AUBURN UNIVERSITY
FOREST HEALTH COOPERATIVE

RESEARCH REPORT 2013-02

EFFICACY OF THREE INSECT TRAP TYPES AT THE OAKMULGEE RANGER DISTRICT

by
Jacob Andrew Thompson and Lori Eckhardt
Forest Health Cooperative, Forest Health Dynamics Laboratory, School of Forestry and Wildlife Sciences
Auburn University, AL

ABSTRACT
Three different trap types (intercept panel, flight intercept and pitfall traps) were directly compared at three subplots of 24 research plots in the Oakmulgee Ranger District of the Talladega National Forest in west-central Alabama. Panel intercept traps captured the majority of insects for nearly all bark and ambrosia beetles, including species that are primarily associated with root habitats. While pitfall traps captured fewer insects than intercept panel traps, they preferentially captured root and lower bole dwelling species. Flight intercept traps captured lower numbers of the same species as panel intercept traps. Panel intercept traps appear to be effective for use in general insect surveys and studies that currently use Lindgren funnel traps. Pitfall fulfilled a specialized function and acted as a useful supplement.

INTRODUCTION

Insect trapping allows consistent, long-term surveys to be conducted in remote areas where insect populations would not otherwise be known. The ideal trap and lure used depends on both the insect species and the variety of insects being targeted. Effective trapping methods mimic the habitat and chemical attractants of the target insects. The efficiency of different bark and ambrosia beetle traps varies between different species and at different settings. Trapping can target individual species or be used to conduct a general survey. Insect traps are often used to monitor the presence and spread of exotic species, for observation of population peaks and better document life histories of insect species (Weinzieri et al., 2005).

Traps attract insects with visual attractants, scent attractants or both. Size, shape, elevation and color are visual components of traps which can mimic habitat and attact insects. For example, many bark beetles are attracted to traps that match the profile of trees (deGroot and Nott, 2001). Dark colored traps have been found to capture more bark beetles and weevils than lighter colored traps. Reflective traps appear to reduce capture of insects sensitive to different visual wavelengths (Mizell and Tedders, 1999). White and yellow traps captured fewer insects than black, blue, brown, green, grey and red traps. However, Lindgren (1983) concluded that ambrosia beetles are not affected by trap color which was supported by Strom and Goyer (2001). Pheromones and chemicals issued by trees associated with both habitat and prey species have also been effectively used in trapping (Weinzieri et al., 2005). Baiting traps with synthesized chemical attractants to mimic these attractants is considered to be one of the most cost-effective and efficient ways to survey insect populations (Dodd et al., 2010).

Baited traps capture insects more effectively than unbaited traps (Bouget et al., 2009) but effectiveness of chemical lures vary by insect species. Ethanol, turpentine and ethanol and terpentine used in combination are known bark and ambrosia beetle attractants. The combination of ethanol and turpenes is a strong synergistic attractant for bark beetles (Gandhi et al., 2010). Ethanol enhanced the attraction of alpha-pinene for *Xyleborus pubescens* Zimmermann, *Hylastes porculus* Erichson, *H. salebrosus* Eichhoff and *H. tenuis* Eichhoff (Miller and Rebaglia, 2009) and also has a synergistic effect when mixed with turpentine to trap bark beetles such as *Dendroctonus terebrans* (Oliver), pales weevils and pitch eating weevils (Fatzinger, 1985). *Pachylobius picivorus* Germar were strongly attracted to ethanol to turpentine ratios greater than 1:1. *Hylobius pales* Herbst were slightly more attracted to ethanol alone than *P. picivorus*. The turpentine component may be needed for host recognition in baits (Rieske and Raffa, 1991). Ethanol alone has been successfully employed as bait for *Xyleborus* species in 22 states (Rebaglia et al., 2008). Scolytid species have also been more attracted to traps baited with ethanol compared to unbaited traps in hardwood forests (Montgomery and Wargo, 1983). The placement of bait within a trap also affects attraction of insects to traps. Lures placed inside traps were generally found to be more effective than lures above traps (Dodd et al., 2010).

Both flying and root dwelling insects have ramifications on forest health. Aerial traps, such as panel intercept traps, are used to survey southern pine beetle, *Ips* species and other beetles associated with feeding on trees. Some root feeders which are typically captured in pitfall traps have been implicated in premature loblolly pine decline which occurs across the southeastern United States. Because of the great importance of loblolly pine in both unmanaged and commercial forestry it is important to better know the populations of insects such as *Hylastes* species that are known to vector fungi associated with loblolly pine decline. A more comprehensive understanding of populations of southeastern bark and ambrosia beetles isneeded and the use of multiple trap types was intended to capture more of this diversity. This study compared the relative efficacy of panel intercept traps, flight intercept traps and pitfall traps to capture bark and ambrosia beetles. Because of their black coloration, large entrance, profile that resembles trees and broad dispersion of chemicals, panel intercept traps were expected to capture the largest number of insects. Pitfall traps were expected to capture predominantly root feeding insects. It was expected that some traps would be particularly effective at capturing these different species and that this study would be a useful way to observe those details.

METHODS AND MATERIALS

Bark and ambrosia beetles were trapped at twenty-four plots located in the Oakmulgee Ranger District of the Talladega National Forest in Perry, Chilton and Bibb County Alabama. Study sites, selected on the basis of stand history, slope and aspect, were former agricultural lands converted into forest between 1973 and 1984. Each plot included three subplots located 36.57

meters from the center of the plot at bearings of 120, 240 and 360 degrees. Subplots were an array of circles with a radius of 7.62 meters and an overall area of 0.0182 hectares. Plot design followed methods used in the USDA Forest Inventory and Analysis Program (Dunn, 1999).

The three traps used were panel intercept traps, flight intercept traps and pitfall traps. Intercept panel traps (APTIV Company, Portland, Oregon) were hung approximately two meters by wire from a metal pole kept in the ground by a metal sleeve. The bucket of each panel trap was filled with approximately 45 ml of a mixture of two parts distilled water to one part antifreeze, added to prevent the escape of captured insects. Flight intercept traps consisted of a clear plastic 1-gallon milk jug cut open on three sides with the fourth side attached to a pole approximately 0.60 m above the ground. A 120 ml plastic cup attached to the lip of the milk jug served as the receptacle for insects. Two 5 cm long by 2 cm dia pine stems were placed in the cup to attract insects. Pitfall traps consisted of 10 cm by 20 cm diameter PVC plastic pipe with eight entrance holes equally spaced around the circumference. The traps were buried with the entrance holes within 5 cm of ground level at each subplot. A plastic skirt was fitted around the trap to reduce the risk of flooding (Menard, 2007). Two loblolly pine cuttings 5 cm by 2 cm length and diameter were placed in the trap base. The cap was kept loose to facilitate access. Escape of captured insects was prevented though coating with a thin layer of liquid Teflon™ (Northern Products Woonsocket, RI) each collection period. Trapped insects remained in the cup until the following collection period.

