Report on Termites in the Azores

With emphasis on Cryptotermes brevis and its control

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By:

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Background

The Azores archipelago, located in the north Atlantic Ocean, is part of Portugal. The nine islands, located on the mid-Atlantic ridge are all of volcanic origin. The nearest landfall is Lisbon, located about 1,400 km to the east. The coordinates are 28-30° West by 37-39° North. Thus, it is approximately on a line drawn between Washington D.C. and Lisbon. At this latitude, the islands have a mild climate, averaging 23°C in summer and 13°C in winter, and because of the moderating effect of the ocean, are frost-free year round. Because of the extreme isolation of the islands the native flora and fauna are typical of oceanic archipelagos such as the Hawaiian Islands in being extremely depauperate of most continental groups of organisms, high in endemisms evolved from ancient pioneer species (neo-endemics) or actually extinct in mainland (paleo-endemics), with high levels of recent introductions, either intentional or unintentional due to human commerce (70% of vascular plants are exotics) (Silva and Smith, 2004). Termites, representing the insect order Isoptera, were one of many groups of organisms, absent from the islands, until recently.

Pellets, shed wings, and wood damage caused by an unknown insect started to be noticed by some residents in the central section of the city of Angra do Heroísmo, Terceira Island, about ten years ago. One such resident tried a number of surface spray applications of a wood preservative (“Xylofene”) but found this to be ineffective. Despite ongoing infestation by a number of residential properties, the situation was not brought to the attention of relevant authorities until recently. Two years ago insect samples were submitted to staff of the Universidade dos Açores, Dep. de Ciências Agrárias and were determined to be dry-wood termites. Samples sent to the Forestry Division in mainland Portugal resulted in a determination of the species as Cryptoterme brevis, also known as the West Indies powder-post termite, or furniture termite.

In early 2003, I was contacted by a representative of the local government, Mr. Marcolino Candeias regarding the “Newly discovered and extensive infestation of Cryptoterme brevis”. A meeting had been held with the mayor of Angra, other regional government representatives, and entomologists from the University of the Azores. It was suspected on the basis of verbal reports that at least two islands, Terceira and S. Miguel were probably affected. Funding was allocated for the University to conduct a survey that started in February 2004. In my initial e-mail to Mr. Cândias I outlined the general methods of control and also provided other recommendations.

Subsequently, I was contacted by Dr. David Horta Lopes of the Department of Ciências Agrárias, to clarify differences in control for dry-wood and subterranean termite control.

Later I had correspondence with Dr. Paulo Borges who had been selected to be the entomologist coordinator of the project “Termite Survey of Terceira Island”. Dr. Borges is working with two other colleagues, Dr. David Horta Lopes and Dr. Ana Maria A. Simões and two students in this important preliminary survey supported by the Mayor of
Angra do Heroísmo. Dr. Borges’ students, produced an information brochure that was distributed by the mayor of Angra, and are now continuing to conduct house inspections to map the area of infestation in Angra do Heroísmo.

**New Records of Three Termite Species on Terceira Island**

Dr. Borges sent samples of three termite species to me for identification. General localities and identities are as follows:

**ORDER: ISOPTERA**
- **FAMILY: KALOTERMITIDAE**
  1) *Cryptotermes brevis* alates, pseudergates and soldier from buildings in Angra do Heroísmo.
  2) *Kalotermes flavicollis* alates, pseudergates and soldier from olive orchard on just west of Angra and near Porto Judeu.
- **FAMILY: RHINOTERMITIDAE**
  3) *Reticulitermes* sp. sample of alates and workers from the US base near Lajes on Terceira.

Dr. Borges is the leading authority on the insects of the Azores and has compiled an extensive database on insect biodiversity of the Azores based on published records and collections (e.g. Borges, 1990; 1999; Borges et al., in prep.). Until recently there had been no published records or collections of termites from the Azores. The following hypotheses seem to account for these new termite species records.

