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PROJECT DESCRIPTION

PROJECT INFORMATION

Project title:	**Linking satellite indicators and ground data on forest productivity to predict brown bear damages in Europe**
Project ID:	258
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Pulsed resources have prominent effects on community and ecosystem dynamics; however, there is little research on how they affect human-wildlife interactions. Tree masting is a common type of pulsed resource that represents a crucial food for many species and has important bottom-up effects in food webs. In anthropogenic landscapes, years of food shortage after mast years can have negative outcomes for both people and wildlife, for instance when an increased use of anthropogenic foods by animals exacerbates human-wildlife conflicts. In this project we plan to use novel remote sensing indicators of forest productivity and phenology, together with weather cues and ground measures of mast production, to investigate how years of masting and crop failures shape human-wildlife conflict occurrence.

To evaluate that question we will use the study case of European beech (*Fagus sylvatica*) seed production and brown bear (*Ursus arctos*) damage in temperate forest ecosystems. Brown bears are known to rely strongly on the seeds of masting trees, such as white bark pine (*Pinus monticola*) in northwestern North America, pine nuts from Siberian pine (*Pinus sibirica*) in boreal forest of north-central Asia, or beechnuts in temperate Europe. Bears rely on mast seeding particularly during hyperphagia (September-December), when they need to accumulate fat reserves prior to hibernation. Since beechnuts are a key food resource for bears in temperate Europe, we hypothesized that the availability of beechnuts shapes the consumption of other food resources, including human foods, which is associated to bear damages to human properties.

In a preliminary study using local data from the north-eastern Carpathians (southeastern Poland), we have used generalized linear models and a combination of remote-sensing and field-measured productivity indicators to investigate that relationship. Our results proved that damage caused by brown bears in temperate ecosystems increase in years of low beechnut production. Furthermore, we analyzed the temporal variation in field-measured beechnut production as a response to different weather variables and remotely sensed indicators of forest productivity using autoregressive mixed models. Our results demonstrated that combining weather cues and remote-sensing indicators of vegetation growth and phenology can explain and predict year-to-year variation in beechnut production linked to wildlife damage. These results are discussed in a paper that is currently under review.

We are currently planning to scale up and refine our analyses including data from different bear populations in temperate Europe. Overall, we have already compiled information of nearly 22,000 reports of damage caused by bears from 13 study areas distributed across eight countries in temperate Europe (Bautista et al. 2017). These 13 time series span different periods from 1996 to 2020. In addition to the temporal analyses, we now plan to add a spatial dimension to our models. We will adapt our previous modeling approach to an integrated nested Laplace approximation to properly account for spatio-temporal autocorrelation in the dataset. This project is based on a large collaborative effort that brings together wildlife ecologists from over 15 institutions. Specifically, the analyses of this project will be completed in cooperation

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with researchers from the Geography Department of the Humboldt University in Berlin. Together we aim at modeling and predicting beechnut production across space and time based on remote-sensing indicators of vegetation growth and phenology and meteorological data for our 13 study areas in Europe. To train and test our predictive models with the highest probability of success it is very important to have standardized field-measures of beechnut production. For this reason we kindly request to the Program Coordinating Center of the ICP Forests to provide us the time series data on European beech litterfall. We are particularly interested in data of beechnut production either estimated as number of seeds or fruit biomass. To minimize predicting errors in our models it is important to maximize the sample size; i.e., the number and length (in years) of the time series of beechnut production.

Accordingly, we kindly request all data on European beech litterfall (specifically fruit production) available in the ICP Forests. Additionally, we are also interested in getting access to the available meteorological data linked to the beechnut data to include the effect of weather cues on beechnut production in our models.

This project will help gaining a systematic understanding of a fundamental question in ecology: the bottom-up effect that pulses in primary production (such as beech masting) has on higher trophic levels. Particularly this project will focus on how these changes in natural food resources can impact the interaction between large carnivores (the brown bear in our case) and humans. The results from this project will certainly have important implications for the conservation and management of brown bear populations in human-dominated landscapes, particularly in temperate forest ecosystems of Europe. Furthermore, the use of freely available satellite data in modelling and predicting mast production represents a promising pathway to try to understand the response of masting tree species to changes in climate and land systems under future global change scenarios. Finally, our findings can also apply to other continents and to other species of both wild animals and masting trees, which represents a potential contribution to conserving biodiversity in different parts of the world.

References

Bautista, C. et al. Patterns and correlates of claims for brown bear damage on a continental scale. Journal of Applied Ecology 54, 282–292 (2017). https://doi.org/10.1111/1365-2664.12708.

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