced Studies (PWIAS). This is an instituted dedicated to supporting scholarship across disciplines at UBC. They fund scholars, visitors, and roundtables, and their International Research Roundtables must be truly interdisciplinary. I have been affiliated with the centre in the past (as a Scholar in 2016) and found PWIAS to be a uniquely special and supportive environment for interdisciplinary work. I could team up with another UBC faculty and propose a roundtable on a project related to complexity that could kick off a new node at UBC.

3. UBC's current competition for new Research Excellence Clusters. Our new Dean of Science Dr. Meigan Aronson has challenged Faculty of Science departments to identify areas for growth and investment. There is currently an internal

competition and candidate clusters have been identified. At least two of these relate to complexity science: Cluster #4: Computation Systems Biology and Host-microbiome Engineering, and another cluster on Planetary Health. Both of these clusters emphasize coupled human-natural systems. As these move forward, interdisciplinary teams are exploring opportunities for collaboration and investment by the university. A Canadian Network for Complex Systems (CNCS) node would provide the kind of networking context needed to enhance the profile of these clusters. I am participating in the development of both of these cluster proposals, and could facilitate further discussions of these becoming a CNCS node.

4. **Other researchers in my network undertaking complex systems scholarship:**

There are many I could list, but I will begin here with a few I know well, and we can discuss others:

Dr. Jacob Usinowicz: soon-to-be Post Doc in my lab. He uses coexistence theory in ecological systems to understand biodiversity change; he is moving into the problem of how to use information theory to unify ecological understanding across scales.
Keywords: biodiversity, information theory, scale
Methods: experiments, analytical theory, simulation
Disciplines: physics, ecology, information theory

Dr. Andrew Gonzalez, McGill University. Biodiversity theory across scales, community evolutionary rescue, information in ecological systems.
Keywords: semiotics, biodiversity, conservation
Methods: theory, experiments, models
Disciplines: information theory, ecology, conservation

5. **Particular research theme:** As noted above, I'd like to see a node with focus on change in ecological systems across scales. Drawing on the list provided in the WICI call, this would draw upon the themes of complex coupled human-natural systems, thresholds and tipping points, and I would add, integrating information and energy-based theories for life and the biosphere.

6. **Additional information for the committee:** I compiled this application with very little available time, but wanted to get something submitted so that we could continue the conversation. I'm certainly interested in connecting UBC with WICI, and I'm

pushing hard with UBC (and finding support) for increased attention to cross-scale approaches to global change problems.

7. **Supporting Letter.** I think it's too early for a letter of support, though I am happy to pursue options for a node with the Dean of Science.

8. **CV attached.**

MARY I. O'CONNOR

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EDUCATION

2008	Ph.D. Ecology, University of North Carolina – Chapel Hill
2000	B.Sc. Aquatic Biology, Brown University

PROFESSIONAL POSITIONS

2019-2022	*External Faculty,* Santa Fe Institute (SFI)
2019-	*Deputy Director,* Canadian Institute for Ecology and Evolution (CIEE)
2017-2019	*Visiting Scientist,* EAWAG (Swiss Federal Institute of Aquatic and Sciences Technology) Proto-Synthesis Centre
2016 -	*Associate Professor,* Department of Zoology, University of British Columbia
2016-	*Affiliate,* Hakai Beach Institute, British Columbia, Canada
2013 -	*Associate Director,* Biodiversity Research Centre, University of British Columbia
2011- 2016	*Assistant Professor,* Department of Zoology, University of British Columbia
2009 - 2010	*Postdoctoral Associate*, National Center for Ecological Analysis and Synthesis

AWARDS AND DISTINCTIONS

Killam Research Enhancement Award, UBC ($15,000)	2017
International Professional Research Excellence (IRPE) Prize, International Ecology Institute, Otto Kinne Foundation (€3000)	2016
Killam Research Prize, UBC ($5000)	2016
Peter Wall Institute, Early Career Start-up Research Award ($1000)	2013
National Science and Engineering Research Council (NSERC) top-up ($5K)	2013

FELLOWSHIPS

Early Career Fellow, Ecological Society of America (ESA)	2016
Wall Scholars Research Award, Peter Wall Institute for Advanced Studies ($20,000)	2015
Alfred P. Sloan Foundation, Sloan Fellowship for Ocean Sciences ($50,000/yr)	2013
National Science Foundation, Graduate Research Fellowship (3-yr fellowship)	2004
UNC-Chapel Hill, Royster Fellowship (5-yr fellowship)	2003

RESEARCH GRANTS and AWARDS (competitive, selected)

The Living Data Project: Training Canada's biologists in data management, synthesis and collaboration. NSERC Collaborative Research and Training Experience (CREATE) (LOI submitted)	2019
Fisheries and Oceans Canada (DFO) Strategic Program for Ecosystem-Based Research and Advice (SPERA) ($70K)	2019
NSERC Discovery Accelerator Supplement (DAS)($120K)	2018
National Science and Engineering Research Council (NSERC) Discovery Grant ($275K)	2018
Canadian Foundation for Infrastructure (CFI-JELF) ($100,000)	2018
British Columbia Knowledge Development Foundation (BCKDF) ($100,000)	2018

National Science and Engineering Council, RTI, Co-investigator ($150,000) 2017
Canadian Healthy Oceans Network II (CHONe II) ($5M), Network Investigator 2016-2020
Canadian Institute for Ecology and Evolution (CIEE), O'Connor and Gonzalez 2015
German Center for Biodiversity Synthesis (iDiv), Supp, Dornelas and Gonzalez 2015
National Science and Engineering Council, RTI, Co-investigator ($81,410) 2015
National Center for Ecological Analysis and Synthesis (NCEAS), O'Connor and Greig 2012
Canadian Institute for Ecology and Evolution (CIEE), Greig and O'Connor 2012
Canadian Foundation for Infrastructure (CFI) ($325,000) 2012
UBC Mobility Award ($1500) 2012
Bamfield Marine Science Centre Research Grant ($5000) 2012
National Science and Engineering Research Council (NSERC) Discovery Grant ($110K) 2011
National Fish and Wildlife Association's Budweiser Conservation Scholarship ($10K) 2007
Smith Research Grant, UNC-Chapel Hill ($1000) 2006

RESEARCH FUNDING – NOT COMPETITIVE

Coastal Habitat Comprehensive Research Project, Eelgrass Project, funded by Niskamoon Corporation, and entity of the Cree Nation (Quebec) Full project: $618,739.67; Eelgrass portion (O'Connor PI): $212,170. 2019-2020
Tula Foundation, Microbes to Macrophytes ($55,000), Co-investigator 2014-2016
Tula Foundation, Changing Seascapes - Seagrass, Co-investigator 2014-2016

PUBLICATIONS (Peer-reviewed – selected to emphasize synthesis).
*products of O'Connor's NCEAS/CIEE/sDIV working groups
undergraduate, graduate or postdoctoral research under O'Connor's supervision
= equal contributions among authors

O'Connor, M I., M. Pennell, F. Altermatt, B. Matthews, C. Melian, A. Gonzalez. *2019*. Principles of ecology revisited: integrating information and ecological theories for a more unified science. *Frontiers in Ecology and Evolution*.

Fey, S.B., D. A. Vasseur, K. Alujevic, K. J. Kroeker, M. L. Logan, J. P. DeLong, **M. I. O'Connor**, S. Peacor, V. H. W. Rudolf, R. L. Selden, A. Sih, S. Clusella-Trullas. *2019*. Opportunities for Behavioral Rescue Under Rapid Environmental Change. *Global Change Biology*.

*Chase, J., B. McGill, P. L. Thompson, L. Antao, A. Bates, S. Blowes, M. Dornelas, A. Gonzalez, A. Magurran, S. Supp, M. Winter, A. Bjorkman, H. Bruelheide, J. E. K. Byrnes, J. Cabral, R. Elahi, C. Gomez, H. Guzmán, F. Isbell, I. Myers-Smith, H. Jones, J. Hines, M. Vellend, C. Waldock, **M. I. O'Connor**. *2019*. Species richness change across spatial scales. In revision. *Oikos*.

#Garzke, J., S. J. #Connor, U. Sommer, and **M. I. O'Connor**. *2019*. Food chain length modifies the effect of temperature on ecosystems. *PLoS Biology*.

Stier, A. C., S. C. Lee, and **M. I. O'Connor**. *2019*. Temporal variation in dispersal modifies dispersal-diversity relationships in a seagrass metacommunity. *Marine Ecology Progress Series*.

#Whippo, R., N. S. #Knight, C. #Prentice, J. #Cristiani, M. #Siegle, **M. I. O'Connor**. *2018*. Epifaunal diversity patterns within and among seagrass meadows suggest landscape scale biodiversity processes. *Ecosphere* 9(11) e02490.

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Guzman, L., R. Germain, C. #Forbes, S. Straus, **M. I. O'Connor**, D. Gravel, D. Srivastava, P. L. #Thompson. *2018*. Towards a multi-trophic extension of metacommunity ecology. *Ecology Letters* 22(1): 19-33.

#Bernhardt, J. R., J. M. #Sunday, P. L. #Thompson, and **M. I. O'Connor**. *2018*. Nonlinear averaging of thermal experience predicts population growth rates in a thermally variable environment. *Proceedings of the Royal Society of London-B*. 285: 20181076

#Bernhardt, J. R., J. M. #Sunday, and **M. I. O'Connor**. *2018*. Metabolic theory and the temperature size rule explain the temperature dependence of population carrying capacity. *The American Naturalist 192(6): 687-697*.

·Thompson, P. L., A. Gonzalez, **M. I. O'Connor**, F. Isbell, M. Loreau. *2018*. The strength of the biodiversity-ecosystem function relationship depends on spatial scale. 285 *Proceedings of the Royal Society of London, B*.

Louca, S., M. F. Polz, F. Mazel, M. B. N. Albright, J. A. Huber, **M. I. O'Connor**, M. Ackermann, A. S. Hahn, D. S. Srivastava, S. A. Crowe, M. Doebeli, L. W. Parfrey. *Accepted*. Function and functional redundancy in microbial systems. *Nature Ecology and Evolution*. 2: 936-943.

Iacarella, J., #Adamczyk, E., Bowen, D., Chalifour, L., Eger, A., Heath, W., Helms, S., Hessing-Lewis, M., Hunt, B, MacInnis, A., **O' Connor, M. I.,** Robinson, C.L.K., Yakimishyn, J., Baum, J. 2018. Anthropogenic disturbance homogenizes seagrass fish communities. *Global Change Biology* 24: 1904-1918.

#Siegle, M. R., R. B. Taylor, **M. I. O'Connor.** 2018. Prior heat accumulation reduces survival during subsequent experimental heat waves. *Journal of Experimental Marine Biology and Ecology* 501: 109-117.

Barnes, A. D., N. Eisenhauer, C. Scherber, M. Jochum, J. Lefcheck, **M. I. O'Connor**, P. de Ruiter, and U. Brose. 2018. Energy flux: the link between multi-trophic biodiversity and ecosystem functioning. *Trends in Ecology and Evolution*. 33(3): 186-197.

Reynolds, P. L., J. Stachowicz, K. Hovel, C. Bostrom, K. Boyer, M. Cusson, J. Eklof, F. Engel, A. Engelen, B. K. Eriksson, J. Fodrie, J. Griffin, C. Hereu, M. Hori, T. Hanley, M. Ivanov, P. Jorgensen, C. Kruschel, K-S. Lee, K. McGlathery, P-O Moksnes, M. Nakaoka, F. Tomas Nash, **M. I. O'Connor**, N. O'Connor, R. Orth, F. Rossi, E. Sotka, R. Unsworth, M. Whalen, J. E. Duffy. 2018. Latitude, temperature and habitat complexity predict predation pressure in eelgrass across the Northern Hemisphere. *Ecology*. 99(1): 29-35.

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M. W. Pennell and **M. I. O'Connor**. 2017. A modest proposal for unifying macroevolution and ecosystem ecology. *The American Naturalist*. Online.

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M. M. Osmond, M. Barbour, J. #Bernhardt, J. #Sunday, M. Pennell, **M. I. O'Connor**. *2017.* Warming induced changes to body size stabilize consumer-resource dynamics. *The American Naturalist.*

O'Connor, M. I., A. Gonzalez, J. E. K. Byrnes, B. J. Cardinale, J. E. Duffy, L. Gamfeldt, J. Griffin, D. U. Hooper, B. Hungate, A. Paquette, P. Thompson, L. Dee, K. Dolan. *2017.* Toward predictive scaling coefficients for biodiversity and ecosystem functioning relationships. *Oikos* 126: 18-31

Gonzalez, A., B. J. Cardinale, J. E. K. Byrnes, F. Isbell, G. R. H. Allington, D. G. Brown, A. Endsley, D. U. Hooper, **M. I. O'Connor** and M. Loreau. 2016. The challenge of estimating global patterns of local biodiversity change: a critique of recent papers finding no net loss of local diversity. *Ecology*. *In press*.

Brown, C., **M. I. O'Connor,** E. S. Poloczanska, L. Buckley, M. Burrows, C. Duarte, B. Halpern, J. Pandolfi, C. Parmesan, A. J. Richardson. 2016. Ecological and methodological drivers of species' distribution and phenology responses to climate change. *Global Change Biology* 22(4) 1548-1560.

'Tseng, M. and **M. I. O'Connor**. 2015. Predation pressure accelerates evolutionary response of prey to temperature change. *Biology Letters* 11:20150798.

Bruno, J. F., L. A. Carr, and **M. I. O'Connor**. 2015. Marine Metabolic Ecology: Exploring the role of temperature in the ocean through metabolic scaling. *Ecology* 96(12): 3126-3140.

'Huang, A., M. Essak, **M. I. O'Connor**. 2015. Top-down control by great blue herons *Ardea Herodias* regulates seagrass-associated epifauna. *Oikos* 124(11): 1492-1501.

Atkins, R. L., J. N. Griffin, C. Angelini, **M. I. O'Connor**, B. R. Silliman. 2015. Consumer-plant interaction strength: importance of body size, density and metabolic biomass. *Oikos* 124(10): 1274-1281.

•Elahi, R., **M. I. O'Connor**, J. E. K. Byrnes, J. Dunic, B. K. Eriksson, M. J. S. Hensel, and P. J. Kearns. 2015. Recent trends in local-scale marine biodiversity reflect community structure and human impacts. *Current Biology* 25(14): 1938-1943.

•Stafl, N. and **M. I. O'Connor**. 2015. American pikas' (Ochotona princeps) foraging response to hikers and sensitivity to heat in an alpine environment. *Arctic, Antarctic and Alpine Research*. 47(3): 519-527.

Duffy, J. E., P. L. Reynolds, C. Bostrom, J. A. Coyer, M. Cusson, S. Donadi, J. G. Douglass, J. Eklof, A. Engelen, B. K. Eriksson, S. Fredriksen, L. Gamfeldt, C. Gustafsson, G. Hoarau, M. Hori, K. Hovel, K. Iken, J. S. Lefcheck, P-O. Moksnes, M. Nakaoka, **M. I. O'Connor**, J. L. Olsen, J. P. Richardson, J. L. Ruesink, E. E. Sotka, J. Thormar, M. A. Whalen, J. J. Stachowicz. *2015*. Biodiversity mediates top-down control in eelgrass ecosystems: A global comparative experiment. *Ecology Letters* 18:696-705.

•Amundrud, S. L., D. S. Srivastava, and **M. I. O'Connor**. 2015. Indirect effects of predators control herbivore richness and abundance in a benthic eelgrass (Zostera marina) mesograzer community. *Journal of Animal Ecology* 84(4): 1092-1102.

*DeLong, J., B. Gilbert, J. B. Shurin, V. M. Savage, C. F. Clements, A. I. Dell, H. S. Greig, C. D. G. Harley, P. Kratina, K. S. McCann, T. D. Tunney, D. A. Vasseur, **M. I. O'Connor**. 2015. The body size dependence of trophic cascades. *The American Naturalist*. 185: 354-366.

•Knight, N. S., •C. Prentice, •M. Tseng, and **M. I. O'Connor**. 2015. A comparison of epifaunal invertebrate communities in native eelgrass *Zostera marina* and non-native *Zostera japonica* at Tsawwassen, B. C. *Marine Biology Research* 11(6): 564-571.

O'Connor•, M. I., J. Holding•, C. V. Kappel, C. M. Duarte, K. Brander, C. J. Brown, J. F. •Bruno, L. Buckley, M. T. Burrows, B. S. Halpern, W. Kiessling, P. Moore, J.M. Pandolfi, C. Parmesan, E. Poloczanska, D. Schoeman, W. Sydeman, A. J. Richardson. 2015. A Confidence Index for Attribution of Biological Impacts of Climate Change. *Global Ecology and Biogeography*. 24(1): 64-76. [OPEN ACCESS]

*Gilbert, B., T. D. Tunney, K. S. McCann, J. P. DeLong, D. A. Vasseur, V. Savage, J. B. Shurin, A. I. Dell, B. T. Barton, C. D. G. Harley, H. M. Kharouba, P. Kratina, J. L. Blanchard, C. Clements, M. Winder, H. S. Greig and **M. I. O'Connor**. 2014. A bioenergetic framework for the temperature dependence of trophic interaction strength. *Ecology Letters*. 17: 902-914.

Clarke, A. and **M. I. O'Connor**. 2014. Carnivores are cool: diet and body temperature in vertebrates. *Global Ecology and Biogeography*. 23: 1000-1008.

Gerber, L. R., M. d. M. Mancha-Cisneros, **M. I. O'Connor** and E. R. Selig. 2014. Climate change impacts on connectivity in the ocean: Implications for conservation. *Ecosphere* 5(3) Article 33. [OPEN ACCESS]

*Vasseur, D.A., J. P. DeLong, B. Gilbert, H.S. Greig, C. D. G. Harley, K.S. McCann, V. Savage, T.D. Tunney, and **M. I. O'Connor**. *Accepted*. Increased temperature variation poses a greater risk to species than climate warming. *Proceedings of the Royal Society*.

Burrows, M. T., D. Schoeman, A. J. Richardson, J. G. Molinos, A. Hoffman, L. B. Buckley, P. Moore, C. J. Brown, J. F. Bruno, C. M. Duarte, B. S. Halpern, O. Hoegh-Guldberg, C. V. Kappel, W. Kiessling, **M. I. O'Connor,** J.M. Pandolfi, C. Parmesan, W. J. Sydeman, S. Ferrier, K. Williams, and E. S. Poloczanska. *Accepted Dec 31, 2013.* Climate velocity and geographical limits to shifts in species' distributions. *Nature.*

Balvanera, P., I. Syddique, L. Dee, A. Paquette, F. Isbell, A. Gonzalez, J. Byrnes, **M. I. O'Connor**, B. A. Hungate, J. N. Griffin. 2014. Linking biodiversity and ecosystem services: current uncertainties and the necessary next steps. *Bioscience.* 64(1): 49-57.

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Gilbert, B. and **M. I. O'Connor**. 2013. Climate change and species interactions: Beyond local communities. *Annals of the New York Academy of Sciences.* 1297: 98-111.

Leis, J. M., J. E. Caselle, I. R. Bradbury, T. Kristiansen, J. K. Llopiz, M. J. Miller, **M. I. O'Connor**, C. B. Paris, A. L. Shanks, S. M. Sogard, S. E. Swearer, E. A. Treml, R. D. Vetter, R. R. Warner. *2013*. Does fish larval dispersal differ between high and low latitudes? *Proceedings of the Royal Society of London, B.* 280: 1759.

Cuddington, K., M.-J. Fortin, L. Gerber, A. Hastings, A. Liebhold, **M. I. O'Connor**, C. Ray. *2013.* Ecological management in a changing world requires process-based models. *Ecosphere. 4(2).*

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Wolkowich, E. M., J. Regetz, and **M. I. O'Connor**. *2012.* Advances in global change research require open science at the individual-level. *Global Change Biology.* 18: 2102-2110.

Long, Z. T., **M. I. O'Connor** and J. F. Bruno. 2012. Effects of predation on intraspecific aggregation of prey and prey diversity in a subtidal marine food web. *Journal of Experimental Marine Biology and Ecology.* 416: 115-120.

O'Connor, M. I., E. R. Selig, M. L. Pinksy and Florian Altermatt. *2012.* Toward a conceptual framework for climate change ecology. *Global Ecology and Biogeography.* 21: 693-703.

Burrows, M. T., D. Schoeman, C. M. Duarte, **M. I. O'Connor**, L. B. Buckley, C. V. Kappel, C. Parmesan, B. S. Halpern, C. J. Brown, K. Brander, J. F. Bruno, J.M. Pandolfi, W. J. Sydeman , A. J. Richardson, E. S. Poloczanska. 2012. The Pace of Shifting Climate in Marine and Terrestrial Ecosystems. Letter: Response to Hulme. *Science.*

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Kiessling, **M. I. O'Connor**, J.M. Pandolfi , C. Parmesan , F. B. Schwing, W. J. Sydeman, A. J. Richardson. 2011. The Pace of Shifting Climate in Marine and Terrestrial Ecosystems. *Science* 334: 652-655.

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Smith, M. D., C. A. Rohiem, L. B. Crowder, B. S. Halpern, M. Turnipseed, J. L. Anderson, F. Asche, L. Bourillon, A. G. Guttormsen, A. Khan, L. A. Liguori, A. McNevin, **M. I. O'Connor**, D. Squires, P. Tyedmers, C. Brownstein, K. Carden, D. H. Klinger, R. Sagarin, K. A. Selkoe. 2010. Sustainability and Global Seafood. *Science* 327: 784-786.

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* recommended by P. Kareiva to Faculty of 1000.

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REPORTS, ARTICLES, BOOK CHAPTERS (selected)

Cavender-Bares, J., Arroyo, M.T.K., Abell, R., Ackerly, D., Ackerman, D., Arim, M., Belnap, J., Castañeda Moya, F., Dee, L., Estrada-Carmona, N., Gobin, J., Isbell, F., Jaffe, R., Köhler, G., Koops, M., Kraft, N., Mcfarlane, N., Martínez-Garza, C., Metzger, J. P., Mora, A., Oatham, M., Paglia, A., Pedrana, J., Peri, P. L., Piñeiro, G., Randall, R., Robbins, W. W., Weis, J., and Ziller, S. R. Chapter 3: Status, trends and future dynamics of biodiversity and ecosystems underpinning nature's contributions to people. In IPBES (2018): The IPBES regional assessment report on biodiversity and ecosystem services for the Americas. Rice, J., Seixas, C. S., Zaccagnini, M. E., Bedoya-Gaitán, M., and Valderrama, N. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany, pp. 171-293, contributing author: **Mary O'Connor** (Canada).

Hoegh-Guldberg, O., C. Ronghuo, P. B. Brewer, V. J. Fabry, K. Hilmi, S. Jung, E. Poloczanska, S. Sundby, J. Bell, C. J. Brown, M. T. Burrows, L. Cao, S. Donner, C. M. Eakin, A. Eide, B. Halpern, C. R. McClain, S. McKinnell, **M. I. O'Connor**, C. Parmesan, R. Ian Perry, A. J. Richardson, S. Schoeman, S. Signorini, W. Skirving, D. Stone, W. Sydeman, R. Zhang, R. van Hooidonk. *Chapter 30. The Ocean*. In: Climate Change 2014: Impacts, Adaptation and Vulnerability, Fifth Assessment Report (AR5), Intergovernmental Panel on Climate Change (IPCC). 2014.

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WORK SUBMITTED (including publisher and date of submission)

Gonzalez, A., R. Germain, D. S. Srivastava, E. Filotas, L. E. Dee, D. Gravel, M. I. O'Connor, P. L. Thompson, J. Cowles, F. Isbell, J. Montoya, Y. Zelnick, M. Loreau. *In review*. Scaling-up biodiversity-ecosystem functioning research. *Ecology Letters*.

•Bernhardt, J. R. and **M. I. O'Connor**. *In review*. Aquatic biodiversity enhances multiple nutritional benefits to humans. *Nature*. *Submitted Jan 2019*.

•Stark, K. A., P. L. •Thompson, J. Yakimishyn, L. Lee, **M. I. O'Connor**. Beyond a single patch: local and regional processes explain diversity patterns in a seagrass epifaunal metacommunity. *Revising following rejection from Ecology*. *Submitted to Ecology Dec 2018*.

•Siegle, M. R., R. B. Taylor, **M. I. O'Connor**. Short-term population growth rates influenced by experimental heat waves do not predict long-term abundance trends. *Ecology*. *In revision*.

*Dunic, J. C., R. Elahi, M. J. S. Hensel, P. J. Kearns, **M. I. O'Connor**, D. Acuna, A. Honig, A. R. Wilson, and J. E. K. Byrnes. *In revision*. Human activities influence the direction and magnitude of local biodiversity change over time. *Ecology*.

Hernan Martinez, G., M. Ortega, A. Josep, K. Boyer, S. Cimon, V. Combes, M. Cusson, C. Hereu, M. Hessing-Lewis, K. Hovel, P. Jorgensen, S. Kiriakopolos, N. Kollars, **M. O'Connor**, J. Olsen, P. Reynolds, J. Ruesink, E. Voigt, F. Tomas. *Submitted*. Resource availability shapes latitudinal gradients of plant defense against herbivory in a marine foundation species. *Ecology Letters*.

