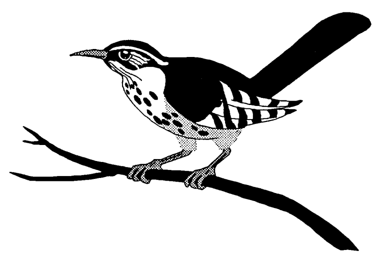
FINAL
CONTRACT REPORT

THE INFLUENCE OF THORNY ELAEAGNUS ON AUTOMOBILE-INDUCED BIRD MORTALITY



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The Influence of Thorny Elaeagnus on Automobile-induced Bird Mortality

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Supplementary Notes

Abstract

Thorny Elaeagnus (*Elaeagnus pungens*) has been used throughout the southeastern United States as a highway median plant for more than 30 years. Native to Asia, elaeagnus has a number of characteristics that make it ideal for roadside planting. The plant is a heat and drought resistant, evergreen shrub that is fast growing. Because elaeagnus forms a dense, tall hedgerow, it provides an effective divider between opposing lanes of traffic.

In the spring of 1999, representatives of the U.S. Fish and Wildlife Service collected 459 dead birds along discreet sections of highway near Richmond, Virginia. Roadway sections were adjacent to median plantings of thorny elaeagnus containing dense fruit crops. The objective of this field study was to investigate the possible relationship between median plantings and bird mortality. A simple one-way study design was used with median condition as the single factor. Three median conditions were examined including (1) no median planting, (2) elaeagnus without fruit, and (3) elaeagnus with fruit. Replicate roadway segments containing desired median conditions were surveyed 3 times/week for live and dead birds from mid-March to mid-May.

The presence of ripe elaeagnus fruit had a significant influence on both the use of medians by birds and bird mortality. Of 1,270 live birds observed along the roadways, 1,200 were detected along plantings that contained dense fruit crops. These same roadway sections accounted for 78 of 80 dead birds collected. Bird density and mortality within medians that supported shrubs without fruit were not appreciably higher than control medians that contained only grass. Additionally, the seasonal timing of median use and mortality was found to correspond to the peak availability of ripe fruit. Finally, the composition of live and dead birds was dominated by fruit-eating species.

The results of the study suggest that birds are attracted to elaeagnus fruit within median plantings and that mortality is a consequence of this attraction. The juxtaposition of dense fruit crops with high-traffic areas seems to result in elevated bird mortality. Birds are being struck and killed by oncoming traffic as they fly across roadways to reach fruit crops.

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the University of Virginia)

Charlottesville, Virginia

November 2000
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NOTICE

ABSTRACT

Thorny Elaeagnus (*Elaeagnus pungens*) has been used throughout the southeastern United States as a highway median plant for more than 30 years. Native to Asia, elaeagnus has a number of characteristics that make it ideal for roadside planting. The plant is a heat and drought resistant, evergreen shrub that is fast growing. Because elaeagnus forms a dense, tall hedgerow, it provides an effective divider between opposing lanes of traffic.

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The presence of ripe elaeagnus fruit had a significant influence on both the use of medians by birds and bird mortality. Of 1,270 live birds observed along study roadways, 1,200 were detected along plantings that contained dense fruit crops. These same roadway sections accounted for 78 of 80 dead birds collected. Bird density and mortality within medians that supported shrubs without fruit were not appreciably higher than control medians that contained only grass. Additionally, the seasonal timing of median use and mortality was found to correspond to the peak availability of ripe fruit. Finally, the composition of live and dead birds was dominated by fruit-eating species.

The results of this study suggest that birds are attracted to elaeagnus fruit within median plantings and that mortality is a consequence of this attraction. The justaposition of dense fruit crops with high-traffic areas seems to result in elevated bird mortality. Birds are being struck and killed by oncoming traffic as they fly across roadways to reach fruit crops.

BACKGROUND

Context

In April and May of 1999, representatives of the U.S. Fish and Wildlife Service (FWS) discovered an unusually high number of dead birds along a few discrete sections of Virginia roadways. This discovery began on 22 April when 145 Cedar Waxwings (*Bombycilla cedrorum*) were discovered within a high-traffic area in Richmond. The section contained a planting of thorny elaeagnus (*Elaeagnus pungens*) in the median with a large crop of berries. A cursory survey of four similar locations resulted in the collection of 314 additional waxwings and 11 birds of other species. Concern for the population of waxwings and other federally protected species, the FWS contacted the Virginia Department of Transportation (VDOT) to discuss potential solutions.

Native to Asia, thorny elaeagnus has a number of characteristics that make it ideal for roadside plantings. The plant is a heat and drought resistant, evergreen shrub that is fast growing. Because elaeagnus forms a dense, tall hedgerow, it provides an effective divider between opposing lanes of traffic. Elaeagnus has been used extensively throughout the southeastern United States as a median plant. VDOT has been planting thorny elaeagnus along roadways for nearly two decades. Roadside plantings of thorny elaeagnus in Virginia are currently concentrated within the greater Richmond area and the I-64 corridor between Richmond and Newport News (data from VDOT).

The occurrence of thorny elaeagnus with dense berry crops along high-traffic roadways, appears to represent a hazard to fruit-eating birds. This potential hazard is increased by the timing of fruit set relative to the timing of northward migration for many fruit-eating birds. Elaeagnus generally flowers from October through November and fruits in April and May. The peak of spring migration through the mid-Atlantic region is late April through mid-May. Migrant birds use fruit resources to build fat reserves before continuing north to the breeding grounds.

Objectives

The observation that dead birds collected during the spring of 1999 were concentrated around elaeagnus shrubs suggests a possible relationship between median plantings and bird mortality. The broad objective of this study was to investigate this possible relationship. Specific objectives included (1) an investigation of the influence of elaeagnus shrubs and fruit on the use of medians by birds, (2) an investigation of the influence of elaeagnus shrubs and fruit on bird mortality, and (3) documentation of the frequency of fruit set by elaeagnus within roadside plantings during the spring of 2000.

METHODS

Study Area

Based on information provided by VDOT (Appendix I), it appears that the greatest concentration of thorny elaeagnus used along roadways in Virginia occurs along the downtown expressway in Richmond and within the I-64 corridor between Richmond and Newport News. This area includes the sites of the original mortality events detected by the FWS in 1999.

