Early Morning Arrivals Trial

Foreword

Following the Government's consultation on its aviation policy framework, which encouraged the aviation industry and local stakeholders to strengthen and streamline the way in which they all work together, a 'noise dialogue group', was set up. This group was made up of Aviation Environment Federation, British Airways, HACAN, Heathrow Airport and NATS to share views on opportunities to improve the management and communication of aircraft noise. Two issues were focussed on:

- Noise communication – in particular the role of supplementary metrics,
- Predictability of noise from departing and arriving aircraft – concentrating on how to extend the concept of alternation to provide predictable relief from noise for communities under Heathrow's flight paths.

This trial represents the first of two trials initiatives agreed at this group in relation to the provision of respite from arriving aircraft. More information about the second trial on departing aircraft will follow later this year.

Flights in the early morning are a source of disturbance for many residents living in the areas across London and to the west of Heathrow in parts of Berkshire. Night being the most sensitive but also the least busy period provided an opportunity to explore arrival alternation beyond the traditional runway centreline. This collaborative trial aimed to test the concept of providing predictable periods of respite from early morning aircraft noise for residents in specific areas by introducing zones on the approach paths to be avoided by arriving aircraft. Two pairs of zones were established, inner and outer, both to the east and west of the airport. Air traffic controllers routed flights around the active zones between 2330 and 0600 each night, the zones being rotated on a weekly basis. The trial sought to understand

- the extent to which the exclusion zones could be adhered to,
- community reaction to the changes introduced by these procedures,
- any operational impacts .

The trial ran from 5TH November 2012 to 31st March 2013 after which operations returned to normal as planned.

In this report, the trial is described with its outcomes, both positive and negative. Lessons learnt from the trial will be used to inform the design and operation of future trials. We intend for the collaborative working to continue to help develop and evolve innovative ways to provide aircraft noise respite to the local communities.

August 2013

Heathrow Airport -
Early Morning Arrival Trial Analysis

Final report

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Executive Summary

An early morning arrival trial was conducted by Heathrow airport between November 2012 and March 2013 in order to examine the feasibility of providing predictable respite to some communities under the approach paths. The trial was developed together with HACAN (Heathrow Association for the Control of Aircraft Noise) following community feedback on the value of predictable respite. A number of trial zones were designed to be free of aircraft movements and were activated on a schedule system thereby providing respite on a predictable basis. The zones were active each day between 2330 at night and 0600 in the morning. This report provides an assessment of the trial both in terms of feasibility of operation as well as looking at the overall impact on communities both within and outside of the zones.

From an operational perspective the zones were operated successfully by NATS (UK National Air Traffic Service) throughout the trial. The zones were operated for 94% of the planned trial nights with a small number of suspensions due to e.g. low visibility procedures being in operation. There were three nights during the trial when the zones were activated incorrectly or not at all resulting in a loss of respite. However, it is expected with more robust procedures such instances could be minimised in any future trial. Analysis of flight data from outside of the trial period both from 0600 onwards each day and after the end of the trial showed that aircraft quickly returned to their normal flight paths.

When the zones were operational the vast majority of arrivals (96%) were successfully vectored to avoid them. Some flights did pass through the active zones but these were predominantly medical emergencies (allowed to pass through) or else they simply 'clipped' the zone during a turn. The majority of nights (71%) saw no zone infringements. When an infringement did occur it was typically a single flight through the entire night period.

Aircraft involved in the trial typically incurred a small number of additional track miles (4.2nm on average). These figures were dominated by additional track miles flown when the inner zone to the west of the airport was active. This is due to a preponderance of aircraft arriving from the east of Heathrow in the early morning. When operating on runways 09L and 09R such aircraft are generally turned onto the final approach around the area in which the inner zone has been established. Hence, when the inner zones operated during the trial aircraft had to fly a longer down-wind leg before being turned onto the final approach. When operating on runways 27L and 27R the additional track miles incurred were between 1.5 and 2.8nm. Overall the additional distance led to an average additional fuel cost of £33 per arrival and across the trial as a whole led to an additional 264 metric tonnes of CO_2 being emitted.

From a respite perspective good periods of predictable respite were provided to households within the active zones as well as in an area to the north of the northern zones and south of the southern zones (due to the nature of the traffic patterns and vectoring of aircraft). During the feedback sessions with HACAN and the local communities positive feedback on the impact of the trial was obtained from people living within these areas.

However, the trial also had other impacts. The trial resulted in a number of aircraft joining the approach path further from touchdown (particularly discernible when the zones to the east of the airport were active). This resulted in communities between the zones on the extended centreline experiencing a significant increase in over-flights during the trial. Not only were there more flights, but they were also more laterally concentrated onto the centreline. This resulted in a significant negative impact to these communities.

Therefore, whilst the trial was successful in demonstrating the practicality of the concept of providing predictable respite the fact that some communities experienced a significant dis-benefit means that it overall it did not achieve its objectives and will not be taken forward in its current form. The trial is therefore complete.

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1 Introduction

1.1 Heathrow early morning arrival trial

Each night, between 2330 and 0600 (local time), approximately eleven to twenty-four aircraft land at Heathrow, the majority of them between 0430 and 0600. Despite advances in aircraft and engine technology, as well as operational procedures such as Continuous Descent Approaches (CDAs), these aircraft still have a noise impact on the communities living under or close to Heathrow's approach paths.

To provide some mitigation to this noise and in response to community requests, Heathrow Airport, British Airways, NATS (UK National Air Traffic Service) and the Heathrow Association for the Control of Aircraft Noise (HACAN) conducted a five month trial to test the feasibility of providing a degree of predictability in the nights when some communities close to Heathrow's approach paths were overflown. The trial ran from 5th November 2012 to the 31st March 2013.

The feasibility of providing predictable respite was investigated by establishing exclusion zones close to Heathrow's approach paths. Two pairs of zones were established to the east of Heathrow and two to the west (for both directions, one pair of zones was located approximately 10-15nm (nautical miles[1]) from Heathrow and the other pair were located at approximately 15-20nm). On odd numbered weeks of the trial the zones closest to Heathrow ('inner zones') were active between 2330 and 0600 local, while on even numbered weeks the zones furthest from Heathrow ('outer zones') were active for the same period.

Aircraft were routed around the active zones, thereby providing a degree of predictability as to when the communities beneath them would be overflown (referred to as predictable respite). Exceptions were when the trial was suspended or when safety could be compromised (for example in the case of in-flight medical emergencies).

1.2 Trial report

This document provides an independent analysis of the trial that investigates/summarises:

- If the exclusion zones were successfully operated during the trial (section 4);
- If traffic patterns in the vicinity of the exclusion zones changed during the hours of the trial (section 5);
- Any unexpected consequences of the trial, such as an increase in the number of flights overflying areas between the zones (section 6), and changes to traffic patterns outside of the hours of the trial and after the trial period had ended (section 10);
- The extent to which the trial produced predictable respite for both areas beneath the zones and those surrounding them (section 7).
- Feedback on the trial from the different participating stakeholders (section 8).
- Any changes to the distances flown and fuel burnt by arriving aircraft during the trial (section 8.3).

[1] One nautical mile equates to 1.15 miles.

- Conclusions drawn from the trial (section 12) and any lessons that could be applied to future trials (section 11).

The report also explains the operation of the exclusion zones (section 2) and how the analysis of the trial was conducted (section 3).

1.3 Terminology used

The terminology used in this report is summarised in Figure 1 in section 2.2.

2 Explanation of the trial and the exclusion zones

2.1 Trial period

The trial took place between 5th November 2012 and 31st March 2013 during the hours corresponding to Heathrow's night quota period; 2330 to 0600 local time.

2.2 Exclusion zones, exclusion zone schedule

The trial used a series of exclusion zones close to each of Heathrow's approach paths. Each of the four approach paths had two exclusion zones: an inner zone and an outer zone see Figure 1.

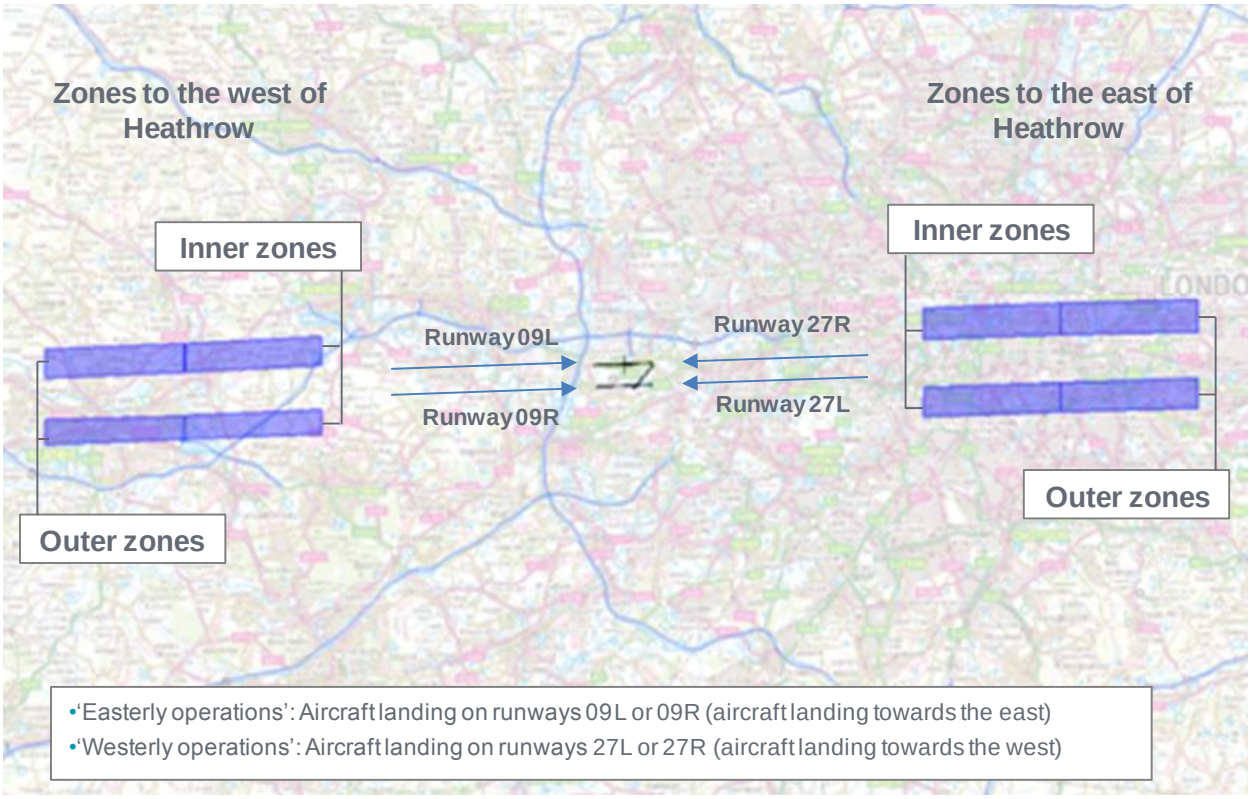


Figure 1: Early morning arrival trial exclusion zones & terminology

The exclusion zones operated according to a weekly schedule. The inner and outer zones were active on alternate weeks, i.e.:

- The inner exclusion zones were active for the 'odd' weeks of the trial only (weeks 1, 3, 5 etc).
- The outer exclusion zones were active for the 'even' weeks of the trial only (weeks 2, 4, 6 etc).

The changes to the active zones were made on a Monday night in accordance with the schedule below.

Week commencing	Runway alternation period	Exclusion zones in operation (flights are not permitted to fly through it)
5th November 2012	09R/27L	Inner
12th November 2012	27L/09R	Outer
19th November 2012	09L/27R	Inner
26th November 2012	27R/09L	Outer
3rd December 2012	09R/27L	Inner
10th December 2012	27L/09R	Outer
17th December 2012	09L/27R	Inner
24th December 2012	27R/09L	Outer
31st December 2012	09R/27L	Inner
7th January 2013	27L/09R	Outer
14th January 2013	09L/27R	Inner
21th January 2013	27R/09L	Outer
28th January 2013	09R/27L	Inner
4th February 2013	27L/09R	Outer
11th February 2013	09L/27R	Inner
18th February 2013	27R/09L	Outer
25th February 2013	09R/27L	Inner
4th March 2013	27L/09R	Outer
11th March 2013	09L/27R	Inner
18th March 2013	27R/09L	Outer
25th March 2013	09R/27L	Inner

Table 1: Exclusion zone alternation schedule

2.3 Location of the exclusions zones

Figure 2 and Figure 3 show the exact locations of the exclusion zones. The inner zones were located approximately 10nm to 15nm from Heathrow and the outer zones at approximately 15nm to 20nm either side of Heathrow's approach paths. Each zone was approximately 1nm wide and northern and southern zones were approximately 1.7nm apart.

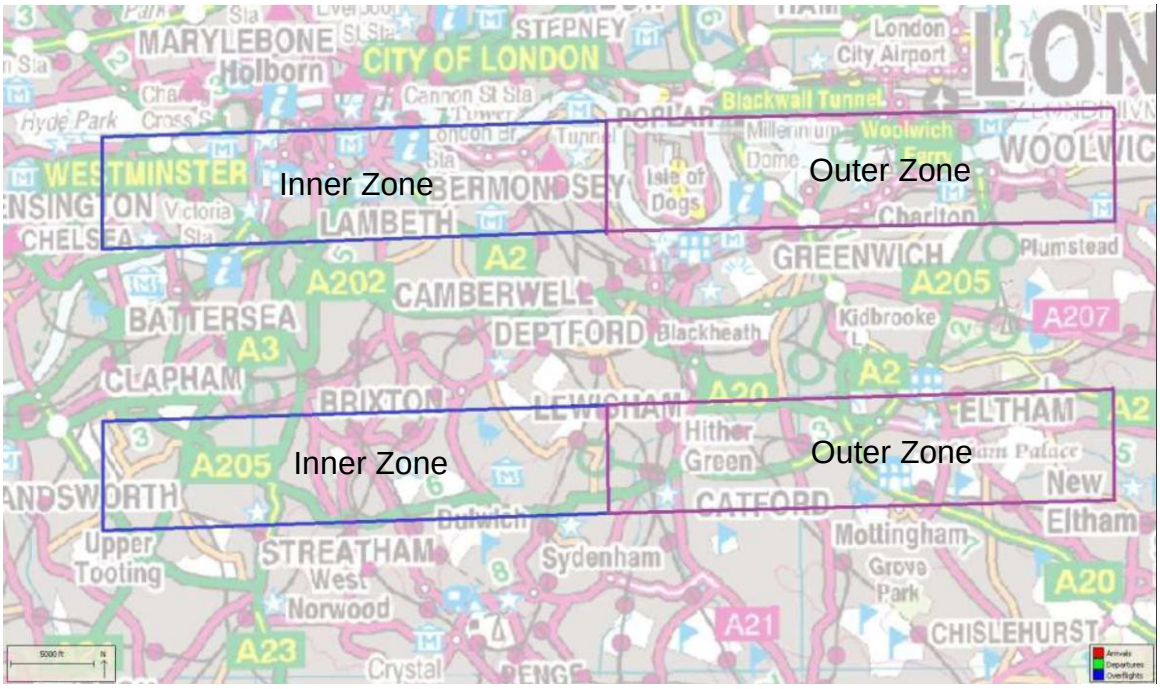


Figure 2: Location of the exclusion zones to the east of Heathrow

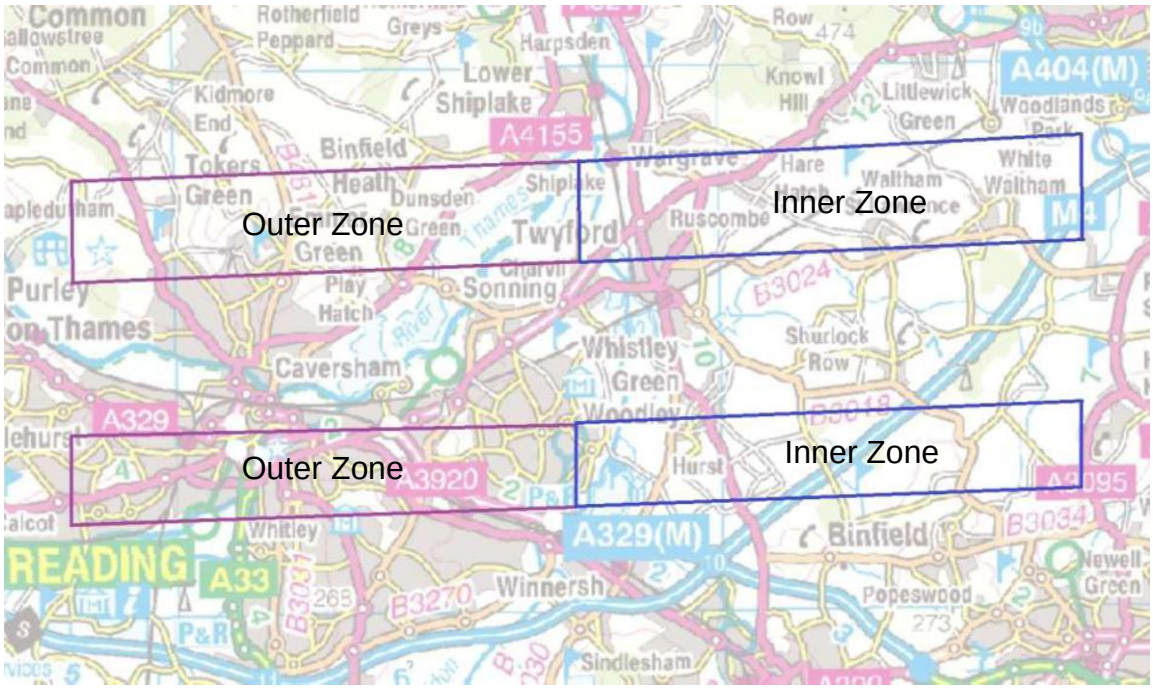


Figure 3: Location of the exclusion zones to the west of Heathrow

2.4 Operation of the exclusion zones

Between 2330 and 0600 (local times) the appropriate exclusion zones (i.e. inner zones or outer zones) were displayed on the screens of Heathrow approach controllers – the air traffic controllers who vector aircraft onto final approach to the airport. When a zone was active, aircraft were routed around it (obvious exceptions being safety related situations such as in-flight medical emergencies). Apart from the usual ATC procedures applied to aircraft approaching Heathrow at night, there were no other requirements placed on where the aircraft should fly (for example, there was no requirement for aircraft to be routed over the inactive zone). At 0600 the exclusion zones were deactivated, no longer displayed on controllers screens and normal operations resumed.

Examples of controllers vectoring aircraft to avoid each of the four pairs of exclusion zones are shown in the following images.

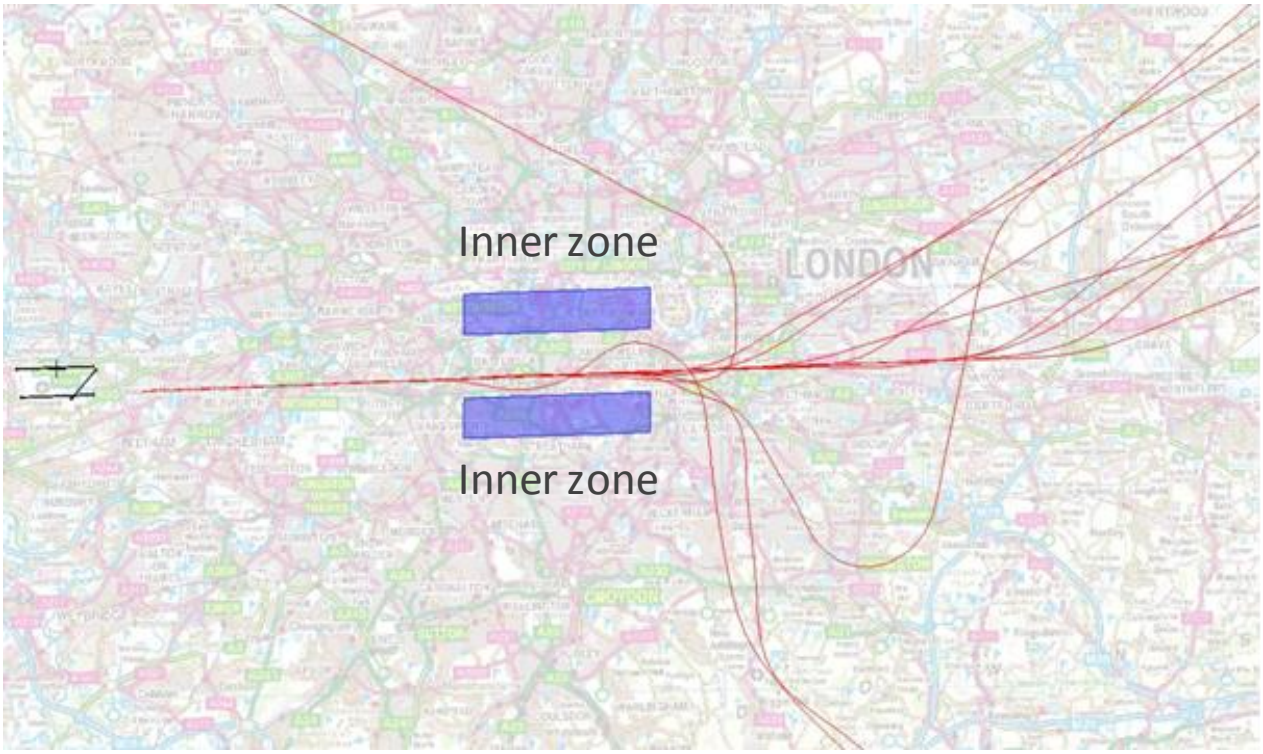


Figure 4: Example of the inner zones to the east of Heathrow operating (7th Dec 2012)

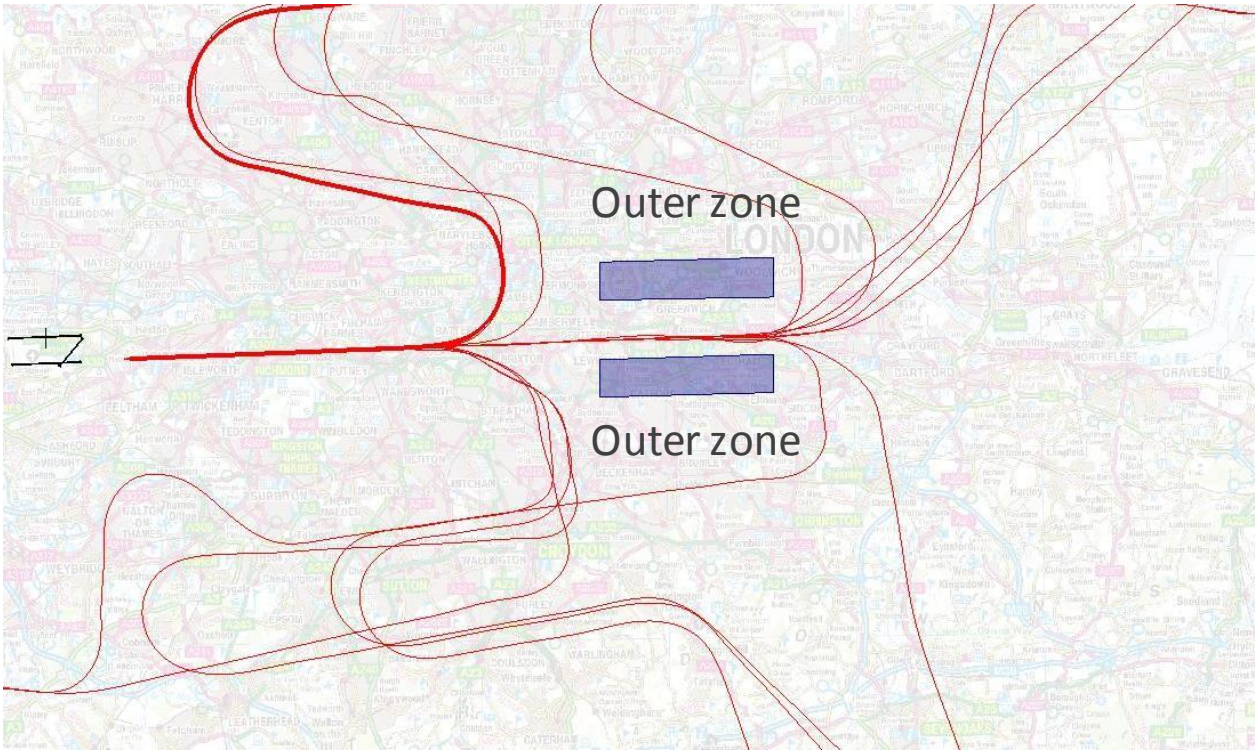


Figure 5: Example of the inner zones to the east of Heathrow operating (10th Dec 2012)

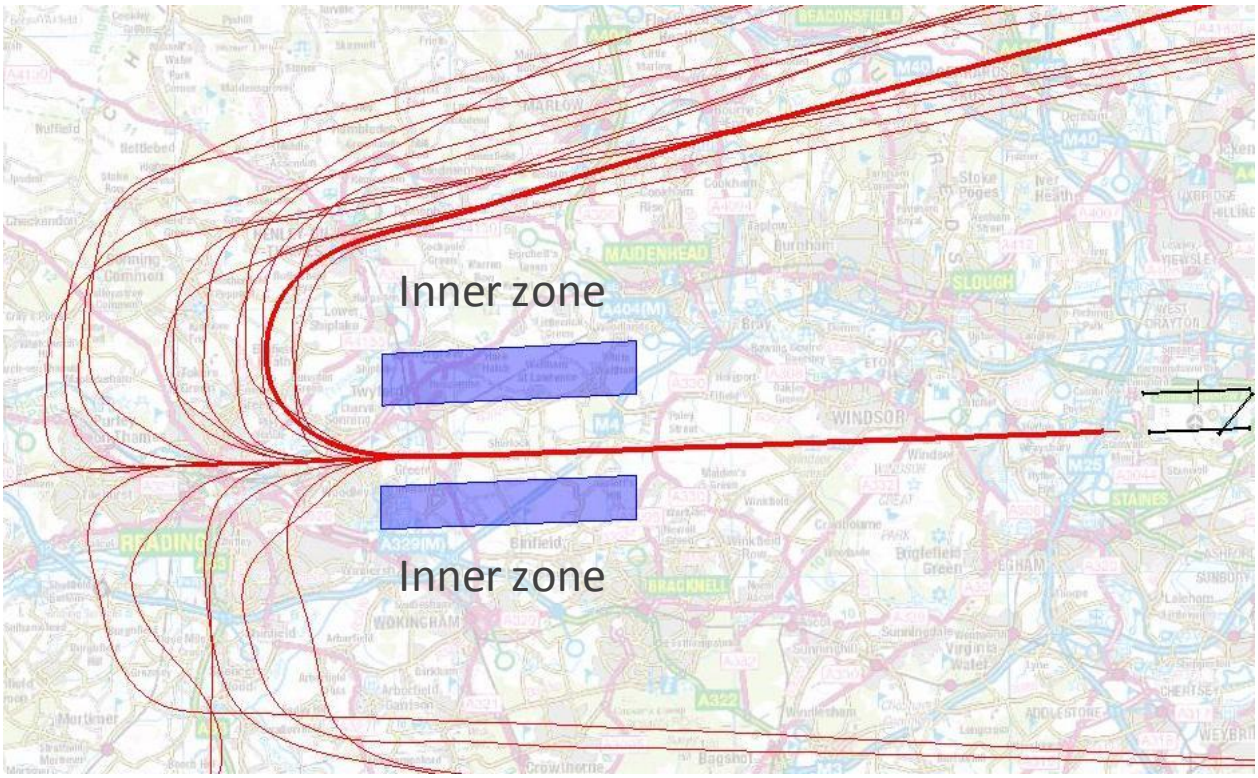


Figure 6: Example of the inner zones to the west of Heathrow operating (25th Feb 2013)