TEACHING AND MENTORSHIP

I lead an active research group of post-doctoral researchers, research associates, doctoral and masters students and undergraduates. I also teach courses annually on Advanced Ecology (Biol 306), Aquatic Ecology (Biol 402) and Ecosytem Ecology (Biol 438j). More information on teaching and mentoring is available upon request and at our group's website: http://oconnorlab.weebly.com/people.html

PRESENTATIONS

Invited seminars

2019 Toward a Unified Science of Ecological Change: Advances and Challenges in Biodiversity and Metabolic Scaling
Santa Fe Institute (SFI), Santa Fe, New Mexico, USA
Toward a Unified Science of Ecological Change: Advances and Challenges in Biodiversity and Metabolic Scaling
Institute for the Ocean and Fisheries, University of British Columbia
Toward a Unified Science of Ecological Change: Advances and Challenges in Biodiversity and Metabolic Scaling
Duke University Marine Lab, Beaufort, NC, USA

2018 Toward a Unified Science of Ecological Change: Advances and Challenges in Biodiversity and Metabolic Scaling
University of Montana, Bozeman, USA

Toward a Unified Science of Ecological Change: Advances and Challenges in Biodiversity and Metabolic Scaling
Simon Fraser University, Canada
Toward a Unified Science of Ecological Change, Reed College, Oregon, USA
Toward a Unified Science of Ecological Change: Advances and Challenges in Biodiversity and Metabolic Scaling
Oxford University, UK
Toward a Unified Science of Ecological Change: Advances and Challenges in Biodiversity and Metabolic Scaling
EAWAG, Kastanienbaum, Switzerland
Toward a Unified Science of Ecological Change: Advances and Challenges in Biodiversity and Metabolic Scaling. *Annual E. O. Wilson Biodiversity Lecture*.
Helmoltz Centre, Oldenburg, Germany
Toward a Unified Science of Ecological Change: Advances and Challenges in Biodiversity and Metabolic Scaling.
National Centre for Ecological Analysis and Synthesis (NCEAS), Santa Barbara, CA, USA
Toward a Unified Science of Ecological Change: Advances and Challenges in Biodiversity and Metabolic Scaling.
Imperial College London, Silwood Park, UK
Toward a Unified Ecological Science
University of Zurich, Zurich, Switzerland

2017 Marine Biodiversity in a time of humans: biodiversity crisis or resilient living system?
University of California, Davis – Bodega Bay Marine Lab, USA
The Tyranny of Temperature in Ecological Systems
University of California – Davis, USA
The Tyranny of Temperature in Ecological Systems
University of California – Santa Cruz, USA
The Tyranny of Temperature in Ecological Systems
University of Florida, UFL, USA
Toward a Unified Ecological Science
University of Zurich, Zurich, Switzerland

2016 The Tyranny of Temperature in Ecological Systems
Hopkins Marine Station, Stanford University, Monterey, CA, USA
The Tyranny of Temperature in Ecological Systems
Eawag, Zurich, Switzerland
Marine Biodiversity in a time of humans: biodiversity crisis or resilient living system?
Oregon Institute of Marine Biology (OIMB), Charleston, OR, USA
Biodiversity Change (or not?): Challenges and Next Steps. German Synthesis Centre of Biodiversity Sciences (sDIV), Leipzig, Germany
Harvard University, Herbaria Seminar Series. Cambridge, MA, USA
Wall Wednesday Seminar Series, Peter Wall Institute for Advanced Studies, UBC

2015 University of Chicago, Ecology and Evolution seminar series, Chicago, IL, USA
McGill University, Student-invited speaker for Organismal Biology, Montreal, QC

University of Arizona, Ecology and Evolution seminar series, Phoenix, AZ
University of Colorado-Boulder, Ecology and Evolutionary Biology seminar series, Colorado, USA

2014 Japanese Association of Marine Biological Stations, Tokyo, Japan
Sapporo University, Sapporo, Japan
National Marine Fisheries Service, NOAA, Seattle, USA
Oregon State University, Corvallis, OR

2013 Columbia University, New York, USA
University of Victoria, Victoria, BC
Dartmouth College, New Hampshire, USA
Environment Canada, Pacific Wildlife Research Centre, Delta, BC

2011 Bodega Marine Lab, UC – Davis, California, USA
Simon Fraser University, Vancouver, BC
Western Washington University, Bellingham, WA, USA

2009 University of Santa Barbara, Ecology, Evolution and Marine Biology Department, CA, USA
University of British Columbia, Vancouver, BC
University of Toronto, Toronto, Canada
Carnegie Institute for the Environment, Stanford University, Palo Alto, CA, USA

Other Presentations

2016 Uncharted Waters: novel ecosystems in the marine environment. Panel discussion as part of Harvard University's center for the Environment series entitled Ecological Systems in the Anthropocene. *Discussion moderator (invited).* Feb 3.

UBC Science ONE weekly lunch seminar (invited)

2015 Understanding Recent Biodiversity Change, Organized and participated in symposium: UBC, May 4th, 2015.

Sea Change and the Anthropocene: a curriculum to mobilize the witness of ecology + art. Hosted by Edith Krause and Erica Grimm at Trinity Western University, Langley, BC

Conference Participation (Organizer, Keynote Speaker, etc). All presentations are first-authored talks or, when indicated, first-authored posters. Presentations by students or collaborators on which I am a non-presenting co-author are not listed. Student presentations not listed here.
**** indicates Invited Speaker***

2019 *Global Change and Biodiversity Conference, Monte Verita, Switzerland (Keynote)

2018 *Gordon Research Conference, Unifying Ecology Across Scales. Biddeford, ME, USA

2017 *British Ecological Society, Aquatic Group Annual Meeting, London, UK
*Canadian Society for Ecology and Evolution, Victoria, CA

2016 *Western Society of Naturalists, Presidential Symposium, Monterey, CA, USA
*Gordon Research Conference, Unifying Ecology Across Scales. Biddeford, ME, USA
*Gordon Research Conference, Predator-Prey Interactions. Ventura, CA, USA

2015 *Ecological Society of America 100th Annual Meeting, Baltimore, MD, USA
*Canada's Healthy Oceans Network 2 (CHONE2) first annual meeting, Montreal, CA

2014 Western Society of Naturalists (WSN), Seattle, WA
*Canadian Society of Ecology and Evolution (CSEE), Montreal, CA
*Joint Aquatic Sciences Meeting (JASM), Portland, OR, USA
*Zostera Experimental Network (ZEN) Conference, Washington DC, USA
Gordon Research Conference: Unifying Ecology Across Scales, Maine, USA. *Invited discussion leader.*

2013 *Ecological Society of America (ESA) Annual Meeting, Minneapolis, MN, USA. *Session organizer.*

2012 Ecological Society of America (ESA) Annual Meeting, Portland, OR, USA.
*Climate Change and Species Interactions, National Science Foundation meeting and Cary Conference, Cary Institute, NY, USA.

2011 *National Council on Science and the Environment (NCSE) Changing Oceans meeting, Washington, D.C.

2010 *AQUASHIFT Conference: Life in Changing Waters, Kiel, Germany. *Keynote speaker.*
Gordon Research Conference on Metabolic Ecology, Maine, USA. *Invited participant* (poster presentation)
*Ecological Society of America (ESA), Annual Meeting, Pittsburgh, PA, USA.

2009 *British Ecological Society (BES) Annual Meeting. England, UK.
Western Society of Naturalists (WSN) Annual Meeting, Seaside, CA, USA.

2008 Benthic Ecology Meeting (BEM), Providence, RI, USA.
*American Society for Limnology and Oceanography (ALSO – Ocean Sciences). Orlando, FL, USA.

2007 Estuarine Research Federation (ERF) Annual Meeting. Providence, RI. USA. (poster)
Benthic Ecological Meeting (BEM). Atlanta, GA, USA.

2006 International Temperate Reefs Symposium (ITRS), Santa Barbara, CA, USA.
Gordon Research Conference on Metabolic Ecology. Maine, USA. *Invited participant* (poster presentation)

2005 Ecological Society of America (ESA), Annual Meeting, Portland, OR, USA.
Benthic Ecological Meeting (BEM). Williamsburg, VA, USA.

2004 Benthic Ecological Meeting (BEM). Mobile, AB, USA.

SYNTHESIS ACTIVITIES (selected)

Acronyms for funders: Canadian Institute for Ecology and Evolution (CIEE), US National Center for Ecological Analysis and Synthesis (NCEAS), German Synthesis Centre of Biodiversity Sciences (sDIV), Quebec Center for Biodiversity Science (QCBS).

* Proposals written and groups led or co-led by O'Connor

**Understanding how thermal variation affects ecological processes*. Led by Joey Bernhardt, Jennifer Sunday, Andrew Gonzalez and Mary O'Connor. Funded by CIEE. 2019

Long-term Ecological Research: Scaling-up Productivity Responses to Changes in Biodiversity, funded by NCEAS – National Science Foundation (NSF) Long-Term Ecological Research (LTER) partnership. Led by F. Isbell, L. Dee and J. Cowles. 2017-2019

**Information in Ecology*, Led by M. I. O'Connor and F. Altermatt; funded by Swiss Federal Institute of Aquatic Sciences (EAWAG). 2019

**Does Community Openness Affect Resilience of Freshwater Ecosystems?* Led by M. O'Connor and F. Altermatt; funded by Swiss Federal Institute of Aquatic Sciences. 2017-2018

Scaling biodiversity and Ecosystem Function. Funded by QCBS and CRNS. Led by A. Gonzalez, M. Loreau and P. Thompson. 2017-2019

Trophic Metacommunities. UBC Collaborative group resulting from a student reading group I initiated. Biodiversity Centre and CIEE funded group led by R. Germain, M. Guzmann and P. Thompson. 2016-2018

Identifying Wildcards to Climate Change. UBC working group, led by D. Srivastava 2017

**Quantifying Biodiversity Change Through Time (sChange)*. German Synthesis Centre of Biodiversity Sciences (sDIV), Leipzig, Germany. Feb 22-27. *Co-Leader with Maria Dornelas and Sarah Supp*. 2016

**Understanding recent biodiversity change across spatial and temporal scales*. Working group jointly funded by Canadian Institute for Ecology and Evolution (CIEE), Quebec Center for Biodiversity Science (QCBS) and UBC's Biodiversity Research Centre. O'Connor and Gonzalez, organizers. 2015

**Synthesizing theory and databases to advance a general framework for how warming affects trophic interactions* (NCEAS), M. O'Connor and H. Greig co-lead 2012-2013

**Integrating body size and thermal scaling to understand the effects of temperature on food webs* (CIEE), H. Greig and M. I. O'Connor co-lead. 2012

Zostera Experimental Network (ZEN), partner in global comparative experiment 2011-2013

Biodiversity and Ecosystem Function: Future Challenges working group (NCEAS), invited participant, led by Bradley Cardinale, David Hooper and Emmett Duffy, 2010 - 2012

Effects of Climate Change on Marine Systems working group (NCEAS), invited participant, led by Anthony Richardson and Elvira Poloczanska, 2009-2012

Envisioning a Sustainable Seafood System (NCEAS), invited participant, led by Mary Turnipseed, Marty Smith and Larry Crowder 2009-2012

SERVICE (selected)

Memberships in scholarly societies, including offices held and dates

Canadian Society for Ecology and Evolution (2014, 2017)
American Society for Limnology and Oceanography (2008, 2014)
Ecological Society of America (2003, 2005, 2010, 2013, 2014, 2015, 2016)
British Ecological Society (2009)
Western Society of Naturalists (2009, 2014, 2016)

International service and leadership, including dates

Western Society of Naturalists Secretariat (elected), 2018-2021
Gordon Conference Vice Chair (elected), Unifying Ecology Across Scales, 2014-2016
Gordon Conference Chair (elected), Unifying Ecology Across Scales, 2016-2018

Editorships (list journal and dates)

Ecology, 2016 - present
Ecology Letters, 2015 - 2019
Frontiers in Marine Sciences, 2015- 2015
Ecology and Evolution (open access journal), 2013-- 2015
PLoS ONE (open access journal), 2011-2013
Proceedings of the National Academy of Sciences (PNAS) guest editor (2014, 2015)

APPENDIX E: EXTERNAL CORE MEMBER APPLICATION – RAJA SENGUPTA (M^{C}GILL)

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15th July 2015

Dr. Dawn Parker
Director
Waterloo Institute for Complexity and Innovation (WICI)
University of Waterloo

Dear Dr. Parker:

May I request you to consider my application to become an "External Core Member" of the Waterloo Institute for Complexity and Innovation (WICI). As part of my application, I have highlighted my prior background and scholarship in complex systems research below. I have also elucidated my vision for a local Canadian Network for Complexity Science (CNCS) node in Montreal; along with a list of potential members of the node. Please also find attached a letter of support from the Chair of Geography at McGill (my home department), and a complete CV.

Prior Background and Scholarship in Complex Systems Research:

I have worked with complex systems simulations, particularly Agent-Based Models (ABMs), for the past two decades. I obtained my doctoral degree at Southern Illinois University-Carbondale in Geography in 2000, and subsequently worked at University of Iowa (Visiting Instructor), Southern Illinois University-Carbondale, and McGill as Assistant and Associate Professor specializing in GIScience. Although I initially started with the characterization of software agents (Sengupta and Bennett, 2003), I subsequently focused on ABM applications of Landuse-Landcover change (Sengupta et al., 2000; Sengupta et al., 2005), and their ability to capture individual landholder's response to changes in policy environments. Of late, I and my graduate students have focussed on developing ABMs of mobile objects, primarily red colobus monkey groups, and their movements in response to environmental and landscape level stimuli (Bonnell et al., 2010, Bonnell et al., 2013; Bonnell et al, 2016). For a part of this ABM research, we have also simulated the potential spread of disease vectors as a consequence of changing patterns of animal movement in response to weather patterns. An additional research trajectory is networks, both physical (O'Farrill et al., 2013) as well as social spatial networks (Sarkar et al., 2019). In the recent work, my former doctoral student looked at developing new metrics that captured and compared the distance between two entities in both geographic (i.e., physical distance) as well as social network (i.e., distance along the developed social network) space. I, alongwith Dr. Liliana Perez (University de Montreal), also co-edited a group of papers that became an edited book consisting of chapters that discussed state of the art complex systems simulations (including Agent-Based Models, Complexity Science, and Spatial Networks)(Perez et al., 2018). My most recent research has focussed on using large datasets with high-granularity spatiotemporal data as the basis for extracting potential preference for locations and identifying step-lengths that can be used to build ABM models of movement from these datasets.

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Vision for a local CNCS node:

My primary interest in sending in this application to your call for "External Core Members" is to assist in the development of a Canadian Network for Complexity Science (CNCS). I believe that it is important to build a pan-national and cross-university network of researchers who are working on complexity science topics across Canada, to build capacity in disseminating information about complexity science to the next generation of researchers. I believe that networking and education will be the main two thrust areas of CNCS, with a focus on building a strong cohort of Complexity Science graduate students across Canada. The main reason for these thrusts is because there is a lack of critical concentration of Complexity Science scholars at any one geographic location, let alone at any one institution. There is, therefore, a need for collaboration across institutions to build this capacity. A natural outcome of this approach will be interdisciplinarity (as researchers who form the core members of nodes will come from many disciplines) as well as incentives for collaboration. For the latter, it is conceivable that frequent interactions will lead to joint efforts to obtain research grants from tri-council agencies, and perhaps even bold new initiatives under the Frontiers calls.

A few concrete suggestions I would have for the node in Montreal would include:

1. A 13-week webinar/course taught over Skype and with the involvement of many scholars across Canada. For example, if 13 faculty members each gave a 3-hour webinar over Skype on a topic of their choice, this could result in adequate coverage of Complexity Science topics from scholars across Canada. Credit for such a course could be offered to graduate students via their graduate supervisors, i.e., they would enroll in "independent studies". They would be expected to submit a formal research paper at the end of the webinar on a topic of their choice to be evaluated by other scholars as well as their own supervisor.

2. Once a month "local" research talk: this would involve rotating talks by members of one node to a common audience in the area. This talk would be an "in-person" event, and it is expected that all members of a node as well as their graduate students would attend this event. Rooms could be booked in a host-institution to allow for these talks to occur.

3. Working groups for specific topics: Complexity Science is an evolving concept. This is highly relevant for the present where data is abundant but hard to analyze properly. Working groups will be constituted to brainstorm about potential impacts of big data or other topics relevant to Complexity Science. The constitution of these groups will include pan-national members from other nodes to ensure diverse views on topic from across Canada. Further, some working groups will also be set up to encourage the development of interdisciplinary teams in response to specific topics proposed by tricouncil funding agencies. The recently launched Frontiers grants are those that come to mind.

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4. I also forsee the local Montreal CNCS node becoming a "connector node" between Universities for the region. For example, McGill has launched the McGill Sustainable Systems Initiative (MSSI). Other universities are likely to have priorities that may or may not match MSSI's goals. By having members from multiple universities, it is possible to build collaborations that cross institutional boundaries, thus building a cross-institutional connections that pull together the strategic initiatives of several universities that link to Complexity Science topics.

The structure of the CNCS node would consist of several core members, and other "affiliates". Core members would be expected to shoulder the responsibility of organizing and participating in most of the activities, whereas the affiliates would be invited to the activities but not take a major role in organization. I therefore expect that most researchers who have a complex systems focus in their research will apply to be "core members", whereas those with passing interest will chose the "affiliate membership" route. Further, leadership of the node would rotate amongst the core members, with a new chair for the node selected every 3 years.

For now, I believe the CNCS could be initiated without funding. However, in the long term it would be sustained with membership fees, and contributions from home universities of the core members.

List of Researchers who could be core members of the node:

Member	**Institution**	**3 research applications**	**3 methods**	**3 disciplinary areas**
Francesco Ciari	Polytechnique Montreal	1. Mobility as a Service 2. Autonomous Vehicles 3. Transport Planning	1. Agent-Based Models 2. MATSim 3. Travel Demand Models	1. Transportation choice 2. Transport Planning 3. Multi-Agent Systems (MAS)
Paul Charbonneau	Universite de Montreal, Physics	1. Solar Activity Cycle 2. Meridonal Cycles 3. Lithium Abundance	1. Genetic Algorithms 2. Flux-Transport Models 3.Global Large-Eddy Simulation	1. Astrophysics 2. Computational Physics 3. Chaos Theory
Liliana Perez	Universite de Montreal, Geographie	1. Biodiversity 2. Climate Change 3.Coupled Natural-Human Systems	1. Cellular Automata 2. Agent-Based Models 3. Geosimulation	1. Complex Systems 2. GIScience 3. Multi-Agent Systems (MAS)

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Mir Abolfazl Mostafavi	Universite Laval, Geomatics	1. Health 2. Disaster Management 3. Fire simulation	1. Cellular Automata 2. Multidimensional GIS 3. Geosimulation	1. Geomatics 2. Sensors 3. Path Optimization
Brian Robinson	McGill University, Geography	1. Livelihood choices 2. Land Tenure 3. Deforestation	1. Econometric Modelling 2. Hierarchical Modelling 3. Population Dynamics	1. Livelihoods 2. Economic Geography 3. Environment and Development
Raja Sengupta	McGill University, Geography	1. Movement Ecology 2. Coupled Natural-Human Systems 3. Landuse-Landcover Change	1. Agent-Based Models 2. Network Analysis 3. Social Network Analysis	1. Multi-Agent Systems (MAS) 2. GIScience 3. Sensors
Brince Jones (PhD student)	Universite de Montreal, Geographie and McGill University, Geography	1. Movement Ecology 2. Human Dynamics 3. Disease dynamics	1. Agent-Based Models 2. Machine Learning 3. Raster GIS	1. Multi-Agent Systems (MAS) 2. GIScience 3. Big Data
Jeffrey Kattan (Masters student)	Universite de Montreal, Geographie	1. Human Dynamics 2. Disaster Management 3. Group Evacuations	1. Agent-Based Models 2. Network Analysis 3. Multi-dimensional GIS	1. Multi-Agent Systems (MAS) 2. GIScience 3. Emergency Management

Please do not hesitate to contact me should you need further details.

Thank you,
Sincerely,

Raja Sengupta, PhD
Associate Professor

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15th July, 2019

Dr. Dawn Parker
Director
Waterloo Institute for Complexity and Innovation (WICI)
University of Waterloo

Dear Dr. Parker:

This is to confirm that the Department of Geography at McGill is in support of Dr. Raja Sengupta's application to become an "External Core Member" of the Waterloo Institute for Complexity and Innovation (WICI).

The department has several research and teaching facilities that will facilitate the development of a node for the Canadian Network of Complex Systems (CNCS). The Geographic Information Center (GIC) is a University supported research and teaching facility that offers fast workstations for geospatial analysis and have a powerful server at hand to custom build geospatial solutions. Dr. Sengupta can request research time on these workstations for his complex systems research.

Additionally, Dr. Sengupta has access to a meeting room (Burnside Hall BH512) housed within the GIC, that can be booked on request for a time period of upto 2 hours. This can serve as a meeting room for CNCS webinars and local meetings, if booked adequately in advance.

Finally, Dr. Sengupta's own laboratory space (shared with Dr. Renee Sieber), the Roger Tomlinson Laboratory for GIScience (tomlinson.lab.mcgill.ca) is capable of hosting regular and visiting graduate students whose research focus matches those of the faculty.

Do not hesitate to contact me should you need additional information.

Thank you,
Sincerely,

Dr. George W. Wenzel, Professor and Acting Chair,
Signing for

Dr. Nigel Roulet
Chair, Geography

Raja Sengupta, PhD
Associate Professor, Department of Geography & School of Environment, McGill University,
805 Sherbrooke St W., Montreal QC H3A0B9 Canada Ph: 514-398-5316; raja.sengupta@mcgill.ca

Area of Expertise: Geographic Information Science (Agent-Based Modelling) analysing complexity related to Environmental Conservation, Public Health & Water Resources.

Experience:

2003-present	2009-**Associate Professor** (tenured); 2003-2009 **Assistant Professor** (tenure-track) Department of Geography & School of Environment, McGill University, Montreal, Canada. (Leave of Absence: 2011-2012)
2011-2012	**Associate Professor** Indraprastha Institute of Information Techonology-Delhi, India.
2009-2010	**Visiting Faculty**, Center for Rural Development and Technology, Indian Institute of Technology, Delhi, India (1 Dec 2009-30 May 2010)
2009	**Visiting Fellow**, Ashoka Trust for Research in Environment and Ecology (ATREE), Bangalore, India (1 June 2009-30 Nov 2009)
2000-2003	**Assistant Professor** (tenure-track) Department of Geography, Southern Illinois University – Carbondale, Illinois, USA.
1999-2000	**Visiting Instructor** Department of Geography, The University of Iowa, Iowa City, Iowa, USA.

Education:

1995-2000	**Ph.D. (Geography)**. Southern Illinois University – Carbondale, Illinois, USA.
1993-1995	**M.S. (Geology)**. Southern Illinois University – Carbondale, Illinois, USA.
1991-1993	**M.Sc. (Applied Geology)**. Indian Institute of Technology, Mumbai, India.
1989-1991	**B.Sc. (Geology)**, St. Xavier's College, University of Bombay (Mumbai), India.

Honorary Positions:

2006-2007	Interim Editor, *Water International* journal (2003-2006 Book Review Editor)
2015-2016	Local Organization Chair, *GIScience 2016* www.giscience2016.org

Editorial Board Memberships:

- Transactions in GIS (2011-2016); http://www.wiley.com/bw/journal.asp?ref=1361-1682
- Water International (2007-2010; 2016-present); http://www.tandf.co.uk/journals/rwin/

Program Committee (PC) Memberships/Specialists Meetings (selected):

- GIScience (2018, 2016 and 2012): www.giscience.org
- GeoProcessing 2018: http://www.iaria.org/conferences2018/GEOProcessing18.html
- CAMUSS 2016 (International Symposium on Cellular Automata Modelling for Urban and Spatial Systems): www.camuss.net
- Co-chair, Workshop on "Rethinking the ABCs: Agent-Based Models and Complexity in the age of Big Data, Agent-Based Models and Complexity Science" (held in conjuction with GIScience 2016 and GIScience 2018).
- Joint ICA/ISPRS WG IV/5 meeting (2011); www.sfu.ca/dragicevic/workshops2011/
- Spatial Knowledge and Information Canada (2007-2014); rose.geog.mcgill.ca/ski/

- InvitedParticipant, NCGIA Specialists Meeting on Agent-based Modeling of Complex Social Systems (2007); ncgia.ucsb.edu/projects/abmcss/
- XIIth World Water Congress, New Delhi, India (2005); www.iwra.org

Awards

- Dissertation Research Award (Southern Illinois University-Carbondale, 1999).
- *J.N. Tata Endowment Award* (1993) for the Higher Education of Indians Abroad.
- *S. K. Khalil Award* (University of Mumbai, 1991) for 1st place in University exams in Geology
- *Noshirwan H. Sethna Scholarship* (St. Xavier's College, University of Mumbai, 1989 & 1990) for a deserving Geology student in the first and second years B.Sc.

Publications (Supervised student co-authors, both present and past, are underlined):

Edited Books:

1. Perez, L., Kim, E.K., and **Sengupta, R.** (eds), 2017. *Agent-Based Models and Complexity Science in the Age of Geospatial Big Data. Series: Advances in Geographic Information Science Series*. Springer International Publishing, Zurich, Switzerland.

Peer Reviewed Journal Articles

1. Sarkar, D., Chapman, C., Valenta, K., and **Sengupta, R.,** *In Press*. A Tiered Analysis of Community Benefits and Conservation Engagement from the Makerere University Biological Field Station, Uganda. *Professional Geographer*. https://www.tandfonline.com/doi/full/10.1080/00330124.2018.1547976

2. Sarkar, D., Andris, C., Chapman, C., and **Sengupta, R.** 2019. Metrics for characterizing Network Structure and Node Importance in Spatial Social Networks. *International Journal of Geographical Information Science* 33(5): 1017-1039. https://doi.org/10.1080/13658816.2019.1567736

3. Bonnell, T.R., Ghai, R.R., Goldberg, T.L., **Sengupta, R.** and Chapman, C.A., 2018. Simulations of environmentally-transmitted parasites under habitat fragmentation suggests that as habitat is lost, its configuration becomes more important. *Landscape Ecology* 33 (8): 1259-1272.