Project Design

A simple one-way design was used to assess the influence of thorny elaeagnus on avian mortality with median condition as the single factor (Figure 1). Median condition was assessed at three levels including (1) no median planting, (2) thorny elaeagnus without fruit, and (3) thorny elaeagnus with fruit. Both bird use and mortality were dependent variables used to assess conditional effects.

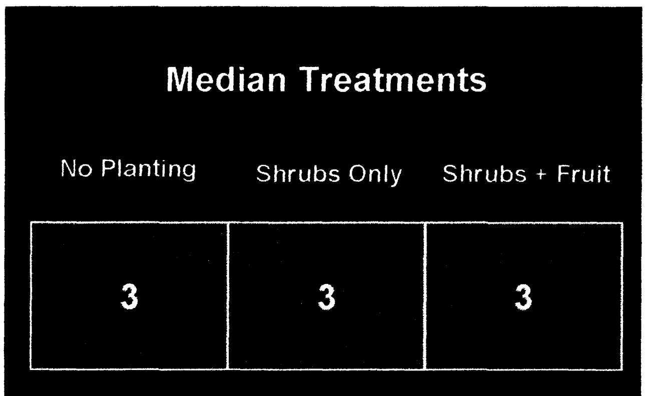


Figure 1: Numbers indicate spatial replicates

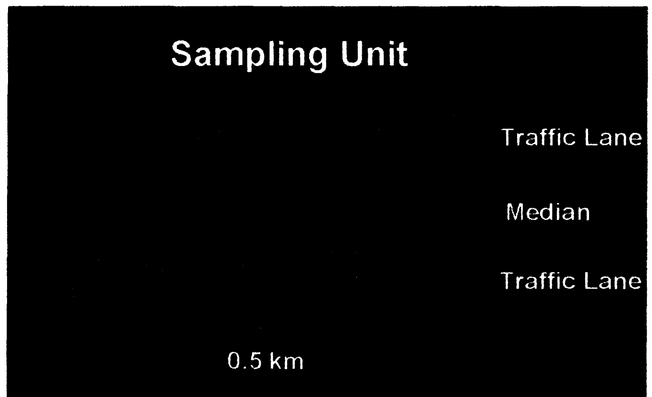


Figure 2: Roadway section

Median conditions were evaluated within the study area between 15 and 28 February 2000. Based on information collected during this reconnaissance phase, it was determined that the majority of elaeagnus plantings did not contain viable fruit in 2000 and medians with fruit represented short, disjunct segments. For this reason, both the length and possible locations of median treatments were limited. To accommodate this limitation, segment length was standardized to 0.5 km. Three spatial replicates were selected for each treatment level. Each replicate included the median and both opposing lanes of traffic (see Figure 2).

Median samples were established between 1 and 15 March 2000. Study areas selected included median segments along the downtown expressway in Richmond and within the I-64 corridor just east of Richmond. Medians were subdivided into 10 50-m segments that were indicated with black paint along the roadway edge. Boundaries of study medians were delineated with flagging tape. Each 50-m segment within the shrub + fruit treatment was classified according to the distance of shrubs from the road edge. Segments with shrubs beyond 5 m were considered "far" and segments with shrubs within 5 m were considered "close". These classifications were used to examine the influence of distance to shrubs on bird mortality.

Roadway segments with shrubs and fruit were classified as "close" as shown on left or as "far" as shown on right.

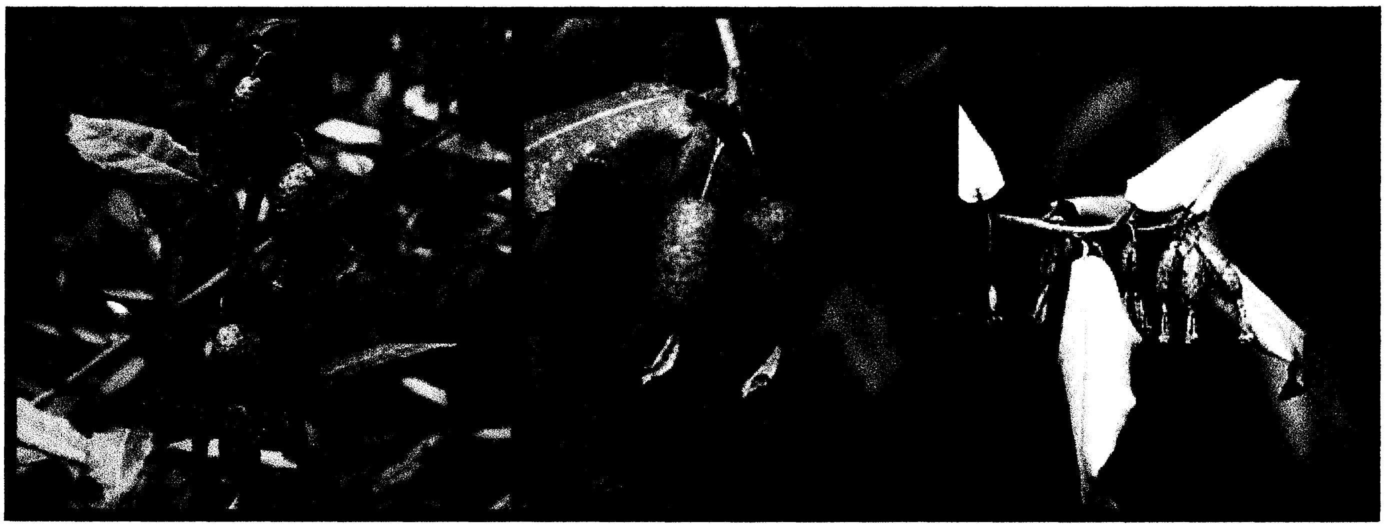
Bird Surveys

Birds were surveyed within study sites 3 times/wk between 20 March and 8 May 2000. Surveys included both sides of each median. All medians included in the study were surveyed each field day. Surveys were conducted between 9:30 and 15:00 to avoid times of high traffic. Medians were surveyed by walking slowly along the roadway edge and counting all live and dead birds detected. All birds associated with the median (dead or alive) were counted, identified to species, and recorded within 50-m segments. All dead birds that were in reasonable condition were collected, labeled, and frozen.