*Cryptotermes brevis* is native to the Caribbean region where it is known from all the islands of the Greater and Lesser Antilles. Is also occurs in southern Florida and coastal regions Mexico, Central America and northern South America. It has been introduced to Pacific islands including the Galapagos, Fiji, Hawaii, Marguises, Midway, New Caledonia, and Easter Island. It is known from the Atlantic Islands of Ascension, Bermuda, Canary, Madeira and St. Helena. It has also been introduced to the coastal areas of continents including Australia, China, Madagascar, Camiba, Ghana, Nigeria, Senegal, Sierra Leon, South Africa, Uganda and Zaire. The species often infests the spars and decking of wooden boats and may have been widely distributed in the early days of wooden whaling ships. Modern sailing craft tend to have aluminum spars and fiberglass hulls. However many boats continue to harbor infestations in the decking or interior wood furnishings, and visitation by infested craft could lead to infestation of the islands due to alate flying from boats in harbors to nearby buildings. Another route of entry is through freight ships, which often have wood dunnage, which may be infested, or goods packed on wooden pallets that may be infested (Stanaway, et al, 2001). When the wooden pallets are off loaded the infestation is brought ashore. The species also infests a wide range of wood species including hardwoods from which furniture is made, therefore it frequently infests furniture and is frequently introduced to new localities in wooden furniture. *Cryptotermes brevis* is probably the most widely dispersed termite species in the world and has become a major structural pest in all places where it has been introduced. The currently known infestations of *Cryptotermes brevis*, are only from
buildings, in a number of blocks extending from the harbor, suggesting entry in the port area at least several decades ago, possibly at the time of the last major earthquake, in 1980 and associated with extensive importation of building materials and rebuilding at that time. However other parts of the island are also infested (Borges, pers. comm.).

The infestations of *Kalotermes flavicollis*, in contrast, are not known from buildings but only from orchard trees in two widely separated areas (at least 10 km apart). The species, therefore, may have been introduced in vineyard or orchard stock imported from mainland Portugal. It may actually have been imported to the islands long ago and may now be fairly widespread but has evaded detection because it is mainly restricted to introduced woody plants and attacks mainly dead branches on living trees and is not a significant pest. However, it can be a minor pest of vineyards and a minor structural pest in wood with high moisture content (Harris, 1970). Further surveys in orchards and vineyards on Terceira and other islands would be of interest to clarify the distribution of this termite. *Kalotermes flavicollis* is the only European species of Kalotermitidae. *K. dispar* Grassé is known from the Canaries Islands, and *K. approximatus* is known from the southeastern United States and Bermuda. Specimens from Terceira were directly compared with specimens of *K. approximatus* and did not match. Specimens were compared with illustrations of *K. flavicollis* in Krishna (1961) and nearly identical illustrations of *K. dispar* in Grassé (1986). On the basis of the slightly greater projection of the left second marginal tooth of the soldier mandibles, the specimens appear to match *K. flavicollis*. Furthermore the yellow pronotum of the dealate queen also matches the description of *K. flavicollis*.

*Reticulitermes* sp. is known only from one or a few buildings on the American base near Lajes. Therefore it was presumably introduced from the United States and treatment of the affected buildings suggests that it is currently under control. However, further contact with the American military officials should be made to ascertain the limits of the infestation and to insist that baiting or other relevant efforts (such as Trap-Treat-Release) be implemented with the objective of eradication before this termite has a chance to spread and become established.

**Observations of Cryptotermes brevis structural infestations**

The main focus of concern at the current time is the structural damage being caused by *Cryptotermes brevis*. To observe the structural infestations in the Azores first hand, I made a short, four-day visit to Terceira and Angra do Heroísmo, (March 28-31, 2004). During my visit Dr. Borges escorted me to a number of infested buildings including several private residences, government buildings and offices, a large Catholic seminary and the local museum. In every case the main site of infestation, or at least the most accessible and visible damage, was seen in the attic areas of the infested buildings.

Angra do Heroísmo is a very old city, founded in 1430. Buildings in the infested area are hundreds of years old and built according to the European style of construction in which the most units are three stories high and each separate residence shares common dividing walls. Therefore all the buildings of a city block are essentially joined together as a
unitary structure. This situation would create difficulties and hazards for use of tent fumigation with toxic gases.

The exterior walls and foundation are stone, rubble and solid masonry. The shared walls between residences are also stone or masonry. The ground floor is usually not wooden, but in some cases there is a cellar and the ground floor is wood. Usually the second and third floors (ceilings of the first and second floors) are supported by heavy wood beams and wood joists with hard wood flooring. The ceiling is usually made of plaster on wood lath. As well, in some of the historic buildings there are elaborate hardwood ceilings and/or moldings. The ceiling of the third floor is also constructed of wood joists which hold the lath for the ceiling plaster and dorsally are covered with planking, forming the floor Partitioning walls on all floors above the first floor are made of wood studs and most walls throughout are finished with plaster on lath finishing rather than drywall. Window and doorframes are wooden. Frequently second floor windows open as double doors to a wrought iron balcony and are not screened. Windows and doors in general are not screened and frequently left open for ventilation, thus providing easy entry by flying alates.