4. Chapman, C.A., Bortolamiol, S., Matsuda, I., Omeja, P.A., Paim, F.P., Reyna-Hurtado, R., **Sengupta, R.** and Valenta, K., 2018. Primate population dynamics: variation in abundance over space and time. *Biodiversity and Conservation* 27(5): 1221-1238. https://doi.org/10.1007/s10531-017-1489-3.

5. MacKenzie, C., S. Moffat, Ogwang, J., Ahabyona, P., and **R. Sengupta**, 2017. Advocating for Primary Education: Spatial and Temporal Patterns in Enrolment and Exam Achievement in Rural Uganda. *Children's Geographies* 15(3): 334-348.

6. Sakar, D., C.A. Chapman, W. Kagoro, and **R. Sengupta**, 2016. Countering elephant raiding with SMS: Challenges of deploying public participation based systems in an Information Communication Technologies resource sparse setting. *The Canadian Geographer* 60(4): 493-504.

7. Chapman, C.A., S. Friant, K. Godfrey, C. Liu, V.A.M. Schoof, D. Twinomugisha, J.M. Rothman, D. Sakar, **R. Sengupta,** K. Valenta, and T.L. Goldberg, 2016. Gastrointestinal parasites influence the social behaviour and network of vervet monkeys (Chlorocebus aethiops). *PLoS ONE* 11(8): e0161113. doi:10.1371/journal.pone.0161113.

8. Bonnell, T.R., Ghai, R.R., Goldberg, T.L., **Sengupta, R.** and Chapman, C.A., 2016. Spatial patterns of persistence for environmentally transmitted parasites: Effects of regional climate and local landscape. *Ecological Modelling*, 338, pp.78-89.

9. Bonnell, T., Chapman, C., and **Sengupta, R**., 2016. Interaction between scale and scheduling choices in simulations of spatial agents. *International Journal of Geographic Information Science*, 30(10): 2075-2088.

10. MacKenzie, C., **Sengupta, R.,** and Kaoser, R., 2015. Chasing Baboons or attending class: protected areas and childhood education in Uganda. *Environmental Conservation*, 42(4): 373-383.

11. Vora, K., Yasobant, S., **Sengupta, R.,** De Costa, A., Upadhyay, A., Mavalankar, D., 2015. Options for Optimal Coverage of Free C-Section Services for Poor Mothers in Indian State of Gujarat: Location Allocation Analysis Using GIS. *PLoS ONE* 10(9): e0137122. doi:10.1371/journal.pone.0137122 [online]

12. Sarkar, D., Chapman, C., Griffin, L., and **Sengupta, R.,** 2015, Analyzing Animal Movement Characteristics from Location Data. *Transactions in GIS* 19(4), 516-534.

13. Benessaiah, K., and **Sengupta, R.,** 2014, How is Shrimp Aquaculture Transforming Coastal Livelihoods and Lagoons in Estero Real, Nicaragua? The Need to Integrate Social–Ecological Research and Ecosystem-Based Approaches. *Environmental Management* 54(2): 162-179.

14. O'Farrill, G., Gauthier-Schampaert, K., Rayfield, B., Bodin, O., Calmé, S., **Sengupta, R.,** and Gonzalez, A., 2014. The Potential Connectivity of Waterhole Networks and the Effectiveness of a Protected Area under Various Drought Scenarios. *PLoS ONE*. Doi: 10.1371/journal.pone.0095049

15. Bonnell, T.R., Campenni, M., Chapman, C., Gogarten, J., Reyna-Hurtado, R., Teichroeb, J., Wasserman, M., and **Sengupta, R.,** 2013. Emergent group level navigation: an agent-based evaluation of movement patterns in a folivorous primate. *PLoS ONE* doi: 10.1371/journal. pone.0078264.

16. Bonnell, T.R., Dutilleul, P., Chapman, C. A., Reyna-Hurtado, R., Hernández-Sarabia, R.U., **Sengupta, R.,** 2013. Analysing small-scale aggregation in animal visits in space and time: the ST-BBD method. *Animal Behaviour* 85(2): 483-492.

17. Chapman, C.A., T.R. Bonnell., **R. Sengupta.,** T.L. Goldberg, and J.M. Rothman, 2013. Is Markhamia lutea's abundance determined by animal foraging? *Forest Ecology and Management* 308: 62-66.

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19. O'Farrill, G., Calme, S., **Sengupta, R.,** and Gonzalez, A., 2012. Effective dispersal of large seeds by Baird's tapir: a large-scale field experiment. *Journal of Tropical Ecology* 28(1): 119-122.

20. Heller, E., Rhemtulla, J.M., Lele, S., Kalacska, M., Badiger, S., **Sengupta, R**., Ramankutty, N., 2012. Mapping Irrigated Areas and Cropping Intensities: the contribution of Multi-season data in highly heterogeneous regions of Southern India. *Photogrammetric Engineering and Remote Sensing* 78(8): 815-827.

21. Samal, A.R., **Sengupta, R.,** and Fifarek, R., 2011, Modeling spatial anisotropy of gold concentration data using GIS-based interpolated maps and variogram analysis: implications for structural control of mineralization. *Journal of Earth System Science* 120(4): 583-594.

22. Bonnell, T., Chapman, C., **Sengupta, R.,** and Goldberg, T., 2010, Linking landscapes to disease: Implications of spatial changes in resource distribution for red colobus monkey disease transmission using Agent-Based Models. *Ecological Applications* 221(20): 2491-2500.

23. Jacob, A.L., Vaccaro, I., **Sengupta, R**., Hartter, J., and Chapman, C.A., 2008. Integrating landscapes that have experienced rural depopulation and ecological homogenization into tropical conservation planning. *Tropical Conservation Science* 1(4): 307-320.

24. Jackson, J., Forest, B., and **Sengupta, R.,** 2008. Agent-Based Simulation of Urban Residential Dynamics and Land Rent Change in a Gentrifying Area of Boston. *Transactions in GIS,* 12(4): 475-491.

25. **Sengupta, R.,** Rosenshein, L., Gilbert, M., and Weiller, C., 2007, Ecoregional Dominance in Spatial Distribution of Avian Influenza (H5N1) Outbreaks [letter]. *Emerging Infectious Diseases*, 13(8): 1269-1271.

26. **Sengupta, R.,** and Sieber, R., 2007, Geospatial Agents, Agents Everywhere.... *Transactions in GIS*, 11(4): 483 -506.

27. **Sengupta, R**, Lant, C., Kraft, S., Beaulieu, J., Peterson, W., and Loftus, T., 2005, Modeling CRP Enrolment using Agents within Spatial Decision Support Systems: An Example from Southern Illinois. *Environment and Planning B*, 32(6): 821-834.

28. **Sengupta, R**., Middleton, B., Chen, Y., Zuro, M., and Hartman, H., 2005, Propagule deposition and landscape characteristics of source forests of Rhizophora mangle in coastal landscapes in Florida. *Landscape Ecology*, 20 (1): 63-72.

29. Most, M., **Sengupta, R.,** and Burgener, M., 2004, Spatial Scale and Population Assignment Choices in Environmental Justice Analyses. *The Professional Geographer* 56(4): 574-586.

30. Heine, R., Lant, C., and **Sengupta, R.,** 2004, Development and Comparison of Approaches for Automated Extraction of Stream Channel Networks. *Annals of the Association of American Geographers*, 94(3): 447-490.

31. **Sengupta, R.,** and Chen, Y., 2004, Hybrid Spatio-Temporal Data Model and Structure (HST-DMS) for Efficient Storage and Retrieval of Land Use Information. *Transactions in GIS*, 8(3): 351-366.

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Editorials:

1. **Sengupta, R.,** 2007, Topic 2: Applied Models and Decision Support Systems (DSS). *Water International*, 32(3): 395-396.

2. **Sengupta, R.,** 2006, Water International: A look at the past, present and future. *Water International*, 31(3): 287.

Book Chapters:

1. **Sengupta, R.,** Chapman, C.C., Sarkar, D., and Bortolamiol, S., 2017. Automated Extraction of Movement Rationales for Building Agent-Based Models: Example of a Red Colobus Monkey Group. In *Agent-Based Models and Complexity Science in the Age of Geospatial Big Data*. Perez, L., Kim, E.K., and **Sengupta, R.** (eds). *Advances in Geographic Information Science Series*. Springer International Publishing, Zurich, Switzerland.

2. Yadav, P., Deshpande, S., and **Sengupta, R.,** (2017). Animating Maps: Visual Analytics meets Geoweb 2.0. *In* Advances in Geocomputation (Geocomputation 2015: The 13th International Conference), Dallas, TX, USA. Griffith, D.A., Chun, Y., and Dean, D. (eds). *Advances in Geographic Information Science Series* Vol. 10: 75-84. Springer International Publishing, Cham, Switzerland.

3. Sarkar, D., Sieber, R., and **Sengupta, R.,** (2016). GIScience Considerations in Spatial Social Networks. *In* GIScience 2016: Proceedings of the 9th International Conference on Geographic Information Science), Montreal, QC, Canada. Miller, J., O'Sullivan, D., and Wiegand, N. (eds). *Lecture Notes in Computer Science* Vol. 9927:85-100. Springer, Berlin, Germany.

4. Chapman, C.A., Twinomugisha, D., Teichroeb, J.A., Valenta, K., **Sengupta, R**., Sarkar, D. and Rothman, J.M., 2016. How Do Primates Survive Among Humans? Mechanisms Employed by Vervet Monkeys at Lake Nabugabo, Uganda. In *Ethnoprimatology* (pp. 77-94). Springer International Publishing, Zurich, Switzerland.

5. Chapman, C.A., Huffman, M.A., Ryan, S.J., **Sengupta, R.** and Goldberg, T., 2008. Ways forward in the study of primate parasite ecology. In *Primate parasite ecology: the dynamics and study of host-parasite relationships*. Huffman, M.A. and Chapman, C.A. (eds). *Cambridge Studies in*

Biological and Evolutionary Anthropology pp. 487-505 [ISBN 978 0 521 87246 1]. Cambridge University Press, UK.

6. **Sengupta, R.,** 2006. Simulation Modelling within Collaborative Spatial Decision Support Systems using cause-effect models and Software Agents. In *Collaborative GIS* (S. Dragicevic and S. Balram, Eds.) pp. 134-149 [ISBN 1-5914-0846-6]. Idea Group Publishing, Hershey, PA.

7. Samal, A.R., Fifarek, R., and **Sengupta, R.,** 2005. Geostatistical Investigation of Elemental Enrichment in Hydrothermal Deposits. In *Quantitative Geology and Geostatistics*, Vol. 14 (O. Leuangthong and C.Deutsch, Eds.) pp. 491-500 [ISBN: 1-4020-3515-2]. Springer: New York, NY.

8. **Sengupta, R.,** and Bennett, D. A., 2001. Making Data Rich Depositories of Geographical Data Usable with Intelligent System Technologies. In *Geographic Data Mining and Knowledge Discovery* (H. Miller and J. Han, Eds.). pp. 110-128. [ISBN: 0-4152-3369-0]. Taylor and Francis: Levittown, PA.

9. Bennett, D. A., **Sengupta, R.,** Beaulieu, J., and Kraft, S. E., 2000. Integrating Simulation Models and Geographic Information For Environmental Problem Solving. In *Spatial Information for Landuse Management* (Michael. J. Hill and Richard J. Aspinall, Eds.) [ISBN: 9-0569-9315-1]. Blackwell Publishers: Blackwood, NJ.

10. Bennett, D. A., Wade, G. A., and **Sengupta, R.,** 1999. Geographical Modeling in Heterogeneous Computing Environments. In *Interoperating Geographic Information Systems* (M. Goodchild, M. Egenhofer, R. Fegeas, and C. Kottman, Eds.) [ISBN: 0-7923-8436-9]. Kluwer Academic Publishers: Dordrecht, Netherlands.

Book Reviews:

1. **Sengupta, R**., 2003: Review of *World Water and Food to 2025: Dealing with Scarcity*. Mark W. Rosegrant, Ximing Cai and Sarah A. Cline. Washington DC, USA: International Food Policy Research Institute. 2002. 322 pp. *Water International*, 28(1): 132-133.

Refereed Conference Proceedings:

1. Yadav, P., Deshpande, S., and **Sengupta, R.,** 2015. Animating Maps: Visual Analytics meets Geoweb 2.0. *Geocomputation 2015: Proceedings of the 13th International Conference on GeoComputation*. Dallas, TX: Department of Geospatial Information Sciences, University of Texas-Dallas (21 May 2015).

2. Hughes, C., **Sengupta, R.,** Naik, V., and Saxena, D., 2014. Geovisualization for cluster detection of Hepatitis A & E outbreaks in Ahmedabad, Gujarat, India. *Proceedings of the Third ACM SIGSPATIAL International Workshop on the use of GIS in Public Health*. Dallas, TX: Dept. Of Geography, Texas A&M University (4 November, 2014).

3. Koti, S.R., and **Sengupta, R.,** 2012, Distributed Web Processing Service (DWPS) for Real Time Analysis of Health Data. *Proceedings of GIScience 2012*. Columbus, Ohio: Dept.of Geography, The Ohio State University (18-21 September, 2012).

4. Bonnell, T.R., **R. Sengupta,** C. A. Chapman and T. L. Goldberg, 2011, Linking landscapes to disease: An agent-based model simulating the impact of forest composition on spread of disease in red colobus populations. *Proceedings of ICA-ISPRS 2011 Joint Workshop*, Burnaby, Canada (10-12 August, 2011).

5. Bonnell, T., **Sengupta, R.,** and Chapman, C., 2011, "Spatial Epidemiology and GIS/ABM: a case study of the red colobus monkey." *Spatial Knowledge and Information (SKI) Canada*: Fernie, BC, Canada (4-6 March, 2011).

6. **Sengupta, R.,** and Bonnell, T., 2008, Emerging Infectious Diseases and Agent-based Models: Moving Epidemiology from Analyzing Pattern to Simulating Process. *Spatial Knowledge and Information (SKI) Canada*, Fernie, BC, Canada (15-17 Feb, 2008).

7. Samal, A.R., Fifarek, R., and **Sengupta, R.**, 2005. 'The Spatial Pattern of Trace Elements Relative to Gold Concentrations in an Epithermal Gold Deposit'. *Proceedings of IAMG '05: GIS and Spatial Analysis (Vol. 1: p. 458-463), Toronto, Canada:* International Association for Mathematical Geology, Kingston, Ontario, Canada.

8. **Sengupta, R.,** Beaulieu, J., and Kraft, S., 2003, 'Assisting Decision-Makers Manage Compensatory Payments to Preserve Water Quality in Agricultural Watersheds through modeling and simulation'. *Proceedings of the XIth World Water Congress, Madrid, Spain* (11th-9th October, 2003): International Water Resources Association, Carbondale, Illinois 62901, USA.

9. **Sengupta, R**., Beaulieu, J., Kraft, S., Loftus, L., Shcherbanuik, M., and Soman, S., 2002, 'Modeling Trade-Offs between Water Quality and Profits in Agricultural Watersheds'. *Proceedings of Water for Human Survival: IWRA Regional Conference, New Delhi, India*: Central Board of Irrigation and Power, Malcha Marg, New Delhi 110 021, India.

10. **Sengupta, R.,** Loftus, T., and Shcherbaniuk, M., 2002. 'Agent-based modeling of human decision-making behavior within Spatial Decision Support Systems'. *Proceedings of GIScience 2002: Second International Conference on Geographic Information Science, Boulder, CO:* National Center for Geographic Information Analysis (NCGIA), University of California-Santa Barbara, CA.

11. Radhakrishnan, P., and **Sengupta, R.,** 2002. 'Groundwater modeling in GIS by integrating ArcView 3.2, MODFLOW and MODPATH'. *Proceedings of the 2002 ESRI Users Conference, San Diego, CA:* ESRI Inc, Redlands, California, USA.

12. **Sengupta, R.**, Bennett, D., and Armstrong, M. P., 2000, 'Agent-oriented Modeling Environment for Spatial Decision Support'. *Proceedings of GIScience 2000: First International Conference on Geographic Information Science, Savannah, GA:* National Center for Geographic Information Analysis (NCGIA), University of California-Santa Barbara, CA, USA.

13. Armstrong, M. P., Bennett, D., Densham, P., and **Sengupta, R.,** 2000, 'Theoretical Perspectives on Agent-Oriented Geographic Information Management and Analysis'. *Proceedings of GIScience 2000: First International Conference on Geographic Information Science, Savannah, GA:* National

Center for Geographic Information Analysis (NCGIA), University of California-Santa Barbara, CA, USA.

14. Wade, G.A., Bennett, D., and **Sengupta, R.,** 1997. 'An interactive distributed architecture for geographical modeling'. *Proceedings of Auto-Carto 13, Seattle, WA:* American Congress on Surveying and Mapping, Bethesda, MD, USA.

15. **Sengupta, R.,** and Bhattacharya, S., 1997. 'Zip codes for direct marketing modeling using GIS'. *Proceedings of AIS '97 Americas Conference, Indianapolis, IN*: Association of Information Systems, Atlanta, GA, USA.

16. **Sengupta, R.,** Bennett, D., and Wade, G., 1996. 'Agent mediated links between GIS and spatial modeling software using a model definition language'. *Proceedings of GIS/LIS '96, Denver, CO:* American Congress on Surveying and Mapping, Bethesda, MD, USA.

Conference and Invited Presentations (including student-led presentations):

1. Sengupta, R., Pathak, A., and Buddhiraja, B., 2019. "Estimating UHI from Remote Sensing and Weather Stations: Some Caveats." *American Association of Geographers Meeting (2019),* 3 Apr, Washington, DC, USA.

2. Sengupta, R. and Perez, L., 2018. Big Data (r)evolution in ABM and Complexity Science. *In* "Workshop W5: Rethinking the ABCs: Agent-Based Models and Complexity in the age of Big DataAgent-Based Models and Complexity Science", *GIScience 2018,* 28 Aug, Melbourne, VIC, Australia.

3. Sengupta, R., 2018. Manipulating objects to cultivate fields: A Spatio-Temporal Data Structure for Sensor placements to measure the Urban Heat Island phenomenon. *GIScience 2018*, 29 Aug, Melbourne, VIC, Australia.

4. Pathak, P.A. and Sengupta, R., 2017. Urban Heat Island (UHI) Effect in the context of urban matrix: evaluation with ground-based, low cost sensors. *Annual Meeting of the Association of American Geographers*: 5-9 April, Boston, MA, USA.

5. Sengupta, R., 2015. "Adding time to space: Models and GIS". *Invited Presentation, TERRA Guest Lecture Series, Dept. of Geology, St. Xavier's College, University of Mumbai,* Mumbai, India. (July 17, 2015).

6. Sengupta, R., and Bonnell, T., 2014, "What's so Special about Spatial Agents?". *Annual Meeting of the Association of American Geographers*: 8-11 April, Tampa, FL, USA.

7. Bonnell T., **Sengupta, R,** Chapman, C., and Goldberg, T., 2012, "Linking Landscapes to Disease: An Agent-Based Model simulating the impact of forest composition on spread of disease in red colobus populations". *Annual Meeting of the Association of American Geographers*: 24-28 February, New York, USA.

8. Bonnell, T., **Sengupta, R.,** and Chapman, C., 2011, "Spatial Epidemiology and GIS/ABM: a case study of disease transmission amongst Red Colobus monkeys". *Annual Meeting of the Association of American Geographers*: 12-16 April, Seattle, USA.

9. **Sengupta, R.,** 2010, Spatial Technologies for e-Governance. *Invited Presentation, Indian Institute for Public Administration,* New Delhi, India (April 13, 2010).

10. **Sengupta, R.,** 2010, Integrating spatially-explicit human decisions with GIS: An agent-based approach. *Invited Presentation, Centre for the Study of Regional Development, Jwaharlal Nehru University,* New Delhi, India (January 22, 2010).

11. **Sengupta, R.,** Bonnell, T., and Chapman, C., 2009. Simulating Parasite-Host Interactions using Agent-Based Models: A Case-Study of Kibale National Park, Uganda. *Annual Meeting of the Association of American Geographers*: 22-27 March, Las Vegas, USA.

12. **Sengupta, R.,** 2009, Integrated Spatial Modelling and Geoinformatics: Emerging and Essential tool for Understanding Complex Environmental Dynamics. *Invited Presentation, Ashoka Trust for Research in Ecology and Environment,* Bengaluru, Karnataka, India (July 1, 2009).

13. Bonnell T., Chapman, C., and **Sengupta, R.,** 2009 "Linking landscapes to disease: red colobus foraging behaviour and its implications for the spread of disease in logged forests." Quebec center for Biodiversity Science: Nov 30 – Dec 2, Montreal, Quebec, Canada

14. **Sengupta, R.,** 2007, Application of Geographic Information Science in Natural & Social Science Research. *Invited Presentation, Institute for Social and Economic Change,* Bengaluru, Karnataka, India (June 4, 2007).

15. **Sengupta, R.,** 2006, 'Agents in a Virtual Watershed: Modeling agricultural policy response. *Presented at the Annual Meeting of the Association of American Geographers*, Chicago, IL (March 7-11, 2006).

16. **Sengupta, R.,** 2005, 'CRP Adoption using agents: the Virtual Watershed Project. Presented at the *West Lakes Division Meeting, Association of American Geographers*, Iowa City, IA (November 3-5, 2005).

17. **Sengupta, R.**, 2004. 'Modeling Adoption of Conservation Cover Programs using Software Agents'. Presented at the *Canadian Association of American Geographers Annual Meeting, Moncton, NB, Canada*.

18. **Sengupta, R.,** 2004, Spatial Decision Support Systems and Agents: Modelling meets Social Science. *Invited Presentation, Department of Geography, Universite de Montreal*, Montreal, Quebec, Canada (Nov 30, 2004).

19. **Sengupta, R.,** and Sieber, R., 2004. 'Agent, Agents Everywhere…' Presented at the *Association of American Geographers Annual Meeting, Philadelphia, PA, USA*.

20. **Sengupta, R.,** 2003. 'Modeling Acceptance of Ecosystem Service Payments in Decision-Support Systems using Software Agents'. Presented at the *2003 Open Meeting of the Human Dimensions of Global Environmental Change Research Community, Montreal, Canada*.

21. **Sengupta, R.,** Loftus, T., and Shcherbanuik, M., 2003. 'Agent-based modeling of human decision-making behavior within Spatial Decision Support Systems'. Presented at the *Association of American Geographers Annual Meeting, New Orleans, LA, USA*.

22. **Sengupta, R.,** 2002. 'Assisting decision-makers manage CRP payments in agricultural watersheds through modeling and simulation'. Presented at the *Association of American Geographers Annual Meeting, Los Angeles, CA, USA*.

23. **Sengupta, R.,** Radhakrishnan, P., Loftus, T., and Bennett, D., 2001, 'SARs: Software Agents that represent stakeholders at the bargaining table'. Presented at the *Association of American Geographers Annual Meeting, New York City, NY, USA*.

24. **Sengupta, R.,** and Bennett, D., 2000, 'Analysis on a platter: agents that assist in the integration of data and analytical tools'. Presented at the *Association of American Geographers Annual Meeting, Pittsburgh, PA, USA*.

Patents:

1. Heine, R., Lant, C., and **Sengupta, R.,** 2002. "A Rapid Method for Stream Channel Mapping" (Patent held on behalf of Southern Illinois Univ. – Carbondale, Illinois, USA, Mar 11, 2002).

Research Funding:

- 2019-2020. *India-Canada IMPACTS Networked Centers of Excellence (Improving Occupant Survivability in Buildings During Fires)*. 'Mobile app for improving survival in fires through efficient egress using impromptu indoor WiFi localization and georeferenced building maps.' PI-Canada with Srinivasan, A. (PI-India), Naik, V., Perez, L. C$150,000.

- 2017-2019. *India-Canada IMPACTS Networked Centers of Excellence (Smart and Green Buildings in Sustainable Cities)*. 'Urban Heat Island Effect and building energy demand: linkages explained using a dense, low cost sensor network'. PI-Canada with Pathak, P (PI-India), Liang, S., Mostafavi, MA., Agarwal, P., Mondal, A., Neeti, N. C$171,000.

- 2016-2017. *McGill Global Health Programs (Steinberger Fund for Interdisciplinary Health Research)*. 'Early detection of the spatial origin of infectious diseases allows the testing of hypotheses of emergence'. Co-PI with Chapman, C. (PI), Goldberg, T., Hartter., J., Salerno, J., Silva Serio, J.C., and Ward, B. C$45,000.

- 2015-2016. *National Geographic Society (Conservation Trust). Principal Investigator*. 'Using SMS to facilitate assistance by Ugandan Wildlife Authority against elephant crop raiding and foster park-people relations'. With Tumwesigye, C (Co-PI). US$23,600.

- 2010-2017. *Social Science and Humanities Research Council of Canada (Major Collaborative*

Research Initiatives Program). 'The Indian Ocean World: the making of the first global economy in the context of human-environment interactions'. Co-PI with Campbell, G. (PI), Bush, A., Chen, C., Cheriet, M., Chmura, G., Gillon, B., Luginaah, I., Kalacska, M., Schottenhammer, A., Unruh, J., Warren, J. C$2,500,000.

- 2011-2014. *Fonds Québécois de la Recherche sur la Nature et les Technologies (FQRNT- Projet de recherche en équipe).* Vers la compréhension des dynamiques de transmission des maladies: utilisation des approches de l'épidémiologie spatiale et de la modélisation multi-agent sur deux continents. Co-PI with Chapman, C. (PI), Calme, S., and Reyna-Hurtado, R. C$145,500.

- 2012-2013. *National Geographic Society (Committee on Research and Exploration).* 'Use of Cell Phones for Detecting and Controlling Infectious Diseases'. Co-PI with Naik, V. (PI), Arnaert, A., Estrin, D., Saxena, D., and Singh, A. US$20,000.

- 2007-2008. *McGill-India Strategic Research Initiative Grant (Internal).* 'Payment for Environmental Services in the Western Ghats: An exploration of the socio-economic, biophysical and institutional issues at a watershed scale.' Principal Investigator with Ramankutty, N., and Lele, S. C$40,000.

