Bechtel Nevada

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**Plant-Damage Assessment Technique for
Evaluating Military Vehicular Impacts to Vegetation
in the Mojave Desert**

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SERDP Project CS-1131

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ABSTRACT

A new plant-damage assessment technique was developed by plant ecologists from Bechtel Nevada at the U.S. Department of Energy's National Nuclear Security Administration Nevada Operations Office and funded by the Strategic Environmental Research and Development Program Project CS-1131 in cooperation with the U.S. Army's National Training Center (NTC) at Fort Irwin, California. The technique establishes linear transects the width of vehicle tracks from evidence of vehicle tracks in the soil (usually during a prior training rotation period of 30 days or since the last rain or wind storm), and measures vegetation within the tracks to determine the area of plant parts being run over, the percent of the impacted parts damaged, and the percent of impacted parts expected to recover. It documents prior-damage classes based on estimates of damage that plants have apparently experienced previously (as assessed from field indicators of damage such as plant shape and height). The technique was used to evaluate different vehicle types (rubber-tire wheels vs. tracks) in six areas at the NTC with different soils and training intensity levels. The technique provides tabular data that can be sorted and queried to show a variety of trends related to military vehicular impacts. The technique also appears suitable for assessing other non-military off-road traffic impacts. Findings report: (1) differences in plant sensitivity to different vehicular impacts, (2) plant cover and density by species and training area, (3) the degree to which wheels have less impact than tracks, and (4) the mean percent survival is inversely proportional to the degree of prior damage received by the vegetation (i.e., plants previously impacted have lower survival than plants not previously impacted).

INTRODUCTION

This study was conducted by plant ecologists from Bechtel Nevada and was funded by the Strategic Environmental Research and Development Program Project CS-1131 in cooperation with the U.S. Department of Energy's National Nuclear Security Administration Nevada Operations Office and the U.S. Army's National Training Center at Fort Irwin, California. Plant damage caused by vehicular traffic passing over the vegetation can be estimated by a simple plant damage assessment technique that incorporates the collection of field data and its analyses.

The technique is relatively rapid and efficient. It yields considerable information about plant community structure, vehicular impacts, and plant recovery, and it provides a means of comparing sites to evaluate their relative degree of past plant disturbance. It not only permits the evaluation of plant community data, but also provides details about individual species response and their relative sensitivity to military or recreational vehicular impacts.

The technique is designed to assess recent impacts (e.g., one to four weeks) rather than cumulative impacts (e.g., one to four years). Cumulative impacts are better assessed by other techniques, such as the Land Condition Trend Analysis (U.S. Army Environmental Center, 1999) or comparable techniques that provide quantitative values of reductions in canopy cover and shifts in plant community composition (Bonham, 1989; Kent and Coker, 1992). The plant damage assessment technique requires recent vehicular activity in an area where the density of vehicle tracks are sufficiently spaced so as to be able to clearly identify individual tracks and the impacted vegetation. It is limited when tracks are too numerous (e.g. multiple passes), too old, or not clearly discernible as might result from a recent rain, or when crushed vegetation blows away during a wind storm. Ideally, it is performed in the spring of the year when vegetation is green and a week or more after the vehicular impact to permit time to determine surviving plant parts, such as leaves, branches, or new sprouts.

METHODS

Field equipment required for measurements includes a simple centimeter tape measure (a spring-loaded metal tape works best) or ruler, pencil and data form, or palmtop computer with spreadsheet capabilities. Data analyses are best performed on a desktop personal computer with spreadsheet, statistical, and database software capabilities, although they can also be calculated by hand. A simplified diagram of typical field conditions is shown in Figure 1. The assessment technique consists of identifying a vehicle track of interest in a selected area. This can be done by driving along a road and observing intersecting tracks of interest such as the type of track (e.g., wheeled versus tracked types and their widths). A starting point is determined for the survey. This may be done by using a random number of paces in from the road in areas where vegetation is present and representative of the area to be evaluated. Global positioning satellite coordinates are recorded or the position marked on aerial photographs or topographic maps. The width of the vehicle track is then measured using a tape measure (in centimeters). This should include the outermost measurement where evidence suggests the widest width of the track. For

example, some tank tracks may have a narrow rubber skid and a wider metal support for the track.

Figure 1. Diagram of typical field conditions for assessing plant damage from vehicular traffic.

