Forest Health Protection
Alaska Region

R10-S&PF-FHP-2007-2

February 2007

Four Years of Early Detection Rapid Response Insect Trapping in Juneau, AK

Mark Schultz, Melinda Lamb, and Prentiss Adkins
USDA FS, S&PF, FHP, Juneau, AK
(Contact: mschutz01@fs.fed.us)

Roger Burnside
State of Alaska, Dept. of Natural Resources,
Division of Forestry Central Office, Anchorage, AK
(Or: roger_burnside@dnr.state.ak.us)

Summary

No non-native beetles (coleopterans) were found in a total of 332, two week, trap periods. Of the nine lures or attractant combinations tested, ethanol plus turpentine trapped the most scolytid bark beetles (Coleoptera: Fam. Curculionidae, Subfam. Scolytinae) and long-horned wood borers (cerambycids). Five, six, eleven, and two thousand beetles were trapped in 2002, 2004, 2005, and 2006, respectively.

A peak flight of both scolytids and cerambycids occurred in the middle of May. Flights were bimodal; the second flight occurring in August for scolytids (one location) and June for cerambycids (two locations). The Juneau International Airport (JIA) location was as much as 8 ˚C warmer than the Government Services Administration (GSA) location. Temperature alone seemed to explain the number of coleopterans caught. Elution rate of ethanol was highest for the warmest days. Elution was the greatest for the middle of June. However, the greater catch of scolytids and cerambycids at the GSA site compared to the JIA site may be related to the distance that these lures were from emerging beetles.

Traps at the GSA site were placed in an old-growth forest, whereas at the JIA site, traps were placed at the edge of a timber harvest area. The diversity of coleopterans caught from year to year varied. The greatest diversity occurred in 2005; 81 species in 29 families were trapped. However, the diversity of scolytidae and cerambycidae did not increase linearly with the total number of coleopterans caught. Diversity per number caught was greatest for the first 5 thousand individuals caught. Staphylinid beetles (Coleoptera: Staphylinidae) were the most common coleopterans caught, many times more than any other coleopteran family.

Introduction

Early detection and rapid response (EDRR) is part of a larger program to monitor and control invasive species. Within USDA, the Agricultural Research Service (ARS), Animal & Plant Health Inspection Service (APHIS), Cooperative State Research Education and Extension Service, Economic Research Service, Forest Service, and Natural Resource Conservation Service currently have programs which address the survey, diagnosis and monitoring of invasive species. Five agencies within the U.S. Department of the Interior have invasive species responsibilities. The National Park Service surveys and monitors for primarily for invasive plants and models their risk of spread. Research programs of the U.S. Geographic Survey include all major taxonomic groups of invasive organisms ("Microbes to Mammals - Invasive species program" publication). The U.S. Fish and Wildlife, Division of Environmental Quality, was recently directed to: 1. Increase public awareness of invasive species, 2. Coordinate aquatic nuisance species, 3. Provide technical assistance, 4. Coordinate and conduct research activities, and 5. Prevent the importation of non-indigenous nuisance species through the regulatory process. The Bureau of Land Management's responsibility is to remove exotic and invasive plants and wildlife from the lands they administer. Bureau of Reclamation is leading a multi-bureau coordinated effort to eradicate tamarisk from stream banks, Giant Salvinia (*Salvinia molesta*) from irrigation drainages, and Hydrilla (*Hydrilla verticillata*) from streams.

Since 2001, the focus of EDRR in North America has been semiochemical trapping near coastal port facilities where wood inhabiting insects could emerge from solid wood packing material (SWPM). Later, in the US, several inland "port" areas were monitored once it was determined that additional entry pathways for exotics (bark beetles and wood borers) could be as important as the initial entry ports (e.g., trans-continental movements were identified for some species as early as 2002). In Canada, Humble (2001) found, during a massive trapping effort from 1995 to 1999 in fifty-five (55) forest habitats around import facilities, and in parks, reserves and industrial forest areas of southwestern British Columbia, that three previously unknown non-indigenous scolytids were widely distributed. Allen and Humble (2002) broadened the perspective of potentially destructive non-indigenous species by providing references for destructive-pathogen introductions. They also emphasize that early detection "requires the development of detection methodologies and diagnostic tools". Some of the most famous early pathogen invaders of North America were Dutch elm disease, chestnut blight, and white pine blister rust. More recently, the most famous insects were gypsy moth, brown spruce beetle, Asian long-horned borer, and emerald ash borer.

Insect pheromones and host stimuli have been known for some time to attract phytophagous insects to their plant hosts (Wood 1982). Insect traps, host compounds, and aggregation pheromones have been used extensively to record the spatial, temporal, magnitude of bark beetle populations. These types of monitoring data will become critical to any future efforts to manage tree killing bark beetle populations. Beetle management techniques, whether tree removal (thinning or complete removal of host trees), use of anti-aggregation pheromones (masking aggregation pheromones), or chemical control (applying protective chemicals or biologicals), are most effective when conducted out-in-front of tree killing bark beetle populations. Despite every effort to locate tree destructive populations of bark beetles and wood borers, once established in an area, they are almost impossible to control to numbers that do not have an economic impact. Destructive beetles are probably better controlled, or mitigated by limiting the movement of woody materials from areas where they are established in large numbers.

