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INTERNATIONAL ORIENTEERING FEDERATION

THE EFFECT OF AN ORIENTEERING EVENT ON BREEDING WHEATEAR *Oenanthe oenanthe* AT TITTERSTONE CLEE, SHROPSHIRE, UK

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SUMMARY:

An orienteering event with over 1000 competitors took place over the former upland mining area of Titterstone Clee in the West Midlands of the United Kingdom on 31 May 1999. The area supports a population of about 40 breeding pairs of migrant Wheatear *Oenanthe oenanthe,* which are monitored by local ornithologists.

The event had no observable effect of the breeding success of the nests within the competition area. However, four nests were abandoned in the derelict quarry used for the car parking and the competition facilities. This area had been selected for this purpose according to established successful practice, to minimise visual intrusion and ecological disturbance, but the propensity for Wheatear to nest in such man-made terrain was unknown to the event organisers. Measures have been put in place to prevent a recurrence.

Retrospective analysis of data from the orienteers and the ornithologists has quantified the levels of potentially disturbing orienteering activity near nests. It is concluded that breeding *O. oenanthe* are very tolerant of transient disturbance. Similar tolerance is expected for Stonechat *Saxicola torquata*, also present on Titterstone Clee.

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1. Introduction

The Wheatear *Oenanthe oenanthe* is a breeding summer visitor from equatorial Africa to the United Kingdom (Šťastny 1995). It is a typical bird of stony mountainsides and rocks but also found at lower altitudes in quarries and stony terrain with thin vegetation. Short turf, created by grazing animals or poor soils on steep rocky slopes is essential for feeding. Nests are made in piles of stones, rock crevices, rabbit burrows or even derelict machinery. These conditions are found on Titterstone Clee.

Titterstone Clee is a hill rising to modest height (533m) above the lowland area of the county of Shropshire in the West Midlands of the United Kingdom (Shropshire Geology, 2004). Its prominent form results from an intruded dolerite sill which caps its summit and protects the underlying limestone, ironstone and coal measures from erosion. All of these strata have been worked in the past and a large quarry extracting roadstone still operates. The hill is extensively marked with old workings, varying from exploratory scrapings, bell pits and shafts to large derelict quarries. These together form a complex terrain of interest to, amongst others, industrial archaeologists and orienteers.

The Wheatear is not a UK protected species listed under Schedule 1 of the Wild Life and Countryside Act 1981. However, it is a migrant well regarded by ornithologists for its attractive appearance, distinctive song and spectacular flight. There is particular interest in the important population of 40 or more breeding pairs on Titterstone Clee, which appears to be increasing, against a national trend of decline (Shropshire Ornithological Society 1992). The Society conducts annual detailed surveys to locate each nest and ring the young before they fledge. In 1999 a total of 46 breeding pairs were identified and their nests precisely located.

In that year an orienteering event took place on 31st May, at which time the eggs had hatched but the young were not fully fledged. The event was large, with 1173 competitors, part of a regional multi-day 'Springtime in Shropshire' series. Normal good practice was observed for its environmental conduct. No ecological constraints had been identified for the competition terrain and the competition centre (the car parking, general assembly and administrative area) was located in derelict quarries to reduce visual intrusion and, by previous experience, to avoid ecological impact on flora and fauna of merit. This last intention was, unbeknown to the orienteers at the time, to be thwarted. The organising club received a letter in December 1999 from the Shropshire Wildlife Trust stating that there had been a problem with the event (Tucker 1999). This had not arisen from the individual orienteers moving across the competition terrain but was due to tents associated with the event being located in an area of high density of nests and causing considerable disturbance to the parent birds trying to feed their young. In some cases tents had been placed directly over nests, causing them to fail.

This communication caused considerable concern among the orienteers and contact was made with the local ornithologist responsible for the Titterstone Clee Wheatear survey to obtain further information. He indicated that it was the concentration of Registration, Enquiries and Traders' activities that had caused four nests to be lost. This was unexpected by the orienteers because they had placed their tentage on the wide verges of the public road at the derelict quarries, these verges being commonly used for public parking. The ornithologist explained that the Wheatear favoured the old quarry workings and stone rubble directly bordering the verges and the closely adjacent continuous disturbance of the event facilities had prevented the parent birds from feeding their young. He further reported no failures of nests elsewhere although several were in locations close to orienteering activity.

Mutual arrangements were agreed between the Shropshire Wildlife Trust's ornithologists and the Harlequins Orienteering Club to safeguard the viability of the Wheatears at future events. The Club undertook, where possible, to hold their events on Titterstone Clee outside the nesting season for Wheatears. When this was not possible, every eight years or so, there would be full and constructive liaison with the Trust (Vickers 2000).