Traps were collected on a biweekly basis between March 2008 and February 2010. Each trap was baited with a mixture of 95% ethanol and turpentine. Because each trap type was present at each subplot, it was possible to directly compare the relative effectiveness of each trap at capturing insects present at the Oakmulgee Ranger District. Through direct comparisons the project should allow a determination of whether alternatives to pitfall traps could adequately capture bark and ambrosia beetles associated with roots and the lower bole.

STATISTICS

SAS 9.1 ((SAS Institute Inc., Cary, N.C.), analysis of variation (ANOVA) was used to compare capture data from intercept panel traps, flight intercept traps and pitfall traps. The data included was the total collection totals per species at each plot during each collection. Analysis of variation was determined using a Tukey test and the threshold of significant difference was set at 0.05.

RESULTS

Differences between trap types

Panel intercept traps captured a significantly greater total of nearly every insect species observed in the study (Table 1). The only exception was for the root feeding bark beetle *H. tenuis*, in which pitfall traps captured significantly more individuals than panel traps. The vast majority of individuals of bark and ambrosia beetles, not associated with roots, were captured in panel traps. Overall, panel intercept traps captured the most insects and the broadest range of species. Insect species primarily associated with flight, with no root feeding associated with their lifecycle

(*Gnathotrichus materiarius* Fitch, *Thanasimus dubius* Fabricius and *Temnochila virescens* Fabricius) were captured so predominantly in intercept panel traps that differences between other trap types were not statistically significant.

Differences between flight intercept trap and pitfall trap collection totals were also observed for many species (Table 2). Flight intercept traps collection totals were significantly greater than in pitfall trap capture for *H. salebrosus*, *Ips grandicollis* Eichhoff, *G. materiarius*, *Xylosandrus crassiusculus* (Motschulsky), *Xyleborinus saxesenii* Ratzburg, *T. dubius* and *T. virescens*. Pitfall traps captured more *H. tenuis*, *P. picivorus*, *H. pales* than flight intercept traps. Collections of *Hylastes salebrosus*, *H. porculus*, *D. terebrans*, *G. materiarius, T. dubius* and *T. virescens* were not significantly different between flight intercept and pitfall traps.

Differences between timing of species abundance

The majority of insect species were captured in the greatest abundance during April and May of each year but no two species displays identical population patterns. *Hylastes salebrous* was most frequent during March and April in both 2008 and 2009 and had a smaller peak that occurred in the fall, which was larger in 2009 than in 2008 (Fig. 1). The peak collection period for *H. tenuis* was in April and May with a second, smaller peak in September (Fig. 2). The number of *H. porculus* trapped during October and November of 2009 was larger than at any other time although smaller peaks were observed in the fall of 2008 and April of both years (Fig. 3).

Hylobius pales and *P. picivorus*, although about equally common, were largely captured at different times of year. *Pachylobius picivorus* were recovered in April and May of both years, with more individuals collected in 2009 than in 2008 (Fig. 4). *Hylobius pales* were most common in March and April with a smaller fall peak, during the 2009 season (Fig. 5). *Dendroctonus terebrans* collections showed a small peak in March and early April 2009 followed by a larger peak in July and August 2009. The summer 2009 peak constituted a significant part of the total *D. terebrans* collected (Fig. 6). *Ips grandicollis* was collected most frequently from April to June (Fig. 7).

Gnathotrichus materiarius was the only species captured in the largest numbers during the winter months (Fig. 8). Capture was reduced, however, when temperatures dropped below freezing for several days. *Xylosandrus crassiusculus* was most numerous in March and April during both years (Fig. 9). *Xyleborinus saxesenii* was more common in early spring than many other species, peaking in March during both years (Fig. 10). Of the predator species, *Thanasimus dubius* was captured most frequently during May and June, particularly in 2009 (Fig. 11). *Temnosheila virescens* peaked earlier in the year and was most numerous in late March and early April (Fig. 12).

DISCUSSION

Pitfall traps are generally used to capture bark beetle species but the supplemental use of other trap types appeared to increase the accuracy of the survey. Because capturing overall diversity of bark and ambrosia beetle populations was an important goal, aerial traps such as intercept panel traps were employed. The use of intercept panel traps in particular greatly increased the total capture of bark and ambrosia beetles. The most important diversity trends appeared to be the large proportion of overall insect capture that occurred in intercept panel traps, the presence of root dwelling bark beetles and weevils in the panel traps and the specialized function of pitfall traps. Intercept panel traps may, therefore, have potential to be used to survey general bark beetle populations the way that funnel traps are used in seasonal surveys of species such as southern pine beetle.

Almost every species collected during the study was captured more frequently in intercept panel traps. Intercept panel traps possessed several characteristics which likely increased their insect capture. Entrances of these traps were larger than those of flight intercept and pitfall traps and correspondingly easier for insects to enter. A comparatively higher elevation allowed panel intercept traps to better capture insects flying through the forest. Since the late 1970s, scientists have known that the similarity of the silhouette of the panel traps to host pine species helps attract insects (Lindgren, 1983), so visual resemblance to trees probably enhanced effectiveness of intercept panel traps. Black traps are unreflective and therefore attract bark beetles. Profile and color likely heightened the attracted of the intercept panel traps. Flight intercept traps did not have the silhouette of pine trees, were more difficult to enter and easier to escape from due to the absence of teflon or antifreeze. Flight intercept traps generally captured the same species as intercept panel traps whereas pitfall traps captured proportionately more root-dwelling insects. In this study, with its emphasis on capturing bark beetle diversity, the use of panel intercept traps probably enhanced the accuracy of the count through greatly increased capture of non-root feeders.