The roof is formed of red terracotta roofing tiles in alternating concave and convex series. This roofing system is mandated by local bylaws to maintain the historic appearance of the city. Such roofs do a good job of shedding rainwater but the tiles do not interlock tightly and hence such a roofing system has many cracks and gaps, which make it far from airtight. The tiles themselves are supported by framework of unfinished wooden beams and rafters. Often the entire attic area is internally cladded with unfinished softwood lumber. So the attics, because of their tile roofs with many gaps, afford easy access for termite entry and because of the abundance of unfinished wood rafters ceiling joists, flooring, cladding, and ceiling lath offer an abundance of dry wood ideal for termite infestation. In addition, there is a common local anobiid beetle which frequently attacks the wood in the attics, though its damage is less severe than that of the termites, its exit holes provide an abundance of entry holes for termites, thus further facilitation termite infestation and re-infestation.

The growth rate of kalotermitid colonies is slow. Once the first termite colony becomes established in an attic it may take 4 or 5 years to reach reproductive maturity, after which it will start to produce an annual crop of alates which will fly in the attic and most of which will then re-infest the attic. As the colony grows, to a population maximum of up to about five thousand, the annual alate output per colony may be hundreds to a few thousand. Thus, over a period of 10 to 15 years, an attic can become infested with hundreds or thousands of separate termite colonies, each of which may number up to several thousand termites. In the earlier stages of such infestation, individual piles of pellets indicate the location of separate colonies. This type of situation, with discrete colonies identifiable by separate piles of pellets was seen in some of the houses and in the attic of the museum. In more advanced stages, most of the beams are infested throughout their length and pellets are dropped everywhere so that distinct separate colonies are not discernable. This heavier stage of infestation can exist in an attic possibly for a decade or more without seeing much or any evidence of termites in the lower parts of the house.
Eventually infestations can be expected to move into the lower floors of the house as a few alates find their way into the house and establish colonies in furniture or wood molding or flooring. Colonies can also be expected to descend to lower portions of the house as galleries in the wood gradually extend from joists in the attic down through wall studs of the interior partitioning walls.

In many cases entire city blocks have shared walls so that the entire block is effectively one structure. Because of the style of construction with shared walls it would be difficult to separate individual properties with airtight tarps for the purpose of chemical fumigation. It might be possible to do some buildings and some small blocks. However, even this is questionable, because the streets are very narrow and therefore the adjacent blocks are much closer than would normally be the case in such places as Florida and Los Angeles where chemical fumigation is commonly practiced, and consequently a greater danger due to leakage and wafting fumigant during the final aeration process.

To Eradicate or to Manage?

If only a few buildings were infested then an all out effort to eradicate would be warranted. However, it is my belief that the situation is too far-gone to realistically expect that eradication is now achievable, and re-infestation due to commerce and movement of furniture would be inevitable anyway. Any attempt to achieve eradication through a massive publicly funded fumigation program would probably be unsuccessful in the long run. Such an eradication program was undertaken in Durban, South Africa when *C. brevis* was first discovered in 1918. The programs eventually failed to achieve eradication and continuous spread of the pest was seen as inevitable (Coaton and Sheasby, 1979). In Queensland, Australia *C brevis* was first discovered in the 1960s. Under the Diseases of Timber Act of 1975 it was designated a “notifiable pest”, meaning that any infestation must be reported to the authorities. Tent fumigation was then undertaken and supervised by Department of Forestry with no cost to the householder (Peters, 1982). Despite this ongoing publicly financed program, the pest appears to have become established along the coast of Queensland. Therefore the more realistic view of the situation is one of long term management and reckoning with the higher periodic building maintenance costs and more rapid deterioration of historic structures. In this respect, the Azores has sadly joined company with such other localities as south Florida, New Orleans, and Hawaii as places where this pest has or inevitably will become permanently established and requires continuous costly control measures. Truly, the introduction of *C. brevis* is a major slowly unfolding natural disaster whose cost will soon eclipse that of previous sudden disasters such as earthquakes.