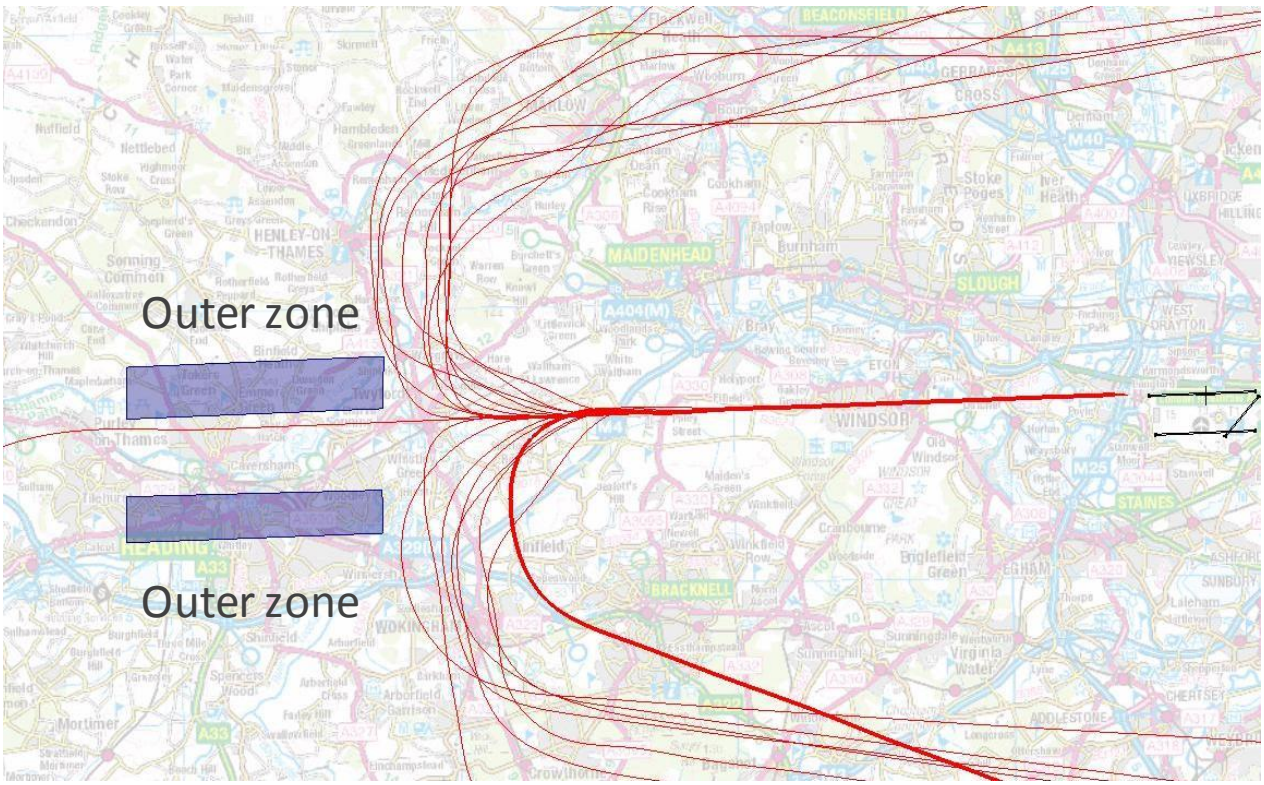


Figure 7: Example of the outer zones to the west of Heathrow operating (6th Mar 2013)

2.5 Suspension of the trial

The trial could be suspended when certain criteria were met, for example the onset of Low Visibility Procedures (LVPs).

3 Analysis of the trial

3.1 Overview

This section provides an overview of how the analysis of the trial was conducted. There were three main tasks:

- collection of data,
- analysis of the data and
- reviewing the analysis with stakeholders.

The work was undertaken iteratively, with early findings being reviewed with the stakeholders to inform the work during the remainder of the study.

3.2 Collection of data

3.2.1 ANOMS

The majority of data used in the study was extracted by Heathrow's Flight Performance Unit from the Airport's noise and track-keeping system - ANOMS (Aircraft Noise and Operations and Monitoring System). ANOMS records data on all aircraft arriving to or departing from Heathrow. This data can then be extracted in graphical (e.g. images of aircraft tracks) or numerical form (e.g. flight-by-flight data giving the details of the flight, arrival runway and positions (latitude, longitude and altitude) either at specific time intervals or on entering/exiting a specified area).

ANOMS data used in the analysis included:

- images of aircraft tracks during and outside of the trial period,
- a list of all arrivals that infringed the exclusion zones during the trial (including the time/date of the infringement) and
- flight-by-flight data for all aircraft during the trial and baseline[2] period giving:
    - the distance from touchdown that aircraft joined the final approach paths,
    - position information at 4 second intervals,
    - the time taken to fly from 6,000 feet to touchdown and
    - the position and time that aircraft entered and exited a series of 4nm by 4nm grid squares close to Heathrow.

3.2.2 Additional data

In addition to the data from ANOMS, the following information was also used for the analysis:

- Data on periods of low visibility, in-flight medical emergencies and go-arounds – supplied by NATS.

[2] In order to highlight any differences with normal operations, identical data was analysed for the same period of the previous year (2330-0600 local between the 5th November 2011 and 31st March 2012), this period is known as the baseline.

- Population data for areas around the zones – supplied by Anderson Acoustics.

3.3 Analysis conducted

3.3.1 Investigations made

Investigations made for the period during the trial included:

- The operation of the zones, for example:
  - the number of nights that the trial operated out of the total possible,
  - the proportion of nights when infringements of the active zones occurred and
  - the proportion of flights that infringed on the active zones.
- Aircraft track patterns resulting from the operation of the zones.
- The extent to which predictable respite was achieved beneath the zones and in areas close to the zones. The analysis also investigated the population affected.
- Any unexpected impacts due to the operation of the zones. For this study the focus was on the areas between the zones/approach paths and changes to aircraft tracks outside of the trial (both after the zones were deactivated in the morning and after the completion of the trial period). For the approach path analysis the population affected was also investigated.
- Changes to the number of track miles flown by the early morning arrivals, and associated fuel burn, during the trial.

3.3.2 Periods analysed

Data from a number of periods were analysed:

- Trial period: 2330-0600 local time between 5th November 2012 and 31st March 2013[3].
- Baseline period: In order to highlight any differences with normal operations, identical data was analysed for the same period of the previous year (2330-0600 local time between 5th November 2011 and 31st March 2012).

The relative sample sizes for each of these periods are given in the table below. It is noted that the figures for the trial exclude arrivals on nights when the trial was suspended. Differences in the number of arrivals during easterly and westerly operations are due to differences in the prevailing wind direction during the trial and baseline. When the baseline and trial periods were compared, these differences were addressed by comparing percentages of flights.

[3] The trial finished at midnight on 31st March 2013. Given that the trial did not operate for a full night on the 31st March it has not been counted in the analysis.

Runways in operation	Inner zones operating	Outer zones operating	Trial Total	Baseline
09L & 09R (easterly operations)	401 (18%)	433 (20%)	834 (38%)	738 (30%)
27L & 27R (westerly operations)	738 (33%)	644 (29%)	1,382 (62%)	1,751 (70%)
Total	1,139	1,077	2,216	2,489

Table 2: Number of arriving aircraft during the trial (excluding those when the trial was suspended[4]) and baseline periods

- Periods outside of the trial:
    - 0600 to 0659 for each day of the trial and baseline.
    - 2330 to 0600 for the two weeks following the end of the trial and also for a two week period in May 2013.

3.4 Stakeholder feedback

Feedback on the analysis, the trial itself and lessons that should be applied to any future trials was provided by various stakeholders:

- British Airways
- HACAN
- Heathrow Airport
- Members of local communities
- NATS
- UK Civil Aviation Authority.

[4] Including the nights when the trial was suspended there were 2,431 arrivals.

4 Operation of the exclusion zones during the trial

4.1 Overview

This section provides an overview of the operation of the exclusion zones during the trial. It summarises the following:

- The nights that the trial operated[5],
- The number of arrivals during the trial,
- The number of zone infringements during the trial - overall and by zone.

4.2 Nights of operation and trial suspensions

The exclusion zones operated for 137 (94%) of the planned trial nights.

The figure below summarises the nights on which the trial was operated or suspended. Zones were in operation from 2330 to 0600 local time. Where specific dates are mentioned in this report, this refers to the period starting at 2330 (e.g. the night of 3rd March is the period from 2330 on the 3rd March to 0600 on the 4th March).

The trial operated on 137 (94%) of the 1465 nights of the trial. In accordance with the rules of the trial, it was suspended on 9 nights due to LVPs. A notable proportion of these suspensions took place in January when Heathrow was suffering from snow disruption.

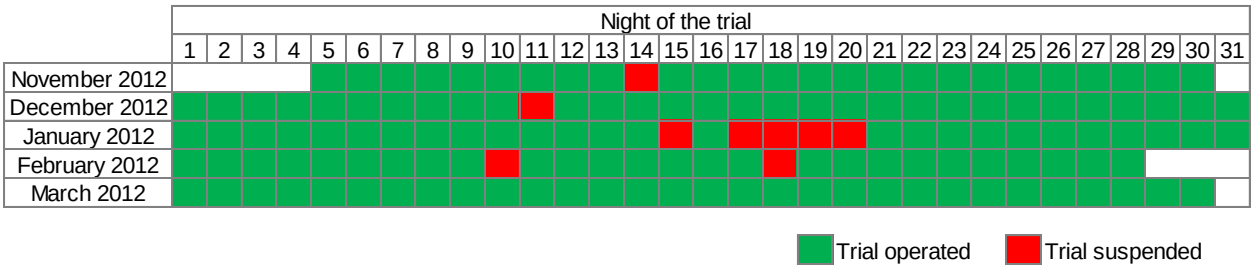


Figure 8: Summary of nights on which the trial was operated (5th Nov 2012 to the 31st Mar 2013)

Appendix A gives a full list of the nights that the trial was in operation, and the main inner or outer zone operated[6].

[5] The trial started at 2330 on the 5th November 2012 and finished at midnight on 31st March 2013. Given that the trial did not operate for a full night on the 31st March it has not been counted in the analysis.

[6] On 19 nights of the trial aircraft landed on both easterly and westerly runways. On the majority of these nights the majority of aircraft landed in one direction while typically 1-2 landed in the other.

4.3 Air Traffic Movements during the trial

4.3.1 Arriving aircraft

During the trial period 2431 arriving aircraft landed at Heathrow between 2330 and 0600 local time. Excluding the nine nights on which the trial was suspended this figure was 2,216 arrivals. On the nights where the trial operated, there was an average of 16 arrivals per night, ranging from a minimum of 11 to a maximum of 24 (Figure 9). As can be seen from Figure 10, 97% of arrivals during the trial arrived between 0400 and 0600 local time.

In terms of the direction of operation, 62% of arriving aircraft approached Heathrow from the east (known as 'westerly operations'), while the remaining 38% approached from the west (known as 'easterly operations').

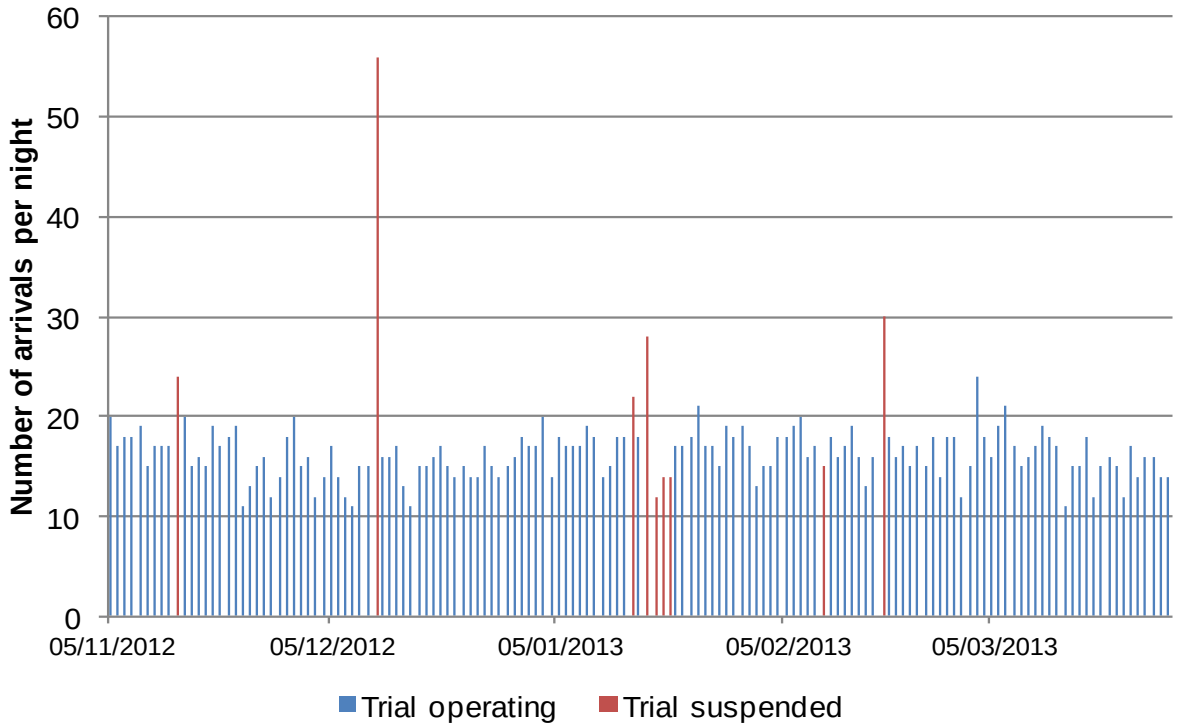


Figure 9: Number of arrivals between 2330 and 0600 local time during the trial period

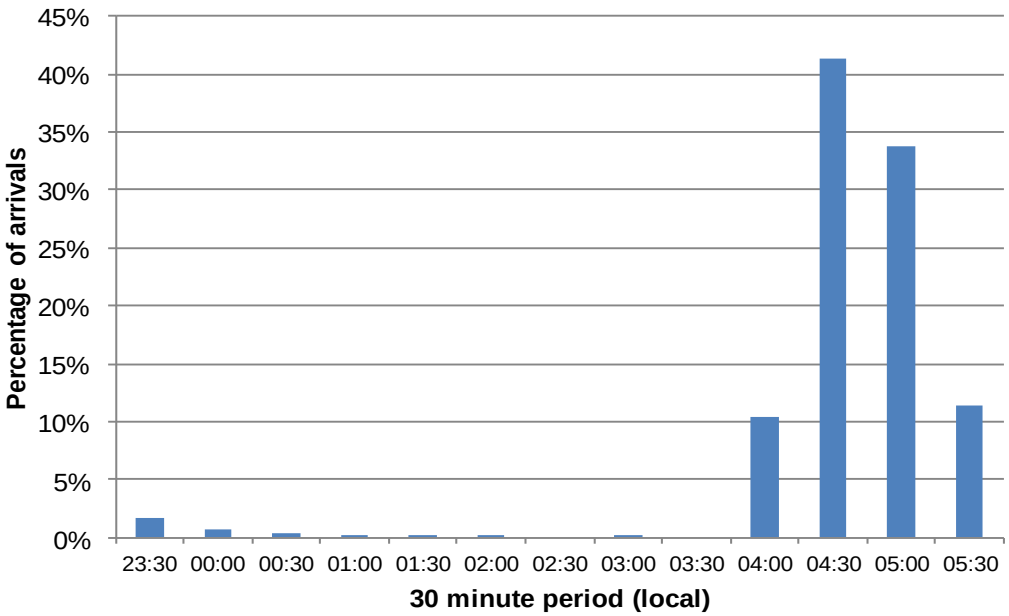


Figure 10: Breakdown of arrivals between 2330 and 0600 local time during the trial period (30 minute time periods) – excludes trial suspensions

4.3.2 Calibration flights

Calibration flights took place on the first three nights during the first week of the trial. The purpose of these flights was to calibrate Heathrow's Instrument Landing System (ILS). To perform this task the turboprop aircraft involved flew predefined profiles to check the ILS and could not avoid the exclusions zones. Calibration flights have been excluded from the analysis on the basis that were the trial to be part of normal operations the active zones would most likely be amended to accommodate such flights.

4.4 Zone infringements – all zones

Excluding nights when the trial was suspended:

- **The zones were avoided by a very high proportion of arrivals (96%).**
- **The majority of nights had no zone infringements (71%).**
- **When infringements did occur there were typically only 1-2 per night.**

Overall there were a small number of zone infringements during the trial, approximately 40% of the total occurred over three nights. Therefore, while the analysis is reflective of the trial period some caution should be taken with extrapolating these figures over a longer period.

4.4.1 Number of zone infringements

Excluding the nights when the trial was suspended, 85 arrivals infringed the exclusion zones. This equates to 96% of arriving aircraft avoiding the zones.

Analysing the nights on which the infringements occurred shows no infringements occurred on 97 nights of the trial for the entire period from 2330 to 0600 (Figure 11). On the remaining nights there were typically only one or two infringements (Figure 12).

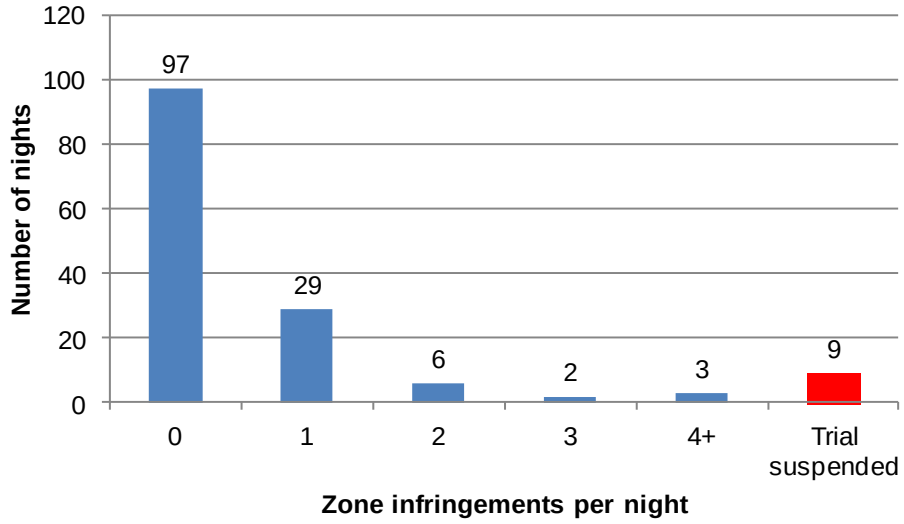


Figure 11: Count of zone infringements per night

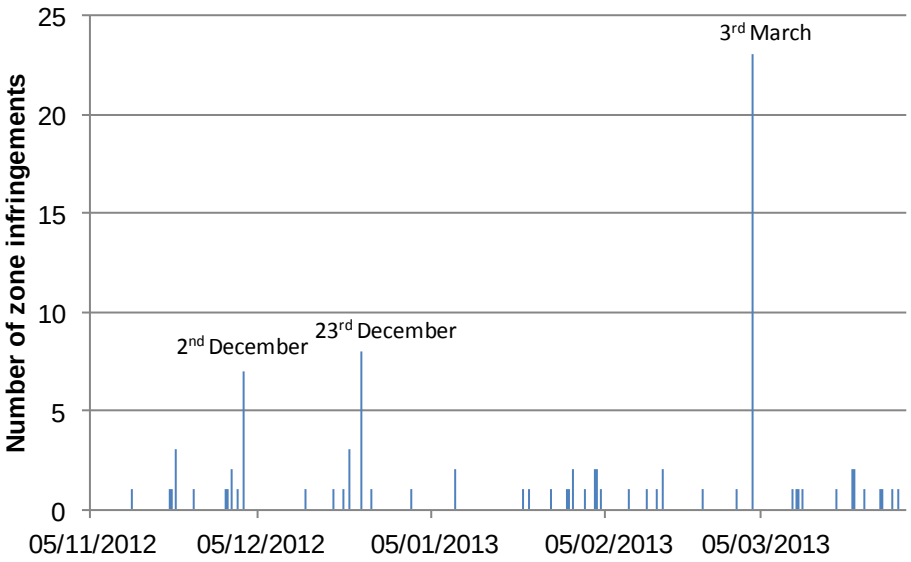


Figure 12: Breakdown of the number of infringements per night– excludes trial suspensions

Notable in Figure 12 are the nights of the 2nd December, the 23rd December and the 3rd March which had 7, 8 and 23 infringements respectively – 44% of the total infringements during the trial. NATS reported that the wrong zones were erroneously displayed on the screens of controllers for at least part of these nights (for example, on the night of the 3rd March, the outer zones were displayed instead of the inner zones). However, these infringements have been included in the analysis.

The infringements were analysed to determine the time of night they occurred. In line with the arrival pattern, 75 of the 85 infringements took place after 0430. Of the 10 infringements that took place pre-0430, all but two occurred on the 3rd March. Additionally, no infringements took place between 0400 and 0429, a period in which 10% of arrivals landed during the trial.

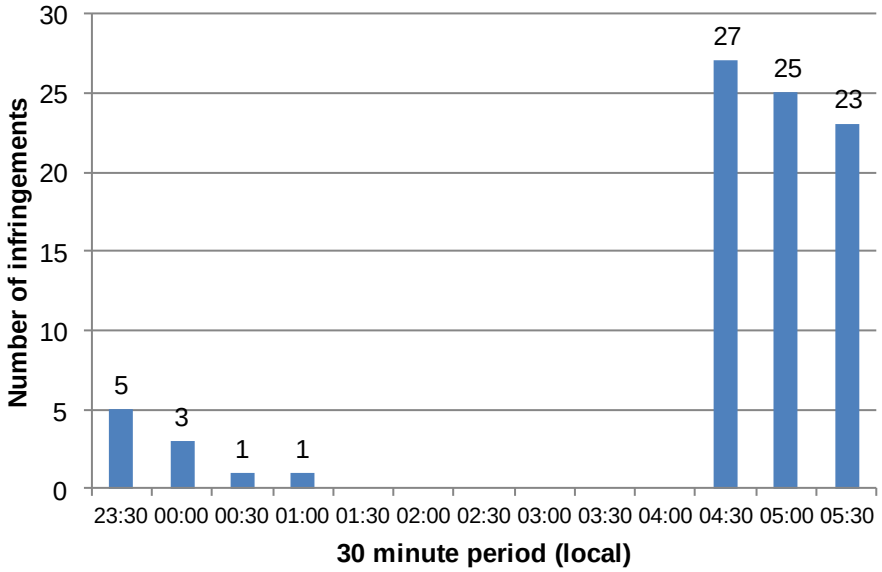


Figure 13: Time periods in which the infringements occurred (30 minute time periods) – excludes trial suspensions

4.5 Classification of zone infringements

A reasonable proportion (38%) of infringements occurred only at the extremities of the zones.

ANOMS screenshots of each zone infringement were reviewed visually and two groups identified:

- Infringements that passed through the zones: For this group, infringing aircraft directly overflew the zones (see example in Figure 14). This group accounted for 53 (62%) of the 85 infringements and included some emergency flights and 38 infringements on the 3 nights when the wrong zones were mistakenly operated.
- Infringements close to the edges of the zones: 38% of infringements occurred at the extremities of the zones, for example on the corners of the zones (see example in Figure 15) or on the east/west faces.

Although this highlights that a sizeable proportion of infringements took place at the extremities of the zones, no subdivision of infringements has been made for the remainder of this section.

