

**Final Research Progress Report: 9 August 2011**

**Funds approved in current fiscal year:** \$ 26,058

**Project contract number:** CAC # 65103

**Project title:** Surveying Avocados in the Baja Peninsula for Pests that May Enter California

**General Research Topic:** Pest Management

**Duration of Project:** Year 1 of 1

**Project start date:** November 1, 2010

**Project end date:** October 31, 2011

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**Summary of Results:** Over the period 23-25 January 2011 residential areas in Tijuana Mexico were surveyed for the presence of avocado trees, and when possible trees were inspected for arthropods associated with trees. Google Earth was used to pre-select six separate residential areas that showed high levels of greenery (i.e., parks, and well maintained residential gardens). In these six areas, 267 residential street blocks were surveyed. From these blocks, a total of 634 properties were inspected from the road. The percentage of street blocks with avocados in pre-selected sections of Tijuana ranged from 23% to 45% of blocks having at least one tree. A total of 80 avocado trees were found from these surveys. Of surveyed properties, 10% or 64 properties had at least one avocado tree. The number of avocados per property ranged from 1 to 5 trees. The GPS coordinates were recorded for each tree and when possible foliage was inspected for avocado pests. The only pest found on foliage in January was perseia mites and < 10% of sampled plants had very low densities of this mite.

Over the period 27 June 2011 to 2 July 2011 residential areas in Rosarito, Ensenada, and Tecate in Baja California Mexico were surveyed for the presence of avocado trees, and when possible trees were inspected for arthropods associated with trees. Google Earth was used to pre-select residential areas that showed high levels of greenery (i.e., well maintained residential gardens). In these areas, residential street blocks were surveyed for avocados growing in gardens. In Rosarito, Ensenada, and Tecate, a total of 1,880, 955, and 628 properties were inspected from the road, respectively. The percentage of street blocks with avocados in pre-selected sections of Rosarito, Ensenada, and Tecate were 11%, 32%, and 13% of blocks, respectively, having at least one tree. A total of 27, 72, and 11 avocado trees were found from these surveys for Rosarito, Ensenada, and Tecate, respectively. The number of avocados per property ranged from 1 to 6 trees. The GPS coordinates were recorded for each tree and when possible foliage was inspected for avocado pests. The following pest species were found infesting avocado leaves in the Baja: (1) perseia mite, (2) avocado thrips, (3) red banded whitefly, (4) greenhouse thrips, (5) an unidentified leaf miner, and (6) an

unidentified mealybug. No evidence of leaf galling psyllids (i.e., *Trioza* species [<http://biocontrol.ucr.edu/hoddle/trioza/trioza.html>]) was found.

On 27 June 2011 the largest fruit market in Tijuana, Mercado M. Hildago, was inspected for avocado fruit. Numerous vendors sold fruit of varying quality that originated from Michoacan, Puebla, and Oaxaca. This market has high potential to put fruit feeding pests in close proximity to Southern California.