Control Options

First, it is important to make certain critical distinctions about termite control and then to layout the framework of dry-wood termite control. It is critically important to understand that from an applied perspective there are basically two types of pest termites, either dry-wood termites or subterranean termites. The types of control that are appropriate are entirely different for the two. Subterranean termite control usually entails soil termiticide
barrier treatments while dry-wood termite control usually entails direct treatment of infested wood, compartmentalized treatment of areas with infested wood or whole-house fumigation.

Secondly, there is a tendency to think mainly in terms of remedial control but a larger vision of the problem, should include preventive control. Preventive control can be subdivided into 1) regulatory control, 2) inspection measures and 3) construction practices such as caulking and screening aimed at blocking termite entry points. Remedial control can be either 1) removal and destruction of infested furniture or isolated structural members 2) direct treatment of known infested items of furniture or exposed wood work or 3) compartmentalized treatment of rooms or attic areas that can be more or less closed off and individually treated or 4) whole-house or whole-structure control or 5) whole-block control usually by gas fumigation or heat treatment.

**Regulatory Control and Inspection**

New regulations should be legislated and would probably fall under existing phyto-sanitation and inspection regulations or procedures. Considering the long settlement of the Azores it is surprising that termite introductions are only now becoming a problem. As an island archipelago, with substantial shipping traffic, it is almost inevitable that exotic pests, including several other species of termites will from time to time be introduced and therefore procedures should be in place to prevent such introduction. All dry-wood (Kalotermitidae) and subterranean termites (Rhinotermitidae) should be listed as prohibited from introduction and the inspection services should have the power to intercept and destroy or fumigate at owners cost any imported article found with such infesting insects. Additional termite species which are especially notorious for transport and introduction are: *Cryptotermes domensticus, Cryptotermes dudleyi, Cryptotermes cynocephalus, Coptotermes formosanus, Coptotermes havilandi, Heterotermites spp. and Reticulitermes spp.* (Gay, 1969; Gay and Watson, 1982; Milano and Fontes, 2002). Inspections must be trained in the identification of termites and signs of termite infestation including the appearance of termite damage, dry-wood termite fecal pellets, and subterranean termite shelter tubes.

**Prevention of Initial Infestation**

The public at large should also be educated about the extreme danger of importing wooden articles from abroad that may harbor dangerous new introductions of wood destroying organisms such as wood boring beetles and termites. In addition people must be made aware of what areas are currently infested and not to move or take any wooden furniture from such areas and to be very cautious about bringing any old wooden furniture into their home. In addition, screening of windows and sealing all cracks and holes which would provide nesting sites for alates to start colonies, with caulk and paint around door and window frames is advisable. New wood construction in attics should be with pressure treated wood. Wood in attics should be treated with wood preservatives, for example, borate compounds such at disodium octaborate tetrahydrate formulated for with glycol for dry-wood application such as Boracare should be used to treat unfinished
Attics can also be dusted with silica aero-gel or boric acid to deter alates from successfully initiating new colonies (Ebeling, 1994b). Such measures are likely to be only partially effective, but nevertheless should be used.

**Prevention of Re-Infestation**

The pattern of infestation suggests that infestation usually start from an introduced item of furniture or from an infestation of the attic. In either case, the infestation dramatically worsens as the process of re-infestation takes place following flights of alates from the original infesting colony. Therefore early detection is important and intensive efforts should be made to eliminate the initial colony by wood removal and disposal or direct treatments. When infestations in attics reach the point where this is not possible without complete replacement of all timbers then efforts should be made to trap alates. This can be done with a light trap over a bucket of engine coolant. The light will attract the alates and which will fall into the bucket and drown. Alate flights have been reported mainly during the evening hours during the months of June and July, and therefore traps should be operated during these months. Further research could be conducted by the University of the Azores to improve trapping efficiency.

**Removal and Disposal or Furniture Fumigation**

In the initial stages of infestation it is often possible to identify an infested piece of furniture by the fecal droppings from it. Such items should either be removed and destroyed or treated in such a way as to positively kill the termites. A designated place at the municipal landfill should be set aside for such furniture or other known or suspected termite infested materials to be disposed. Such items should be either buried or incinerated. If a large amount of such material accumulates it should be buried or incinerated before the season of alate flights to prevent flight that could lead to local infestations near the landfill. Many items of infested furniture may be valuable and worth trying to salvage. In this case it should be possible to treat them in a vault with gas fumigant. Alternatively a closed container such as an old trucking or shipping container could be used and would not have to be air-tight if the method of treatment was non-toxic physical controls such as propane heat, CO2 (Delate et al, 1995), or N gas. Another option would be to find a local cold storage facility where they could be held at below freezing temperatures for several weeks. Again, research by the University could lead to a practical method for doing this locally.

