The effect of newly installed

Puffin crossings on collisions

This study looked at changes in collisions before and after implementation at 23 new stand-alone Puffin crossings grouped into 16 site groups. The Tanner test was performed, which combined the results from sites and compared any changes with borough control data for the same time periods.

Over all sites, following the introduction of a Puffin crossing, there were reductions of 15% in total collisions and 26% in pedestrian collisions. These reductions were not statistically significant at the 0.05 level. When grouped by previous crossing facility, there were reductions in total and pedestrian collisions for nearly all site types.

Therefore, there is no evidence that Puffin crossings pose a significantly greater risk to road users than other formal crossing types. However, where there had previously been no formal crossing, total collisions rose slightly but not statistically significantly.

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1. Introduction

Puffin (**P**edestrian **U**ser-**F**riendly **IN**telligent) crossings were designed to reduce delays to vehicles and improve pedestrians' feelings of safety while crossing the road. By detecting pedestrians on the crossing and varying the length of the pedestrian phase accordingly, they aim to give pedestrians (especially older or disabled pedestrians) a greater sense of protection compared with Pelican crossings. Puffin crossings do not use the flashing far side pedestrian signal associated with Pelican crossings. Instead, nearside pedestrian signals aim to avoid any confusion over when to cross which might arise from a flashing signal and reduce intimidation from drivers. The nearside signals are also intended to facilitate crossing for people with visual impairments[1] and encourage pedestrians to watch approaching traffic and the pedestrian signal simultaneously. In addition, Puffin crossings aim to reduce delays to vehicles by using kerbside detectors to detect when a pedestrian has pressed the button on the demand unit to cross, but subsequently finds an opportunity to cross before the green pedestrian phase. In these situations, the call for a pedestrian phase is cancelled.

The potential road safety benefits of Puffin crossings, according to Traffic Advisory Leaflet 1/01[2] are:

- Reduced harassment experienced by pedestrians as a result of the withdrawal of the flashing pedestrian phase.
- Reduced frequency of shunt collisions as unnecessary signal changes are avoided.
- Reduced confusion for pedestrians as the blackout and flashing pedestrian signal are not used.
- Increased convenience and reduced confusion associated with the wider use of pedestrian stages at signalised junctions.

There are currently 111 stand alone Puffin crossings in service in Greater London. The Department for Transport (DfT) intention is that they will become the standard form of provision of signalled pedestrian crossings[3]. However, there is still some uncertainty about the road safety implications of Puffins in comparison with other pedestrian crossing facilities.

To date, only limited evaluation of Puffin crossings has been undertaken. One early study found little difference in collision rates between Pelican and Puffin crossings.[4] However, this study examined only five sites in London and found that some collision types declined while others increased. Another study of two pilot Puffin sites incorporated both behavioural and attitudinal measures but did not assess the collision data[5]. The current study aimed to meet the need for further evaluation of the safety record of Puffin crossings and forms part of a series of three studies investigating behavioural and attitudinal aspects of Puffin crossings.

2. Aims and Objectives

The aim of this study is to assess the collision record of newly installed Puffin crossings in London and draw comparisons with previous crossing facilities and more specifically to:-

- To compare the rate of total collisions and the rate of collisions involving pedestrians before and after installation of Puffin Crossings;
- To determine whether the type of previous crossing facility is important;
- To summarise the types of collisions which occur at Puffin crossing sites and highlight any patterns.

3. Method

3.1. Site Selection and Control Data

23 stand-alone Puffin crossings were used in this analysis: 19 single sites and 4 dual sites staggered over wider roads or dual carriageways. These were chosen to give the maximum amount of collision data since installation. Appendix 7.1 gives the locations and installation dates of the Puffin crossings included in this study. Several Puffin crossings have been commissioned more recently but were excluded from the study because of insufficient “after” data.

This study aimed to compare the change in collisions at the Puffin crossing sites (site data) with the general trends in collision levels over the same period (control data) and test the statistical significance of any differences using the Tanner test[6]. There are restrictions on the type of control data that can be used: for this test, the control data should ideally be at least 10 times as numerous as the site data and the two sets of data should be mutually exclusive. Therefore, to enable the use of statistical tests, borough-wide collision figures were used as control and, to ensure that the borough control data were mutually exclusive, sites within the same borough with overlapping dates for data extraction were grouped together.

To enable statistical analysis using control data, sites in the same borough were grouped together into a single borough site group. For each site group, 36 months “before” collision data were extracted and as many months of “after” data as were available up to and including the end of May 2005 (the most recent data available at the time of study). The “before” and “after” periods were calculated based on the installation dates of the crossing with the month of installation being excluded from the analysis. Installation dates varied for sites within the borough site groups. For each borough site group with more than one site, the “before” period was defined as the 36 months prior to the earliest installation date of the group. The “after” period included as many months’ data as possible up to 36 months after the month of the most recent installation date of the sites in that borough.

Where there was a minimum of 72 months between the installation dates of sites in one borough site group, two separate site groups were produced. This made it possible to use independent control data for each site group. Combining sites within boroughs in this way generated a total of 16 site groups.