- 2005-2010. *Natural Sciences and Engineering Research Council of Canada (Discovery Grants). Principal Investigator.* 'A decision-support tool to evaluate the co-production of ecosystem services in agricultural landscapes using agents and physical process models.' C$100,000.

- 2005-2010. *Social Science and Humanities Research Council of Canada (Community-University Research Alliance).* 'Protected area creation, culture and development at the Cree community of Wemindji, James Bay, Quebec'. Co-PI with Scott, C. (PI), Berkes, F., Brown, P., Costopoulos, A., Fyles, J., Humphries, M., Ingram, R., Mikkelson, G., Mulrennan, M., Sieber, R. C$998,636.

- 2005-2008. *Social Science and Humanities Research Council of Canada (Aboriginal Research Program).* Co-Principal Investigator with Scott, C. (PI), Brown, P., Costopoulos, A., Fyles, J., Humphries, M., Mikkelson, G., Mulrennan, M., and Sieber, R. 'Building Knowledge based partnerships for environmental protection, Cree cultural survival and community education at Wemindji, James Bay, Quebec'. C$240,000.

- 2004-2008. *US National Science Foundation (Biocomplexity in the Environment: Coupled Natural Human Systems).* 'Virtual Watershed: Agricultural Landscape Evolution in an Adaptive Management Framework' Principal Investigator for McGill sub-contract, with Lant, C. (PI), Beaulieu, J., Kraft, S., Malanson, G., Nicklow, J., Schnoor, J. US$ 450,000.

- 2004-2006. *Social Science and Humanities Research Council of Canada (Northern Research Development Program).* Co-PI with Scott, C. (PI), Brown, P., Costopoulos, A., Fyles, J., Humphries, M., Mulrennan, M., and Sieber, R. 'Building Knowledge based partnerships for environmental protection, Cree cultural survival and community education at Wemindji, James Bay, Quebec'. C$40,000.

- 2004. *Social Science and Humanities Research Council of Canada (Community-University Research Alliance Letter of Intent Award).* Co-PI with Scott, C. (PI), Brown, P., and Mulrennan, M. 'Protected area creation, culture and development at the Cree community of Wemindji, James Bay, Quebec'. C$20,000.

Previous grants at Southern Illinois University (since 2000):

- 2001. *Office of Research Development and Administration (ORDA), Southern Illinois University (Faculty Research/Creative Activities Grant).* Principal Investigator. 'Prioritizing Mangrove Swamp Fragments for Ecological Preservation using Remote Sensing and GIS'. US$ 23,634.

- 2000-2003. *Illinois Council on Food and Agricultural Research (Strategic Research Initiative in Water Quality).* Co-PI with Beaulieu, J. (PI), Bennett, D., Kraft, S., Lant, C., Nicklow, J. 'Decision Support for Water Quality Planning in Multiple-Ownership Watersheds'. US$ 204,000. Yearly average: US$ 68,000.

Graduate Student Supervision:

Completed Graduate Students at McGill (Five PhD, Five Masters):

- **Dipto Sarkar** (PhD 2018). *Supervisor, co-supervisor: Colin Chapman*. Spatial Social Networks: Exploring Theoretical and Methodological Challenges.

- **Tyler Bonnell** (PhD 2014). *Supervisor, co-supervisor: Colin Chapman*. Spatial simulations of infectious disease: environment, behaviour, and their interaction in a primate population.

- **Catrina MacKenzie** (PhD 2011). *Supervisor* Spatial Patterns of Resource Extraction around Kibale National Park, Uganda.

- **Georgina O'Farrell**. (PhD 2010). *Co-supervision with Andrew Gonzales (Biology)* Identification of Keystone Species in protected areas of the Yucatan Peninsula, Mexico.

- **Martha Otero** (PhD 2010). *Supervisor* A framework for landscape-level analysis of ecosystem service payment alterations of Latin American watersheds: A case study of Las Ceibas, Colombia.

- **Carl Hughes** (MA 2016) A method for near real-time surveillance of Hepatitis A and E cases in Ahmedabad, India.

- **Tyler Bonnell** (MSc 2010) Agent-based models of infectious disease transmissions amongst Colobus Monkey groups in Kibale National Park, Uganda.

- **Paola Bauche Petersen** (MSc 2007) Interactions of Payment for Hydrological Services and Forest Transitions: A case study of the Rio Cuale Watershed, Mexico.

- **Karina Benessaiah** (MSc 2008) Degradation of mangrove ecosystem in Nicaragua: a study of socio-economic drivers.

- **Sandra Bolanos** (MSc 2007) Using Image Analysis and GIS for Coffee Mapping in Colombia.

- **Jeremy Jackson** (MA 2008) Agent-based models of gentrification in Boston, MA, USA.

Past Graduate Student Supervision at Southern Illinois University-Carbondale:

- **Rui Ding** (M.S., 2001): 'Pricing Residential Disamenities: The Cost of Crime' (Co-supervised with James LeBeau, Administration of Justice Department, Southern Illinois University-Carbondale).

- **Cheng Luo** (M.S., 2001): 'Building an Efficient Temporal Geographical Information System (TGIS) Data Model'.

- **Fareeza Karimushan** (M.S., 2002): 'Spatial variations in hurricane occurrence during La Nina, El Nino and Neutral Phases'.

- **Bradley Larson** (M.S., 2002): 'An SDSS capable of applying Species-Specific Viability Parameters to National GAP Analysis Program Datasets'.

- **Premkrishnan Radhakrishnan** (M.S., 2002): 'An SDSS for Evaluation of Agricultural Acreage in Well Head Protection Areas'.

- **Yan Chen** (M.S., 2002): 'HST-DSM: A Hybrid Spatio-temporal Data Model'.

- **Mike Paluzzi** (M.S., 2003): 'Improving Location-Allocation models using heuristic approaches: applications to emergency management systems'.

Teaching:

Recognition: The McGill Geography Undergraduate Society's (MUGS) Mug for teaching excellence and mentoring awarded in the year 2008. Selection was by voting amongst undergraduate students.

Courses taught at McGill University (2003-present):

- Introduction to Geographic Information Science
- Socio-Economic Applications of GIS
- Graduate Seminar in Geo-Information Science
- Introduction to Earth System Science (for non-majors)
- Environmental Research Methods
- Environmental Research (Team Projects)

Courses taught at IIIT-Delhi (2011-2012):

- Geospatial Data Management
- Environmental Earth System Science: Our changing planet (for non-majors)

Courses taught at Southern Illinois University (2000-2003):

- Introduction to Geographic Information Science
- Advanced Geographic Information Science
- Spatial Decision Support Systems

Courses taught at University of Iowa (1999-2000):

- Introductory GIS
- Advanced GIS
- Water Resources Management
- Spatial Decision Support Systems and Location Allocation

APPENDIX F: KEYWORDS SURVEY RESULTS

Default Report

Keywords Survey for CNCS
March 3, 2020 11:28 AM MST

Q1 - Please provide up to three academic disciplines that your work spans:

1st Discipline	2nd Discipline	3rd Discipline
business	corporate governance	politics
Policy analysis	Futures studies	N/A
Computer Vision	Machine Learning	Inverse Problems
Restoration Ecology	Hydrology	Art
Health Services	Psychiatry	Gerontology
nutrition	N/A	N/A
Sociology	Political Science	Computer Science
Chemistry	Process Engineering	Sustainability and Environment
Public and population health	N/A	N/A
Psychology	Economics	Anthropology
Nonlinear Dynamics	Bifurcation Theory	Chaos & Crises
Political Science	Psychology	Economics
sociology	criminology	N/A
Human and Social Ecology	Industrial Ecology	Ecological Economics
sociology	political philosophy	environment

Q2 - Please provide up to three application areas that describe your research:

1st Area	2nd Area	3rd Area
business analytics	corporate governance	quantitative methods
Climate change	Sustainability	Energy
Remote Sensing	High resolution imagery	N/A
Integrated Watershed Management Planning	Communication of Science to a general audience	Interactive Art Exhibit
Assessment Systems	Mental Health and Addictions	Healthcare policy
dietary assessment	dietary patterns	evaluating interventions
Diffusion and contagion (emphasis on information)	Collaboration and communication networks	Privacy and security
carbon dioxide utilization	energy storage	solar fuels
Public and population health	Health policy	Nutrition and food systems
wisdom	emotional complexity	cultural evolution and change
System Stability	Network Dynamics	Population Dynamics
Belief system change	Violent conflict	Social and economic innovation
criminal networks	N/A	N/A
Material and Energy Flow Analysis (MEFA)	Material Stock Analysis (MSA)	Disaster and humanitarian aid
degrowth ecological economy	community and resilience	traditional music

Q3 - Please provide up to three methods that you use in your work:

1st Method	2nd Method	3rd Method
network analysis	exploratory data analysis/text analysis	regression analysis
Scenario analysis	Event trees	Markov chains
Deep learning	Statistical random fields	N/A
Case Study of Watershed Restoration work and measured change of environmental parameters	Social Research involving survey, focus group and interviews	Production of Ecological Art
Multivariable models	Spatial Analysis	Psychometrics
concept mapping	neural networks	a priori/data driven methods for dietary patterns
Computational network models	Computational text analysis	Surveys and interviews
Catalysis	Electrosynthesis	Device engineering
Quantitative methods	Program evaluation	Literature searching
Behavioral Experiments	Surveys	Archival and Big data-based (e.g., Google Books) analyses
Perturbation Methods	Numerical (shooting) Method	Algebraic Maps
Cognitive-affective maps	Ideological state-space assessment	Formal modeling of system change
social network analysis	archival data	multivariate statistics
Material and Energy Flow Analysis (MEFA)	Material Stock Analysis (MSA)	Agent Based Modelling (ABM)

Q4 - If applicable, please let us know what you consider your more important complex systems based publications. You can send us citations or links. (We will not post any publicaitons on the WICI website). (Core members: We already have this information from you!)

If applicable, please let us know what you consider your more important com...

Bendix, W., & Mackay, J. 2017. Partisan Infighting Among House Republicans: Leaders, Factions, and Networks of Interests. Legislative Studies Quarterly, 42(4): 549–577. https://onlinelibrary.wiley.com/doi/abs/10.1111/lsq.12168

P. Fieguth, An Introduction to Complex Systems: Society, Ecology, and Nonlinear Dynamics, Springer Verlag, 346pp, 2017 Wesley Campaigne, Paul Fieguth, "Frozen State Hierarchical Annealing," IEEE Transactions on Image Processing (22) #4, pp.1486–1497, 2013 P. Fieguth, "Differential Equations, Agent Models, and Resilience," Council of Engineering Systems Universities — Global Conference, Tokyo, 2018

Perlman, C. M., Law, J., Luan, H., Rios, S., Seitz, D., & Stolee, P. (2018). Geographic Clustering of Admissions to Inpatient Psychiatry among Adults with Cognitive Disorders in Ontario, Canada: Does Distance to Hospital Matter?. The Canadian Journal of Psychiatry, 63(6), 404-409. Perlman, C., Kirkham, J., Velkers, C., Leung, R. H., Whitehead, M., & Seitz, D. (2019). Access to Psychiatrist Services for Older Adults in Long-Term Care: A Population-Based Study. Journal of the American Medical Directors Association, 20(5), 610-616.

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- Al-Ghamdi MS, Khater ME, Stewart KM, Alneamy A, Abdel-Rahman EM, Penlidis A. Dynamic bifurcation MEMS gas sensors. Journal of Micromechanics and Microengineering. 2018 Nov 26;29(1):015005. - Al-Ghamdi MS, Khater ME, Abdel-Rahman EM. Switching intermittency. Applied Physics Letters. 2018 Oct 8;113(15):153501. - Park S, Khater M, Effa D, Abdel-Rahman E, Yavuz M. Detection of cyclic-fold bifurcation in electrostatic MEMS transducers by motion-induced current. Journal of Micromechanics and Microengineering. 2017 Jul 20;27(8):085007.

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Noll, D., Wiedenhofer, D., Miatto, A., Singh, S. (2019). Infrastructure expansion, waste generation and EU recycling targets on Samothraki, Greece. Resources, Conservation and Recycling. Elsevier. Symmes, R., Fishman, T., Telesford, J., Tan, S-Y, de Kroon, K., Singh, S. (2019). The weight of islands: A GIS-based material stock analysis of Grenada in the context of extreme weather and climate change. Journal of Industrial Ecology. Wiley. Singh, S.J., Fischer-Kowalski, M., Haas, W. (2018). The Sustainability of Humanitarian Aid: The Nicobar Islands as a Case of 'Complex Disaster. In: Reddy, S. (eds.): The Asian Tsunami and Post-Disaster Aid. Springer. Fetzel, T., Petridis, P., Noll, D., Singh, S.J., Fischer-Kowalski, M. (2018). Reaching a socio-ecological tipping point: Overgrazing on the Greek island of Samothraki and the role of European agricultural policies. Land Use Policy, Elsevier. Fraňková, E. Haas, W., Singh, S. (2018). Socio-Metabolic Perspectives on the Sustainability of Local Food Systems: Insights for Science, Policy and Practice. Dordrecht: Springer. (Book)

APPENDIX G: FEEDBACK FOR INTERDISCIPLINARITY TASK FORCE

To: Jean Andrey and Interdisciplinarity review committee
From: Dawn Parker, WICI director, Professor, School of Planning
4 Dec 2019

Here is a brief summary of factors that I've seen to facilitate interdisciplinary scholarship, developed since I was a post-doc.

1. Teaching and scholarship:
    a. Ability to cross-list courses among different departments and faculties;
    b. Financial models that do not penalize units that host cross-listed classes, or equivalently penalize units that allow their students to enrol in these classes;
    c. Required/core courses in multiple units, which bring together a cohort of students across departments and faculties (units);
    d. Project or active-learning based activities based on interdisciplinary groups from different units. (Team should be purposively arranged by instructors to try to assure diversity in disciplinary perspectives and skills);
    e. Problem-based assignments that can be approached from an interdisciplinary perspective;
    f. Team-taught or speaker panel courses that bring in lecturers from multiple units;
    g. Development of cross-disciplinary certification or specializations, which can be adjunct to a student's degree program, supported by a small number of core courses.
2. Advising:
    a. Ability to advise students in other units;
    b. "Internal external" thesis committee requirements;
3. Faculty appointments:
    a. I do not favour split appointments. They place a very high service burden on faculty members, and make merit evaluation difficult. I've been in this situation and it was very difficult;
    b. Cross-appointments or affiliations are great—those that allow you to advise and perhaps teach in other units, but do not involve a service or co-evaluation component.
    c. Inherently interdisciplinary units such as knowledge integration, all other department in ENV, systems design engineering, and applied math;
    d. Interdisciplinary tenure committees for highly interdisciplinary scholars;
    e. Interdisciplinary tenure and promotion external reviewers;
    f. Very good understanding of disciplinary norms for publication and productivity in all merit review processes. This is particularly important for scholars who publish in different disciplines with different norms.
4. Research funding and administration:
    a. Allow administration and overhead splits across faculties, so that deans will encourage and support interdisciplinary grants.
    b. If you return some modest portion of overhead to individual PIs for all grant, including tri-council awards, it gives PIs some funds with which to take risks, and to maintain continuity of their research program during time periods where higher risk, high gain funding applications have not succeeded. Our current system disadvantages scholars who gain funds primarily through tri-council, and who pursue basic science vs. industry

partnership supported applied research. Much basic science interdisciplinary research may be too early stages to have clear industry partnership opportunities.

c. Research centres and institutes play a key role in connecting researchers at all levels with common methodological or topical interests, which span disciplinary boundaries. In my view research centres are a more effective model to accomplish these goals that cross-appointments for faculty.
    i. Allow research centres to run grants through the centre, recapturing a proportion of overhead for administration and grant support, with the rest distributed over regular channels. Ensure that centre overhead is not captured by one or a small number of individuals, but generates collective benefits.
    ii. Participation in research centres (especially for administration and leadership) needs to be incentivized, otherwise high-performing faculty members cannot allocation time and resources to participate. Some system needs to be developed that offers concrete benefits, and recognizes contributions to, research centres. If returned overhead is not possible, other options are modified appointment percentages, centralized administration support for grant budgets and other preparation and administration, and teaching releases.
d. National large-scale funding for interdisciplinary research is the magic elixir that makes interdisciplinarity happen. Institutions are then motivated to adapt in whatever ways are needed to help their faculty capture these resources.
e. Competitive, objectively reviewed, internal resources for interdisciplinary scholarship can provide a key mechanism to jumpstart faculty research collaborations, and hopefully lead to winning these larger national and international awards.
f. Internal workshop and collaboration funds, which can provide critical seed funding to jumpstart larger team collaborations
g. Consider competitive, periodic funding calls for research centres. The current model works if faculty running, or proposing the centre have strong relationships with high-level personnel in the Office of Research and/or the Provost's office. However, the pathway for those without those connections is more difficult. Further, with on-off decisions made on approval and funding, the process might not lead to the highest impact centres being funding, and if resources are allocation to one centre, they would not be available for another. These funding awards would need to be long-term enough to ensure some financial stability for the units. The current path to centre funding is highly uncertain, and may disadvantage groups without strong network connections at the university.

APPENDIX H: RESEARCH THEME CLUSTERS IDENTIFIED FROM JULY NETWORKING EVENT

Cluster 1: Materials Science and Innovation

Keywords: biofuels, bioplastics, biotechnology, construction, industrial ecology, nanomaterials, quantum materials

FIRST NAME	LAST NAME	EMAIL	DEPARTMENT	DISCIPLINES	METHODS	APPLICATIONS	CDRC	COLLABORATIVE INTERESTS
Joel	Blit	jblit@uwaterloo.ca	Associate Professor, Economics	Economics of Innovation; Geography; Management	Econometrics	Immigration; Innovation; Patents	RDF502	Machine Learning
Trevor	Charles	tcharles@uwaterloo.ca	Professor, Biology	Plant Science/Agriculture; Microbiology; Molecular Biology/Biotechnology	DNA Sequencing; Gene Editing; Genome Engineering	Bioproducts (Bioplastics); Controlled Enginonment Agriculture; Sustainable Agriculture	RDF106	Bioplastics; Controlled Environment Agriculture
Elizabeth	English	english@ecenglish.ca	Associate Professor; Architecture	Architecture; Engineering; Environment	Amphibious Construction	Climate Change Adaptation; Flood Risk Reduction; Retrofits for Vulnerable Populations	RDF604	Environmental Justice; Freeze-Thaw Dynamics; Material Science
Michel	Gingras	gingras@uwaterloo.ca	Professor, Physics and Astronomy; Canada Research Chair in Condensed Matter Physics and Statistical Mechanics	Condensed Matter Physics; Neuroscience; Statistical Mechanics	Computer Solutions/Techniques; Mathematical Methods; Numerical Methods	Materials Science; Theoretical Condensed Matter Physics	RDF103	Experiments in Materials Science, Neuroscience, and Quantum Materials
Juewen	Liu	liujw@uwaterloo.ca	Professor, Chemistry; University Research Chair in Bionanotechnology; Water Institute	Chemistry; Nanotechnology	Combinatorial DNA; Fluorescense Sectroscopy; Nanopartical Functionalization	Biomedical Diagnosis; Drug Delivery; Water Contamination	RDF211	Application-Based Research
Kesen	Ma	kma@uwaterloo.ca	Associate Professor, Biology	Biochemistry; Biotechnology; Microbiology	Enzymatic Assay; Genomics; Fermentation	Biocatalysis; Biofuel Production; Fermentation	RDF210	Biotechnology; Enzymology; Metabolism
Luis	Ricardez-Sandoval	laricard@uwaterloo.ca	Associate Professor, Chemical Engineering, University Research Chair	Dynamic Optimization of Systems Under Uncertainty; Modelling and Optimization of Emerging CO2 Capture Energy Systems; Multiscale Modelling and Optimization	Multiscale Modelling; Optimization; Uncertainty Analysis	Advanced Energy Systems; Analytical Services Facilities; Conventional Emerging CO2 Capture Systems	RDF205	Dynamic Optimization; Industrial-Scale Applications; Multiscale Modelling; Supply Chains

Cluster 2: Environmental Impacts and Justice

Keywords: agriculture, climate change, contamination and pollution, environmental science and management, flood mitigation, indigenous rights, renewable energy, resilience, sustainability science, urban infrastructure and development, watershed management

FIRST NAME	LAST NAME	EMAIL	DEPARTMENT	DISCIPLINES	METHODS	APPLICATIONS	CDRC	COLLABORATIVE INTERESTS

Trevor	Charles	tcharles@uwaterloo.ca	Professor, Biology	Plant Science/Agriculture; Microbiology; Molecular Biology/Biotechnology	DNA Sequencing; Gene Editing; Genome Engineering	Bioproducts (Bioplastics); Controlled Enginronment Agriculture; Sustainable Agriculture	RDF106	Bioplastics; Controlled Environment Agriculture
Bernadette	Conant	bconant@cwn-rce.ca	CEO, Canadian Water Network	Biology; Civil Engineering; Environmental Management	Connecting Users in Knowledge Base; Interdisciplinary Collaboration; Problem Definition	Resilient Cities; Water Governance; Water Management	RDF105	Intersections
Goretty	Dias	gdias@uwaterloo.ca	Associate Professor; School of Environment, Enterprise and Development (SEED)	Industrial Ecology; Lifecyle Assessment; Sustainability Science	Lifecycle Sustainability Assessment	Healthy and Sustainable Diets; Process Optimization for Engineering and Technology; Sustainable Food Production Systems	RDF405	Compact Agriculture; Engineering/Architecture/Design; Greenhouse Design; Health-Nutrition; Agent-Based Modelling; Systmes Dynamic Modelling
Elizabeth	English	english@ecenglish.ca	Associate Professor; Architecture	Architecture; Engineering; Environment	Amphibious Construction	Climate Change Adaptation; Flood Risk Reduction; Retrofits for Vulnerable Populations	RDF604	Environmental Justice; Freeze-Thaw Dynamics; Material Science
Aynur	Kadir	akadir@uwaterloo.ca	Assistant Prof, Digital Media Arts and Communication	Ethics; New Media; Museum	Community-Based, Participatory Design; Ethnography	Design for Museums; Ethics of AI; Reactivating Archives	RDF508	Computer Scientists; Prototypes; Systems to Explore Theories of Design
Juewen	Liu	liujw@uwaterloo.ca	Professor, Chemistry; University Research Chair in Bionanotechnology; Water Institute	Chemistry; Nanotechnology	Combinatorial DNA; Fluorescense Sectroscopy; Nanopartical Functionalization	Biomedical Diagnosis; Drug Delivery; Water Contamination	RDF211	Application-Based Research
Logan	MacDonald	l36macdonald@uwaterloo.ca	Assistant Prof, Fine Arts	Art History; Education; Indigenous Art; Visual Arts and Culture	Curation/Presentation; Creative Production; Decolonization; Respect/Relevance/Reciprocity/Responsibility	Criticism; Experimental Learning; Interdisciplinary Installation Art	RDF604	Accessibility Modalities; Digital Mediation of Creative Expression
Sean	McKenna	sean.mckenna@uwaterloo.ca	Earth Science; Project Manager, Waterloo Institute for Sustainable Energy	Geothermal Energy; Geochemical Engineering; Thermodynamics	Lifecycle Analysis; Thermal Energy Storage;	Compressed Air Storage; Energy Analysis; Compressed Air Storage	RDF105	Partnerships with Northern/Indigenous Communities

Rebecca	Saari	rsaari@uwaterloo.ca	Assistant Professor, Civil and Environmental Engineering	Environmental Inequality; Health/Economic Effects of Air Pollution; Sustainable Infrastructure	Lifecycle Assessment; Modelling Atmospheric Impacts; Optical Measures of Atmospheric Composition	Air Pollution; Climate Change; Human Health	RDF201	Environmental Justice
Luis	Ricardez-Sandoval	laricard@uwaterloo.ca	Associate Professor, Chemical Engineering, University Research Chair	Dynamic Optimization of Systems Under Uncertainty; Modelling and Optimization of Emerging CO2 Capture Energy Systems; Multiscale Modelling and Optimization	Multiscale Modelling; Optimization; Uncertainty Analysis	Advanced Energy Systems; Analytical Services Facilities; Conventional Emerging CO2 Capture Systems	RDF205	Dynamic Optimization; Industrial-Scale Applications; Multiscale Modelling; Supply Chains
Chris	Yakymchuk	cyakymchuk@uwaterloo.ca	Assistant Professor, Earth and Environmental Science	Chemistry; Earth Sciences; Environmental Sciences	ICP-MS; Microscopy; Spatially Resolved Laser Ablation	Contamination; Isotopes; Natural Sciences	RDF105	Biologists; Materials Chemists

Cluster 3: Health Technologies

Keywords: biotechnology, chronic disease, diagnosis, drug delivery, epidemiology, genetic disease, microbiology, nanobiology, neuroscience, nutrition, pharmaceuticals, stem cell research, tissue engineering, vaccines