Researcher conducts bird survey along the downtown expressway

Fruit Surveys

In order to monitor fruit condition, fixed sample plots were established along each of the shrub + fruit transects. Six monitoring stations were established along each 500-m median segment (three along each lane of traffic). Monitoring stations consisted of the outer 0.5 m of five terminal branches. Individual fruits contained within branch segments were counted and placed in one of three ripeness categories once per week. Fruit categories included green, ripe, and overripe. Fruit were considered ripe when they were soft but firm and achieved a pink to red color. Fruit were considered overripe when they began to shrivel and turn brown.



Categories of fruit condition included green (left), ripe (middle), and overripe (right).

Researcher surveys fruit availability and condition on a marked branch.

In order to determine the extent of fruiting within the study area, all known plantings of elaeagnus were inspected. Plantings were measured on foot with a measuring wheel and examined to determine fruiting status. Lengths of segments containing viable fruit were determined and recorded separately

RESULTS

Fruit

The availability of fruit within the shrub + fruit median segments declined several fold during the study period (Figure 3). This decline was presumably due both to fruits being consumed by frugivores and to overripe fruit falling from shrubs. Both of these sources of loss were observed during the study period. In addition to the decline in fruit abundance with time, the condition of available fruit changed with the season (Figure 4). Green fruit were at a peak in abundance during the first week of the survey. Red or ripe fruit peaked during the second week of the survey. Overripe fruit peaked during the fifth week of the survey. It is evident from these temporal patterns that the short study period did not completely encompass the fruiting period. The spring of 2000 seemed to be unusually early and ripe fruit was available in low amounts as early as the first week of March.

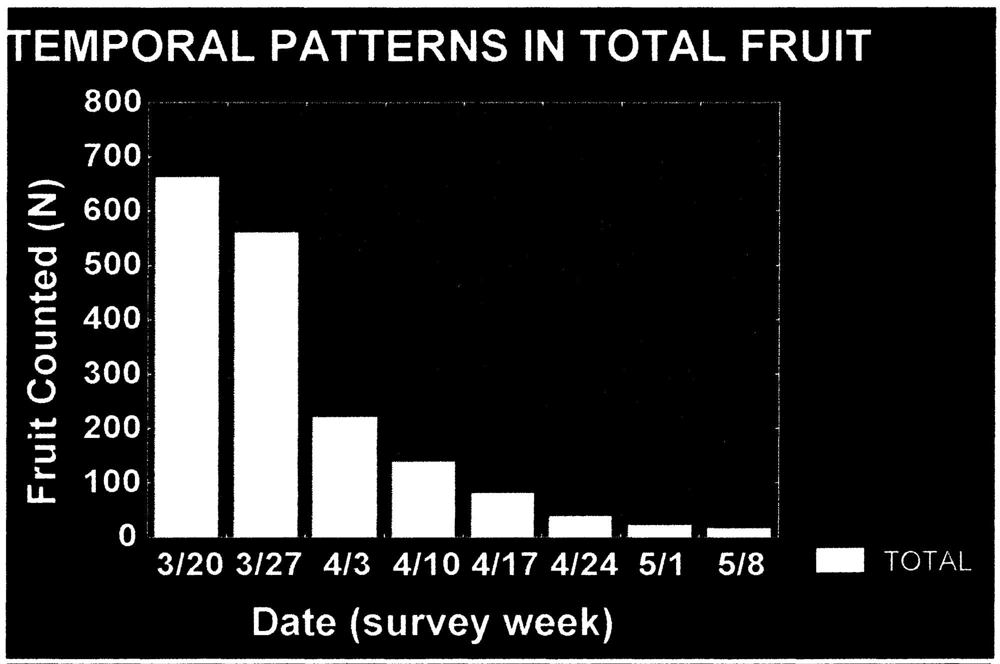


Figure 3: *Seasonal pattern in fruit availability as measured by weakly counts of fruit on "indicator" branches.*

