BIOLOGICAL INVASION: THE IMPACT OF RED IMPORTED FIRE ANTS ON SMALL MAMMALS

WENDEE FINLAY
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W. E. Grant
Dr. William E. Grant
Fellows Advisor

Dale T. Knobel

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INTRODUCTION

While most introduced species do not become established, those that do often have biological attributes that allow them to be extremely successful invaders (Newsome & Noble 1986). These attributes include small body size, high mobility, wide potential niche, high population growth, and high fecundity (Di Castri 1990). The Red Imported Fireant, or RIFA, (Solenopsis invicta), introduced near the port of Mobile, Alabama in the 1940's (Hung and Vinson 1978), possesses all of the above-mentioned characteristics (Maxwell et al. 1982, Vinson & Greenburg 1986, Porter 1988), and has been a particularly successful invader. This aggressive, omnivorous ant species has colonized over 100 million hectares in the southern US since its introduction, and continues to move westward, despite eradication and control efforts (Lofgren 1986). Such a widespread and successful exotic is apt to affect the structure of those communities it invades. Research has documented a decline in the diversity of native ant and arthropod decomposer communities after invasion by red fire ants (Porter & Savignano 1990, Vinson 1991). Imported fire ant predation on various vertebrate species has been extensively documented (Hill 1969; Mount 1981; Mount et al. 1981; Ridlehuber 1982; Masser & Grant 1986; Sikes & Arnold 1986; Flickinger 1989). However, little is known about the ecological response of vertebrate populations to fire ant invasion. Smith et al. (1990)

found that transient northern pigmy mice (Baiomys taylori) were trapped more frequently in areas of high fire ant mound density than were resident mice. Residents avoided areas of high mound density throughout the year. Killion et al. (in press) found that pigmy mice were captured more frequently in areas where fire ants had been removed than untreated areas. In addition, pigmy mice burrows were located in areas that had low ant foraging activity during certain months of the year.

This recent research suggests that Red Imported Fire Ants are most likely to impact ground-dwelling vertebrates by subtly altering patterns of habitat utilization. In light of the recent findings, I examined the impact of Red Imported Fire Ants on habitat use by small mammals in a post-oak savanna community. Specifically, I compared habitat use by small mammals to habitat use by RIFA's, and to 8 vegetation variables.

METHODS

The study was conducted on the Texas A&M University Range Area, 10 km. southwest of College Station, Texas from September 1991 through November 1992. Climate consists of warm, wet winters and hot, dry summers. Dominant plant species include brownseed paspalum (Paspalum plicatulum), little bluestem (Schizachyrium scoparium), yaupon (Ilex vomitoria), and southern dewberry (Rubus trivialis).

A 9 x 9 grid, with 10m spacing between grid points, was established in an old field. Small mammals and fire ants were sampled at each grid point during the study, and vegetation was characterized at each point. Sampling occurred during three distinct periods, Sep-Oct 1991 (Fall 91), Mar-May 1992 (Spring 92), and Sep-Oct 1992 (Fall 92), which roughly correspond to Fall & Spring in east-central Texas.

SMALL MAMMAL SAMPLING

Small mammals were censused, using Sherman live traps (7.5 x 9 x 23cm), for 5 weeks in Fall 91, 4 weeks in Spring 92, and 5 weeks in Fall 92. One "week" consisted of 3-4 days of daily trapping, followed by 3 to 4 days of no trapping. Small mammals were trapped for 4 days per week unless weather conditions were too severe for field work. Traps were baited between 1600 and 1800 each evening, and were checked between 0530 and 1000 the following morning. Bait consisted of a mix of millet, corn, and wheat. Granular ant poison was placed under each trap to prevent small mammal mortality (Chabreck et al. 1986). Each animal captured was marked with a unique numbered ear tag. Species, sex, weight, identification number, and location were recorded for each individual, and animals were released at the point of capture.