FIRST NAME	LAST NAME	EMAIL	DEPARTMENT	DISCIPLINES	METHODS	APPLICATIONS	CDRC	COLLABORATIVE INTERESTS
Javad	Behravan	javad.behravan@uwaterloo.ca	Adjunct Professor, School of Pharmacy	Breast Cancer; Stem Cells; Tissue Engineering	Cell Tissue and Culture; Phage Display; Vaccine Design	Pharmaceutical Science; Therapeutics	RDF304	
Joel	Blit	jblit@uwaterloo.ca	Associate Professor, Economics	Economics of Innovation; Geography; Management	Econometrics	Immigration; Innovation; Patents	RDF502	Machine Learning
Melanie	Campbell	melanie.campbell@uwaterloo.	Professor, Physics and Astronomy	Engineering; Medicine; Physics	Artificial Intelligence; Scanning Laser Polarity	Adaptive Optics; Macropathology; Retinal Imaging	RDF103	
Goretty	Dias	gdias@uwaterloo.ca	Associate Professor; School of Environment, Enterprise and Development (SEED)	Industrial Ecology; Lifecyle Assessment; Sustainability Science	Lifecycle Sustainability Assessment	Healthy and Sustainable Diets; Process Optimization for Engineering and Technology; Sustainable Food Production Systems	RDF405	Compact Agriculture; Engineering/Architecture/Design; Greenhouse Design; Health-Nutrition; Agent-Based Modelling; Systmes Dynamic Modelling
Juewen	Liu	liujw@uwaterloo.ca	Professor, Chemistry; University Research Chair in Bionanotechnology; Water Institute	Chemistry; Nanotechnology	Combinatorial DNA; Fluorescense Sectroscopy; Nanopartical Functionalization	Biomedical Diagnosis; Drug Delivery; Water Contamination	RDF211	Application-Based Research

Kesen	Ma	kma@uwaterloo.ca	Associate Professor, Biology	Biochemistry; Biotechnology; Microbiology	Enzymatic Assay; Genomics; Fermentation	Biocatalysis; Biofuel Production; Fermentation	RDF210	Biotechnology; Enzymology; Metabolism
Dale	Martin	dale.martin@uwaterloo.ca	Assistant Prof, Biology	Biochemistry; Cell Biology; NeuroScience	Cell Culture; Microscopy; Mouse Models	Health/Disease Models; Brain/Bone/Muscles	RDF301	Bone and Muscle
Rebecca	Saari	rsaari@uwaterloo.ca	Assistant Professor, Civil and Environmental Engineering	Environmental Inequality; Health/Economic Effects of Air Pollution; Sustainable Infrastructure	Lifecycle Assessment; Modelling Atmospheric Impacts; Optical Measures of Atmospheric Composition	Air Pollution; Climate Change; Human Health	RDF201	Environmental Justice
Germán	Sciaini	gsciaini@uwaterloo.ca	Associate Professor, Chemistry; Canada Research Chair, Atomically Resolved Dynamics and Ultra-Fast High Resolution Imaging	Chemistry; Health; Physics		Electron Microscopy; Micro and Nano Fluidics; Ultrafast Spectroscopy	RDF104	Health Sciences

Cluster 4: Systems Dynamics and Optimization

Keywords: circular economies, human factors analysis, lifecycle assessment, multiscale modelling, network analysis, operations management, organization theory, process optimization, statistical mechanics, supply chain management, systems design engineering, thermodynamics, transportation, uncertainty analysis

FIRST NAME	LAST NAME		DEPARTMENT	DISCIPLINES	METHODS	APPLICATIONS	CDRC	COLLABORATIVE INTERESTS
Shi	Cao	shi.cao@uwaterloo.ca	Assistant Prof, Systems Design Engineering	Cognitive Modelling; Human Factors	Augemented Reality and Virtual Reality Development; Cognitive Modelling; Field Observation; Simulator Experiment	Interface Design and Evaluation; Human-Computer Interaction; Transportation Safety	RDF102	AR/UR Development; Education Psychology
Goretty	Dias	gdias@uwaterloo.ca	Associate Professor; School of Environment, Enterprise and Development (SEED)	Industrial Ecology; Lifecyle Assessment; Sustainability Science	Lifecycle Sustainability Assessment	Healthy and Sustainable Diets; Process Optimization for Engineering and Technology; Sustainable Food Production Systems	RDF405	Compact Agriculture; Engineering/Architecture/Design; Greenhouse Design; Health-Nutrition; Agent-Based Modelling; Systems Dynamic Modelling
Michel	Gingras	gingras@uwaterloo.ca	Professor, Physics and Astronomy; Canada Research Chair in Condensed Matter Physics and Statistical	Condensed Matter Physics; Neuroscience; Statistical Mechanics	Computer Solutions/Techniques; Mathematical Methods; Numerical Methods	Materials Science; Theoretical Condensed Matter Physics	RDF103	Experiments In Materials Science, Neuroscience, and Quantum Materials
Suzanne	Kearns	suzanne.kearns@uwaterloo.ca	Associate Professor, Geography and Environmental Management/ Geography and Aviation	Aviation Psychology; Education; Human Factors	Cognitive Test Analysis; Consensus Modelling	Aviation Training; Aviation Safety; Professional Licensing and Policy	RDF501	Cognitive Science; Education Psychology; Machine Learning

Sean	McKenna	sean.mckenna@uwaterloo.ca	Earth Science; Project Manager, Waterloo Institute for Sustainable Energy	Geothermal Energy; Geochemical Engineering; Thermodynamics	Lifecycle Analysis; Thermal Energy Storage;	Compressed Air Storage; Energy Analysis; Compressed Air Storage	RDF105	Partnerships with Northern/Indigenous Communities
Luis	Ricardez-Sandoval	laricard@uwaterloo.ca	Associate Professor, Chemical Engineering, University Research Chair	Dynamic Optimization of Systems Under Uncertainty; Modelling and Optimization of Emerging CO2 Capture Energy Systems; Multiscale Modelling and Optimization	Multiscale Modelling; Optimization; Uncertainty Analysis	Advanced Energy Systems; Analytical Services Facilities; Conventional Emerging CO2 Capture Systems	RDF205	Dynamic Optimization; Industrial-Scale Applications; Multiscale Modelling; Supply Chains
Germán	Sciaini	gsciaini@uwaterloo.ca	Associate Professor, Chemistry; Canada Research Chair, Atomically Resolved Dynamics and Ultra-Fast High Resolution Imaging	Chemistry; Health; Physics		Electron Microscopy; Micro and Nano Fluidics; Ultrafast Spectroscopy	RDF104	Health Sciences
David	Yevick	yevick@uwaterloo.ca	Professor, Physics and Astronomy	Computer Science; Engineering; Physics	Artificial Intelligence; Statistical Physics; Statistical Programming	Optical Communication; Scientific Programming; Statistical Methods	RDF103	AI; Communication Systems; Optical Physics/Engineering
Kejia	Zhu	kejia.zhu@uwaterloo.ca	Assistant Prof, Management Sciences	Management; Organization Theory; Sociology	Archival Data Analysis; Dynamic Network Models; Statistical Modelling	Innovation; Knowledge Management; Organizational Change	RDF502	

Cluster 5: Computational Methods, Simulation, Imaging and Communication

Keywords: artificial intelligence, cognitive science, communication systems, computer science, digital design, education, innovation, interface design, knowledge translation, medical imaging, new media, optical physics, simulation, virtual reality

FIRST NAME	LAST NAME	EMAIL	DEPARTMENT	DISCIPLINES	METHODS	APPLICATIONS	CDRC	COLLABORATIVE INTERESTS
Joel	Blit	jblit@uwaterloo.ca	Associate Professor, Economics	Economics of Innovation; Geography; Management	Econometrics	Immigration; Innovation; Patents	RDF502	Machine Learning
Melanie	Campbell	melanie.campbell@uwaterloo.	Professor, Physics and Astronomy	Engineering; Medicine; Physics	Artificial Intelligence; Scanning Laser Polarity	Adaptive Optics; Macropathology; Retinal Imaging	RDF103	
Shi	Cao	shi.cao@uwaterloo.ca	Assistant Prof, Systems Design Engineering	Cognitive Modelling; Human Factors	Augemented Reality and Virtual Reality Development; Cognitive Modelling; Field Observation; Simulator Experiment	Interface Design and Evaluation; Human-Computer Interaction; Transportation Safety	RDF102	AR/UR Development; Education Psychology

Bernadette	Conant	bconant@cwn-rce.ca	CEO, Canadian Water Network	Biology; Civil Engineering; Environmental Management	Connecting Users in Knowledge Base; Interdisciplinary Collaboration; Problem Definition	Resilient Cities; Water Governance; Water Management	RDF105	Intersections
Aynur	Kadir	akadir@uwaterloo.ca	Assistant Prof, Digital Media Arts and Communication	Ethics; New Media; Museum	Community-Based, Participatory Design; Ethnography	Design for Museums; Ethics of AI; Reactivating Archives	RDF508	Computer Scientists; Prototypes; Systems to Explore Theories of Design
Suzanne	Kearns	suzanne.kearns@uwaterloo.ca	Associate Professor, Geography and Environmental Management/ Geography and Aviation	Aviation Psychology; Education; Human Factors	Cognitive Test Analysis; Consensus Modelling	Aviation Training; Aviation Safety; Professional Licensing and Policy	RDF501	Cognitive Science; Education Psychology; Machine Learning
Logan	MacDonald	l36macdonald@uwaterloo.ca	Assistant Prof, Fine Arts	Art History; Education; Indigenous Art; Visual Arts and Culture	Curation/Presentation; Creative Production; Decolonization; Respect/Relevance/Reciprocity/Responsibility	Criticism; Experimental Learning; Interdisciplinary Installation Art	RDF604	Accessibility Modalities; Digital Mediation of Creative Expression
Germán	Sciaini	gsciaini@uwaterloo.ca	Associate Professor, Chemistry; Canada Research Chair, Atomically Resolved Dynamics and Ultra-Fast High Resolution Imaging	Chemistry; Health; Physics		Electron Microscopy; Micro and Nano Fluidics; Ultrafast Spectroscopy	RDF104	Health Sciences
David	Yevick	yevick@uwaterloo.ca	Professor, Physics and Astronomy	Computer Science; Engineering; Physics	Artificial Intelligence; Statistical Physics; Statistical Programming	Optical Communication; Scientific Programming;	RDF103	AI; Communication Systems; Optical Physics/Engineering

SYNERGIES: Cross-Disciplinary Colloquium on Design

Post-Event Report by Simon Leroux

Objective & Outcome

On November 21st, 2019, a first dialogue was initiated targeting complex problems between the Waterloo Institute for Complexity and Innovation and University of Waterloo's School of Architecture. Graduate students from a diverse range of academic backgrounds gathered at the Cambridge campus to share related thesis topics through both formal and informal activities.

The event began with a graduate research colloquium, where students from the University of Waterloo and Balsillie School of International Affairs presented thesis work, followed by moderated discussions. The panels were presented as follows:

1. Land-use and ecologies — Moderated by Jane Hutton, Assistant Professor and Graduate Officer

Hannah Spasov — M. Arch Candidate, Architecture
A Reimagination of the Ontario Lodge: The family-run lodge as an alternative model to the contemporary cottage through the design of communal spaces and shared environmental stewardship

Anita Lazurko — PhD Candidate, Environment
Water resource management under conditions of deep uncertainty: Exploratory Future Scenarios for Adaptation, Transformation and Resilience

Adrienne Mason — MSc Candidate, Environment
Art as an Interface for Watershed System Resiliency

Heba Alzaben — PhD Candidate, Mechanical and Mechatronics Engineering
Investigating the exergy destruction principle applied to precision agriculture using thermal remote sensing

James Clarke-Hicks — M. Arch Candidate, Architecture
SELL TO SAVE: Examining the Perpetuation of the North-South divide through Carbon Sinks

2. Narrative and System Re-Design — Moderated by Adrian Blackwell, Associate Professor

Kelsey Malott — M. Arch Candidate, Architecture
An Homage to a Generation

Wayne Yan — M. Arch Candidate, Architecture
The Value of Sacred Space

Ilhan Ozdemir — M. Arch Candidate, Architecture
Anatolian Regional Modernism: A Study of Architectural Tradition in Search of a New Critical Regional Modernism in Anatolia

Alice Huang — M. Arch Candidate, Architecture
Site specific data to insights: digital tool and framework for navigating architectural data landscape

Leo Liu — M. Arch Candidate, Architecture
Dynamic Visualizations: Developing a Framework for Crowd-Based Simulation

3. Humanizing Design — Moderated by Philip Beesley, Professor

Jonathan Hui, PhD International Affairs
Return of the Empires: China and the US as world ecologies

Lilian Camacho, pursuing a PhD in Environment
Exploring the role of local intermediaries in sustainability transformations in the Canadian fashion industry

Jasdeep Multani — M. Arch Candidate, Architecture
The 5 Senses - Designing for the Autistic Spectrum through Sensorial Reduction and Heightening

Maighdlyn Hadley — M. Arch Candidate, Architecture
Hurry up and Wait: A spatial proposal for urban stress relief

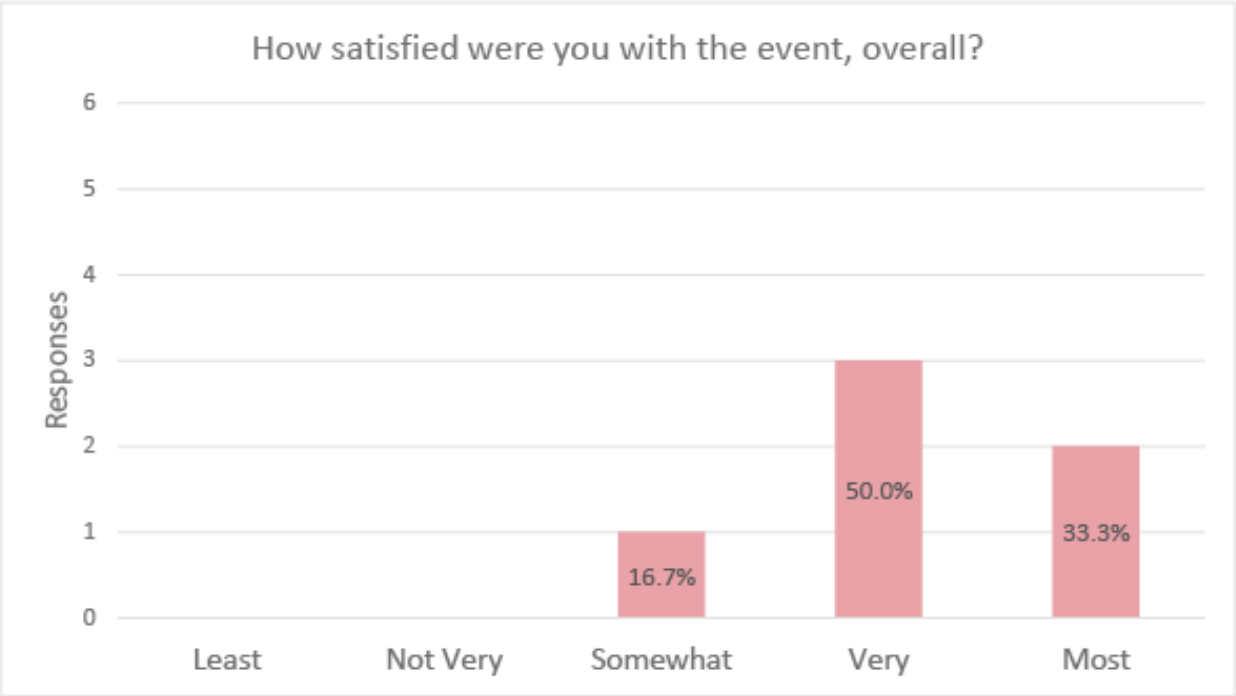
Following the colloquium, a mixer was held in the school's loft area, where food and casual conversations were had alongside showcased undergraduate and graduate projects.

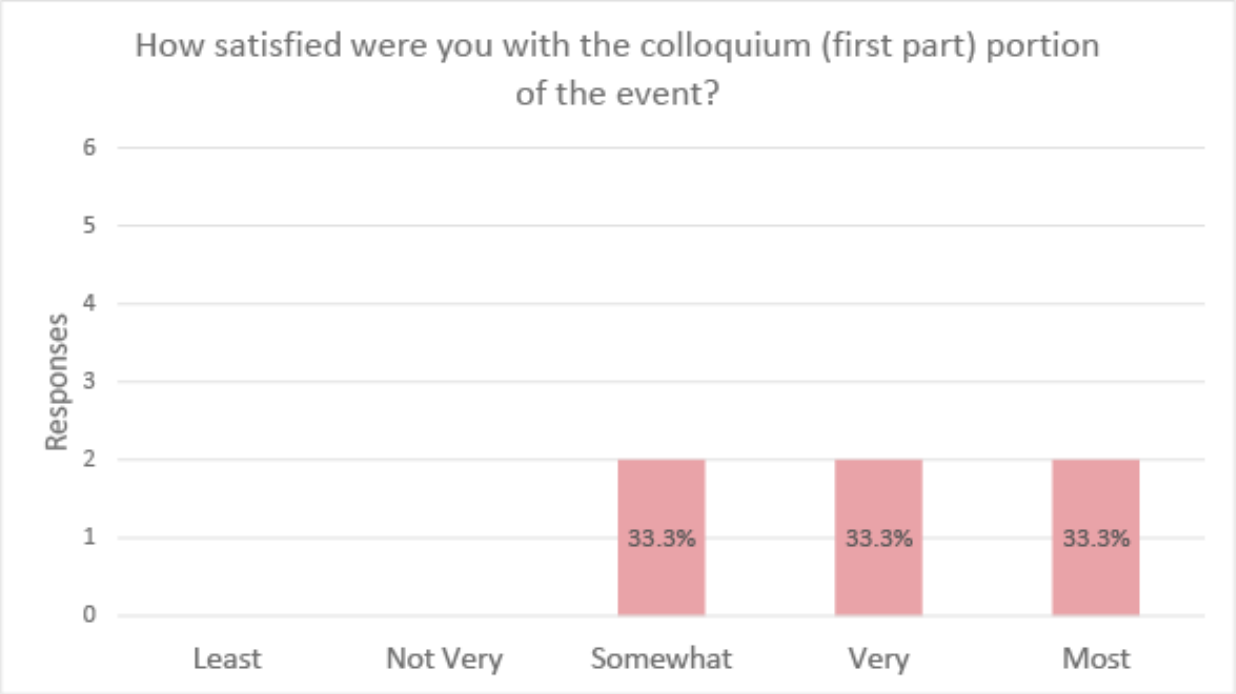
Participation

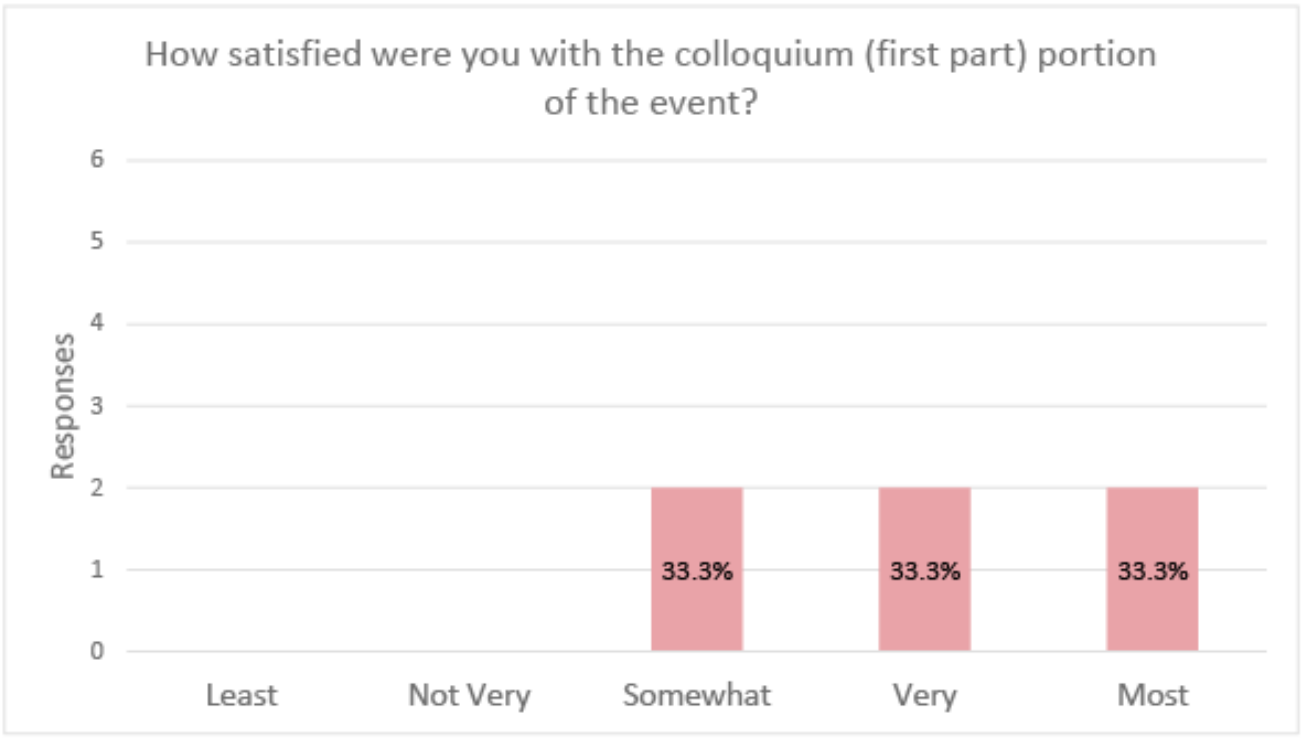
This 2-part event was fortunate to accommodate over 60 attendants, which included a range of faculty members, graduate and undergraduate students from Environment, Engineering, International Affairs, and Architecture.

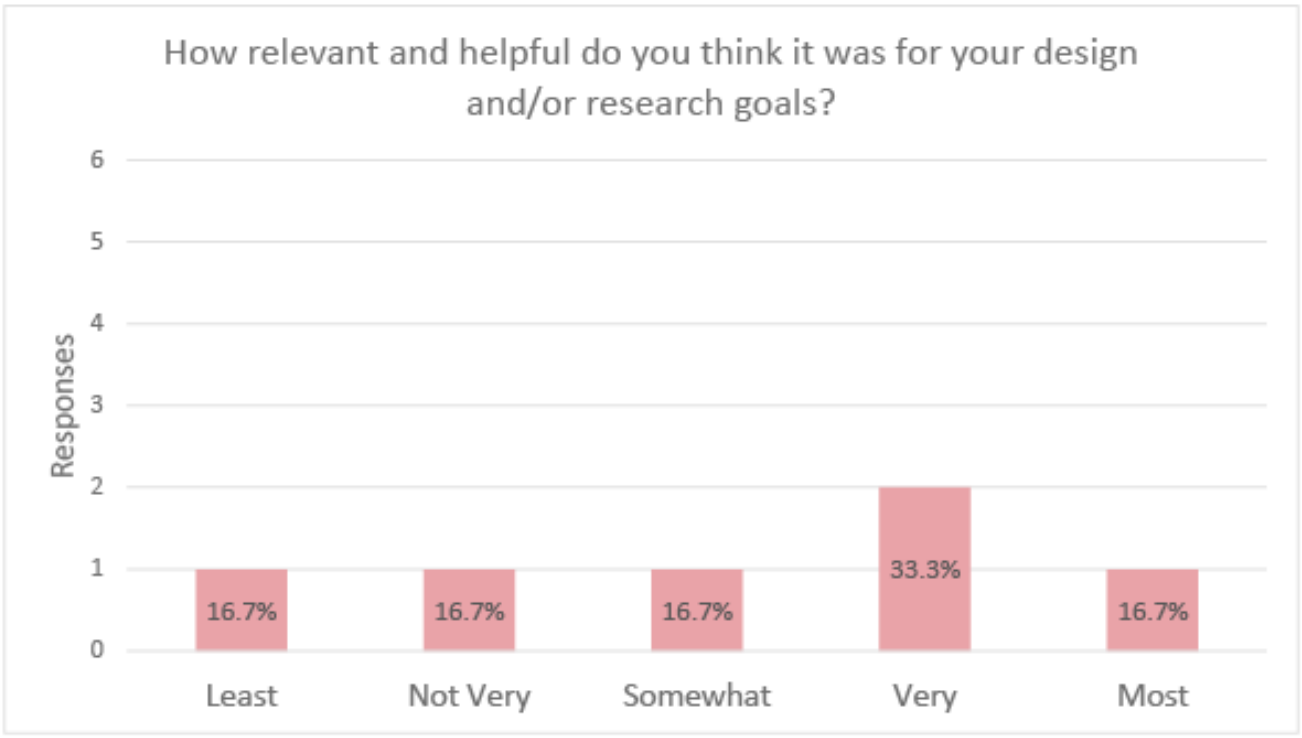
Event Photos (Below)