Overall, species that are associated with the mid-bole of trees and higher were captured almost exclusively in aerial traps and root and lower bole feeders were captured in both aerial and pitfall traps. The proportion of relatively large *P. picivorus* and *Hylobius pales* in the pitfall traps and the greater amount of effort required for the weevils to enter these traps leads credence to the idea that these species are particularly attracted to the roots and will expend a greater amount of energy to get to them. *Hylastes* species and weevils were also significantly more abundant in pitfall traps than flight intercept traps. This was expected considering that these species are associated with pine roots (Eckhardt, 2003). Many of the root-feeding species are associated almost exclusively with roots and the lower bole, so while the presence of *Hylastes* spp., *Pachylobius picivorus* and *Hylobius pales* in pitfall traps were unsurprising, it was less expected that collection totals of all other root feeders except for *H. tenuis* were greatest in panel traps. Panel traps, even hung nearly two meters in the air typically captured more individuals of root-dwelling species than pitfall traps. The significantly greater capture of these insects in panel traps demonstrates the often underestimated importance of flight in the lifecycle of these insects.

The presence of nine traps in each of the collection plots may have increased the overall capture totals within each plot. The release of chemical attractants from different trap types and different subplots within the plot may have interacted with one another. This could have potentially been a confounding factor if insects were frequently captured by a different trap than the one which initially attracted them. *Ips* collections have been affected by both the number of traps in a block and the total concentration of attractants (McMahon et al., 2010) in Wisconsin. However, attractants are less widely dispersed in pitfall traps because of their trap design, so all traps may not have made the same contribution to the plume. Possible interference between different traps and whether bait from some traps may attract insects to different, adjacent traps may be a potential topic for future research.

Many studies only keep traps out for a few months and few trap for insects later in the year than September. Detection of unexpected population patterns is a possible justification for winter trapping. Many of the insect species in the study showed population peaks in March, after leafout and were seldom or never trapped after October but there were several exceptions, including several species associated with loblolly pine decline. September and October collection peaks of *H. tenuis* and December and January peaks of *G. materiarius* appeared to be the most consistant off-season increases of beetles in the study. The bigger fall populations of *H. porculus* compared to *H. salebrosus* in the second year of the study was not entirely surprising, given that the range of *H. porculus* is more northerly (Edmonds et al., 2000). Both *Hylastes tenuis* and *Hylobius pales* were had peaks during fall in prior studies (Zanzot et al., 2010) and considering the population patterns that emerged in this study, it appears autumn peaks typical of the life history of this species. *Dendroctonus terebrans* had a particularly large population peak during July and August following resin sampling while many species were relatively rare. A large increase in *D. terebrans* collection numbers in only a few plots accounted for this peak. Like the addition of panel intercept traps, trapping insects during the fall appeared to increase the accuracy of surveys.

Although this study used different traps than other studies, the same bark and ambrosia beetle species were observed as were reported in other work conducted in the southeastern United States. Many studies trap insects such as *D. frontalis* and *Ips* species with Lindgren funnel traps. Lindgren funnel traps were not used in this study but have captured similar insects as intercept panel traps did at the Oakmulgee Ranger District. Dodd et al. (2010) compared insect capture of intercept panel traps to Lindgren funnel traps and canopy malaise traps in a mature *Pinus strobus* L. stand in New Hampshire and found that total bark beetle capture and species richness did not vary between traps. Ambrosia beetles were captured in greater numbers in the intercept panel traps, but differences in species richness were not found between the three traps. In a Christmas tree plantation in upstate New York, panel intercept traps were used along with Theyson slot traps and Lindgren funnel traps. Funnel traps captured greater totals of *Hylastes opacus* Erichson, Theyson traps captured more *Orthotomicus caelatus* Eichhoff and *I. grandicollis* while *X. saxesenii* did not differ between traps (Petrice et al., 2004). The most common species observed at the Oakmulgee Ranger District reflect data from similar studies elsewhere (Eckhardt et al., 2003, Zanzot et al., 2010) and the utility of pitfall traps to capture insects more specifically attracted to roots has also been observed in previous studies (Hyvarinen et al., 2006). Comparing the findings of these traps to the trapping results from these previous studies, it seems likely that both trapping results appeared to be credible and that the addition of panel intercept traps increased the accuracy of the survey.

CONCLUSION

Intercept panel traps proved to be an efficient means to capture a broad range of insect species, including those associated with roots, the lower bole or mid-bole and higher and the best use of these traps would be in general surveys. Bark and ambrosia beetle species captured by intercept panel traps were similar to captures in Lindgren funnel traps in previous studies in the southeastern United States. When trapping species associated with roots, the use of pitfall traps to supplement panel intercept traps appears to be advisable. Pitfall traps would also be a useful supplement if the capture of live insects is an objective. Flight intercept traps captured the same species as panel intercept traps but in fewer numbers. Panel intercept traps proved to be durable and capable of use over long-term surveys with only minimal maintenance. Year-long intercept panel trapping appear to be applicable in instances when the traps must be sturdy, and a broad range of species are to be collected. Compared to the flight intercept and pitfall traps, intercept panel traps had an obvious superiority at capturing flying insects. Pitfall traps, due to their specialized role in capturing root feeding insects provided a valuable complement. This study was well suited to traps which captured a wide assortment of insect species but more specific traps, such as pitfall traps, would better suit researchers seeking insects living in highly specialized habitats.

Table 1. Mean collection totals of insect species per trap per collection period. Significant differences have different letters. (α= 0.05) indicate significant difference in insect collection between trap type.

Species	Panel trap	FIT trap	Pitfall trap	F-value	P-value
H. salebrosus	16 a	2 b	1 b	254.92	<0.0001
H. tenuis	1 b	0 c	2 a	155.72	<0.0001
H. porculus	3 a	1 b	0 b	131.29	<0.0001
P. picivorus	1 a	0 c	1 b	55.62	<0.0001
H. pales	1 a	0 c	1 b	56.54	<0.0001
D. terebrans	1 a	0 b	0 b	87.11	<0.0001
I. grandicollis	6 a	1 b	0 c	368.15	<0.0001
G. materiarius	17 a	1 b	0 b	502.72	<0.0001
X. crassiusculus	1 a	1 b	0 c	101.20	<0.0001
X. saxesenii	3 a	0 b	0 c	202.63	<0.0001
T. dubius	2 a	0 b	0 b	88.61	<0.0001
T. virescens	3 a	0 b	0 b	263.27	<0.0001