3.2. Data Extraction

All sites were stand-alone Puffins, rather than at junctions. Dual (staggered) crossings were counted as one site. Collision records were extracted for 50m either side of the crossing. Those collisions which occurred on side roads were not included and, where a site was within 50m of a larger junction, only those collisions which occurred on the relevant arm or the junction were included. Where an existing crossing had been relocated during conversion to a Puffin, an area which extended 50m either side of the new and relocated location was included. At staggered dual crossings, an area 60m either side of the centre of the two crossings was used.

In order to reduce the effect of signal equipment faults on the collision records, signal site histories were examined for the "before" and "after" periods for each site. Any collision which coincided with a serious fault would be excluded from the analysis. However, no collisions were excluded on this basis.

Collisions before and after implementation were categorised by severity, time of day, road user, road conditions and contributory factors. The locations of collisions and the nature of the conflicts were plotted on site plans.

3.3. Statistical Analysis

The Tanner test was performed on the total collision and pedestrian collision data from the 16 site groups. This test aims to determine the effect of a given measure over several sites when the duration of time since implementation varies between sites. To conduct this test, control data were required. For this study, total and pedestrian collisions for the borough in which each crossing was located were used as a control. The analysis took no account of the number of pedestrians crossing the road before or after implementation of the Puffin crossings.

The Tanner test uses two parameters to determine the statistical significance of differences in collision data before and after implementation of the Puffin crossing;

- "t" is used to test the overall effect of the Puffin crossing over all the sites combined, relative to control data;
- "χ^2" is used to test whether the effect of the Puffin crossing varied between the sites groups (see Appendix 7.2 for more detail).

In this study the 95% confidence level was used as a threshold. Where the number of collisions both before and after introduction was zero, the zeros were substituted by 0.01 to allow the Tanner test to run correctly.

Past studies have found that the effect of new signalised crossings on collisions differs depending on whether or not there was a previous crossing facility[7]. Where there had been no crossing previously, collisions rose. It was considered important to look for evidence of that effect here. Therefore, once the initial overall analysis using borough site groups was completed, sites were re-grouped according to the type of crossing facility that had previously existed on that site and the Tanner Test re-run. These categories were:-

- no formal pedestrian crossing facility;
- a Zebra crossing;
- a Pelican crossing.

However, not all sites within a borough site group as defined above had the same previous crossing facility. To enable this analysis, where two sites had previously had different facilities, site groups were split into single sites. In these cases, to ensure consistency with overall analysis, the same before and after periods were used for the control data as were used in the overall analysis.

4. Results

4.1. All Collisions and Pedestrian Collisions

Table 1 presents the Tanner test results for all the analyses performed.

Table 1: Summary of Tanner Test Results

		Total Collisions				Pedestrian Collisions			
	No. of sites	% Change	χ^2	t	P (%)	% Change	χ^2	t	P (%)
All site groups	16	-15%	16.80	-1.040	29.8	-26%	13.98	-1.226	22.0
No formal crossing	6	8%	8.16	0.232	81.6	-36%	6.97	-0.704	48.1
Zebra Crossing	6	-14%	5.90	-0.506	61.6	-8%	4.00	-0.255	79.9
Pelican Crossing	6	-39%	1.07	-1.793	7.3	-30%	4.00	-0.706	48.0

The interpretation of t is given by referring to a table of percentage points of the t-distribution for infinite degrees of freedom referring. A t-value of 1.96 would represent a 5% significance level.

χ^2 is interpreted by reference to a table of percentage points for the χ^2 distribution, for N-1 degrees of freedom, where N is the number of sites being tested. If χ^2 is significant, we may conclude that the effect of the treatment is not the same at all sites.

The Tanner test showed that, when grouped into 16 site groups there was a reduction in total collisions of 15% over and above that recorded at control sites. This difference was not statistically significant at the 5% level. For pedestrian collisions, there was a 26% reduction over and above that recorded at control sites. This difference was not statistically significant at the 5% level.

A 39% reduction in total collisions was found where a Puffin crossing replaced a Pelican crossing. This result was significant at the 10% level, but not the 5% level. The chi-squared test result was not significant at the 5% level for this group. This indicates that there is no evidence that the collision trends at the sites in this group vary significantly from one another. It is therefore reasonable to take the change as systematic and related to the implementation of the Puffin crossing.

The Tanner test results are described in more detail in the following sections.

4.2. All Sites Combined, With No Control Data

Table 2 summarises all the collisions over all 23 sites for the periods before and after installation of the Puffin crossings without any adjustment for control data. It shows that there was a slight increase in the rate of fatal collisions (equating to one collision in both the before and after periods). There were reductions of 27% in collisions involving serious injury and 26% in slight injury collisions*. There were large percentage reductions in the rates of collisions involving children (86%) and of collisions which occurred on the pedestrian crossing itself were down by 53%.

