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Name of Principal Investigator:	Dr. Jack Liu
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Name and Address of recipient's institution:	Michigan State University 426 Auditorium Rd., Room 2, East Lansing, MI 48824
NASA Grant / Cooperative Agreement Number:	NNX10AD19G

Reference 14 CFR § 1260.28 Patent Rights *(abbreviated below)*
The Recipient shall include a list of any Subject Inventions required to be disclosed during the preceding year in the performance report, technical report, or renewal proposal. A complete list (or a negative statement) for the entire award period shall be included in the summary of research.

Subject inventions include any new process, machine, manufacture, or composition of matter, including software, and improvements to, or new applications of, existing processes, machines, manufactures, and compositions of matter, including software.

Have any Subject Inventions / New Technology Items resulted from work performed under this Grant / Cooperative Agreement?	No ◉	Yes ○
If yes a complete listing should be provided here: Details can be provided in the body of the Summary of Research report.		

Reference 14 CFR § 1260.27 Equipment and Other Property (abbreviated below)
A Final Inventory Report of Federally Owned Property, including equipment where title was taken by the Government, will be submitted by the Recipient no later than 60 days after the expiration date of the grant. Negative responses for Final Inventory Reports are required.

Is there any Federally Owned Property, either Government Furnished or Grantee Acquired, in the custody of the Recipient?	No ◉	Yes ○
If yes please attach a complete listing including information as set forth at § 1260.134(f)(1).		

Attach the Summary of Research text behind this cover sheet.

Reference 14 CFR § 1260.22 Technical publications and reports (December 2003)
Reports shall be in the English language, informal in nature, and ordinarily not exceed three pages (not counting bibliographies, abstracts, and lists of other media).

A Summary of Research (or Educational Activity Report in the case of Education Grants) is due within 90 days after the expiration date of the grant, regardless of whether or not support is continued under another grant. This report shall be a comprehensive summary of significant accomplishments during the duration of the grant.

Report about the "NASA-MSU Professional Enhancement Awards" in 2015

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With support from NASA and Michigan State University (MSU), 17 "NASA-MSU Professional Enhancement Award" recipients were able to attend the 2015 World Congress of Landscape Ecology.

This year's conference was held in Portland (Oregon) during July 5-10, 2015 (http://www.ialeworldcongress.org/). On May 6, a dinner gathering was organized for the new NASA-MSU Award recipients. At the gathering, the participants first made a brief self-introduction regarding their background and research interests. Then they formed five groups to work on manuscripts. Furthermore, each new awardee was recognized with a certificate at the conference luncheon on July 6. In addition, the awardees attended a "Student/Mentor Lunch" on July 8 when the awardees (and other students) met with leading scientists. The awardees also attended a workshop on telecoupling on July 5. The awardees had a great time and were very productive at the conference, and many are continuing to collaborate on preparing manuscripts after the conference and preparing presentations for next year's meeting of US-IALE.

NASA was gratefully acknowledged at the conference. NASA's continued support and contribution was greatly appreciated by the landscape ecology community and the attendees. Enclosed are a list of NASA-MSU Award recipients and comments. Please let me know if additional information is needed. Thank you very much for your continued support of the NASA-MSU Awards program.

Comments of the 2015 NASA-MSU Awardees

The NASA-MSU Professional Development Award was indispensable for monies toward my attendance of the IALE 2015 World Congress. Its goal of professional development has already started to be returning dividends. From this meeting, I have connected with researchers in my field. I can now say that a much larger collection of fellow Master's Candidates, Ph.D. Candidates, researchers, university faculty, and other professionals in landscape ecology can be called colleagues and friends. I was pleased to meet such a broad swathe of the attendees in the Telecoupling workshop and meetings. Many of us have conferred with each other and have developed ideas for new research and papers. This is also to be true of other contacts and lab mates that I attended the conference. The symposia and contributed papers (of which I presented one) have been very informative to the direction of current work. They also provided insight into where future research should be focused (particularly useful for a new researcher). If I needed to sum up the conference, presentations, and NASA-MSU workshop it would be like this: fun, collaborative, and productive. Now I just have to find the time to work on all the new ideas spurred on by my experience there.

