**NASA DEVELOP National Program**

Langley Research Center

**Fall 2014**

**Northwest United States Agriculture**

*Evaluating Habitat Suitability of Cydia pomonella in Washington State from 2002 to 2065*

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**Applied Sciences National Applications Addressed:**

Agriculture & Climate

**Study Area:** Washington State

**Study Period:** July 2002 - 2065

**Partners/Collaborators**

USDA Agricultural Research Service: Dr. Michael Glenn

**80-100 Word Blurb**

Agriculture is a large part of Washington State’s economy, with apples being the dominant crop. In order to maximize production, all variables that reduce or can potentially reduce the quantity or quality of apples should be identified. A major pest to apples and other pome fruit is the poikilothermic codling moth, *Cydia pomonella*, which can devastate apple production. The maps created for this project identified current and future regions around the Washington State area where MODIS land surface temperatures indicate favorable conditions for *C. pomonella*.

**Community Concerns**

* In 2012 Washington State’s agriculture contributed 13% to the state economy. Fresh market apple sales alone produced almost 2.5 billion dollars and constituted seventy percent of all 2012 US apple production.
* Pests (specifically *C. pomonella*) that destroy the fruit are becoming increasingly difficult to control due to strict regulations on chemical use and pests developing resistances to modern pesticides.
* As the costs of labor and pesticides increase in tandem with the trend towards species specific pesticides, the costs of owning an orchard are substantially increasing. Rising temperatures and less predictable weather may require orchards to use more applications of pesticides to help ensure the profitability of the apple crop.
* Several factors can control insect growth and developmental rates but temperature is the most influential factor. Studies suggests that a warmer climate could potentially affect the phenology of apple tree pests, and may lead to changes in suitable habitat, i.e. their distribution and abundance, and increase their adaptability to changes in temperature.
* An understanding of optimal conditions for codling moth growth and its development is crucial because if apple growing regions become more suitable for *C. pomonella,* apple production as well as local and US economic contributions may be reduced due to increases in pest control costs and damaged crops.

**Current Management Practices & Policies**

Many growers rely on previous *C. pomonella* phenology models to time and maximize the efficacy of their pest control measures. For example, degree days will determine when larvae, pupae and adult *C. pomonella* emerge (specific values vary by the phenology model used). Growers will adjust their control measures based on the life stage of *C. pomonella*, as certain stages are more susceptible to specific treatments than others.

The treatments that are commonly used include chemical and kaolin sprays, pheromone emitters, sterile moth release, biocontrols, as well as organic practices that promote the existence of natural codling moth enemies (birds, ants, spiders, and in some cases bats). Many of these practices are costly, heavily regulated, and can have deleterious effects on other organisms.

An alternative to intensive pest management are integrated pest management (IPM) practices. Integrated Pest Management, the implementation of diverse methods of pest controls, paired with monitoring to reduce unnecessary pesticide applications, is a more holistic approach than traditional pest control methods (USDA National Institute of Food and Agriculture, 2012). IPM incorporates multiple techniques to reduce preventable losses, but requires growers to better understand the ecology surrounding the production of apples. Identifying the suitability for codling moths within the apple growing regions of Washington State can aid growers with their IPM practices. Additionally, projected pest risk maps based on climate models can provide growers with insight needed to plan future orchards in areas with minimal risk.

**Abstract**

Washington State is the number one apple producer in the United States, providing 70% of the nation’s apples. The current climate in Washington is favorable for apple production; however, as temperatures rise it also becomes more suitable for many apple pests.The codling moth (*Cydia pomonella*)’s suitable habitat is likely to expand its range in Washington with rising temperatures, placing more orchards at risk of infestation. The United States Department of Agriculture (USDA) Agricultural Research Service (ARS) has shown interest in codling moth distribution because the moth has a well-defined temperature range for development, between 10° C to 31° C. Using Aqua MODIS Land Surface Temperature (LST) from 2003 to 2013, growing degree days (GDD) for insect development were calculated for the codling moth to show current at-risk areas. Further, inclusion of an ensemble model from the North American Regional Climate Change Assessment Program (NARCCAP) forecasted climate changes for 2045 and 2065 were used to determine future pest ranges. Final products show that rising temperatures will allow codling moth ranges to move closer to the Cascades and further north. Additionally, a rise in temperature will allow more growth time for the moth each summer, ultimately leading to larger pest populations. The current and long-range forecast risk maps benefit orchard managers by improving pest management and better handling of current orchards.

**Decision Support Tools**

* Pest Risk Map - maps showing current suitability areas for *Cydia pomonella*
* Forecasted Pest Suitability Map - maps with forecasted suitable areas for *Cydia pomonella* based on NARCCAP climate-change estimates

**Benefit to End-User:**

* Maps of current risk aid end-users in adapting to the spread of pests in their area before they reach orchards
* Future risk maps help orchard managers in preparation for and mitigation of possible pest infiltration in the future

**Earth Observations & Parameters**

Aqua MODIS - Land Surface Temperature (LST) data (MYD11A1)

**Future Applicable NASA Missions**

CLARREO - RS and IR suites

HyspIRI - HyTES

**Ancillary Datasets Utilized**

A composite of the North American Regional Climate Change Assessment Program (NARCCAP) models

NOAA weather station data – precipitation, daily low temperature, and daily high temperature

**Software Utilized**

ArcGIS - Map design and presentation

Python - MODIS data processing and raster generation

R - Statistical analysis of weather station and MODIS data

**References:**

USDA National Institute of Food and Agriculture. (2012). Integrated Pest Management. Retrieved October 06, 2014, from http://www.csrees.usda.gov/ProgViewOverview.cfm?prnum=18946