The proper width would be the widest part of the track; in this case, the metal support that can potentially crush or damage vegetation. For rubber-tired wheels, the width would be from side to side, or from outside of the first dual tire to the inside of the second dual tire. This will be the width of the belt transect. Only one side of the vehicle (e.g., the right set of wheels or tracks) is measured at a time. A return trip can measure impacts on the other side of the vehicle (e.g., the left set of wheels or tracks). The distance in paces is then recorded to the nearest plant. This value is recorded as a pace length on the data form or spreadsheet. Paces can later be converted to centimeters. The measured length of 50 to 100 consecutive paces will give the mean distance in centimeters of a pace's length.

When the first plant that is within the track belt transect is encountered, several measurements for that plant are taken. First, the species alphacode is recorded. The alphacode consists of its standardized abbreviated scientific name, usually comprised of the first two letters of the genus and the first two letters of the species (U.S. Department of Agriculture, 1996). Numbers are used to distinguish between different plants with similar abbreviations. Because the alphacodes are accepted as U.S. national standards, they are consistent among federal agencies as well as many state agencies. The second parameter that is recorded is the assessment of the prior plant damage class. Figure 2 shows the four codes for damage classes typically used (low, moderate, high, and very high).

The basic principle is to get a quick estimate of the area of the shrub that has been run over. Adjust the size of the rectangle or square to best fit the shape of the shrub. Obviously, most shrubs are round or oval in shape so the rectangle needs to be adjusted to best approximate the area. A few limbs may extend beyond the symmetrical boundary of the shrub profile or there may be holes in the plant canopy. Consistency in how shrubs are measured is key to reliable measurements. The measurement of these variables will help in the estimation of the impacted area (length x width) and the impacted volume (volume = length x width x height).

Figure 2. Prior plant damage classes.

The code is assigned based on evidence of prior damage from vehicular traffic. Plant symmetry is the major factor. Additional measured parameters to be recorded include: height of the plant (height in centimeters or the mean height of the majority of the branches), length of the impacted portion of the plant (in centimeters), and width of the impacted portion of the plant (in centimeters) (refer to Figure 1 for examples of shrub measurements).

Two other estimated parameters include an estimate of what percentage of the shrubs has been impacted by the vehicle and an estimate of what percentage of the impacted vegetation will survive based on green leaves, stems, or resprouts. Cover estimates can be recorded to the nearest 2 percent at the lower cover values and to the nearest 5 or 10 percent at the higher cover values. Charts that assist the visualization of percent cover are often useful. Charts can be laminated in plastic and trimmed to facilitate their use in the field. Figure 3 shows representations of cover from 1 to 50 percent.

Additional higher cover perceptions can be achieved by considering the cover of the white area. For example, a square with a 30 percent black cover can also be used to help visualize 70 percent cover of the white area in the same square. The cover of two charts can be mentally added into the same area to visualize cover percentages not shown in the charts (e.g., $20\% + 3\% = 23\%$). Frequent early reference to information in the chart can help reduce errors in visual estimates. Practice with other experienced scientists prior to collection field data can also help reduce such errors.

Once data are documented for the first plant, the scientist then locates the next plant. If it is in the same area as the first plant (e.g., an understory shrub), a linear distance of 0 is recorded for the number of paces. The measured pace for the second value begins at the precise point that the previous pace concluded. When the transect crossed barren areas like roads and tank trenches,

Cover Representation from 1 to 50%
(Each 1/4 of any large square has the same amount of black)

Figure 3. Visualization chart for cover representations from 1 to 50%.

the paces across these areas were ignored and the count continued where vegetated ground was reencountered. When the last pace distance is recorded, it can be added to the previous last pace value to complete the transect (e.g., if the last plant pace distance was 8 paces and the transect extends an additional 10 paces to the end of the transect, then the last value of 10 would be added to the previous value of 8 to obtain a new value of 18).

An example of a typical data form is shown in Figure 4. Users of palm-top computers would want to modify the header information and include them as five new columns to the left of the "Parameters" in the main lower body of the data form (e.g., include abbreviations for the column headings, location, grid, category, collector, and date). Headings can be "locked" in place so that they are always visible when scrolling up or down. The use of such computers minimizes transcription data errors. Most batteries last through a 10-hour day of data collection before they have to be recharged. Field supplemental power is also available as an accessory. The surface of the palm-top computers should consider using adhesive-back plastic overlays designed to protect the surface from scratching from blowing sand. Such covers last several days before they have to be replaced.