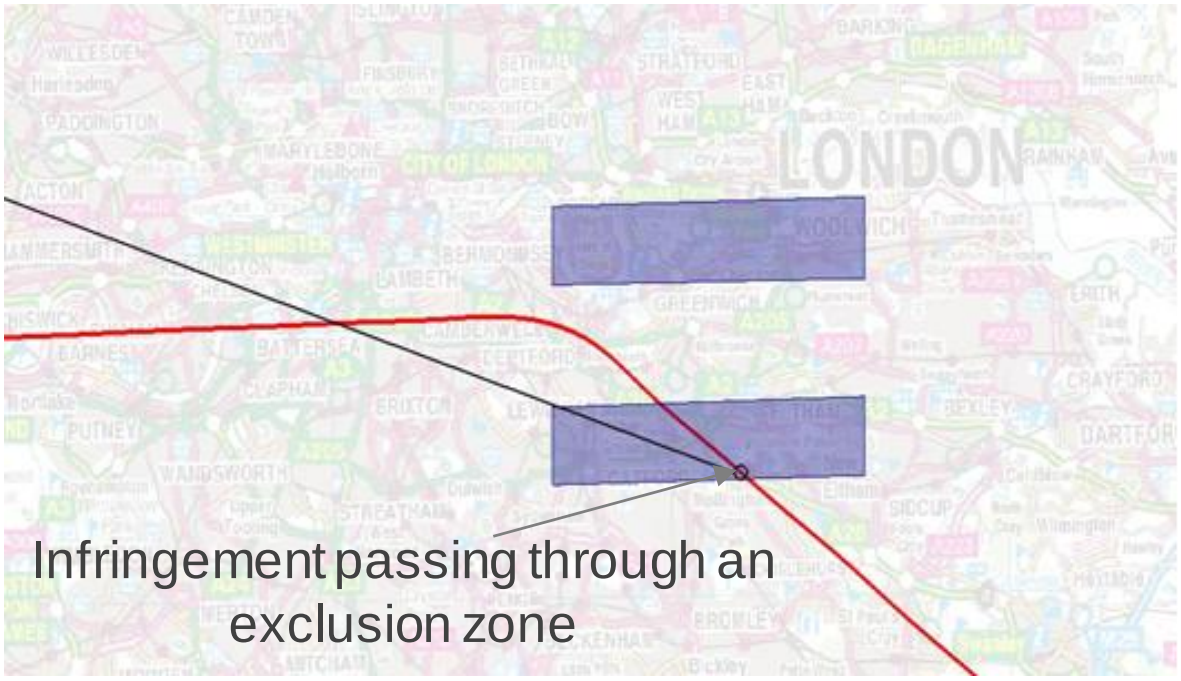


Figure 14: Example of an infringement passing through a zone (1st Dec 2012)

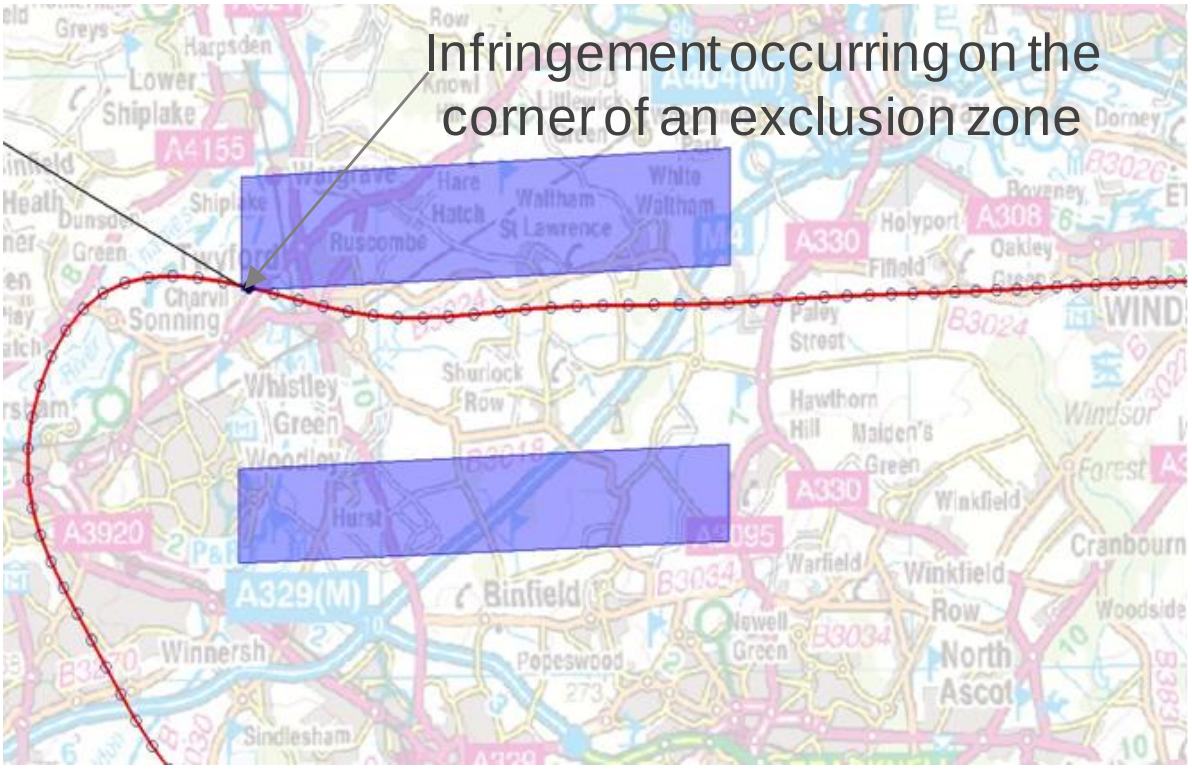


Figure 15: Example of an infringement occurring close to a zone edge (23rd Nov 2012)

4.6 Operation of the zones during the trial – by zone

With the exception of the inner exclusion zones to the west of Heathrow, the percentages of aircraft infringing the zones, and the percentage of nights on which infringements occurred, were broadly similar between zones pairs. However, the small samples sizes involved mean that it is not possible to make a definitive comparison between zone pairs.

4.6.1 Infringements by zone

This sub-section summarises the operation of individual pairs of exclusion zones. Figure 16 presents the number of infringements per zone and Figure 17 presents the number of nights each zone had infringements (the figures above the bars are the total infringements or number of nights respectively for that zone and what percentage this represents for the zone). The operation of each individual pairs of zones is summarised in sub-sections 4.6.2 to 4.6.5.

The percentage of aircraft infringing each pair of zones, and the percentage of nights on which infringements occurred were reasonably similar, the exception being the inner zones to the west of Heathrow. Some of the differences can be explained by the inclusion of the nights of the 2nd December, 23rd December and 3rd March in the analysis. However, the analysis is also sensitive to both the relatively small number of nights each pair of zones was operated and the associated number of infringements, and should be interpreted accordingly.

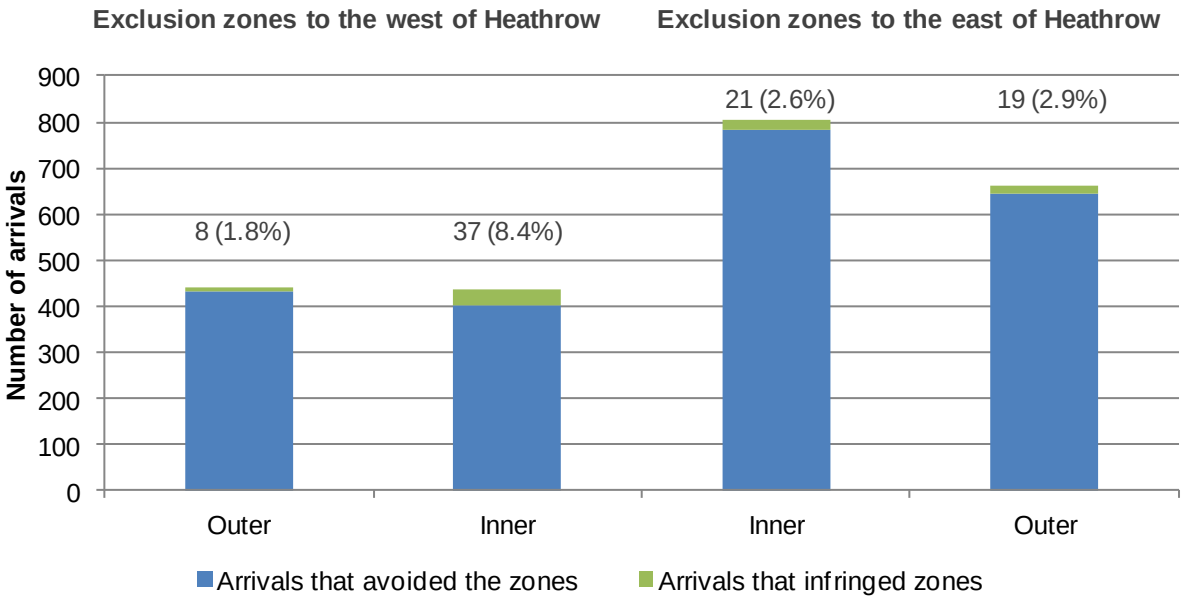


Figure 16: Number of infringements by zone

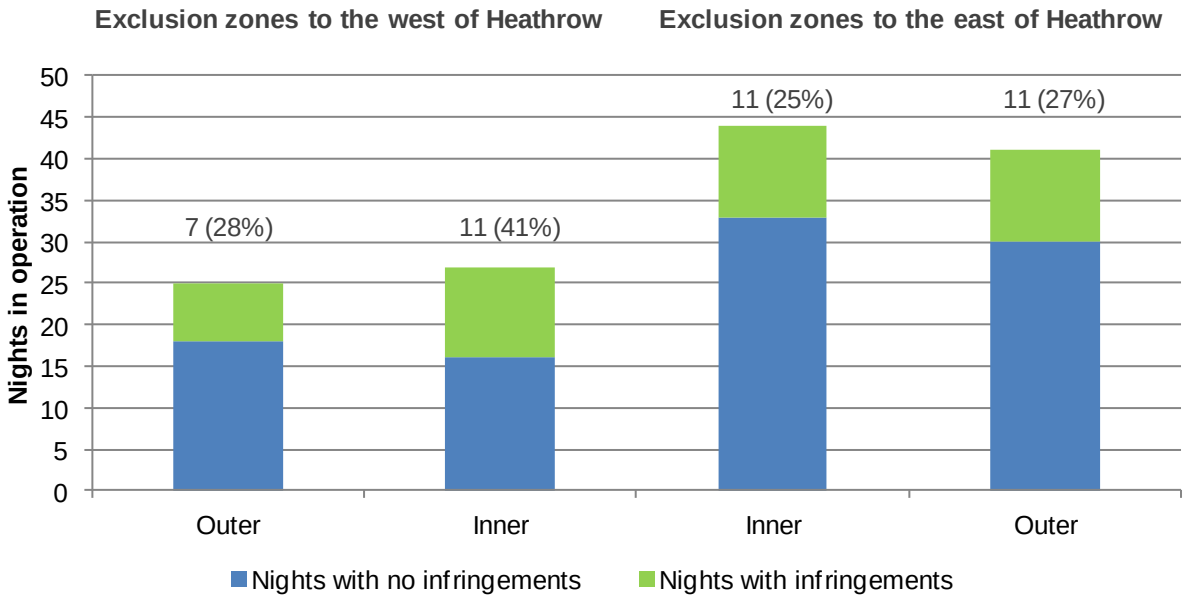


Figure 17: Number of nights with infringements - by zone.

4.6.2 Outer zones to the west of Heathrow (runways 09R and 09L in operation)

Figure 18 summarises the operation of the outer zones to the west of Heathrow during the trial. The grey areas show nights when these zones were inactive, the white areas when they were active and the red bars when infringements occurred. The zones operated for 25 nights of the trial (this excludes any nights when the runways were temporarily alternated and the zones only operated for a short period). This accounted for 18% of the nights that the trial was in operation. There were a total of eight infringements spread across seven nights (28% of operating nights).

Figure 19 shows the tracks of arriving aircraft close to the zones during the trial. As the majority of aircraft at night arrive from the east, in order to minimise track miles and fuel burn, these turned on to the approach paths 'in front' (i.e. to the east) of the zones, while the small proportion of aircraft arriving from the west mainly flew between the zones. Consequently, the majority of the infringements (six of the eight) occurred on the eastern faces of the zones.

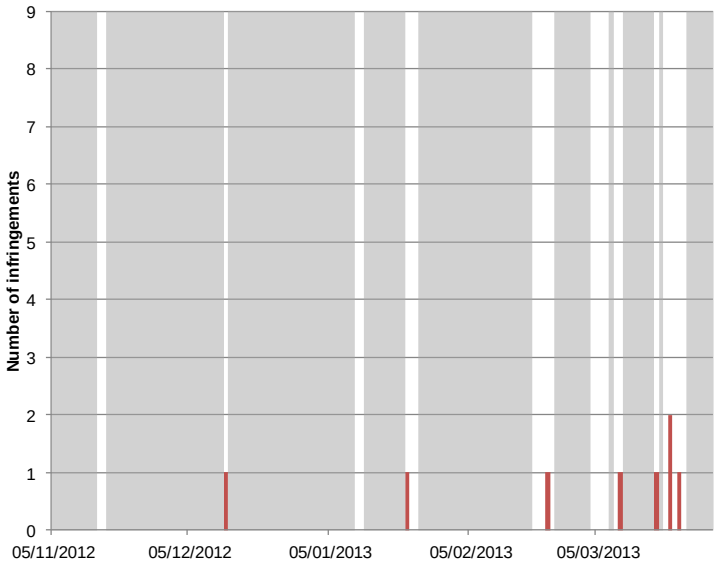


Figure 18: Zone infringements – outer zones to the west of Heathrow

Figure 19: Aircraft tracks close to the outer zones to the west of Heathrow

4.6.3 Inner zones to the west of Heathrow (runways 09R and 09L in operation)

Figure 20 shows that the inner zones to the west of Heathrow were operated for 27 nights of the trial (this excludes any nights when the runways were temporarily alternated and the zones only operated for a short period). This accounted for 20% of the nights that the trial was in operation. There were ten nights with

infringements (41% of operating nights), seven of these nights only had one infringement, two had three infringements and one night (3rd March) had 23 infringements (see 4.4 for an explanation). There was also one medical emergency flight that was routed through the zone on the night of the 29th March. Excluding this flight and the 3rd March there were 13 infringements.

Figure 21 shows the tracks of arriving aircraft close to the zones during the trial. As arriving aircraft need to join the extended centreline 10nm before touchdown during night time hours, and the eastern faces of the inner zones were approximately 10nm from touchdown, aircraft were directed 'behind' the zones during the trial (i.e. joined the approach path either to the west of the inner zones or within the areas between the zones). As can be seen from Figure 21 the majority of the infringements were due to aircraft turning close to the south west corner of the northerly zone. This reflects that many night-time arrivals approach from the north east of London.

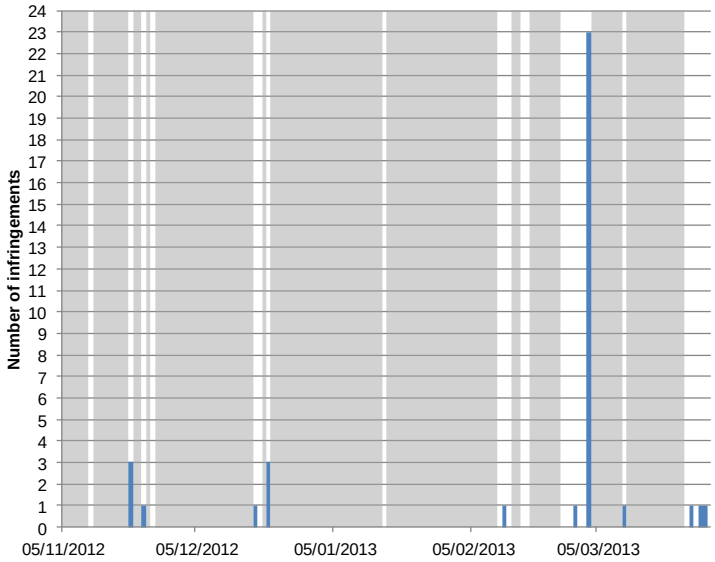


Figure 20: Zone infringements – inner zones to the west of Heathrow

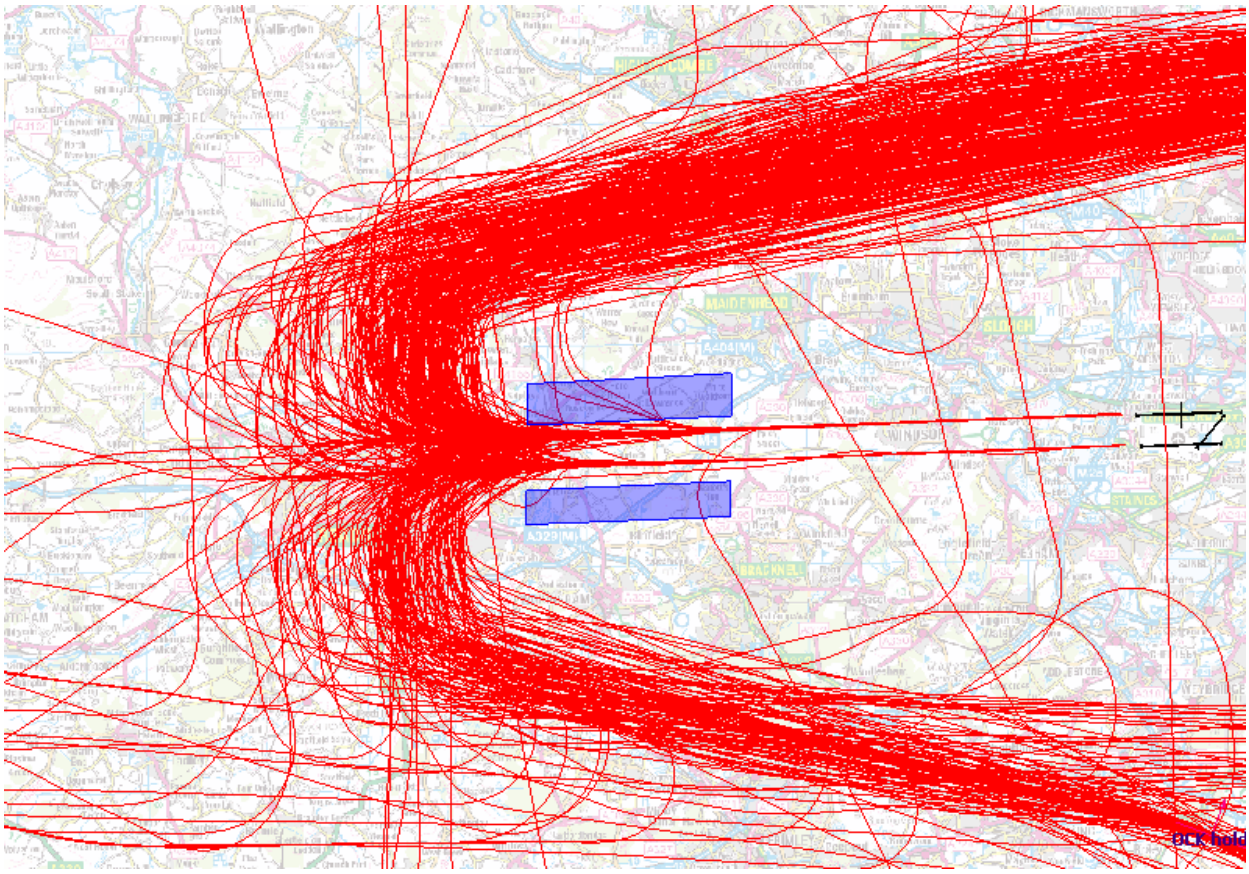


Figure 21: Aircraft tracks close to the inner zones to the west of Heathrow (excluding 3rd Mar 2013)

4.6.4 Outer zones to the east of Heathrow (runways 27R and 27L in operation)

Figure 22 shows that the outer zones to the east of Heathrow operated for 41 nights of the trial (this excludes any nights when the runways were temporarily alternated and the zones only operated for a short period). This accounted for 30% of the nights that the trial was in operation. There were 11 nights with infringements (29% of operating nights); only one night had more than two infringements giving 19 aircraft in total during the period. This includes the night of the 2nd December when there were seven infringements. There was also a medical emergency flight that went through the zone on the 1st December. Excluding this flight and the 2nd December there were 11 infringements.

Figure 23 shows the tracks of arriving aircraft close to the zones during the trial. Unlike the outer zones to the west of Heathrow, arriving aircraft mainly overflew the areas between the zones rather than joining the approach 'in front' (i.e. to the west) of the zones. This is most likely to reflect the number of aircraft approaching Heathrow from the east and making 'straight-in' approaches during the night time. However a proportion of aircraft, particularly those that had to enter one of the Heathrow holds were directed to join 'in front' (i.e. to the west) of the zones. Many of the infringements, excluding those on the 2nd December, were at the edges of the zone.

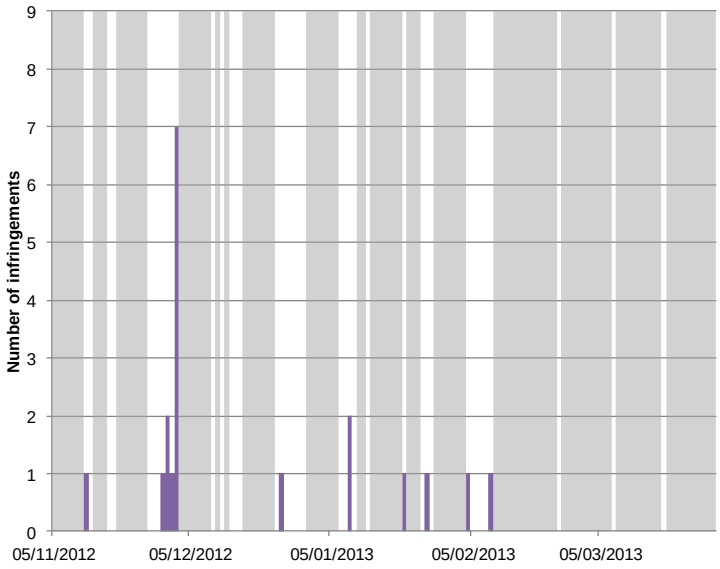


Figure 22: Zone infringements – outer zones to the east of Heathrow

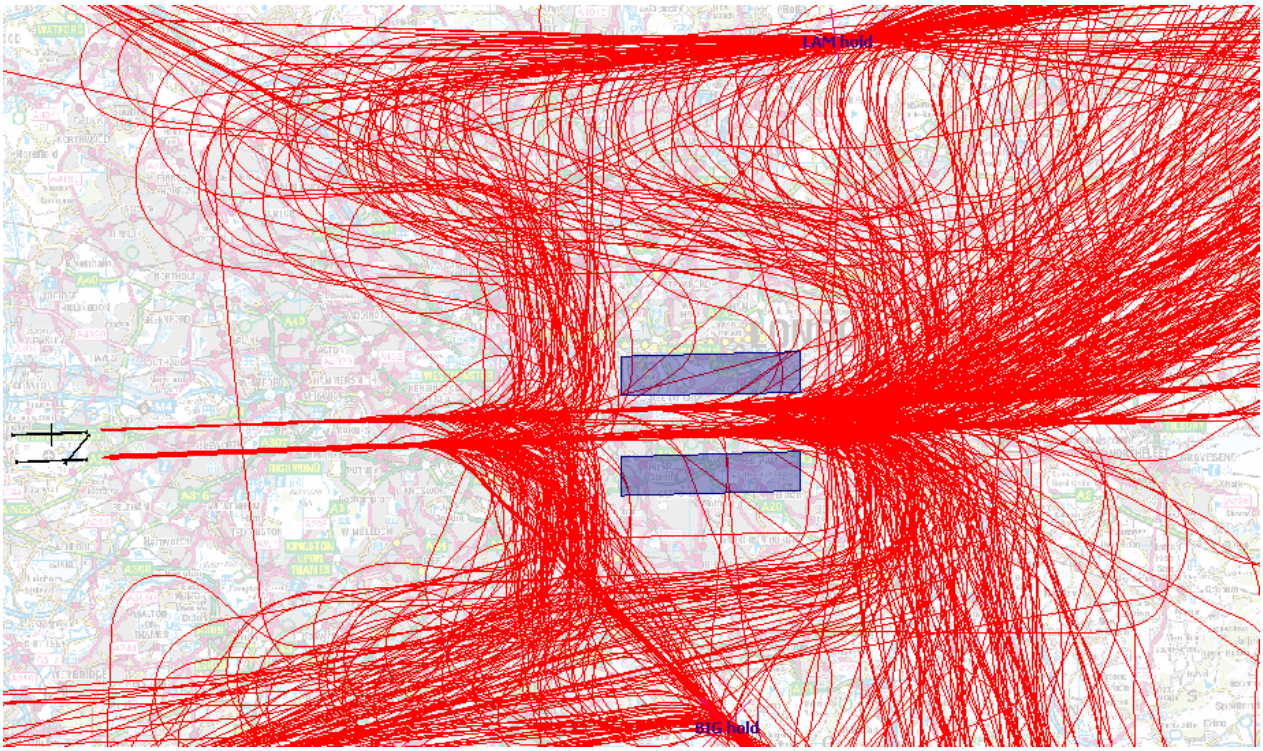


Figure 23: Aircraft tracks close to the outer zones to the east of Heathrow

4.6.5 Inner zones to the east of Heathrow (runways 27R and 27L in operation)

Figure 24 shows that the inner zones to the east of Heathrow were operated for 44 nights of the trial (this excludes any nights when the runways were temporarily alternated and the zones only operated for a short period). This accounted for 32% of the nights that the trial was in operation. There were 11 nights with infringements (25% of operating nights), ten of these nights had at most two and one night the 23rd December had eight (see 4.4 for an explanation). Due to bad

weather there were also two flights on the 21st November that needed to overfly the zones and two emergency flights on other nights. Excluding these flights and the 23rd December there would therefore have been 9 infringements.

Figure 25 shows the tracks of arriving aircraft close to the zones during the trial. As arriving aircraft need to join the extended centreline 10nm before touchdown during night time hours, and the western faces of the inner zones were approximately 10nm from touchdown, aircraft were routed 'behind' the zones during the trial (i.e. joined the approach path either to the east of the outer zones or within the areas between the zones). Many of the infringements excluding those on the 21st November and 23rd December just entered at the edges of the zones, especially the southwest corner of the northern zone. This reflects that many night-time arrivals approach from the north east of London.

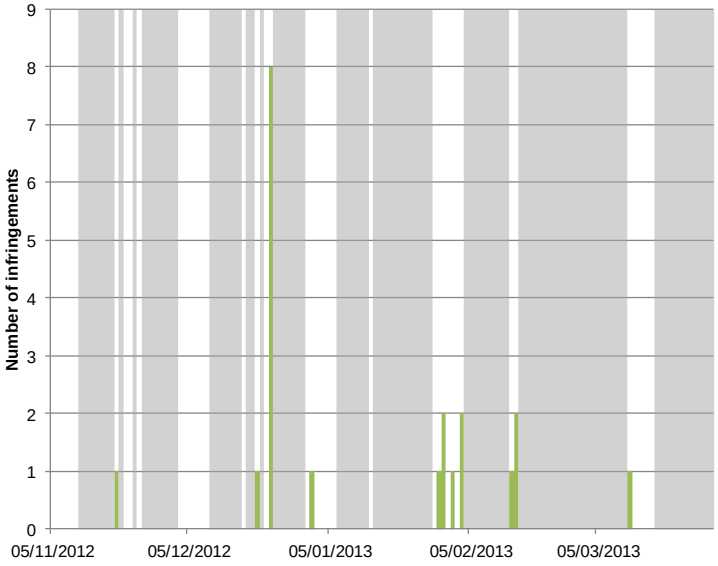


Figure 24: Zone infringements – inner zones to the east of Heathrow

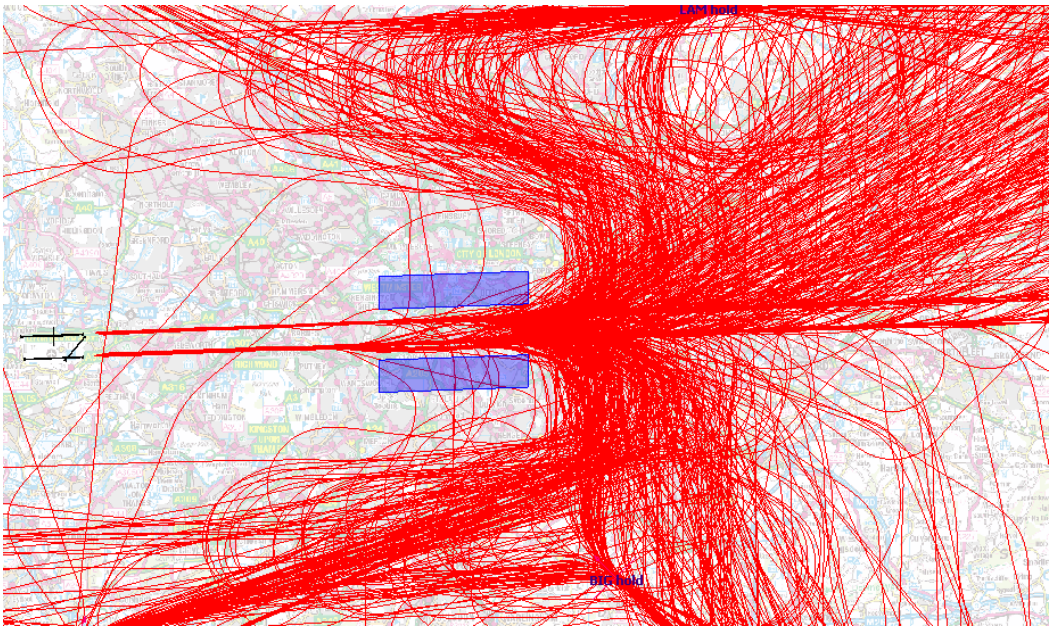


Figure 25: Aircraft tracks close to the inner zones to the east of Heathrow

4.7 Summary

The exclusion zones were successfully operated during the trial. They were operated for the majority of planned trial nights (94%) and on these nights were avoided by a high proportion of arriving aircraft (96%). There were no zone infringements on the majority of nights the trial operated (71%), and when they did occur there were typically only between one and two per night, with many 38% occurring at the extremities of the zones. Notable exceptions were the nights of the 2nd December, 23rd December and 3rd March when the wrong zones were mistakenly operated.