Humble (2001) identified more than 2,500 adult insects, representing over 40 species of bark beetles, were detected in twenty-nine (29) log bolts that had been shipped to Montreal and then sent by rail to Vancouver. There is a critical need to associate significance of what is found in SWPM with risk to our native forests and potential displacement of native species. Three species of potentially destructive bark beetles recently introducted into North America (*Pityogenes chalcographus, Polygraphus poligraphus, and Ips typographus*) were recovered from Humble's bolts.

However, some introduced insects are pests in Canada (e.g. brown spruce longhorn borer, *Tetropium fuscum*) but not in their native habitat.

Without a program in place for early intervention and rapid identification of potentially invasive insects and pathogens, it's very unlikely that eradication of damaging exotics will be possible, once established. Alaska decided to implement a small-scale, base program to find out what species, including native insects, could be trapped at potential "port" sites and the effectiveness of conventional EDRR trapping systems utilizing insect pheromones and attractive host compounds. EDRR insect trapping in Alaska started in earnest in 2002 with the "Rapid Detection of Exotic Scolytidae Pilot Project Western Region Protocol" (APHIS 2006). This effort got started mostly due to the detection of the Asian Longhorned Borer, *Anoplophora glabripennis*, and subsequent regulations that followed on importation of unprocessed wood, wood articles, and SWPM into North America (U.S. Federal Register 1998). Forest Service western region coordinators, State, and APHIS representatives met to develop a trapping protocol for a top-ten list of insects that were known to be destructive in their native habitats but not yet known to occur in the West coast areas (Alaska, California, Oregon, Washington).

Methods

Two to six Lindgren traps (partially nested funnels with a collecting cup at the bottom (PheroTech, Inc. 7572 Progress Way Delta, British Columbia CN V4G 1E9 *www.pherotech.com*), or two intercept traps (two vertical crossing panel that direct beetle to a collection cup at the bottom, APTIV inc, 2828 SW Corbett Ave, Suite 114, Portland, OR 97201, *www.aptivinc.com*), were hung not closer than 75 feet from one another at five sites. One site just above the Alaska Marine Lines shipping container facility on Government Services Administration (GSA) property, across Thane Road, south of downtown Juneau, was used for each of the four years in the monitoring study (figure 1, table 1). Another site used in 2002 and 2003 was on Bureau of Land Management (BLM) property, above Greenwood Ave. just east of World Wide Movers container facility. The Auke Recreation Area (AUKE) and Echo Cove (ECHO) sites were used only in 2004. A fifth site, was above Fred Meyer's Department Store not far from the Juneau International Airport (JIA), was used in 2005 and 2006.

Traps and Insect Collections

One or two lures were hung from the middle funnel of each 12 funnel Lindgren trap. EDRR trapping was done using a "wet" collection method consisting of undiluted propylene glycol (biologically safe antifreeze solution) in the collection cups. A few inches of the solution is adequate to kill and preserve any trapped bark beetles, wood boring insects (e.g., *Sirex* spp.) and any associated target insect predators and parasites. The wet method of trapping also preserves samples held over in the field until collection and identifications were done. Collections were made every 7 to 14 days. Labeled paint filters were used to filter away antifreeze solution (which was reused when not too dilute) and store each trap sample. Once the collection was made the paint filters were folded, placed in a Ziploc bag, washed with a 70 percent alcohol solution, and stored in the refrigerator until specimens could be sorted and identified.

Lures -- Aggregation Pheromones and Tree Compounds

Five ultra-high release (UHR) lure combinations were used in year 2002 (ethanol [EtOH], EtOH + α-pinene, EtOH + turpentine, a 3-component exotic bark beetle lure [IPS], and Chalcoprax) (see description below and Table 1). UHR lures consisting of EtOH alone, EtOH + α-pinene, and EtOH + turpentine are host compounds generally attractive to any and all bark beetles and wood borers, mimicking several basic host breakdown components found in both hardwoods and conifer tree species.

A three component exotic bark beetle lure, the aggregant pheromone for *Ips typographus*, the European spruce bark beetle (IPS - *ipsdienol [(4S)-2-methyl-6-methylene-2,7-octadien-4-ol], methyl butenol, and cis-verbenol [4, 6, 6-trimethylbicyclo [3. 1. 1] hept-3-en-2-ol]*) was used to monitor for *Ips typographus* and other non-native Ips beetles, such as *Ips sexdentatus* (Six-spined engraver beetle), *Hylurgus ligniperda* (goldenhair bark beetle), and *Orthotomicus erosus* (Mediterranean pine engraver beetle).

