Whitney K. Newcomb

Humboldt State University

Arcata, CA 95521

October 31, 2016

Dear Esther Li, Controller

Foundation for Deep Ecology

Building 1062, Fort Cronkhite

1606 Union Street

San Francisco, CA 94123

Dear Esther Li,

I am submitting this grant proposal request for $260,242 to cover the costs to establish a program out of Humboldt State University (HSU) that aims to prevent the spread of bark beetle infestations in Humboldt County’s forests using satellite imagery and imagery acquired from unmanned aerial vehicles (UAVs), or commonly called drones, using advanced imagery analysis techniques to determine accurately individual trees to be removed before spreading of the parasitic bark beetles can occur. I have chosen the Foundation for Deep Ecology for funding due to your passions for protecting nature from the growing threats of human-induced climate change. I believe that my project aligns with your values as an organization because it embodies the idea that we should protect our forests for their intrinsic, historical, and cultural values – not just their commercial value. I ask that reviewers of this proposal have expertise in both remote sensing and forestry ecology. My own geospatial skillset gained from attending HSU is vital to this project as I can provide the training, project management, and broad insight this project requires. If you have any questions or concerns please feel free to contact me at any time.

Thank you for your time and consideration,

Whitney Newcomb

Environmental Science – Geospatial Analysis

Arcata, CA

wkn9@humboldt.edu

**Cover Sheet**

|  |  |  |  |
| --- | --- | --- | --- |
| **Applicant Name (PI) and**  **Contact Information** | Whitney K. Newcomb | | |
| **Address** | Arcata, CA | |
| **Phone** | (760) 819-#### | |
| **Email** | wkn9@humboldt.edu | |
| **Project Title** | Prevention of Bark Beetle Infestation in Humboldt County Using Advanced Remote Sensing Techniques | | |
| **Organization**  (where the PI is working) | **Name** | Humboldt State University | |
| **Address** | 1 Harpst St. Arcata, CA 95521 | |
| **Phone** |  | |
| **Email** |  | |
| **Amount Requested** |  | **Project Start Date** | January 2016 |
| **$260,242** |  | **Project Duration** | 3 years |

**Abstract**

Many western states, including California have seen a rise of bark beetle infestations in forests and as such has seen massive forest loss. As climate change progresses bark beetles are moving north and could potentially impact Humboldt County’s forests. This project will establish a program to keep any progressing bark beetles in check by removing infested trees before they have time to spread. Humboldt State University (HSU) has in place the infrastructure to make this project a reality; they will provide much of the equipment needed to achieve the goals of this project. The PI, Whitney Newcomb, a senior geospatial science student at HSU, will lead the project using the skills learned through her various classes, such as Intermediate Remote Sensing and Advanced GIS, to make sure the project has everything it needs to succeed. The project will work as followed: citizens of Humboldt County will submit areas of potential infestation that will be analyzed using Landsat imagery, once target infestation sites have been found a team of Unmanned Aerial Vehicle (UAV) experts will travel to the sites and fly UAVs equipped with multispectral cameras, the data from the flight will then be analyzed and individual trees will be marked for local logging companies, such as Green Diamond, to remove the trees. Evaluation of each site will occur several months after the trees have been removed; the most recent Landsat imagery will be analyzed to see if infestation is still occurring or has spread – if so, the process will be repeated until no bark beetles are present at the site. The project will include salaries for student interns, UAV Team members, and the PI, UAV equipment and field equipment will be purchased, and funding for travel and lodging will be provided for the UAV team members. HSU and Green Diamond will provide much of the total cost. For this three year project $260,242 is requested.

**Introduction**

Statement of the Problem

Bark Beetle infestations have become one of the largest problems for not only Californian forests, but much of the U.S.’s north-western area and other parts of the globe. From 2002 to 2012 the United States lost 46 million acres of forest due to bark beetles, both native and invasive (Funk et al., 2014). Currently Humboldt County’s forests have had little problem with infestations and this project would create a toolset to keep infestations to a minimum using UAVs with imagery sensors to determine individual problem trees and have them removed before an outbreak can occur. This will allow Humboldt County to remain free from large tree mortality events and severe forest loss.

Specific Aims:

This project first aims to educate and informs the people of Humboldt County of the impacts on forests from bark beetle infestations through an informational website and flyers.

This project will prevent any spread of bark beetles in Humboldt County using public input, advanced image acquisition and analysis techniques, and quick removal of impacted trees.