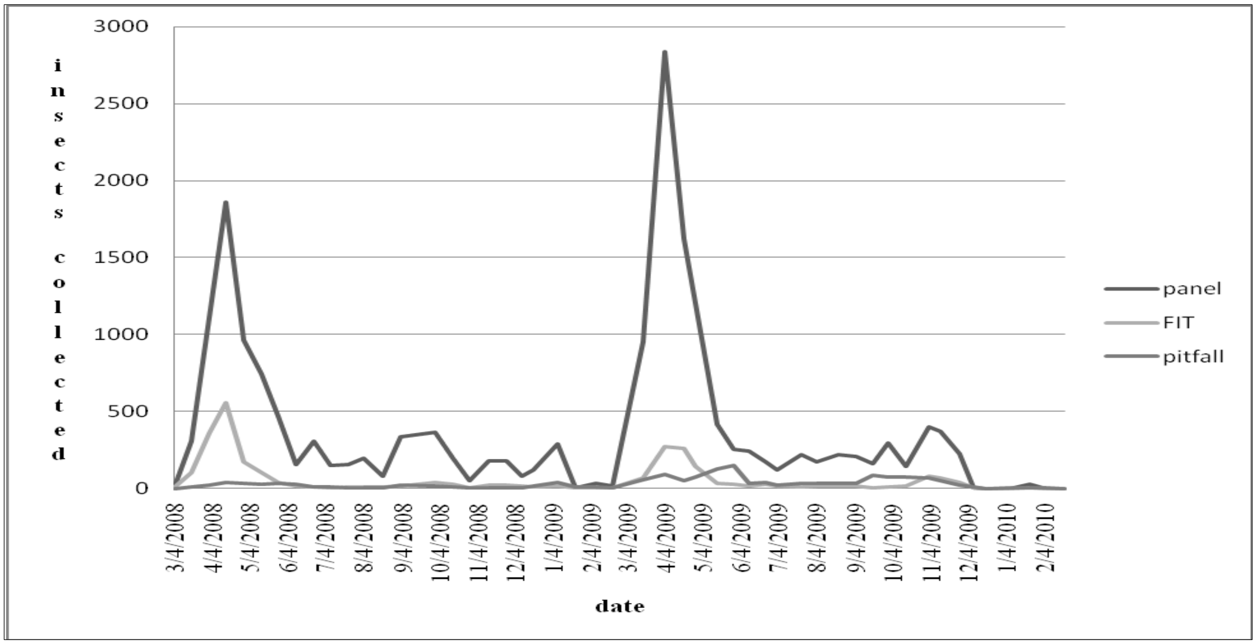

Figure 1. *Hylastes salebrosus* totals at panel, flight intercept and pitfall traps over two-year period.

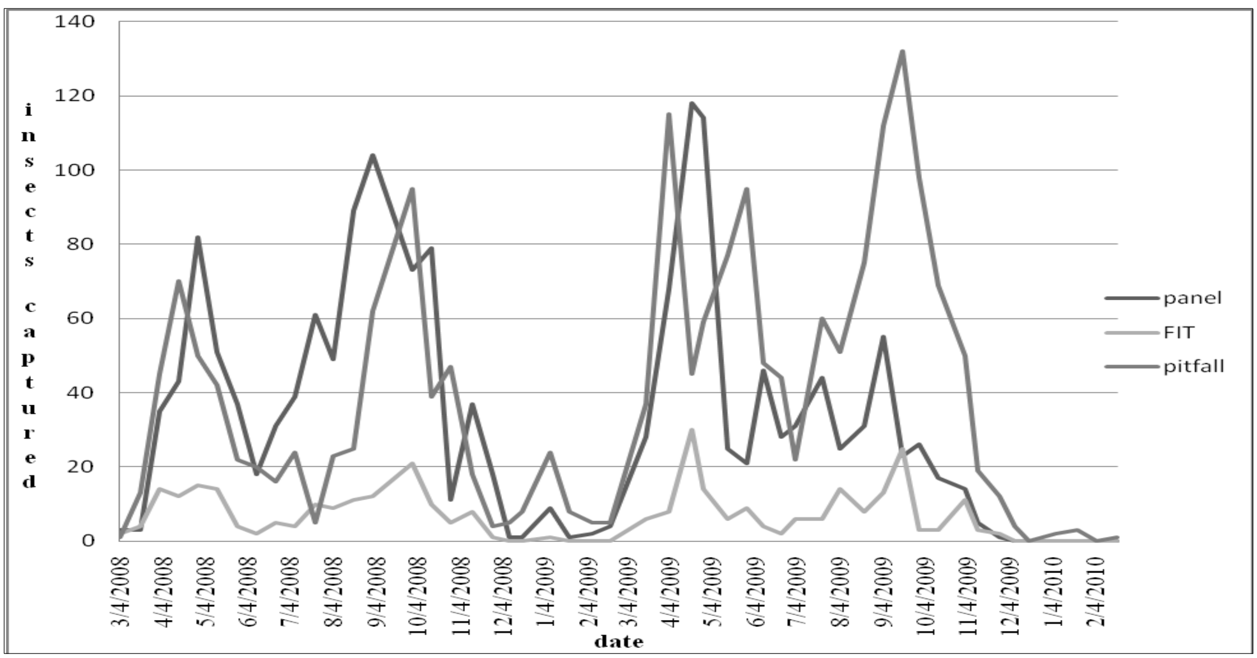

Figure 2. *Hylastes tenuis* totals at panel, flight intercept and pitfall traps over two-year period.