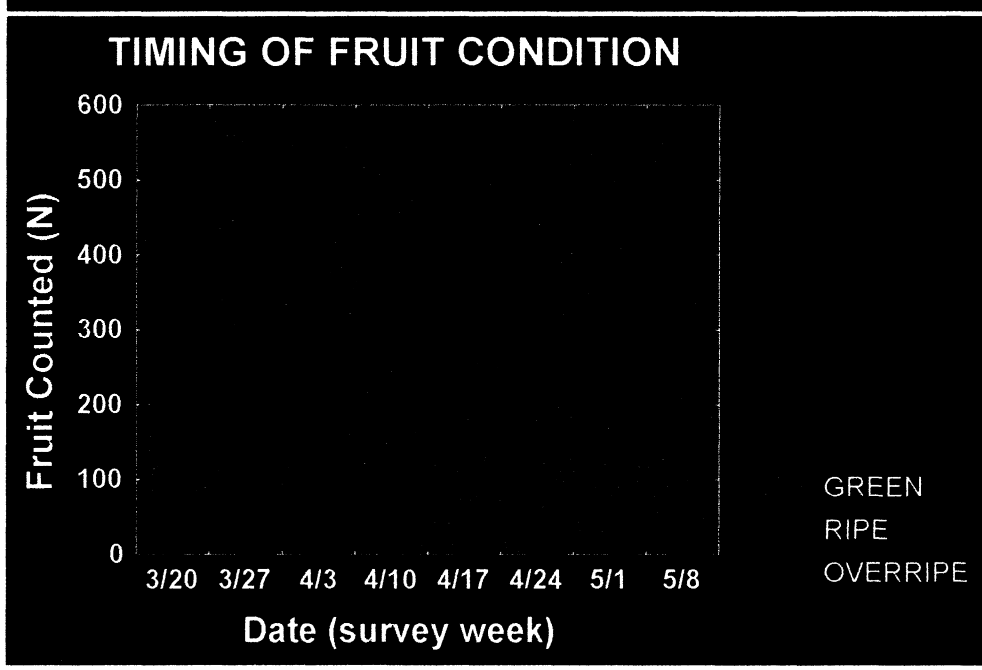


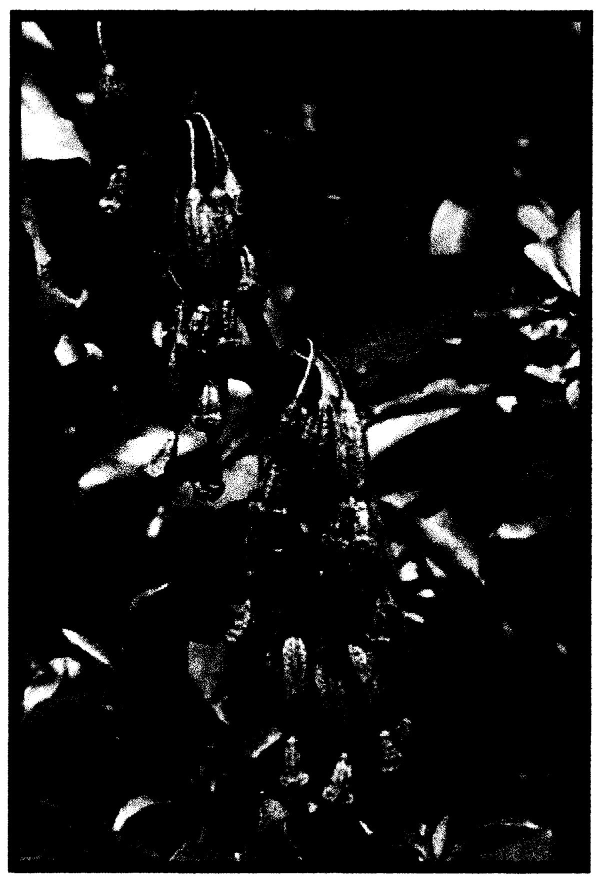
Figure 4: *Seasonal pattern in fruit condition. All fruit counted on "indicator" branches were classified according to condition.*

Elaeagnus shrubs that contained significant crops of viable fruit were uncommon and spatially restricted during the spring of 2000 (Table 1). Viable fruit was found along only 14% of shrub plantings within the study area. Even within these areas, fruit was often patchy and/or in low density. Only two areas contained significant fruit crops. These were the downtown expressway and the Route 360 interchange with I-95. Even within these median segments, fruit was not continuous along the plantings.

Table 1: Results of survey for fruiting elaeagnus shrubs within the study area.

VDOT District	County	Location	Meters of Planting Surveyed	Fruiting Status	Meters of Planting with Ripening Fruit
Richmond	Henrico	I-64 (east of the 360 interchange plantings)	2220	Very little ripening fruit present.	110
Richmond	Henrico	I-64 (plantings 500m east and west of 360 interchange)	699	Ripening fruit present in patches.	280
Richmond	Henrico	Route 195, 76, 146 median (downtown expressway)	1119	Large amounts of ripening fruit present in large patches.	670
Richmond	Chesterfield	Route 60 median near Powhatan	729	Little or no ripening fruit.	0
Suffolk	James City	I-64	2374	Little or no ripening fruit.	25
Suffolk	James City	Route 60	50	Ripening fruit present in patches.	25
Suffolk	York	Route 17	916	Little or no ripening fruit.	30
Total			**8107**		**1140**

Numerous segments of Elaeagnus plants contained dense crops of nonviable fruit. This fruit was light brown in color and completely dry. The fruit appeared to have been arrested in early development. The underlying cause of this condition was not apparent. No birds were observed to use this fruit.



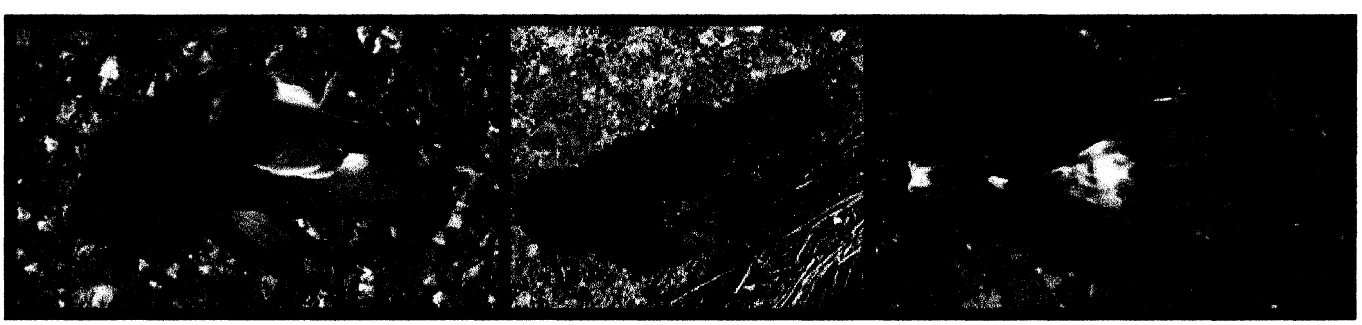
Dry, nonviable fruit such as those pictured at right were abundant throughout the study area. This fruit appeared to have no wildlife value and did not increase avian mortality rates.

Birds

A total of 1,270 live birds and 80 dead birds representing 19 species were detected during transect surveys (Table 2). Bird species included 8 non-migratory species, 8 temperate migrants, and 3 neotropical migrants (Appendix II). The European Starling was the most abundant species observed foraging within median segments. Starlings represented 71.4% of all individuals detected. Other common species included the Cedar Waxwing, American Robin, and Common Grackle. Collectively, these 4 species accounted for more than 90% of all live birds surveyed. These 4 species were also the most common dead birds collected (See Appendices III and IV for detailed accounting of observations).

Table 2: Results of median surveys.

Bird Species	Birds Alive (numbers)	Birds Alive (percentage)	Birds Dead (numbers)	Birds Dead (percentage)
European Starling	907	71.4	10	12.5
Cedar Waxwing	88	6.9	9	11.3
American Robin	78	6.1	14	17.5
Common Grackle	76	6.0	16	20.0
Northern Cardinal	29	2.3	3	3.8
Northern Mockingbird	23	1.8	3	3.8
House Sparrow	18	1.4	1	1.3
Mourning Dove	14	1.1	3	3.8
Song Sparrow	11	0.9	4	5.0
Blue Jay	7	0.6	0	0
American Crow	7	0.6	0	0
White-throated Sparrow	6	0.5	5	6.3
Gray Catbird	4	0.3	4	5.0
Common Yellowthroat	1	0.1	0	0
Yellow Warbler	1	0.1	0	0
Pigeon	0	0	4	5.0
Brown Thrasher	0	0	2	2.5
Ring-billed Gull	0	0	1	1.3
Downy Woodpecker	0	0	1	1.3



Cedar Waxwing, European Starling, and American Robin were three of the most common birds found dead along roadway segments.