Literature Review

Bark beetles are a family of insects that are known to bore under the bark of a tree where they feed and reproduce, this is mostly done in trees that are already stressed or dying, (Franceschi et al., 2005). In California there are several native species of these beetles and as climate change progresses it will cause California’s climate to warm and its precipitation levels to decrease each year as well as prior poor forest management and fire suppression the forests are suffering from bark beetle infestations. In California’s most recent, and most severe drought hundreds of thousands of acres of forest are dying – bark beetle mortality events have been correlated to such drought events (Kretchun et al., 2016). In Humboldt County where even in drought years we still get more rain than the rest of California we shouldn’t overlook this issue as experts say that bark beetles are moving north and it is important that we establish a systematic program to prevent any spread in Humboldt County (Fimrite, 2015).

Across the Western states many groups and organizations, including universities, the U.S. Forest Service, and Cal Fire have been trying to combat the infestations in a variety of ways: forest thinning, insecticide use, supplemental irrigation in drought years, and pheromone traps (Bark Beetle F.A.Q., 2013). Although these methods are occasionally successful and are designed to work once an outbreak has already occurred, it has been studied that early detection and tree removal can prevent further damage and spread (Ortiz et al., 2013). This problem is widespread and not likely to disappear any time soon, there are however, few studies that bring together both early detection and prevention of infestations. Humboldt State University, well known for its forestry and geospatial programs, can utilize its resources and start an early detection and prevention program.

Brief Methods

Problem forest areas will be detected using Landsat imagery attained through the USGS and will be processed using ENVI and ArcMap software. Trained UAV pilots will work on the project using UAVs and high spectral resolution cameras. Students will be trained to process the data from the flights to target individual trees to be removed. Working with logging companies the tagged trees can be removed and used for timber.

Intellectual Merits and Broader Implications

Stopping the spread of disease before it becomes too much to handle will save Humboldt Counties forests from the massive tree mortalities seen in southern parts of the country. Keeping our forests healthy is a vital way of curbing carbon dioxide levels in our atmosphere which in turn keeps the planet, and ourselves, healthy. Everyone who works on this project, especially the HSU students that will be employed, will gain a skill set that they will carry with them as they graduate and enter the work force where they will be able to help a wider variety of people and fight bark beetle infestations in other parts of the country and world.

**Methods**

To start the project, a way for the general public to submit locations of bark beetle infestation will be created. The PI will create a website that allows users to submit detailed locations of infestation areas. The website will also be an informational site to explain the importance of fighting and the dangers of bark beetle infestations and why we need to protect Humboldt County – the site will also provide details on how to identify infestations. Along with the website a phone line and an address will be established so that people who cannot access the internet can report potential infestations. The PI will also create a poster and small flyer to mail to various Humboldt County organizations and locations to inform people of the project and give them the information to report problem areas.

Upon the acquisition of a sighting submission a HSU Geospatial student will acquire the data needed to determine the location of problem areas to a finer spatial scale based on the methods provided by (Senf et al., 2015). If the data processing does not show any sign of bark beetle infestation, the site will be noted and processed again in 1 month. If the analysis does show signs of infestation the process to determine individual unhealthy threes will begin.

Using land ownership data the student will contact the land owner to ask for access to the land and permission to fly Unmanned Aerial Vehicles (UAV’s) on the site. If permission is not granted the owner will be provided with other options of protecting their land against bark beetle.

Once permission is granted the student will then use Google Earth/Maps to determine a drivable route to the site for the UAV Team of 2 – 3 people. The UAV Team will then drive to the site, assess the site and determine if UAV flights are applicable to the area, some sites may not allow for safe and legal flights. If they cannot fly, they will contact the land owner and provide alternative methods to combating bark beetle infestations.

If the site allows for safe and legal UAV flight the Team will establish ground control points with high accuracy GPS units, plan the flight using the Mission Planner Software, and proceed to fly the area and collect the multispectral imagery for analysis.

The team will travel back to HSU to process the data. Processing the images will start with filtering out the unusable images. The usable images will then be processed in ArcMap to create a photomosaic using the ground control points. Individual problem trees will be determined through the analysis methods provided by (Näsi, 2015). Detailed coordinates will be provided for each tree and taken back to the site.

A Team member with extensive forestry knowledge will travel back to the site and mark individual trees with non-toxic paint. A local logging company will be contracted and given the detailed information on tree locations and have the infested trees removed as within one month. This process should then be repeated for each submission, approximately every 3 months.

Evaluation

Each site will be evaluated 6 months after tree removal through the most recent Landsat imagery data. If the data shows that there has been no spread of infestation the site will be determined successful. If there appears that in infestation was not removed or has spread, the process will be repeated again in the area until no bark beetles are present in the area.