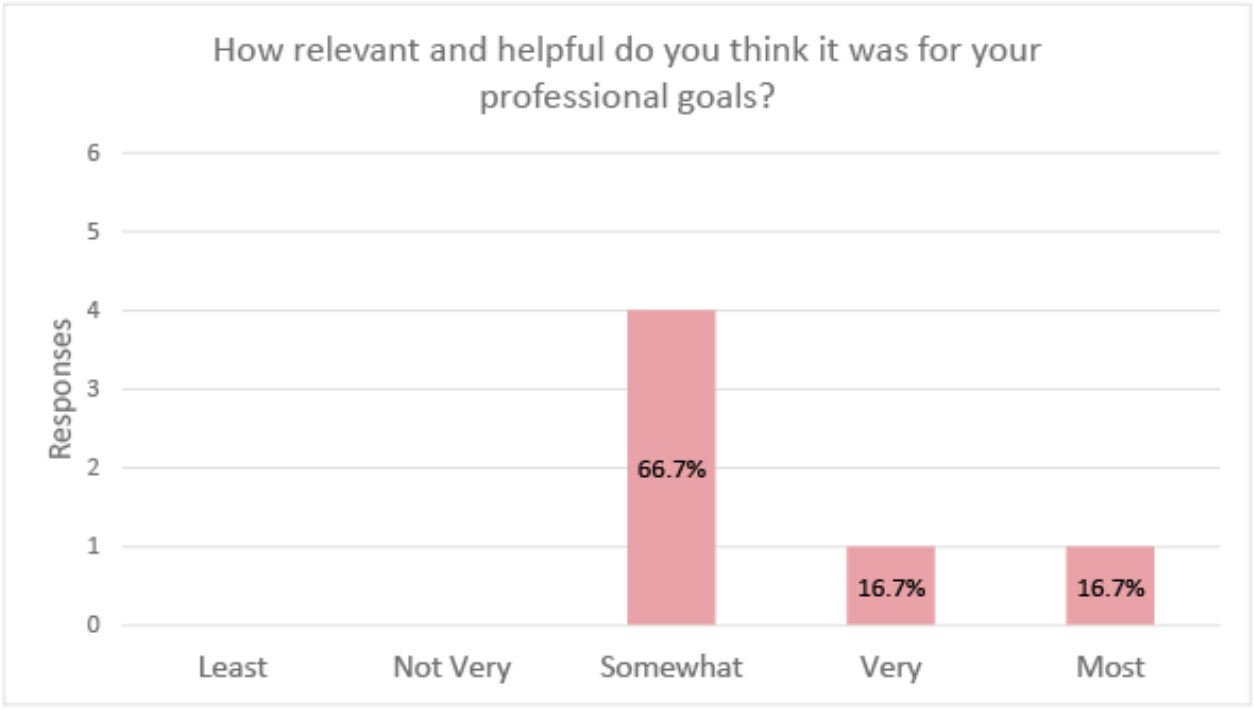
Participant Survey Results

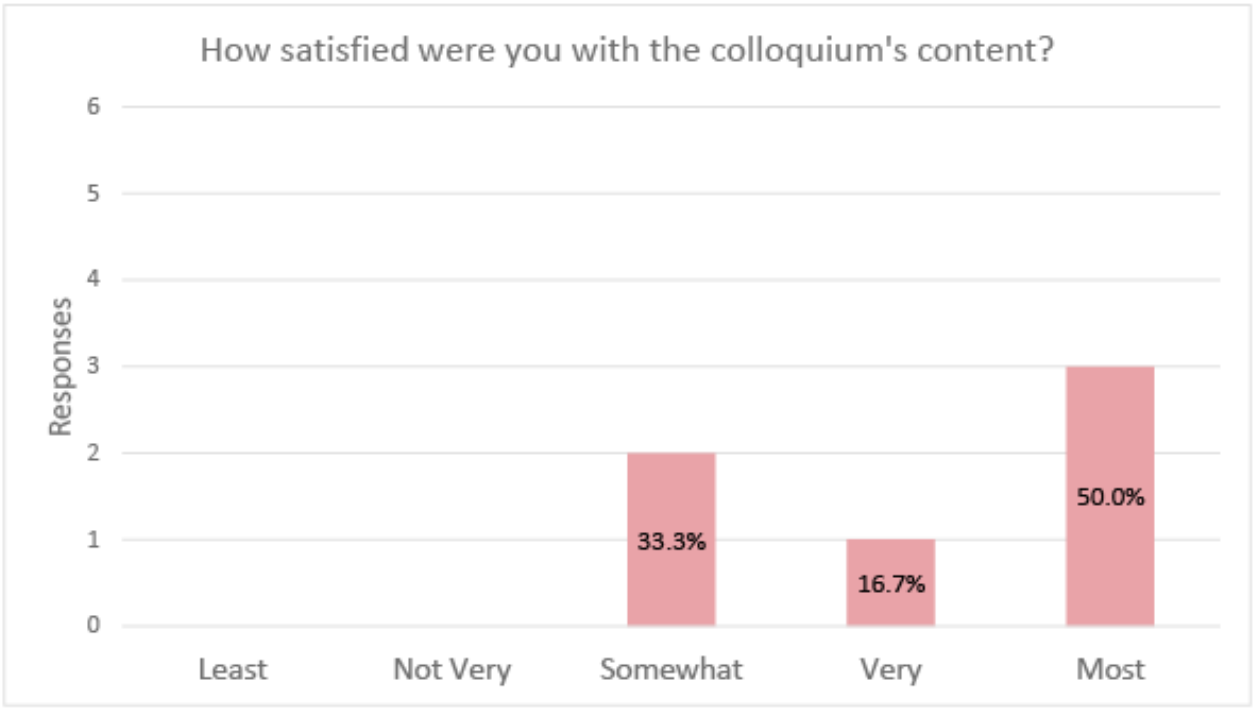


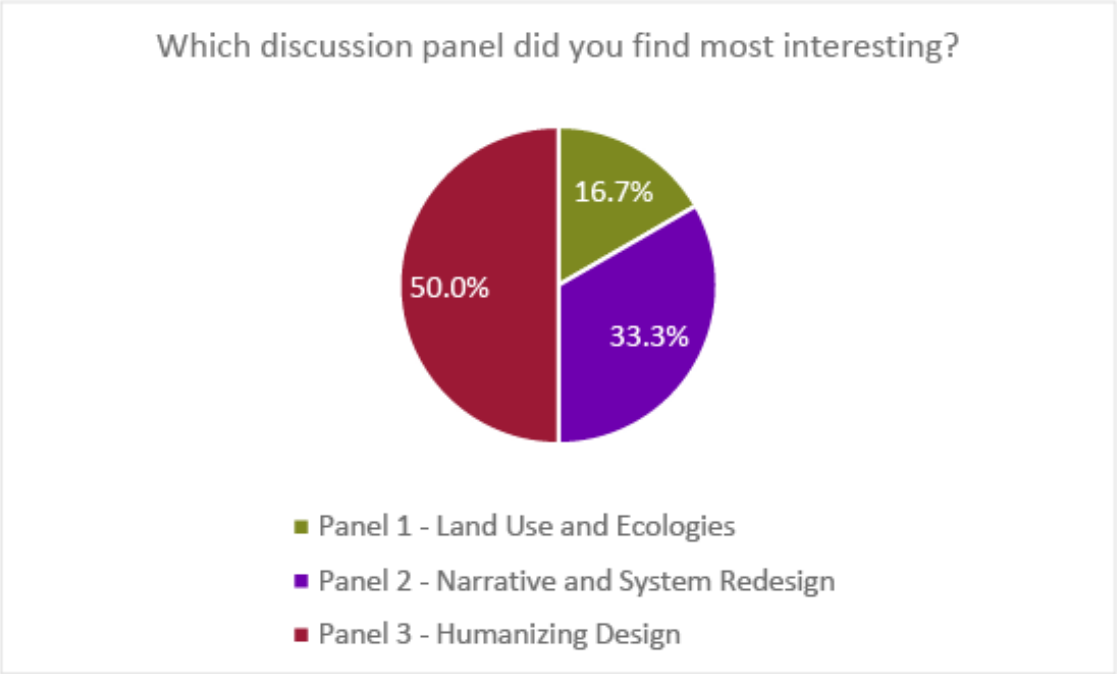



How satisfied were you with the colloquium (first part) portion of the event?
Responses
6
5
4
3
2
1
0
33.3%
33.3%
33.3%
Least
Not Very
Somewhat
Very
Most


How relevant and helpful do you think it was for your design and/or research goals?
Responses
6
5
4
3
2
1
0
16.7%
16.7%
16.7%
33.3%
16.7%
Least
Not Very
Somewhat
Very
Most

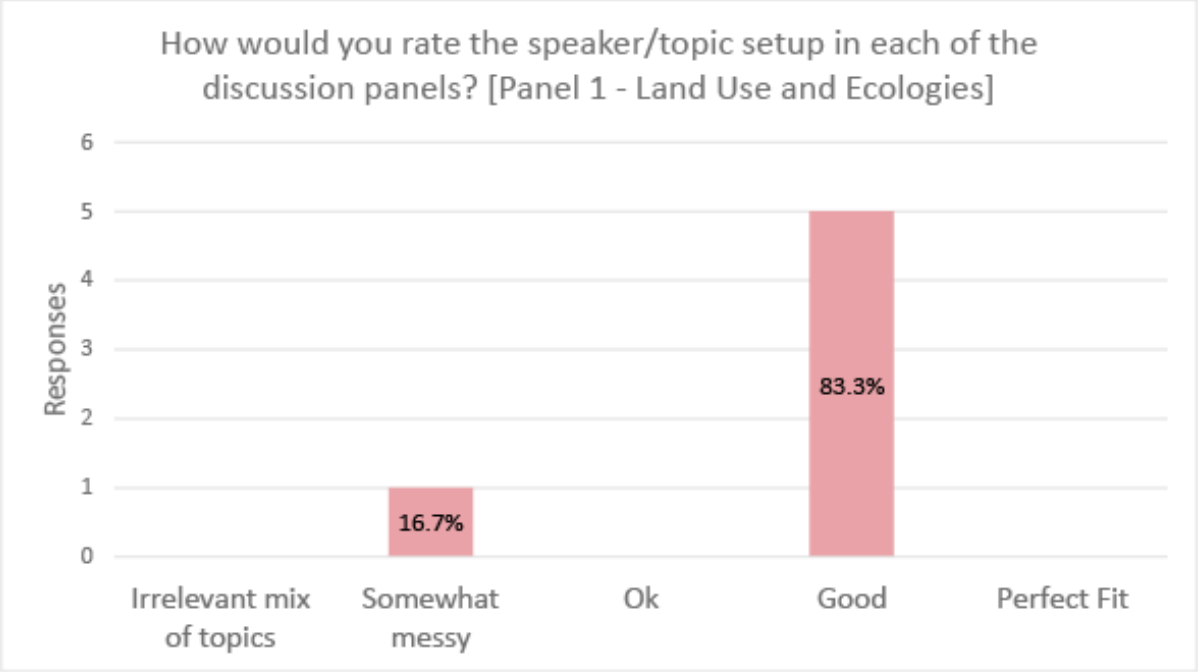

How relevant and helpful do you think it was for your professional goals?
Responses
6
5
4
3
2
1
0
66.7%
16.7%
16.7%
Least
Not Very
Somewhat
Very
Most

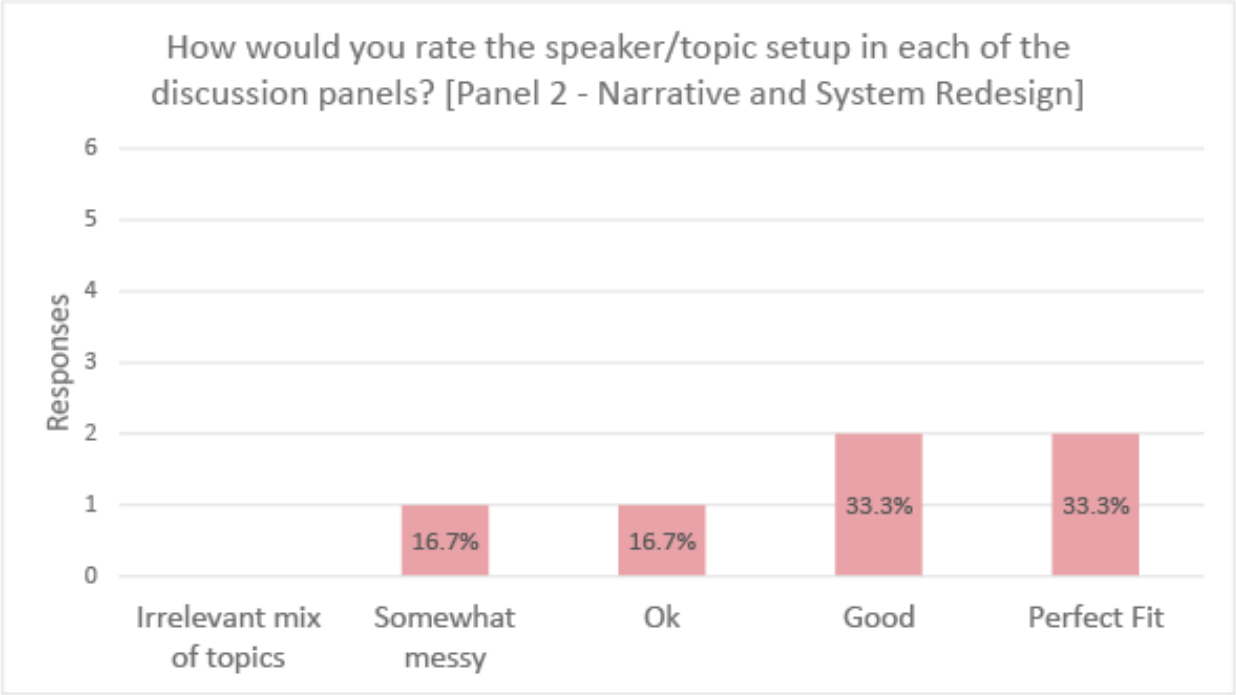

How satisfied were you with the colloquium's content?
Responses
6
5
4
3
2
1
0
33.3%
16.7%
50.0%
Least
Not Very
Somewhat
Very
Most

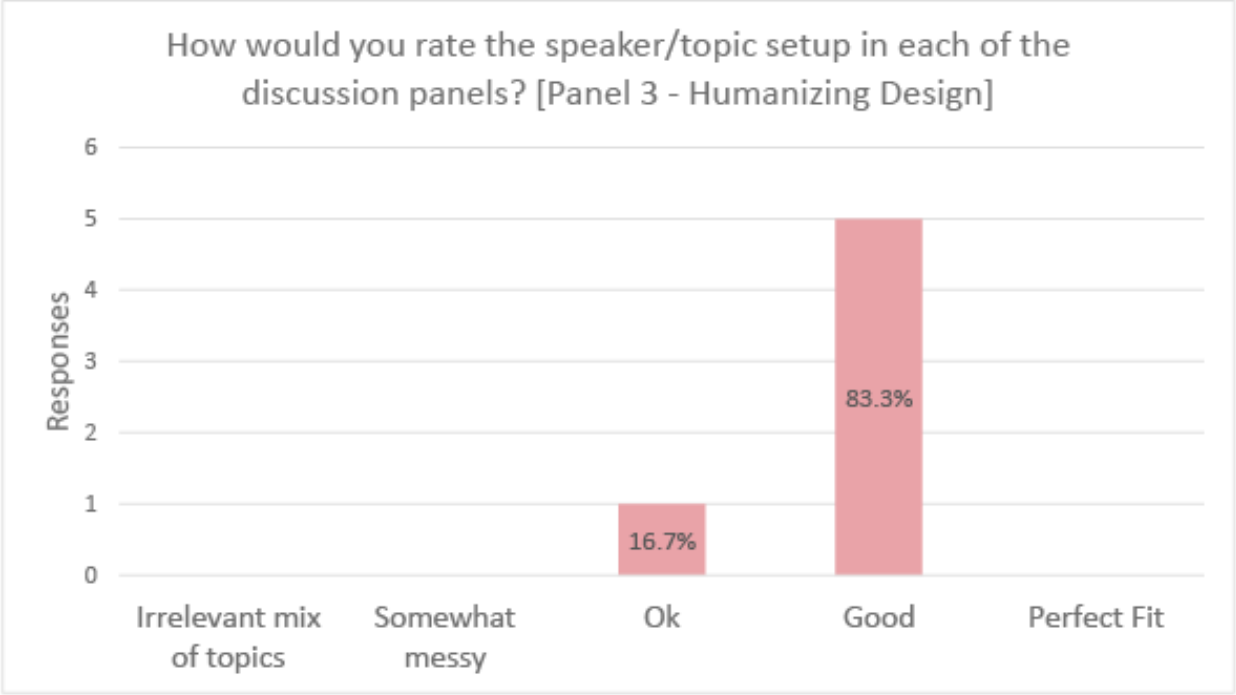


Q: Is there anything in particular that stood out as interesting?

A: **(1)** Topic [Panel 3 – Humanizing Design] relevant to my research.



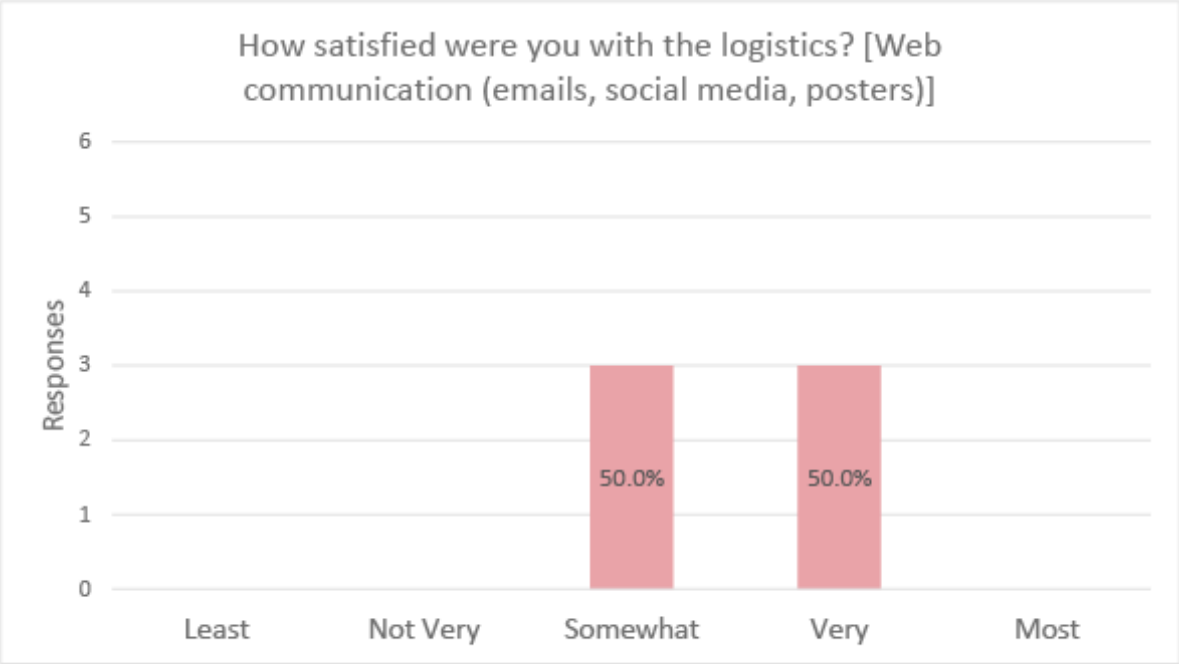

How would you rate the speaker/topic setup in each of the discussion panels? [Panel 2 - Narrative and System Redesign]
Responses
6
5
4
3
2
1
0
16.7%
16.7%
33.3%
33.3%
Irrelevant mix of topics
Somewhat messy
Ok
Good
Perfect Fit

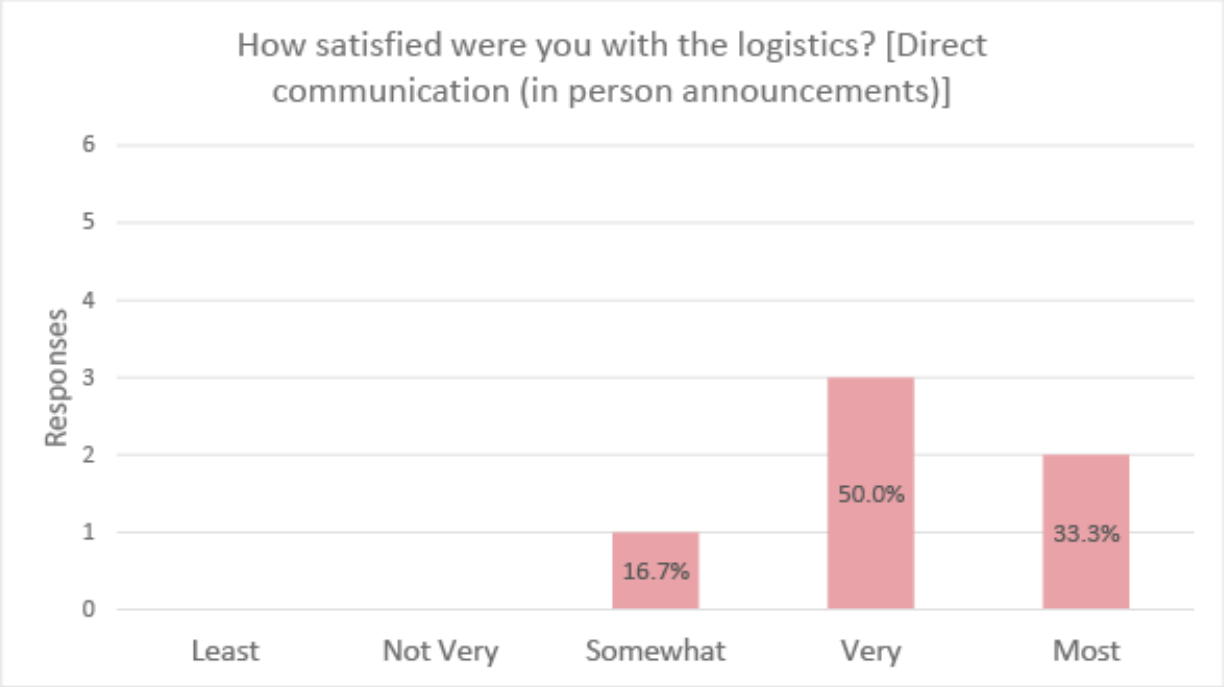

How would you rate the speaker/topic setup in each of the discussion panels? [Panel 3 - Humanizing Design]
Responses
6
5
4
3
2
1
0
16.7%
83.3%
Irrelevant mix of topics
Somewhat messy
Ok
Good
Perfect Fit

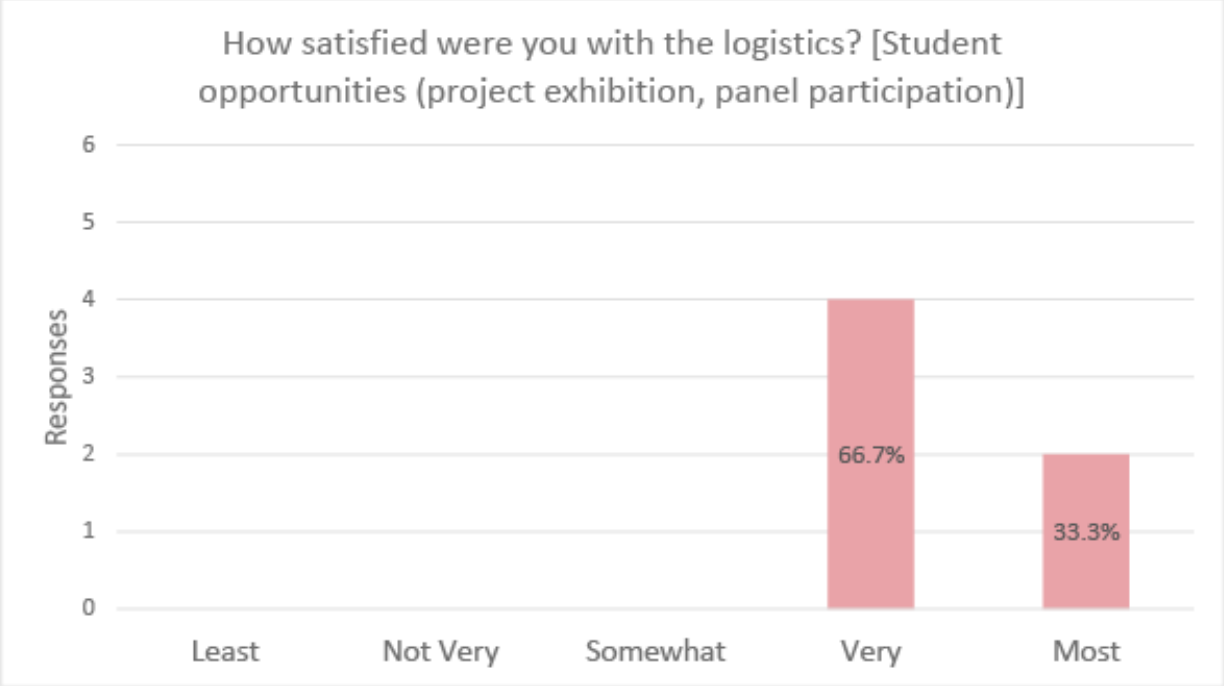
Q: Do you have any suggestions for improving the formal discussion panels?

A: **(1)** Panel 2 didn't have a clear direction. Would be interesting to bring in profs from outside of architecture.

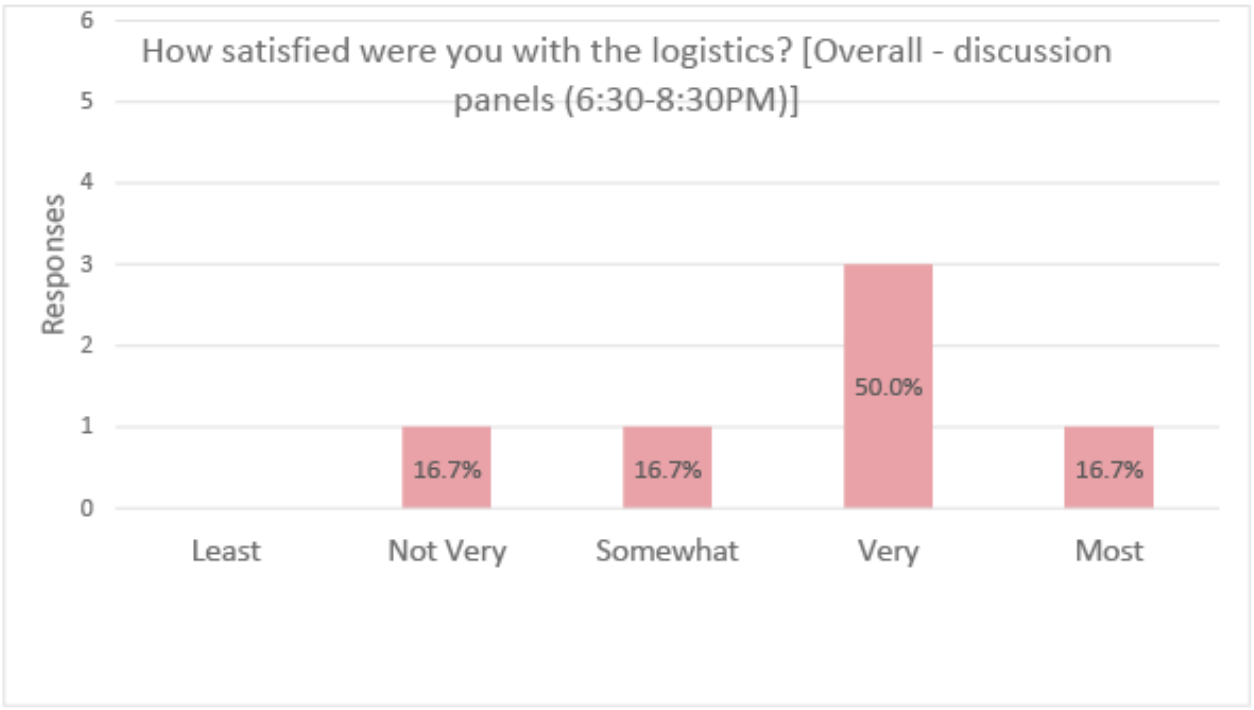
(2) For a group of speakers with very diverse topics, it may be useful to ask all speakers to address a common question in their presentations, such as "how can your work inform design". It may also help if panel moderators had questions like these ready beforehand, based on the abstracts submitted.