And there the matter rested, with an agreed solution acceptable to both sides and a good example of the benefits of conflict resolution. However, it was apparent that more could be learned from this ecological setback, that sufficient data could be recovered from the ornithologists on nest locations and from the orienteers on the characteristics of the event to allow a useful case study analysis with conclusions about levels of disturbance which would consolidate the administrative agreements for Titterstone Clee and be of value to those interested in populations of Wheatear elsewhere. There is also the possibility of tentative extension of the conclusions to other bird species.

2. Retrospective analysis

The potential disturbance and damage to breeding viability of bird populations by the sport of orienteering is a contentious issue in the United Kingdom. Despite some evidence that the dispersed and transient nature of orienteering (Goodall and Gregory 1991) does not damage a wide range of breeding bird species, many land managers apply closed seasons to the sport in the interests of protecting ground- and low-nesting species. Although the Goodall and Gregory conclusions applied to 54 species being undisturbed by an orienteering event, there is a reluctance by ecologists to extend the findings to other areas, on the grounds that there may be important increased sensitivity to disturbance arising from differences in habitat, weather, timing of the stages of the breeding cycle, inter-species competition, etc. Advised of such uncertainty, land managers are obliged to exercise the Precautionary Principle, which requires any potential conflict between recreation and conservation to be resolved in favour of the latter. The extent to which there is a conflict and the degree of resolution required are matters of subjective judgment. This can give rise to punitive exclusions, such as that in the Dartmoor National Park in south west England, where orienteering is not permitted between the end of February and the middle of July.

It might be thought that objective studies of the disturbance of breeding birds by sport and recreation would be a clear priority and usefully improve the current data scarcity. Orienteers internationally certainly hold this view (Parker and Viti 2005). Unfortunately, in the United Kingdom, the government agency for nature conservation, English Nature, thinks otherwise (Langslow 1995). It appears that English Nature, focussing on the long-term status of bird populations, has difficulty of correlation with ephemeral activities and is unwilling to support research whose results might encourage such activities taking place with restrictions being reduced or removed.

The result of the attitude of English Nature and other bodies who consider that exclusions under the Precautionary Principle are currently a satisfactory management tool is that the research programme into the disturbance of breeding birds by orienteering, of which the Goodall and Gregory (1991) study was the first, has been cancelled. In the long term this non-research approach is untenable. Ephemeral activities do take place and any objective study of their disturbance of breeding birds has value, notwithstanding any difficulties of correlation. Until such time that pre-planned research is back in favour, bird disturbance studies will remain subject to chance circumstances.

An opportunity has arisen for retrospective case study analysis of the ecological impact of the Titterstone Clee orienteering event on the population of breeding Wheatear *Oenanthe oenanthe.* The objective in this study is to quantify as far as possible the levels of disturbance which resulted in four nests failing and a number of others being unaffected. For this the protocol adopted by Goodall and Gregory (1991) at the Brandon Park, Suffolk, event for denoting activity levels within the bird territories is adopted and expanded.

The sources of information are the Shropshire Wildlife Trust for the location of Wheatear nests and the Harlequins Orienteering Club for the location of the control sites and the courses linking them in the competition terrain, the numbers and timings of competitors on the courses, and details of the competition centre facilities.

The questions to be asked concern, for disturbance in the competition terrain, the accuracy of location of the nest sites on the map and the accuracy of the competitors routes in the vicinity of the nests.

The conclusions will attempt to identify the maximum levels of disturbance of the birds which remained unaffected and the levels which resulted in the loss of four nests. The relevance to other bird populations will be considered.

3. Location of Wheatear nests

The Shropshire Wildlife Trust ornithologists had produced a map based on two adjacent Ordnance Survey 1:25000 maps covering the area, colour photocopied and enlarged by a factor of 1.4, giving a map of scale about 1:18000. A reduced size and modified copy is shown in Figure 1.

In Figure 1 the nest locations are indicated by the coloured discs. There are three clusters; the northern group near the top of the hill, the eastern group and the south western group in and around the working quarries. This south western working area is out of bounds to orienteers, but not to Wheatears, which suggests they have a high tolerance of disturbance. The cluster of four red discs in the group at the hill top are those nests lost during the orienteering event. The meaning of the red disk at the main road is unknown. The diameter of the discs is equivalent to 90m on the ground.