Chalcoprax (Cyanamid Agrar, Ingelheim am Rhein, Germany), the aggregation pheromone for *Pityogenes chalcographus* (six-toothed spruce bark beetle) *(methyl-E,Z-2,4-decadienoate and 2-ethyl-1, 6- dioxaspiro [4.4] nonane)* was used to monitor for the non-native bark beetle of Norway spruce in Europe. However, it has been demonstrated by Hedgren (2004) that *P. chalcographus* alone had a low ability to kill Norway spruce.

A two component *Monochamus* spp. lure (ipsenol - *[2-Methyl-6-methylene-7-octen-4-ol. 2-Methyl-6-methylene-7-octen-4-ol]*, ipsdienol blend, and low release ethanol) was used in 2004. EtOH plus α-pinene attractant lures, manufactured by three different companies (Pherotech International [Pherotech] [*www.pherotech.com/*], Synergy Semiochemicals Corp.[Synergy], and Advanced Pheromone Technologies Inc., now APT IV Inc. (apt) [*www.aptivinc.com*]) were used in 2005 to compare their effectiveness.

Lure weights were taken in the field at each collection date in 2005 to compare relative elution rates over time for each of the UHR lure components. With shrinking funds for trapping, we went back to a basic four lure test in 2006 (EtOH, EtOH + α pinene, EtOH + turpentine, and IPS).

Identification and Analysis
Insects from the 2002 collection date were sent to Jim LaBonte, Taxonomist, Oregon Department of Agriculture, Plant Division in Salem, OR, for identification. Insects from 2004, 2005, and 2006 collections were identified in Juneau to genus and data placed in a Microsoft Access® database. Only previously unknown and native Coleoptera were saved from the trap collection for identification in 2003. Graphs were created in Microsoft Excel ®.

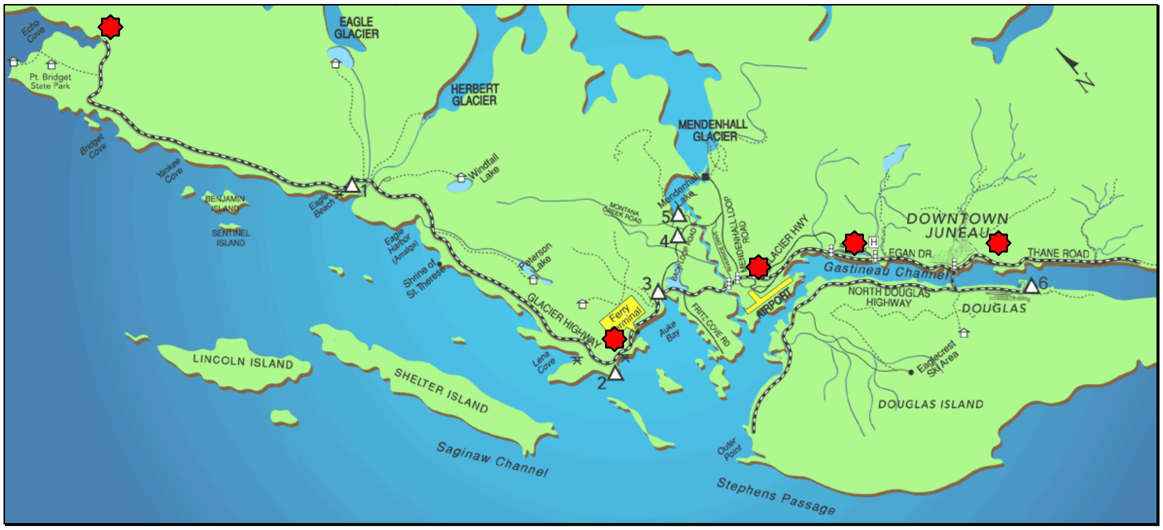

Figure 1. Location of traps: - left to right - ECHO[%], AUKE[&], JIA[$], BLM[@], and GSA[#].
% - Echo Cove, & - Auke Recreation Area, $ - Juneau International Airport, @ - Bureau of Land Management, # - Government Services Administration.
Map from Juneau Convention and Visitors Bureau:
http://www.traveljuneau.com/discover/maps/area/index.cfm

Table 1. Lures and trap locations for years 2002 to 2006 in Juneau

Year	Location	EtOH*	EtOH & α-Pinene (Synergy)	EtOH & α-Pinene (Pherotech)	EtOH & α-Pinene (apt)	EtOH & Turpentine	IPS	Chalcoprax	α-Pinene	Monochamus
2002	GSA[#]	1		1		1	1	1		
2002	BLM[@]	1		1		1	1	1		
2004	AUKE[&]					1	1		1	1
2004	ECHO[%]						1			1
2004	GSA	1				1			1	1
2005	GSA	1	1	1	1	1	1			
2005	JIA[$]	1	1	1	1	1	1			
2006	GSA	1			1	1	1			
2006	JIA	1			1	1	1			

Results

No non-native coleopterans were trapped in 2002, 2004, 2005, or 2006 in fifty-four (54) traps over approximately three-hundred and thirty-two (332) trap periods (an average trap period is one trap collection over a fourteen day period). There were 80, 84, 120, and 48 trap periods in 2002, 2004, 2005, and 2006, respectively. No trap data was kept for 2003.