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My coming to IALE World Congress 2015 was mission accomplished. Aside been provided with the opportunity to present my PhD research orally to a wide spectrum of audience that you could call the big stage, I was also able to meet and share research and professional experiences with like-minded contemporaries and seniors who have been working on local, regional and global landscape problems, both privately and during workshops. I had the chance to listen first-hand to variety of talks on existing methodological approaches currently being used in problem solving (e.g. the telecoupling framework, visualization of problems through the coupled human and natural systems perspectives etc.), as well as the state of the art in landscape science globally.

It was a great delight to have all of these benefits together at the same time within one conference in the space of one week. I couldn't have wished for more. My very many thanks goes to National Aeronautics and Space Administration (NASA) and the Michigan State University (MSU) for their support in making this a reality.

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I am halfway through my PhD studies in Landscape Ecology at the University of New South Wales, Australia. My research uses graph theory network modelling to study landscape connectivity through time and across large spatial extents. I recently attended the IALE 2015 World Congress held in Portland (July 5-10th) as a NASA-MSU Professional Enhancement awardee, where I gave an invited presentation at the *'Landscape Connectivity and Its Implications for Conservation Management and Planning'* symposium.

IALE 2015 has been one of the highlights of my PhD to date. I feel very lucky to have attended such a fascinating, varied and engaging conference at this stage in my candidature, and to have presented in a symposium along with several of the most eminent landscape ecologists in my area of study. The wide range of topics presented at the conference have confirmed my belief in

the important role landscape-scale research has to play in guiding conservation within increasingly modified and contested landscapes, and I hope to apply many aspects of what I have learnt throughout the conference in my own research.

While IALE 2015 has been fantastic part of my PhD, I would have been unable to attend had I not been fortunate enough to receive a NASA-MSU Professional Enhancement Award. Receiving this award and being part of the special NASA-MSU program greatly enriched my conference experience. Completing an interdisciplinary honours degree combining geoscience with environmental studies has made me keenly aware of the complex linkages which exist between the human and natural worlds, a theme which was central to the fascinating one-day workshop on the 'telcoupling' framework presented by Jack Liu. Getting to know other awardees at this workshop and at other NASA-MSU events (including a luncheon and banquet dinner overlooking Portland) was also a highlight of the conference, and I look forward to many new and exciting collaborations between now and my next IALE attendance!

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I write to thank you for the opportunity to attend the 2015 IALE World Congress. I presented my research in the symposium: “Drivers and Outcomes of Regime Shifts in Land-use Systems” (Symposium S17). I presented my research at Dartmouth, “Avoiding Regime Shifts in Great Lakes Coastal Wetlands”. In addition, I attended the day-long workshop on Telecoupling, led by Dr. Jianguo Liu. Together, the workshop and my participation in the symposium, was an excellent experience for professional networking and intellectual growth. The symposium in which I participated included established scientists whose work I greatly admire, as well as up-and-coming scholars such as myself, with whom formed relationships. By participating in the telecoupling workshop, I had the opportunity to explicitly apply the telecoupling conceptual framework. In fact, I am currently working with other participants in the workshop to study sand scarcity as a limited resource using the telecoupling framework, and we recently submitted a proposal to present this work at next year’s IALE meeting in the telecoupling symposium. The Landscape Ecology community has been an integral part of my career trajectory, and this year’s participation provided an unparalleled opportunity to present my work at the IALE World Congress, to expand my professional network and to integrate my current work into the important emerging telecoupling conceptual framework. Thank you very much for your support.

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My research interest coincides with the theme of the 9th IALE World Congress, “Crossing scales, crossing borders: Global approaches to complex challenges”. The World Congress program helped me to study the linkages between ecosystem services and human society at different spatial and temporal scales by using landscape ecology theory. The World Congress provided various sessions that dealt with ecosystem services. I identified that many researchers have expanded their interests from the supply of ecosystem services to the flow and demand of ecosystem services. For example, researchers can not only map the locations of various coastal ecosystem services (supply part) but also identify how these ecosystem services flow and benefit to human well-being.

I’m particularly intrigued by a session “Ecosystem Services: Supply, Flows and Demands in and Between Landscapes” and Felix Muller’s research (Kiel University in Germany). Since a telecoupling framework is so strong and welldesigned to adopt to the ‘ES: Supply, Flows and Demands’ at a regional and global level, I will try to link an ecosystem services framework to

the telecoupling framework. The telecoupling framework can accommodate ecosystem service flows (flows), supply (sending systems), demand (receiving systems), and more.