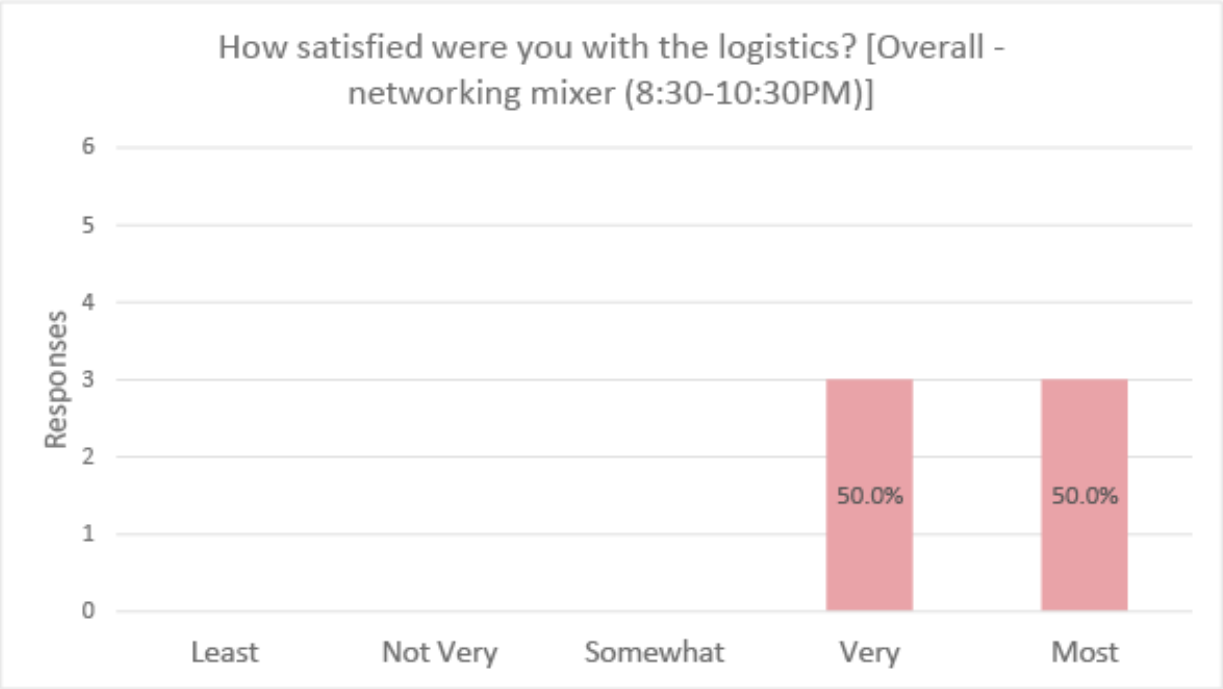



How satisfied were you with the logistics? [Direct communication (in person announcements)]
Responses
6
5
4
3
2
1
0
16.7%
50.0%
33.3%
Least
Not Very
Somewhat
Very
Most


How satisfied were you with the logistics? [Student opportunities (project exhibition, panel participation)]
Responses
6
5
4
3
2
1
0
66.7%
33.3%
Least
Not Very
Somewhat
Very
Most


How satisfied were you with the logistics? [Accommodation (food & beverages)]
Responses
6
5
4
3
2
1
0
50.0%
50.0%
Least
Not Very
Somewhat
Very
Most


How satisfied were you with the logistics? [Overall - discussion panels (6:30-8:30PM)]
Responses
6
5
4
3
2
1
0
16.7%
16.7%
50.0%
16.7%
Least
Not Very
Somewhat
Very
Most



Q: What did you like most about the event?

A: **(1)** The bridge between many disciplines

(2) I enjoyed the interdisciplinary approaches that many researchers took to tackle complex problems

(3) Networking mixer was much needed when students are working on projects individually in masters.

(4) Diversity of topics; opportunity to meet researchers and learn about the work in the School of Architecture.

Q: What could have been done better or differently? Was there anything that you found to be unnecessary?

A: **(1)** I thought that everything was well done!

(2) Would be ideal to have the even either right after midterms of TRD1 or beginning of other terms to update everyone on what they are working on in their thesis. Panels would be more helpful during M2-M3 as thesis topics are more developed. Possibly reduce number of students per panel and increase time for presentation.

(3) I'd suggest having a compost/recycling bin next to the coffee station and adding signs with directions to the restrooms. I would also recommend publishing the event agenda as soon as it is available.

Q: What were your key take-aways from this event?

A: Humanizing design in the built and 'natural' landscape is essential and working across disciplines is an important method for achieving this.

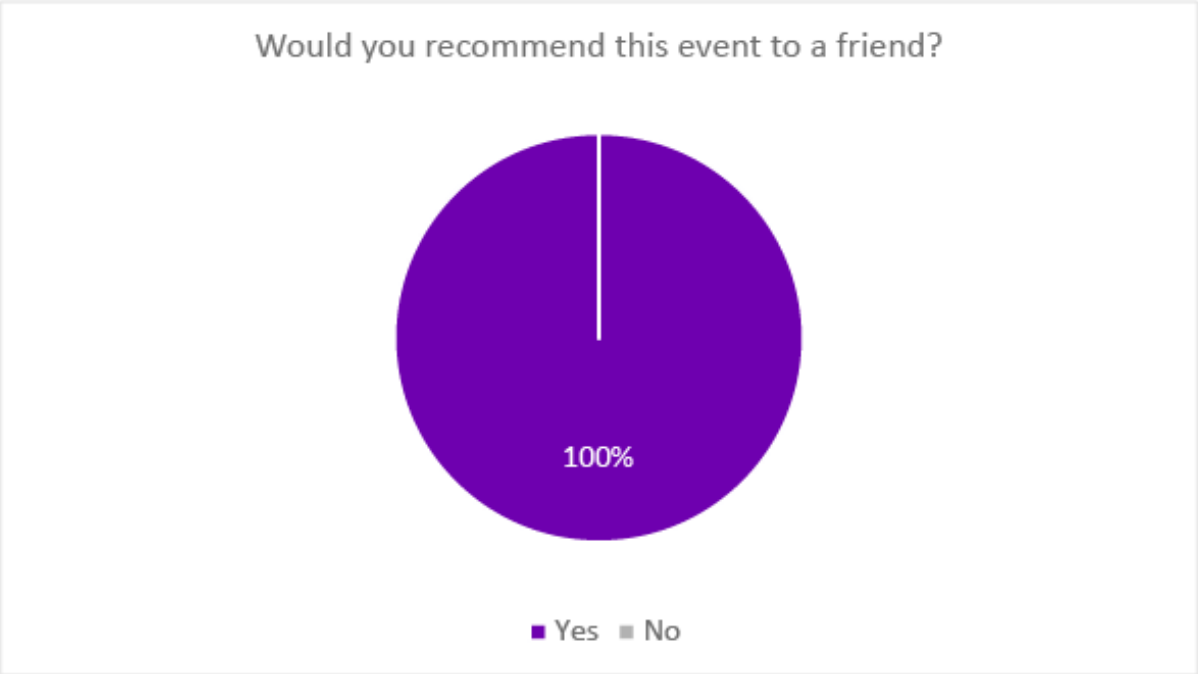
Q: Any overall feedback for the event?

A: **(1)** Really good

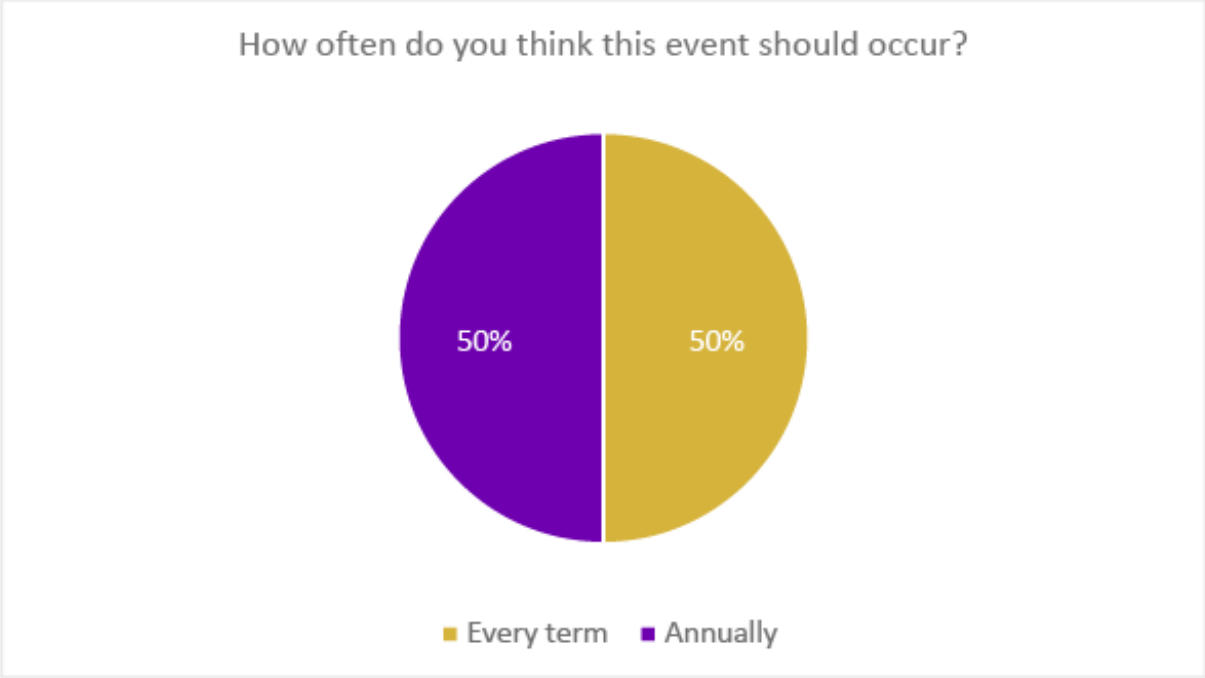
(2) Great work organizing an excellent event that covered a diverse range of projects focusing on elements of complexity

(3) A much needed direction in the school.

(4) I hope this event becomes a tradition.


Would you recommend this event to a friend?
100%
Yes
No


Would you consider attending a similar event in the future?
100%
Yes
No



Future Opportunities

Since the colloquium, there have been ongoing efforts from various parties to foster stronger links across disciplines. Two Waterloo-Cambridge campus socials have been organized by the Graduate Students Association, namely "Cambridge GSA visits the Graduate House" on November 29th, 2019 and "Cambridge goes to Winter Blast: Grad Student Party" on January 31st, 2020.

Regarding research opportunities, more cross-campus activities are on the horizon as the student body in Architectural Engineering grows and with the potential future expansion of the Cambridge campus. Closer engagement with multidisciplinary initiatives such as the Collaborative Water Program and Certificate in Structural Engineering could also bring new and exciting academic projects to fruition.

The Synergies colloquium was organized by the Design chapter of Waterloo Institute for Complexity and Innovation, WICI: Design. Due to changing cohorts following the Winter term, the branch is currently seeking new leadership. If you are interested in leading actions to promote complexity science through interdisciplinary research and design at UW, please reach out to Simon Leroux (s2leroux@uwaterloo.ca).

WICI: Design Team

Simon Leroux, Planning lead, external coordinator | s2leroux@uwaterloo.ca
Amal Dirie, Treasurer | aadirie@uwaterloo.ca
Andrea Quinn, Internal coordinator | asquinn@uwaterloo.ca
Dhroov Patel | d85patel@uwaterloo.ca
Vishak Alex | vsalex@uwaterloo.ca
Alice Huang | jj6huang@uwaterloo.ca

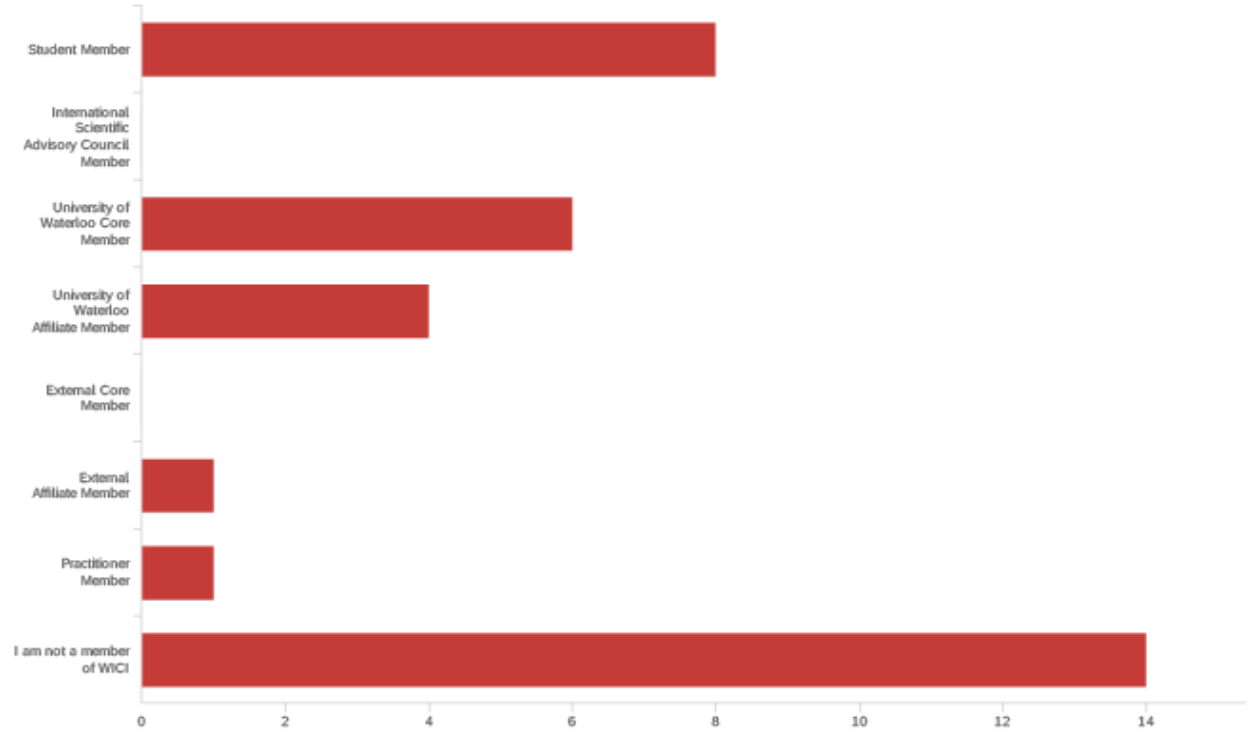
All photography courtesy of Dhroov Patel.

APPENDIX J: WICI 2019 SURVEY RESULTS

Default Report

Fall 2019 Waterloo Institute for Complexity and Innovation Member Survey
March 3, 2020 11:08 AM MST

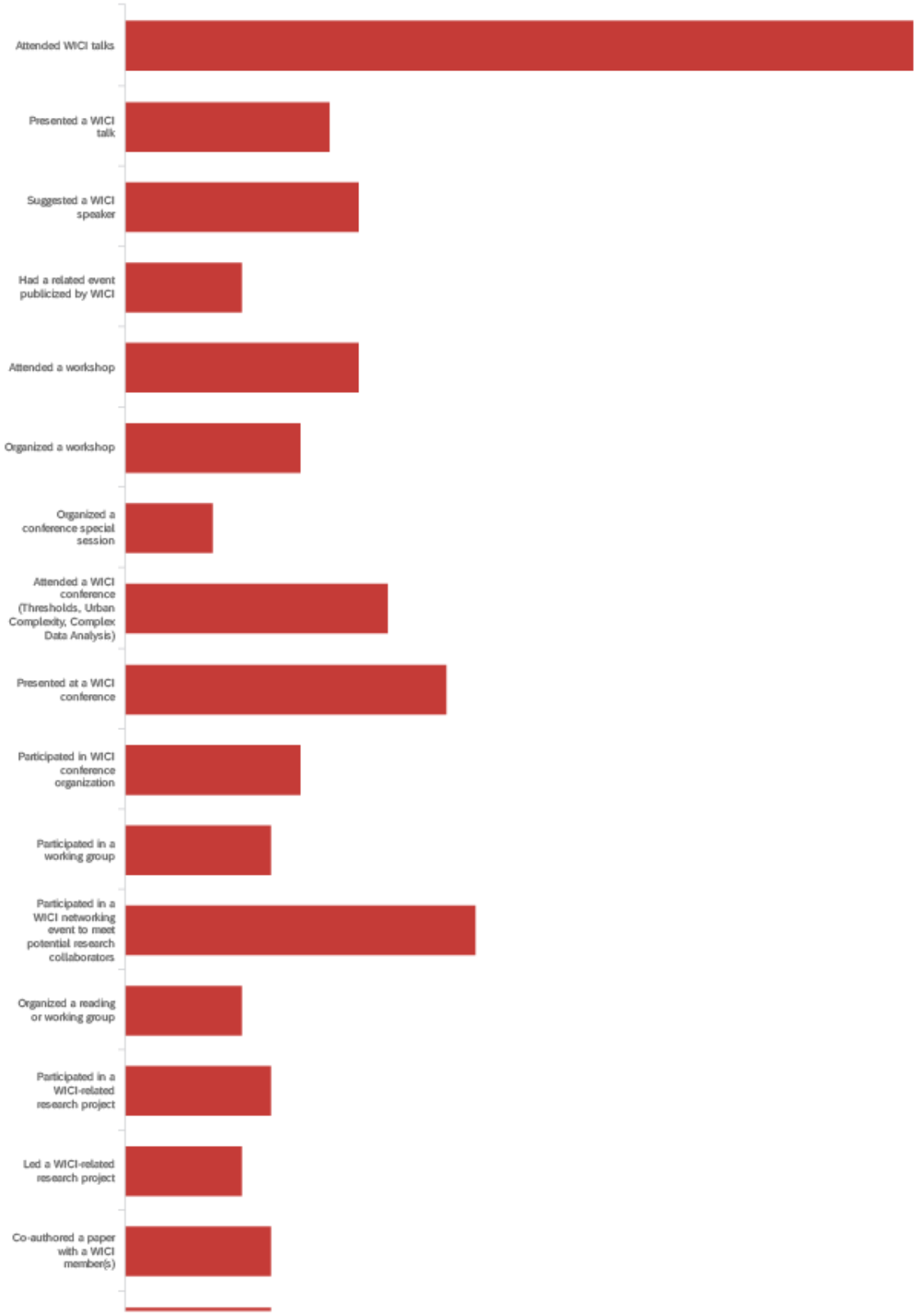
Q1 - What is your membership category?

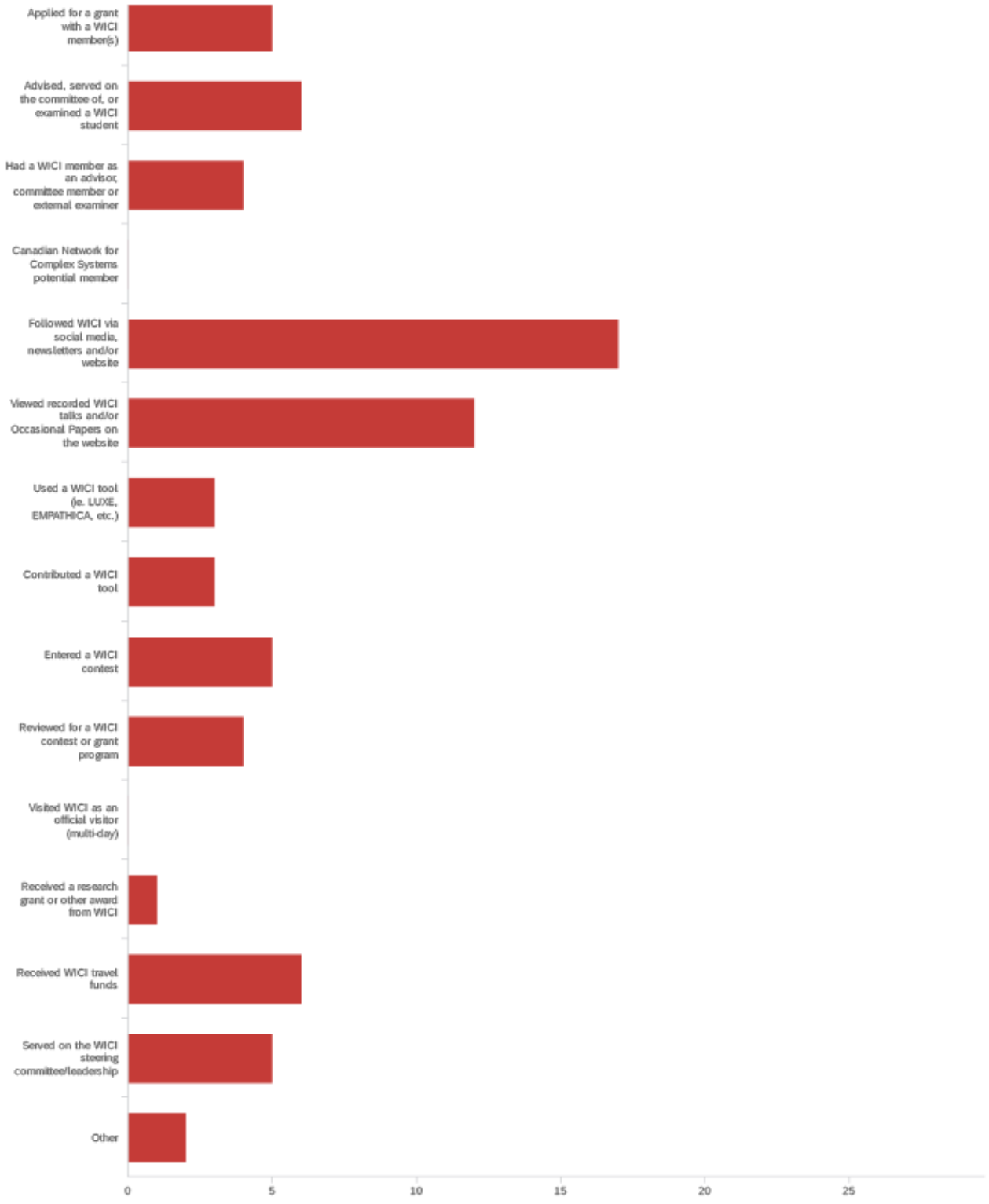


#	Field		Choice Count
1	Student Member	23.53%	8
2	International Scientific Advisory Council Member	0.00%	0
3	University of Waterloo Core Member	17.65%	6
4	University of Waterloo Affiliate Member	11.76%	4
5	External Core Member	0.00%	0
6	External Affiliate Member	2.94%	1
7	Practitioner Member	2.94%	1
8	I am not a member of WICI	41.18%	14
			34

Showing rows 1 - 9 of 9

Q2 - How have you engaged with WICI in the past 5 years? (Please select all that apply).