Ethanol, in addition to standard commercial grade turpentine as attractants, overall, trapped the most coleopterans (figures 2 and 3). Considering just the scolytids and cerambycids trapped, ethanol + turpentine (2-component lure) was still the best attractant (figure 4). However, EtOH alone, EtOH + α-pinene, or IPS, trapped the most coleopterans for some sites in 2005 and 2006. More scolytids were trapped in May and August than in June or July (figure 4). More cerambycids were trapped in May and June than in July or August.

Of the 5,308 coleopterans trapped in 2002 there were 30 different species in 10 families of which 13 were scolytids and three cerambycids (figure 5). Most scolytids were trapped at the BLM site. Of the 5,503 coleopterans trapped in 2004 there were 59 species in 21 families of which seven were scolytids and five cerambycids. Most of the coleoptera were staphylinids and scolytids trapped at the GSA, Auke Recreation Area, and Echo Cove sites. Of the 11,184 coleopterans trapped in 2005 there were 81 species in 29 families of which 12 were scolytids and 10 cerambycids. Most were staphylinids, leiodids, and scolytids trapped at both the GSA and JIA sites. Of the 1,898 coleopterans trapped in 2006 there were 38 species in 16 families of which eight were scolytids and four were cerambycids. Most were staphylinids, scolytids, and nitidulids trapped at the JIA site.

Elution from the UHR ethanol lures was greatest overall in the first part of June, 2005 (figure 6). Release rates were higher at the JIA site than the GSA site early in June. The air temperature at the JIA site was 5 to 10 ˚C higher than the GSA site in 2005 (figure 7). Air temperature could explain the higher catch of Coleoptera species at the JIA site.

Discussion

The large number of trap periods and attractants used in five distinct sites resulted in the trapping of many Coleoptera species.

All but final identifications of specimens was completed in Juneau. This underscores the need for para-taxonomic experience to successfully perform an EDRR trapping effort. This program requires the maintenance of an insect museum, and a good dissecting microscope with digital camera. Any unknowns can be sent to a scolytid taxonomist for final species determinations. A digital image should be sent first, followed up with a reference specimen. A good reference collection, including both identified native and non-native species for comparing with potential exotics in trap samples, should be a standard requirement for conducting EDRR sampling.

The primary cost for EDRR monitoring have been in the collection, identification, and databasing of specimens. In the future, the cost and time of trapping could be reduced by deploying only three to four traps per site using a few basic attractants. Specific components are needed that have attractiveness over a broad range of insect feeding groups, including exotic bark beetles and wood boring beetles. Un-denatured ethanol, plus turpentine or α-pinene as attractants, and the "exotic Ips" lure were as effective in trapping several diverse groups of bark beetles and other wood boring insects, as the more species-specific lures (e.g., *P. chalcographus* "Chalcoprax" lure). The Pherotech lures, though hard to handle, released consistently throughout the trapping period. However, for delimitation and eradication of exotic insects, once detected, species specific lures may be more important in determining the specific combination of enantomeric blends needed to attract exotic insects outside their native habitats (Sweeney et al., 2006).

We may eventually find a way to collect from traps at remote sites at the far ends of southeast Alaska, near Skagway and Ketchikan. These could be two important places of exotic insect entry due to their proximity to known exotic habitats in Canada.

We may also want to change our traps to fully suspended panel traps with dry collecting heads because wet trapping in Juneau often results in putrefied specimens during rainy periods (the antifreeze solution become too dilute to be effective as a preservative). This may not be as important in "drier" locations such as Interior or south-central Alaska.

Literature Cited

Allen E.A. and L.M. Humble. 2002. Nonindigenous species introductions: a threat to Canada's forests and forest economy.

APHIS. PPQ/EDP/EP staff. 2006. Exotic Wood Borer Bark Beetle National Survey Field Manual. Borer Bark Beetle National Survey Field Manual 2006. 125p.

Cavey, J. 1998. Solid wood packing material from China. Initial pest risk assessment on certain wood boring beetles known to be associated with cargo shipments: Asian Longhorned beetle (*Anoplophora glabripennis), Ceresium, Monochamus and Hesperophanes*. USDA APHIS, Pest Risk Assessment, Riverdale, Md.

Hedgren P. O. 2004. The bark beetle *Pityogenes chalcographus* (L.) (Scolytidae) in living trees: reproductive success, tree mortality and interaction with *Ips typographus*. J.Appl.Ent.128, 161–166.

Humble, L.M. 2001. Invasive bark and woodboring beetles in British Columbia, Canada. Protection of the World Forests from Insect Pests: Advances in Research. Edited by E. Alfaro, K. Day, S. Salmon, et al. XXI IUFRO World Congress, IUFRO World Series, Vienna, Austria. Vol. II [on line]. pp. 69–77. Available from *http://warehouse.pfc.forestry.ca/pfc/*19565.pdf [accessed May 2002].