With the exception of the inner exclusion zones to the west of Heathrow, the percentages of aircraft infringing the zones, and the percentage of nights on which infringements occurred, were broadly similar between zones pairs. However, the small sample sizes involved mean that it is not possible to make a definitive comparison between the zones.

5 Aircraft tracks in the vicinity of the exclusion zones

5.1 Overview

This section summarises an analysis of aircraft tracks in the vicinity of the exclusion zones. It was undertaken in two stages:

- Visual comparisons of ANOMS track images between the baseline and trial. For example, from a visual inspection was it possible to deduce areas where there was an increase/decrease in over-flights when a given zone operated?
- Flight-by-flight analysis of aircraft entering and exiting a set of 4nm by 4nm grids in the vicinity of the exclusion zones. The purpose of this analysis was to provide a high-level validation of the visual comparison.

5.2 Visual comparison of tracks

Visual inspection of aircraft tracks in the vicinity of the exclusion zones shows distinct patterns for aircraft tracks when the inner and outer zones were operated.

Excluding the areas between the zones, these patterns indicate areas which experienced a decrease in over-flights when one pair of zones (e.g. outer) operated, and an increase when the other pair of zones operated (e.g. inner).

ANOMS track images were visually examined to identify any noticeable changes to aircraft tracks as a result of the trial. It is noted that this analysis solely looked at aircraft tracks and did not take into account noise from aircraft (i.e. noise may be heard from aircraft over a larger area than those identified in the analysis).

5.3 Exclusion zones to the west of Heathrow

ANOMS screenshots of aircraft tracks during the baseline period, inner zones operating and outer zones operating are shown in Figure 27, Figure 28 and Figure 29 respectively (as these plots contain a larger number of tracks they are repeated for seven nights only in Figure 30, Figure 31 and Figure 32 – note that the colour coding of heights are different for these images). When the images are overlaid, it is possible to see a number of areas where there was a distinct pattern of tracks. These were mirrored to the north and south of the zones. This pattern is shown in Figure 26 and summarised in the bulleted text below (areas between the zones are analysed separately in section 6).

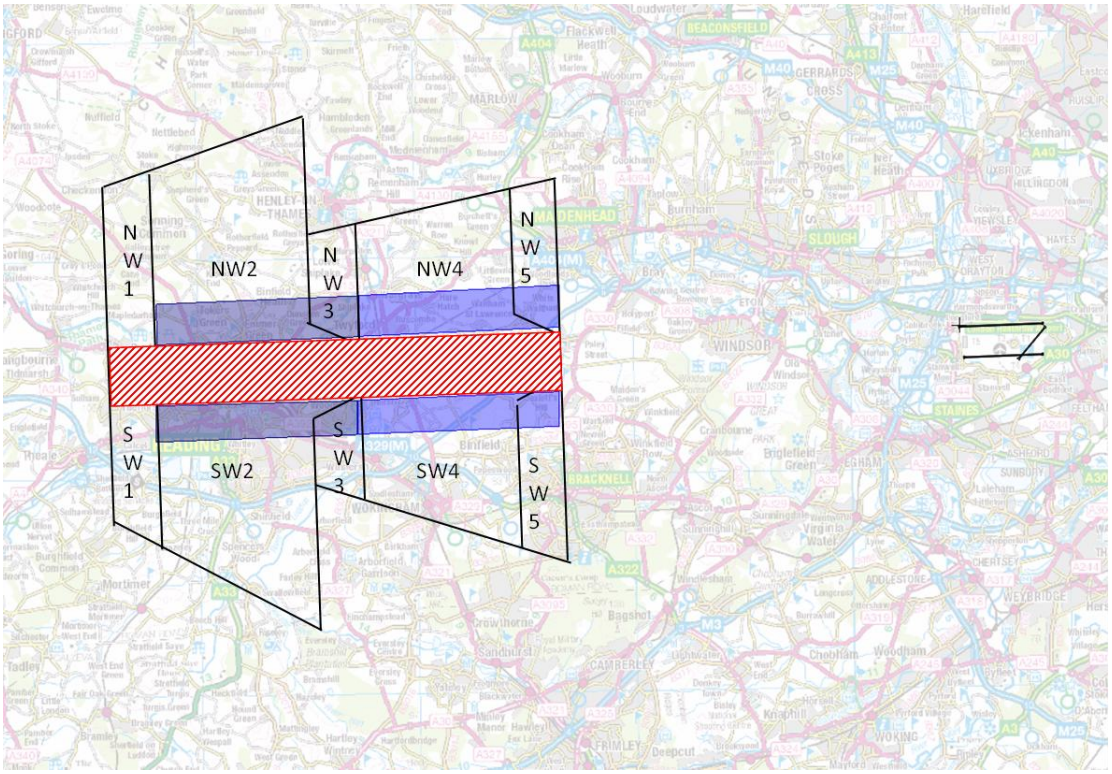


Figure 26: Schematic of areas with distinct track patterns when the exclusion zones to the west of Heathrow were operated (areas have been positioned visually and should be interpreted accordingly)

- NW1 and SW1: These areas were approximately 1nm wide and extended approximately 5nm north/south of the outer zones. Visual inspection indicates these areas had an increase in flights compared to the baseline when the inner zones operated.
- NW2 and SW2: These areas were approximately 4nm wide and extended approximately 5-6nm north/south of the outer zones. When the outer zones operated very few flights passed through these areas, however there was an increase in flights when the inner zones operated.
- NW3 and SW3: These areas were positioned at the rear of the inner zone, approximately 1nm wide and extended 2-3nm north/south of zones. In order to avoid infringing the inner and outer zones, very few aircraft overflew these areas during the trial.
- NW4 and SW4: These areas were approximately 4nm wide and extended approximately 4nm north/south of the inner zones. When the inner zones operated very few aircraft overflew these areas, however visual inspection suggests there was an increase in flights when the outer zones operated.
- NW5 and SW5: These areas were approximately 1nm wide and extended approximately 4-5nm north/south of the eastern portion of the inner zones. There was no noticeable change in the number of aircraft overflying these areas compared to the baseline.

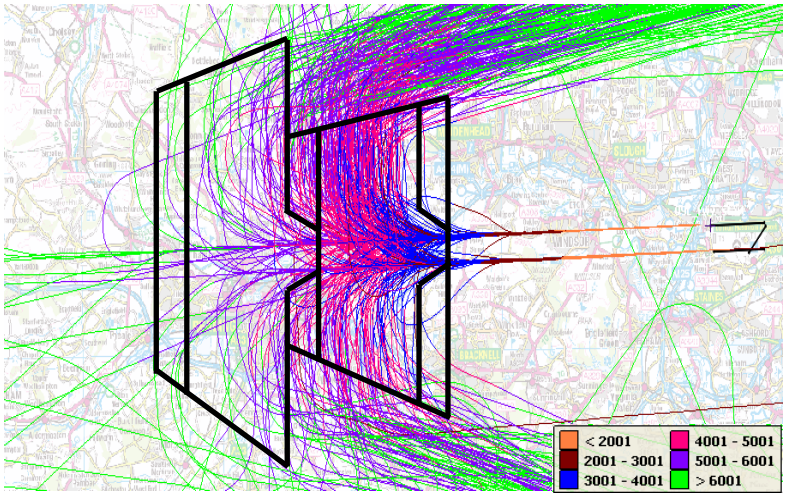


Figure 27: Aircraft tracks for the baseline period ~ 25 nights (2011/2012)

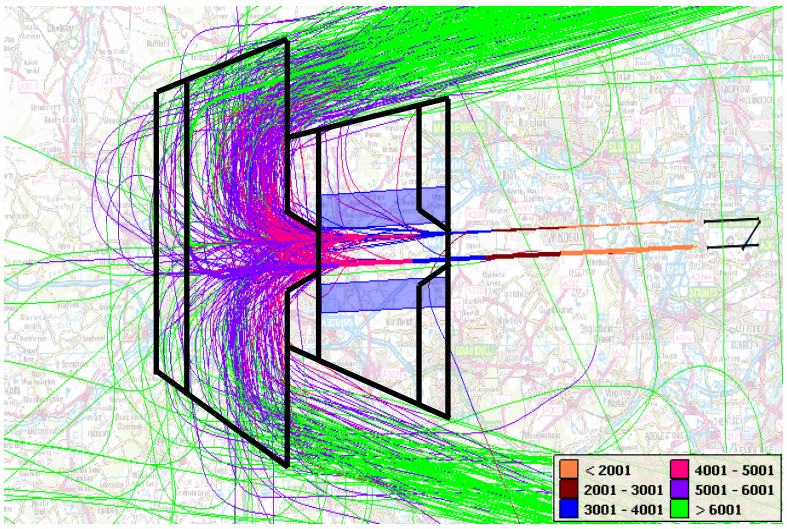


Figure 28: Aircraft tracks when the inner exclusion zones to the west of Heathrow operated - 25 nights (excludes 3rd March)

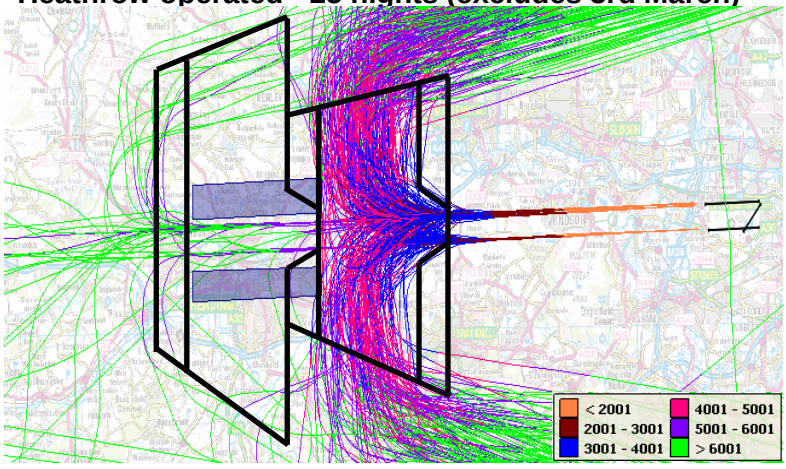


Figure 29: Aircraft tracks when the outer exclusion zones to the west of Heathrow operated - 25 nights

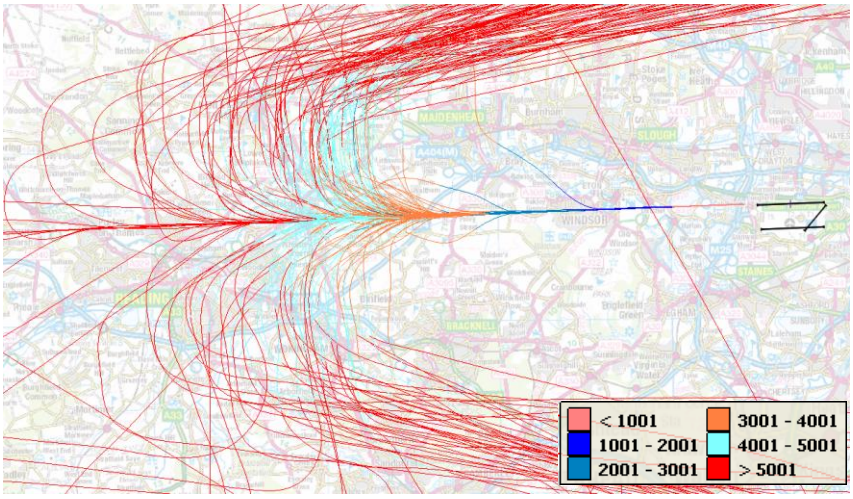


Figure 30: Aircraft tracks for the baseline period - 7 nights (2011/2012)

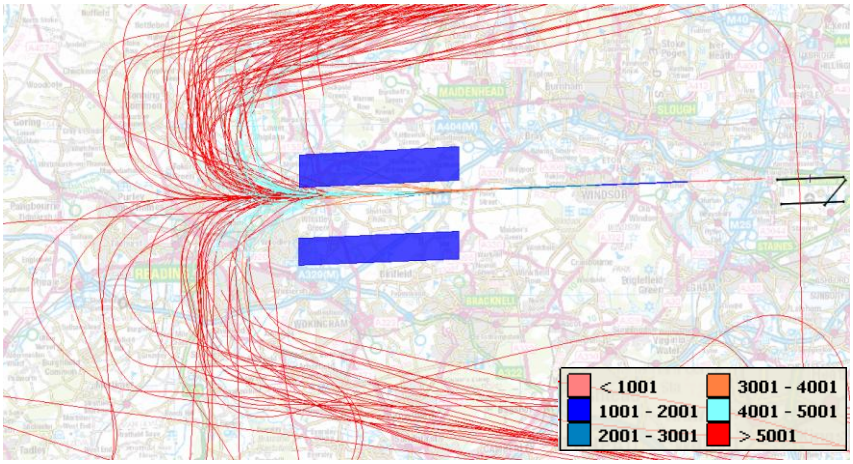


Figure 31: Aircraft tracks when the inner exclusion zones to the west of Heathrow operated - 7 nights

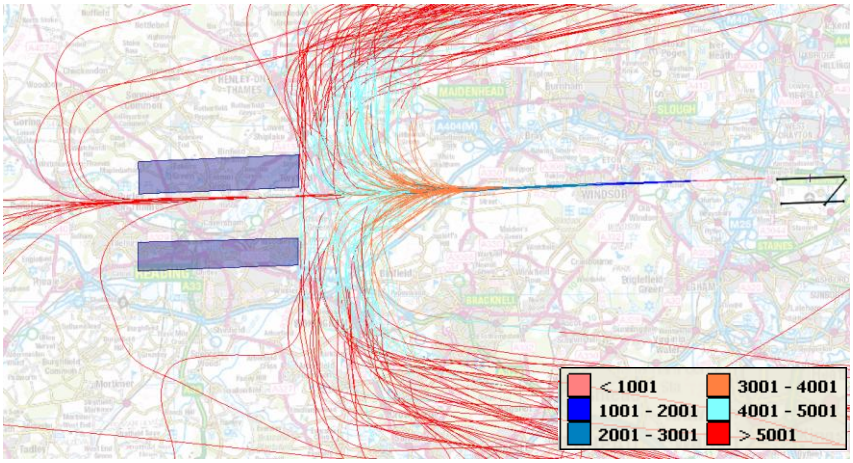


Figure 32: Aircraft tracks when the outer exclusion zones to the west of Heathrow operated – 7 nights

5.4 Exclusion zones to the east of Heathrow

When the exclusion zones to the east of Heathrow operated there were again a distinct pattern of tracks which were mirrored to the north and south of the zones. This pattern is shown in Figure 33 and summarised in the bulleted text below (areas between the zones are analysed separately in section 6).

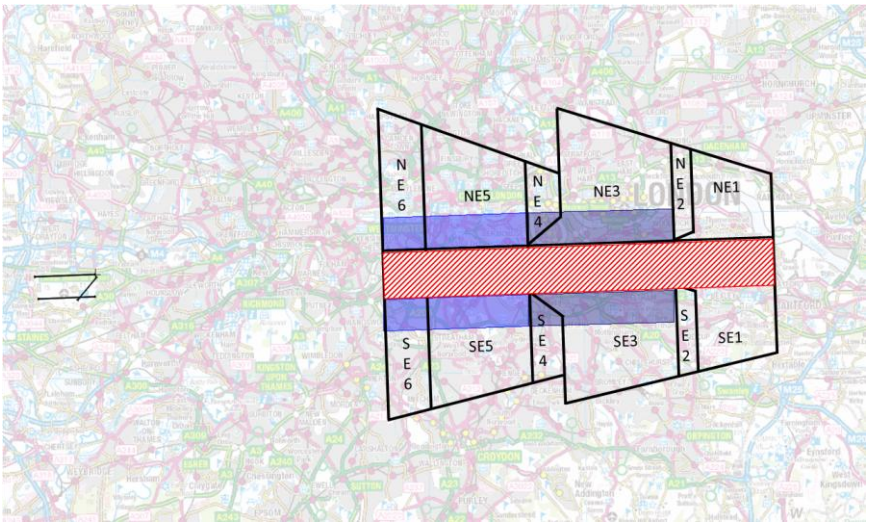


Figure 33: Schematic of areas with distinct track patterns when the exclusion zones to the east of Heathrow were operated (areas have been positioned visually and should be interpreted accordingly)

- NE1 and SE1: These areas were approximately 3nm wide and extend approximately 3nm north/south of the outer zones. Visually it is difficult to judge the degree to which there was an increase/decrease in flights in these areas.
- NE2 and SE2: These areas were positioned near the eastern end of the outer zones, were approximately 1nm wide and extend 2-3nm to the north/south. In order to avoid infringing the zones, very few aircraft overflew these areas when the outer zones operated. However when the inner zones operated they were much like NE1 and SE1 above.
- NE3 and SE3: These areas were approximately 4nm wide and extended approximately 5-6nm to the north/south of the outer zones. When the outer zones operated very few flights passed through these areas, however there was an increase when the inner zones operated.
- NE4 and SE4: These areas were positioned near the eastern end of the inner zones, were approximately 1nm wide and extended approximately 2nm to the north/south. In order to avoid infringing the both the inner and outer zones, very few aircraft overflew these areas during the trial.
- NE5 and SE5: These areas were approximately 4nm wide and extend approximately 4nm north/south of the inner zones. When the inner zones operated very few flights passed through these areas, however visual inspection suggests there was an increase in flights when the outer zones operated.
- NE6 and SE6: These areas were approximately 1nm wide and extended approximately 4-5nm north/south of the inner zones. Very few flights passed through these areas during the baseline and trial periods.

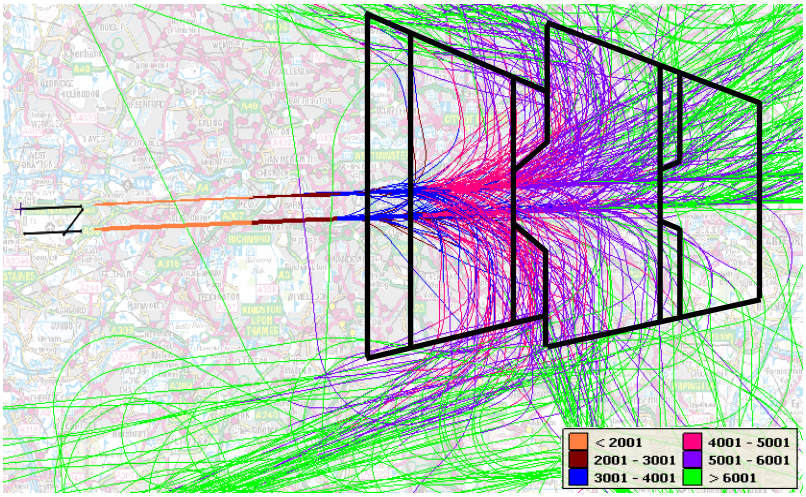


Figure 34: Aircraft tracks for the baseline period (2011/2012) ~45 nights

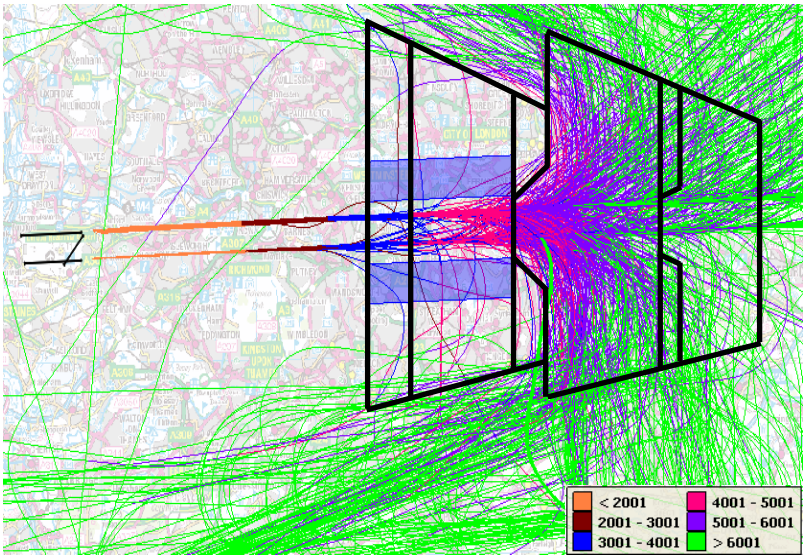


Figure 35: Aircraft tracks when the inner exclusion zones to the east of Heathrow operated - 44 nights

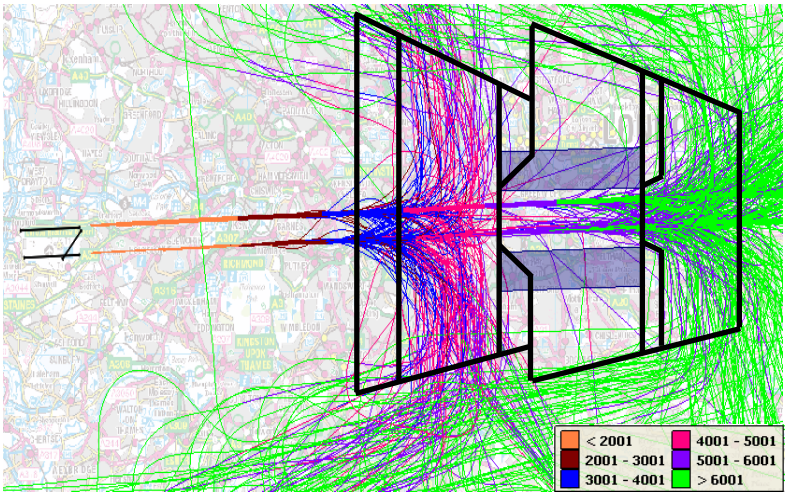


Figure 36: Aircraft tracks when the outer exclusion zones to the east of Heathrow operated - 41 nights

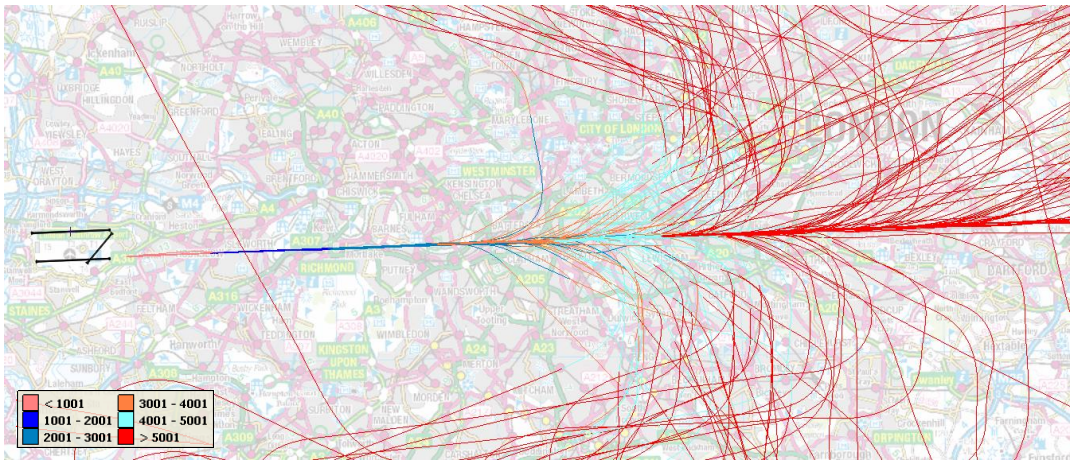


Figure 37: Aircraft tracks for the baseline period - 7 nights (2011/2012)

Figure 38: Aircraft tracks when the inner exclusion zones to the east of Heathrow operated - 7 nights

Figure 39: Aircraft tracks when the outer exclusion zones to the east of Heathrow operated - 7 nights

5.5 Analysis of 4nm by 4nm grids around the zones

Flight-by-flight analysis of 4nm by 4nm grids broadly validates the visual analysis of aircraft tracks, although some differences did occur.

In order to provide a high-level validation of the visual comparison, a flight-by-flight analysis was performed in the vicinity of the zones.

Practical limitations meant that it was not possible to extract and analyse flight-by-flight data for the exact areas identified in Figure 26 and Figure 33. Therefore, a series of 4nm by 4nm grids were created, six to the west and eight to the east of the airport. These were arbitrarily given the names of places within them and are shown in Figure 40 and Figure 41 below. The grids were created to match as closely as possible to the edges of the zones and areas the visual analysis indicated had a change in over-flights when one of the zone pairs operated during the trial. Flights entering and exiting these grids were then extracted from ANOMS (data included the date/time/position of each aircraft entering and exiting the grid, and their height).

Some grids included the areas between the zones/approach paths. These grids were subdivided to exclude these areas from the analysis.