Formulas and variables used for calculating values associated with the plant damage assessment technique include:

$$C_T = \sum C_s$$

$$C_i = (\sum A_s)/V * 100$$

where,

C_T = Total plant cover summed over all species (species i through species j),
expressed as a percent of the total vehicular impacted area

= Total vegetative damage impact created by the vehicle, expressed as
a percent of the total vehicular impacted area

C_i = Percent cover of the i th perennial plant species

Species $_i$ = The i th perennial plant species identified within the vehicular impacted area

V = Vehicle impacted area in square centimeters = $L_t * W_t$

L_t = Length in centimeters of the vehicular track that is sampled

W_t = Width in centimeters of the vehicular track

D_t = Distance in paces along L_t from the starting point or plant to the next plant
or finish point

$\sum$ = Sum of the individual measurements for species i through species j

A_i = Area in square centimeters of the i th species = $L_i * W_i$

L_i = Length in centimeters of the i th species that was run over by the vehicular track

W_i = Width in centimeters of the i th species that was run over by the vehicular track

Other descriptive statistics and statistical tests can be used to stratify the data by site, species, prior damage class, and survival values.

In order to test the assessment technique, six different areas at Fort Irwin, California, were selected for sampling. Each area had slightly different soils and microclimate. Prior use varied among sites. Military training activities were sufficiently ongoing at each of the areas to yield numerous vehicular tracks across the sites. Severely impacted areas within these sites were

Results

Approximately 20 tracks and nearly 500 shrubs were sampled at the six different areas at Fort Irwin to evaluate the plant damage assessment technique. The technique provided rapid and relatively comprehensive data upon which to evaluate the impacts to perennial vegetation. The technique was evaluated under conditions that provided a good test of the technique, because it was a relatively dry year with little precipitation. This was due to the fact that plant damage is greater under dry conditions than moist conditions and it is more difficult to determine survival of plant matter that is relatively dormant (i.e., living twigs without leaves). Additionally, resprouting after vehicular damage is also delayed more under dry conditions than during periods of adequate precipitation.

Vehicle tracks consisted of two types, those from wheeled vehicles such as rubber tires on humvees or trucks, and tracks from vehicles such as armored personnel carriers or tanks. Our analyses focused on impact damage from vehicles moving in a straight line, not during turns when soil displacement and damage is much greater, and more difficult to compare and assess. One-way analysis of variance for the mean percent survivability of vegetation after being run over by ten different track or wheel widths suggests that there were significant differences ($p < 0.001$ level) in the mean survivability between track widths. In general the wider the track or wheel, the lower the survivability of the vegetation, probably suggesting that wider tracks support greater weights of vehicles resulting in greater damage near the root crown. A comparison of tracked vehicular damage versus wheeled vehicular damage using one-way analysis of variance suggest that there was a significant difference ($p < 0.001$) between the two types. Tracked types across all plant species had a mean percent survivability of 27 percent ($n=288$ observations) while wheeled types had a mean percent survivability of 39 percent ($n=188$ observations).

Survivability of individual plants varied by species with some species being more sensitive than others. A comparison of percent survivability using one-way analysis of variance suggests that there was a significant difference ($p < 0.05$) between plant species percent mean survival values. Percent mean survival is the estimated percentage of the vegetation that has been run over that is expected to survive. Field evidence of survivability included green stems still attached to the root crown, resprouting of old stems or crowns, or remaining green, leafy plant parts. A ranking of the predominant shrubs and their associated mean survival values is shown in Table 1.

Prior damage to vegetation by vehicular traffic varied by site at Fort Irwin. The percent of all shrubs at each site falling into the four following prior damage classes - low, moderate, high, and very high - is shown in Figure 5.

Survivability following vehicular impact also appeared to be dependent on the physiological condition of the plant as determined by prior damage. Table 2 shows the differences in percent survival for different damage classes across all sites, species, and for all track types and widths.

Table 1. Comparison and ranking of plant species percent mean survival after vehicular impact.