Table 2: Frequency and Rates of Different Types of Collision Over All 23 Sites

	Total Collisions Before	Total Collisions After	Monthly collision rate before	Monthly collision rate after	Change in Collision rates (%)
Number of Months	828	794			
Fatal	1	1	0.001	0.001	4
Serious	23	16	0.028	0.020	-27
Slight	94	67	0.114	0.084	-26
Child Pedestrian	15	2	0.018	0.003	-86
Pedestrians	41	24	0.050	0.030	-39
Pedestrian over 60	5	2	0.006	0.003	-58
On pedestrian crossing	11	5	0.013	0.006	-53
Shunt on approach	6	5	0.007	0.006	-13
Wet	26	14	0.031	0.018	-44
Dark	31	30	0.037	0.038	1
Single vehicle (no ped)	12	4	0.014	0.005	-65
Bus/coach	5	5	0.006	0.006	4
Pedal Cycle	5	5	0.006	0.006	4
Powered Two Wheeler	29	24	0.035	0.030	-14
Weekday	88	61	0.106	0.077	-28
Weekend	30	23	0.036	0.029	-20
0700-1000 hours	24	16	0.029	0.020	-30
1000-1600 hours	35	28	0.042	0.035	-17
1600-1900	28	16	0.034	0.020	-40
1900-0700	31	24	0.037	0.030	-19
Total	118	84	0.143	0.106	-26

One of the predicted benefits of Puffin crossings was a reduction in shunt type collisions on the approach to the crossing. The data confirm that there was a slight reduction in the rate of shunt collisions on the approach (from 6 in the before period to 5 in the after period). However, it is worth noting that 9 of the 23 sites had no formal crossing before introduction of the Puffin crossing.

* Treat percentage reductions with caution as they are based on small numbers of casualties

Although the actual numbers were very small, there were small increases in the rates of three types of collision; those which occurred in the dark (up 1%) and those involving a bus/coach (up 4%) or pedal cycle (up 4%).

Table 3 shows the total collision frequencies and monthly rates for each site before and after implementation of the Puffin crossing as well as percentage change between the before and after periods. Over all borough site groups, the monthly total collision rate fell between the before and after periods by 26% from 0.205 to 0.151.

However, the rate rose at 5 of the 23 sites, 2 of which had previously had no formal crossing facility, 2 of which had been Zebra crossings and one which had been converted from a Pelican crossing.

4.3. Pedestrian Collisions at Each Site

Table 4 shows the pedestrian collision frequencies and monthly rates at each site before and after implementation of the Puffin crossing. Over all sites, the monthly pedestrian collision rate fell by 39% from 0.071 to 0.043.

The monthly rate rose at 7 out of 23 sites, of which 4 had previously had no formal crossing, 2 had been a Zebra crossing and 1 had been a Pelican crossing previously.

Table 3: Total collision data for all sites and borough control data

Site Group	Borough	Site References	Number of months		Number of Collisions		Collision Rate per Month		Change in Collision Rate (%)	Gross control		Net control	
			Before	After	Before	After	Before	After		Before	After	Before	After
1	Camden	02/236	36	30	7	2	0.194	0.067	-66	4392	2636	4381	2634
		02/238	36	30	4	0	0.111	0.000	-100				
2	Islington	03/122	36	33	9	5	0.250	0.152	-39	3849	2527	3835	2520
		03/160	36	33	5	2	0.139	0.061	-56				
3	Lewisham	07/111	36	36	6	3	0.167	0.083	-50	4226	4035	4220	4032
4	Wandsworth	10/135	36	36	9	5	0.250	0.139	-44	4136	4111	4127	4106
5	Kensington & Chelsea	12/150/151	36	36	2	4	0.056	0.111	50	3145	2146	3141	2141
		12/200	36	36	2	1	0.056	0.028	-50				
6	Waltham Forest	13/035	36	32	2	2	0.056	0.063	13	2706	2138	2704	2136
7	Redbridge	14/158/159	36	36	9	20	0.250	0.556	122	3421	2814	3406	2792
		14/175/176	36	36	6	2	0.167	0.056	-67				
8	Bromley	19/118	36	36	4	0	0.111	0.000	-100	3573	2966	3562	2964
		19/127	36	36	7	2	0.194	0.056	-71				
9	Croydon	20/051	36	36	6	4	0.167	0.111	-33	4897	4478	4891	4474
10	Croydon	20/258/	36	30	2	2	0.056	0.067	20	3980	2823	3978	2820
		20/259	36	30	0	1	0.000	0.033	∞				
11	Richmond	24/040/141	36	36	11	6	0.306	0.167	-45	2267	2124	2256	2118
12	Ealing	27/232	36	36	3	2	0.083	0.056	-33	4667	3908	4664	3906
13	Brent	28/149	36	36	7	7	0.194	0.194	0	4023	3987	4016	3980
14	Barnet	30/156	36	36	1	0	0.028	0.000	-100	5362	4764	5361	4764
15	Haringey	31/071	36	36	3	1	0.083	0.028	-67	3393	3192	3390	3191
16	Haringey	31/182	36	36	5	11	0.139	0.306	120	3303	3159	3290	3146
		31/183	36	36	8	2	0.222	0.056	-75				
		Total for all site groups	576	557	118	84	0.205	0.151	-26			61222	51724

Tanner test results (see Table 1)
k = 0.850, i.e. a 15% reduction relative to control.
t = -1.040 (p = 30%), i.e. the reduction is not statistically significant
χ^2 = 16.796 (p = 33%), i.e. there is no evidence that the effect of installing a Puffin crossing varied from site to site.