I participated in Telecoupling workshop and consisted of working groups to study the nature-based tourism for protected areas and its impact on biodiversity over distances. The research of nature-based tourism would be the first step to integrating the ecosystem services framework to the telecoupling framework. I am ongoing the research about nature-based tourism using telecoupling framework. I hope I will present this result at the 2016 US-IALE meeting.

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Attending the International Association of Landscape Ecology (IALE) World Congress in July 2015 allowed me to present my research on cross-scale urban water connections, receive valuable feedback, and network with important current and future collaborators. The workshop and networking opportunities provided by the NASA-MSU program proved particularly fruitful, offering settings throughout the week to develop relationships with like-minded student and early-career researchers. My focus group has continued communications following the conference, and we plan to work towards a joint manuscript building from our discussions at IALE. Attending the conference also gave me the opportunity to co-present the IALE Student Workshop, "Using R to Model, Manipulate, and Manage Spatial Data." The workshop allowed me to share expertise with my peers and make additional connections with a wide array of student researchers using similar tools and approaches to conduct landscape scale research. In my research and career, I aim to contribute integrated, sustainable solutions for regional water management in human-environmental systems, and my experience at IALE 2015 helped me share my current work, meet potential future collaborators, and widen my perspectives and understanding.

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It has been very interesting to get involved into the IALE community at my first participation at the IALE congress. My poster and talk were well perceived. I got positive feedback and constructive and critical question, especially following my presentation, which possibly help me in further advance my research. Next to my personal presentation I very much enjoyed the Telecoupling workshop and the following dinner and discussions.

Most interesting sessions from my perspective were related to land use change, agrarian landscapes, and ecosystem services. Here I like to highlight especially the session: agrarian landscapes I, land use change IV and VIII, and ecosystem services IV. While the first two gave me some insights on current research advances in my field of study, systematic approaches on ecosystem service assessments and definitions opened a new and interesting field for me.

Overall the conference was very well organized and filled with opportunities to get to know and meet people. For me participation was profitable and I would go again.

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I was very honored to be a recipient of this award and to stand among the company of so many successful colleagues. I was pleased to see the award was associated with a telecoupling workshop, luncheon and dinner with fellow awardees, as this ensured we understood the

context behind the award we had received. It helped to highlight telecoupling and propel the understanding and science of this growing topic among like-minded individuals. During the luncheon I was able to sit at the same table with Dr. Liu and I found him to be very approachable, and interested in my work, and I felt very proud to accept my award in front of conference attendees. During the Awardees dinner that same evening, I joined the "Invasive Species/Biodiversity group" and participated in some fascinating discussion about long distance connections between human and non-human processes as they related to wildlife species and pathogen movement. My group was comprised of researchers covering topics as diverse as vector-borne diseases, pathogens of old growth forests, aspects of social/human geography, and remote sensing habitat modelling. It was challenging to find common ground from which to develop a paper topic, but our conversations were thought-provoking and pushed me to consider the bigger picture (i.e., the global interconnectedness of our own individual research, and how they can be linked). I particularly enjoyed the portion of the dinner where everyone introduced themselves and shared something funny or interesting, which really helped to build a feeling of comradery among our group.

Thank you again for the honor of this award, and for the special events held on our behalf. Thank you especially to Dr. Liu for organizing and hosting these events, for sharing his experiences, and being so generous and welcoming.

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Participating in the IALE World Congress has been a very enriching experience. As a PhD student it provided me the opportunity to interact with many people working in similar research areas as myself, and it also exposed me to new areas of research. During my time in the conference I was able to attend many presentations that provided me with insight and ideas for my current and future research. During the social events I had the opportunity to meet other science professionals that followed various careers paths after completing their PhD. It was very interesting to meet this people and know of the various job opportunities out there for people with PhD in ecology. I was also very excited to have the opportunity to present my research as part of the Landscape Genetics symposium during the meeting (S46) and have experts in the field listen and give me feedback about my research.