### **Survey Findings for Tijuana:**

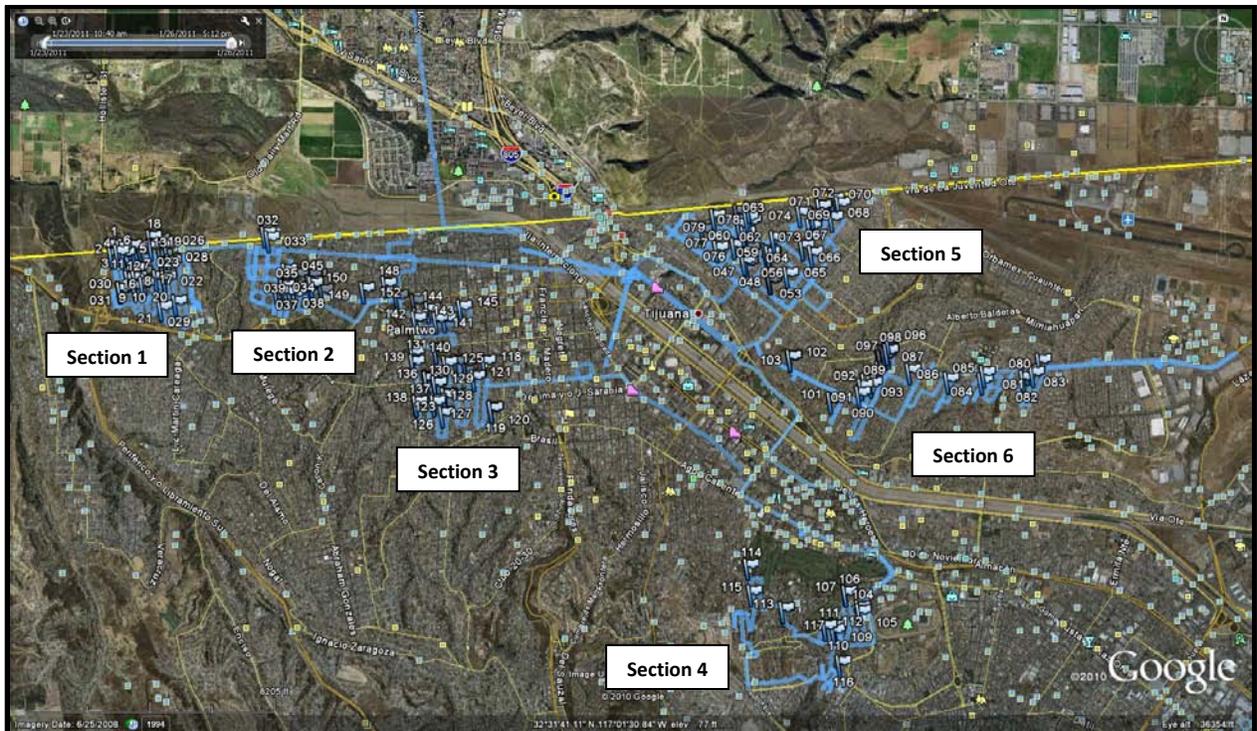
Tijuana Mexico was surveyed for avocado trees growing in residential areas. This is of interest to California avocado producers because it is unknown how common avocados are in Tijuana and it is possible that avocado pests could move through Mexico to infest avocados in Tijuana at the California-Mexico border before moving into southern California. Should new pests establish on avocados in Tijuana it puts them in very close proximity to urban and commercial plantings in San Diego County. This invasion pathway was recently utilized by Asian citrus psyllid, a serious pest of citrus, it invaded San Diego and Imperial Counties from northern Mexico. Could avocado pests invade southern California in a similar way?

Over the period January 23-25 2011 residential areas in Tijuana were surveyed for avocado trees. Google Earth was used to pre-select six separate residential areas that showed high levels of greenery. These areas had parks, well maintained residential gardens, and in some instances, Google Street View clearly showed avocados growing in gardens. In these six areas that were pre-selected for inspection 267 residential street blocks were surveyed. From these blocks, a total of 634 properties were inspected from the road. The percentage of street blocks with avocados that were surveyed per pre-selected section of Tijuana ranged from 23% of blocks with avocados to 45% of blocks having at least one avocado tree. All (i.e., 6/6 or 100%) pre-selected sections of Tijuana chosen *a priori* for inspection had residential blocks (i.e., 23-45% of surveyed blocks) with avocado trees. A total of 80 avocado trees were found from these surveys. Just 10% (i.e., 64 residences) of surveyed properties had at least one avocado tree, and of those properties with trees the number of avocados per property ranged from 1 to 5 trees. Despite being told regularly that Tijuana has no avocados, they were relatively easy to find with the survey method we adopted and many were located right on the USA-Mexico border.