Temporal Patterns - The number of live birds observed along study transects varied with season (Figure 5). Use of the medians by birds reached a peak during the last week of March and then declined consistently throughout the remainder of the survey period. The peak density early in the season was several times higher than that observed later in the season. With the exception of a spike in mortality during the last week of the study, the temporal pattern of bird mortality was comparable to that observed for live birds (Figure 6). Mortality rate peaked during the first week of April and then declined steadily until the last week of the survey.

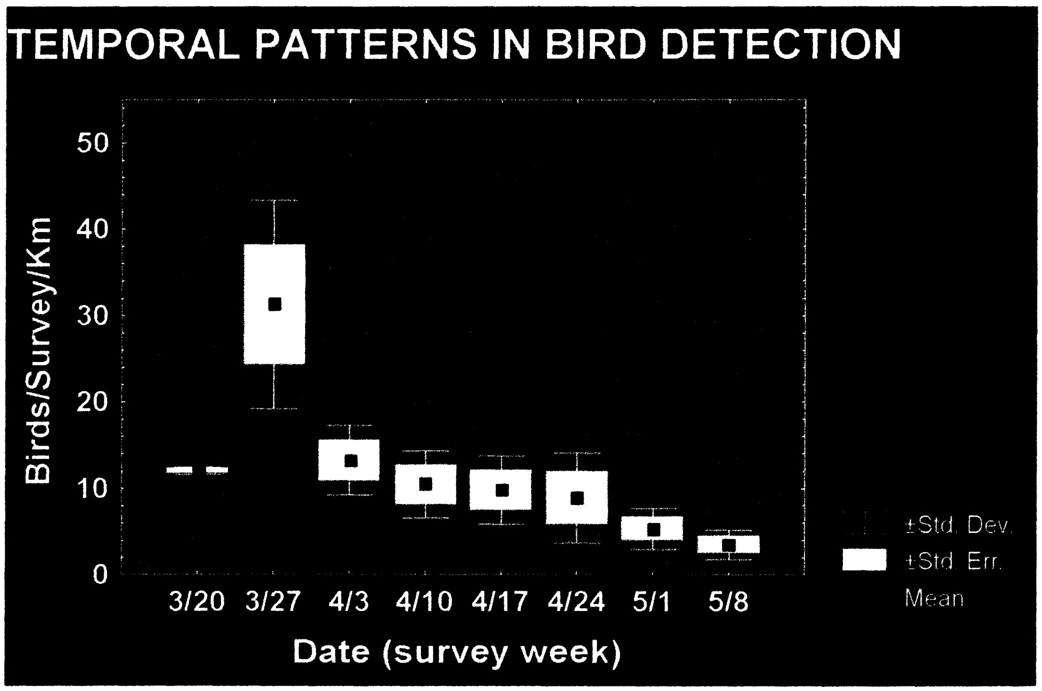


Figure 5: *Temporal pattern in detection of live birds along roadway sections. Each data point represents the mean of three surveys.*

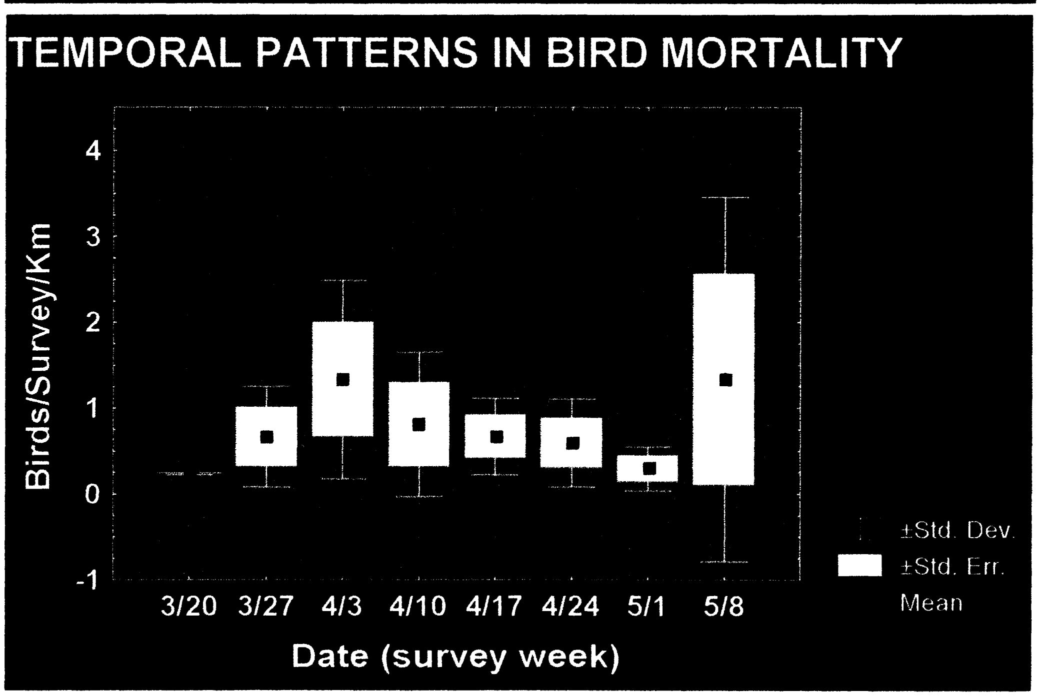


Figure 6: *Temporal patterns in detection of dead birds along roadway sections. Each data point represents the mean of three surveys.*

Treatment Effects - The distribution of birds within the study area was strongly influenced by the condition of roadway medians. More than 94% of all birds detected were associated with medians that contained shrubs with viable fruit. Medians with no fruit supported very few birds (Table 3). The difference in bird use between medians with fruit and the other two median conditions was statistically significant (Figure 7). Patterns in the distribution of dead birds collected were virtually identical with those of live birds detected (Table 3). More than 97% of all dead birds collected were associated with medians that contained viable fruit. As with live birds using medians, the difference in mortality rate between medians with fruit and the other two median conditions was statistically significant (Figure 8).

