VISITOR RESPONSE TO FIRE ANTS IN TEXAS PARKS

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ABSTRACT

This study analyzes the impact of Red Imported Fire Ant (RIFA), Solenopsis invicta (Buren), infestations on recreational visitation to Texas state park facilities. Data representing a nineteen year period were analyzed for thirty-five park facilities. Tests of significance were conducted to determine if visitation to parks with RIFA infestations was affected. Analysis indicates that RIFA's presence in Texas state park facilities at the infestation levels existing in the study period have not affected visitation to those facilities.

INTRODUCTION

Visitors to public recreational park facilities have tolerated pestiferous insect, arachnid (i.e. ticks, mites, spiders, etc.), plant and other biological organisms since parks were first established. Most persons seeking a picnic site consider the presence of any of these pests as a negative influence on enjoyment and prefer sites devoid of such members of the plant and animal kingdoms. However, many picnickers and outdoor activists have come to expect to find that biologically adaptive pest commonly referred to as ants. How many of us have ever been fortunate enough to ingest a meal in an open area without being bothered by ants? Not only does the presence of ants tend to decrease the potential enjoyment of a picnic or outing but their bites and/or stings can result in immense pain leaving a much more lasting impression than merely tolerating their presence.

This study considers the impact of the presence of an ant pest while estimating the aggregate demand for recreational park visitation in the state of Texas. This pest is reported to have been introduced into Mobile, Alabama between 1938 and 1943, and is known as the red imported fire ant (RIFA), Solenopsis invicta (Buren). The RIFA has become an agricultural and urban pest to much of the southern United States. Posing a risk to human health, RIFA also causes damage to a wide range of objects, including machinery, crops, and livestock (Banks, Lofgren and Wojcik, 1978; Wojcik and Lofgren, 1982; and Wojcik, 1986 and 1987).

Spreading in a fan like fashion, RIFA was first recognized to be in Texas in 1953 (Culpepper, 1953). Since then, RIFA's territory within the state has reached approximately 76,827 sq. miles, representing 29 percent of the state (Cokendolpher and Phillips, in review). With this spread of the pest comes an increase of RIFA infested Texas state parks and public exposure to the ant. According to the Texas Parks and Wildlife Department, park operations change very little when a park becomes infested with RIFA (Riskind, 1988). Park personnel chemically treat mounds in "use" areas where conflict could occur. Because of environmental concerns, park administrators generally attempt to minimize chemical use. Therefore, persons visiting RIFA infested parks often come into contact with the pest and establish attitudes about any change in utility caused by the presence of RIFA.

Michalson (1975) reported that Washington state recreational park visitors responding to questionnaires were willing to incur the expense and/or inconvenience to travel to parks which were not infested by Mountain Pine Beetle, Dendro'ctonus pondero'sae (Hopkins). Similarly, Texas state recreational facilities infested by RIFA may be losing park visitors due to visitors attempting to avoid this pest. Or, park visitors may view RIFA as an unavoidable nuisance similar to flies and mosquitoes, continuing to visit parks when RIFA is present.

Whether recreational park visitation is affected by RIFA's presence has not been determined. The purpose of this study is to estimate the impact of the presence of RIFA on recreational park visitation in the state of Texas. An aggregate demand model representing park visitation as the dependent variable was developed. The null hypothesis being tested is that RIFA has no impact on park visitation.

Predominant study methods found in current literature presenting results which explore the response of park visitors to the introduction of a negative influence on their recreational enjoyment will typically use one of two approaches: the travel cost method (TCM) and the contingent valuation method (CVM). The CVM approach relies on the stated intentions of a cross-section of the affected population to pay for recreation use of resources contingent on changes in their availability (Stoll, Shulstad, and Smathers (eds.) 1983; and Cummings, Brookshire, and Schulze (eds.) 1986). The values reported represent the maximum willingness to pay rather than forego the recreation opportunity. Although this method could be used to determine the estimated cost of RIFA in Texas parks, it would merely provide the anticipated impact based on visitor attitudes towards RIFA rather than actual intentions. Attitudes with respect to RIFA may be formed largely by such sensational writings as that written by Emily Yoffe (1988), an article appearing in the Texas Monthly entitled "The Ants From Hell". Thus, it was felt that attitudes may not realistically reflect future intentions to return to infested parks.