Timeline



**Budget Summary**

**Proposal Title: Prevention of Bark Beetle Infestation in Humboldt County Using Advanced Remote Sensing Techniques**

**Principal Investigator: Whitney Newcomb**

**Year 1**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | **Funds Requested** |
| **A. Salaries** | **Salary (Rate)** | | **Total Salary (per year)** | | | | x |
| PI | $20.00 | | $9,600 | | | | x |
| Co-PI(s) | $30.00 | | $19,200 | | | | x |
| Other personnel | $15.00 | | $4,800 | | | | x |
| 1. **TOTAL SALARIES** | | | | | | | $33,600 |
| **B. Fringe Benefits** (15% of total salary) | | | | | | | $5,040 |
| **C. Equipment** (*Only for items that are* ***individually*** *over $500*) | | | | | | | $12,749 |
| **D. Travel** | | Domestic | | | $324 | | x |
| Foreign | | |  | | x |
| **D. TOTAL TRAVEL COSTS** | | | | | $324 |
| **E. Participant Support** | | *Total # of Participants* | | | | 2 | x |
| Stipends | | $1,040 | | | x |
| Travel | |  | | | x |
| Subsistence | |  | | | x |
| Other | |  | | | x |
| **E. TOTAL PARTICIPANT COSTS** | | | | | $1,040 |
| **F. Other Direct Costs** | | Supplies | | $800 | | | x |
| Publication | |  | | | x |
| Consultants | |  | | | x |
| Computers | |  | | | x |
| Other | |  | | | x |
| **F. TOTAL OTHER DIRECT COSTS** | | | | | $800 |
| **G. TOTAL DIRECT COSTS (add lines A to F)** | | | | | | | **$53,553** |
| **H. Indirect Costs (use 15% rate for total on line G)** | | | | | | | **$8,032.95** |
| **I. TOTAL (Direct and Indirect Costs: G + H)** | | | | | | | **$61,585.95** |
| **J. AMOUNT REQUESTED** | | | | | | | **$61,585.95** |
| **K. Other Support** (other grants, matching funds or in-kind support) | | | | | | | $35,200 |

**Year 2**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | **Funds Requested** |
| **A. Salaries** | **Salary (Rate)** | | **Total Salary (per year)** | | | | x |
| PI |  | |  | | | | x |
| Co-PI(s) | $30.00 | | $57,600 | | | | x |
| Other personnel | $15.00 | | $14,400 | | | | x |
| 1. **TOTAL SALARIES** | | | | | | | $72,000 |
| **B. Fringe Benefits** (15% of total salary) | | | | | | | $10,800 |
| **C. Equipment** (*Only for items that are* ***individually*** *over $500*) | | | | | | |  |
| **D. Travel** | | Domestic | | | $972 | | x |
| Foreign | | |  | | x |
| **D. TOTAL TRAVEL COSTS** | | | | | $972 |
| **E. Participant Support** | | *Total # of Participants* | | | | 2 | x |
| Stipends | |  | | | x |
| Travel | | $2,600 | | | x |
| Subsistence | |  | | | x |
| Other | |  | | | x |
| **E. TOTAL PARTICIPANT COSTS** | | | | | $2,600 |
| **F. Other Direct Costs** | | Supplies | |  | | | x |
| Publication | |  | | | x |
| Consultants | |  | | | x |
| Computers | |  | | | x |
| Other | |  | | | x |
| **F. TOTAL OTHER DIRECT COSTS** | | | | |  |
| **G. TOTAL DIRECT COSTS (add lines A to F)** | | | | | | | **$86,372** |
| **H. Indirect Costs (use 15% rate for total on line G)** | | | | | | | **$12,955.80** |
| **I. TOTAL (Direct and Indirect Costs: G + H)** | | | | | | | **$99,327.80** |
| **J. AMOUNT REQUESTED** | | | | | | | **$99,327.80** |
| **K. Other Support** (other grants, matching funds or in-kind support) | | | | | | | $24,000 |