Table 3: Summary of observations of live and dead birds by median treaatment.

Treatment	Birds Alive (numbers)	Birds Alive (percentage)	Birds Dead (numbers)	Birds Dead (percentage)
Shrubs with Fruit	1,200	94.5	78	97.6
Shrubs without Fruit	37	2.9	1	1.2
No Shrubs	33	2.6	1	1.2
Total	1,270	-----	80	-----

Figure 7: *Influence of median treatment on the number of live birds observed. Each data point represents the mean of three spatial replicates.*

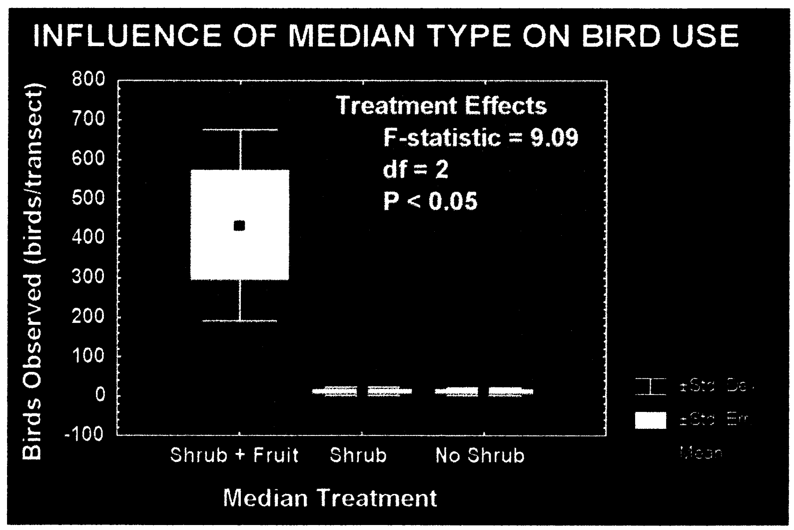
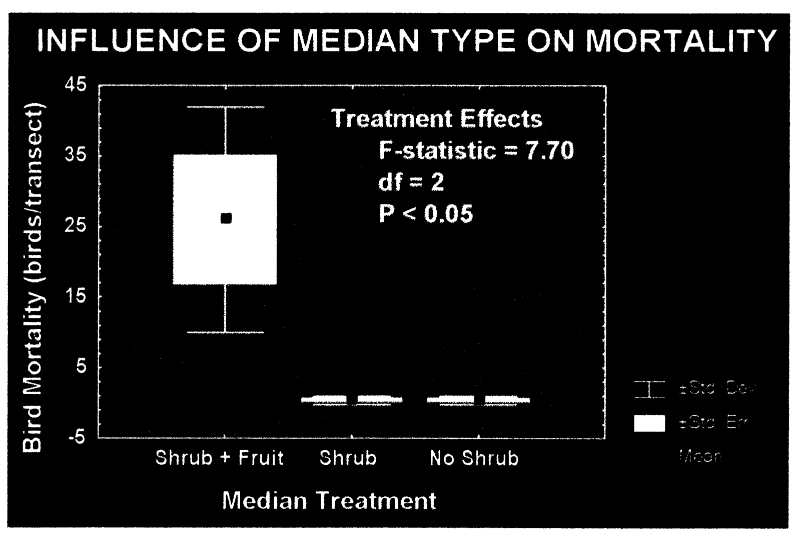
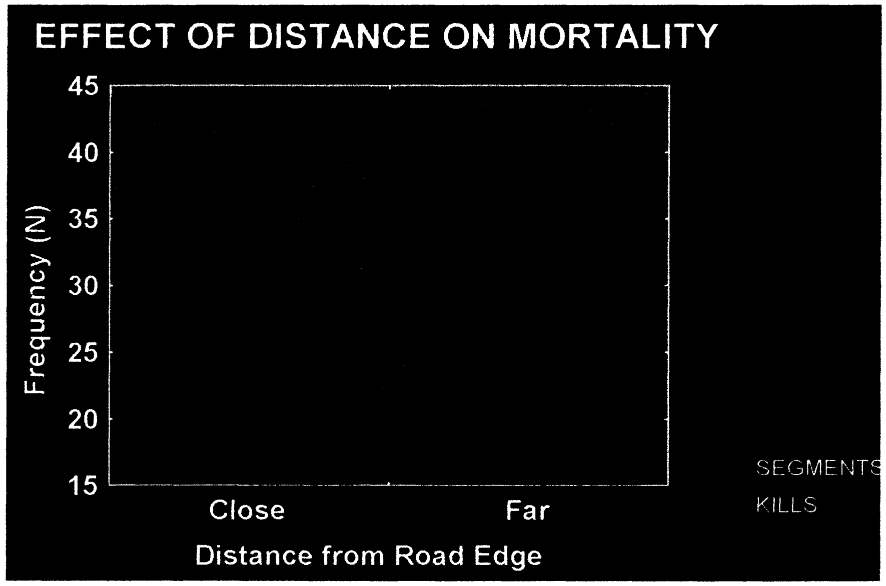


Figure 8: *Influence of median treatment on the number of dead birds collected. Each data point represents the mean of three spatial replicates.*



Influence of Shrub Position - The distance of shrubs from the road edge did not appear to have an influence on bird mortality. The location of dead birds was not statistically different than expected (X^2 statistic = 1.48, $P > 0.05$) based on the number of segments with shrubs in close and far positions (Figure 9). It should be noted that this result is constrained by the available distances within the study area. Shrubs positioned further from the road edge than those examined here may or may not have an influence on bird mortality.

***Figure 9:** The number of shrub + fruit segments that were classified as close and far from the roadway edge and the number of dead birds collected within these segments.*



DISCUSSION

The results of this study suggest that birds are attracted to roadway medians to forage on available fruit. Several aspects of the data support this conclusion. The first is that the vast majority of birds detected within roadway medians were associated with shrubs that contained viable fruit. Bird densities within medians that supported shrubs without fruit were not appreciably higher than those within control medians that contained only grass. Additionally, the peak in bird density corresponds with the peak in the availability of ripe fruit. If birds were using medians for reasons other than feeding on fruit, we would not expect this high degree of temporal correspondence. Last, the composition of species observed using medians was highly skewed to species that specialize on fruit for food. Bird species diversity within coastal Virginia is very high. The fact that the birds using medians with dense fruit crops represented such a biased portion of the community suggests that birds are using medians primarily to access available fruit.