Table 4: Pedestrian collision data for all sites and borough control data

Site Group	Borough	Site references	Months included		Number of Collisions		Collision Rate per Month		Change in Collision Rate (%)	Gross control		Net control	
			Before	After	Before	After	Before	After		Before	After	Before	After
1	Camden	02/236	36	30	5	1	0.139	0.033	-76	1244	800	1237	799
		02/238	36	30	2	0	0.056	0.000	-100				
2	Islington	03/122	36	33	3	3	0.083	0.091	9	983	649	976	645
		03/160	36	33	4	1	0.111	0.030	-73				
3	Lewisham	07/111	36	36	3	2	0.083	0.056	-33	1152	1064	1149	1062
4	Wandsworth	10/135	36	36	2	1	0.056	0.028	-50	1064	933	1062	932
5	Kensington & Chelsea	12/150/151	36	36	1	2	0.028	0.056	100	916	547	915	545
		12/200	36	36	0	0	0.000	0.000	0				
6	Waltham Forest	13/035	36	32	1	2	0.028	0.063	125	619	488	618	486
7	Redbridge	14/158159	36	36	0	0	0.000	0.000	0	527	437	525	437
		14/175/176	36	36	2	0	0.056	0.000	-100				
8	Bromley	19/118	36	36	2	0	0.056	0.000	-100	663	532	658	531
		19/127	36	36	3	1	0.083	0.028	-67				
9	Croydon	20/051	36	36	1	0	0.028	0.000	-100	1157	1036	1156	1036
10	Croydon	20/258	36	30	0	1	0.000	0.033	∞	870	644	870	642
		20/259	36	30	0	1	0.000	0.033	∞				
11	Richmond	24/040/141	36	36	1	0	0.028	0.000	-100	428	360	427	360
12	Ealing	27/232	36	36	0	0	0.000	0.000	0	976	809	976	809
13	Brent	28/149	36	36	4	3	0.111	0.083	-25	1032	957	1028	954
14	Barnet	30/156	36	36	1	0	0.028	0.000	-100	1017	858	1016	858
15	Haringey	31/071	36	36	1	0	0.028	0.000	-100	1091	995	1090	995
16	Haringey	31/182	36	36	0	5	0.000	0.139	∞	927	854	922	848
		31/183	36	36	5	1	0.139	0.028	-80				
		Total for all site groups	576	557	41	24	0.071	0.043	-39			14625	11939

Tanner test results (see Table 1)
k = 0.740, i.e. a 26% reduction relative to control.
t = -1.226 (p = 22%), i.e. the reduction is not statistically significant.
χ^2 = 13.976 (p = 53%), i.e. there is no evidence that the effect of installing a Puffin crossing varied from site to site.

4.4. Total Collisions for Different Previous Crossing Facilities

Table 5, Table 6 and Table 7 present the total collision frequencies and rates for each site group or site according to which types of crossing facility previously existed at the site (no formal crossing, Zebra and Pelican respectively). Table 1, above presents the Tanner test results for each grouping.

Where there had been no formal crossing facility previously (N=6), there was a 15% reduction in total collisions over all sites. A Tanner test showed that this represented an increase of 8% relative to control data. The difference was not statistically significant. At these conversions, the χ^2 result (P=14.8%) showed that the effect did not vary significantly across all the sites.

Where a Puffin replaced a Zebra crossing (N=6), there was an overall reduction in the monthly total collision rate of 23%. A Tanner test showed that this represented a 14% reduction relative to controls. The difference was not significant. At these conversions, the χ^2 result (P=31.6%) showed that the effect did not vary significantly across all the sites.

Where a Puffin had replaced a Pelican crossing (N=6), there was an overall reduction in the monthly total collision rate of 42%. A Tanner test showed that this represented a 39% reduction relative to controls which was indicative. At these conversions, the χ^2 result (P=95.7%) showed that the effect did not vary significantly across all the sites.

In summary, total collisions rose relative to controls where there had been no formal crossing previously and fell at sites which had previously been Zebra or Pelican crossings. These changes were not statistically significant. However, where a Puffin crossing replaced a Pelican crossing, the 39% reduction in total collisions was statistically significant at the 10% level and there was not significant variation between sites in this group.

4.5. Pedestrian Collisions for Different Previous Crossing Facilities

Table 8, Table 9 and Table 10 present pedestrian collision frequencies and rates for each site group or site according to which type of crossing facility previously existed at the site (no formal crossing, Zebra and Pelican respectively).