**Year 3**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | **Funds Requested** |
| **A. Salaries** | **Salary (Rate)** | | **Total Salary (per year)** | | | | x |
| PI |  | |  | | | | x |
| Co-PI(s) | $30.00 | | $57,600 | | | | x |
| Other personnel | $15.00 | | $14,400 | | | | x |
| 1. **TOTAL SALARIES** | | | | | | | $72,000 |
| **B. Fringe Benefits** (15% of total salary) | | | | | | | $10,800 |
| **C. Equipment** (*Only for items that are* ***individually*** *over $500*) | | | | | | |  |
| **D. Travel** | | Domestic | | | $972 | | x |
| Foreign | | |  | | x |
| **D. TOTAL TRAVEL COSTS** | | | | | $972 |
| **E. Participant Support** | | *Total # of Participants* | | | | 2 | x |
| Stipends | | $2,600 | | | x |
| Travel | |  | | | x |
| Subsistence | |  | | | x |
| Other | |  | | | x |
| **E. TOTAL PARTICIPANT COSTS** | | | | | $2,600 |
| **F. Other Direct Costs** | | Supplies | |  | | | x |
| Publication | |  | | | x |
| Consultants | |  | | | x |
| Computers | |  | | | x |
| Other | |  | | | x |
| **F. TOTAL OTHER DIRECT COSTS** | | | | |  |
| **G. TOTAL DIRECT COSTS (add lines A to F)** | | | | | | | **$86,372** |
| **H. Indirect Costs (use 15% rate for total on line G)** | | | | | | | **$12,955.80** |
| **I. TOTAL (Direct and Indirect Costs: G + H)** | | | | | | | **$99,327.80** |
| **J. AMOUNT REQUESTED** | | | | | | | **$99,327.80** |
| **K. Other Support** (other grants, matching funds or in-kind support) | | | | | | | $24,000 |

**Budget Summary – all years**

|  |  |
| --- | --- |
| **Number of years funding requested** | 3 |
| **total salaries** | $177,600 |
| **total fringe benefits** | $26,640 |
| **total equipment** | $12,749 |
| **total travel** | $2,268 |
| **total other direct costs** | $7,040 |
| **total indirect costs** | $33,944.55 |
|  | |
| **Total amount requested** | **$260,242** |

**Budget Justification**

Direct costs for this project include salaries, equipment, gas for traveling, food and lodging stipends, and several supplies.

This project will have salaries for the UAV Team members, the student interns and for the PI. Two UAV Team Members will be hired at $30.00 an hour, work part time, for 2 years and 4 months, totaling $134,400 for the entire project, [Total: 2 x $30.00 x 80 hours a month x 28 months = $134,400; Year 1: 2 x $30.00 x 80 hours a month x 4 = $19,200; Year 2: 2 x $30.00 x 80 hours a month x 12 = $57,600; Year 3: 2 x $30.00 x 80 hours a month x 12 = $57,600]. Two Student Interns will be hired at $15.00 an hour, work part time (10 hours a week), for 2 years and 4 months, totaling $33,600 for the entire project, [Total: 2 x $30.00 x 80 hours a month x 28 months = $134,400; Year 1: 2 x $30.00 x 80 hours a month x 4 = $19,200; Year 2: 2 x $30.00 x 80 hours a month x 12 = $57,600; Year 3: 2 x $30.00 x 80 hours a month x 12 = $57,600]. The PI will be hired at $20.00 an hour, work part time (15 hours a week), for the first 8 months of project, totaling $9,600 for the entire project; [$20.00 x 15 hours x 32 weeks = $9,600]. The total request for salaries is $177,600 [$134,400 + $33,600 + $9,600 = $177,600].

Several big-ticket equipment items will need to be purchased for this project. DJI Smarter Farming Kit with Precision Hawk is a complete premade agriculture UAV and sensor package costing $8,500. An Asus brand field laptop will be purchased for $750. A Professional license for Agisoft PhotoScan software costs $3,499. Total costs for equipment is $12,749 [$8,500 + $750 + $3,499 = $12,749].

For the UAV Team’s traveling, gas will be included in direct costs. Currently gas has been estimated to cost $0.54 per mile, with the project allowing for 150 miles driven each month for 2 years and 4 months, the total price for gas will be $2,268, [Total: $0.54 x 150 miles x 28 months = $2,268; Year 1: $0.54 x 150 miles x 4 months = $324; Year 2: $0.54 x 150 miles x 12 months = $972; Year 3: $0.20 x 150 miles x 12 months = $972].

Each UAV Team Member will receive an extra stipend for lodging and food, costing $1,300 a year, totaling $13,000 for the entire project, [Total: 2 x $1,300 x 2.6 years = $ 6,760; Year 1: 2 x $1,300 x 0.4 years = $1,040; Year 2: 2 x $1,300 x 1 year = $2,600; Year 3: 2 x $1,300 x 1 year = $2,600]

Supplies will include extra UAV and field equipment and basic poster craft supplies. Four extra Batteries for the DJI cost $50 each, [4 batteries x $50 = $200]. A DJI Field Case for UAV and equipment costs $450. Materials to create ground control points costs $50. Materials for flyers and postage costs $100. Total cost for supplies is $800 [$200 + $450 + $50 + $100 = $800].