The TCM approach to the estimation of the nonmarket value of recreation is based on observed behavior of a cross-section of users in response to direct out-of-pocket travel cost and the opportunity cost of time (see Dwyer, Kelly, and Bowes 1977; McConnell 1985; Rosenthal, Loomis, and Peterson 1984; and Ward and Loomis 1986). The total use of the recreation site is measured objectively, usually in visitor days, using vehicle recorders, camper-registration records, etc. In a Mountain Pine Beetle study in Washington state recreational parks, Michalson (1975) used procedures similar to TCM to collect cross sectional data by interviewing approximately 500 recreational users in six campgrounds of the Targhee National Forest. All areas of the Targhee National Forest have some Mountain Pine Beetle infestation. Three campgrounds were defined as infested (over 50 percent of the trees were affected by Mountain Pine Beetle), and three as non-infested (10-20 percent of the trees infested). He developed statistical demand models for infested, non-infested, and all of the campgrounds in the study. Thus, he was able to determine the Mountain Pine Beetle's impact on park visits. His questionnaire determined origin-destination data, transfer costs of the recreation trip, a profile of the recreational user, and a catalog of the activities in which the responding camper participated. He estimated the annual economic losses of recreation values based on a reliable comparison of visitors' attitudes visiting infested and non-infested campgrounds. Although this method of estimating the cross-sectional impact of the introduction of a pest to public recreational parks is shown to be valid, it is very expensive in terms of both time and money, and again does not necessarily reflect what will actually occur. Alternatively, the current paper reports an estimate of the actual historical impact of RIFA on park visitation in Texas.

METHODS

Secondary data from both state and federal agencies were used in this study. Texas Parks and Wildlife Department (TPWD) provided in-house summaries of annual number of visitors and revenues generated from entrance fees and concession receipts representing individual parks (TPWDa-

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c). The summaries were developed from park entrance registration forms. Another publication provided by TPWD described available facilities, size and location of each park in the state park system (TPWDd). Texas statewide population and per capita income were obtained from the U. S. Bureau of Census. Population between census time periods was interpolated at an average rate between years. A study by Cokendolpher and Phillips (in review) described the movement of RIFA and years in which counties became infested with the pest. It was assumed that infested counties have infested parks. Thus, county infestation dates established by Cokendolpher and Phillips were assumed to represent park infestation dates.

Data for thirty-five parks over a 19 year period (fiscal years 1969 to 1987) were gathered. Data for fiscal year 1976 for some variables were unavailable, reducing the number of study years to eighteen over the nineteen year study period. Criteria for those parks selected to be used in the study were i) they represent an outdoor recreation state park facility used primarily for overnight camping, and ii) annual data for the eighteen years during the study period were complete.

Time is required for RIFA to become introduced into an area, become established, and reproduce to a pestiferous population level allowing visitors to react to the presence of the pest. Therefore, the data for the thirty-five parks were separated into three categories based on whether a park: a) never had RIFA during the study period (four parks); b) had RIFA during the entire study period (nine parks); or c) became infested with RIFA during the study period (twenty-two parks). Two analysis were then conducted. The first analysis represented a test to determine whether parks infested with RIFA throughout the study period had lower visitation than parks free of the pest throughout the study period. This data set consisted of thirteen parks comprising nine infested and four non-infested parks. Acreage of parks without RIFA ranged from 573 to 1869 acres, while parks with RIFA ranged from 105 to 4860 acres.

The second analysis represented a test to determine whether parks becoming infested with RIFA during the study period had fewer visitors after infestation than before. This data set consisted of twenty-two parks having an average of 1,123 acres ranging from 105 to 5200 acres. Analyzing this data was difficult, because the time required for the pest to become introduced into a park and to reach a population density considered pestiferous by visitors has not been determined. Therefore, in an effort to account for this lack of information the data were analyzed numerous times allowing the variable representing RIFA's presence to be lagged by successive years. Thus, when the variable was lagged by five years this signified that the RIFA population density reached a pestiferous status in its fifth year in the parks. It was assumed that park aesthetics, facilities and/or attractions were not changed during the study period and when a county becomes infested, the parks within the county are also infested.

To accomplish the study objectives, demand analysis must be used to estimate the impact particular variables have on the level of visitation to Texas state parks. Among other variables, a qualitative variable was developed for the presence of RIFA. The estimated statistical significance/insignificance of this variable was used to determine whether RIFA's presence has altered park visits. Several variables required modification and/or omission from the model due to the inflexible nature of using these data. For the purpose of this study it was desirable to use regressors which were consistent with previous studies. The unit of observation is a given park in a given year. The dependent variable park visitation (PV) was transformed from yearly park totals to a per capita basis as advised by Brown et al. (1983).

The model was developed to include as many of the explanatory variables as was possible with available data. Independent variables used in the model included Texas per capita income (TPCI) representing income of the population most likely to attend the parks, average cost per visit to each park (AVGCOST) representing the ratio of gross receipts from visitor expenditures and total number of visitors, park size in acres (ACRES), annual average price per barrel of crude oil (OIL) used as a travel cost proxy, and a qualitative variable representing the presence of RIFA (RIFA). The annual average price per barrel of crude oil was used as a travel cost proxy for the model.

