Berry risk mapping and modeling of native and exotic defoliators in Alaska

Project Leader:

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Cooperators:

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Project Summary: A recent (2008-2012) outbreak of Geometrid moths has decimated subsistence berry harvest in South Central Alaska; this is the first time a Geometrid outbreak has been seen in Alaska. We propose to develop a risk model to predict where subsistence berry plants will be most resistant to Geometrid attack. This model will be used to identify areas where berry improvement silvicultural treatments are most likely to be successful, to sustain a supply of subsistence berry resources to our tribes and fuel wood for wood energy projects.

Objective and Need: Chugachmiut is a tribal consortium representing the seven tribes of the Chugach Region of Alaska (Chenega Bay, Eyak, Nanwalek, Port Graham, Qutekcak, Tatitlek, and Valdez). The Native people of the region rely heavily on subsistence gathered food for sustenance and nourishment. Studies by the Alaska Department of Fish and Game show that a significant portion of the total foods consumed, 375 pounds per person per year, are from subsistence hunting and gathering. In the traditional Native diet berries were the only sweet food and hence are culturally as well as nutritionally important.

Beginning in 2008, an outbreak of native Geometrid (*Geometridae*) moths caused widespread defoliation of salmonberry and blueberry plants in many Native communities in the Chugach Region, resulting in major berry failures and resource loss. The outbreak was particularly severe in Port Graham, Nanwalek, and Seldovia. In Seldovia, a tribal for-profit enterprise based on blueberries was placed in jeopardy because of successive failure of their blueberry crops. This outbreak continued through 2012 when Geometrid populations began to decline only to be replaced by an exotic leaf roller (*Epinotia solandriana*). Although this is the first known Geometrid outbreak in Alaska, in other areas of the world where these same species of moth are native, outbreaks return on cycles of 10 years. This cycle of outbreaks is so regular that Geometrids are used in entomology textbooks as an example of cyclical insects. Hence, we expect that we will see outbreaks of the Geometrid moths in the future.

Tribal elders from our tribes, who have occupied these lands for millennia, tell us that the tribe has no memory of any loss of the culturally important berry resource. What the tribal elders tell us is consistent with the western scientific records that show no moth outbreaks affecting berries since recordkeeping began roughly 50 years ago. Our hypothesis is that global climate change has allowed the moth populations, which may have been previously limited by climate, to grow to massive defoliating populations capable of destroying the berry resource. This hypothesis is consistent with recent research

by Berg[1] and his colleagues and trends in local climate data. It is important to us to try to understand the effects on the abundance and distribution of defoliators, and other damaging insects, with similar biologies, to predict where outbreaks will occur in the future and what we can do to ensure a continued flow of subsistence production for the berry plants we depend on.

Simply put, we need to develop methods to assess the vulnerability of our subsistence berries to damaging insects, and tools to help us prepare for future impacts. We suggest a project aimed at developing risk maps and models for prediction of moth defoliation on berry resources in the Port Graham and Nanwalek area. This will allow us to assess their risk of defoliation by new insect outbreaks and climatic scenarios that may lead to continued defoliation disturbances or the loss or gain of suitable berry habitat. The resulting risk maps and predictive models will be used by Chugachmiut and other land managers to make decisions about forest treatments aimed at sustaining berry resources into the future under the uncertainty of climate change.

We expect to reap great benefits from risk maps and model predictions of moth defoliation to berry resources. With this knowledge we can target forest management operations to increase berry production in areas most likely to be protected from future and current moth outbreaks. Blueberry plants in the Port Graham vicinity require partial shade to thrive, while salmonberries do well in full sun. Forest conditions in the area are typically closed canopy and do not allow enough light to reach the forest floor for berry plants. Opening the forest canopy by removing trees will greatly enhance the existing berry plants, and doing so in areas where other environmental factors are most favorable to berry plants will be ideal. We anticipate that the developing Port Graham wood fired district heating loop will allow us to implement these needed berry improvement treatments in the surrounding forest.

Port Graham is currently in Phase 3 of 4 (engineering, design, and permitting; completion 2013) developing a wood fired district heating loop. One product of phase 3 is fuel source agreements with owners of timberlands near Port Graham. Although beyond the scope of this proposal, the risk maps produced by modeling will allow us to create harvest plans as part of Phase 4 (construction and startup up, completion 2014) of the Port Graham wood fired district heating loop. Principles of Integrated Pest Management (IPM) are based on first having a healthy plant to prevent diseases and insect damage. By following the principles of IPM and using model derived risk maps, our forester will locate ideal berry habitat that will help grow healthy, productive and resilient berry plants while at the same time provide fuel wood for the district heat loop in Port Graham. We believe that these projects will assist in creating a sustainable community, both economically and environmentally, be more prepared for changes to local climate, and at the same time help sustain the traditional way of live for our tribal people.