Where there had been no crossing facility previously (N=6), there was a 54% reduction in monthly pedestrian collision rate over all sites. A Tanner test showed that this represented a decrease of 35% relative to control data. However, the difference was not statistically significant. At these conversions, the χ^2 result (P=22.3%) showed that the effect did not vary significantly across all the sites.

Where a Puffin replaced a Zebra crossing (N=6), there was an overall reduction in pedestrian collisions of 23%. A Tanner test showed that this represented an 8% reduction relative to controls. The difference was not significant. At these conversions, the χ^2 result (P= 55.0%) showed that the effect did not vary significantly across all the sites.

Where a Puffin had replaced a Pelican crossing (N=6), there was an overall reduction in total collisions of 43%. A Tanner test showed that this represented a 30% reduction relative to controls which was not statistically significant. At these conversions, the χ^2 result (P=55.0%) showed that the effect did not vary significantly across all the sites.

In summary, although all site groups saw a decrease in pedestrian collisions relative to controls after implementation of a Puffin crossing, none of these were statistically significant.

Table 5: Total Collision Frequency and Rates at Puffin crossing sites with no previous formal crossing facility

Site Group	Borough	Site References	Number of Months		Number of collisions		Collision Rate per Month		Change in Collision Rate (%)	Gross control		Net control	
			Before	After	Before	After	Before	After		Before	After	Before	After
1	Camden	02/236	36	30	7	2	0.194	0.067	-66	4392	2636	4381	2634
2	Islington	03/122	36	33	9	5	0.250	0.152	-39	3849	2527	3835	2520
		03/160	36	33	5	2	0.139	0.061	-56				
7	Redbridge	14/158/159	36	36	9	20	0.250	0.556	122	3421	2814	3406	2792
		14/175/176	36	36	6	2	0.167	0.056	-67				
8	Bromley	19/118	36	36	4	0	0.111	0.000	-100	3573	2966	3562	2964
10	Croydon	20/258/	36	30	2	2	0.056	0.067	20	3980	2823	3978	2820
		20/259	36	30	0	1	0.000	0.033	∞				
12	Ealing	27/232	36	36	3	2	0.083	0.056	-33	4667	3908	4664	3906
		Total for site groups	216	204	45	36	0.2083	0.1765	-15			23826	17636

Tanner test results: k = 1.1080, (i.e. an 8% increase). t = 0.232 (P=81.6%, non-significant). χ^2 = 8.162 (P=14.8%, non-significant).

Table 6: Total Collision Frequency and Rates at Puffin crossing sites which replaced a Zebra crossing

Site Group	Borough	Site References	Number of Months		Number of collisions		Collision Rate per Month		Change in Collision Rate (%)	Gross control		Net control	
			Before	After	Before	After	Before	After		Before	After	Before	After
1	Camden	02/238	36	30	4	0	0.111	0.000	-100	4392	2636	4381	2634
5	Kensington & Chelsea	12/150/151	36	36	2	4	0.056	0.111	100	3145	2146	3141	2141
		12/200	36	36	2	1	0.056	0.028	-50				
8	Bromley	19/127	36	36	7	2	0.194	0.056	-71	3573	2966	3562	2964
13	Brent	28/149	36	36	7	7	0.194	0.194	0	4023	3987	4016	3980
14	Barnet	30/156	36	36	1	0	0.028	0.000	-100	5362	4764	5361	4764
16	Haringey	31/182	36	36	5	11	0.139	0.306	120	3303	3159	3290	3146
		31/183	36	36	8	2	0.222	0.056	-75				
		Total for site groups	216	210	36	27	0.1667	0.1286	-23			23751	19629

Tanner test results: k = 0.863 (i.e. a 14% reduction). t = -0.502 (P=61.6%, non-significant). χ^2 = 5.904 (P=31.6%, non-significant).

Table 7: Total Collision Frequency and Rates at Puffin crossing sites which replaced a Pelican crossing

Site Group	Borough	Site References	Number of Months		Number of collisions		Collision Rate per Month		Change in Collision Rate (%)	Gross control		Net control	
			Before	After	Before	After	Before	After		Before	After	Before	After
3	Lewisham	07/111	36	36	6	3	0.167	0.083	-50	4226	4035	4220	4032
4	Wandsworth	10/135	36	36	9	5	0.250	0.139	-44	4136	4111	4127	4106
6	Waltham Forest	13/035	36	32	2	2	0.056	0.063	13	2706	2138	2704	2136
9	Croydon	20/051	36	36	6	4	0.167	0.111	-33	4897	4478	4891	4474
11	Richmond	24/040/141	36	36	11	6	0.306	0.167	-45	2267	2124	2256	2118
15	Haringey	31/071	36	36	3	1	0.083	0.028	-67	3393	3192	3390	3191
		Total for site groups	216	212	37	21	0.1713	0.0991	-42			21588	20057

Tanner test results: k = 0.608 (i.e. a 39% reduction). t = -1.793 (P=7.3%, significant at 10% level). χ^2 = 1.067 (P=95.7%, non-significant).

