

Trip Report for December, 2000, Visit to Brazil to Continue Cooperative Integrated Pest Management Work on the Woodwasp, *Sirex noctilio*, a Serious Pest of Pines in Brazil

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The purpose of this December 2 – 9, 2000 trip by Mason and Ellenwood was to:

- A) Overview the sirex problem and learn the status of biological control and remote sensing work** that was conducted under the 1997-2000 Participating Agreement between the USDA Forest Service and the Brazilian Agricultural Corporation (EMBRAPA);
- B) Review the new draft 2001-2003 agreement** and develop a draft calendar year 2001 operating plan that specifies actions to be done in support of the four objectives in the new agreement; and
- C) Review and make recommendations on remote sensing work** done by EMBRAPA since the visit in March, 2000, to support development of a host-type map for areas susceptible to sirex in the state of Parana (host-type map is objective #1 in the draft 2001-2003 agreement).

Following are our observations/findings/recommendations for followup from the trip as they pertain to the three purposes of the trip.

A. Overview of Sirex and Status of Biological Control and Remote Sensing Work

On December 4, we were given a tour of the EMBRAPA forestry research facility in Curitiba and some nearby pine, *Eucalyptus*, and *Auracaria* plantations. We listened to a presentation by EMBRAPA remote sensing specialists on the host-type mapping project titled "Mapping Temperate Pine Species in Southern Brazil Using Landsat 7". We also met and learned about current EMBRAPA staff responsibilities for the Sirex project and this trip:

Vitor Hoeflich, Chief of EMBRAPA Forestry (will approve new agreement)
Erich Schaitza, EMBRAPA Communications Director (our main host for the trip, key contact for the new agreement, translator)
Susete Penteado, sirex team leader, entomologist
Carlos Mazza, remote sensing specialist
Yeda Oliveira, remote sensing specialist and translator
Edson Iede, entomologist
Wilson Reis Filho, entomologist
Iran Silva, laboratory technician
Carla Castellano, laboratory technician

On December 5, we took a field trip west of Curitiba to field check pine stands in a test area in the Irati National Forest that were tentatively classified from one of the Landsat 7 images. We observed 20-25 year old loblolly and slash pine stands where trap trees had been established in October, 2000. Groups of about five trees were stressed by injection with a herbicide. On several trees we observed flowing resin which may indicate the trees had been recently attacked by female sirex. The presence of sirex could not be confirmed until the eggs develop into larvae, about March 2001. We reviewed and discussed the current image processing challenges of identifying pine stands and in particular the similarities in the first test area between loblolly pine and *Auracaria* plantations.

Late on December 5, we traveled south to a forest property owned by the Remasa Forestry Company, about 30 kilometers west of the town of General Carneiro, which is close to the border of the states of Parana and Santa Catarina. We met Gilson Geronassa, Director of Remasa, and several other forest landowners. Pentead and Mazza gave a presentation to a group of local forest landowners about the status of biological control activities and the host-type mapping project. The landowners showed strong support for developing a host-type map for the State of Parana and would like to see it completed as soon as possible. We stayed overnight at the Remasa company bunkhouse.

On December 6, Gilson Geronasso gave us a tour of his forest management operations including a pine container nursery and numerous managed stands on his approximately 20,000 acre property. We observed sirex damage on several trap trees that were established in the past 2-3 years. We found numerous sirex larvae and observed one male woodwasp emerge and fly away. We removed several sirex infested wood sections that will be tested in the laboratory for the presence of the predator *Deladenus* nematodes. Geronasso has been an active participant in the trap tree program with EMBRAPA and he is actively managing his property with silvicultural practices that should reduce the risk of sirex mortality. Geronassa provided a stand map of his property and several air photos for EMBRAPA to use in classifying the Landsat image

On the Remasa property we also observed girdling damage in the top of pine trees by a native monkey. Advice was requested on how to control the increasing amount of damage that Geronasso is observing in the forest. Mason agreed to provide to EMBRAPA the name of an animal damage specialist at the APHIS Wildlife Research Center in Fort Collins.

Later in the day on December 6, we met Sal Vin, head of a local forest landowners association. He took us on a tour of a property owned by Miguel Forte, who is major forest landowner in the area. The property is located south of the town of General Carneiro and highway BR 153, very close to the State of Santa Catarina. We observed active harvest operations for firewood, pulp, peeler/sawtimber and considerable evidence of sirex and emerging adult

woodwasps in decked logs. Much of this property appeared to have been at very high stocking levels which provided ideal conditions for sirex. One of the parasitic wasps, *Ibalia leucospoides*, was also observed.

Early on December 7, we toured the nematode and parasitoid rearing operation at the EMBRAPA laboratory in Curitiba.

B. Review of the new draft 2001-2003 agreement and 2001 draft operating plan

On December 7 and 8, Mason reviewed the draft agreement with Schaitza and Penteado. The host-type mapping was agreed to be a very high priority with EMPBRAPA's desire that Jim Ellenwood continue to provide assistance with the satellite image processing and classification. EMPRAPA would also like Dennis Haugen's assistance/oversight of biological control activities to continue. Dennis is scheduled to return in April, 2001, during the time that trap trees are inoculated with the nematode.

We discussed the need to acquire from Australia new strains of two parasitoids, *M. nortoni* and *R. persuasoria*, and to reintroduce them to Brazil. This is high priority work that could begin in 2001 if there could be financial assistance from the United States to purchase the parasitoids and begin the quarantine process. The parasitoids would be mass reared starting in 2002.