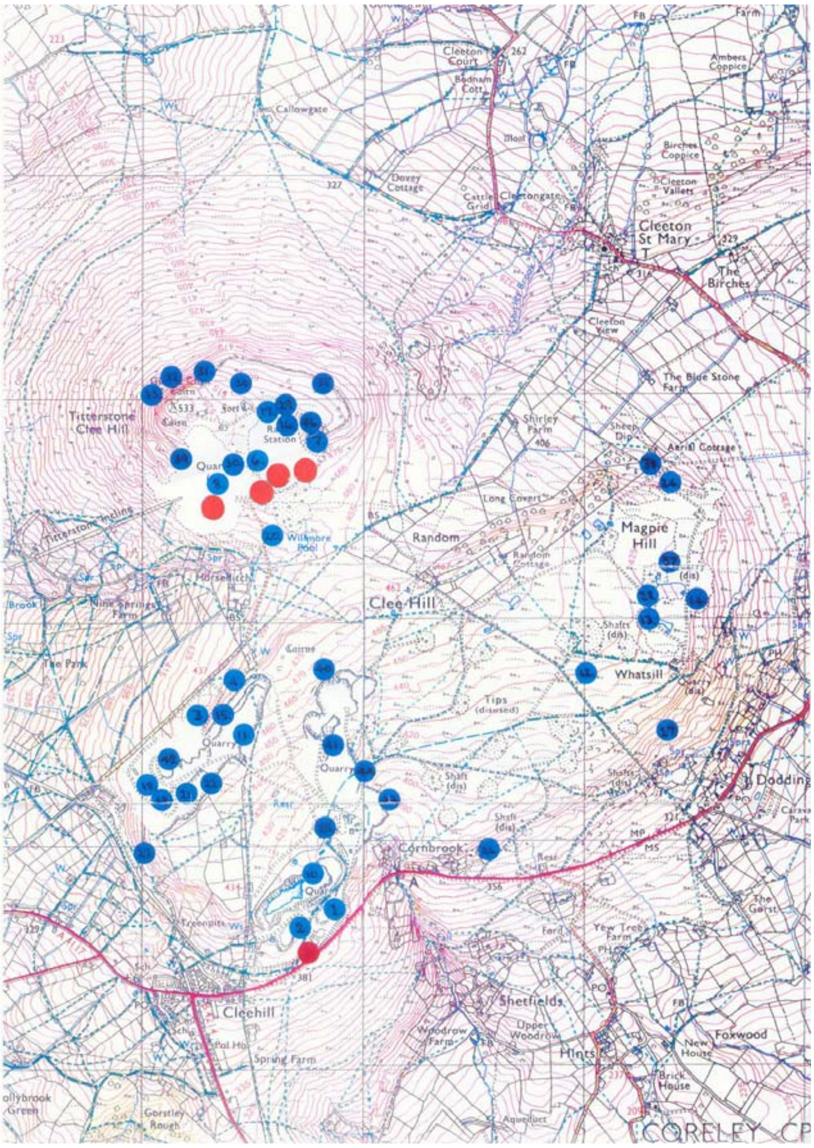

Figure 1. Wheatear nest sites, Titterstone Clee, 1999, modified to show, in red, the four nests lost during the orienteering event.
(Map from Shropshire Ornithological Society)

The accuracy of the nest location markings on the map needs to be considered. The national Ordnance Survey map, because of the mine and quarry workings over the area, shows more detail than might normally be expected of moorland terrain. This allows many of the nests to be precisely located and these can be transferred to the orienteering map (specially surveyed at 1:7500) with confidence. Of the remainder, most can be located on features which are shown on the orienteering map but not on the Ordnance Survey version, and minor adjustments made to fix their positions. One or two are marked in positions with no obvious feature and the accuracy of these depends on the surveying and cartographic skills of the ornithologist in judging the position of each nest on the ground and transferring this to the map. With the exception of these last mentioned nests, to which attention is drawn in the detailed analyses, it is estimated that the actual position of each nest is within 25m of the point marked, after due deliberation, on the orienteering map.

The combined information on the orienteering courses is given in Figure 2 together with the nest locations. There were 19 courses in all, ranging from those seeking to extract the maximum technical difficulty from the terrain to simple courses along the paths for very young children.