Sweeney, J., Gutowski, J.M., Price, J., and P. De Groot. 2006. Effect of semiochemical release rate, killing agent, and trap design on detection of *Tetropium fuscum* (F.) and other longhorn beetles (Coleoptera: Cerambycidae). J. Environ. Entomol. 35(3): 645-654.

U.S. Federal Register. September 18, 1998. Solid Wood Packing Material From China; Interim Rule Federal Register (Volume 63, Number 181) 7 CFR Parts 319 and 354. [Docket No. 98-087-1] RIN 0579-AB01.

USGS. 2006. Microbes to Mammals -- Invasive Species Program. *http://biology.usgs.gov/invasive/Publications/invasivespecies-brochure.pdf*. U.S. Geological Survey. 12201 Sunrise Valley Drive. Biological Resources Discipline. Invasive Species Program. MS-301. Reston VA 20192. 8p.

Wood, D. L. 1982. The role of pheromones, kairomones, and allomones in the host selection and colonization behavior of bark beetles. Ann. Rev. Entomol. 27:411-46.

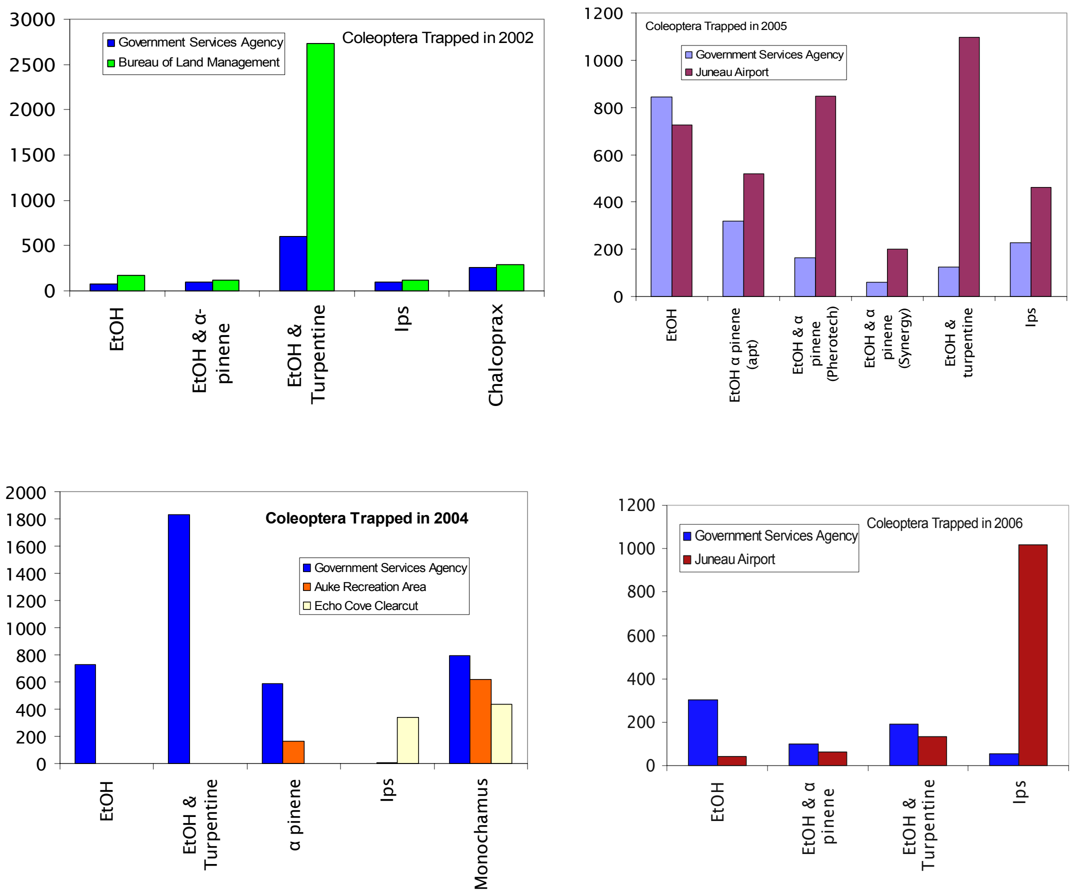

Figure 2. Number of Coleoptera trapped in 2002, 2004, 2005, and 2006 by location and lure.