We discussed the need to establish a bi-lingual website (English, Portuguese) that initially would have a general description of the biological control work and abstracts of the estimated 70 publications and papers related to sirex. EMBRAPA requests financial assistance to develop the abstracts and make the initial translation into English. Schaitza suggested that Dennis Haugen could edit the draft abstracts to ensure accurate scientific translation.

We discussed the need and feasibility of establishing an aerial survey program. Mason suggested that a new aerial survey specialist could visit the project with Dennis Haugen in April, 2001, and work with EMBRAPA to do a feasibility/needs assessment for aerial survey. This was agreed as a logical first step. EMBRAPA has a concern about the cost of aircraft, commitment of staff to aerial survey, etc., although they recognize that survey and mapping of sirex mortality in a GIS is important in order to accomplish long-term control. Since EMBRAPA is a research institution, an ongoing aerial survey program is really not in their mission, i.e., aerial survey is a management function. It was agreed that the host-type map, when completed, could be used as a base map for the aerial surveys that might be conducted by members of the forest landowners association. The highest priority area for aerial survey initially might be high risk stands in the "leading edge" of the infestation in Parana.

We also discussed EMBRAPA's future needs for financial assistance. In the 1997-2000 agreement the Forest Service committed to \$25,000, which was used

for nematode rearing and related biological control work, workshops for forest landowners, equipment, and to purchase 13 Landsat 7 images of the State of Parana. In 2001-2003, EMPBRAPA would like whatever financial assistance that could be provided. There are many needs that could be addressed with funds transferred to Brazil or, in some cases, it might be more efficient if the Forest Service could purchase items and transfer them to EMBRAPA (e.g., computers, Landsat images). The estimated needs are shown in the financial plan in the new draft agreement. Mason agreed to look into funding sources in the Forest Service and other agencies, if necessary, to meet these needs. The agreement will be revised as per the changes discussed on this trip and exchanged for approvals between the Forest Service and Brazil early in calendar year 2001.

We also developed and reviewed an operating plan for calendar year 2001. Penteado developed the actions for objectives 3 and 4 which relate to the biological control work and technology transfer program. Mazza, Oliveira, and Ellenwood identified work needed to accomplish Objective 1 (host-type map). It was agreed earlier that an aerial survey needs/assessment would be done to address Objective 2.

C. Review and make recommendations on remote sensing work

Ellenwood met with Mazza and Oliveira on December 7 and 8 to review the image processing work that had been completed with one of the Landsat 7 images following procedures and using SPRING software developed by the Brazilian Space Agency (INPE) for classifying pine plantations.

Procedures that were outlined at the previous meeting last March were implemented. A number of problems were observed from that implementation. Performance issues were a key problem that was resolved through the purchase of a new Dell computer with processing speed, sufficient memory (512 MB), and storage. Concerns still remain as to whether the PC platform is robust enough for the classification of full scene satellite imagery with the SPRING software. A discussion was made concerning the use of Linux that is more efficient at managing memory and may allow for better processing of imagery. Though there are on-site knowledgeable people on Unix (Linux) operating systems, the principle remote sensing specialists are not too familiar with the operating system. Ellenwood expressed an opinion, that in the interest of time efficiency and the stated support for the SPRING software from INPE, the best course of action would be to continue with the planned use of SPRING on the Wintel platform.

All 13 images were geo-coded but not terrain corrected. There were questions as to whether this is absolutely necessary. Ellenwood stated that while there may be some loss of classification precision, there should not be any reason not to move forward. Ellenwood will investigate the latest terrain correction technology and attempt to acquire 90-meter DTED data or, if available, 30 meter

data from the SRTM (Shuttle Radar Topography Mission). Also noted was that SPRING did not have terrain correction algorithms. An analysis of the PCI software indicated it does, however, it could not be confirmed that the module that performs the terrain correction is one of the licensed modules. In a future release, SPRING will have the capabilities to perform terrain correction.

Additional concerns were expressed about atmospheric conditions. Image 221, 78 contains a substantial amount of haze. Ellenwood discussed some of the techniques to adjust for this; however, routines are not built into the SPRING program, but can be manually entered through a program interface. Ellenwood will investigate the latest techniques for applying atmospheric correction to Landsat-7 imagery.

The segmentation routines take 3 days to complete for full scenes. Successful runs were completed in a smaller subset image. The results were mixed in which the polygon separation was not fully completed. Ellenwood suggested additional transforms, ratio bands, and texture bands. These will be investigated in the follow up test. Additionally, Ellenwood suggested classification without segmentation to see if there was a significant difference in the resultant classification. This was an effort to move the process forward.

A supervised maximum likelihood classification procedure is the next step and had not been attempted due to the previously stated problems. It was suggested to possibly break up the classification procedure into 2 steps. The first step would be to conduct an unsupervised classification and aggregate the pixels assumed to be pine (based upon comparison with the training sites). The resultant classification would be used as a mask to conduct the supervised classification.

A detailed description of making training sites ensued. Polygons rather than points were emphasized. GPS of all the training stands was mentioned, however, in the interest of time efficiency, single points, visual reference, and personal knowledge are often adequate for training sites. Efforts will be made to establish 30 training sites per class with about half withheld for accuracy assessments. After accuracy assessments, corrected classifications will be maintained for the final cartographic product.

The testing phase will involve additional communication via e-mail to test each element proposed. As results are achieved, decisions will be discussed to select a "standard" procedure from which to continue the analysis of the remaining images. A follow-up meeting will be held after the first complete image is classified to ensure the procedures can be implemented on the remaining images.