5.6 Grids analysed to the west of Heathrow

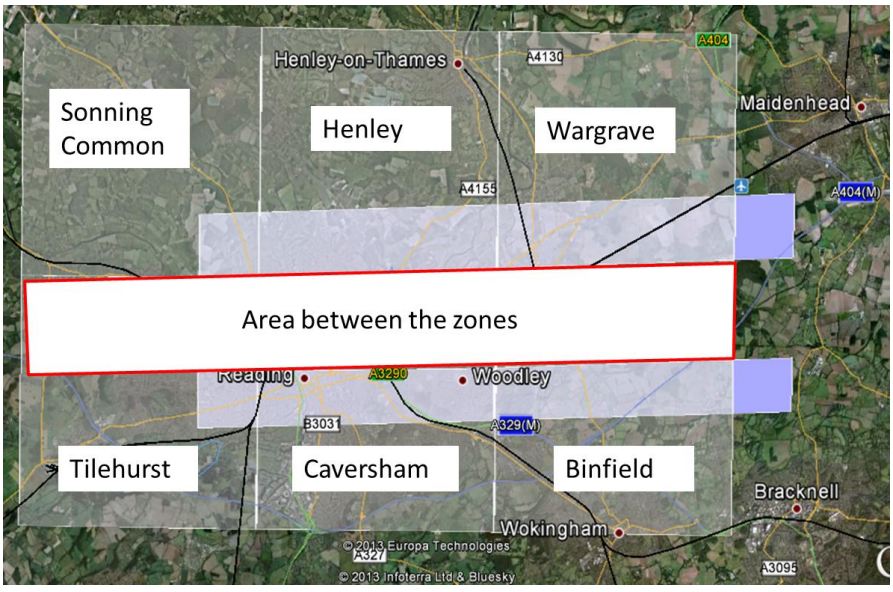


Figure 40: Grids analysed to the west of Heathrow

The table below presents a summary of the analysis conducted on the grids when the exclusion zones to the west of Heathrow were operated (areas between the zones are analysed separately in section 6):

- Column 2: The percentage of flights that passed through the grids (the percentages in brackets are the equivalent figures for the baseline period). Note that aircraft can pass through multiple grids.

- Columns 3 and 4: The percentage of flights that passed through the grids when the inner and outer zones operated respectively.
- Column 5: The percentage of nights the grid was overflown (the percentages in brackets are the equivalent figures for the baseline period). However, given the relatively small sample sizes involved some caution should be applied when interpreting these figures.
- Columns 6 and 7: The percentage of nights the grids where overflown when the inner and outer zones operated respectively.
- Column 8: The average height of aircraft passing through the grid (the figures in brackets are the equivalent average heights for the baseline period).

Grid	% of flights	Inner % of flights	Outer % of flights	% of nights	Inner % of nights	Outer % of nights	Average height
Sonning	6% (4%)	11%	2%	37% (37%)	63%	16%	5832 (5060)
Henley	30% (26%)	58%	4%	63% (93%)	93%	38%	5269 (5226)
Wargrave	78% (66%)	71%	84%	93% (100%)	89%	97%	3591 (4369)
Tilehurst	2% (1%)	4%	0%	19% (15%)	37%	3%	5632 (5795)
Caversham	11% (13%)	22%	2%	49% (83%)	89%	16%	5109 (4998)
Binfield	19% (20%)	3%	34%	54% (100%)	15%	88%	4243 (4184)

Table 3: Summary of aircraft overflying the grids to the west of Heathrow

The analysis for these grids broadly matches with the visual analysis of aircraft tracks in section 5.3. Compared to the baseline:

- For Sonning, Tilehurst, Henley and Caversham there was a decrease in the percentage of aircraft overflying the grids when the outer zones operated and an increase when inner zones operated. This was due to flights having to avoid these areas when the outer zone was in operation and more flights joining the approach path prior to the inner zones when these were in operation which required the aircraft to pass through these grids.
- For Wargrave and Binfield there was a decrease in the percentage of flights overflying the grids when the inner zones operated and an increase when outer zones operated. This was due to more flights going through the area between the zones when inner zones operated and a concentration of flights inside the outer zones.

There were some slight differences in the average heights of the aircraft through the zones but this has not been investigated in detail.

5.7 Grids analysed to the east of Heathrow

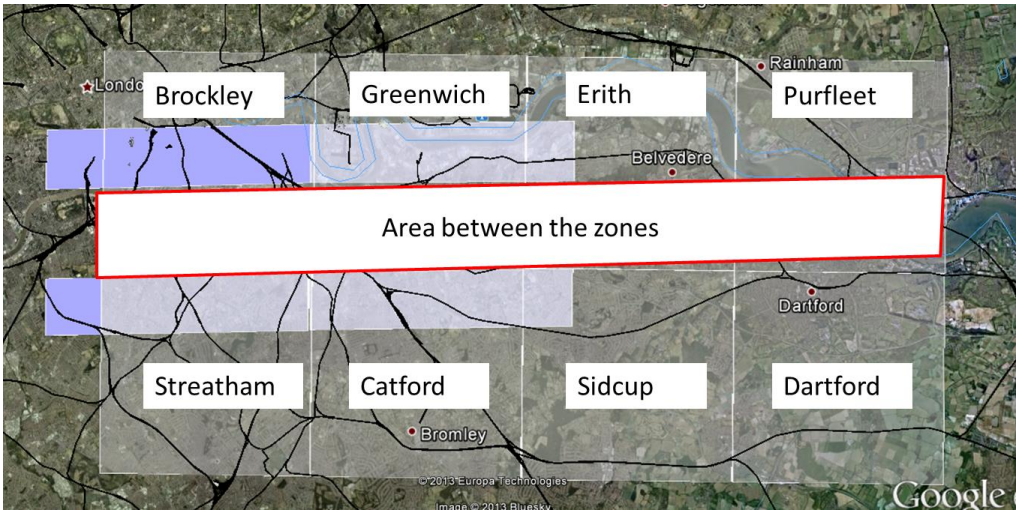


Figure 41: Grids analysed to the east of Heathrow

The table below presents a summary of the analysis conducted on the grids when the exclusion zones to the west of Heathrow were operated (areas between the zones are analysed separately in section 6):

Grid	% of flights	Inner % of flights	Outer % of flights	% of nights	Inner % of nights	Outer % of nights	Average height
Brockley	6% (18%)	4%	9%	43% (86%)	36%	51%	4138 (4220)
Greenwich	9% (24%)	15%	1%	46% (92%)	72%	16%	5132 (5168)
Erith	11% (14%)	12%	10%	74% (83%)	78%	70%	5814 (5805)
Purfleet	3% (4%)	3%	3%	40% (44%)	38%	42%	5011 (5904)
Streatham	10% (20%)	4%	17%	62% (93%)	40%	88%	4090 (4619)
Catford	17% (21%)	29%	2%	57% (97%)	88%	21%	5462 (5306)
Sidcup	8% (4%)	10%	5%	57% (44%)	66%	47%	5699 (5800)
Dartford	2% (0.3%)	0%	3%	16% (6%)	4%	30%	5963 (5931)

Table 4: Summary of aircraft overflying the grids to the east of Heathrow

The analysis for the grids broadly matches with the visual analysis of aircraft tracks in section 5.4, but not in all cases. Compared to the baseline:

- For Brockley and Streatham, there was the expected decrease in the percentage of flights overflying the grids when the inner zones operated.

However the perceived increase in flights when the outer zones operated from the visual analysis was not validated. This may reflect the visual analysis not being able to identify the density of flights making straight-in approaches through the eastern faces of these grids.

- For Greenwich and Catford there was a decrease in the percentage of flights overflying the grids when the outer zones operated and an increase when inner zones operated. This was due to aircraft having to avoid these areas and joining the area between the zones earlier when the outer zones operated and more aircraft going through these areas to join the approach path through these areas at these points when the inner zone was in operation.

- For Erith, Sidcup Purfleet and Dartford, within a few percent there was relatively little change in the proportion of arrivals overflying these areas. The exception was Sidcup which experienced a higher proportion of over-flights when the inner zone operated.

There were some slight differences in the average heights of the aircraft through the zones but this has not been investigated in detail.

5.8 Summary

Visual inspection of aircraft tracks in the vicinity of the exclusion zones shows distinct patterns for aircraft tracks when the inner and outer zones were operated. Excluding the areas between the zones, these patterns indicate areas which experienced a decrease in over-flights when one pair of zones (e.g. outer) operated, and an increase when the other pair of zones operated (e.g. inner). Simple flight-by-flight analysis of 4nm by 4nm grids broadly validated this visual analysis, although some differences did occur.

6 Approach paths and areas between the zones

6.1 Background

Feedback from local communities was that the trial had resulted in more arriving aircraft joining the approach path further from touchdown, which in turn had led to more flights within the areas between the exclusion zones. The following analysis was conducted on the basis of this feedback.

6.2 Methodology

Using ANOMS, Heathrow's Flight Performance Unit implemented a narrow box around each of Heathrow's four approach paths (the boxes for runways 27L and 27R are shown in the schematic below). The boxes extended approximately 30nm from touchdown and were approximately 480 metres wide.

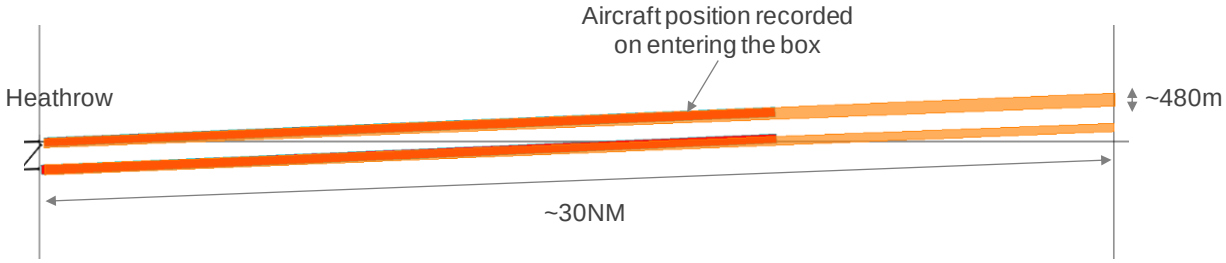


Figure 42: Schematic of the boxes used for the approach path analysis (runways 27L and 27R)

ANOMS recorded the position of each aircraft when it entered the box associated with its landing runway, thereby allowing the distance from touchdown that aircraft joined the approach path to be calculated. This allowed changes in the following to be compared between the baseline and trial:

- Distances from touchdown that aircraft joined the approach path.
- Proportion of aircraft overflying the areas between the zones.

Using other outputs from ANOMS the lateral concentration of flights between the zones was also investigated.

6.3 Areas between the exclusion zones to the west of Heathrow

This sub-section presents an analysis of areas between the zones to the west of Heathrow (i.e. when aircraft were landing on runways 09L and 09R).

6.3.1 Distances from touchdown that aircraft joined the approach paths (runways 09L and 09R)

Aircraft joined the approach paths for runways 09L and 09R further from touchdown when the inner zones operated, but closer to touchdown when the outer zones operated.

Figure 43 shows the distance from touchdown that aircraft joined the approach paths for runways 09L and 09R combined in 0.5nm increments[7]. From top to bottom these graphs are for:

- Baseline period.
- Trial – outer zones only.
- Trial – inner zones only.
- Trial – inner and outer zones combined.

These graphs show the combined picture for aircraft joining runways 09L and 09R and from different directions (i.e. north, south and east). A map of the area close to the approach paths is also included to provide a point of reference.

The graphs show that during the trial, compared to the baseline:

- Outer zones operating: Arriving aircraft joined the approach paths for runways 09L and 09R closer to touchdown. Overall there was relatively little change in the concentrations of where aircraft joined the approach path.
- Inner zones operating: Arriving aircraft joined the approach paths for runways 09L and 09R further from touchdown. There were concentrations of flights joining the approach paths around the western end of the inner zones (around 15nm from touchdown).

Figure 43 shows that during the baseline period, approximately 80% of aircraft joined the approach paths in the area between the inner zones, while the remaining 20% (approximately) joined in the area between the outer zones. Therefore a simplistic explanation for the changes during the trial is that a small proportion of aircraft joined the approach paths later when the outer zones operated, while a large proportion of arriving aircraft joined the approach paths earlier when the inner zones operated. The number of aircraft making 'straight-in' approaches from east meant that the above was not observed when the outer zones to the east of Heathrow (i.e. those for runways 27L and 27R) were in operation.

[7] The x-axis shows the distance from touchdown that aircraft join the approach paths in 0.5nm increments, and the y-axis the percentage of flights that joined in each 0.5nm increment. Percentages have been used to allow a comparison between the different numbers of flights in the baseline and trial datasets.

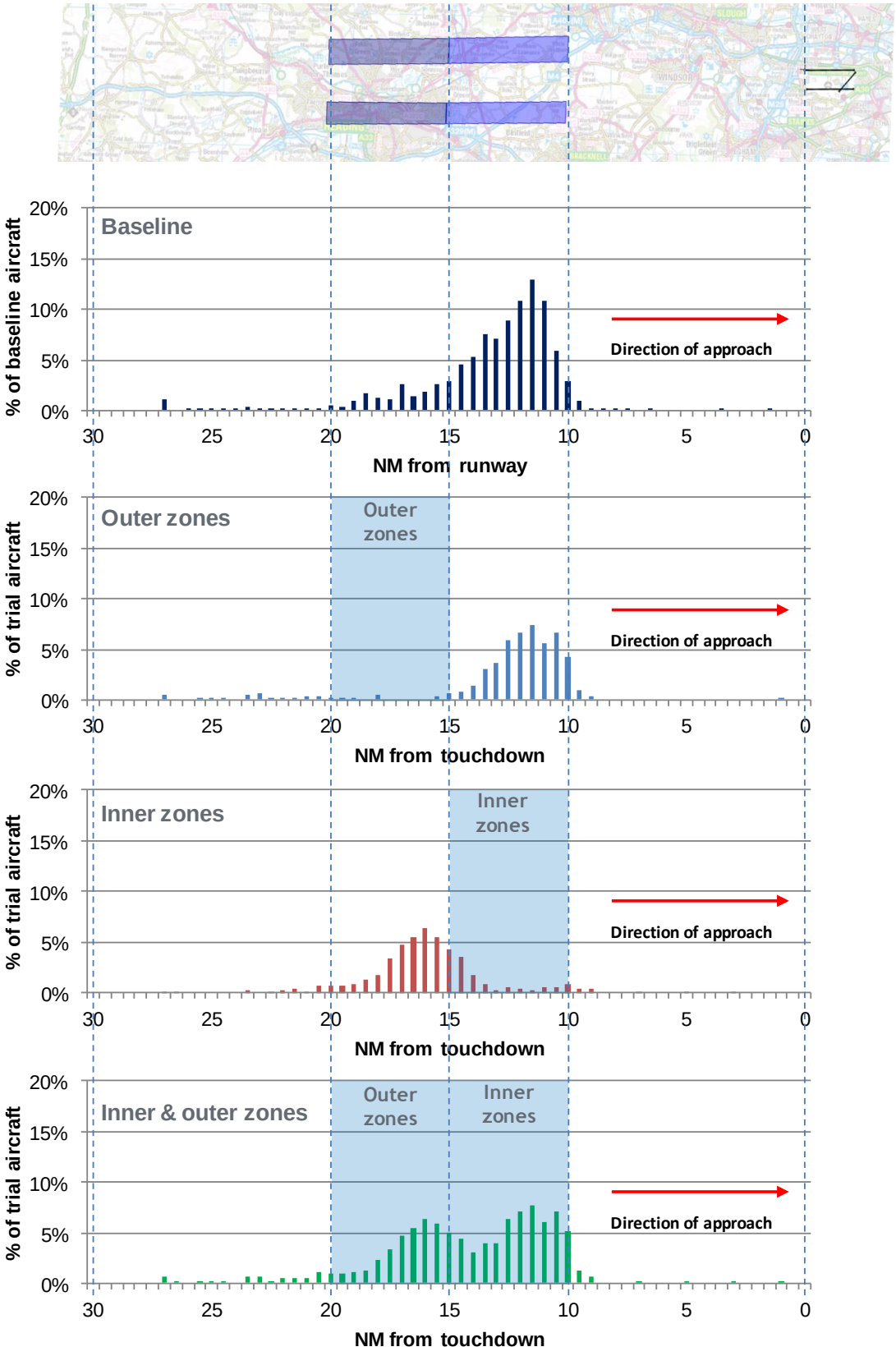


Figure 43: Distances from touchdown that aircraft joined the approach paths (runways 09L and 09R)

6.3.2 Proportions of aircraft on the approach paths (runways 09L and 09R)

Areas between the zones were overflown more when the inner zones operated but less when the outer zones operated. Over the entire period of the trial the net impact was that more arriving aircraft overflew the areas between the zones.

Figure 43 compares the proportions of aircraft on the approach paths for runways 09L and 09R at different distances from touchdown[8]. Three graphs are presented, from top to bottom these are:

- Baseline verses trial – outer zones only.
- Baseline verses trial – inner zones only.
- Baseline verses trial – inner and outer zones combined.

The graphs show that:

- Outer zones operating: Fewer arriving aircraft overflew the areas between the zones.
- Inner zones operating: More arriving aircraft overflew the areas between the zones.

Over the entire period of the trial the net impact was that more arriving aircraft overflew the areas between the zones. The explanations for these findings are as per section 0. In addition, there were relatively few 'straight-in' approaches from the west which resulted in only a small number of aircraft flying in the areas between the outer zones.

[8] This is analysis in section 0 presented in a cumulative form. The x-axis shows the distance from touchdown in 0.5nm increments, and the y-axis the percentage of flights that had joined the approach paths at/before each 0.5nm increment.

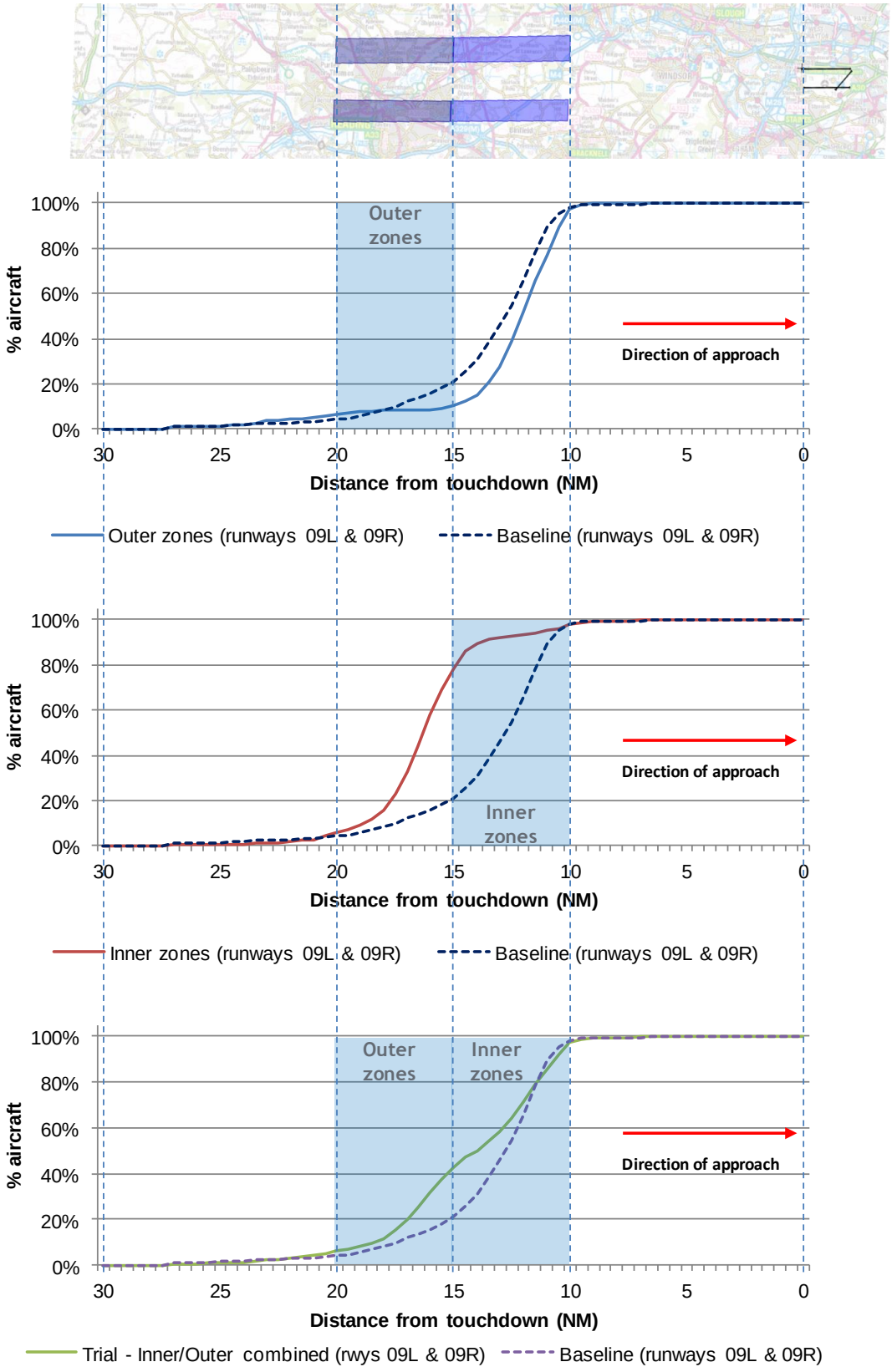


Figure 44: Proportions of arriving aircraft on the approach paths at different distances from touchdown (runways 09L and 09R)

6.3.3 Lateral concentration of flights between the exclusion zones (runways 09L and 09R)

Overall, arriving aircraft were more concentrated laterally in the areas between the zones during the trial

The images in Figure 45 compare the lateral concentration of arriving aircraft at 15nm from touchdown (the boundary between the inner and outer zones)[9]. Three graphs are presented, from top to bottom these are:

- Baseline.
- Trial – outer zones only.
- Trial – inner zones only.

At 15nm from touchdown, when the inner zones operated, arriving aircraft were more concentrated laterally in the areas between the inner zones. When the outer zones operated, very few arriving aircraft are shown on the image. With reference to Figure 43, this is because the majority of aircraft joined the approach path less than 15nm from touchdown when the outer zones operated.

The lateral concentration of flights at 11nm and 19nm from touchdown are shown in the appendices. The images show that the degree lateral concentration was dependent on the zone in operation. When the outer zones operated, there were only a small number of aircraft that flew between the zones at 19nm from touchdown. When the inner zones operated aircraft were laterally dispersed in a similar way to the baseline at this distance from touchdown. At 11nm from touchdown aircraft were more laterally concentrated compared to the baseline when the inner zone was in operation. When the outer zones operated the lateral dispersion of aircraft was similar to the baseline.

[9] The x-axis shows the distance in nm, and the y-axis height in feet. Each red triangle represents the position of a single arrival at 15nm from touchdown.

Figure 45: Lateral concentrations of arriving aircraft at 15nm from touchdown (runways 09L and 09R)

6.4 Areas between the exclusion zones to the east of Heathrow

This sub-section presents an analysis of areas between the zones to the east of Heathrow (i.e. when aircraft were landing on runways 27L and 27R).

6.4.1 Distances from touchdown aircraft joined the approach paths (runways 27L and 27R)

Aircraft joined the approach paths for runways 27L and 27R further from touchdown during the trial. They did so in order to avoid overflying the exclusion zones.

Figure 46 shows the distance from touchdown aircraft joined the approach paths for runways 27L and 27R in 0.5nm increments. Figure 46 shows that during the trial:

- Aircraft were joining the approach paths further from touchdown in order to avoid infringing the zones (during the trial approximately 20% of arrivals joined the approach path less than 15nm from touchdown, for the baseline this figure was closer to 40%).
- There were concentrations of flights joining the approach paths at the eastern end of each zone (around 15nm when the inner zone operated and around 20nm when the outer zone operated).

The graphs also show that aircraft join the approach paths between the zones. As can be seen from Figure 47, this reflects aircraft not being on the approach path when they entered the area between the zones, rather than the aircraft infringing the exclusion zones.