Table 8: Pedestrian Collision Frequency and Rates at Puffin crossing sites with no previous formal crossing facility

Site Group	Borough	Site references	Number of Months		Number of collisions		Collision Rate per Month		Change in Collision Rate (%)	Gross control		Net control	
			Before	After	Before	After	Before	After		Before	After	Before	After
1	Camden	02/236	36	30	5	1	0.139	0.033	-76	1244	800	1237	799
2	Islington	03/122	36	33	3	3	0.083	0.091	9	983	649	976	645
		03/160	36	33	4	1	0.111	0.030	-73				
7	Redbridge	14/158159	36	36	0	0	0.000	0.000	0	527	437	525	437
		14/175/176	36	36	2	0	0.056	0.000	-100				
8	Bromley	19/118	36	36	2	0	0.056	0.000	-100	663	532	658	531
10	Croydon	20/258	36	30	0	1	0.000	0.033	0	870	644	870	642
		20/259	36	30	0	1	0.000	0.033	∞				
12	Ealing	27/232	36	36	0	0	0.000	0.000	0	976	809	976	809
		Total for site groups	216	204	16	7	0.0741	0.0343	-54			5242	3863

Tanner test results: k = 0.644 (i.e. a 36% reduction). t = -0.704 (P=48.1%, non-significant). χ^2 = 6.972 (P=22.3%, non-significant).

Table 9: Pedestrian Collision Frequency and Rates at Puffin crossing sites which replaced a Zebra crossing

Site Group	Borough	Site references	Number of Months		Number of collisions		Collision Rate per Month		Change in Collision Rate (%)	Gross control		Net control	
			Before	After	Before	After	Before	After		Before	After	Before	After
1	Camden	02/238	36	30	2	0	0.056	0.000	-100	1244	800	1237	799
5	Kensington & Chelsea	12/150/151	36	36	1	2	0.028	0.056	100	916	547	915	545
		12/200	36	36	0	0	0.000	0.000	0				
8	Bromley	19/127	36	36	3	1	0.083	0.028	-67	663	532	658	531
13	Brent	28/149	36	36	4	3	0.111	0.083	-25	1032	957	1028	954
14	Barnet	30/156	36	36	1	0	0.028	0.000	-100	1017	858	1016	858
16	Haringey	31/182	36	36	0	5	0.000	0.139	∞	927	854	922	848
		31/183	36	36	5	1	0.139	0.028	-80				
	Total for site groups		216	210	16	12	0.0741	0.0571	-23			5776	4535

Tanner test results: k = 0.919 (i.e. an 8% reduction). t = -0.255 (P=79.9%, non-significant). χ^2 = 3.999 (P=55.0%, non-significant).

Table 10: Pedestrian Collision Frequency and Rates at Puffin crossing sites which replaced a Pelican crossing

Site Group	Borough	Site references	Number of Months		Number of collisions		Collision Rate per Month		Change in Collision Rate (%)	Gross control		Net control	
			Before	After	Before	After	Before	After		Before	After	Before	After
3	Lewisham	07/111	36	36	3	2	0.083	0.056	-33	1152	1064	1149	1062
4	Wandsworth	10/135	36	36	2	1	0.056	0.028	-50	1064	933	1062	932
6	Waltham Forest	13/035	36	32	1	2	0.028	0.063	125	619	488	618	486
9	Croydon	20/051	36	36	1	0	0.028	0.000	-100	1157	1036	1156	1036
11	Richmond	24/040/141	36	36	1	0	0.028	0.000	0	428	360	427	360
15	Haringey	31/071	36	36	1	0	0.028	0.000	-100	1091	995	1090	995
	Total for site groups		216	212	9	5	0.0417	0.0236	-43			5502	4871

Tanner test results: k = 0.700 (i.e. a 30% reduction). t = -0.706 (P=48.0%, non-significant). χ^2 = 3.996 (P=55.0% non-significant).

5. Discussion

Overall, this analysis of 16 site groups suggests that Puffins do not present an increased risk to road users in general or specifically to pedestrians. Neither do they significantly reduce the number of collisions. However, Puffin crossings are not necessarily installed on safety grounds.

The fact that none of the changes in collision rates were found to be statistically significant at the 5% level might be explained by the relatively small numbers of sites and therefore the number of collisions included in the analysis. Since the start of this study, more new Puffin crossings have been commissioned across London. The inclusion of further sites would increase the likelihood of detecting any statistically significant changes in safety before and after implementation of Puffin crossings.

When compared with previous formal crossing types (namely Zebra and Pelican) Puffin crossings do not result in significantly different collision rates. The reduction in pedestrian collision rates at Pelican and Zebra crossings (relative to controls) is of a similar proportion to the reduction in total collision rates at those sites. Where there had been no formal crossing there is less consistency in the changes in collisions. Installing a crossing facility where previously there had been none will tend to concentrate pedestrian activity at the crossing and probably increase the potential for conflict between road users at that location.