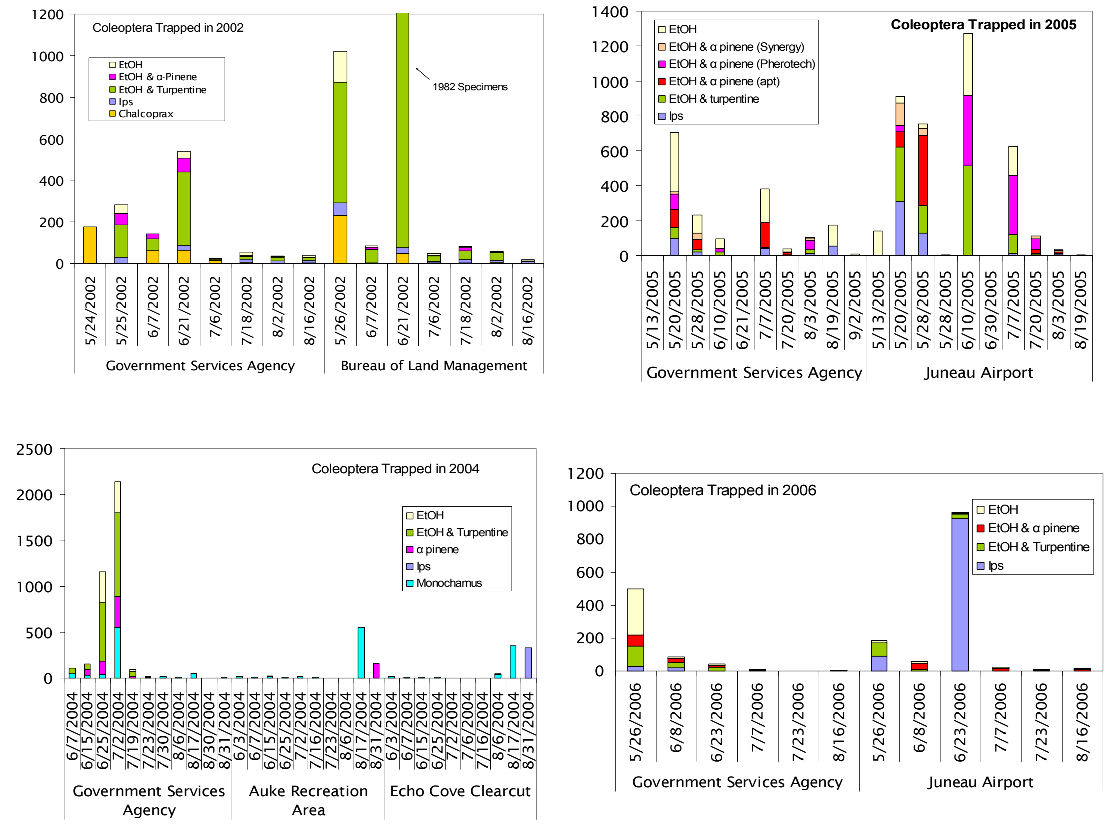

Figure 3: Number of Coleoptera trapped by location, date, and lure in 2002, 2004, 2005, and 2006.