Scientific Name	Common Name	Percent Mean Survival	Standard Error of the Mean $\pm$	Number of Measurements
<i>Lycium pallidum</i>	rabbit thorn	12.8	4.4	15
<i>Hymenoclea salsola</i>	white burrobush	18.0	4.6	36
<i>Cassia amata</i>	spiny senna	32.1	8.3	17
<i>Ambrosia dumosa</i>	white bursage	32.5	1.9	293
<i>Larrea tridentata</i>	creosote bush	38.9	3.6	84

In general, plants that have little prior damage tend to have higher mean percent survival values than plants with higher prior damage. Plants with a better physiological status appear to be better able to recover after impact. An exception to this is with plants that have been very highly damaged previously. These plants are usually very small, with prostrate branches that resist further damage and result in a higher percent survival than larger plants with more upright branching patterns that are more susceptible to damage. Because they are very small, they often fit between the tracks escaping further damage completely.

When mean percent survival was considered at specific sites and for specific track types and widths, many specific patterns were observed. Some sites like John Wayne Hill, Red Pass, and Valley of Death are too disturbed by previous training activities to have any plants that fit into the “low” prior damage class.

Table 2. Mean percent survival for plants by prior damage class after vehicular impact.

Prior Damage Class	Mean Percent Survival	SE Mean ($\pm$)	N
Low	51.4	6.5	35
Moderate	29.3	2.6	139
High	25.9	2.5	144
Very High	32.8	3.7	91

Drink Water on the other hand had such low previous disruptions that there were no plants that fit into the “very heavy” prior damage class.

Figure 5. Percentage of shrubs at Fort Irwin Sites by prior damage to vegetation codes.

It is apparent that the patterns described for each site reflect the past training levels and current plant community structure of the site. For example, Red Pass has been impacted so heavily in the past and has very sandy soils, making it more susceptible to damage, that the site is covered by a nearly complete monoculture of creosote bush. Certainly shifting sands created by secondary impacts once vegetative cover is removed tends to bury other shorter and smaller plants.

Reductions in shrub cover due to vehicular traffic is a function of the track type, the plant cover prior to disturbance, the survivability characteristics of the plant species, and the degree of previous plant damage. Mean reduction in plant cover per pass of tracked vehicles was 74 percent, while mean reduction in plant cover per pass of wheeled vehicles was 69 percent. In other words between 69-74 percent of all vegetation run over by vehicles was killed in the sampling transect. Percent mean reduction in plant cover per vehicle pass was also higher in areas of initial higher plant cover than in areas of initial lower plant cover. Regression analysis for percent reduction in plant cover versus percent plant cover for wheeled and tracked vehicles were both statistically significant ($p < 0.001$), although the amount of variation being accounted for was generally low ($r^2 = 23.3$ percent for wheeled and $r^2 = 70.3$ percent for tracked vehicles). The reason for this relationship appears to be that initial impact to relatively undisturbed vegetation is greater than impacts to vegetation that have been run over several times, thereby selecting for branching patterns and plant sizes that are better able to withstand vehicular traffic.

This plant damage assessment technique appears to provide a rapid means of assessing impacts of vehicular traffic in areas moderately to heavily disturbed. Its use is limited in areas where prior severe plant damage has occurred resulting in low species cover (i.e., less than 3 percent canopy cover) and large sampling distances required to provide statistically adequate sampling of the vegetation. Examples of additional plant community parameters are shown in Appendix A.

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APPENDIX A

Example of Possible Formats for Information Obtained Using the Plant Damage Assessment Technique