Despite the slight reduction in the rate of shunt type collisions after implementation of the Puffin crossings, the change is too small to determine whether the predicted reduction in shunt type collisions will be achieved. Recent observational research suggests that the pedestrian demand cancellation facility at stand-alone Puffins is rarely called into use in London because Puffin controllers are often run under pre-timed maximum timings to respond quickly to pedestrian demands or because a there are too many pedestrians on the footway to allow the call to be cancelled[8]. This might explain why the effect on shunt collisions is not very pronounced at the sites studied.

6. Conclusions

A collision analysis of total and pedestrian collisions before and after implementation of 23 Puffin crossing sites across greater London was conducted. Usually the area 50m either side of the crossing was included in the analysis. A Tanner test was performed to combine information from a number of sites and to compare any changes with suitable control data for the same time periods.

Over all sites, there were reductions of 15% in total collision rates and 26% in pedestrian collision rates relative to control sites. These differences were not statistically significant.

When grouped by previous crossing facility, there were reductions in total and pedestrian collisions for nearly all site types. However, where there had previously been no formal crossing, total collisions rose.

Given the evidence available from 23 Puffin sites in London, there seems no argument against the installation of Puffin crossings on safety grounds. There is no evidence that Puffin crossings pose a significantly greater risk to road users than other formal crossing types in London. This is true for a variety of site types; either new crossing locations or as a replacement for a Zebra or Pelican crossing.

However, this study provides only preliminary results and further analysis should include more sites, longer periods of time and perhaps should focus on selection of collisions judged relevant to the crossing. Given that Puffin crossings are still relatively rare across London, further work should also examine user understanding and acceptance of this type of facility.

7. Appendices

7.1. Appendix 1: Details of sites included in analysis

Borough	Site number	Location	Grid Ref	Installation date	Previous facility	Distance included either side of crossing (m)
Camden	02/000236	A4200 Eversholt Street By Aldenham Street	529436, 183044	15-Aug-01	No formal crossing	50
Camden	02/000238	B518 Mansfield Road by Oak Village	528260, 185623	11-Nov-02	Zebra	50
Islington	03/000122	Seven Sisters Road by Axminster Road	530657, 186180	3-May-01	No formal crossing	50
Islington	03/000160	A103 Hornsey Road by A503 Seven Sister Road	530700, 186361	23-Aug-02	No formal crossing	50
Lewisham	07/000111	A205 Stanstead Road By Kemble Road	535916, 173286	29-May-92	Pelican	50
Wandsworth	10/000135	Upper Richmond Road by Charlwood Road	523636, 175179	21-Jul-93	Pelican	50
Kensington	12/000150	Exhibition Road by Princes Gate Mews (Southbound)	526849, 179255	11-Nov-98	Zebra	60
Kensington	12/000151	Exhibition Road by Princes Gate Mews (Northbound)	526840, 179283	11-Nov-98	Zebra	60
Kensington	12/000200	Sloane Avenue By Makins Street	527395, 178656	30-Oct-01	Zebra	50
Waltham Forest	13/000035	St James Street By High Street	536340, 188793	2-Sep-02	Pelican	50
Redbridge	14/000158	A12 (T) Eastern Avenue by The Drive (Eastbound)	542333, 188379	24-May-01	No formal crossing	60
Redbridge	14/000159	A12 (T) Eastern Avenue by The Drive (Westbound)	542346, 188367	24-May-01	No formal crossing	60
Redbridge	14/000175	A1400 Woodford Avenue By Grasmere Gardens Northwest Bound	542651, 189033	3-May-02	No formal crossing	60
Redbridge	14/000176	A1400 Woodford Avenue By Grasmere Gardens Southeast Bound	542656, 189046	3-May-02	No formal crossing	60
Bromley	19/000118	High Street Beckenham By Burnhill Road	537232, 169358	18-May-98	No formal crossing	50
Bromley	19/000127	Bromley Road By Westgate Road	538007, 169409	19-Mar-01	Zebra	50
Croydon	20/000051	Purley Way By Fairmead Road	530863, 166499	17-Jun-92	Pelican (possibly relocated)	50
Croydon	20/000258	A214 Westow Hill By Beardell Street	533528, 170713	13-Nov-02	No formal crossing	50
Croydon	20/000259	Westow Street By Carberry Road	533439, 170558	13-Nov-02	No formal crossing	50
Richmond	24/000041	Lower Mortlake Road By Pagoda Avenue Westbound	518690, 175528	28-Mar-96	Pelican relocated 20m SW May 1996.	60W and 80E as was relocated
Richmond	24/000040	Lower Mortlake Road By Pagoda Avenue Eastbound	518701, 175524	28-Mar-96	Pelican relocated 20m SW May 1996.	60W and 80E as was relocated
Ealing	27/000232	B452 Windmill Road By Murray Road	517154, 178539	24-May-02	No formal crossing	50
Brent	28/000149	Manor Park Road By Crownhill Road	521606, 183554	16-Oct-96	Zebra	50
Barnet	30/000156	The Ridgeway By St Pauls School	522533, 192720	28-Oct-96	Zebra	50
Haringey	31/000071	High Road Tottenham By Townsend Road	533647, 188721	31-May-93	Pelican	50
Haringey	31/000182	Tottenham High Road By Ruskin Road	533912, 190862	15-Dec-00	Zebra	50
Haringey	31/000183	Tottenham High Road By Moselle Place	533887, 191287	15-Dec-00	Zebra	50