*The photographs above show avocados in residential areas in Tijuana Mexico that were recorded as part of this survey.*

GPS coordinates were recorded for each tree and the track function in the hand-held GPS unit was used to record the driving path taken through Tijuana. These data, the GPS points for avocado trees and the driving tracks were plotted in Google Earth.



*The Google Earth Map above shows the position of avocado trees in the six residential sections surveyed in Tijuana Mexico. This map shows the “tracks” (the light blue line) of the driving route that was taken while surveying for avocados and the “flags” show the locations of avocado trees in Tijuana. It is interesting to note that trees were found very close to the USA-Mexico Border (the bright yellow line).*



*This photograph above was taken from a residential area in Tijuana that has backyard avocados. The USA-Mexico Border Fence is clearly visible as is San Diego in the background. Avocado pests could possibly traverse this distance with the assistance of maritime breezes.*

When possible, foliage was inspected in Tijuana for avocado pests. The only pest found on foliage in January 2011 was the perseia mite and < 10% of sampled plants had very low densities of this mite. This finding raises a very interesting and important question: “Did perseia mite balloon on the air into San Diego County from infested plants in Tijuana in 1990 or did it enter California on avocado plants brought into the state from some other region of Mexico?” This survey is attempting to address this issue to ascertain the potential invasion threat that an incursion pathway for avocado pests from Baja Mexico to Southern California poses.

### **Survey Findings for Rosarito, Ensenada, and Tecate:**

Rosarito, Ensenada, and Tecate in Baja California Mexico were surveyed for avocado trees growing in residential areas over the period 27 June 2011 to 2 July 2011. It is unknown how common avocados are in Baja California and it is possible that avocado pests could move from Oaxaca, Puebla, Michoacan, or Nyarit, for example, to infest avocados in the Baja at the California-Mexico border before moving into southern California (i.e., San Diego County). Should pests (e.g., leaf galling psyllids, or fruit feeding moths and weevils) that are native to other areas of Mexico establish on avocados in Baja California, for example, it puts them in very close proximity to urban and commercial plantings in San Diego County.

Over the period June 27 to July 2 2011 residential areas in Rosarito, Ensenada, and Tecate in Baja California Mexico were surveyed for avocado trees. Google Earth was used to pre-select residential areas in each city that showed high levels of

greenery. These areas had parks, well maintained residential gardens, and in some instances, Google Street View clearly showed avocados growing in urban gardens. GPS coordinates were recorded for each tree and the track function in the hand-held GPS unit was used to record the driving path taken through Rosarito, Ensenada, and Tecate. These data, the GPS points for avocado trees and the driving tracks, were plotted in Google Earth and are presented here.

### Survey Results:

Rosarito: In Rosarito five sections of this city were surveyed for avocados. In section 1, 2, 3, 4, and 5; 35 (376 properties with gardens were surveyed), 37 (388 properties surveyed), 28 (219 properties surveyed), 38 (382 properties surveyed), and 46 (515 properties surveyed) residential blocks were surveyed, respectively. The total number of blocks and houses surveyed were 189 and 1,880, respectively. The total number of avocados found in Rosarito was 27, and 11% of blocks and 1% of properties surveyed had avocados. No avocados were found in Section 4. This was likely due to the close proximity to the coast, and salt and sandy soils may not have favored avocados in this area.



*The Google Earth Image above shows the GPS tracks for five different sections of Rosarito that were surveyed for avocados. The numbered flags indicate the positions of avocado trees growing in gardens.*

Conclusion: Rosarito is a very popular destination town for tourists from California. Although not abundantly common, avocado trees in residential areas were still fairly easy to find. Rosarito would be considered as low to moderate risk for avocado pests, mainly because of its close proximity to California and its high popularity as an easy beach town for vacationing.