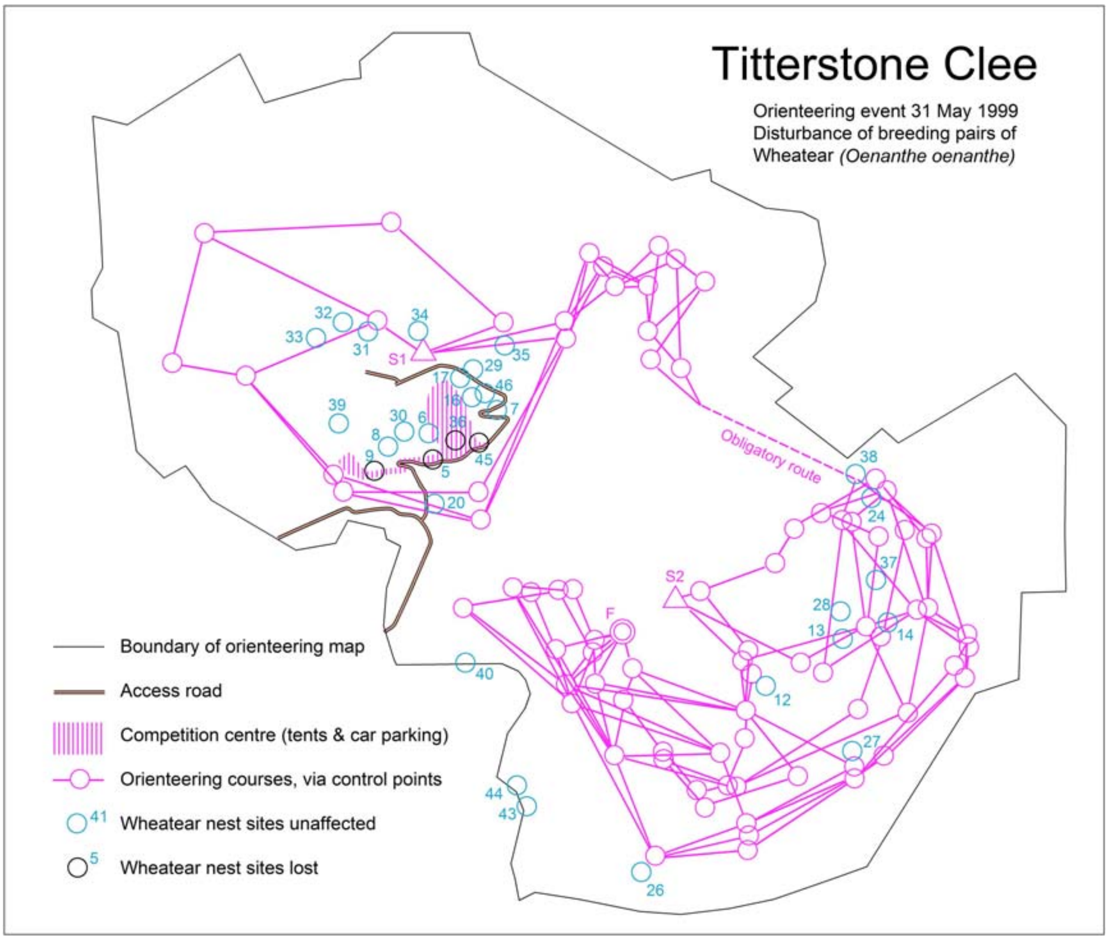

Figure 2. A reduced scale all-controls map of the orienteering event of 31 May 1999, showing the courses and the positions of the Wheatear nests (map by the author from information from Harlequins Orienteering Club).

The map shows two starts and one finish, the longer courses (659 competitors) starting at S1 and the shorter technical courses for older and younger competitors, and easier courses for novices, starting at S2 (514 competitors). The purple control point circles on the courses are precisely positioned to an accuracy of 5m. The lines connecting the control points simply indicate the control sequence and do not necessarily represent the route to be followed on the ground. The map shows many of the courses apparently passing in close proximity to nest sites and causing transient disturbance. In addition, there is the prolonged disturbance associated with the competition centre. These two different conditions are considered separately, in that order.

4. Routes followed on the courses

At the Brandon Park event (Goodall and Gregory 1991) the researchers asked each orienteer, before leaving and while memory was fresh, to draw up on a second map the route he or she followed during the event. This Titterstone Clee research does not have that facility and an alternative method has had to be devised to determine competitor routes. The nature of the terrain at Titterstone Clee offers testing ground detail recognition and fine navigation but little valid route choice. This means that, for the majority of experienced competitors, the best route for each leg from one control to the next, as identified by any one competitor, will closely match that of any other. It is possible from the map alone, because of its accuracy, for any orienteer experienced in high level skills in the checking of courses and competitor performance, to make a good estimation of that route without detailed inspection of the terrain. It may be useful to illustrate the methodology. Figure 3. shows leg 1-2 on two of the longer courses.

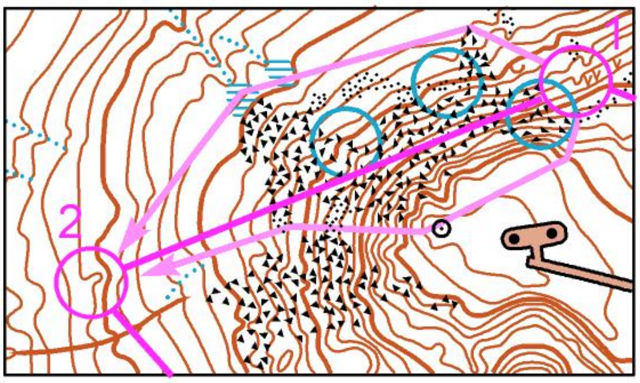

Figure 3. An example of most likely route.
(map by the author from the Titterstone Clee orienteering map at 1:10000, the yellow open-area colouration being omitted for clarity).

The competitors are required to select the quickest route from Control 1 to Control 2. The straight line connecting the controls represents a very bad choice because it passes over an extensive and difficult boulder field. The southern route option is shorter but involves climbing back up the hill, dropping steeply between the boulder fields and following a compass bearing towards the control. If the control is missed, the competitor has no obvious immediate relocating feature. On the other hand, the northern route option is downhill all the way, with gentler gradients. This route skirts the boulder field to the two marshes then follows a compass bearing. If the control is missed, the competitor is 'collected' by the long gully parallel to the bottom edge of the map segment. The northern option, although longer, is both quicker and less time penalising in case of navigation error. It may safely be assumed that an overwhelming majority of competitors, perhaps all, will have made this particular choice.