Technical Approach: Spatial statistical models will be developed to describe the spatial distribution and abundance of berries and defoliation caused by the Geometrid moths. Independent variables considered

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[1]Berg, Edward E., et al. "Spruce beetle outbreaks on the Kenai Peninsula, Alaska, and Kluane National Park and Reserve, Yukon Territory: relationship to summer temperatures and regional differences in disturbance regimes." *Forest Ecology and Management* 227.3 (2006): 219-232.

for use in the models include: topography, climate models, vegetation maps, soils maps, aerial photographs, limited LIDAR, existing forest inventory data, relative abundance surveys for berry plants, and traditional subsistence harvest data. New survey data documenting the influence of forest stand structure on the abundance of berries and the extent and severity of the recent and ongoing defoliation events will also be collected. The area of interest will be stratified using satellite imagery, climate data and traditional subsistence harvest data to characterize the spatial variability of the vegetation in the area. Sample plots corresponding to the resolution of the satellite imagery will be randomly located within each stratum. All sample locations will be georeferenced. At each sample location, data will be collected on forest stand structure (e.g., basal area and canopy closure), the abundance of berries and the presence and severity of the defoliation. Information from the available GIS layers (satellite imagery, topography, climate, soils, etc.) in which complete coverage is available will be extracted and combined with the field data. Regression analysis will be used to model the large scale variability in the field data, while a tree-based stratified sample design will be used to describe the small-scale variability in the data. Regional scale applications of the models will be undertaken through the use of spatially-variable, geographic data sets (soils, climate and topography). All models will be cross-validated to evaluate the predictive performance of the models. Standard error surfaces will also be developed to assess the uncertainty in the estimates provided by the models.

Geographic Extent: Our risk model will be applicable to the area in and around Port Graham and Nanwalek, Alaska from where the data will be derived but the model may be extrapolated to a broader scale. The Geometrid Month outbreak has been seen from the Talkeetna Mountains, near Wasilla and Palmer Alaska, south through Anchorage, the Kenai Peninsula to Port Graham and Nanwalek, approximately 200 miles. The model may also be adaptable to areas in the Prince Williams Sound and south east Alaska wherever geometrid moths and host plants are found. For example, the Seldovia Native Association is in jeopardy of closing their commercial berry growing operations 5 miles north of Port Graham in part due to moth induced berry failures. Tribes like Seldovia and other non-tribal communities of the region will certainly benefit from our outreach. Beyond the scope of this project; we plan to work with the Alaska Cooperative Extension Service to outreach and educate others in our region about the results of our berry research. This outreach will benefit our tribes as well as neighboring tribes and commercial berry growers in Alaska.

Timeline of Schedules, Products and Outcomes:

- Startup- June 2013
  - Obtain available GIS layers, satellite imagery and other related data- June 2013
  - Design the field survey- August 2013- October 2013
- Conduct field survey- May-August 2014 (growing season)
- Data analysis and model development- August 2014-November 2014
- Model evaluations-September 2014-December 2014
- Final Model, Final Report, and project completion – December 2014
- **Cooperator Roles and Responsibilities**
  - **Chugachmiut-**
    - **Project Management**
    - **Hiring of a village based field survey crew**
    - **Arrange for local lodging and transportation of researchers**

- **Utilize the risk mapping products to implement berry management on appropriate areas as part of forest management in the region**
- **USDA-Forest Service State and Private Forestry**
  - **Provide technical assistance through their State and Private Forestry Forest Health Staff.**
- **Colorado State University**
  - **Obtain available GIS layers, satellite imagery and other related data**
  - **Design and implement the field survey**
  - **Data analysis and model development**
  - **Model evaluations**

In addition, the results of this study will be published in peer reviewed literature and, possibly, as a Master's thesis or Ph.D. dissertation. Results will also be presented as various phases of this work are completed as posters and oral presentations at scientific meetings, both locally and nationally.

Cooperator's Prior experience

Mr. Nathan Lojewski is the Forestry Manager for Chugachmiut, he holds a Master's degree in Forestry, and is a Certified Forester. Mr. Lojewski has extensive experience managing federal trust programs on Native Trust land in Alaska, developing and deploying forest inventory, GIS analysis, project management on various projects as diverse as land management planning, wildland fire crew administration, applied research projects, and is experienced in education and outreach from past projects within the Chugach Region and his time spent as a Peace Corps Volunteer in West Africa. Chugachmiut has worked cooperatively with the US Forest Service and the Alaska Cooperative extension service for the past three years preparing articles and pamphlet publications relating to the ongoing Geometrid outbreak and giving talks and presentations throughout the region to diverse groups of people.

Dr. Robin M. Reich is an expert in the application of spatial statistics in designing natural resource inventories and ecosystem modeling. Dr. Reich has been a professor of Forest Biometrics and Spatial Statistics in the Department of Forests and Rangeland Stewardship, Colorado State University since 1985 and has published more than 100 peer-reviewed papers and technical reports. Dr. Reich has worked extensively with John Lundquist, USDA Forest Service in modeling the spatial relationships of various insects and diseases throughout Colorado, South Dakota and Alaska.

Dr. John E. Lundquist is a Forest Entomologist, with the U.S. Forest Service, State and Private Forestry, Forest Pest Management, Pacific Northwest Research Station in Anchorage, AK. Dr. Lundquist is an expert of Alaska's forest pests and diseases. He has authored numerous peer-reviewed publications and technical reports, serves as an editor to the Journal of Forestry and has edited a textbook. Dr. Lundquist has worked extensively with Dr. Reich on other modeling projects throughout the United States.