FIRE ANT SAMPLING

Fire ant foraging activity was measured four times in Fall 91, twice in Spring 92, and 14 times in Fall 92. Plastic containers (35mm film canisters) were baited with dry cat food and placed on their side at each grid point. After 10 minutes, containers were capped and collected and number of fire ants was counted at a later time. Average number of fire ants was calculated for each grid point. The fire ant population was assumed to be polygyne based on mound densities at the site (240 mounds/ha; Greenburg et al. 1985, Vinson & Sorensen 1986) and personal communication with S.B. Vinson (Dept of Ento, TAMU).

VEGETATION SAMPLING

Vegetation was sampled during the Fall 1992 period. At each grid point, a circular quadrat with a 1.5m radius was established. Percent of ground surface covered by litter, bare ground, grass, forbs, and woody vegetation was estimated visually and recorded for each quadrat. Depth of litter, and height of woody and nonwoody vegetation also were recorded (Bonham 1989).

STATISTICAL ANALYSIS

Data were analyzed on the individual, population, and community levels. At the individual level, number of captures at each grid point provided an index of habitat use for each small mammal species. Average number of ants at each grid point was used as an index of fire ant foraging activity. Analysis consisted of 4 series of stepwise linear regressions (SAS User's Guide 1990) with the data aggregated across seasons (series1), and analyzed for each season (series 2, 3, and 4). Within each series, one regression was run for each of the different small mammal species. Number of captures per grid point of each small mammal species was the dependent variable, and average number of RIFA's per grid point, and each of 8 vegetation variables were independent variables. The variable selection procedure used only included vegetation variables that were significant at the p=0.15

level or less in the regression model. Average RIFA foraging activity was included in each regression model.

For the population level analysis, high and low RIFA foraging activity areas were delineated based on whether grid points had greater or less than average foraging activity. Number of unique individuals captured was used as an index of population size for each small mammal species. Population size was compared between high and low RIFA areas. One would expect population sizes to be equivalent in high and low RIFA areas if small mammals are not preferentially avoiding areas of high ant activity. Community level analysis consisted of comparing species diversity between high and low ant activity areas, based on Shannon-Wiener diversity values (Brower & Zar, 1984).

RESULTS

During the study, a total of 653 captures were made of 533 individuals belonging to four species. Northern pigmy mice, (Baiomys taylori), white-footed mouse (Peromyscus leucopus), hispid cotton rat (Sigmodon hispidus), and the eastern harvest mouse (Reithrodontomys humulis) comprised 34%, 33%, 25%, and 8% of all captures, respectively.

Individual-level results

Red imported fire ants did not explain a significant amount of the variation in habitat use by any of the four small mammals species when data were aggregated across seasons (Table 1), or when data were analyzed separately for each season (Tables 2,3, and 4). Vegetation characteristics most influencing small mammal habitat use varied between species. R. humulis were consistently positively correlated with percent litter cover during each season, and for the entire study period (Tables 1-4). P.leucopus showed a significant positive association with height of woody vegetation in Fall 91 ($p<0.01$; Table 2b), and with percent cover of woody vegetation in Spring 92 ($p<0.01$; Table 3b), Fall 92 ($p<0.10$; Table 4b), and for the entire study period ($p<0.01$; Table 1b). The positive correlation with height of woody vegetation and percent woody cover implies P.leucopus prefer wooded, or shrubland areas over open areas. B. taylori was negatively associated with height of woody vegetation for Spring 92 ($p<0.02$; Table 3a), Fall 92 ($p< 0.10$; Table 4a), and for the entire study period ($p< 0.06$). Interestingly, during Spring of 92, B. taylori were positively associated with percent woody vegetation ($p<0.01$; Table 3a) while being negatively correlated with height of woody vegetation. These seemingly anomalous results may be due to small sample sizes during Spring and Fall 92 (11 and 20 captures respectively). Factors influencing S. hispidus habitat use varied between seasons. Overall trends imply they prefer woody or shrubland areas. During Fall 92, no variable explained a significant amount of variabilty in S. hispidus distribution (Table 4d). Again, this may be due to small sample size (11 captures).