Appendix A - Fort Irwin Vegetation Damage Assessment Data

August 15, 2001	Track				Mean				Mean			Total		Impact Area	Plant	Reduction in	
Location	Type cm	Width cm	Prior Damage Class	Number	Damage (Percent)	Survival	Height cm	Length cm	Width cm	Volume cm ³	Damage Area cm ²	Damage cm ²	Distance m	Dam./Dist. cm ² /m	Cover (Percent)	Plant Cover/Pass (Percent)	
Central Corridor	T	55	(Not Rated)	0	0	0	0	0	0	0	0	0	0				
		55	L	2	17.5	25.0	43.0	62.5	46.0	123,625	2937.0	5,874	58				
		55	M	1	10.0	90.0	100.0	100.0	100.0	1,000,000	10000.0	10,000	8				
		55	H	7	55.7	32.1	36.9	92.7	62.1	212,350	7374.9	51,624	50				
		55	V	5	74.0	32.0	22.0	41.0	33.0	29,766	1465.0	7,325	80				
		55	All Classes	15	54	35	37	72	53	140,257	4,988	74,823	196	382	6.94%	65%	
	W	28	(Not Rated)	26	80.0	31.0	16.0	42.3	30.2	20,467	1952.7	50,769	329				
		28	L	0	0	0	0	0	0	0	0.0	0	0				
		28	M	2	20.0	40.0	16.0	45.0	25.0	18,000	1200.0	2,400	5				
		28	H	11	54.6	50.0	18.0	35.2	23.4	14,792	974.9	10,724	184				
		28	V	22	62.1	56.4	14.7	35.2	20.6	10,649	1021.4	22,470	294				
		28	All Classes	61	67	44	16	39	25	15,604	1,424	86,891	812	107	3.82%	56%	
	Central Corridor	Combined	Combined	Combined	76	65	42	20	45	31	27,735	2,119	161,020	1,008	160		
	Drink Water	T	55	(Not Rated)	0	0	0	0	0	0	0	0	0	0			
55			L	4	42.5	41.3	28.3	23.0	15.8	10,234	441.5	1,766	13				
55			M	45	70.8	22.2	20.7	31.1	21.3	13,721	741.3	33,357	174				
55			H	14	57.5	27.9	27.0	35.8	22.3	21,539	955.1	13,371	80				
55			V	0	0	0	0	0	0	0	0	0	0				
		55	All Classes	63	66	25	23	32	21	15,123	770	48,494	266	182	3.31%	75%	
Drink Water	Combined	Combined	Combined	63	66	25	23	32	21	15,123	770	48,494	266	182			
John Wayne	T	55	(Not Rated)	0	0	0	0	0	0	0	0	0	0				
		55	L	2	17.5	25.0	43.0	62.5	46.0	123,625	2937.0	5,874	58				
		55	M	12	49.6	28.8	31.7	38.3	20.0	24,285	471.0	5,652	115				
		55	H	13	40.5	11.9	38.5	45.7	22.08	38,856	588.3	7,648	101				
		55	V	4	63.8	18.8	37.3	39.0	26.3	38,135	526.0	2,104	15				
		55	All Classes	30	47	19	35	41	21	30,666	518	15,548	237	66	1.19%	81%	
John Wayne	T	60	(Not Rated)	0	0	0	0	0	0	0	0	0	0				
		60	L	0	0.0	0.0	0.0	0.0	0.0	0	0.0	0	0				
		60	M	1	50.0	10.0	31.0	28.0	15.0	13,020	420.0	420	1				
		60	H	7	62.6	16.1	22.0	39.6	22.43	19,526	1180.3	8,262	126				
		60	V	8	72.5	9.4	29.3	42.5	31.1	38,698	1456.5	11,652	73				
		60	All Classes	16	67	12	26	42	26	28,810	1,271	20,334	200	102	1.69%	88%	
John Wayne	W	60	(Not Rated)	0	0	0	0	0	0	0	0	0	0				
		60	L	0	0.0	0.0	0.0	0.0	0.0	0	0.0	0	0				
		60	M	4	58.8	6.3	37.5	43.2	27.9	45,194	1362.9	5,452	51				
		60	H	7	44.6	2.1	26.5	39.6	22.86	23,950	901.4	6,310	48				
		60	V	4	51.5	1.3	27.9	30.5	15.9	13,524	571.0	2,284	92				
		60	All Classes	15	50	3	30	38	22	25,376	936	14,045	191	74	1.23%	97%	
John Wayne	Combined	Combined	Combined	61	53	13	31	40	23	29,130	818	49,927	628	79			