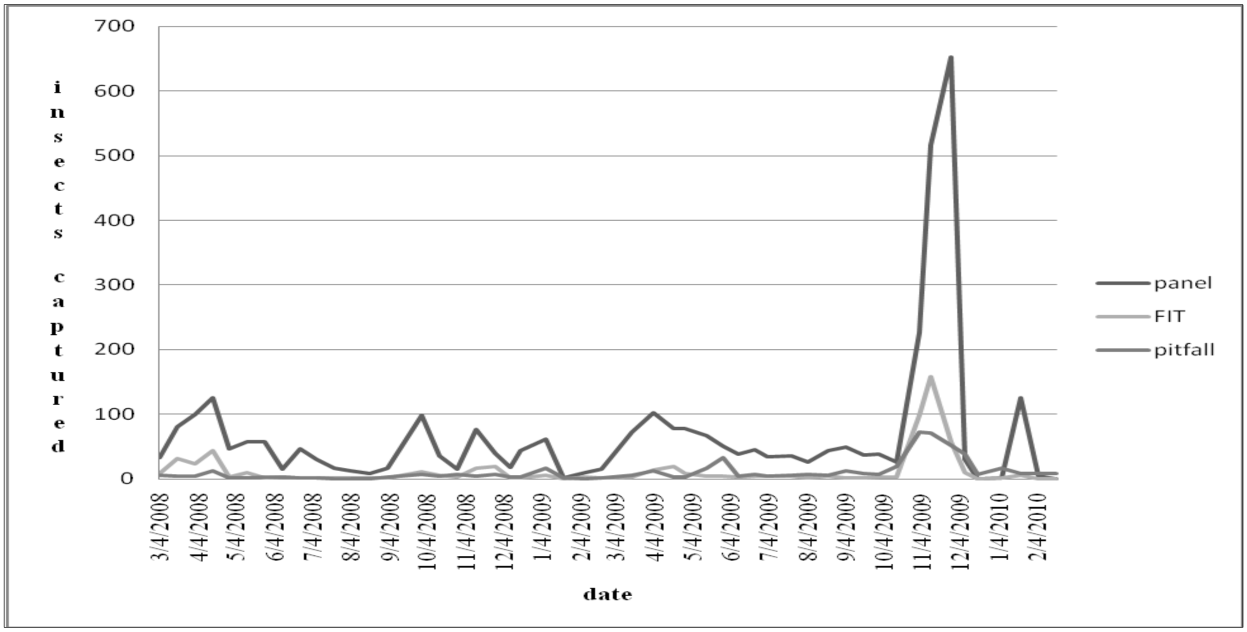

Figure 3. *Hylastes porculus* totals at panel, flight intercept and pitfall traps over two-year period.

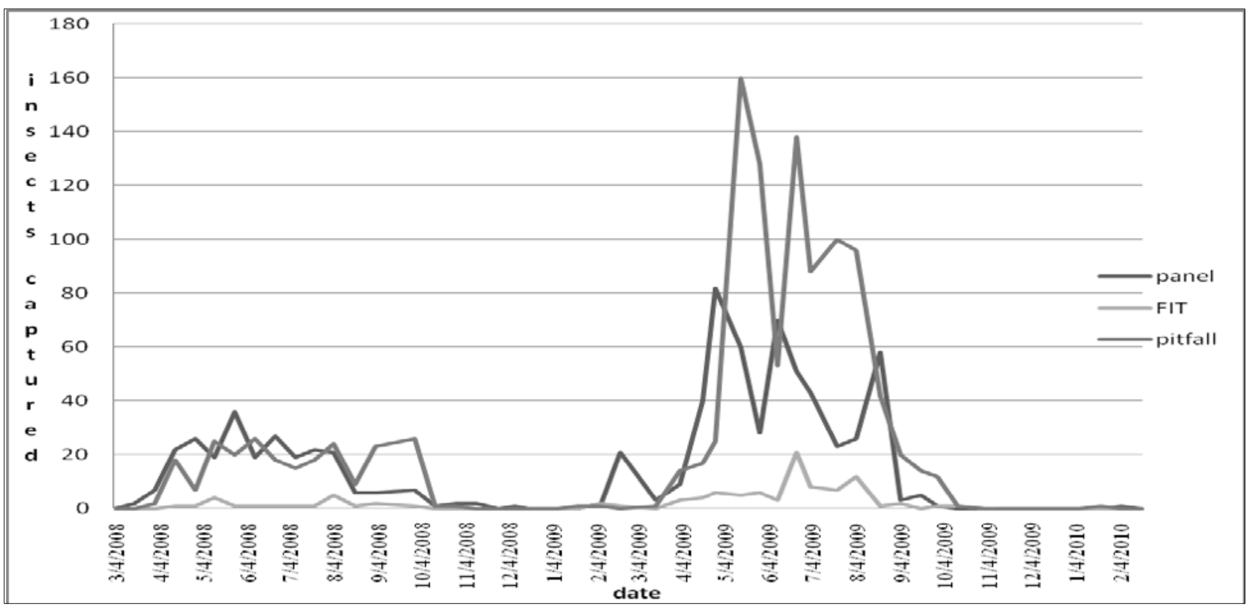

Figure 4. *Pachylobius picivorus* totals at panel, flight intercept and pitfall traps over two-year period.

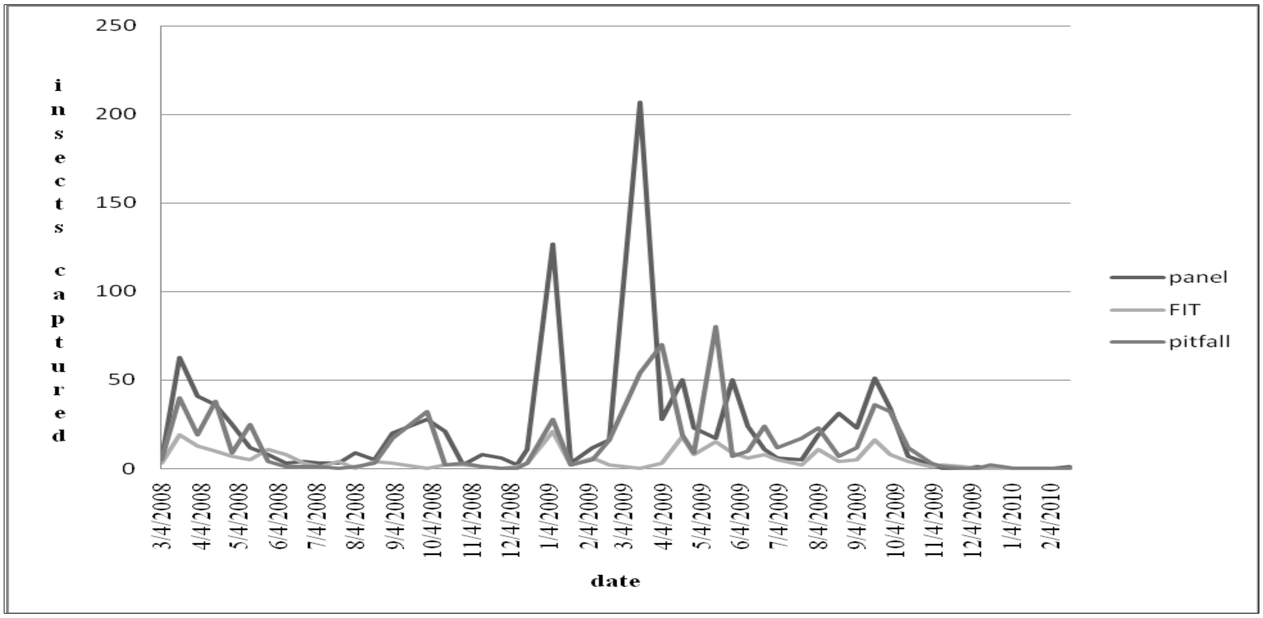

Figure 5. *Hylobius pales* totals at panel, flight intercept and pitfall traps over two-year period.