7.2. Appendix 2: A solution to the problem of combining accident frequencies from a number of sites

The Tanner test is based on a method devised by J.C. Tanner of the Transport and Road Research Laboratory. It is used in situations where it is required to combine accident data from a number of sites where similar changes have taken place, such as introduction of a traffic management feature. The explanation of Tanner's method has been simplified in this note, but a detailed analysis is given in Biometrika, Volume 45, parts 3 & 4, pages 331-to 342 *A problem in the combination of accident frequencies*.

The analysis performs two functions. Firstly it tests the overall effects for all sites combined, and secondly it tests for variation between the different sites.

The theory of the analysis is as follows:

Let N = number of sites from which data is to be combined

b_i = Number of accidents in the before period at site i (where i = 1, 2, …..N)

a_i = Number of accidents in the after period at site i

C_i = Ratio of accidents after to before the control area for site i (The control is assumed free from error. In practice, control figures should be at least 10 times greater than the test data)

$n_i = a_i + b_i$

Then $k_i = a_i/(b_iC_i)$ is the measure of the apparent effect of the change at site i.

Firstly, it is necessary to calculate a value for K that will be the overall value of the apparent effect of the change at all sites. This is done by solving the equation:

$$\sum b_i = \sum \frac{n_i}{1+KC_i} \qquad \text{\_\_\_(1)}$$

The right hand of the equation (1) is calculated for trial values of K until a sufficiently accurate solution is obtained, and can be done by iteration using a computer program.

Having calculated K it is then possible to calculate t, which indicates the level of significance of the overall effect of the changes.

$$t = \frac{\log_e K}{\text{Standard Error}(\text{Log}_e K)} \qquad \text{\_\_\_(2)}$$

where $\text{Standard Error}(\text{Log}_e K) = \sqrt{\text{Variance}(\log_e K)}$

The sampling variance of $\log_e K$ is approximately given by:

$$\text{Variance} \log_e K = \frac{(1+\Phi)\left(1+\frac{2}{\sum n_i}\right)}{\sum \frac{KC_i n_i}{(1+KCi)^2}} \qquad \text{\_\_\_(3)}$$

Where $$\Phi = \left(\frac{\chi^2}{N-1} - 1\right)\frac{N\sum n_i^{\ 2}}{(\sum n_i)^2} \qquad \text{\_\_\_(4)}$$

and $$\chi^2 = \sum \frac{(a_i - kb_i C_i)^2}{KC_i n_i} \qquad \text{\_\_\_(5)}$$

Two values of t are calculated. The first value is calculated by putting K = 1 in equation (3). If t is found to be significant, a second value of t is calculated using the value of K from equation (1) to calculate the variance and hence the standard error.

If the first value of t is not significantly different, the second is not calculated. The test is really a test of the significance of the departure of K from unity.

The χ^2 value given by equation (5) indicates, if significant, that the effects of the change varied form site to site.

The overall percentage change is determined from the value of K. A value of less than one indicates a decrease whereas a value above one indicates an increase. A K-value of 1 indicates no change.

For example, a K value of 0.75 indicates a percentage change of (K-1)x100%, i.e. a decrease of 25%.

The values of t and χ^2 are interpreted as follows:

t is interpreted by referring to a table of percentage points of the normal distribution. However the percentage value in the table has to be doubled to allow for the fact that Tanner's test is two-sided. Hence a t-value of 1.96 would be interpreted as 2.5% from the table but would in fact represent 5% significance level. It should be noted that t is unrestricted by degrees of freedom. (An alternative means of interpreting t is by referring to a table of percentage points of the t-distribution for infinite degrees of freedom. In this case it is not necessary to double the percentage value, as the t-distribution is two-sided).

χ^2 is interpreted by reference to a table of percentage points for the χ^2 distribution, for N-1 degrees of freedom, where N is the number of sites being tested. If χ^2 is significant, we may conclude that the effect of the treatment is not the same at all sites.

This method of combining accident frequencies does have certain disadvantages, including the fact that it uses a control ratio rather than absolute figures. However, provided certain conditions are observed it can be used quite successfully to combine accident data. The conditions are:

(i) The control data must be at least ten times greater than the test data.

(ii) Wherever possible, each site should have its own mutually exclusive control data. However, it must be realised that this is not always possible. Also the dividing up of a large control figure into a number of mutually exclusive control figures does not always adequately reflect real differences.

(iii) The element (1+ Φ) in equation (3) must be omitted when there is no evidence of significant variation between sites. Although in Tanner's analysis it stated that (1+ Φ) *may* be omitted when there is no firm evidence of variations between sites, experience has shown that (1+ Φ) *must* be omitted in such a case.

8. References

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