**Direct Wood Treatment of Limited Infestations in Exposed Timbers**

Chemical of physical methods can be used for direct wood treatment. Chemical treatment can involve sprays or drill and injection. Surface sprays are not likely to be effective. Injecta by Nisus is a borate product that seems to me to be one of the best options and also one of the safest for the applicator to use.

[www.nisuscorp.com](http://www.nisuscorp.com) 100 Nisus Dr., Rockford, TN 37853 (800) 264-0870
It has been shown that various essential oils with low toxicity to humans can be used for dry-wood termite control (Sbeghen et al, 2002). D-limonene an extract of citrus peels has also recently been tested and registered for dry-wood termite control, and would appear to offer a relatively safe botanical treatment option. This is available as a newly registered product called XT-2000 from the San Diego CA based company Xtermite.


Other fast-acting drill and injection systems are available such as Whitmire’s PT270 (Dursban) pressurized injection system.

Physical methods include microwaves, electrocution (Lewis et al, 2000; Lewis and Haverty, 1996) Spot treatment with a 700 W microwave device for 8 minutes at the infested area. Etex, Las Vegas, Nevada, markets a commercially device called the electrogun. The device emits high voltage (90,000 V) at low current (ca. 0.5 amp).

www.Etex-ltd.com  3200 Polaris Ave., Suite 9 Las Vegas, NV 89102 (702) 364-5911 Fax (702) 364-8894 Email: etex1@aol.com

Non-Air-Tight Compartmentalized Treatment of Rooms, Attics or Portions of Structures

Thermal control can be achieved with excessive heat generated and blown into rooms or attics using specially designed propane convection heater/blowers. Circulating fans are used inside to maintain and even heating. The lethal temperature for the termites is about 49°C (120°F). However, to achieve this inside the wood it is necessary to raise the air temperature to 65°C (150°F) for about 6 hours (Ebeling, 1994). Some building components can be damaged at this temperature such as warping of PVC plastic pipes. Companies that have developed some expertise in thermal control and offer licensing are:

- Isothermics (714) 974-0951 Orange Co., California
- Temp-Air at: www.temp-air.com, Florida
- ThermaPure at www.thermapure.com, Florida

Liquid nitrogen can be used to achieve below freezing temperatures. This method is mainly used for treating inaccessible wall voids. Holes are drilled into the plaster or drywall and the liquid nitrogen is poured into the wall voids. Dosage rates of about 200kg/ m³ (Lewis and Haverty, 1996). Other methods which seem to warrant further university research are 1) drill and steam injection and 2) drill and wrapping of infested boards with solid fumigants such as those used in moth balls (para-dichlorobenzene, naphthalene or dichlorvos). Again, a research breakthrough on either of these fronts could greatly simplify and reduce the cost of control.
Air-Tight Whole-Structure or Whole-Block Fumigation

Conventional treatment for heavily infested structures involves tent fumigation with toxic gases methyl bromide or sulfuryl fluoride (Vikane) (DowElanco). This method requires the complete enclosure of the structure to be treated with airtight tarps and a safe distance of the structure away from neighboring structures. Because of the adjacent construction with shared walls of most of the infested buildings in the historic district of Angra where the termite infestation is located, it seems to me that it would be difficult and dangerous and require exceptionally large tarps to employ this method in the area. Some of the more isolated buildings however might be treated in this manner. As no local company has the expertise required for such work, it would be necessary to contract US companies in Florida for this sort of work.