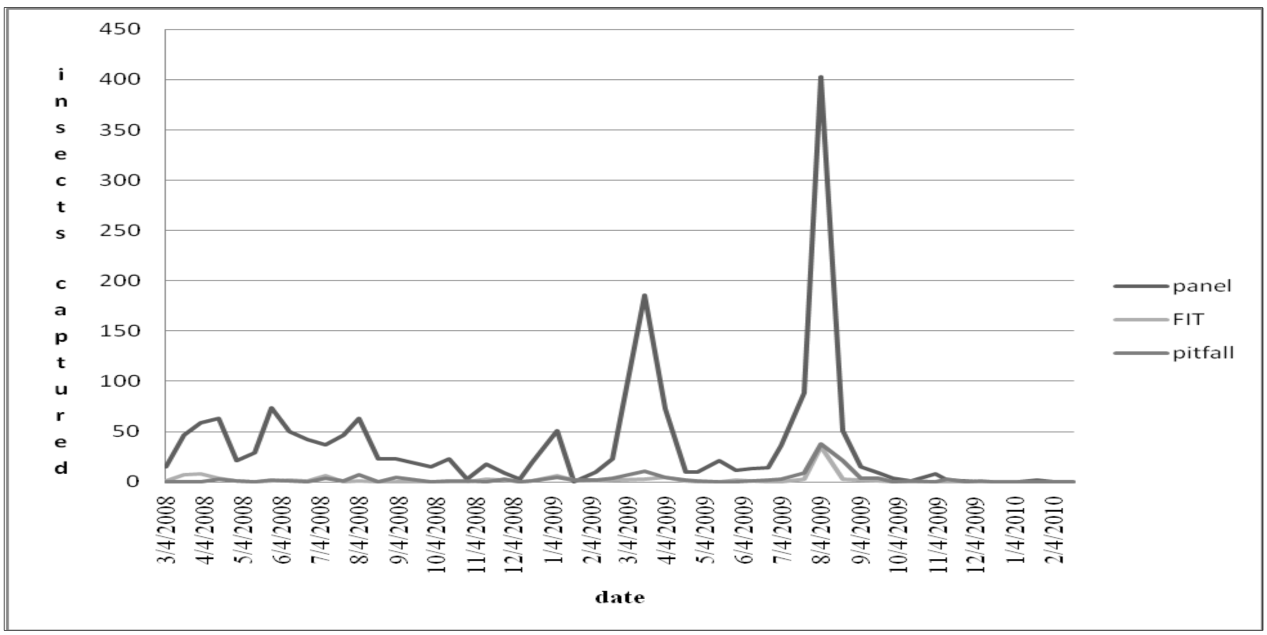

Figure 6. *Dendroctonus terebrans* totals at panel, flight intercept and pitfall traps over two- year period.

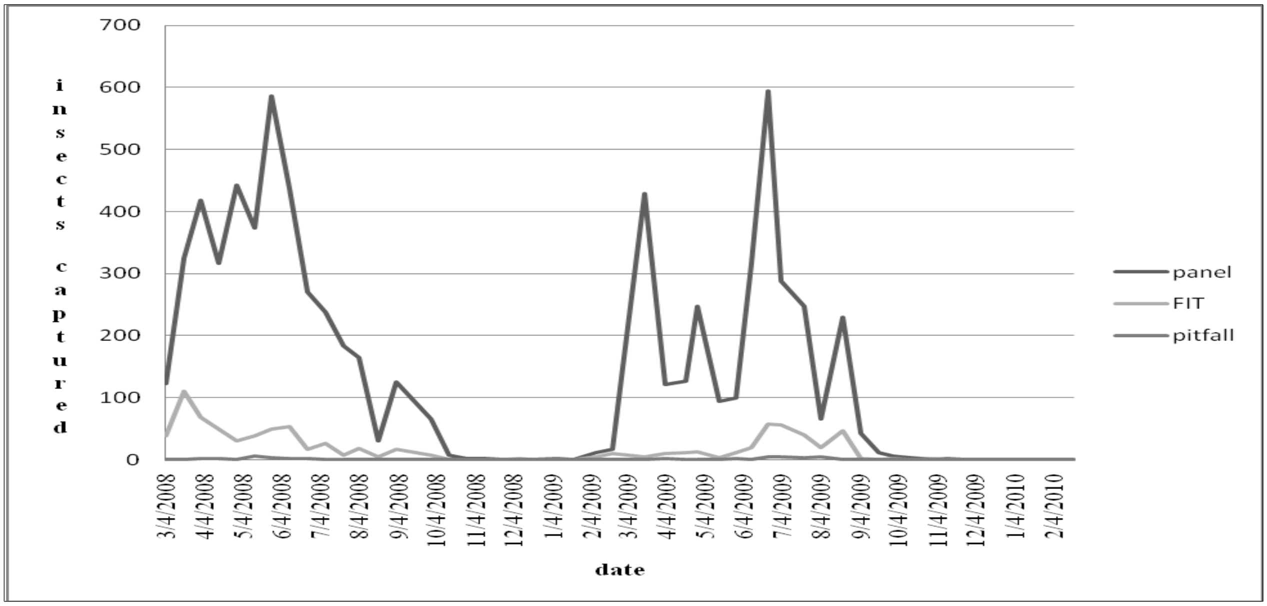

Figure 7. *Ips grandicollis* totals at panel, flight intercept and pitfall traps over two-year period.