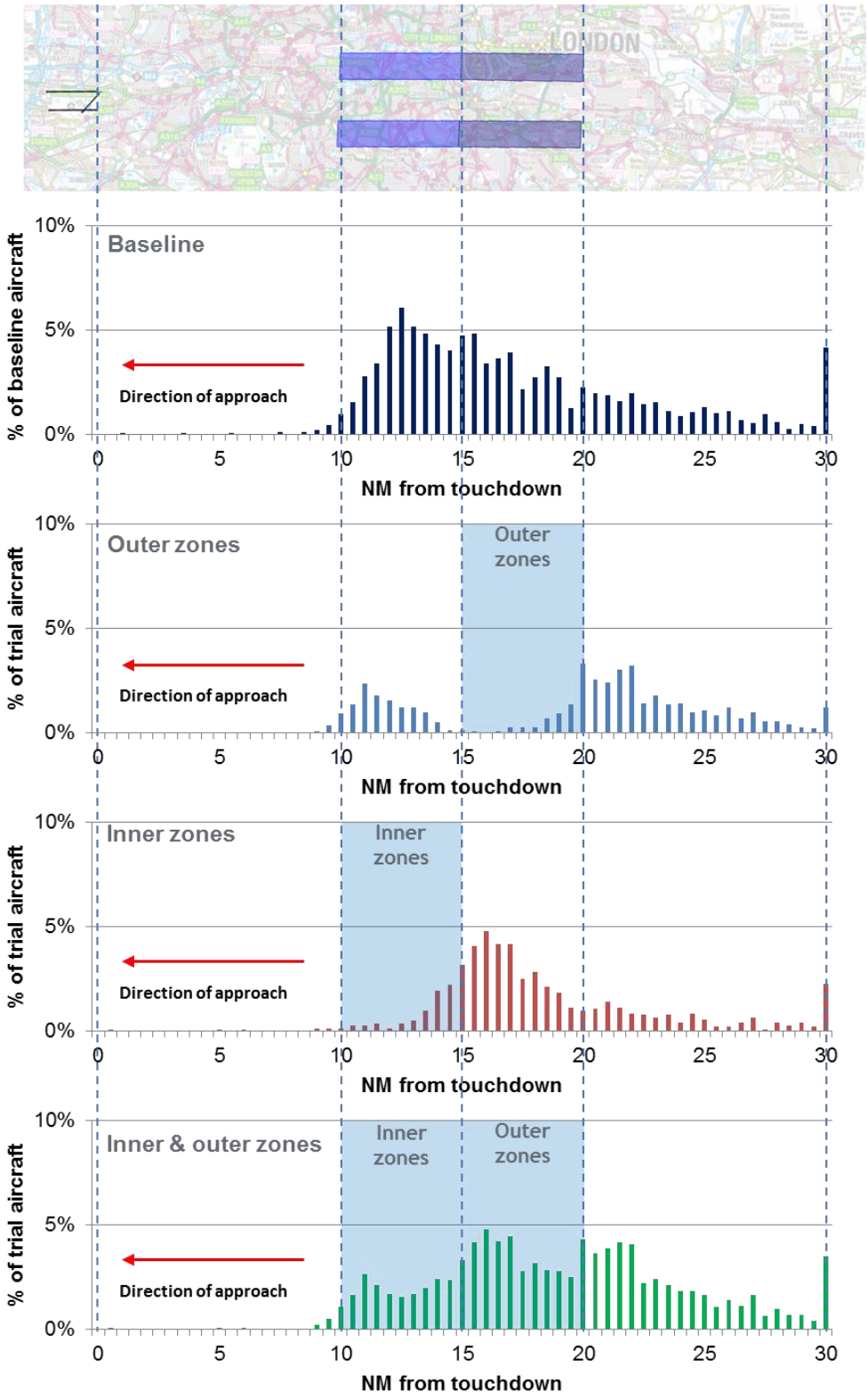


Figure 46: Distances from touchdown aircraft joined the approach paths (runways 27L and 27R)

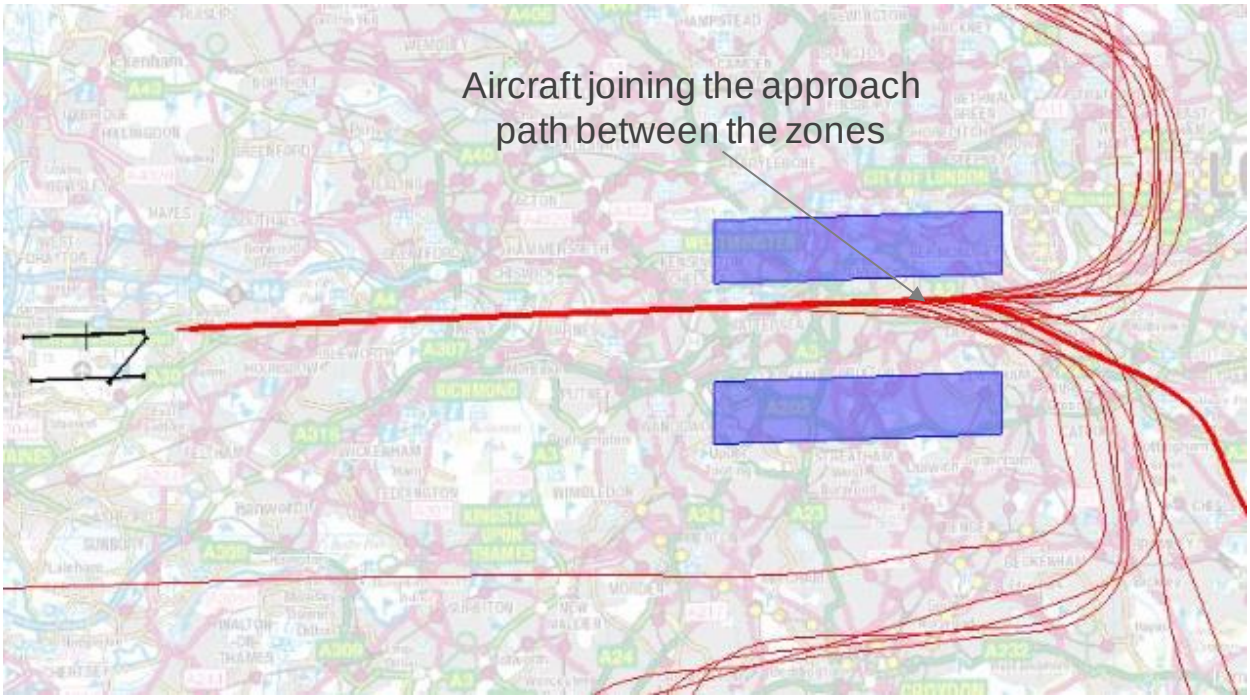


Figure 47: Examples of arriving aircraft joining the approach paths between the exclusion zones

6.4.2 Proportions of aircraft on the approach paths (runways 27L and 27R)

Areas between the zones (and the areas to the east of the outer zones when operated) were overflown more during the trial.

Figure 48 compares the proportions of aircraft on the approach paths for runways 27L and 27R at different distances from touchdown between the baseline and trial.

The graphs show that during the trial a higher proportion of aircraft overflew the areas between the zones (and the areas to the east of the outer zones when they operated). The difference between the proportions of aircraft on the approach paths during the baseline and trial were highest at the eastern end of each of zone (around 15nm when the inner zones operated and around 20nm when the outer zones operated).

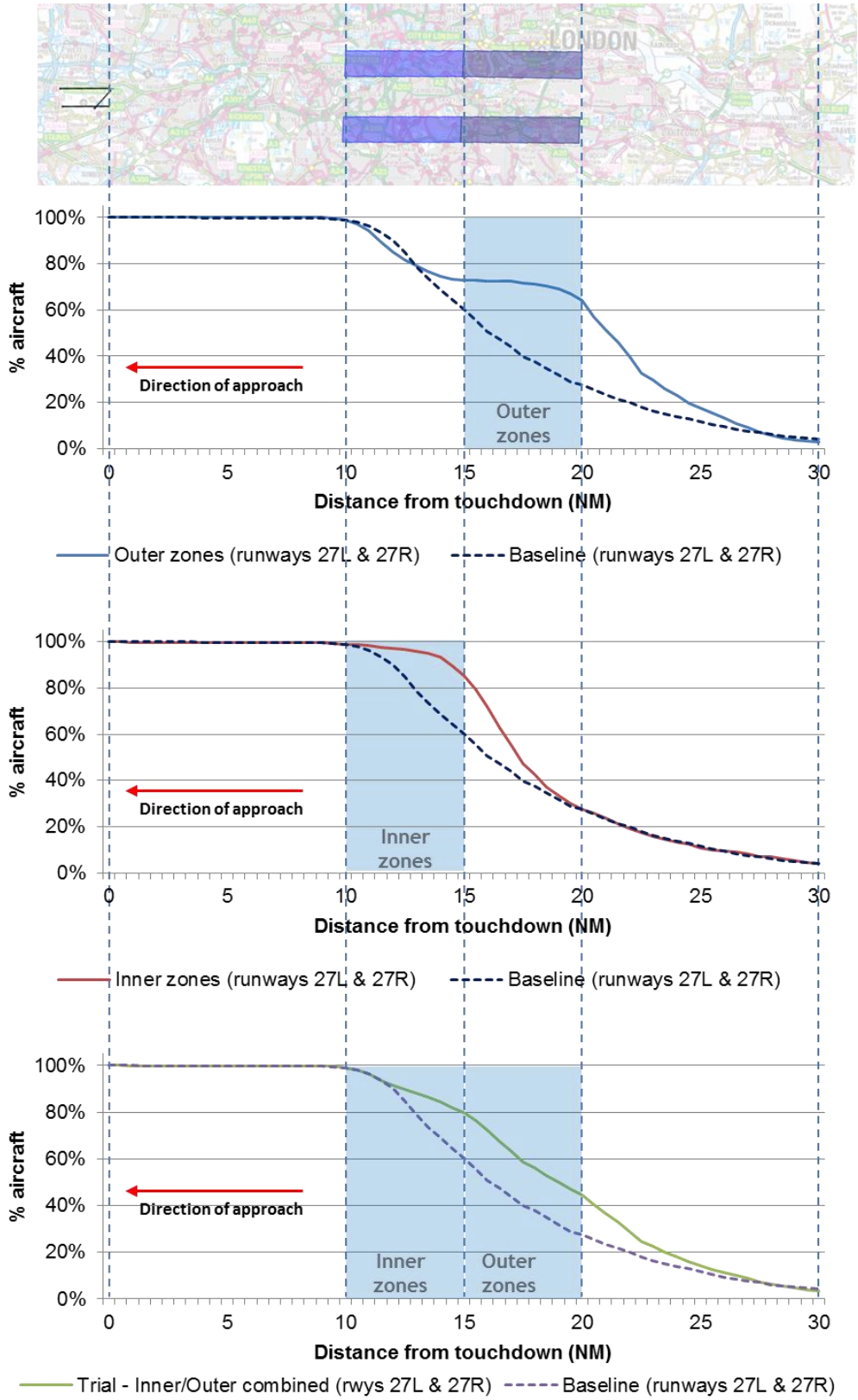


Figure 48: Proportions of arriving aircraft on the approach paths at different distances from touchdown (runways 27L and 27R)

6.4.3 Lateral concentration of flights between the exclusion zones (runways 27L and 27R)

Overall, arriving aircraft were more concentrated laterally in the areas between the zones during the trial.

Figure 49 compares the lateral concentration of arriving aircraft at 15nm from touchdown (the boundary between the inner and outer zones).

The figures show that, in the areas between the zones, at 15nm from touchdown arriving aircraft were more concentrated laterally during the trial. This is particular noticeable when the outer zones were operated because arriving aircraft had already joined the approach path while flying in the area between the outer zones. Arriving aircraft were not as laterally concentrated at 15nm when the inner zones operated. This is because not all had joined the approach path on entering the areas between the inner zones.

The lateral concentration of flights at 11nm and 19nm from touchdown are shown in the appendices. The figures show that the degree of lateral concentration was dependent on the zone in operation. At 19nm from touchdown, when the outer zones were operated aircraft were already laterally concentrated, while when the inner zones were operated the lateral dispersion of arriving aircraft was similar to the baseline. At 11nm from touchdown aircraft were more laterally concentrated compared to the baseline when both the inner and outer zones were operated (there was a degree of dispersion when the outer zones are in operation due to some aircraft joining the approach path to the west of these zones).

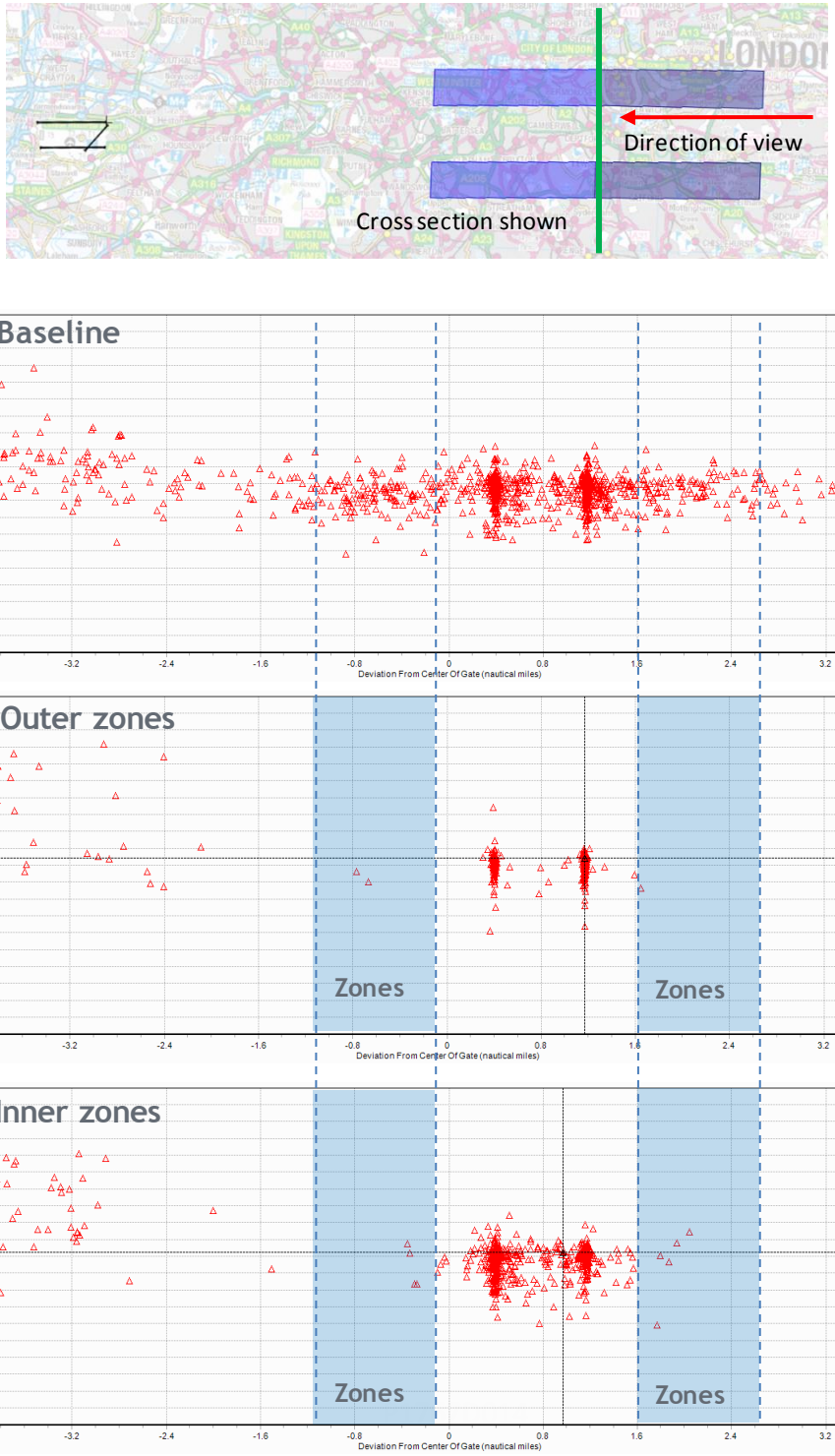


Figure 49: Lateral concentrations of arriving aircraft at 15nm from touchdown (runways 27L and 27R)

6.5 Continuous Descent Approach, late and low compliance

During the trial there was no deterioration in core night time CDA compliance or increase in night time joining point 'Lates' or 'Lows'.

During normal night-time operations at Heathrow a number of requirements exist that aim to keep aircraft higher for longer and avoid prolonged periods of level flight, therefore benefiting communities close in to the airport. These are:

- Continuous Descent Approach (CDA): A CDA is a noise abatement flight technique during which a pilot descends at a rate with the intention of achieving a continuous descent to join the glide-path at the correct height for the distance. For monitoring purposes at Heathrow, a descent will be deemed to have been continuous provided that no segment of level flight longer than 2.5nm miles occurs below 6,000 feet above mean sea level and level flight is interpreted as any segment of flight having a height change of not more than 50 feet over a track distance of 2nm or more as recorded in the airport noise and track keeping system.
- Joining point 'lates' and 'lows': During the hours in which the trial operated, aircraft were required to be established on the ILS not lower than 3,000ft above mean sea-level and join the ILS no closer to the runway than 10nm.

Statistics on these measures during the trial are compared with annual figures for 2011 and 2012 in the table below. These show no deterioration in core night time CDA compliance or increase in night time joining point 'lates' or 'lows'.

	2011	2012	Trial
CDA Core Night Average	94.4%	94.9%	94.4%
Joining Point Night 'lates' Average	2.0%	1.6%	1.0%
Joining Point Night 'lows' Average	0.6%	0.2%	0.2%

Table 5: CDA compliance, 'lates' and 'lows' during the 2011, 2012 and the trial period

6.6 Summary

6.6.1 Zones to the east of Heathrow

For the zones to the east of Heathrow, overall:

- Aircraft joined the approach paths further from touchdown in order to avoid overflying the exclusion zones.
- Areas between the zones were overflown more during the trial.
- Arriving aircraft were more concentrated laterally in the areas between the zones during the trial. However, the degree to which this occurred depended on the distance from touchdown and specific exclusion zones in operation.

6.6.2 Zones to the west of Heathrow

When the inner zones to the west of Heathrow operated, overall the findings were as per the zones to east of Heathrow.

However, when the outer zones operated, overall:

- Arriving aircraft joined the approach paths closer to touchdown.
- Areas between the zones were overflown less during the trial.
- Arriving aircraft were more concentrated laterally in the areas between the zones.

The findings for the outer zones to the west of Heathrow were due to the proportion of aircraft that joined the approach paths to the east of the outer zones not being too dissimilar between the baseline and the trial.

However, the net impact of the trial when the zones to the west of Heathrow operated was that aircraft joined the approach paths further from touchdown and more arriving aircraft overflew the areas between the zones.

6.6.3 Continuous Descent Approach, late and low compliance

There was no deterioration in core night time CDA compliance or increase in night time joining point ‘lates’ or ‘lows’ during the trial.

7 Predictable respite

7.1 Introduction

The purpose of the trial was to investigate the feasibility of providing a predictable respite period for some communities close to Heathrow's approach paths. This section investigates the degree of respite achieved during the trial, for both the areas under the zones and those surrounding them.

7.2 Predictable respite

Predictable respite is desirable for the communities near the approach paths but there are no established principles as to what constitutes respite that can be formally applied to trials.

There is no formal definition for predictable respite and there are a number of different ways by which it could potentially be measured. From meetings with local communities during the trial it is clear that predictable respite is desirable, but work is needed to identify what is required and accordingly establish some associated principles that can be applied in the future. To this end this study has provided an indication of the degree of respite during the trial, but not attempted to link it to any specific definition.

7.3 Areas under the zones

Exclusions zones will not provide 100% predictable respite. However when the trial operated a significant amount of respite was provided under the zones.

An indication of the amount of respite achieved during the trial has been derived in two ways:

- The number of nightly zone infringements. See Figure 50.
- The number of continuous hours without the zones being overflown. See Figure 51.

The above figures show that exclusion zones will not provide 100% predictable respite due to trial suspensions, and safety reasons such as in-flight medical emergencies. However, they also show that when the trial operated a significant amount of respite was provided under the zones:

- There were no zone infringements for the majority of nights. During the trial there were 97 nights when no infringements occurred (approximately 70% of nights when the trial operated[10]) and 126 nights when there was either a single infringement or no infringements (approximately 90% of nights when the trial operated[11]).

[10] Including nights when trial was suspended, this figure is approximately 65%.

[11] Including nights when trial was suspended, this figure is approximately 85%.

- The zones remained free of arrivals for at least 6 continuous hours for 111 nights (approximately 80% of nights when the trial operated[12]).

The above is presented in Table 6 along with the approximate population under each. The table shows that approximately 88,900 people to the west of Heathrow received a significant amount of respite during the trial, while to the east of Heathrow this figure was 586,300.

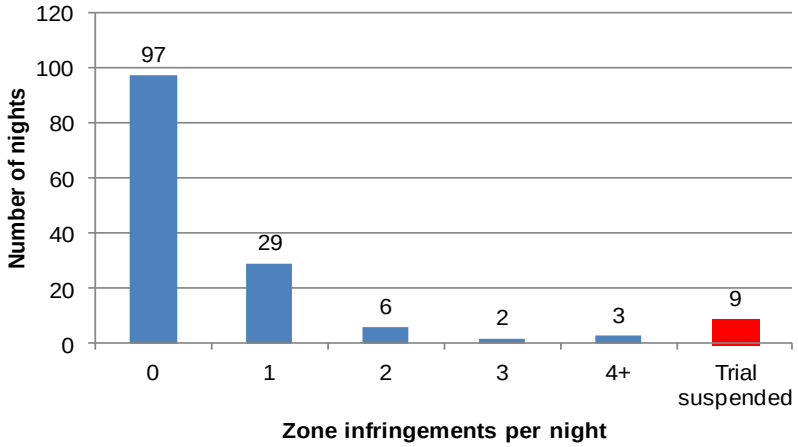


Figure 50: Count of zone infringements per night

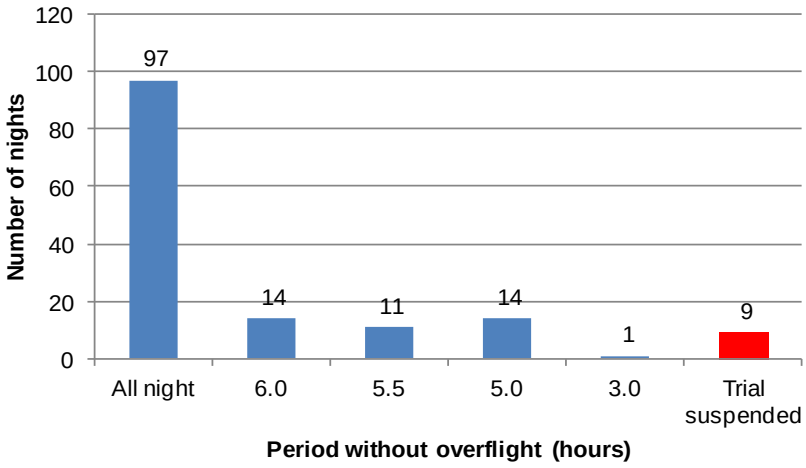


Figure 51: Number of hours without infringement per night

[12] Including nights when trial was suspended, this figure is approximately 75%.

Zone location	Zones	Nights with no infringements	Nights with 0 or 1 infringement	Nights free of arrivals for at least 6 hours	Approximate population
West of Heathrow	Inner	16	24	19	7,700
	Outer	18	24	22	81,200
East of Heathrow	Inner	33	40	36	381,400
	Outer	30	38	34	204,900
	Total	97	126	111	675,200

Table 6: Summary of infringements by zone and populations under the zones[13]

7.4 Areas to the north and south of the zones (excluding the area between the zones)

Areas to the north and south of the zones (excluding the areas between the zones) experienced a degree of respite during the trial.

Figure 52 shows the tracks of arriving aircraft in the vicinity of the zones. The left hand images show tracks of aircraft landing on runways 09L and 09R, and the right hand images for runways 27L and 27R. From top to bottom the images are:

- Baseline.
- Trial – inner zones only.
- Trial – outer zones only.

The images show that areas to the north and south of the zones (excluding the areas between the zones) experienced a degree of respite during the trial when either the inner of outer zone operated. Table 7 shows that the combined population in these areas to the west of Heathrow is 135,600 while to the east of Heathrow is it 1,076,000. The images also show that, for each pair of zones, a relatively predictable pattern of traffic occurred to the north and south of the zones during the trial. Other features of the images are:

- Areas to north and south of 'front' of the inner zones (i.e. the 1nm of the inner zones closest to Heathrow) incurred relatively little change as a result of the trial.
- Small areas close to the intersections of the inner and outer zones (approximately 15nm from touchdown) received a degree of respite throughout the trial.

Within the timescales of the study no analysis has been made to quantify the number of nights or continuous hours without over-flight in these areas.

[13] The above table is based upon the main direction of operation for a given night - on 19 nights of the trial aircraft landed on both runways 09L/09R and 27L/27R. On most nights the majority of aircraft landed in one direction while typically 1-2 landed in the other.

Zone location	Zones operating	Approximate population in the areas receiving a degree of respite (see Figure 52)
West of Heathrow	Inner	50,900
	Outer	73,500
	Both	11,200
East of Heathrow	Inner	548,000
	Outer	430,900
	Both	97,100
	Total	1,211,600

Table 7: Populations under the areas close to the zones that received a degree of respite during the trial

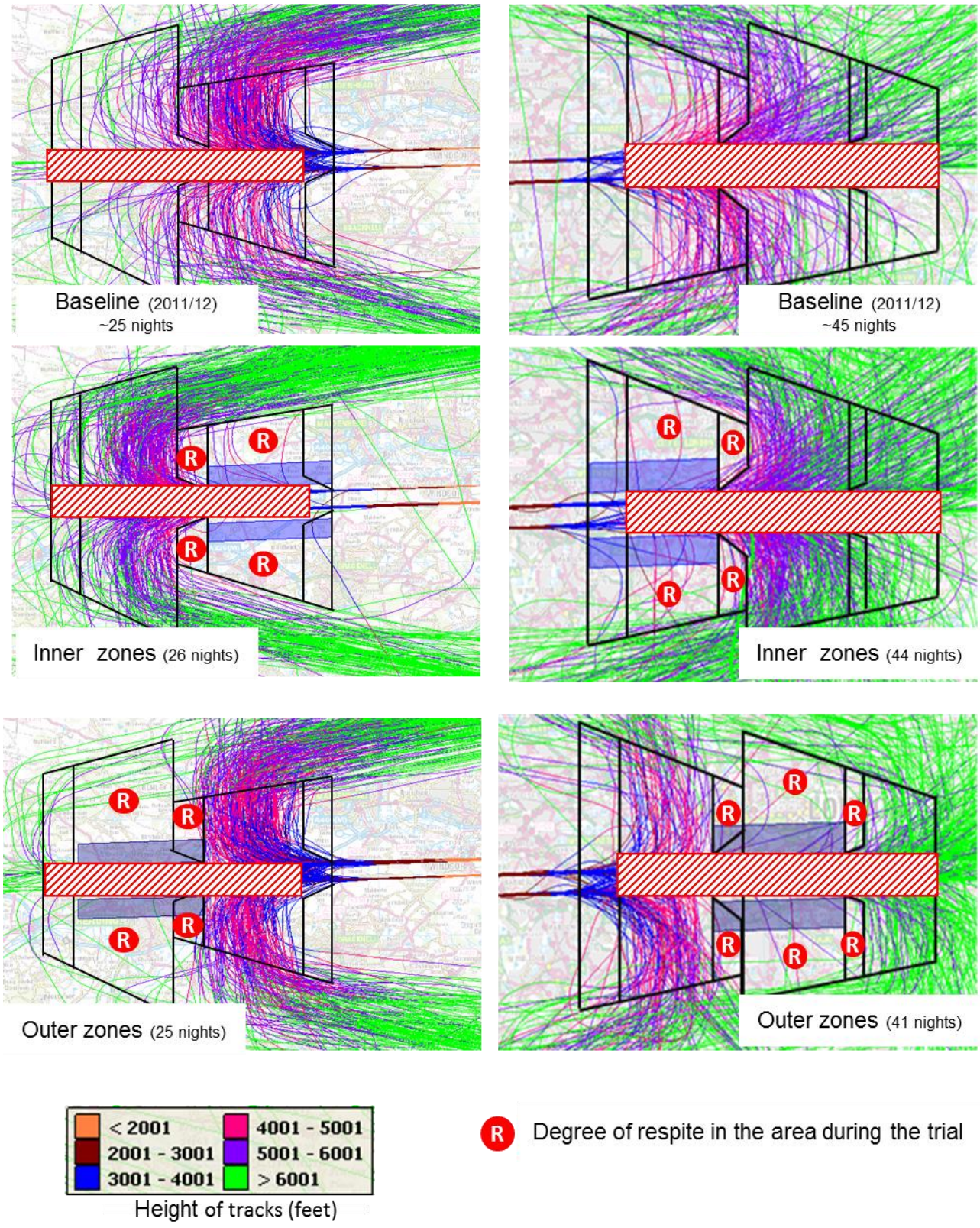


Figure 52: Tracks of arriving aircraft in the vicinity of the zones (note - images to the left and right are of a different scales)

7.5 Areas between the zones

Areas between the zones were overflown more during the trial.