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With the generous support the NASA-MSU Professional Award, I attended the 9th International Association of Landscape Ecology (IALE) World Congress at Portland, OR held from 5-10 July, 2015. During the conference, I presented an interdisciplinary study as part of my PhD research that examines the role of multi-level water governance in sustaining hydrologic services in agricultural landscapes. The audience provided excellent feedbacks and suggestions that are very helpful to guide the next step of this work. In addition, I attended a workshop on telecoupling which is a research frontier for coupled human and natural systems. This workshop not only explained the detailed conceptual framework along with interesting empirical examples of telecoupling research, but also break down into sub working groups to allow for in-depth and productive discussions. Each group has a focused research topic, and at the end of the workshop, we came up with a research plan and outlined a manuscript that will carry on after the conference. Also, this award program greatly helps me enlarge my professional network, and build up connections with the same cohort of awardees as well as other leading scientists and researchers at the conference. Finally, I also learned a lot about the

cutting-edge science at the frontiers of landscape ecology during this meeting, which inspire new ideas for future research. I much appreciate this great opportunity for graduate students and early career scientists and would highly recommend it to my colleagues and peers.

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At this stage of my professional career it is extremely important to show to the scientific community the progress of my research and to have the opportunity for networking with my peers. My experience at the 9th IALE World Congress in Portland Oregon enabled me to achieve these goals. Specifically in this occasion, I had the chance to heard talks from relevant topics in my area, which also gave the opportunity to further interact in person with others colleagues. Moreover, during the workshop and dinner organized for the NASA-MSU awardees I had the interesting experience of getting to know other researchers with broad areas of expertise. In this experience, we had the opportunity to establish further collaborations (Telecoupling workshop) for a team research project. From attending to the IALE conference I really appreciate the multiple opportunities I had to increase my collaborative network, and I look forward for attending to future IALE conferences.

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Thanks to funding from the NASA-MSU award, I recently attended the 9th IALE World Congress in Portland, OR. This was my first time attending IALE, which was a great experience. Attending the NASA-MSU workshop on telecoupling allowed me to meet a great group of colleagues. My telecoupling working group and I are now working on a manuscript that we plan to submit to a special journal section on telecouplaing being organized by Dr. Jack Liu.

Presenting my dissertation work was also a great experience. I received positive feedback from several IALE attendees, which led to discussions about possible post-doc opportunities next year. Additionally, presenting my researched and attending other presentations helped me situate my scholarship within the landscape ecology community. As a human-environment scholar working in a geography department, this was my first time attending a landscape ecology conference. It was rewarding to see the breadth of human-environment scholarship at IALE. As such, I look forward to contributing to future IALE meetings.

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The NASA-MSU Professional Enhancement Award allowed me to attend the IALE 2015 World Congress in Portland, OR. This was a tremendous opportunity for me to gather expert feedback on my thesis project, refine my understanding of telecoupling, and expand my professional network. As part of this conference, I was able to present my thesis research, entitled, "Modeling the impact of hydrological alterations: Shifts in Eurasian spoonbill habitat in Poyang Lake, China". In addition to the questions and comments I received after my presentation, I personally talked with a number of landscape ecology experts to identify improvements and potential extensions to my analysis. The information I gathered in sessions and symposium further enhanced my modeling capabilities.

Beyond developing my own research, I also took advantage of this opportunity to delve into Dr. Liu's telecoupling framework. In a specially-designed workshop, I formed a small group with a number of colleagues and began working towards a manuscript operationalizing the

telecoupling framework in a study system closely related to my own. Through this project, I will be able to expand my knowledge of hydrological systems and gain valuable experience collaborating with other researchers. I look forward to continuing this project and to following up on the new connections I've made.

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The 2015 IALE conference in Portland, OR, was the first of its kind in my case. My background and past work experience mainly spanned from Statistics to geographical information systems (GIS) with applications in invasive species modeling. Landscape Ecology became a major component of my research about a year ago. The IALE conference was a pleasant surprise because I realized how many topics and applications overlap with my research interests and past background: patterns crossing spatial scales and temporal resolutions, interactions between humans and the environment across borders, and computational challenges when dealing with large ecological problems.

The workshop on “Telecoupling Framework for Studying Cross-border and Cross-scale Interactions” exposed me to a novel research topic and sparked my interest in trying to understand how to re-think any real-world problem within the telecoupling framework. Prior to this year’s IALE, I never had a chance to study this topic and I really enjoyed learning about several case studies where the telecoupling framework has been applied. Finally, co-instructing the student workshop on “Using R to Model, Manipulate, and Manage Spatial Data” was extremely helpful to build my teaching skills, directly interact with students and receive their feedback to improve future workshops. Throughout the conference, I enjoyed making new connections, expanding my research network, and building new friendships.

