

Spatio-temporal Patterns in Giant Panda Behavior across a Coupled Human and Natural System (CHANS)

Final Report

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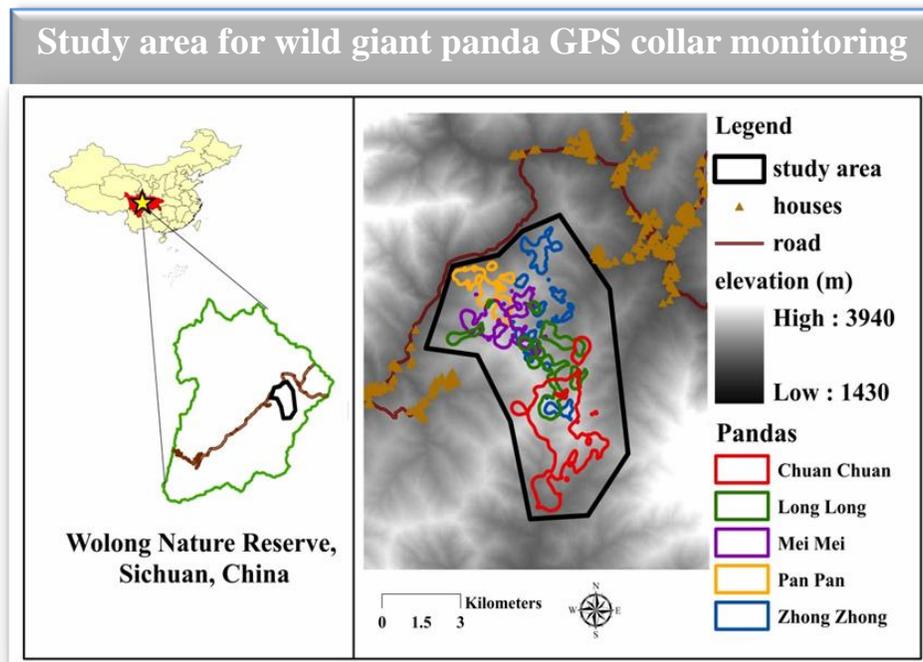
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Proposal Summary

The giant panda (*Ailuropoda melanoleuca*) is currently the most endangered bear on Earth, a status that results from extensive human development occurring across its habitat in China. Despite decades of international protection efforts, the behavior of wild giant pandas is not well understood. This considerable research gap exists due to a government ban on all telemetry tracking of these elusive animals since 1995. We conducted a cutting-edge GPS collar study in the renowned Wolong Nature Reserve, Sichuan, China, with the goal of investigating wild giant panda space use and habitat selection patterns, with a particular emphasis on characterizing individual giant panda responses to human impacts, the major cause of panda endangerment. We integrate the GPS collar data with field sampling data, remotely sensed imagery, and household interviews in a comprehensive analysis of animal behavior involving movement models, resource selection models and management evaluations. The study makes several original contributions to the conservation of this endangered ursid. The main contributions include: (1) publishing of original research in peer-reviewed journals to fill crucial knowledge gaps about giant panda behavior and ecology, and (2) directly informing management plans for the giant panda habitat by applying an individual animal perspective to understanding panda-human interactions for the first time. The study also makes broad contributions to the scientific and management communities by providing a novel and rigorous approach to analyzing the behavior of endangered bears navigating coupled human and natural systems, where humans and natural components interact.



Project Accomplishments

This project made a number of meaningful contributions to giant panda ecology and conservation. One of our efforts was a quantitative synthesis of published studies on giant panda habitat selection (Hull et al. in press). This paper explored for the first time several complexities in giant panda habitat selection such as multivariate effects, interactions among habitat factors, and selection across levels. By synthesizing previous literature, we found evidence of interactive effects of different habitat characteristics on panda habitat selection (e.g. slope and forest disturbance), variation in selection across different selection levels (e.g. geographic range vs. home range), and differences in habitat use based on habitat availability (e.g. declining use with increasing availability of secondary forests). We put forth recommendations for improvement of habitat selection studies on giant pandas in the future, guidance which also informed the development of our field project.