The analysis of the areas between the zones in section 6 showed that during the trial aircraft joined the approach paths further from touchdown in order to avoid overflying the exclusion zones. This in turn resulted in the areas between the zones being overflown more during the trial. Table 8 below shows that the approximate population being overflown more as a result of the trial was 92,500 to the west of Heathrow and 505,400 to the east of Heathrow.

Zone location	Zones in operation	Approximate population
West of Heathrow	Inner	92,500
	Outer	
East of Heathrow	Inner	505,400
	Outer	
	Total	597,900

Table 8: Approximate population between the zones

7.6 Summary

Predictable respite is desirable for the communities near the approach paths but there is no formal definition. Work is needed to identify what is required and accordingly establish some associated principles that can be applied in the future.

In terms of the trial:

- Exclusions zones will not provide 100% predictable respite. However when the trial operated a significant amount of respite was provided under the zones. This was provided to approximately 88,900 people to the west of Heathrow and 586,300 to the east of Heathrow.
- Areas to the north and south of the zones (excluding the areas between the zones) experienced a degree of respite during the trial. The approximate population in these areas to the west of Heathrow was 135,600, while to the east of Heathrow this figure was 1,076,000.
- Overall areas between the zones where overflown more during the trial. This resulted in approximately 92,500 of the population to the west of Heathrow receiving an increase in over-flights during the trial. To the east of Heathrow this figure was 505,400.

The success of the trial cannot be judged by comparing the population receiving respite verses those experiencing an increase in over-flights. However, to illustrate the overall impact of the trial, for every 1,000 people under the zones receiving a significant amount of respite during the trial:

- A further 1,840 people experienced a degree of predictable respite to the east of Heathrow, but approximately 860 people received an increase in over-flights in the areas between the zones.
- To the west of Heathrow, this figure was 1,520 for people experiencing a degree of predictable respite, and 1,040 for those receiving an increase in over-flights in the areas between the zones.

8 Community response

Feedback from the various stakeholders involved in the trial was as follows.

8.1 British Airways

No issues were raised by British Airways pilots during the trial. The instructions received by pilots during the trial would not have been any different to those in normal operations or changed activities on the flight deck.

One area of interest for British Airways was whether the track miles flown and fuel burnt by arriving aircraft had changed during the trial.

8.2 HACAN and local communities

Feedback from HACAN on the trial was as follows:

- A majority of residents agreed that the trials were an important initiative.
- Many people who lived inside the boxes or close to them welcomed the respite which the trials provided.
- A number of residents did not notice much difference – possibly because, at some distance from the airport, they are less aware of night flights than day flights.
- There were areas where many people complained about an increase in flight numbers. This was largely because, in order to avoid both boxes, more flights flew over their homes. This was an unforeseen consequence of the trial and would need to be rectified in any future trial.

8.3 NATS

NATS were satisfied with the way the trial had run. NATS controllers regularly route aircraft around restricted airspace such as military training areas, therefore the operation of the exclusion zones was not a new concept. However, due to safety critical situations such as in-flight medical emergencies, it is not possible to operate such zones in a way that ensures all arriving aircraft avoid them.

8.4 Heathrow Airport Community Relations Team

8.4.1 Engagement with residents

This section summarises Heathrow's stakeholder engagement during the Early Morning Arrivals Trial. It also considers the community reaction to it.

It was agreed with the organisations involved that there would be no advance notification to residents about the trial. This was so that data could be collected in the first few weeks of the trial that could then be used to communicate about how the trial was working in practice.

Communication to residents/stakeholders included:

- Website: Information was placed on the Heathrow Noise Website about the trial from 4th December 2012. This included maps showing how the 'exclusion zones' had been used in the first few weeks of the trial.

- Media: A press release was issued to national and local media on 4th December 2012. This was picked up by various media outlets including the BBC and Evening Standard.

8.4.2 Community Forums

Local Focus Forum

On 20th November 2012 Heathrow's Community Relations Team briefed the Local Focus Forum on the details of the trial and invited them to give their views.

Heathrow Airport Consultative Committee

On 23rd January 2013 a presentation was made to the Heathrow Airport Consultative Committee which includes representatives from local authorities, residents groups, Government and industry bodies.

8.4.3 Resident meetings

During the trial, a number of meetings were organised which residents were invited to attend. Newspaper advertisements were placed in the south London press to advertise the meeting on 8th March 2013 since there had been a high level of interest in the trial from this area.

4th December 2012 – joint meeting with HACAN/Heathrow in Aldgate East to brief residents on the EMAT trial and its intended effects. This meeting was well attended and positive with good feedback from residents on the plans.

11th December 2012 – joint meeting with HACAN/Heathrow/NATS in Stockwell. This was also met with positive reaction, although many residents wished to voice concerns about arrivals traffic outside the trial area.

27th January 2013 – joint meeting with HACAN/Heathrow/NATS held at the Royal Docks area of East London.

8th March 2013 – joint meeting with HACAN/Heathrow where the effects of the trial were discussed with residents. This meeting was organised specifically in response to complaints from the Brockley area who had perceived more intense air traffic over certain areas of South East London. Residents argued that the trial should end and that the operation should return to how it was prior to EMAT.

8.4.4 Feedback from residents

Relative to other areas that the Heathrow Community Relations team receive comments on, there were very few complaints from residents and little awareness of the trial. Heathrow received some positive comments from residents regarding the plans, and is working collaboratively with HACAN to improve residents' experiences of the noise around the airport.

A number of residents from Brockley contacted the Community Relations team following the introduction of the trial. A small number of residents in this area said that they were aware of increased traffic although initially they were unaware there was a trial being run. Through the 'Brockley Central' blogging website, some Brockley residents formed a campaign to end the trial to prevent what they believed to be increased traffic overhead. These residents also involved their local councillor and London Assembly Member Darren Johnson AM who took significant interest in the trial and its effects on residents.

Following this contact with residents, Heathrow and HACAN organised a meeting with residents at the Compass Centre to discuss the trial in detail with operational staff at Heathrow. This meeting was productive and residents asked for assurances that their feedback would be taken into account during the reporting of the results of the trial. It was also agreed that a residents meeting would be held in the New Cross area and this meeting was held on the 8th March.

In addition to the complaints and queries, Heathrow received a small number of positive comments regarding the trial as residents noticed quieter areas in the early morning.

9 Track distance and fuel burn

9.1 Background

One area of interest for British Airways was whether the track miles flown and fuel burnt by arriving aircraft had changed during the trial. The analysis to assess this is summarised below.

9.2 Methodology

Heathrow's Flight Performance Unit extracted track data from ANOMS that gave the position of aircraft (latitude, longitude and height) at four second intervals. Plots were provided from when aircraft entered the area covered by ANOMS (approximately 30nm to the north/south of Heathrow, 28nm to the west and 40nm to the east) to the last track record before landing. Using this data, the following calculations were made:

- Additional track distance flown: The linear distances between consecutive four second intervals, accounting for both change in position and height, were calculated to provide the track distance flown by each aircraft. This allowed the average track distance flown when different zones pairs operated to be calculated and compared to the average track distance during the baseline.
- Additional fuel burn: The average additional flying time when different zone pairs operated was also calculated and approximated to fuel burn, fuel cost and CO_2 emissions. Additional fuel burn was calculated by multiplying the average additional flying time by an average fuel burn per second based upon the different the proportions of aircraft types involved in the trial[14]. Fuel costs were calculated using average aviation fuel prices during the trial and CO_2 derived using a standard jet fuel to CO_2 conversion factor.

9.3 Additional track distance flown

On average, based upon a predefined area, each arriving aircraft flew an additional 4.2nm during the trial. This figure is dominated by additional track miles when the inner zones to the west of the airport were active.

Table 9 shows average track distances flown during the trial and baseline (left hand columns), and additional track distance flown during the trial (right hand columns). For each zone pair, aircraft flew additional track miles; this reflects aircraft joining the approach path further from touchdown. However, compared to the total distances flown by the arriving aircraft involved in the trial[15] these increases are comparatively small. The notable increase in additional track miles for the inner zones to the west of Heathrow is explained by the large proportion of arriving aircraft predominantly coming from the east having to join the approach

[14] 99% of arriving aircraft during the trial were B777, B747, A380, A340, B767 or A320 family aircraft (the remaining 1% of aircraft types were approximated to the last three aircraft types). For each aircraft type the average fuel burn per minute for the aircraft descending between 12,000 feet (the average height of the first track record) and touchdown was approximated using version 3.9 of the Eurocontrol online BADA (Base of Aircraft Data) calculation tool.

[15] Over 45% of arriving aircraft involved in the trial originated from Hong Kong or Singapore.

paths further from touchdown when these zones operated compared to the baseline.

	Average track distance flown per aircraft (nm)			Additional track distance flown during the trial (nm)	
	Baseline	Inner	Outer	Inner	Outer
Zones to the west of Heathrow	65.1	73.0	66.0	7.8	0.8
Zones to the east of Heathrow	46.3	49.1	47.8	2.8	1.5

Table 9: Additional track distance flown during the trial (based upon a predefined area)

9.4 Additional fuel burn

On average, each arriving aircraft is estimated to have burnt approximately 51kg/£33 of additional fuel during the trial.

It is estimated that the trial resulted in arriving aircraft emitting an additional 264 metric tonnes of CO_2.

Table 10 shows additional fuel burn and CO_2 emissions per aircraft during the trial (left-hand columns) and for the trial as a whole (right-hand columns). Overall these increases were comparatively small.

		Average per aircraft			All aircraft		
		Fuel (kg)	Fuel cost (£)	CO_2 (kg)	Fuel (metric tonnes)	Fuel cost (£k)	CO_2 (metric tonnes)
Zones to the west of Heathrow	Inner	129kg	£83	406kg	51.7t	£33.2k	163.0t
	Outer	18kg	£12	58kg	8.0t	£5.1k	25.1t
Zones to the east of Heathrow	Inner	27kg	£18	86kg	20.3t	£13.0k	63.8t
	Outer	6kg	£4	19kg	3.8t	£2.5k	12.1t
	Trial	51kg	£33	162kg	83.8t	£53.8k	264.0t

Table 10: Additional fuel burn and CO_2 emissions during the trial

9.5 Summary

Based upon a predefined area, track distances flown by arriving aircraft increased as a result of the trial. This is attributed to aircraft joining the approach paths further from touchdown during the trial. However, compared to the overall distances flown by arriving aircraft during the trial these increases were comparatively small, as were the corresponding increases in fuel burn and CO_2 emissions.

10 Operations outside of the trial

10.1 Background

This section investigates whether the trial had an influence on the tracks flown by arriving aircraft outside of the trial. Two periods have been investigated:

- After the trial finished each night (0600-0659)
- After the trial was completed (post 31st March 2013)

10.2 After the trial finished each night (0600-0659)

Traffic appears to have returned to normal after the zones were deactivated at 0600 local.

Figure 53 shows the tracks of arriving aircraft in the first hour after the trial had been completed each night for a seven day period (although the zones would have been removed from controllers screens in this hour, they have been retained on the images as a point of reference). The left hand images show aircraft landing on runways 09L and 09R, and the right hand images are for runways 27L and 27R. From top to bottom the images are:

- Baseline (0600-0659 local time).
- Trial – inner zones only (0600-0659 local time).
- Trial – outer zones only (0600-0659 local time).

An analysis to determine if the proportions of aircraft on the approach paths at different distances from touchdown had changed during the 0600-0659 hour was also undertaken. This is shown in Figure 54 for runways 27L and 27R (top graph) and runways 09L and 09R (bottom graph). The profiles for the baseline and trial are almost identical, showing that traffic appears to have returned to normal after the zones were deactivated at 0600 local (this is in contrast to the same graphs presented in sections 0 and 0 which show that overall aircraft joined the approach paths earlier during the trial).

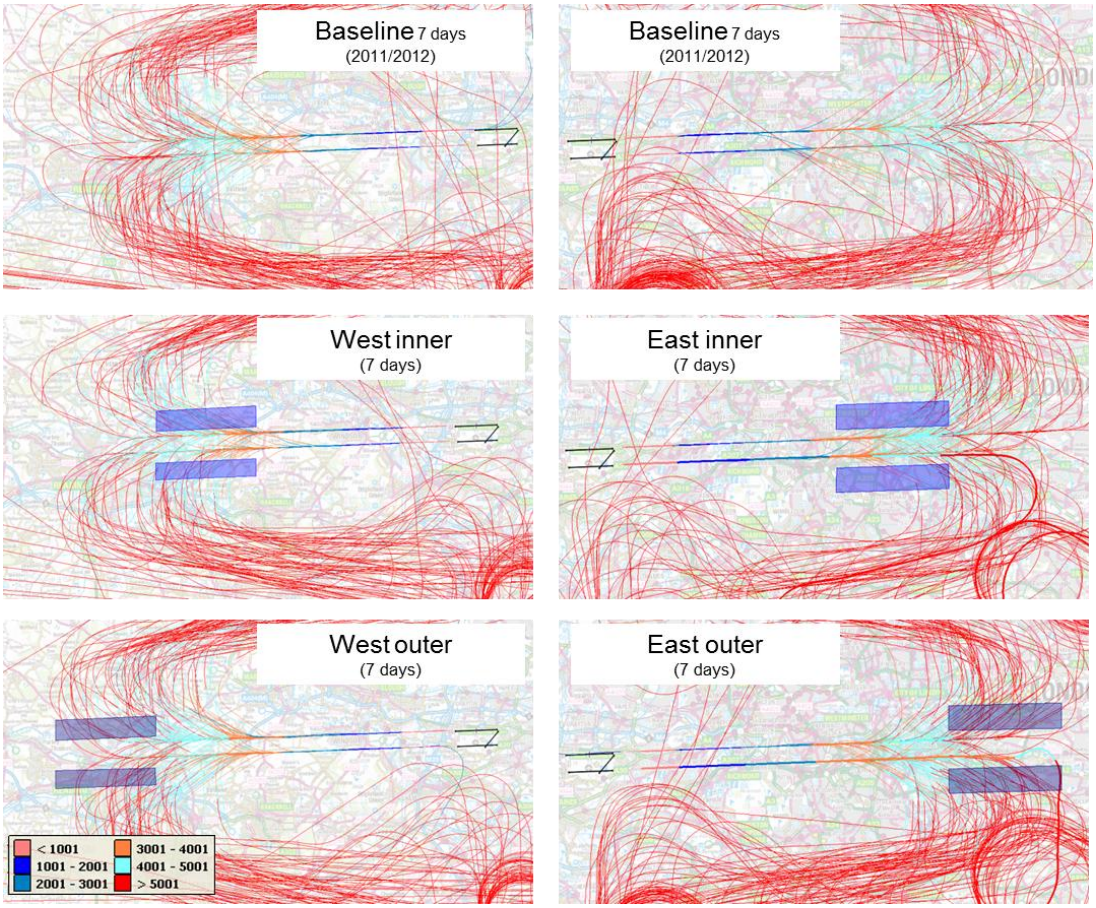


Figure 53: Tracks of arriving aircraft after the zones had been deactivated each night (0600-0659 local time) – 7 day sample

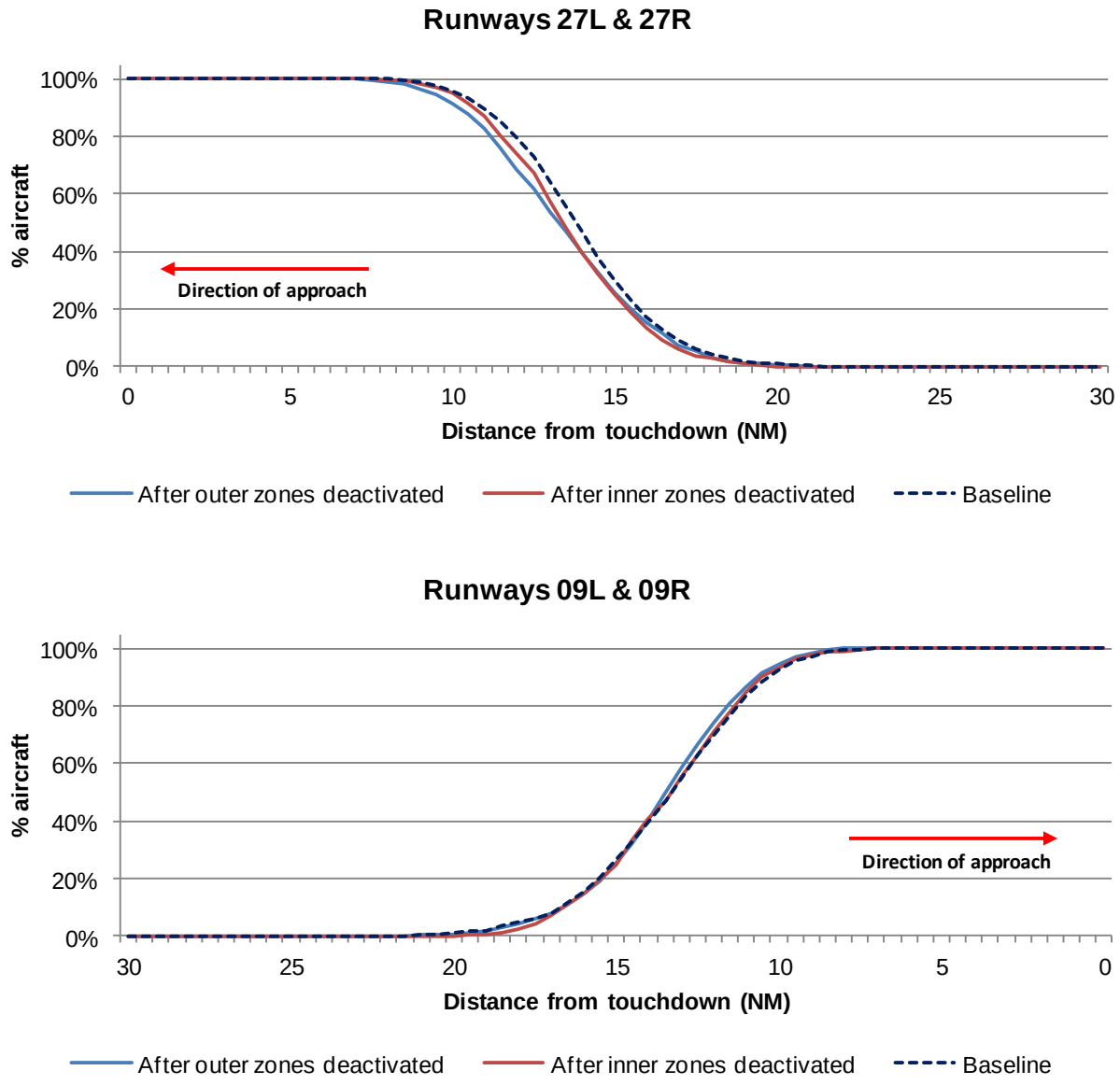


Figure 54: Proportions of aircraft on the approach paths aircraft after the zones had been deactivated each night (0600-0659 local time)

10.3 After the trial was completed (post 31st March 2013)

Traffic appears to have returned to normal after the trial was completed.

Figure 55 shows the tracks of arriving aircraft after the trial was completed. Although the exclusion zones would not have been visible on the controllers screens during this period they have been retained on the images as a point of reference. The top image shows aircraft landing on runways 27L and 27R, and the bottom image is for runways 09L and 09R.

The images give no indication that the zones were being avoided after the trial was completed on the 31st March 2013. This indicates that traffic returned to normal after the trial was completed.

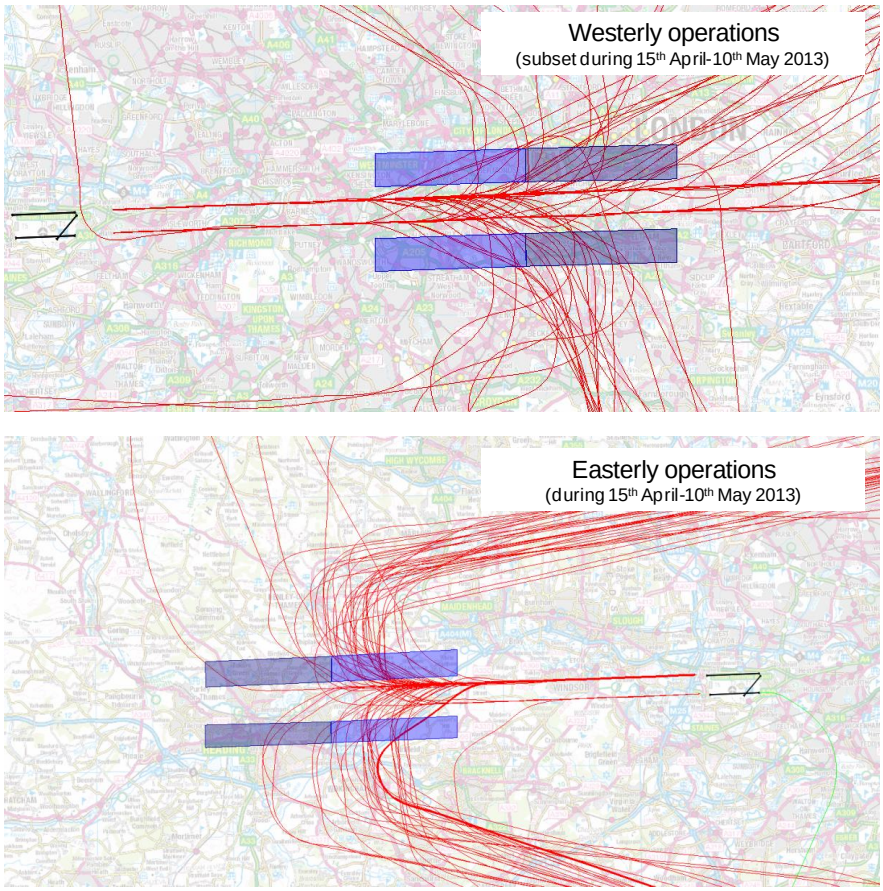


Figure 55: Tracks of arriving aircraft after the trial was completed (2330-0600 local)

10.4 Summary

There is no indication that the exclusion zones were being avoided outside of the trial:

- Traffic patterns appear to have returned to normal after the completion of the trial each night.
- After the completion of the trial on the 31st March there is no indication of any longer term change in traffic patterns as a result of the trial.

11 Lessons learnt

11.1 Overview

The trial was undertaken in response to a desire from the community for greater predictable respite. It provided an opportunity to establish predictable respite and to test the ability of ATC and the airlines to operate in order to deliver the desired results. By design the trial involved redistributing aircraft flight paths and therefore had the potential to impact communities not currently troubled by arriving aircraft during the night-time, or by increasing the concentration to current recipients. In all of these areas there have been lessons learnt that could inform the design and operation of future trials. This section elaborates upon some of these points.

11.2 Operation of the zones

The trial was operated successfully by NATS. There were a few occasions when the trial zones were incorrectly activated, but these were minimal and we would envisage that with greater experience such occurrences would be rare. NATS were effective at ensuring aircraft avoided the zones, accepting that some emergencies were, rightly, vectored through the zones. This provides confidence in the practicality of no-fly zones as a means of delivering respite.

During the trial there were periods within which calibration flights were operated. In future trials if such flights are anticipated it would be preferable if they were scheduled so as to avoid active zones, or if the schedule for the zones could be amended in order to accommodate the flights. This would help ensure that the communities who were planned to benefit from respite received it.

11.3 Predictable respite

The trial was designed to provide communities near the approach paths with predictable respite. From the meetings held with representatives of HACAN and the local communities this remains a desirable objective. However, it was clear that there are a range of views as to what constitutes predictable respite. In some cases it relates to the contiguous periods in the night without flights, in some cases the number of flights in a given time interval. Having a clearer definition of what constitutes respite would be advantageous in the context of future trial design, accepting that this may be a challenging objective.

During the discussions of respite with the communities it was also noted that whilst predictable respite is a good objective if the corollary is that there is greater over-flight in the periods when respite is not being provided then this is most likely unacceptable. There is therefore a need for on-going dialogue in the context of future trials to understand not only the impact of respite periods but also to understand the impact on the same communities outside of the respite periods.

11.4 Redistribution of aircraft tracks

Whilst the design of the trial achieved its objectives within the trial zones there was a detrimental impact to some communities outside of the zones, notably those along the final approach path between the zones who received a net increase in over-flights. With regard to future trial planning it is recommended that there is work undertaken to identify the foreseeable impacts both for the immediate areas planned to receive respite as well as those surrounding them. Such work could involve a relatively short workshop between Heathrow and NATS to identify the likely controller behaviours for any particular concept of operation so that

Heathrow can then assess in a semi-quantitative fashion the impact in terms of redistribution of flights. We acknowledge however that even with such formal assessments there is always still the possibility of unexpected impacts when a trial goes into operation. It may therefore be advisable to implement a process through which the trial can be halted before its foreseen end in the event that a particular community is clearly suffering from excessive noise due to unforeseen events.

11.5 Planned community involvement

The trials were developed as a response by Heathrow to requests from the local communities via HACAN. Feedback from the communities is therefore of key importance to the assessment of success or failure of a given trial. The involvement of HACAN to provide this representation and link was therefore a strongly positive development that should be a prerequisite for future trials.

Despite efforts made there was only a limited specific response to the current trial and where there was strongest feedback it was from communities who were negatively affected. There was no feedback from communities to the west of the airport. A specific element of future trial planning should be to identify at an early point those communities targeted for predictable respite (or possibly to experience a change as a result) and to seek to elicit opinion from those locations directly (for all areas targeted). This will lead to a more systematic and rigorous approach to assessing the benefits and impacts of the trial.

11.6 Communication of trials

There were some positive lessons learnt from the communication activities undertaken during the trial. Members of local communities who had complained about the impact of the trial visited Heathrow and held useful discussions that helped inform of the objective of the trial and of how it worked practically, provided them with the opportunity to feed back on the experience from their perspective and engaged them in helping define particular activities within future trials to mitigate negative consequences. Similarly, HACANs involvement throughout the trial helped ensure that it was a community led initiative, provided insight so that Heathrow could learn from the experience and also provided useful feedback to help assess the overall performance of the trial.

The trial was communicated to the public once it had commenced in order to see if communities observed a difference in respite without pre-empting comments. This is a valid approach to be applied from the perspective of endeavouring to make the assessment of the trial reasonably objective. However, this must be weighed against the benefits of informing people of what they should expect in advance and making them aware of the ways and means of providing feedback so that additional responses can be obtained. We have no strong opinion on this matter, only that it should be considered again at the start of any future trial.

There was feedback during the communities' session at Heathrow that the fact that the trial was on-going and its objectives and operation were not effectively communicated even once it was public knowledge. There needs to be additional consideration of how information is disseminated. Some participants suggested their first port of call would be local council websites and that they obtain information from local council and community newsletters and blogs. Consideration should be given to publicising future trials through such media recognising that this may entail engagement with a diaspora of organisations. In addition the content of future communication also needs to be considered so that

those individuals who have sought out information are provided with a clear description of its aims, objectives and how it will work in practice.