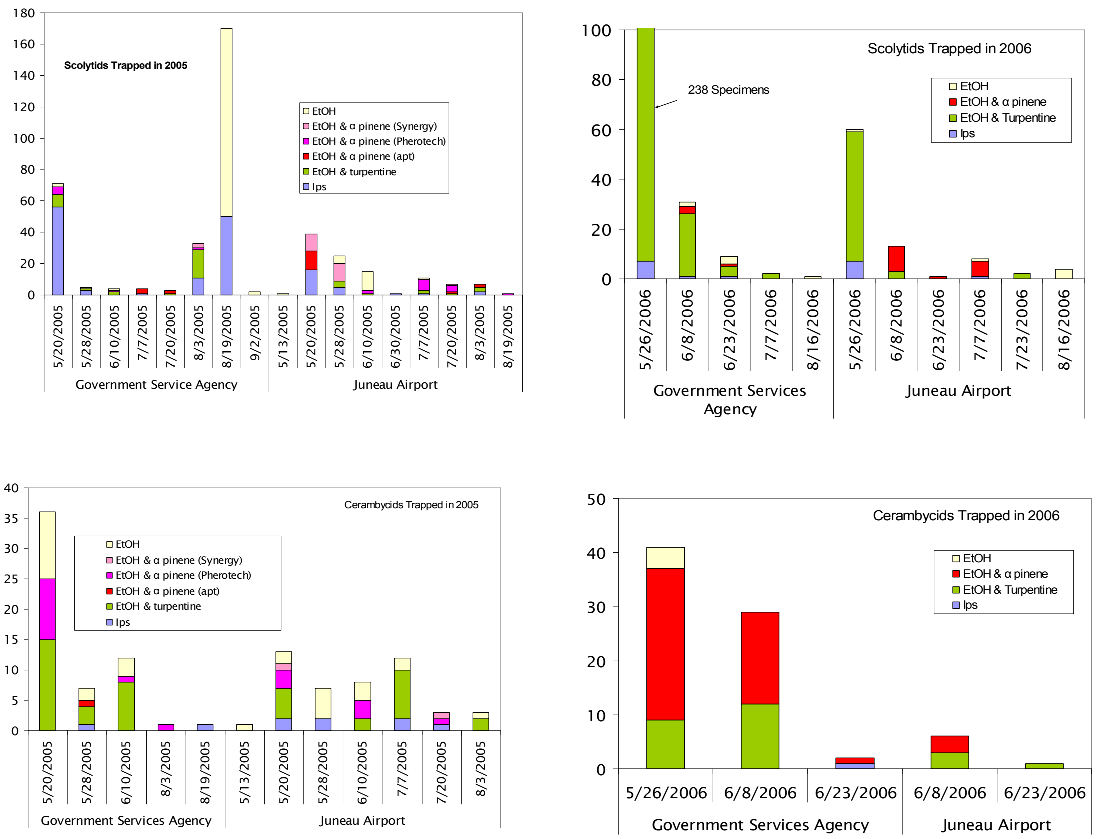

Figure 4. Number of scolytids and cerambycids trapped, by location and date, in 2005 and 2006.

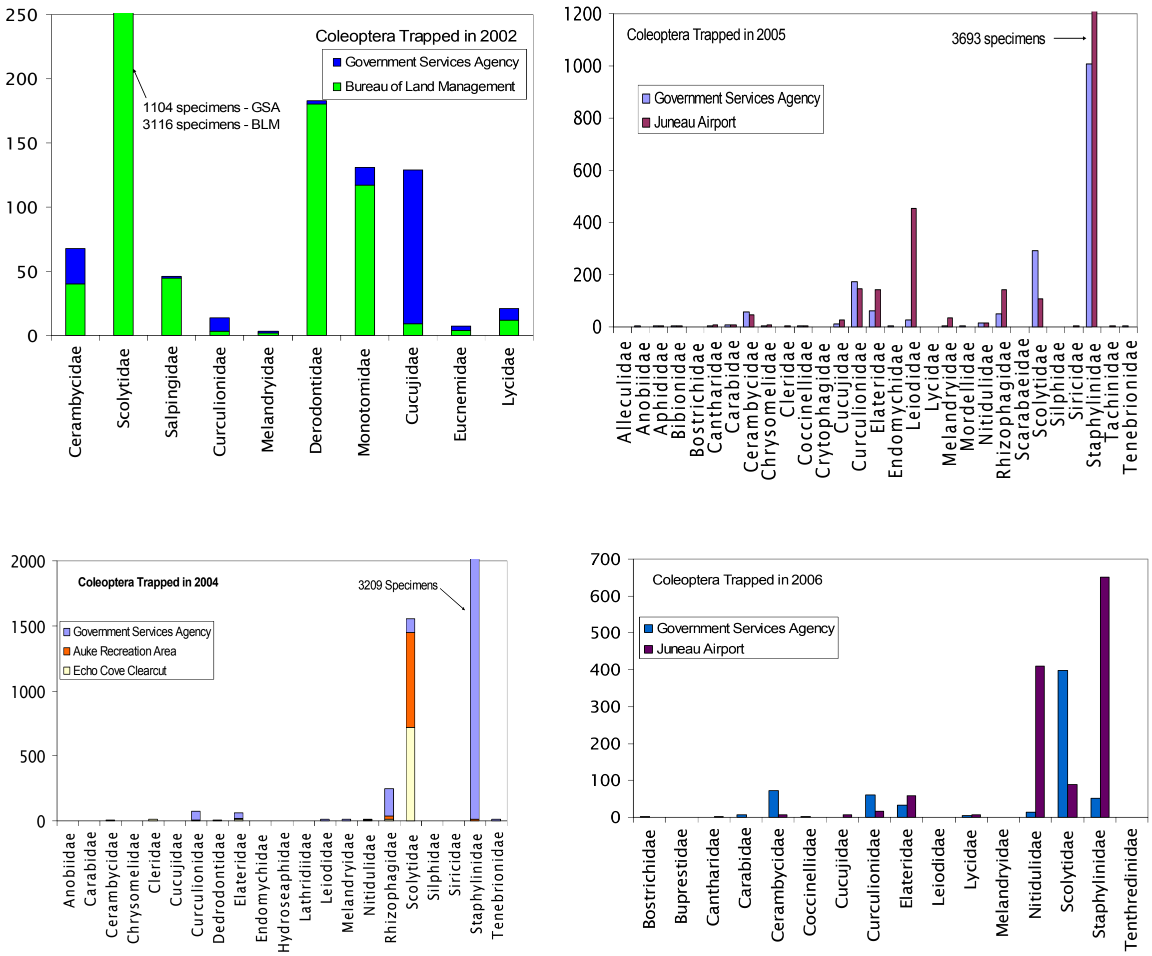

Figure 5. Number of Coleoptera trapped by Family in 2002, 2004, 2005, and 2006.