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As a recent PhD graduate at the University of Toronto, the NASA-MSU award provided me a very rich academic experience at the 2015 IALE world congress in Portland, Oregon.
My research focus is in landscape epidemiology, a frontier discipline that aims to quantify the interactions between landscape structure and disease-transmission processes at the population- and community-level. Landscape ecology therefore remains a core aspect of my current research and is likely to remain the foundation for my future career trajectory in disease monitoring and surveillance. Being provided the opportunity to attend the 2015 conference by the NASA-MSU grant facilitated my networking opportunities with other students, academics, and industry representatives who have similar research interests in this particular niche of environmental and health sciences that is rarely available at alternative infectious disease or health-related conferences I normally attend.

This year, the theme of 'telecoupling' was a central focus of the NASA-MSU awardees. Working with other student awardees on the focus of 'telecoupling' provided a unique interface to connect with other young scientists and to problem-solve issues in multi-scalar links between ecological and human systems. This concept is a cutting-edge perspective on complicity theory and is extremely amenable to my personal work in terms of how local-scale disease outbreaks may drive global-scale pandemics with significant economic, social, and environmental consequences. Therefore, the introduction to 'telecoupling' has provided personal benefits beyond the scope of the group discussions at the conference. For example, I expect to develop multi-scalar disease networks at an agricultural-trade interface using meta network theory

approaches towards understanding critical spatial and economic links that bridge local disease clusters to major global contagion.

Thank you for providing me as a young landscape ecologist the opportunity to attend, present my research, and network at the 2015 IALE conference. I am looking forward to attending this conference annually in the future.

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I am an Agriculture Engineer and currently about to defend my Master of Science thesis on the Natural Resources Master of Science program from the Pontifical Catholic University of Chile. I was accepted to orally present in the 2015 IALE World Congress in Portland Oregon, the results of my research in the Historical Ecology Symposia, titled: **Historical Dynamics of a Patagonian Landscape: Patterns and processes in forest cover and use since late 19th century in Chilean Patagonia.** I briefly describe the unique experience I had during my stay in Portland, OR, to which I must specially acknowledge the support given by Michigan State University and NASA with the NASA-MSU award.

Starting with the Telecoupling workshop led by Dr. Liu, it was a unique experience to meet scientists from all over the world and to establish relationships that will surely develop to the future. All along the week of the congress, this people were like friends. The diversity of the congress speakers every one of the days constituted a real challenge to follow and take advantage of the wide opportunities of opening my frontiers of knowledge in the landscape ecology science. Beside attending a diverse array of presentations, I had the remarkable chance to meet researchers of my specific field (historical ecology), including one of my mentors abroad, Dr. Lars Östulnd, with whom we intensively worked on the research we are together involved. It was as well a great opportunity to revise my Master thesis with him and other experimented researchers in the field. About the effects of the telecoupling framework in my research after attending the congress, I am involved in the premises of a research group formed after the telecoupling workshop, concerning the telecoupling of sand resources. I came back to Chile not only with good advance on my thesis, after having presented it and received the proper critics and advises, but also with a new and diverse group of friendship to develop and nourish in the future.

NASA-MSU Awardees (Class of 2015)

Name	Affiliation
Oludunsin T Arodudu	Leibniz Centre for Agricultural Landscape Research (ZALF), Germany
Robbi C Bishop-Taylor	University of New South Wales, Australia
Jodi S Brandt	Dartmouth College
Min Gon Chung	Michigan State University
Arjan de Bruijn	Purdue University
Jillian M Deines	Michigan State University
Joseph Drake	Texas Tech University
Florian Gollnow	Humboldt-Universität zu Berlin, Germany
Amy B Mui	University of Toronto, Canada
Beatriz Otero Jimenez	University of Michigan
Jiangxiao Qiu	University of Wisconsin-Madison
Yessica Rico Mancebo del Castillo	Royal Ontario Museum, Canada
Jesse S Sayles	Arizona State University
Benjamin K Sullender	University of Wisconsin-Madison
Francesco Tonini	North Carolina State University
Alexander Watts	University of Toronto, Canada
Gabriel Zegers	Pontifical Catholic University of Chile, Chile