Population level results

Average RIFA foraging activity for the study period was 8.35 ants/trap. Thirty of 81 grid points (37%) were classified as high

RIFA Areas (average >8.35 ants/trap). Since 37% of the grid was composed of high RIFA areas, the null hypothesis predicts 37% of the population of each species would be in high RIFA areas. Each small mammal species closely conformed to the expected values. The population size of B. taylori within high RIFA areas was 37% of the total B. taylori population, conforming exactly to the expected value. 43% of the S. hispidus population, 31% of the R. humulis population, and 38% of the P. leucopus population was in high RIFA areas. Thus, in no case was the null hypothesis rejected.

Community-level results

Species diversity, based on the Shannon-Wiener index, was 0.557 for the entire grid, and differed little when calculated for the low RIFA areas (0.558) and high RIFA areas (0.545).

DISCUSSION

Individual, population, and community level results from this study all suggest that red imported fire ants are not influencing patterns of habitat utilization by small mammals on the Texas A&M Range Area. Vegetation characteristics influencing patterns of habitat use by small mammals were consistent with prior research. Masser (1987) found that B. taylori prefer grassy areas, which is consistent with the negative association with percent woody vegetation that I found. The positive association of both S hispidus and P. leucopus with wooded or shrubby areas also supports Masser's (1987) findings.

The lack of correlation between fire ant activity and small mammal habitat use in my study contrasts with other recent findings. Killion & Grant (in press), found a significant negative correlation between fire ant mound density and both S.hispidus and P.leucopus captures at a 900m^2 resolution, but not at a 100m^2 resolution. They found that B.taylori captures were not correlated with mound density at the Texas A&M Range Area at any level of resolution, but were significantly negatively correlated with mound density at the Welder Wildlife Foundation at a 100m^2 resolution. Their results suggest scale is an important consideration when studying small mammals with different home range sizes. My study was closer to the 100m^2 resolution (81m^2), and therefore I may not have been able to detect changes in habitat use by P. leucopus and S. hispidus . Perhaps a study on a larger scale may be able to detect impacts of fire ants on these small mammals with larger home ranges.

Killion et al. (in press) conducted a fire ant removal study, and found that significantly more B.taylori were captured in areas where RIFA's had been removed than in RIFA-infested areas. They concluded that fire ants reduced carrying capacity for certain small mammal species. During the latter half of Spring 92, I removed fire ants from a portion of my grid to determine if individual small mammals would shift their home ranges to treated areas. This project was discontinued because recaptures of resident individuals were too infrequent. However, this would be an interesting future project for study areas with high small mammal recapture rates.

Killion et al. (in press) observed S. hispidus removing fire ants from their fur after being released from a trap. This indicates that small mammals probably are not vulnerable to fire ant predation while foraging. Small mammals may be more susceptible to RIFA predation when confined to their burrow during daytime hours. Killion et al. (in press) did find B. taylori burrows were located in areas of low ant activity compared to a random point. However, D. Ferris (pers. comm.) found that S. hispidus burrows are not located in areas of low ant activity, nor did removal of fire ants significantly alter patterns of habitat use by S. hispidus. He suggests that fire ant impacts may be species-specific. Certain species may not be affected by fire ant invasion, while other species may subtly alter patterns of microhabitat use as a result of fire ant invasion. Killion & Grant (in press) suggest that fire ant foraging activity, measured by number of S. invicta workers recruited to bait, may not be an accurate index of habitat use by RIFA's. Foraging by workers is extremely variable, and depends on factors such as other food sources available and weather. Mound density or number of minutes to recruit workers may provide better estimates of fire ant habitat use.

The fire ant population on the Welder Wildlife Refuge appeared to be monogyne, whereas the population on the Texas A&M Range Area is most likely polygyne. Monogyne populations are territorial and have significantly lower mound densities than polygyne populations (Greenburg et al. 1985). Killion et al. (in press) found that B. taylori locate burrows in pockets of low RIFA activity areas on areas with monogyne fire ant populations. Low RIFA areas may not exist on areas with polygyne populations due to high ant densities, and lack of ant territoriality. Fire ant foraging activity on my study area was not significantly associated with any of 8 measured vegetation variables, indicating a relatively even distribution throughout the grid. Low ant activity areas also may change seasonally. Seasonal analysis may provide a more accurate picture of small mammal and fire ant habitat use, but sample size often is reduced greatly. Areas infested with polygyne fire ants may have reduced carrying capacity for certain small mammal species compared to areas without fire ants. Fire ant removal studies have been conducted only in areas with monogyne fire ants. Removing polygyne fire ants in order to assess the impacts on carrying capacity for small mammals would be an interesting future study.