Summary of Situation

It is reasonable to ask, “Why not simply adopt the methods approved in other developed countries, such as the US and Australia, where this same termite species has been introduced?” The answer is that in those countries there have always been native termite problems, which existed before Cryptotermes brevis was introduced so that an entire termite control industry, regulatory government agencies, and pest control companies existed to deal with the problem. No such existing government or private termite control infrastructure exists in Portugal or the Azores. Termite control is more complicated, potentially dangerous, and with higher liability issues than other types of pest control. In addition, the primary method of dry-wood termite control, namely, tent fumigation, would appear to be very difficult, if not impossible, to implement in some of the most affected areas of the Azores, such as Angra do Heroísmo, because of the architectural style, shared walls, relatively fragile tile roofs, and high density of buildings. Tent fumigation would be difficult and hazardous under such circumstances. The alternative methods, which might be used, have not been tested under the architectural conditions existing in the Azores. Other potentially effective methods, need further testing. Furthermore, obtaining the chemicals and fumigants might also be difficult commercially but would be easier under experimental permit approval. Therefore, I believe that it would be appropriate for the government of Portugal to set up a short term Termite Research Project for three to five years which would have the objective of evaluating appropriate control options for the conditions which exist in the Azores and for coordinating the development and implementation of safe and effective, government approved, and regulated private sector termite control. This will require a short period of government sponsorship after which time, the handling of this problem will be turned over to appropriately trained locally based private enterprise utilizing methods that will be safe and effective.

Research Questions:

Because of the large number of infested structures, most of which have infested, accessible, and removable floor and wall boards from the attic, the situation in Angra provides an exceptional opportunity to conduct research trials. Normally it is fairly
difficult to obtain infested boards for such trials, so this is a rare opportunity to do practical research which could lead to the discovery of locally appropriate and economical approaches to control. Research would be mainly in the form of ongoing treatment trials of infested structures and evaluations of existing structures, supplemented by laboratory studies

- Rate of wood consumption
- Rate of pellet production
- Relationship of pellet dropping to pellet production and population size
- Evaluate various solid fumigants with and without drilling
- Efficacy of drilling and high pressure steaming with and without borate
- Evaluate effect of depressurization with vacuum.
- Evaluation of various wood treatments with and without drilling for boards of different dimensions.
- Evaluation of various alate trap designs.
- Set up vault or container for furniture treatment and to evaluate CO\textsubscript{2}, Heat, etc.
- Set up disposal/incineration site.
- Eradication of the Reticulitermes infestation using TTR.

**Recommendations**

1. Designate a place to dispose of infested wood
2. Set up a fumigation vault, heat chamber or cold storage for treatment of furniture
3. Pass termite legislation which:
   a. Prohibits importation of any termite infested wood
   b. Empowers inspectors to seize and destroy such wood
   c. Or requires owner to pay for cost of fumigation
   d. Requires infested homes to be reported and treated
   e. Specifies the types of treatment which are approved
   f. Requires inspection and clearance at time of sale
5. Set up three to five year “Termite Research Project” to evaluate some existing and some alternative methods of control and determine which are most appropriate and effective for Azores conditions of architectural design.
6. During three year period participation in project trials is on voluntary basis, 50% paid from grant, with no warrantee of efficacy
7. After three years, selected methods and products are submitted for approval in Portugal for termite control (approval process may take 1-2 years)
8. Commercial pest control companies must obtain training and license from the government and must have relevant insurance coverage.
9. Project will do lab and structure trials on about 50 properties per year, produce annual reports, publish results of research, collaborate in development of educational materials, coordinate with relevant government agencies obtaining appropriate permits and developing training and licensing materials.
Funding Estimates

The cost of the research would be partially defrayed by homeowner contributions to control trials in homes. A cost sharing scheme might be worked out in which the local government would pay half the cost and the homeowner the other half with the understanding that the work is being done as an experimental trial with no immediate guarantee of control. If funding can be secured, I would be willing to devote 50% of my time to such a project over the next three years. This would allow for the determination of appropriate local control methods and transfer in 3 to 5 years of the problem to appropriately trained personnel and establishment of the private sector businesses.

Termite Research Project funding estimates:
- 2 MSc projects @$20,000 = $40,000
- Project Supervisor $50,000 + $10K travel & lodging expenses
- Equipment and Supplies $25K
- University administration overhead $15K
- Up to $50K/year allocated one to one matching funds grants to property owners who participate in control trials. Up to $1000/property owners
- Designate lab and office space at University

Total: $140,000/yr X 3 years with $50,000 per year recovered from homeowners. Thus the cost to government would be about $90,000/yr X 3 years = $270,000.

References


Ebeling, W. 1994a. The thermal pest eradication system for structural pest control. IPM Practitioner. 16(2): 1-10.


Final Report submitted: ________________

Signed: ____________________

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