The general model (aggregate visitation model) analyzed was:

$$PV = f(TPCI, AVGCOST, ACRES, OIL, RIFA) \quad (1)$$

where:

PV = number park visitations per capita people,

TPCI = Texas total per capita income, dollars per year,

AVGCOST = per capita visitor expenditures developed as a ratio of gross receipts and park visitation,

ACRES = park size in acres,

OIL = average price per barrel of crude oil (travel cost proxy)

RIFA = dummy variable representing the presence (1) or absence (0) of RIFA.

Anticipated relationships between dependent and independent variables are represented in the signs of derived coefficients of explanatory variables. It was expected that results would indicate a positive relationship exists between the dependent variable PV and independent variables TPCI and ACRES. Thus, it was anticipated that as visitors' incomes increase and/or as park acreage increases, then the number of visitors will also increase. It was expected that results will indicate a negative relationship exists between the dependent variable PV and independent variables AVGCOST, and OIL. Therefore, it was anticipated that as the cost of visiting parks increase, through either expenses at parks or the expense of getting to parks, visitation to parks will decrease. It was expected that if RIFA has affected park visitation, that the impact would cause a decrease in visitor enjoyment, resulting in a decrease in park visitation.

The choice of mathematical functional form for outdoor recreation demand was addressed by Ziemer, Muesser and Hill (1980). They reported that the selected form can have a significant impact on resulting recreation demand equations. To identify the most appropriate functional form necessary for this study, the data were analyzed using the semilog (the dependent variable logged), and log-log functional forms. To alleviate any problems in data transformation to the logarithmic form, the RIFA dummy variable assumed the value of 2.7183 in the presence of RIFA, and 1 in the absence of RIFA.

Advanced statistical procedures were required because the data represented the combination of time-series and cross-sectional groups. A time-series group is represented by eighteen study years of data for one park, while a cross-sectional group is represented by observations of all parks during one time period. The data used in this study represent park observations made over time and observations made over groups of parks within periods. The combination of both types of data is referred to as "pooled time-series and cross-section data".

Time series data often pose problems of correlation between periods (i.e. serial correlation) while cross-sectional data often result in unequal variances (i.e. heteroskedasticity) between experimental units, or parks as in this case. Therefore, because of the potential problems which may result from using this data, residuals from the ordinary least squares (OLS) estimation of equation (1) were tested for heteroskedasticity by park, and for serial correlation over time. The estimated Durbin-Watson statistic was 0.5446, indicating the presence of positive autocorrelation. The assumption of homoskedasticity was rejected using the Goldfeld-Quandt test ($P<.01$) (Pindyck and Rubinfeld, 1976, p. 104-105). To correct the data for the combined problems of autocorrelation and heteroskedasticity the data were transformed using pooling procedures outlined by Kmenta (1986, p. 618). Therefore, differences between parks such as distance from populated areas or varying attractions will not affect analysis results.

RESULTS AND DISCUSSION

Results of testing the two nonlinear functional forms (semilog and log-log) on the data are listed in Table 1. Both models resulted in relatively high coefficients of multiple determination (R^2) with a difference of only .069 between the two models. The Student t-values in parenthesis beneath their respective parameters indicate that ACRES and OIL are insignificant at the 5 percent level in the semilog model, while only OIL is insignificant at the 5 percent level in the log-log model. Whether statistically significant, or not, both models provide signs of the estimated coefficients which are consistent with a priori expectations. Because the log-log model held more variables as significant at the 5 percent level, and there is so little difference between the model coefficients of multiple determination, the log-log functional form was accepted as the most appropriate form for the data set, and used for further analysis.

A test to determine whether parks infested with RIFA throughout the study period had lower visitation due to the presence of the pest, than parks free of the pest throughout the study period was conducted. Thirteen parks comprising nine infested and four non-infested parks were represented in this phase of the analysis. The resulting parameters and Student t-values of the log-log model are listed in Table 2. The model provides signs of the estimated coefficients consistent with a priori expectations. The Student t-values in parenthesis beneath their respective parameters indicate that OIL and RIFA are insignificant at the 5 percent level.

A test of analysis was next conducted on data representing twenty-two parks which became infested with RIFA during the study period. The purpose of this phase of the study was to determine whether park visitation was affected when the presence of the pest was recognized by visitors in parks which had become infested during the study period. As previously stated, the time required for the pest to become introduced into a park and to reach a population density considered pestiferous by visitors, has not been determined. Therefore, the data were analyzed eleven times allowing the variable representing RIFA's presence to be lagged by successive years. Because parks became infested at different times, some parks are omitted from the data set when the lagging of the RIFA variable indicates that the park was infested throughout the study period, or not infested during the study period. Therefore, differences in data observations occurred between analysis of the lagged models. The resulting parameters and Student t-values of the log-log lagged models are listed in Table 3. Each model provides signs of the estimated coefficients consistent with a priori expectations. The Student t-values in parenthesis beneath their respective parameters indicate that OIL and RIFA are insignificant at the 5 percent level for each model. The RIFA variable's statistical insignificance agrees with results listed in Table 2, suggesting that either the state park system is keeping "use" areas sufficiently clear of RIFA such that visitors are not being bothered, or visitors are viewing RIFA as a necessary nuisance which must be tolerated if wishing to continue visiting parks.