Overall, my findings are inconclusive. Either the small mammal species in my study area are not affected by fire ant invasion, or they are affected in ways more subtle than my analysis could detect.

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LITERATURE CITED

Bonham, C.D. 1989. Measurements for terrestrial vegetation. John Wiley and Sons, New York, 338 pp.

Brower, J.E., and J.H. Zar. 1984. Field and laboratory methods for general ecology. Wm. C. Brown Publishers, Dubuque, Iowa, 228 pp.

Chabreck, R.H., B.U. Constantin, and R.H. Hamilton. 1986. Use of chemical ant repellants during small mammal trapping. The Southwestern Naturalist, 31:109-110.

Di Castri, F. 1990. On invading species and invaded ecosystems: the interplay of historical chance and biological necessity. Pp.3-16, in Biological invasions in Europe and the Mediterranean Basin (F.Di Castri, A.J. Hansen, and M. Debussche, eds.). Kluwer Academic Publishers, Boston, Massachusetts, 463 pp.

Flickinger, E.L. 1989. Observations of predation by red imported fire ants on live-trapped wild cotton rats. Texas Journal of Science, 41:223-224.

Greenburg, L., D.J.C. Fletcher, and S.B. Vinson. 1985.

Differences in worker size and mound distribution in monogynous and polygynous colonies of the fire ant Solenopsis invicta Buren. Journal of the Kansas Entomological Society, 58:9-18.

Hill, E.P. 1969. Observations of imported fire ant predation on nestling cottontails. Proceedings of the Southeastern Association of Game and Fish Commissioners, 23:171-181.

Hung, A.C.F., AND S.B. Vinson. 1978. Factors affecting the distribution of fireants in Texas (MYRMINICINAE:FORMICIDAE). The Southwestern Naturalist, 23:205-214.

Killion, M.J., and W.E. Grant. In press. Scale, mound density, and foraging activity in assessing the effects of red imported fire ants on small mammals.

Killion, M.J., W.E. Grant, and S.B. Vinson. In press. Small mammal response to removal of imported fire ants.

Lofgren, C.S. 1986. History of imported fireants in the United States. Pp. 36-47 in Fireants and leaf-cutting ants (C.S. Lofgren and R.K. Vanderneer, eds.). Westview Press, Boulder, Colorado, 435 pp.

Masser, M.P. and W.E. Grant. 1986. Fireant-induced trap mortality of small mammals in east-central Texas. The Southwestern Naturalist. 31:540-542.

Maxwell, F.G., W.A. Banks, J.L. Bagent, W.L. Buren, O. Franke, S. Risch, A. Sorensen, W.L. Sterling, and J.L. Stimac. 1982. Population dynamics of the imported fire ant in Proceedings of the symposium on the imported fire ant.

Mount, R.H. 1981. The red imported fire ant, Solenopsis invicta (HYMENOPTERA:FORMICIDAE), as a possible serious predator on some native southeastern vertebrates: direct observations and subjective impressions. Journal of the Alabama Academy of Science, 52:71-78.

Mount, R.H., S.E. Trauth, and W.H. Mason. 1981. Predation by the red imported fire ant, Solenopsis invicta (HYMENOPTERA:FORMICIDAE), on eggs of the lizard Cnemidophorus sexlineatus (SQUAMATA:TEIIDAE). Journal of the Alabama Academy of Science, 52:66-70

Newsome, A.E., and I.R. Noble. 1986. Ecological and physiological characters of invading species. Pp.1-20, in Ecology of biological invasions (R.H. Groves and J.J. Burdon, eds.). Cambridge University Press, Cambridge, England, 166pp.

Porter,S.D., and D.A. Savignano. 1990. Invasion of polygyne fire ants decimates native ants and disrupts arthropod community. Ecology, 7:2095-2106.

Ridlehuber, K.T. 1982. Fire ant predation on wood duck nestlings and pipped eggs. The Southwestern Naturalist, 27:222.