The same methodology applies to all route selection. Although other routes are less spectacular than the example above, the same principle of clear preference can be applied. In all cases of off-track movement the positional accuracy of most likely routes is about 25m, where paths are on route, the accuracy is better than 5m.

5. Parameters for disturbance

Without very detailed knowledge of specific behaviour of birds it is not possible to specify levels of disturbance. Instead, we can identify different levels of activity which are potentially disturbing and postulate that a general correlation between activity and disturbance exists. The Brandon Park study used the definitions of activity levels at that event given in Table 1. (Goodall and Gregory 1991, 13).

Activity Level	Definition
Very High	More than 200 competitors passing within 25m.
High	100-200 competitors passing within 25m OR more than 200 competitors within 100m.
Medium	10-100 competitors passing within 25m OR 100- 200 competitors within 100m.
Low	Fewer than 10 competitors passing within 25m OR up to 100 competitors within 100m.

Table 1. Activity levels at the Brandon Park bird study (Goodall and Gregory 1991)

It was rightly pointed out that these levels were not absolute but were related to the event being studied. However, this was a professional ornithological study and the parameters chosen must have had some connection with bird disturbance, however tenuous, based on previous experience. It is proposed to use the same protocol in this study, but with important modification and extension. The Titterstone Clee event had twice the number of competitors and the activity level table needs to reflect that. But first a distinction has to be made between the total number of competitors passing a point throughout the duration of the event and the maximum sustained rate, the latter being a better measure of disturbing activity. For the Brandon Park event the graph of percentage of competitors in the competition area with time shows a short plateau which may be approximated to 50% lasting for one hour. Table 1 can therefore be altered to show the maximum sustained rates of activity by halving he competitor numbers. These maximum sustained rates are given in Table 2.

Maximum sustained activity rate	Definition
Very High	More than 100 competitors per hour passing within 25m.
High	50-100 competitors per hour passing within 25m OR more than 100 competitors per hour within 100m.
Medium	5-50 competitors per hour passing within 25m OR 50- 100 competitors per hour within 100m.
Low	Fewer than 5 competitors per hour passing within 25m OR up to 50 competitors per hour within 100m.

Table 2. Maximum activity rates at the Brandon Park bird study 1991

At the Titterstone Clee event there were more competitors (~1200 compared with 480) but starting over a longer period (3 hours instead of 2). The starting rates are therefore 400 competitors per hour compared with 240 competitors per hour. Since the two events were of the same technical standard, planned to the same set of recommended winning times and giving the same overall average competing time of about one hour, their graphs of number of competitors in the terrain with time have similar theoretical characteristics. Both rise to a maximum after about one hour, plateau at that level until the last competitor starts, then decline. This is shown in simplified form in Figure 4.

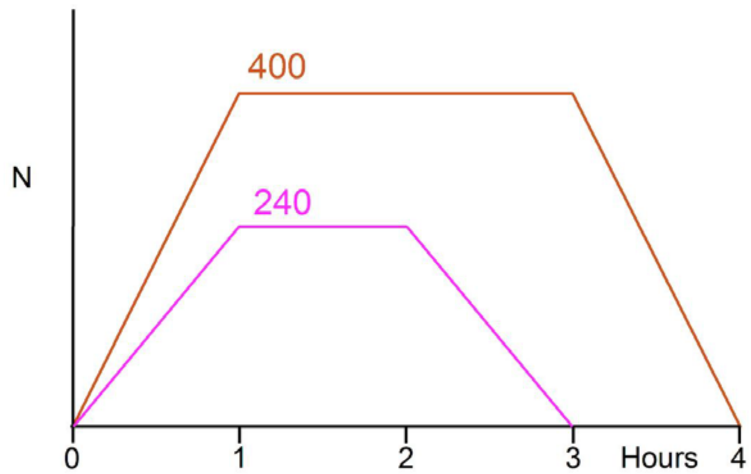

Figure 4. Comparison of competitor numbers in the terrain for Brandon Park (lower purple graph) and Titterstone Clee.

The graphs represent the outcome were each competitor to take exactly one hour and the starting rates were uniform in each case. The actual graphs do approximate to these simplifications (except for smoothing and longer tails) and these comparative figures suffice for this analysis. If the percentage of competitors in the terrain were plotted with time, the plateau value for Brandon Park would be 50% and that for Titterstone Clee 33%.

Since the maximum sustained activity rates were substantially higher at Titterstone Clee, it is necessary to extend the range above the top level used at Brandon Park. The figures used in this study are as in Table 3.