August 15, 2001	Track			Mean		Mean		Mean		Mean		Total	Distance	Impact Area Dam./Dist. cm ² /m	Plant Cover (Percent)	Reduction in Plant Cover/Pass (Percent)
Location	Type cm	Width cm	Prior Damage Class	Number	Damage (Percent)	Survival (Percent)	Height cm	Length cm	Width cm	Volume cm ³	Damage Area cm ²	Damage cm ²				
Langford Impact Zone	T	18	(Not Rated)	13	45.2	42.3	24.5	55.3	43.9	59,419	4485.9	58,316	139			
		18	L	5	17.0	40.0	11.5	16.2	10.8	2,012	187.2	936	52			
		18	M	7	30.0	27.1	23.3	41.1	33.4	32,031	2512.3	17,586	54			
		18	H	5	60.0	26.0	44.0	72.0	55.0	174,240	460.2	2,301	27			
		18	V	2	50.0	0.0	3.0	3.5	3.0	32	11.0	22	13			
		18	All Classes	37	42.0	30.2	13.0	28.5	19.5	7,243	1368.6	50,637	276	184	10.20%	70%
	T	40	(Not Rated)	13	45.2	42.3	24.5	55.3	43.9	59,419	1011.7	13,152	139			
		40	L	6	48.3	50.8	16.7	20.8	19.2	6,657	516.7	3,100	34			
		40	M	7	55.0	26.4	30.7	55.7	43.6	74,542	3928.6	27,500	31			
		40	H	5	60.0	26.0	44.0	72.0	55.0	174,240	8425.0	42,125	27			
		40	V	1	20.0	0.0	35.0	40.0	30.0	42,000	1200.0	1,200	3			
		40	All Classes	32	49.5	36.6	27.8	51.1	40.5	57,385	4132.5	132,241	234	565	14.12%	63%
	T	44	(Not Rated)	0	0	0	0	0	0	0	0	0	0			
		44	L	0	0	0	0	0	0	0	0	0	0			
		44	M	14	52.5	28.9	26.0	44.8	33.9	39,495	1545.7	21,640	94			
		44	H	18	66.1	21.1	17.5	35.1	26.4	16,184	1043.5	18,783	120			
		44	V	4	100.0	23.0	15.9	19.1	14.0	4,226	111.8	447	23			
		44	All Classes	37	65.5	23.8	20.3	36.6	27.7	20,611	1115.4	41,270	237	174	3.96%	76%
	T	60	(Not Rated)	14	79.5	33.9	17.9	41.9	31.3	23,524	2478.9	34,704	35			
		60	L	8	68.8	50.0	20.0	26.9	27.5	14,784	1046.9	8,375	40			
		60	M	17	56.2	31.8	24.7	47.7	40.0	47,097	3019.1	51,325	60			
		60	H	3	100.0	8.3	18.3	25.0	25.0	11,456	641.7	1,925	5			
		60	V	7	95.7	6.3	21.4	45.0	35.7	34,437	2853.6	19,975	23			
		60	All Classes	49	73.2	30.3	21.1	40.9	33.9	29,317	2373.6	116,304	162	718	11.97%	70%
	T	Combined	Combined	155	59.0	30.0	20.4	39.0	30.4	24,127	2196.5	340,453	909	375		
	W	10	(None)	0	0	0	0	0	0	0	0	0	0			
		10	L	0	0	0	0	0	0	0	0	0	0			
		10	M	0	0	0	0	0	0	0	0	0	0			
		10	H	2	70.0	5.0	6.0	8.0	6.5	312	59.5	119	16			
		10	V	3	93.3	35.0	2.7	4.3	4.0	46	27.3	82	100			
		10	All Classes	5	84.0	23.0	4.0	5.8	5.0	116	40.2	201	116	2	0.17%	77%
	W	24	(None)	0	0	0	0	0	0	0	0	0	0			
		24	L	0	0	0	0	0	0	0	0	0	0			
		24	M	0	0	0	0	0	0	0	0	0	0			
		24	H	4	87.5	27.5	15.0	18.5	20.3	5,619	402.5	1,610	220			
		24	V	2	100.0	0.0	4.5	12.0	10.5	567	136.0	272	12			
		24	All Classes	6	91.7	18.3	11.5	16.3	17.0	3,193	313.7	1,882	232	8	0.34%	82%
	W	28	(None)	13	69.6	46.9	12.5	25.3	18.7	5,932	753.0	9,789	95			
		28	L	10	85.5	68.0	16.0	25.5	23.0	9,384	857.5	8,575	54			
		28	M	17	52.1	45.0	30.9	55.9	39.4	68,005	3079.4	52,350	122			
		28	H	7	38.6	22.9	32.3	55.7	42.9	77,100	2635.7	18,450	101			
		28	V	1	100.0	50.0	20.0	20.0	20.0	8,000	400.0	400	10			
		28	All Classes	48	62.8	47.2	22.8	40.5	30.5	28,133	1865.9	89,564	381	235	8.40%	53%
Langford Impact Zone	W	Combined	Combined	59	67.5	42.2	20.1	35.1	27.0	18,966	1553.3	91,647	729	126		

[illegible]