#	Field	Choice Count
1	Attended WICI talks	13.71% 27
2	Presented a WICI talk	3.55% 7

#	Field	Choice Count	
3	Suggested a WICI speaker	4.06%	8
4	Had a related event publicized by WICI	2.03%	4
5	Attended a workshop	4.06%	8
6	Organized a workshop	3.05%	6
7	Organized a conference special session	1.52%	3
8	Attended a WICI conference (Thresholds, Urban Complexity, Complex Data Analysis)	4.57%	9
9	Presented at a WICI conference	5.58%	11
10	Participated in WICI conference organization	3.05%	6
11	Participated in a working group	2.54%	5
12	Participated in a WICI networking event to meet potential research collaborators	6.09%	12
13	Organized a reading or working group	2.03%	4
14	Participated in a WICI-related research project	2.54%	5
15	Led a WICI-related research project	2.03%	4
16	Co-authored a paper with a WICI member(s)	2.54%	5
17	Applied for a grant with a WICI member(s)	2.54%	5
18	Advised, served on the committee of, or examined a WICI student	3.05%	6
19	Had a WICI member as an advisor, committee member or external examiner	2.03%	4
20	Canadian Network for Complex Systems potential member	0.00%	0
21	Followed WICI via social media, newsletters and/or website	8.63%	17
22	Viewed recorded WICI talks and/or Occasional Papers on the website	6.09%	12
23	Used a WICI tool (ie. LUXE, EMPATHICA, etc.)	1.52%	3
24	Contributed a WICI tool	1.52%	3
25	Entered a WICI contest	2.54%	5
26	Reviewed for a WICI contest or grant program	2.03%	4
27	Visited WICI as an official visitor (multi-day)	0.00%	0
28	Received a research grant or other award from WICI	0.51%	1
29	Received WICI travel funds	3.05%	6
30	Served on the WICI steering committee/leadership	2.54%	5
31	Other	1.02%	2

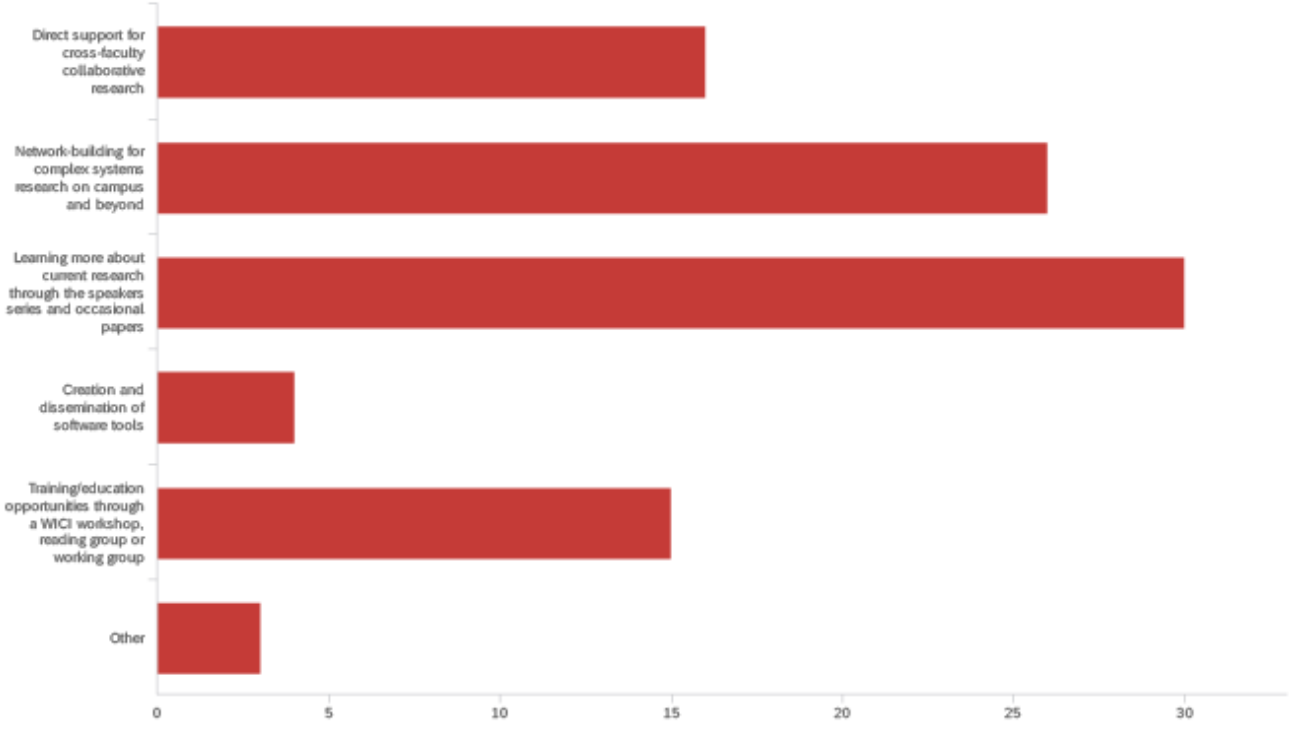
#	Field	Choice Count
		197

Showing rows 1 - 32 of 32

Q2_31_TEXT - Other

Other
I have joined WICI only in Fall 2019, so I have not yet the possibility to give this question specific answers.
received award for artistic contest

Q3 - In which areas do you see WICI providing value, for yourself or others in the community? (Please select all that apply, and please provide specific examples for each response if applicable).



#	Field		Choice Count
1	Direct support for cross-faculty collaborative research	17.02%	16
2	Network-building for complex systems research on campus and beyond	27.66%	26
3	Learning more about current research through the speakers series and occasional papers	31.91%	30
4	Creation and dissemination of software tools	4.26%	4
5	Training/education opportunities through a WICI workshop, reading group or working group	15.96%	15
6	Other	3.19%	3
			94

Showing rows 1 - 7 of 7

Q3_1_TEXT - Direct support for cross-faculty collaborative research

Direct support for cross-faculty collaborative research

Potentially only a small number of faculty notice WICI CFPs

Often only a small group of faculty notice WICI CFPs. If it could be leveraged with more visible interdisciplinary programs, that might help WICI name recognition.

Q3_2_TEXT - Network-building for complex systems research on campus and beyond

Network-building for complex systems research on campus and beyond

wici networking event led to collaboration on a New Frontiers grant

I need a peer reference group for sharing, deepening and pursuing interests in complex systems.

The opportunity to talk to other students as well as professionals in very valuable to me

I've participated because it's a local nexus for complexity topics.

Q3_3_TEXT - Learning more about current research through the speakers series and occasi...

Learning more about current research through the speakers series and occasi...

Dr. Mary O'Connor's talk

WICI can play a key role, since it is otherwise hard to get a variety of researchers from different faculties together.

This has been my main way of engaging with WICI.

I need a peer reference group for sharing, deepening and pursuing interests in complex systems.

I have attended several speaker series organized by WICI and have always learned a great deal about complex problem solving from diverse perspectives.

Many of the talks have been excellent

I've attended public lectures in the past.

Q3_4_TEXT - Creation and dissemination of software tools

Creation and dissemination of software tools

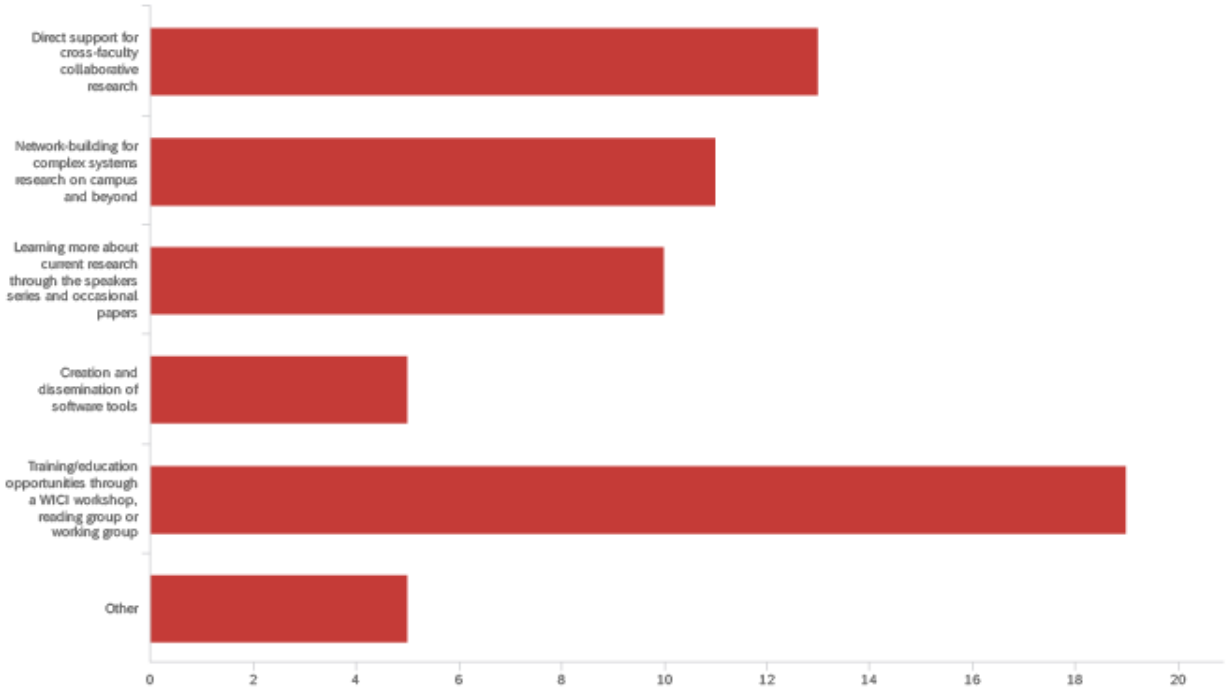
Q3_5_TEXT - Training/education opportunities through a WICI workshop, reading group or...

Training/education opportunities through a WICI workshop, reading group or...
seminars (grad student, discussions with Dr. Sutherland)

Q3_6_TEXT - Other

Other
In general, although I don't get many opportunities to take advantage of what WICI offers, it always seems good quality
Connecting with local off-campus experts in complex systems & innovation
Support for grant acquisition

Q4 - In which of these areas do you think WICI could strengthen their activities? (Please select all that apply, and please provide clarification if any, in the space provided).



#	Field		Choice Count
1	Direct support for cross-faculty collaborative research	20.63%	13
2	Network-building for complex systems research on campus and beyond	17.46%	11
3	Learning more about current research through the speakers series and occasional papers	15.87%	10
4	Creation and dissemination of software tools	7.94%	5
5	Training/education opportunities through a WICI workshop, reading group or working group	30.16%	19
6	Other	7.94%	5
			63

Showing rows 1 - 7 of 7

Q4_1_TEXT - Direct support for cross-faculty collaborative research

Direct support for cross-faculty collaborative research
Well-timed workshops, mini-retreats

Direct support for cross-faculty collaborative research

Funding and organizing interdisciplinary, problem-based research teams

Q4_2_TEXT - Network-building for complex systems research on campus and beyond

Network-building for complex systems research on campus and beyond

Mini-retreats

Possibly WICI could be more intentional about this, employing software to help WICI members make connections (e.g. Exaptive) or supporting student members in identifying appropriate internal-external committee members for exams/defences.

More nodes and which would interact with one another as well as with WICI in Waterloo.

Q4_3_TEXT - Learning more about current research through the speakers series and occasi...

Learning more about current research through the speakers series and occasi...

I remember accessing an occasional paper years ago. Do we receive regular contributions? If not, we could raise the profile of this for people to deposit working papers or even commission working papers.

Occasional papers perhaps could be leverage more

Please find a way to livestream activities. I suggest free-of-charge zoom.us which I have used before. No extra hardware needed.

Q4_4_TEXT - Creation and dissemination of software tools

Creation and dissemination of software tools

Q4_5_TEXT - Training/education opportunities through a WICI workshop, reading group or...

Training/education opportunities through a WICI workshop, reading group or...

Regular trainings for students would be great.

Training on existing tools and methodologies; integrating approaches to complex problems

More exploratory / conversational opportunities would be very intersting.

Best if these can include remote participation somehow.

see below

Q4_6_TEXT - Other

Other
hard to say because I don't take full advantage of WICI resources
Training/education opportunities could be considered that target post-docs and faculty.
Complex systems certificates (grad/undergrad) esp. methods classes at Waterloo
Make more of an effort to foster industry links through relevant complex systems research.
Opportunities for students to see non-academic opportunities

Q5 - Are there other activities, not listed above, that you suggest WICI could engage in?

Are there other activities, not listed above, that you suggest WICI could e...
Training/education opportunities could be considered that target post-docs and faculty.
Summer schools or other credentialing have been discussed. Possibly trainings could also be developed that target professors. Recently I received word about a program at American University targeting professors doing research in international affairs. It combined the benefits of training at an appropriate level with being a multi-day retreat. Might there be value in directing such a training program toward post-docs and professors, where possible outputs include a working paper, draft grant application, etc?
Opportunities for grad students to take part in collaborative research
NA
Initiatives designed to attract industry. This could be a "problems solved" seminar detailing how a company solved a problem through an analysis of complex systems. Alternatively, this could be a "hard unsolved problems" series where industry presenters seek to take a complex systems approach to difficult problems they face. This could better actualize the "innovation" part of WICI. Email: jon.mackay@gmail.com
Group discussions on new Complex Systems topics of interest.
I have answered quickly to make sure you have this, while my dad plays with my kids before bed. If there is any place where you want a good quote I will draft/suggest!
Please find a way to stream WICI events on the Web. Not only would this be valuable to me as a Montreal-based Practitioner Member, but also may I suggest there would be significant value-added through greatly increased potential networking amongst researchers.
The idea of design charrettes was brought up at a WICI meeting at the UW Architecture school (in anticipation for the upcoming round table/ colloquium) and I think that this could be a truly fascinating experience with a transdisciplinary audience who has attended other WICI events.
Could do more for students - more & better advertised working groups More non-academic opportunities (socials & industry-related talks/sessions)
There's a need for complexity literacy in the broader culture, and part of that is addressed in the way subject matter specialists like WICI structure their offerings. Sadly, that means "credentials". WICI can do little for me right now; I work an operational 9-5 job at a charity, but I'd like to expand my scope. In my work, I see that, as the culture becomes more hardened, people find it convenient to treat unpredictable social outcomes as personal moral failures. Funders who demand accountability can learn that, even if everyone acts reasonably "deterministically", unexpected social outcomes still can occur. Complexity analysis might offer techniques, drawn from agent-based modelling or computational social science, to design social programs to make the risks of giving manageable. A study that discusses such things, issued under WICI's imprimatur, would have some momentum to it. But then I'm the weak link when citing it. I can't justify the disruption to my employer--schedule disruption during studies, post-graduation changes in my work remit, making a disruptive business case drawing on Complexity-branded resources--without a trellis to hang those slow-growing vines on. Sadly, sheepskins matter. I'm well aware there's a Sisyphean process involved in establishing recognized credentials. I fully expect that, as happens at any academic centre/lab/institute, WICI has at least had discussions on certificates, licentiates, and whatever other credentials might be sustainable and marketable. I'm writing to say rolling that boulder would be worth it. Encouraging esp. your Math faculty to address the burgeoning interest in applied math by working professionals/hobbyists with tailored structures would be a good & timely activity for WICI. (Or maybe evade the usual processes altogether & do something with Blockchain. Somehow, these days everything always comes back to Blockchain...)

Q6 - How would you describe the mission and scope of WICI to someone outside of WICI?

How would you describe the mission and scope of WICI to someone outside of...
Interdisciplinary collaboration and thinking in an integrative fashion.
not sure
WICI is a networking organization that also pools some resources for seed/travel grants.
WICI is a networking organization and pools useful resources such as descriptions of courses offered in complex systems. Small seed/travel grants are also available for faculty and students. Special events give members opportunities to present their work.
Research node investigating the complex dimensions of social and ecological problems.
Network building & agenda-setting to promote research on complex systems & innovation in this space
Support integrative complex systems thinking, activity, networking and funding across disciplines at U Waterloo and beyond
To be honest, I actually have no idea who/what WICI is and what you do (sorry!)
I'm brand new to WICI - don't know anything about it but was super interested in the talk with Mary O'Connor so learned of WICI b/c of that
Network-building for complex systems research
Not aware of this much.
WICI is concerned with better understanding complex systems in the many ways that they occur and through many perspectives including mathematical, physical and in the social sciences.
Complexity is a highly interdisciplinary domain, and so WICI provides the breadth to bring interdisciplinary people together into a common context.
Complex systems research is fundamental science that deepens our understanding of the common principles that drive physical, biological, and social system. The study of complex systems also has immediate application to improving technology, health, quality of life, and policy design. Waterloo with a concentration in fundamental science, policy, and engineering applications has an advantage in taking innovation from fundamental science through application.
Just joined WICI, so I hold my peace. :)
When I describe WICI to others I have described the groups focus as the ability to conceptualize complex systems and to work with transdisciplinary teams to solve wicked problems.
WICI is a cross-disciplinary group that brings together those who are interested in complex systems.
To advance interdisciplinary research using systems methods and thinking.

Q7 - What do you see as WICI's comparative advantage?

What do you see as WICI's comparative advantage?
Thinking in systems and providing a place to connect with different specialities
not sure
The topic: Complex systems
The topic area: complex systems. No one else at Waterloo is doing this.
Based at the University of Waterloo, a top university in the world.
Membership from across different faculties
harnessing local talent & expertise
Interdisciplinary, complex systems & systems modelling perspective
Interdisciplinary focused on complexity
Interdisciplinary
Highly interdisciplinary
To what? I could not understand the question.
WICI's comparative advantage is that it is cross disciplinary. Because WICI is housed in the University of Waterloo it has access to some of the brightest minds in Canada. This also gives it the status to form links with other international and national research groups concerned with complexity.
I don't understand the question -- in comparison to whom or what?
Leading applied institute of complex systems and the leading Canadian center of complex systems. Waterloo has an opportunity to sustain this advantage by acting decisively/investing now.
Great potential cross-disciplinary and applied potential in the Canadian space.
I see the opportunities presented by WICI as an ability to look at problems from multiple perspectives in one setting and to offer up creativity as a pathway to find solutions through innovation.
Studies cool topics & has engagement from people in really varied areas Brings in strong guest speakers
Complex systems are cool? Also inherently cross-disciplinary?
The fertile math & science ecology at Waterloo.
Potential for collaboration with people from different fields.

Q8 - What do you see as WICI's weakest aspect(s)?

What do you see as WICI's weakest aspect(s)?
Lacking in core tenets or project focuses.
not sure
Organization/leadership seems a bit laissez-faire. Regular well-timed events might help members be more engaged.
WICI may be too laissez-faire (as opposed to implementing targeted activities), which may be why engagement is mixed.
Advertising and community engagement; maintaining interest
Not sure
1 - Lack of core courses available for students of complex systems/systems thinking 2- What is meant by 'complex systems'
Advertising itself and it's talks, etc.
Broad definition, makes it hard to pinpoint the actual work
Can be difficult to build a strong network when addressing highly interdisciplinary content
few guest speakers have seemed relevant to my area of research interests
The mission is not clear.
Currently, there is very little overlap with industry.
I think Complex Systems is *so* big, that it is hard to have sufficient focus. WICI is perhaps spread too thin, and needs to focus a little?
Possibility of missing the opportunity to lead in this space in Canada.
Weak engagement at the department/school level. I suggest you have WICI representatives (faculty and student) in each department/school, tasked with promoting WICI, recruiting members, and leveraging opportunities to collaborate/share resources.
Just joined WICI, so I hold my peace. :)
I am perhaps too new of a member to have noticed any:)
generally low level of activity Even with WICI faculty as advisors, hard to fit WICI activities into overall grad student career - this is another factor limiting engagement.
It is not always clear whether those outside the university are welcome to participate.
- gaining & maintaining momentum, as with any project/movement. - barriers to new participants (talks in early afternoon are inaccessible to 9-5ers without a very good justification).

What do you see as WICI's weakest aspect(s)?
Using the same language; lack of unified mission statement

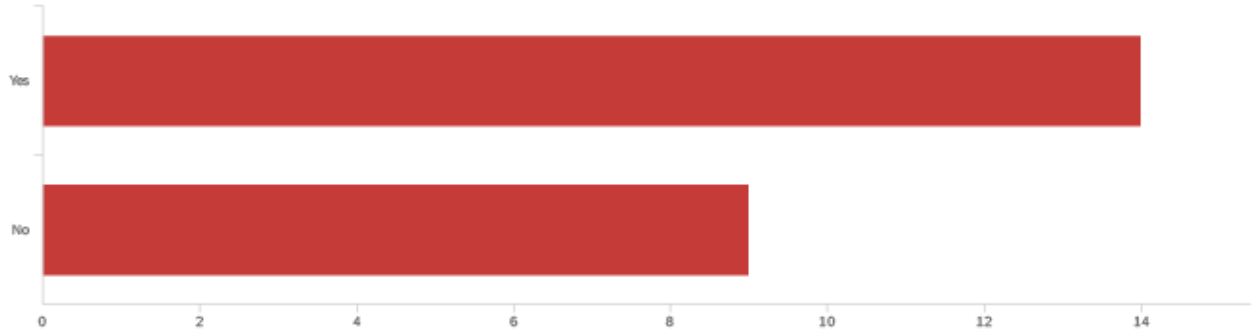
Q9 - What is your vision for WICI's next phase? What specific suggestions might you offer for WICI as we move into our third 5-year term?

What is your vision for WICI's next phase? What specific suggestions might...
WICI as orienting scholarship and graduate work towards pressing problems of our time, like climate change, AI, and political-economic shifts needed in the 21st century.
It's likely my fault, but I don't often hear or notice events, and when I do, I can't make them
Now that there are new grant programs encouraging interdisciplinary scholarship (e.g., Trailblazer, NFRF), WICI may wish to time any of its seed grant offerings in the run-up to the deadlines for those competitions. Similarly, WICI could provide targeted events that are timed in the run-up to those competitions to get faculty mingling/brainstorming/etc. Perhaps WICI could work in conjunction with OR to provide supportive events that might increase the success of Waterloo competitions. Similarly WICI might make it more clear how it can bring value to student members. It is already good that occasional poster presentations and workshops are offered. It might be good to make decisions about what events to offer regularly so that WICI does not seem to be rebuilding wheels.
Focus on promoting collaborative work to address global problems such as climate change that require complex coordination
Build and lead Canadian Complex Systems network
I think WICI should try to develop more industry linkages. Imagine if WICI advertised with industry and facilitated hiring co-operative students in their upper years to solve complex problems with organizations. Students could be based at a company and on UW campus. In effect this could be considered more of a consulting relationship rather than a employee relationship. One way to do this would be to support research into problems that a company sees as potentially relevant but where the way forward is not immediately clear. Companies could support upper year co-op students to look into complex-systems oriented problems they have. Students could leverage the academic excellence of UW while also conducting research into a problem in a limited amount of time. This could give industry a way to follow-up on research ideas without formally setting aside in-house resources. Canadian companies are particularly bad at investing in research so this type of initiative could provide real value to the companies that engage with this program. At the end of a term progress could be analyzed to determine if the basic research sprint had some promising results and was worth re-investing in further research sprints. This would be a low-risk way for Canadian organizations to experiment with innovation while also providing students with research-industry experience.
We need ways to bring people together to actually work together on hard problems.
Clarity of purpose. WICI is uniquely situated but as new entrants move into complexity, we will loose the chance to lead if we don't take advantage to build on where we are and to communicate what we are doing to a larger community. I think it is time to go big in clarity and ambition of purpose. (can refine if you want pieces on this etc.)
Just joined WICI, so I have no "baseline" from which to speak.
I found the workshop/conference on human and planetary health to be very inspirational as well as the presentations on Urban Complexity. I think that organizing speaker series that highlights student research and combines with professionals from related fields and industry provides an interesting audience. Perhaps a call could be made through WICI's professional members for a complex problem to be presented and to be problem solved through facilitated sessions throughout an event or semester, with the outcome being open source for participants to use or to report back to the professional who presented the problem.
Interdisciplinary research projects

Q10 - What is your vision for a Canadian Network for Complex Systems?

What is your vision for a Canadian Network for Complex Systems?
What are Canadian priorities that would benefit from a complex systems approach? A few potential ones include designing regional complex systems approaches, clusters, and core principles.
don't have one
My vision for this is not very well developed, but I think WICI is doing the right thing to look at other models in the world (e.g. Santa Fe Institute) to consider what features WICI would also like to emulate.
Identifying existing researchers and institutions dedicated to complexity and building strong networks and collaborations between them through conferences, social media platforms, annual meetings.
Raising the profile of Canadian work in this space; promoting Canada as a world leader in this space
Source & network to support collaboration projects and funding, esp. in complex systems & government/funding agency awareness to fund complex systems initiatives, wholistic approaches to solving societies'/world's "wicked problems", e.g. global warming, water, integrate systems thinking for planet earth
network to request for interest in collaboration based on expertise, a network to market relevant research, a network to share students and improve recruitment opportunities
I would like to see WICI continue with building its grass roots organization among researchers while also extending its reach both nationally and internationally. I like the idea proposed of increasing the industry engagement of WICI. This could provide increased funds and greater recognition of the relevance of complex systems research among policy makers and the general population.
Key to leveraging Waterloo's position as a first mover into advancement in fundamental and applied research in complex systems.
Just joined WICI, so I have no "baseline" from which to speak.
I don't feel that I have enough information to comment specifically, but generally I think that being able to link real world complex problems encountered by professionals throughout Canada with a diverse cross section of academics would be really valuable!
Not sure what this is.

Q11 - Would you like to receive a summary of our survey results? (If yes, please provide an email address in Q5).

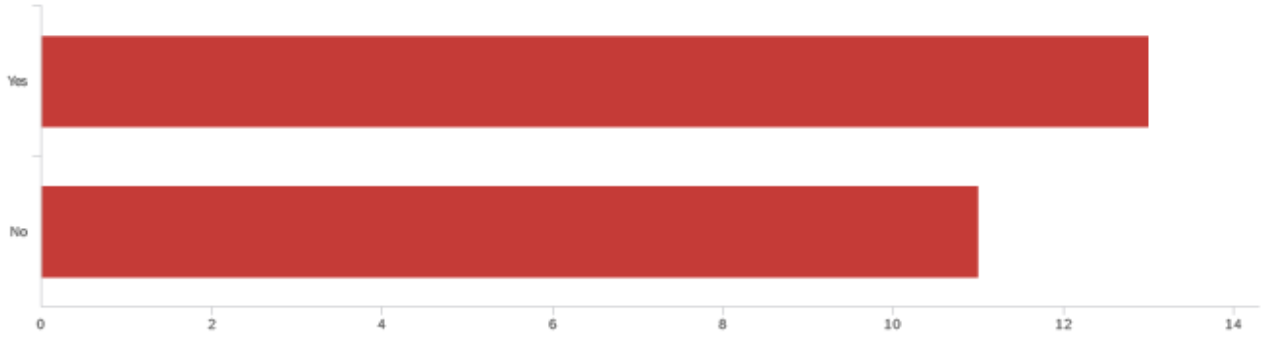


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Would you like to receive a summary of our survey results? (If yes, please provide an email address in Q5).	1.00	2.00	1.39	0.49	0.24	23

#	Field		Choice Count
1	Yes	60.87%	14
2	No	39.13%	9
			23

Showing rows 1 - 3 of 3

Q12 - Could we contact you to discuss your responses? (If yes, please provide name and email address in Q4 and Q5).



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Could we contact you to discuss your responses? (If yes, please provide name and email address in Q4 and Q5).	1.00	2.00	1.46	0.50	0.25	24

#	Field		Choice Count
1	Yes	54.17%	13
2	No	45.83%	11
			24

Showing rows 1 - 3 of 3