*The photograph on the left above shows an avocado tree growing in the front yard of a house in Baja Mexico. When possible, avocado foliage was inspected for avocado pests (photo on right above), and samples were collected and preserved in 95% ethanol for future study.*

**Ensenada:** In Ensenada four sections of this city were surveyed for avocados. In section 1, 2, 3, and 4; 50 (247 properties with gardens were surveyed), 18 (218 properties surveyed), 38 (214 properties surveyed), and 34 (276 properties surveyed) residential blocks were surveyed, respectively. The total number of blocks and houses surveyed were 140 and 955, respectively. The total number of avocados found in Ensenada was 72, and 32% of blocks and 6% of properties surveyed had avocados.



*The Google Earth Image above shows the GPS tracks for four different sections of Ensenada that were surveyed for avocados. The numbered flags indicate the positions of avocado trees growing in gardens.*

Trees in Ensenada had: (1) perseá mite, (2) avocado thrips, (3) red banded whitefly, (4) greenhouse thrips, (5) unidentified leaf miner (all mines were empty), and (6) unidentified mealybug on sampled leaves. Samples were taken and preserved in 95% ethanol for potential future use.



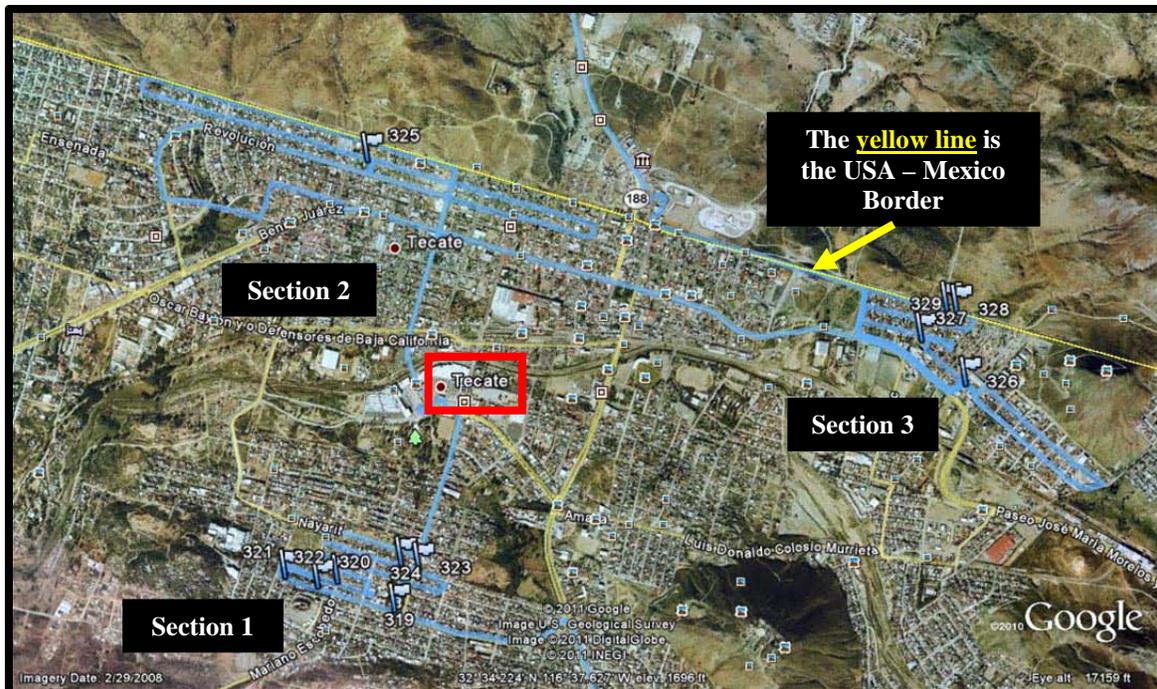
*The photo above shows damage to an avocado leaf caused by an unknown species of leaf miner. Damage was extensive and common on some sampled avocados in Ensenada. At the time of sampling all leaf mines were empty.  
Is this a new pest threat to California?*

Conclusion: Ensenada's close proximity to southern California and its popularity with tourists from this area may possibly make Ensenada a relatively high risk zone for the movement of pest avocado species by people illegally moving plants back to California. Road side plant stands were observed and would be a convenient way for tourists to buy plants to transport in cars or RV's to California.