We also conducted an investigation of space use using data from the GPS collared pandas (Hull et al. in review, Hull 2014). We employed model-based approaches to characterize home ranges, core areas, and space use interactions among giant pandas. Our study showed that pandas occupied small home ranges (2.8 – 6 km²) made up of several (16-39) small core areas that depicted the pandas' unique foraging strategy. Pandas also displayed significant dynamic spatio-temporal interactions with neighboring individuals. We also analyzed variation in habitat use and selection by the collared pandas across their home ranges (Hull 2014). We found that pandas used a broader range of habitat characteristics than previously understood, such as steep slopes and non-forest areas, while solar radiation was a significant predictor of both habitat use and selection (Hull 2014). This work is currently being developed as a manuscript for a peer-reviewed journal.

We also explored an emerging but severely understudied human impact on giant pandas—livestock grazing. We looked specifically at a new livestock threat in Wolong, that of domestic, free-ranging horses grazing in forests (Hull et al. 2014). We integrated data from the GPS-collared pandas with other field and GIS data to examine a number of different aspects of the issue, including the distribution of horses with respect to giant panda habitat, differences between habitat selection patterns of horses and pandas, bamboo consumption by horses, and panda use of horse-affected areas. We found that horses had a measurable negative impact on giant pandas and their habitat by overlapping spatially with suitable giant panda habitat, displaying similar habitat selection patterns as pandas, and consuming large amounts of bamboo. Pandas also appeared to avoid one long-term study site after horses were introduced.

We also conducted other research endeavors related to the funded project. These included research on the role of pandas and other wildlife in coupled human and natural systems (Carter et al. in press), recovery of the panda's natural habitat in response to a major earthquake (Zhang et al. 2014), the emerging telecoupling framework for understanding global change (Liu et al. 2013, Liu et al. 2014), attitudes of urban Chinese towards environmental issues (Chen et al. 2012), and breakthroughs in captive giant panda reproduction research (Huang et al. 2012). These endeavors ultimately helped shape and refine the overall project and broaden our perspective on the role of bears in complex systems.

Publication List

- Hull, V.**, G. Roloff, J. Zhang, W. Liu, S. Zhou, J. Huang, W. Xu, Z. Ouyang, H. Zhang, and J. Liu. A synthesis of giant panda habitat selection. *Ursus*. *In press*.
- Carter, N., A. Viña, **V. Hull**, W.J. McConnell, W. Axinn, D. Ghimire, and J. Liu. Coupled human and natural systems approach to wildlife research and conservation. *Ecology and Society*. *In press*.
- Chen, X., M.N. Peterson, **V. Hull**, C. Liu, D. Hong, and J. Liu. 2012. How perceived exposure to environmental harm influences environmental behavior in urban China. *Ambio*. 42(1):52-60.
- Hull, V.** 2014. Giant panda behavior across a coupled human and natural system. PhD Dissertation, Department of Fisheries and Wildlife, Michigan State University.
- Hull, V.**, J. Zhang, S. Zhou, J. Huang, A. Viña, W. Liu, M. Tuanmu, R. Li, D. Liu, W. Xu, Y. Huang, Z. Ouyang, H. Zhang, and J. Liu. 2014. Impact of livestock on giant pandas and their habitat. *Journal for Nature Conservation* 22(3): 256–264.
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- Liu, J., **V. Hull**, E. Moran, H. Nagendra, S.R. Swaffield, and B.L. Turner. Telecouplings and global land use. 2014. In: Seto, K.C. and A. Reenberg (Eds). Strüngmann Forum Reports-Rethinking Global Land Use in an Urban Era. The MIT Press, Cambridge, Massachusetts.
- Liu, J., **V. Hull**, M. Batistella, R. DeFries, T. Dietz, F. Fu, T. W. Hertel, R. Izaurrealde, E. F. Lambin, S. Li, L. A. Martinelli, W. J. McConnell, E. F. Moran, R. Naylor, Z. Ouyang, K. R. Polenske, A. Reenberg, G. De Miranda Rocha, C. S. Simmons, P. H. Verburg, P. M. Vitousek, F. Zhang and C. Zhu. 2013. Framing sustainability in a telecoupled world. *Ecology and Society* 18(2): 26.
- Zhang, J., **V. Hull**, J. Huang, W. Yang, S. Zhou, W. Xu, Y. Huang, Z. Ouyang, H. Zhang, and J. Liu. 2014. Natural recovery and restoration in giant panda habitat after the Wenchuan earthquake. *Forest Ecology and Management* 319: 1-9.