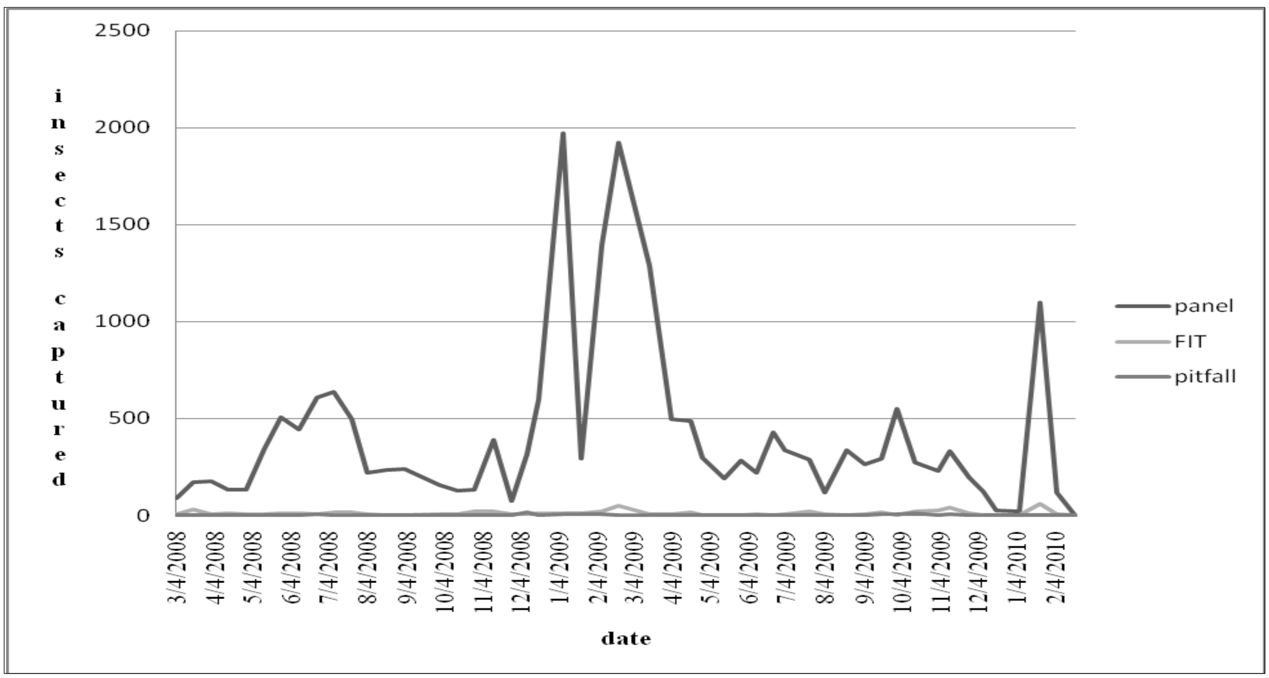

Figure 8. *Gnathotrichus materiarius* totals at panel, flight intercept and pitfall traps over two-year period.

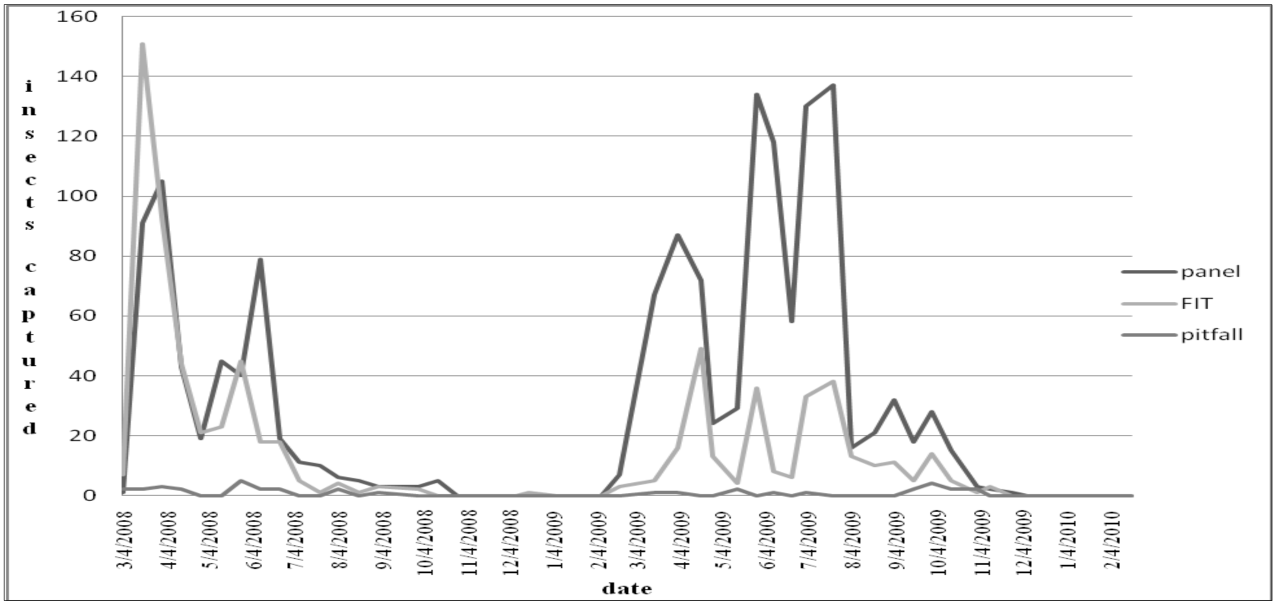

Figure 9. *Xylosandrus crassiusculus* totals at panel, flight intercept and pitfall traps over two-year period.