Maximum sustained activity rate	Definition
Ultra High	More than 200 competitors per hour passing within 25m.
Very High	100-200 competitors per hour passing within 25m OR more than 200 competitors per hour within 100m.
High	50-100 competitors per hour passing within 25m OR 100-200 competitors per hour within 100m.
Medium	5-50 competitors per hour passing within 25m OR 50-100 competitors per hour within 100m.
Low	Fewer than 5 competitors per hour passing within 25m OR up to 50 competitors per hour within 100m.

Table 3. Maximum sustained activity rates at Titterstone Clee

The terminology is borrowed from the radio frequency spectrum. The upper value of 200 competitors per hour passing within 25m is not simply a symmetrical extension of the existing figures in the table but is based on the time the average competitor takes to cross a zone of 25m radius. The average straight line distance across such a zone is about 35m. The average speed of orienteers is in the region of 10 minutes per km (0.6 $s.m^{-1}$) and their time to cross the zone is about 20 seconds. If competitors were evenly spaced, a rate of 3 per minute would result in a constant presence within the zone. In reality, randomness prevails and competitors would overlap and, more importantly for birds feeding young, there would be gaps. Nevertheless, the point at which evenly spaced competitors would give constant presence within the zone is a useful marker. This is 3 per minute, or 180 per hour (rounded to 200 for the table).

6. Disturbing activity near nest sites in the competition terrain

For each of the nest sites approached within 100m by any of the courses the most likely routes followed by the competitors have been estimated in accordance with the procedures outlined above. These, together with overall competitor numbers, have been illustrated on map segments, as given below. On each map the nest circle (blue) is 25m in radius and the map represents a 200m x 200m square. The control points are at the centre of each purple circle.

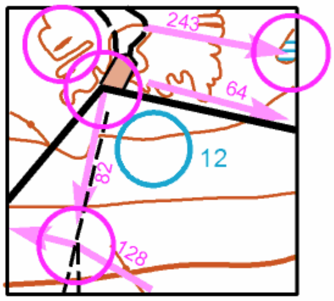

Figure 5. Nest 12
Accuracy of location poor

Total activity within 25m = Nil
Total activity within 100m = 517 (172 h^{-1})

Maximum sustained activity rate - High

Figure 6. Nest 14
Accuracy of location moderate

Total activity within 25m = 258 (86 h^{-1})
Total activity within 100m = 369 (123 h^{-1})

Maximum sustained activity rate – High

Figure 7. Nest 26
Accuracy of location moderate

Total activity within 25m = Nil
Total activity within 100m = 227 (76 h^{-1})

Maximum sustained activity rate - Medium

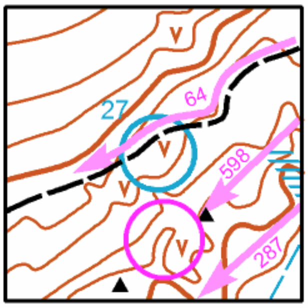

Figure 8. Nest 27
Accuracy of location moderate

Total activity within 25m = 64 (21 h^{-1})
Total activity within 100m = 949 (316 h^{-1})

Maximum sustained activity rate – Very High

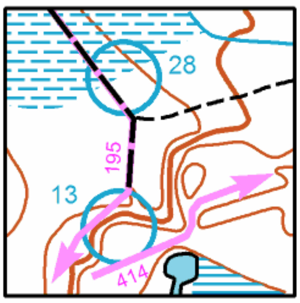

Figure 9. Nest 28
Accuracy of location good

Total activity within 25m = 195 (65 h^{-1})
Total activity within 100m = Nil

Maximum sustained activity rate - High

Refer to Figure 9 above

Nest 13
Accuracy of location good

Total activity within 25m = 609 (203 h^{-1})
Total activity within 100m = Nil

Maximum sustained activity rate – Ultra High

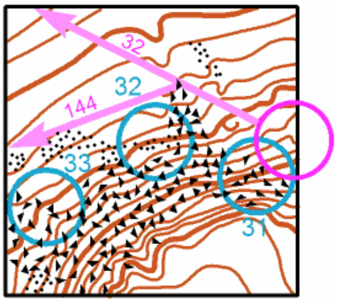

Figure 10. Nest 31
Accuracy of location good

Total activity within 25m = Nil
Total activity within 100m = 176 (59 h^{-1})

Maximum sustained activity rate - Medium

Refer to Figure 10 above

Nest 32
Accuracy of location good

Total activity within 25m = Nil
Total activity within 100m = 144 (48 h^{-1})

Maximum sustained activity rate - Low

Refer to Figure 10 above

Nest 33
Accuracy of location good

Total activity within 25m = Nil
Total activity within 100m = 144 (48 h^{-1})