CONCLUSIONS

It has been shown that the current level of RIFA infestations within the Texas park system has not affected park visitations to date. This implies that RIFA has caused no discernable economic impact to the state park system. Perhaps factors other than RIFA are more important to park visitors in determining park visitation rates if RIFA are considered in the same category by visitors as flies, mosquitoes, etc. Alternatively, the results could imply that the Texas park system is successfully controlling RIFA at a minimal level which satisfies their environmental concerns while also protecting visitor enjoyment. The results of this analysis apply only to those levels of infestation considered within the study. Therefore, RIFA infestation levels greater than those considered cannot be estimated from the results of this study.

Table 1. Results of analysis for two nonlinear functional forms.

Independent Variables	Functional Form: Semilog	Functional Form: Log-Log
Intercept	-4.627 (-38.261)@	-11.735 (-12.877)
Per Capita Income	8.0×10^{-5} (7.625)	0.610 (5.530)
Average Cost per Visit	-1.159 (-9.019)	-0.346 (-9.409)
Acres	-1.0×10^{-5} (-0.186)	0.242 (4.302)
Oil	-0.008 (-1.781)*	-0.112 (-1.392)*
R^2	0.929	0.860
# Obs.	396	396

@Student t statistics are in parenthesis
*Insignificant at the .05 level

Table 2. Results of analysis for parks infested (not infested) throughout study period using log-log form.

Independent Variables	Coefficient (t-value)
Intercept	-16.011 (-10.422)@
Per Capita Income	0.721 (4.736)
Average Cost per Visit	-0.515 (-9.446)
Acres	0.707 (6.752)
Oil	-0.058 (-0.563)*
R^2	0.975
# Obs.	234

@Student t statistics are in parenthesis
*Insignificant at the .05 level

Table 3. Results of lagging the initial effects of RIFA's presence using log-log form.

Time Lagged	Intercept	TPCI	AVGCOST	ACRES	OIL	RIFA	No. Obs.	R^2
Lag(0)ˆ	-12.767 (-11.419)@	0.746 (5.273)	-0.356 (-9.382)	0.246 (4.238)	-0.134 (-1.594)*	-0.083 (-1.509)*	396	0.872
Lag(1)	-12.050 (-11.655)	0.698 (5.359)	-0.347 (-9.810)	0.178 (3.201)	-0.109 (-1.345)*	-0.042 (-0.808)*	396	0.823
Lag(2)	-13.105 (-12.537)	0.776 (6.367)	-0.316 (-9.026)	0.249 (4.422)	-0.090 (-1.052)*	-0.070 (-1.428)*	360	0.921
Lag(3)	-12.775 (-11.643)	0.726 (5.661)	-0.321 (-9.143)	0.255 (4.522)	-0.119 (-1.394)*	0.004 (0.070)*	360	0.913
Lag(4)	-12.529 (-11.015)	0.693 (5.157)	-0.320 (-9.185)	0.254 (4.512)	-0.116 (-1.389)*	0.028 (0.547)*	360	0.912
Lag(5)	-12.395 (-10.618)	0.675 (4.836)	-0.320 (-9.146)	0.254 (4.510)	-0.109 (-1.287)*	0.038 (0.724)*	360	0.912
Lag(6)	-11.445 (-9.848)	0.567 (3.941)	-0.258 (-7.691)	0.270 (5.522)	-0.104 (-1.150)*	0.065 (1.275)*	360	0.886
Lag(7)	-11.799 (-9.848)	0.619 (3.941)	-0.256 (-7.691)	0.268 (5.522)	-0.114 (-1.150)*	0.029 (1.275)*	360	0.886
Lag(8)	-12.484 (-11.551)	0.697 (5.323)	-0.272 (-7.714)	0.271 (5.396)	-0.139 (-1.723)*	0.067 (1.333)*	378	0.970
Lag(9)	-13.172 (-11.551)	0.797 (5.323)	-0.264 (-7.714)	0.268 (5.396)	-0.159 (-1.723)*	-0.010 (-0.187)*	378	0.978
Lag(10)	-12.810 (-11.897)	0.747 (5.835)	-0.265 (-7.573)	0.267 (5.335)	-0.149 (-1.861)*	0.028 (0.595)*	378	0.970

ˆIndicates years RIFA variable is lagged
@Student t statistics are in parenthesis
*Insignificant at the .05 level

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