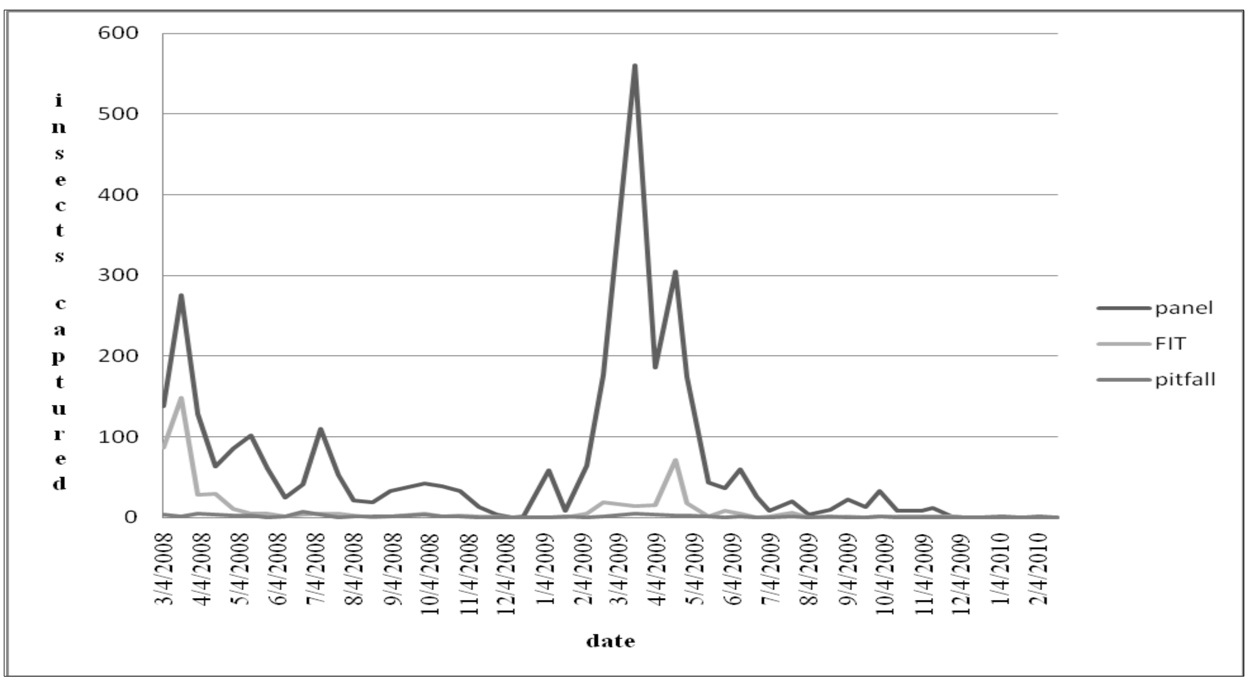

Figure 10. *Xyleborinus saxesenii* totals at panel, flight intercept and pitfall traps over two-year period.

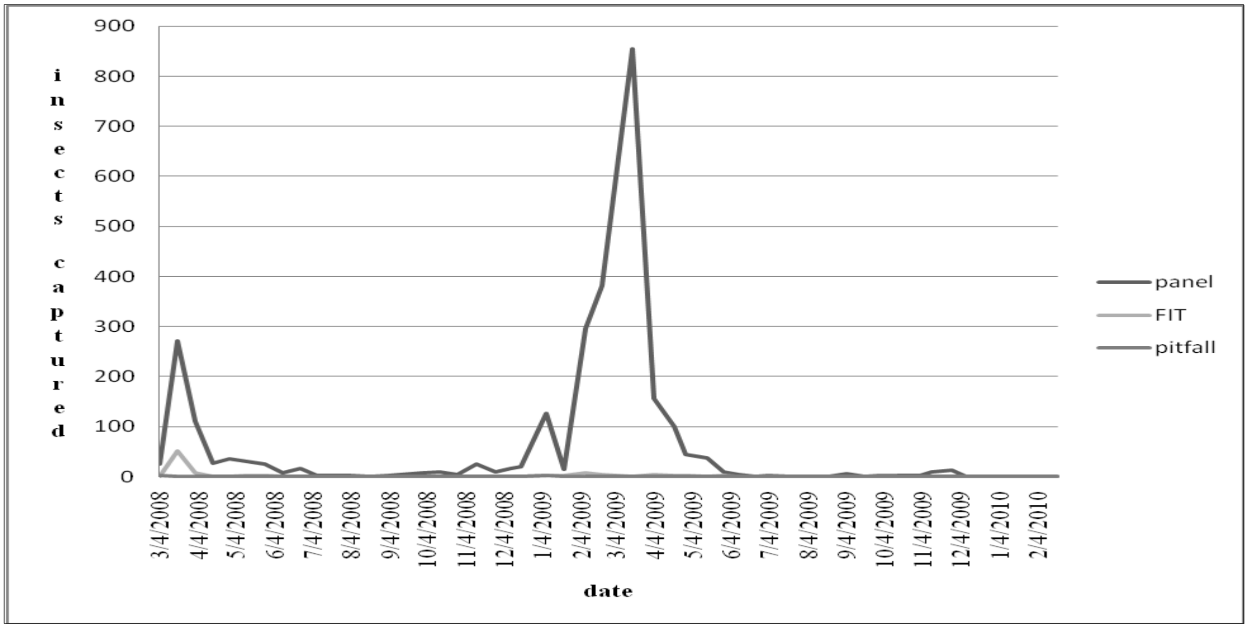

Figure 11. *Thanasimus dubius* totals at panel, flight intercept and pitfall traps over two-year period.

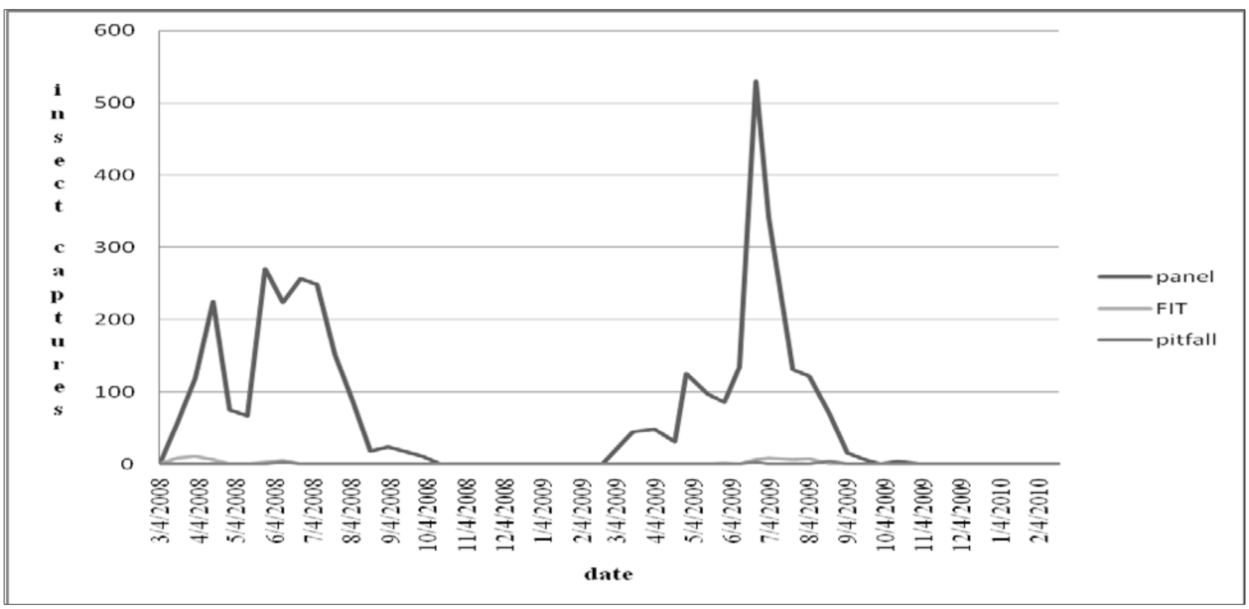

Figure 12. *Temnoscheila virescens* totals at panel, flight intercept and pitfall traps over two- year period.