Sikes, P.J. and K.A. Arnold. 1986. Red imported fire ant (Solenopsis invicta) predation on cliff swallow (Hirundo pyrrhonota) nestlings in east-central Texas. The Southwestern Naturalist, 31:105-106

Smith, S.S., S.A. Smith, and D.J. Schmidly. 1990. Impact of fireant (Solenopsis invicta) density on northern pygmy mice (Baiomys taylori). The Southwestern Naturalist 35:158-162.

Vinson, S.B. 1991. Effect of the imported fire ant (Hymenoptera:Formicidae) on a small plant-decomposing arthropod community. Environmental Entomology, 20:98-103.

Vinson, S.B. and A.A. Sorensen. 1986. Imported fireants: life history and impact. Texas Department of Agriculture, Austin, 28 pp.

Table 1. - Results of Stepwise Linear Regression relating habitat use by 4 small mammal species to average number of RIFA's, and 8 vegetation variables for entire study period. Only the 2 most explanatory vegetation variables are included in the table.

A) Baiomys taylori — R-square = 0.1002

	DF	Mean Square	F	Prob>F
Regression	2	21.6428	2.82	0.0445
Error	78	7.6746		
Total	80			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	2.3449	0.7403	10.03	0.0022
Ave. RIFA	0.0387	0.0590	0.43	0.5137
% Forb Cover	0.0290	0.0161	3.23	0.0762
Ht. Woody Veg.	-0.0027	0.0014	3.68	0.0587

B) Peromyscus leucopus — R-square = 0.1983

	DF	Mean Square	F	Prob>F
Regression	2	54.17	9.65	0.0002
Error	78	5.615		
Total	80			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	2.2953	0.5112	20.16	0.0001
Ave. RIFA	-0.0507	0.0500	1.03	0.3142
%Woody veg.	0.0540	0.0124	18.95	0.0001

C) Reithrodontomys humulis — R-square = 0.0364

	DF	Mean Square	F	Prob>F
Regression	2	1.2735	1.46	0.2395
Error	77	0.8746		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	-1.3190	1.2921	1.04	0.3106
Ave. RIFA	-0.0079	0.0110	0.16	0.6924
% Litter Cover	0.0224	0.0138	2.63	0.1090

D) Sigmodon hispidus — R-square = 0.1169

	DF	Mean Square	F	Prob>F
Regression	3	16.8960	3.35	0.0232
Error	76	5.0377		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	1.8264	0.5803	9.91	0.0024
Ave. RIFA	0.0583	0.0477	1.49	0.2253
% Bare Ground	-0.1665	0.0726	5.27	0.0245
Ht. Woody Veg.	0.0020	0.0011	3.37	0.0704

Table 2. - Results of Stepwise Linear Regression relating habitat use by 4 small mammal species to average number of RIFA's, and 8 vegetation variables for Fall 91. Only the 2 most explanatory vegetation variables are included in the table.

A) Baiomys taylori R-square = 3.4823

	DF	Mean Square	F	Prob>F
Regression	3	18.6540	2.71	0.0508
Error	76	6.8794		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	2.0207	0.6868	8.66	0.0043
Ave. RIFA	0.0326	0.0276	1.39	0.2421
% Forb Cover	0.0303	0.0015	4.06	0.0475
Ht. Nonwoody Veg.	-0.0118	0.0075	2.47	0.1202

B) Peromyscus leucopus R-square = 0.1414

	DF	Mean Square	F	Prob>F
Regression	2	1.6609	6.34	0.0028
Error	77	0.2619		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	0.0431	0.1041	0.17	0.6799
Ave. RIFA	-0.0062	0.0054	1.32	0.2538
Ht. Woody Veg.	0.0008	0.0003	10.22	0.002

C) Reithrodontomys humulis R-square = 0.1290

	DF	Mean Square	F	Prob>F
Regression	3	0.2101	3.44	0.0369
Error	76	0.0582		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	-1.1240	0.5540	4.12	0.046
Ave. RIFA	-0.0020	0.0025	0.65	0.4224
% Litter Cover	0.0113	0.0056	4.09	0.0466
% Bare Ground	0.0383	0.0122	9.81	0.0025