Observations suggest that birds were killed by the trauma resulting from an automobile strike. The majority of dead birds collected were located on the paved median or directly within the lane of traffic. If birds were killed by some condition emanating from the fruits themselves, it seems more likely that birds would have been found under or near the shrubs. Additionally, a number of the dead birds collected had broken bills, wings, or legs, consistent with an automobile strike. Finally, two Cedar Waxwings were observed to be killed when hit by an automobile. These birds were struck while flying across a lane of traffic toward shrubs with fruit. Such birds were frequently observed roosting in trees surrounding roadways. Periodically, these birds flew down from trees, crossed lanes of traffic, and settled into median plantings.

The observations described above are consistent with those made in other parts of the country. For example, 298 dead Cedar Waxwings were collected along 275 m of *Elaeagnus pungens* plantings in Brazos County, Texas ,in 1981 (Dowler and Swanson 1982). Waxwing flocks were observed feeding on Elaeagnus berries, and many individuals were hit by cars over a several day period as they flew back and forth to berries. Shrubs were positioned 3.5 m from the edge of the highway.

Throughout the course of this study, there was no indication that birds were impacted by alcohol toxosis. Birds never exhibited any behavioral signs of alcohol poisoning. Additionally, bird mortality peaked during the time period when ripe fruits were most abundant rather than when overripe fruits were most abundant. Finally, fruits on shrubs and those that had fallen off onto the ground were checked weekly for signs of fermentation. Crushed fruits never exhibited any signs of alcohol formation.

The bird mortality observed during this study was considerably less than that documented during the spring of 1999. The Fish and Wildlife Service reported more than 450 bird casualties collected within four locations in late April. Despite the fact that roadway sections were surveyed repeatedly for more than 2 months, only 80 dead birds were collected. It is not possible to conclusively identify the underlying reasons for the difference in mortality rate between the 2 years. However, some explanations seem plausible. For example, the timing of fruit ripening may have differed between years. The spring of 2000 seemed to be unusually early. Most of the ripe fruit was gone by the time that spring migrants came through in peak numbers between late April and early May. Mortality may have been higher if the peak of fruit condition had coincided with the peak of migration. It is also possible that variation in fruit abundance may contribute to year -to-year differences in attraction of birds and associated mortality rate. In the spring of 2000, many kilometers of plantings had large amounts of brown, nonviable fruit. If this fruit had been viable, medians throughout the study area might have attracted many more birds.

CONCLUSIONS

- Roadway medians that contained elaeagnus shrubs with fruit were shown to have significantly more bird visitation and mortality compared to medians that contained shrubs only or no shrubs.

- The peak in bird visitation and mortality generally coincided with the peak in the availability of ripe fruit.

- The composition of live and dead birds detected along roadway medians was dominated by fruit-eating species.

- Dead birds collected along roadway segments appeared to have been killed by automobile strikes.

- In the spring of 2000, elaeagnus shrubs that contained viable fruit crops were uncommon and spatially restricted.

POTENTIAL AMELIORATIVE ACTIONS

The results of this study suggest that the presence of elaeagnus shrubs alone did not have any discernible influence on the rate of bird mortality. The presence of viable fruit seems to be the sole factor responsible for elevated levels of median use and associated mortality. For this reason, strategies to reduce bird mortality should focus on reducing fruit availability. Potential strategies include (1) actions that prevent fruit formation and/or (2) actions that remove fruit prior to ripening. Either of these strategies may involve the application of appropriate chemical agents or the pruning of fruit-bearing wood.

The design of a management approach and protocol to reduce fruit availability should include both economic and practical considerations. Such designs are beyond the scope of this study. Appropriate management solutions should be sought with the guidance of experienced horticulturists. It should be noted that the distribution of fruiting plants is not likely to be stable over time. For this reason, management prescriptions should be executed throughout the study area wherever elaeagnus is used as a median plant.

ACKNOWLEDGMENTS

We would like to express our appreciation to the Virginia Department of Transportation for exhibiting decisive leadership in investigating this potential wildlife hazard. To our knowledge, Virginia is the first state to mount any investigation of this problem. We would like to express particular thanks to Mike Fitch and Don West for patience and assistance during all aspects of the study. Don Patterson and Eric Holmes of the U.S. Fish and Wildlife Service provided insight into the mortality events documented during the spring of 1999. Funds for this study were provided by the Virginia Transportation Research Council.

REFERENCES

Dowler, R. C. and G. A. Swanson. 1982. High mortality of Cedar Waxwings associated with highway plantings. Wilson Bulletin 94, 602-603.

Appendix I: Locations of *Elaeagnus pungens* plantings by district in Virginia (data provided by the Virginia Department of Transportation).

VDOT District	County	Location	Linear Feet of Planting
Richmond	Hanover	I- 295 at exit 41A (Route 301)	186
Richmond	Hanover	Route 360 median (3 locations)	699
Richmond	Henrico	I-64 (west of I-95)	1,150
Richmond	Henrico	I-64 (east of I-95)	8,882
Richmond	Henrico	Route 195, 76, 146 median (downtown expressway)	4,216
Richmond	New Kent	Route 249 median (between Route 64 and Route 60)	765
Richmond	Chesterfield	Route 60 median near Powhatan	4,206
Richmond	Chesterfield	Route 360 median near Skinquarters	350
Richmond	Amelia	Route 360 median, 10 locations	2,600
Richmond	Prince George	Route 144 median, 2 locations	1,870
Richmond	Prince George	Route 95/Crater Rd. interchange	280
Richmond	Prince George	Route 95, south of Crater Rd.	60
Richmond	Prince George	Route 95 at Wager Rd. interchange	3,095
Richmond	Prince George	Route 95 at Route 35 interchange	50
Richmond	Dinwiddie	Route 460 median, 3 locations	2,302
Richmond	Dinwiddie	Route 85 median at Route 1	1,850
Richmond	Dinwiddie	Route 85/Route 1 interchange	550
Richmond	All	Total	33,111
Fredericksburg	Glouster	Route 17, south of Middlesex/Glouster county line	6,800
Fredericksburg	Stafford	Route 3, just east of Fredericksburg city limits	1,700
Fredericksburg	King and Queen	Route 360, between St. Stephens Chrch and Millers Tav.	3,700
Fredericksburg	All	Total	12,200
Salem	Franklin	Frontage Rd. adjacent to Route 220 near Rocky Mount	100
Salem	Bedford	Route 460 median east and west of Route 122 inters.	600
Salem	All	Total	700
Staunton	Rockingham	I-81 median at mile post 245.9 near Harrisonburg	300
Staunton	Rockingham	I-81 median at mile post 246.1 near Harrisonburg	100
Staunton	Alleghany	I-64 median at mile post 15.6 near Covington	400
Staunton	All	Total	800