*The photo above shows a roadside vendor in Baja California selling potted plants and fruit. Is the illegal movement of potted plants and fruit out of the Baja into San Diego by tourists a potential incursion threat for California?*

Tecate: In Tecate, three sections of this town were surveyed for avocados. In section 1, 2, and 3; 23 (233 properties with gardens were surveyed), 24 (251 properties surveyed), and 20 (144 properties) residential blocks were inspected, respectively. The total number of blocks and houses surveyed were 67 and 628, respectively. The total number of avocados found in Tecate was 11. Just 13% of residential blocks had avocados, and only 2% of surveyed properties had trees.



*The Google Earth Image above shows the GPS tracks for three different sections of Tecate that were surveyed for avocados. The numbered flags indicate the positions of avocado trees growing in gardens. The yellow line at the northern edge of Tecate marks the position of the USA-Mexico Border.*

Foliage inspections revealed an absence of avocado feeding insects or mites. No trees had fruit at the time this survey was executed.

Conclusion: Tecate's location on the USA-Mexico border is a relatively minor threat from invasive avocado pests. The reasons for this low threat conclusion are: (1) relatively few residential trees in comparison to Tijuana, Rosarito, and Ensenada. (2) The high summer temperatures and low humidity are very similar to Riverside California, where no pest arthropods have established, presumably because of the sterilizing effects of high summer temperatures and correspondingly low humidity. (3) The road that leads north from Tecate into the USA has very low levels of discontinuous human habitation. The immediate surroundings are hilly undeveloped wilderness areas. Consequently, there appear to be few opportunities for avocado pests to hopscotch on residential trees from Tecate north/northwest via HWY 188 and HWY 94.

## **Survey Results for Fruit Markets in Tijuana**

On 27 June 2011 fruit stalls at Mercado M. Hildago, the largest aggregation of fresh produce vendors in Tijuana were surveyed for avocado fruit. These inspections had three objectives: (1) To determine how common avocado vendors were, (2) to ascertain

where in Mexico fruit for sale in Tijuana originated, and (3) to assess the quality of fruit. The results of this 90 minute survey were very interesting. Avocado fruit sales are extremely common at this market, there are at least 10 vendors selling fruit. Fruit that was being sold on 27 June 2011 originated from Michoacan, Puebla, and Oaxaca. Fruit quality was extremely variable, from high quality non-damaged fruit to low quality fruit with excessive pest damage. Given the extremely close proximity of this market to California, the high volumes of fruit of questionable quality that pass through this market, and the diversity of sources, this market poses a high risk to California for the introduction fruit feeding avocado pests.



**Photo (A)** above shows the entrance to Mercado M. Hidalgo in Tijuana, the largest fresh fruit market in this city. **(B)** Approximately 10 vendors sell avocados at this market. **(C)** Highly damaged fruit (*avocado thrips scarring?*) for sale that originated from Michoacan. Non-Hass or criollo fruit that originated from Puebla **(D)** and Oaxaca **(E)**. Fruit sales in Tijuana may represent a potential source of new pest species for California avocado growers.

**Completed Project Work Plan:**

Milestone	Completion date (month/year)	Progress
1. Survey Tijuana for Avocados	01/2011	Completed
2. Survey other Areas of the Baja for Avocados	06/2011	Completed
3. Prepare Final Report	09/2011	Completed

**Variation from milestones:** No variation from milestones occurred.

**Outcomes, Deliverables or Products:** A confidential final report for the California Avocado Commission has been completed (this document).

**Project Outreach:** No outreach activity related to this project has been executed due to the sensitive nature of these surveys.