D) Sigmodon hispidus R-square = 0.1309

	DF	Mean Square	F	Prob>F
Regression	3	14.2245	3.17	0.0478
Error	76	3.9120		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	0.6547	0.4883	1.80	0.1840
Ave. RIFA	-0.0163	0.0203	0.64	0.4263
% Woody Veg.	0.0221	0.0101	4.80	0.0314
Ht. Nonwoody Veg.	0.0132	0.0055	5.74	0.0190

Table 3. - Results of Stepwise Linear Regression relating habitat use by 4 small mammal species to average number of RIFA's, and 8 vegetation variables for Spring 92. Only the 2 most explanatory vegetation variables are included in the table.

A) Baiomys taylori R-square = 0.1465

	DF	Mean Square	F	Prob>F
Regression	3	0.3120	4.35	0.007
Error	76	0.0717		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	0.1022	0.0482	4.48	0.0375
Ave. RIFA	-0.0016	0.0022	0.50	0.4802
% Woody Veg.	0.0059	0.0018	11.45	0.0011
Ht. Woody Veg.	-0.0004	0.0002	6.02	0.0165

B) Peromyscus leucopus R-square = 0.1168

	DF	Mean Square	F	Prob>F
Regression	2	15.4234	5.09	0.0084
Error	77	3.0304		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	1.444	0.2919	24.48	0.0001
Ave. RIFA	-0.0039	0.0144	0.07	0.7879
% Woody Veg.	0.0286	0.0092	9.72	0.0026

C) Reithrodontomys humulis R-square = 0.0416

	DF	Mean Square	F	Prob>F
Regression	2	0.6567	1.67	0.1946
Error	77	0.3927		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	-0.8872	0.8550	1.08	0.3027
Ave. RIFA	0.0062	0.0052	1.43	0.2361
% Litter Cover	0.0136	0.0092	2.17	0.1452

A) Sigmodon hispidus R-square = 0.0776

	DF	Mean Square	F	Prob>F
Regression	3	0.5277	2.13	0.1288
Error	76	0.2474		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	0.1355	0.1032	1.73	0.1929
Ave. RIFA	-0.0019	0.0041	0.21	0.6512
% Woody Veg.	0.0039	0.0027	2.13	0.1489
% Forb Cover	0.0064	0.0029	4.90	0.0298

Table 4. - Results of Stepwise Linear Regression relating habitat use by 4 small mammal species to average number of RIFA's, and 8 vegetation variables for Fall 92. Only the 2 most explanatory vegetation variables are included in the table.

A) *Baiomys taylori* R-square = 0.1494

	DF	Mean Square	F	Prob>F
Regression	3	2.1891	4.45	0.0062
Error	76	0.4919		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	0.1800	0.1683	1.14	0.2883
Ave. RIFA	0.0030	0.0151	0.04	0.8447
% Grass Cover	0.0113	0.0042	7.21	0.0089
Ht. Woody Veg.	-0.0006	0.0004	2.77	0.1005

B) *Peromyscus leucopus* R-square = 0.1168

	DF	Mean Square	F	Prob>F
Regression	2	0.6525	1.45	0.2409
Error	77	0.4499		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	0.4033	0.1839	4.81	0.0313
Ave. RIFA	0.0030	0.0143	0.04	0.8332
% Woody Veg.	-0.0135	0.0082	2.73	0.1025

C) *Reithrodontomys humulis* R-square = 0.1290

	DF	Mean Square	F	Prob>F
Regression	2	0.3426	1.46	0.2394
Error	77	0.2353		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	-0.9263	0.6634	1.95	0.1666
Ave. RIFA	0.0017	0.0103	0.03	0.8686
% Litter Cover	0.0122	0.0071	2.91	0.0923

D) *Sigmodon hispidus* R-square = 0.1323

	DF	Mean Square	F	Prob>F
Regression	1	0.0423	0.09	0.761
Error	78	0.4544		
Total	79			

VARIABLE	Parameter est.	SE	F	Prob>F
Intercept	0.1062	0.1272	0.09	0.4064
Ave. RIFA	0.0044	0.0143	0.70	0.7610