Appendix I: -continued- Locations of *Elaeagnus pungens* plantings by district in Virginia (data provided by the Virginia Department of Transportation).

Northern Virginia	Fairfax	I-495/Route 236 median	
Northern Virginia	Fairfax	I-495/Route 50 ramps and shoulder	
Northern Virginia	Fairfax	I-495/Route 620 ramps	
Northern Virginia	Fairfax	I-66/Route123 ramps	
Northern Virginia	Fairfax	I-495/Route 620 ramps	
Northern Virginia	Fairfax	I-66/Route123 ramps	
Northern Virginia	Fairfax	I-66/Route 50 ramps (also Route 50 near Fairfax City)	
Northern Virginia	Fairfax	I-66/Route 7 shoulder	
Northern Virginia	Arlington	I-66/Fairfax Drive median	
Northern Virginia	Prince William	I-95 north bound ramp from westbound Dale Blvd.	
Northern Virginia	All	Total	1-2 acres in district
Lynchburg	———	NONE	NONE
Culpeper	Albemarle, Fluvanna, and Louisa	I-64 east of Shadwell, scattered throughout median for 15-20 miles. (Personally checked median from Richmond to Route 15 and observed no plantings)	???
Bristol	Wise	Route 23	250
Suffolk	Hampton	I-64	???
Suffolk	Newport News	I-64	???
Suffolk	Suffolk	164 west freeway	???
Suffolk	Suffolk	58/460 bypass	???
Suffolk	Portsmouth	I-264	???
Suffolk	Norfolk	I-64	???
Suffolk	Chesapeake	I-64	???
Suffolk	Virginia Beach	I-64	???
Suffolk	James City	I-64	???
Suffolk	James City	Route 60	???
Suffolk	York	Route 17	???
Suffolk	All	Total	???

Appendix II: List of species detected during road surveys.

Common Name	Scientific Name	Migration Status[1]
Ring-billed Gull	*Larus delawarensis*	T
Pigeon	*Columba livia*	R
Mourning Dove	*Zenaida macroura*	R
Downy Woodpecker	*Picoides pubescens*	R
American Crow	*Corvus brachyrynchos*	R
Blue Jay	*Cyanocitta cristata*	T
Common Grackle	*Quiscalus quiscula*	T
White-throated Sparrow	*Zonotrichia albicollis*	T
Song Sparrow	*Melospiza melodia*	T
House Sparrow	*Passer domesticus*	R
Northern Cardinal	*Cardinalis cardinalis*	R
European Starling	*Sturnus vulgaris*	R
Cedar Waxwing	*Bombycilla cedrorum*	T
Yellow Warbler	*Dendroica petechia*	N
Common Yellowthroat	*Geothlypis trichas*	N
Brown Thrasher	*Taxostoma rufum*	T
Gray Catbird	*Dumetella carolinensis*	N
Northern Mockingbird	*Mimus polyglottos*	R
American Robin	*Turdus migratorius*	T

[1]Migration codes are as follows: R – resident/nonmigratory, T – temperate migrant, N – neotropical migrant

Appendix III: Summary of live bird observations by species and week.

Species	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8
Pigeon	0	0	0	0	0	0	0	0
Mourning Dove	0	0	3	3	2	3	3	0
Downy Woodpecker	0	0	0	0	0	0	0	0
American Crow	1	2	0	0	0	3	1	0
Blue Jay	0	3	3	1	0	0	0	0
Common Grackle	12	12	4	3	9	5	15	14
White-thr. Sparrow	1	1	0	2	2	0	0	0
Song Sparrow	2	3	0	0	4	2	0	0
House Sparrow	0	1	1	0	3	6	4	3
Northern Cardinal	4	5	6	5	6	2	1	0
European Starling	123	361	122	115	73	64	33	16
Cedar Waxwing	0	20	32	0	20	16	0	0
Yellow Warbler	0	0	0	0	0	0	0	1
Common Yellowthroat	0	0	0	0	0	0	1	0
Brown Thrasher	0	0	0	0	0	0	0	0
Gray Catbird	0	0	0	0	0	0	3	2
Northern Mockingbird	5	8	2	4	0	3	0	1
American Robin	9	6	6	8	13	14	12	10

Appendix IV: Summary of dead bird observations by species and week.

Species	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8
Ring-billed Gull	0	0	0	0	0	1	0	0
Pigeon	0	1	0	0	3	0	0	0
Mourning Dove	0	0	1	0	1	1	0	0
Downy Woodpecker	0	0	1	0	0	0	0	0
American Crow	0	0	0	0	0	0	0	0
Blue Jay	0	0	0	0	0	0	0	0
Common Grackle	0	1	2	1	2	0	1	9
White-thr. Sparrow	0	0	1	4	0	0	0	0
Song Sparrow	2	0	1	0	0	0	0	1
House Sparrow	0	0	0	0	0	1	0	0
Northern Cardinal	0	0	1	0	1	1	0	0
European Starling	0	0	5	0	1	1	1	2
Cedar Waxwing	1	4	3	0	1	0	0	0
Yellow Warbler	0	0	0	0	0	0	0	0
Common Yellowthroat	0	0	0	0	0	0	0	0
Brown Thrasher	0	0	1	0	0	0	0	1
Gray Catbird	0	0	0	0	0	0	1	2
Northern Mockingbird	0	1	1	0	0	1	0	0
American Robin	0	2	1	6	0	2	0	3