Most of the equipment needed for this project will be provided by HSU. The university will provide the following equipment: ArcMap software, ENVI software, field vehicle, and a computer. ArcMap Advanced software license costs $5,400. ENVI + IDL with atmospheric correction module costs $4,500. A 4WD 4-5 person sport utility vehicle for field work, i.e. 2016 Jeep Wrangler or equivalent costs $23,000. Dell OptiPlex 2030 computer and accessories costs $1100. In kind costs from HSU will total to $$34,000 [$5400 + $4500 + $23,000 + $1,100 = $34,000].

Green Diamond will act as a consultant for free as they will be given the timber product from each infested tree harvest. They will provide tree removal services - Individual tree removal valued at $2,000, estimated 4 trees removed every 4 months for 2 years, totaling $$48,000 in in kind costs, [Total: $2,000 x 4 trees x 6 harvests = $48,000; Year 2: $2,000 x 4 trees x 3 harvests = $24,000; Year 3: $2,000 x 4 trees x 3 harvests = $24,000].

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Senf, C. , Pflugmacher, D. , Wulder, M. , & Hostert, P. (2015). Characterizing spectral–temporal patterns of defoliator and bark beetle disturbances using landsat time series. Remote Sensing of Environment, 170, 166-177.

**Whitney K. Newcomb**

Arcata, CA 95521 | (760) 819 - #### | wkn9@humboldt.edu

|  |  |
| --- | --- |
| Education | Humboldt State University (HSU), Arcata, CA   * Bachelor of Science in Environmental Science, focus in Geospatial Analysis, to be completed in May 2017. * Major GPA: 3.87 | Total GPA: 3.83   King’s Flight School   * Private Pilot’s Written Exam Course, in Progress |
| Pertinent Course Work | Geospatial Science Courses:   * Intermediate Remote Sensing (IP) * Introduction To Remote Sensing * Advanced GIS (IP) * Intermediate GIS * Introduction To GIS * Geospatial Programming I * Mobile Mapping * Cartography * Cartography Practicum (IP)   Environmental Science Related Courses:   * Grant Proposal Writing (IP) * Intro To Environmental Policy * Natural Resource Conservation * Earth Resources And Global Environmental Change * International Issues & Globalization * Environ Conflict Resolution * Environmental Problem Solving   Others:   * General Botany * Introductory Biostatistics * Wildland Resource Principles * Introduction To Soil Science * Physical Geography |
| Scholarships and Awards | Presidential Scholar   * Fall 2013 * Spring 2015 * Fall 2015 * Spring 2016   High School Scholarships   * Academic Honors Award, 2013 * Leadership Award, 2013   CSU Future Scholarship 2014 |
| Research Experience | Land Cover Change in Palm Springs California Over the Last 20 Years Using Remote Sensing Software   * Unpublished Paper, 2015 * Introduction to Remote Sensing Course Final Project   Preparation of High Spatial and Temporal Resolution Data from UAS Sources for GIS Applications   * Unpublished Paper, 2015 * Poster Presentation * Intermediate GIS Course Project   Habitat Study of Humboldt County for Marbled Murrelets Using GIS Software   * Unpublished Paper, 2014 * Introduction to GIS Course Final Project |
| Extracurricular | Conservation Unlimited   * Membership held Fall 2015-present   Geospatial Club   * Membership held Spring 2015-present * Secretary   National Honors Society   * Treasurer * Membership held from 2011-2013   International Thespian Society   * Treasurer, Clerk * Membership held from 2010-2013   Envirothon (Environmnetal Debate/Competition)   * Co-Captain * Membership held from 2009-2011 |
| Volunteer Work | Friends of the Dunes - 2015  G.A.T.E. Children's Summer Program - 2010  Sky's The Limit - 2010-2013  Theater 29 - 2012-2013 |
| Work Experience | Instructional Student Assistant At HSU’s Geospatial Homework Lab   * August 2016 – Present   Undergraduate Database Manager At HSU’s Sponsored Programs   * May 2016 – Present   Instructional Student Assistant At HSU’s Mathematics Department   * January 2015 - Present   Intern Biologist At Ultrasystems Environmental Inc.   * Summer 2014 (300 hours worked) and Summer 2015 (200 hours worked) |
| References | Shelah Spiegal   * Office Manager, Ultrasystems Environmental Inc. * Sspiegal@Ultrasystems.Com   Betsy Lindsay   * Ceo, Ultrasystems Environmental Inc. * Blindsay@Ultrasystems.Com   Tim Payer   * Mathematics Professor, Humboldt State University * Tim.Payer@Humboldt.Edu   Dr. James Graham   * Geospatial Science Professor, Humboldt State University * James.Graham@Humboldt.Edu |