In review:

- Hull, V.**, J. Zhang, S. Zhou, J. Huang, R. Li, D. Liu, W. Xu, Y. Huang, Z. Ouyang, H. Zhang, and J. Liu. Space use by endangered giant pandas. *Journal of Mammalogy*. *In review* 1/2014.
- Zhang, J., **V. Hull**, J. Huang, S. Zhou, W. Xu, Y. Huang, Z. Ouyang, H. Zhang, and J. Liu. Activity patterns of the giant panda in relation to climate. *Journal of Mammalogy*. *In review* 4/30/2014.

Local Engagement in Conservation

Another significant component of this project involved outreach. We are privileged to have an ongoing partnership with a local research organization- the China Center for Research and Conservation of the Giant Panda (CCRCGP) in Wolong Nature Reserve. Our collaborators at this institution have identified an important need for increased knowledge and skills to conduct scientific research, particularly in the field of animal behavior and conservation. An important component of the mentoring arm of this project involved providing advice to inform the CCRCGP's research on captive panda breeding and reintroduction. This was often done informally on-the-ground such as via providing references, suggesting study designs, assisting with administration of collar technologies, and sharing big-picture conservation ideas. One of the more formal outcomes of this relationship was assisting in the writing of a paper on giant panda reproduction, which put forth a novel analysis showing the narrow range of giant panda estrus in captivity (Huang et al. 2012).

With Colleagues at the China Center for Research and Conservation of the Giant Panda (CCRCGP)



Our research also informed on-the-ground management of giant panda habitat. Working together with CCRCGP researchers, we were able to establish an infrared camera monitoring project that measured biodiversity and panda presence throughout our study area. This project helped local researchers better understand animal habitat use and also documented frequencies of local farmer activities in the forest. Preliminary findings also revealed a growing issue of illegal hunting in the study area, data which helped inform long-term management of this challenging issue. This work is currently being developed as a research manuscript.

Example photographs obtained from the biodiversity monitoring project using infrared cameras



Perhaps the most direct use of our research findings for management has been in the treatment of the domestic horses roaming panda habitat. After raising our concerns regarding this emerging issue with the local managers and presenting our findings on the severity of their impact, the reserve administrators instituted a ban of horse rearing in Wolong. The ban was successful and all horses have been removed. However, livestock-panda conflicts are still evolving because preliminary findings from our camera trapping study suggest potential resurgence of other livestock species in the forest. We are in the processes of developing this research and working with managers to address evolving needs in this area.

Domestic, free ranging horses encroaching on giant panda habitat



One other component of the research and local engagement that is still ongoing concerns integrating results from a series of focus groups conducted with local residents regarding human activities occurring throughout giant panda habitat in our study area. We coupled the focus groups with a participatory mapping exercise in which respondents were shown Landsat imagery overlaid on contour and place name maps and asked to draw key features to accompany their discussions. Preliminary findings are revealing in suggesting a complex land use history in the region, information that is still being analyzed to inform research and management in the future.

Participatory mapping with local residents in Wolong Nature Reserve



We hope that the strong foundation that we have established with this project thus far will provide a stepping stone to continue to develop cutting-edge research on this endangered ursid. We also hope to continue to engage with local researchers, managers and other stakeholders to inform management of this complex, biodiverse system. We thank the International Association for Bear Research and Management for the generous support of this research.