Maximum sustained activity rate - Low

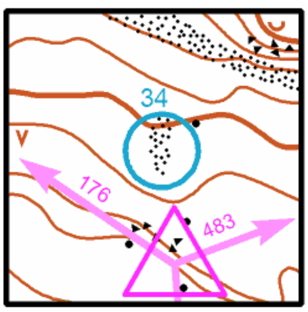

Figure 11. Nest 34
Accuracy of location good

Total activity within 25m = Nil
Total activity within 100m = 659 (220 h^{-1})

Maximum sustained activity rate – Very High

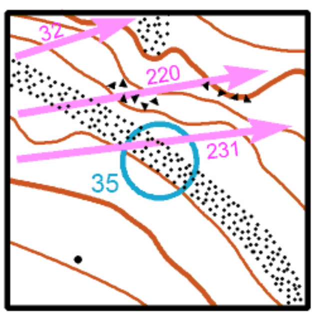

Figure 12. Nest 35
Accuracy of location moderate

Total activity within 25m = 231 (77 h^{-1})
Total activity within 100m = 483 (161 h^{-1})

Maximum sustained activity rate - High

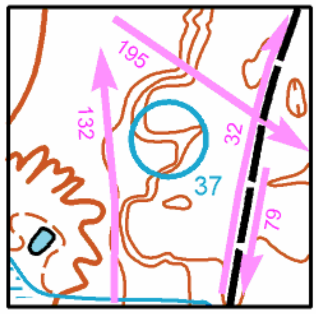

Figure 13. Nest 37
Accuracy of location good

Total activity within 25m = Nil
Total activity within 100m = 438 (146 h^{-1})

Maximum sustained activity rate - High

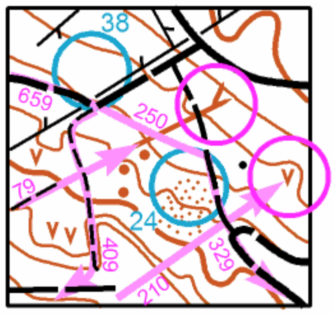

Figure 14. Nest 24
Accuracy of location good

Total activity within 25m = 329 (110 h^{-1})
Total activity within 100m = 948 (316 h^{-1})

Maximum sustained activity rate – Very High

Refer to Figure 14 above

Nest 38
Accuracy of location good

Total activity within 25m = 659 (220 h^{-1})
Total activity within 100m = Nil

Maximum sustained activity rate – Ultra High

7. Disturbing activity near nest sites at the competition centre

The competition centre, comprising the car parking, administration and other facilities, as well as the assembly area for competitors before and after their courses, was situated in the derelict dolerite quarries near the top of the hill. This was an area of intense activity and here the four Wheatear nests were lost. Figure 15 shows the competition centre area and the road to the northern start (S1). The black circles indicate the nests which failed.

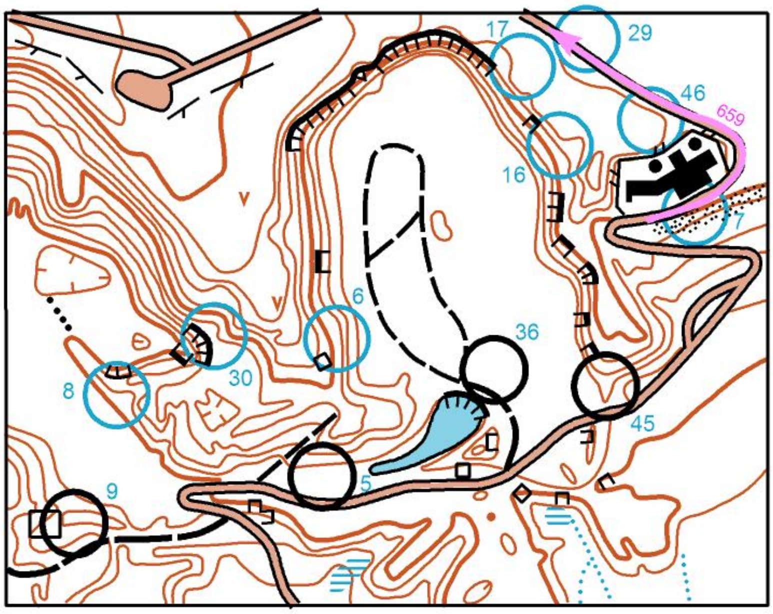

Figure 15. Wheatear nests in and around the competition centre

The loss of the three nests 5, 36 and 45 is consistent with the level of activity in their immediate vicinity. The accuracy of location of the nests on the map is good and indicates the nests were under or adjacent to parked vehicles and tentage associated with the event. It was reported by Vickers (2000) that this was observed by ornithologists on the day. The level of activity cannot be quantified but would have been continuous over a period of 8 hours or more. The loss of nest 9 cannot be explained as readily. There was parking down the track adjacent to it but the level of disturbance from that and competitors walking along the track is not high compared with many other nest sites. However, the accuracy of its location on the map is poor and perhaps it was in a more vulnerable position than that shown. Perhaps the nest failed for reasons not connected with the orienteering event.