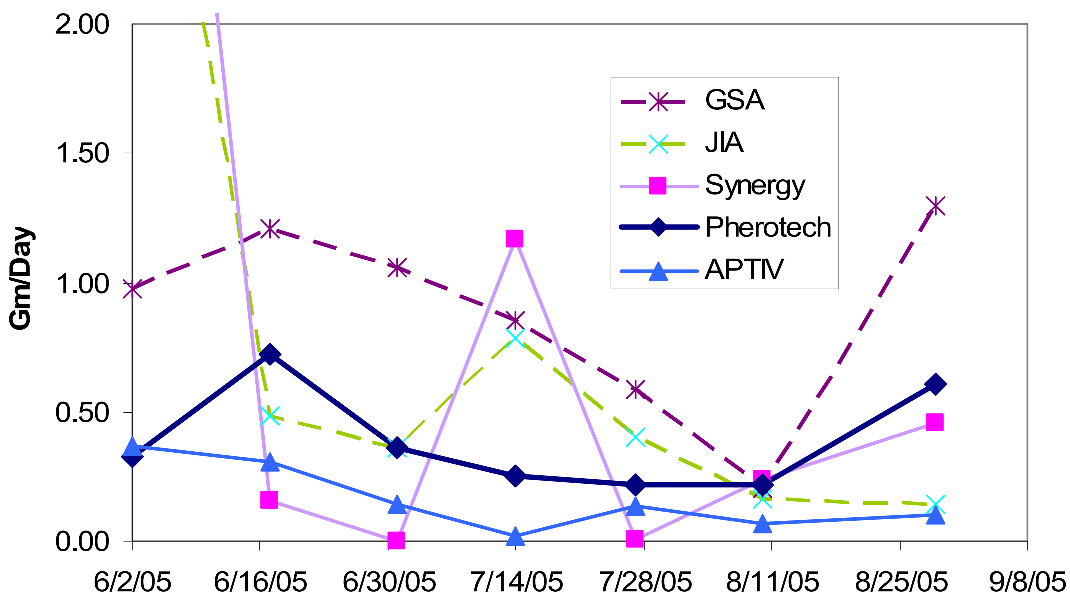

Figure 6. Average elution by weight of ultra-high-release ethanol lures in 2005 at two site (GSA and JIA) and for three lure manufacturers (Synergy, Pherotech, and APTIV).

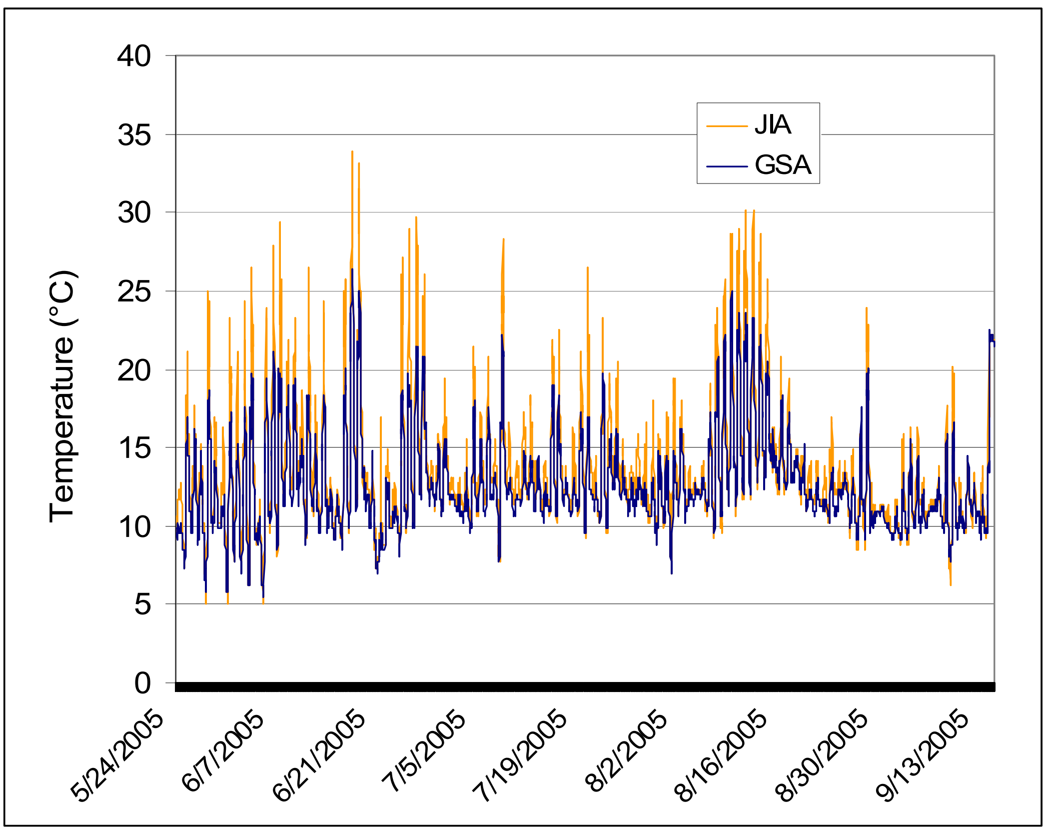

Figure 7. Air Temperature at Juneau International Airport (JIA) and Government Services Administration (GSA) sites in 2005.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.