12 Conclusions and recommendations

12.1 The early morning arrival trial

An early morning arrival trial was conducted by Heathrow airport between November 2012 and March 2013 in order to examine the feasibility of providing predictable respite. The trial was developed together with HACAN following community feedback on the value of predictable respite. A number of trial zones were designed to be free of aircraft movements and were activated on a schedule system thereby providing respite within the active zones. The zones were active each day between 2330 at night and 0600 in the morning. A further objective of the trial was to establish its operational feasibility and to understand any issues that may have arisen to inform future trial design.

From an operational perspective the zones were operated successfully throughout the trial. The zones were operated for 94% of the planned trial nights with a small number of suspensions due to e.g. low visibility procedures being in operation. There were three nights during the trial when the zones were activated incorrectly or not at all resulting in a loss of respite. However, it is expected with more robust procedures such instances could be minimised in any future trial. Analysis of flight data from outside of the trial period both from 0600 onwards each day and after the end of the trial showed that flights returned to their normal flight paths.

Aircraft involved in the trial typically incurred a small number of additional track miles (4.2nm on average). These figures were dominated by additional track miles flown when the inner zone to the west of the airport was active. This is due to a preponderance of aircraft arriving from the east of Heathrow in the early morning. When operating on runways 09L and 09R such aircraft are generally turned onto the final approach around the area in which the inner zone has been established. Hence, when the inner zones operated during the trial aircraft had to fly a longer down-wind leg before being turned onto the final approach. When operating on runways 27L and 27R the additional track miles incurred were between 1.5 and 2.8nm. Overall the additional distance led to an average additional fuel cost of £33 per arrival and across the trial as a whole led to an additional 264 metric tonnes of CO_2 being emitted.

When the zones were operational the vast majority of arrivals (96%) were successfully vectored to avoid them. Some flights did pass through the active zones but these were predominantly medical emergencies (allowed to pass through) or else they simply ‘clipped’ the zone during a turn. The majority of nights (71%) saw no zone infringements. When an infringement did occur it was typically a single flight through the entire night period.

From a respite perspective good periods of predictable respite were provided to households within the active zones as well as in an area to the north of the northern zones and south of the southern zones (due to the nature of the traffic patterns and vectoring of aircraft). During the feedback sessions with HACAN and the local communities positive feedback on the impact of the trial was obtained from people living within these areas.

However, the trial also had other impacts arising from the flight paths of aircraft being vectored around the zones. The trial resulted in a number of aircraft joining the approach path further from touchdown (particularly discernible when the zones to the east of the airport were active). This resulted in communities between the zones on the extended centreline experiencing a significant increase in over-flights during the trial. Not only were there more flights, but they were also more laterally

concentrated onto the centreline. This resulted in a significant negative impact to these communities.

Therefore, whilst the trial was successful in demonstrating the practicality of the concept of providing predictable respite the fact that some communities experienced a significant dis-benefit means that it overall it did not achieve its objectives and will not be taken forward in its current form. The trial is therefore complete.

12.2 Future trials

The current trial is complete and will not be continued in its current form. It did however provide some useful lessons that have been learned that could inform the objectives and design of any future trial.

The trial showed the clear merits of working with HACAN and the local communities particularly with regard to the design and location of respite zones and in obtaining timely and representative feedback from those positively and negatively impacted. There is further work needed with these communities to define the form of predictable respite in the context of future trials.

During the design of future trials there is a greater need to undertake assessments (including as necessary modelling) to predict the likely outcomes before they take place. This is particularly important in the context of the distribution of aircraft tracks to communities outside trial zones and where there may be a net negative impact (e.g. as a result of increased traffic in times outside of the respite periods) to any communities within the trial zones. We acknowledge however that even with such formal assessments there is always still the possibility of unexpected impacts when a trial goes into operation. It may therefore be advisable to implement a process through which the trial can be halted before its foreseen end in the event that a particular community is clearly suffering from excessive noise due to unforeseen events.

The communication with affected communities should be considered in the context of future trials. This should consider the pros and cons of notifying the trial before it commences as well as the optimum channels through which to convey information about the trial and through which to solicit feedback.

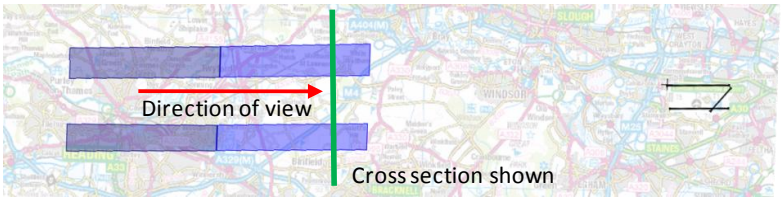
Appendix A Nightly Operation of the Zones

Date	Operation		Date	Operation		Date	Operation
05/11/2012	Eastern Inner		24/12/2012	Eastern Outer		11/02/2013	Western Inner
06/11/2012	Eastern Inner		25/12/2012	Eastern Outer		12/02/2013	Western Inner
07/11/2012	Eastern Inner		26/12/2012	Eastern Outer		13/02/2013	Western Inner
08/11/2012	Eastern Inner		27/12/2012	Eastern Outer		14/02/2013	Eastern Inner
09/11/2012	Eastern Inner		28/12/2012	Eastern Outer		15/02/2013	Eastern Inner
10/11/2012	Eastern Inner		29/12/2012	Eastern Outer		16/02/2013	Western Inner
11/11/2012	Western Inner		30/12/2012	Eastern Outer		17/02/2013	Western Inner
12/11/2012	Eastern Outer		31/12/2012	Eastern Inner		18/02/2013	LVP
13/11/2012	Eastern Outer		01/01/2013	Eastern Inner		19/02/2013	Western Outer
14/11/2012	LVP		02/01/2013	Eastern Inner		20/02/2013	Western Outer
15/11/2012	Western Outer		03/01/2013	Eastern Inner		21/02/2013	Western Outer
16/11/2012	Western Outer		04/01/2013	Eastern Inner		22/02/2013	Western Outer
17/11/2012	Eastern Outer		05/01/2013	Eastern Inner		23/02/2013	Western Outer
18/11/2012	Eastern Outer		06/01/2013	Eastern Inner		24/02/2013	Eastern Outer
19/11/2012	Eastern Inner		07/01/2013	Eastern Outer		25/02/2013	Western Inner
20/11/2012	Western Inner		08/01/2013	Eastern Outer		26/02/2013	Western Inner
21/11/2012	Eastern Inner		09/01/2013	Eastern Outer		27/02/2013	Western Inner
22/11/2012	Eastern Inner		10/01/2013	Eastern Outer		28/02/2013	Western Inner
23/11/2012	Western Inner		11/01/2013	Western Outer		01/03/2013	Western Inner
24/11/2012	Eastern Inner		12/01/2013	Western Outer		02/03/2013	Western Inner
25/11/2012	Western Inner		13/01/2013	Eastern Outer		03/03/2013	Western Inner
26/11/2012	Eastern Outer		14/01/2013	Eastern Inner		04/03/2013	Western Outer
27/11/2012	Eastern Outer		15/01/2013	LVP		05/03/2013	Western Outer
28/11/2012	Eastern Outer		16/01/2013	Western Inner		06/03/2013	Western Outer
29/11/2012	Eastern Outer		17/01/2013	LVP		07/03/2013	Western Outer
30/11/2012	Eastern Outer		18/01/2013	LVP		08/03/2013	Eastern Outer
01/12/2012	Eastern Outer		19/01/2013	LVP		09/03/2013	Western Outer
02/12/2012	Eastern Outer		20/01/2013	LVP		10/03/2013	Western Outer
03/12/2012	Eastern Inner		21/01/2013	Eastern Outer		11/03/2013	Western Inner
04/12/2012	Eastern Inner		22/01/2013	Western Outer		12/03/2013	Eastern Inner
05/12/2012	Eastern Inner		23/01/2013	Western Outer		13/03/2013	Eastern Inner

06/12/2012	Eastern Inner		24/01/2013	Western Outer		14/03/2013	Eastern Inner
07/12/2012	Eastern Inner		25/01/2013	Eastern Outer		15/03/2013	Eastern Inner
08/12/2012	Eastern Inner		26/01/2013	Eastern Outer		16/03/2013	Eastern Inner
09/12/2012	Eastern Inner		27/01/2013	Eastern Outer		17/03/2013	Eastern Inner
10/12/2012	Eastern Outer		28/01/2013	Eastern Inner		18/03/2013	Western Outer
11/12/2012	LVP		29/01/2013	Eastern Inner		19/03/2013	Eastern Outer
12/12/2012	Eastern Outer		30/01/2013	Eastern Inner		20/03/2013	Western Outer
13/12/2012	Western Outer		31/01/2013	Eastern Inner		21/03/2013	Western Outer
14/12/2012	Eastern Outer		01/02/2013	Eastern Inner		22/03/2013	Western Outer
15/12/2012	Eastern Outer		02/02/2013	Eastern Inner		23/03/2013	Western Outer
16/12/2012	Eastern Outer		03/02/2013	Eastern Inner		24/03/2013	Western Outer
17/12/2012	Eastern Inner		04/02/2013	Eastern Outer		25/03/2013	Western Inner
18/12/2012	Western Inner		05/02/2013	Eastern Outer		26/03/2013	Western Inner
19/12/2012	Western Inner		06/02/2013	Eastern Outer		27/03/2013	Western Inner
20/12/2012	Eastern Inner		07/02/2013	Eastern Outer		28/03/2013	Western Inner
21/12/2012	Western Inner		08/02/2013	Eastern Outer		29/03/2013	Western Inner
22/12/2012	Eastern Inner		09/02/2013	Eastern Outer		30/03/2013	Western Inner
23/12/2012	Eastern Inner		10/02/2013	LVP			

Appendix B Lateral concentration of flights between the exclusion zones

Runways 09L and 09R – 11nm from touchdown



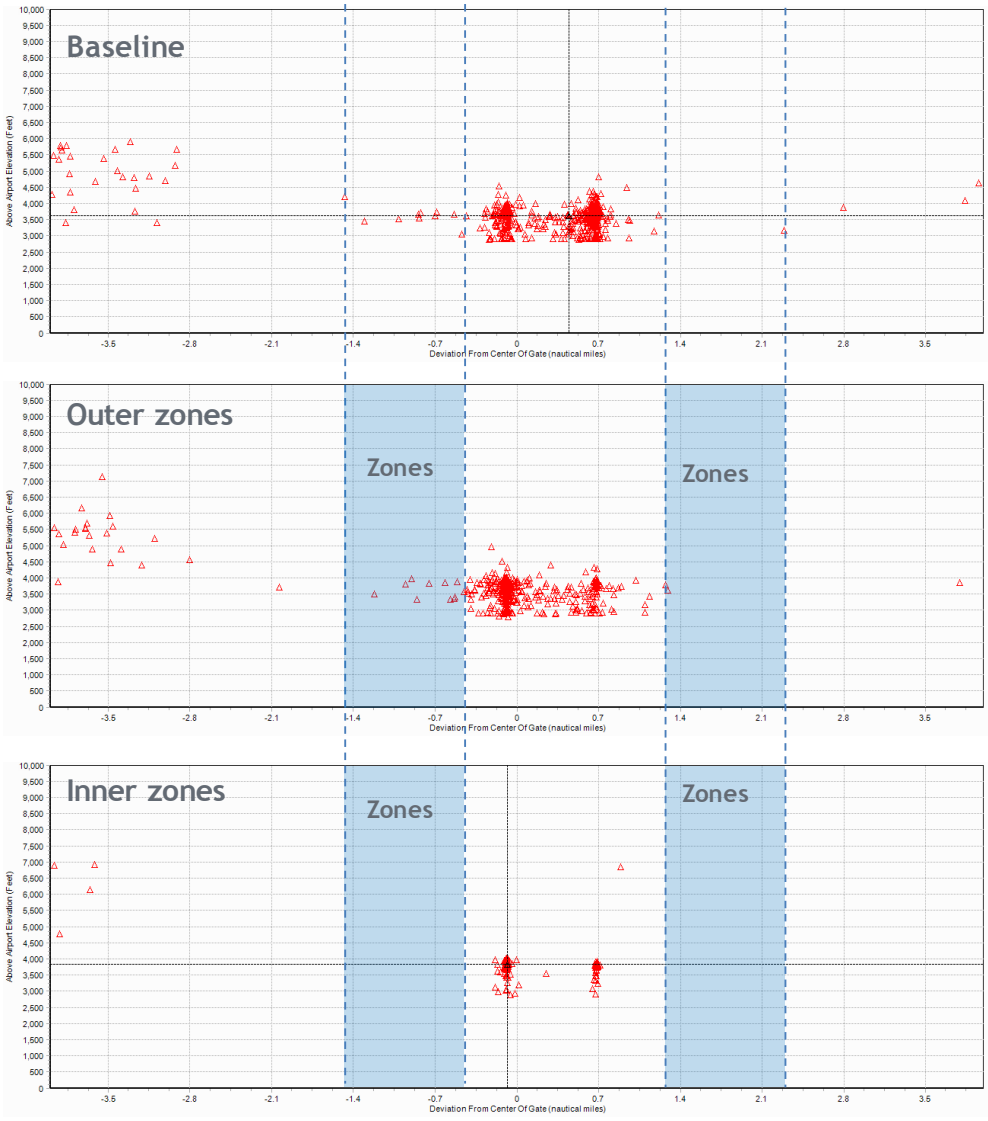


Figure 56: Lateral concentrations of arriving aircraft at 11nm from touchdown (runways 09L and 09R)

Runways 09L and 09R – 19nm from touchdown

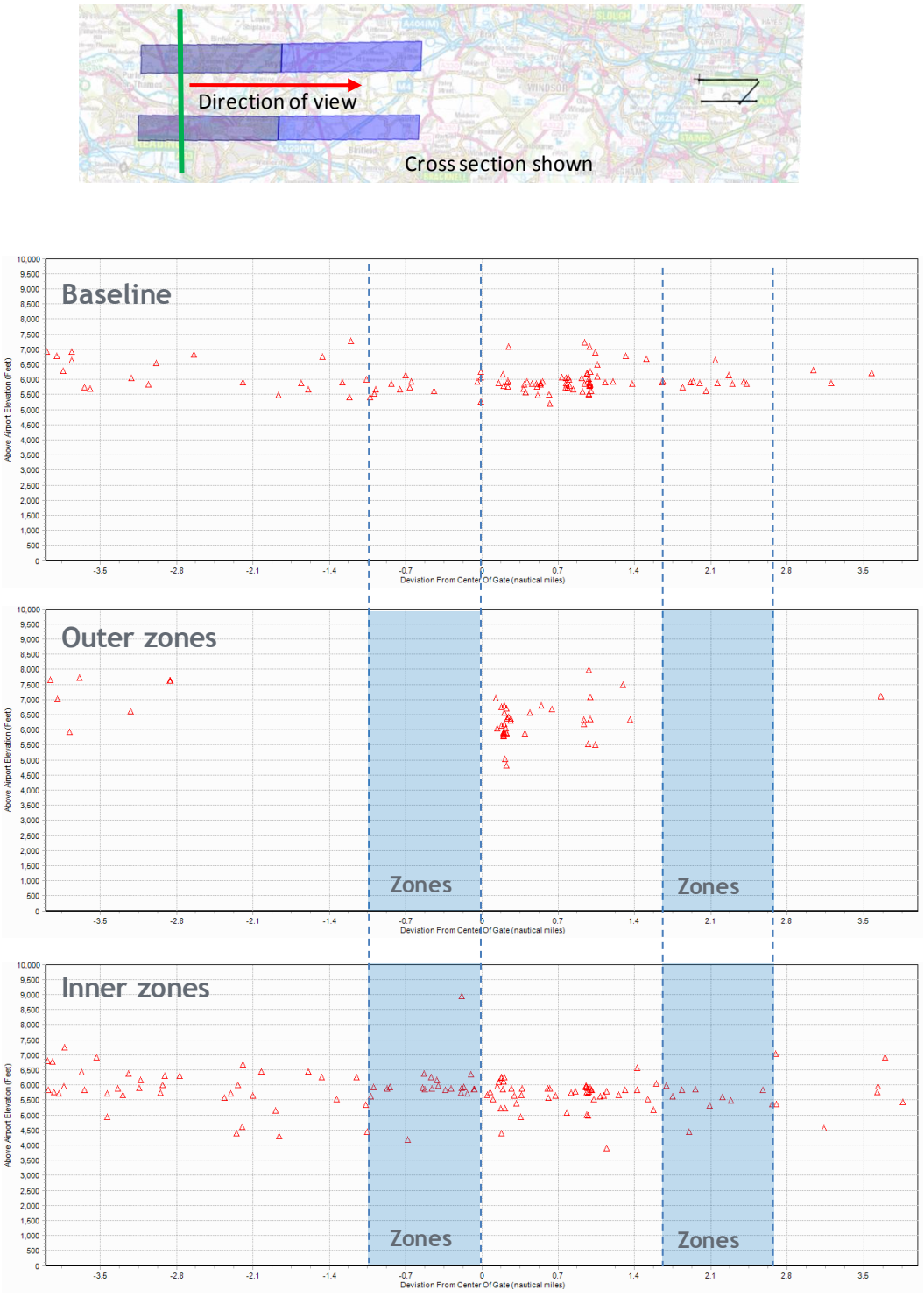
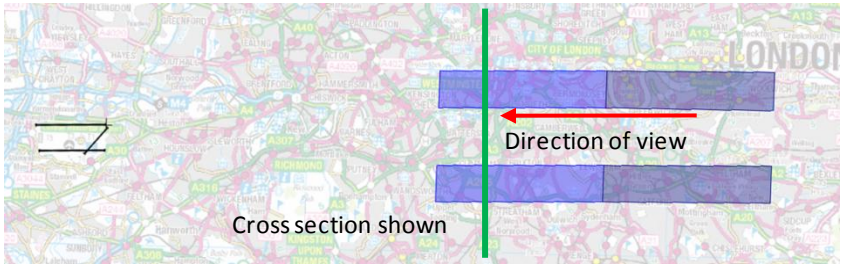


Figure 57: Lateral concentrations of arriving aircraft at 19nm from touchdown (runways 09L and 09R)

Runways 27L and 27R – 11nm from touchdown



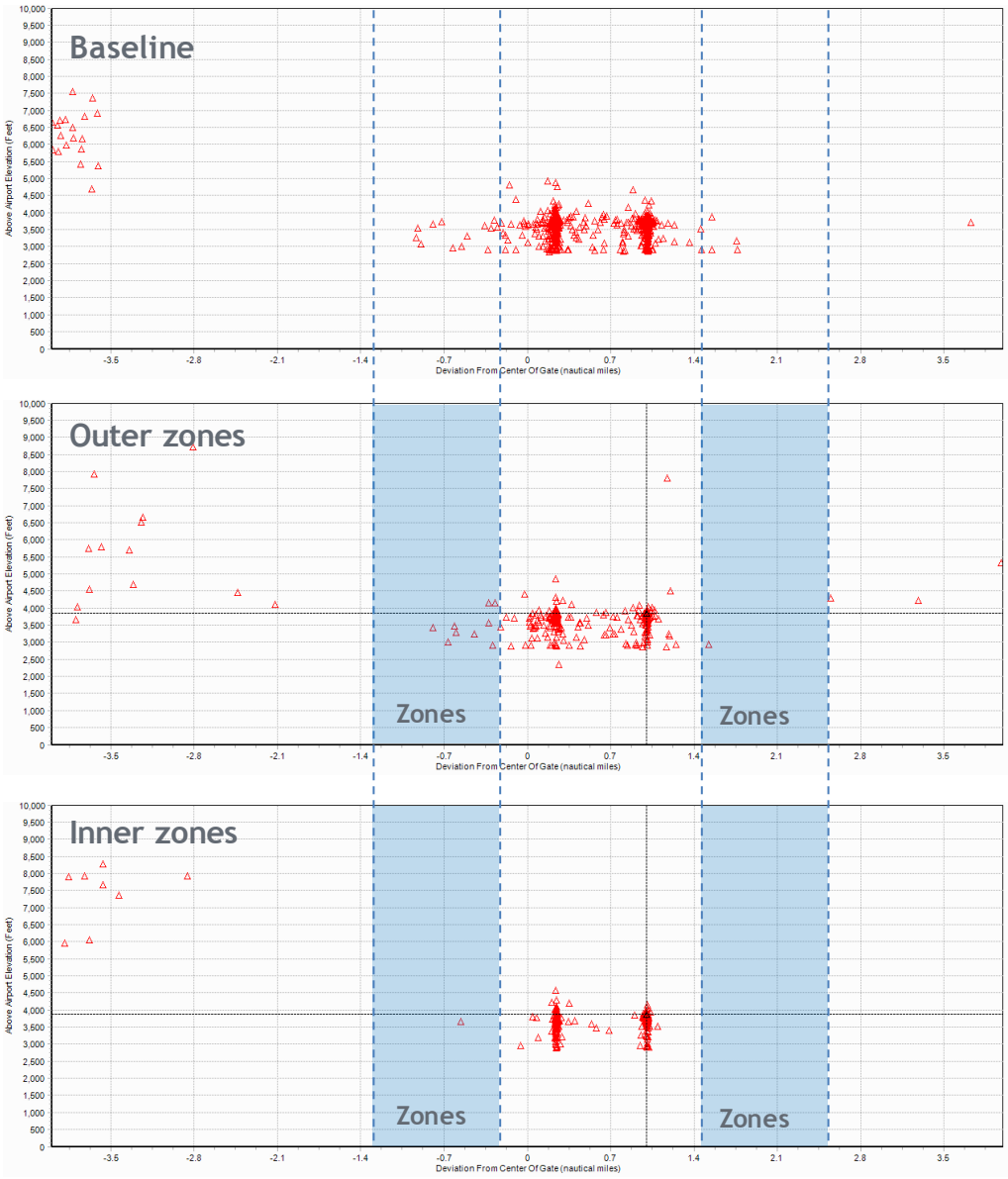


Figure 58: Lateral concentrations of arriving aircraft at 11nm from touchdown (runways 27L and 27R)

Runways 27L and 27R – 19nm from touchdown

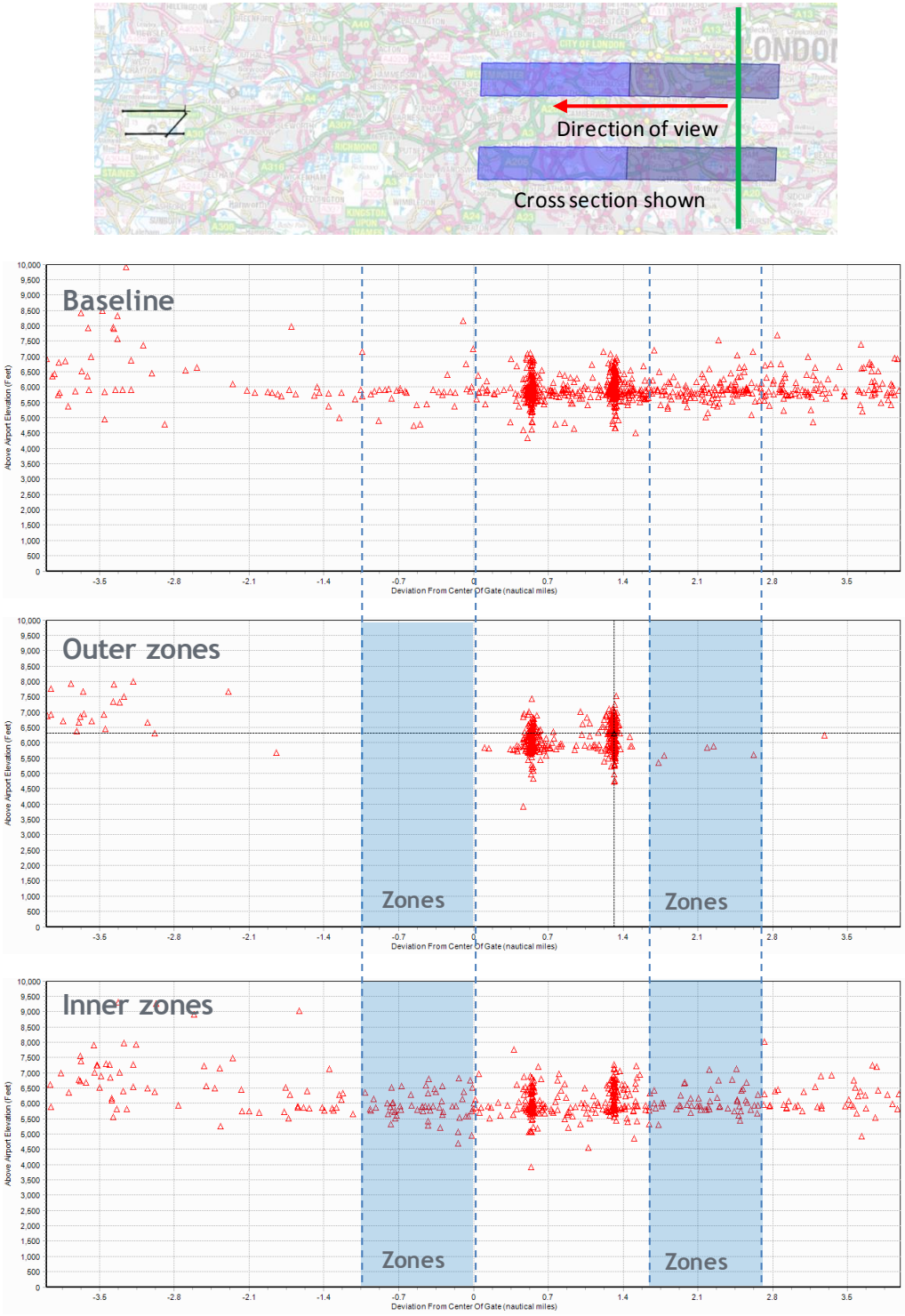


Figure 59: Lateral concentrations of arriving aircraft at 19nm from touchdown (runways 27L and 27R)

Glossary

ANOMS	Airport Noise and Operations Management System
CDA	Continuous Descent Approach
Easterly	Aircraft land or take off towards the east
HACAN	Heathrow Association for the Control of Aircraft Noise
ILS	Instrument Landing System
Lates and Lows	During the daytime the aircraft are required to be "established" on the ILS at 7.5nm from touchdown. This equates to approximately 2500ft. At night the distance is extended to 10nm which equates to approximately 3000ft.
LVP	Low Visibility Procedures when the trial was suspended
NATS	UK air traffic control organisation
nm	Nautical Miles
Westerly	Aircraft land or take off towards the west