Also of interest in this area are the three nest sites adjacent to the road along which 659 competitors walked to reach the northern start. These three nest sites 7, 46 and 29 are located on the map with good accuracy, all within 25m of the road. The same criteria can be used as for the calculations of maximum sustained activity rates in the competition terrain:

Nests 7, 29 and 46
Accuracy of location good

Total activity within 25m = 659 (220h^{-1})
Total activity within 100m = Nil

Rating – Ultra High

It could be argued that the competitors walking to the start were potentially more disturbing than runners would be, because the walkers take longer to pass by and therefore the intervals between disturbances are shorter and less numerous. It could also be argued that birds near the road are more often subjected to disturbance and have become more tolerant of it.

8. Conclusions

Although the Wheatear *Oenanthe oenanthe* is not a listed bird, it is well regarded by ornithologists and the results of this disturbance study are of value. Four nest sites were lost in a general area of intense and prolonged disturbance. Of these, there was a clear cause and effect for three of the nests, with the orienteering tentage and vehicles variously described as being placed over and adjacent to nests. With the fourth nest there is insufficient information to confirm the same clear cause and effect.

A repeat of this interference with breeding Wheatears at orienteering events on Titterstone Clee is prevented by the working agreement between the ornithologists and the orienteering club.

Of the remaining 27 Wheatear nests on the orienteering map, none appeared to have been affected by the event. Their potential disturbance from orienteering activity has been considered. In order to have consistency in bird disturbance reporting the methods of the Brandon Park breeding bird study (Goodall and Gregory 1991) have been used but with modification and extension. The modification is made to permit comparison and the extension arises because there were many nests within areas of orienteering activity at levels considerably higher than those specified in the Brandon Park report. These are shown in Table 4.

Maximum Sustained Activity Rate	Nest Sites
Ultra High	7, 13, 29, 38, 46
Very High	24, 27, 34

Table 4. Eight Wheatear nest sites exposed to potentially severe levels of disturbing orienteering activity.

The activity levels specified in the Brandon Park study have been converted from total competitor numbers activity levels to maximum sustained activity rates to permit comparison with this and any other similar study. An additional level, Ultra High, has been added to accommodate higher levels of disturbing activity. The threshold for this level has been set such that orienteers, or other runners, passing within 25m of nests would, if evenly spaced, present continuous presence within the 25m radius zone. In practice, randomness would produce significant gaps for the Wheatears to exploit.

The positional accuracy of the siting of the nests and of the most likely routes taken by the orienteers in their vicinity has been considered and is generally of the same order as the 25m radius of the zone used for arriving at the highest levels of potentially disturbing activity given in Table 4. With eight nests calculated to be in the categories of ultra high and very high potential disturbance, errors in the calculation arising from positional errors which result in the potential disturbance being overstated is likely to matched by others being understated. The overall picture remains valid.

The conclusion from this study is that the Wheatear *Oenanthe oenanthe,* when feeding young, exhibits very considerable tolerance of disturbance. This conclusion is consistent with the reported siting of nests within a working quarry. One such nest is positioned within 2m of the door of a workshop. It is also consistent with the ornithologist's view that "the main activity of people running intermittently over the area was not the problem, since the feeding parent birds could seize the opportunity to dodge in when the coast was clear" (Vickers 2000). Although there appears to be no pressing need to take precautions to avoid the nests of Wheatear raising young in the competition terrain of an orienteering event, particularly if the event is of modest size, if nest location information is available, it should be used. It makes sense to check, for example, that nests and control sites do not coincide.

The question arises as to whether the conclusions of this research apply to Wheatears incubating eggs. Their behaviour and sensitivity under those conditions may not necessarily be the same as observed when they are feeding young. However, the ornithologist familiar with the Wheatear on this site reports that the species exhibits at least the same degree of confiding behaviour when incubating (Fulton 2004). His experience of the flushing distance, the distance at which an approaching human causes the bird to leave the nest (Liddle 1997, 392), of the incubating Wheatear is one metre or even less for a passing disturber, rather more for a stationary or near stationary disturber. More importantly, he estimates the return distance, the distance to which the human has to retreat before the bird returns to the nest, is about 25m. It is concluded, therefore, that the results of this study are applicable to the whole of the breeding cycle.

Although this is a single case study of the disturbance of one species of breeding bird at one site, it may be used for considering potential disturbance of breeding Wheatear at other sites. It is also possible to draw tentative conclusions about other avian species which are known to have similar tolerance of disturbance to Wheatear. One such species is the Stonechat *Saxicola torquata*, which also nests on Titterstone Clee, in low gorse bushes. The ornithologist reports that, on this site, *S. torquata* appears to be at least as tolerant as *O. oenanthe*, possibly even more so. He observes that *S. torquata* tends to sit tight on the nest and is not flushed until the bush it is in is physically shaken.

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