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INTERNATIONAL ORIENTEERING FEDERATION

REVIEW OF RESEARCH
INTO THE
ECOLOGICAL IMPACT OF ORIENTEERING

ENVIRONMENT COMMISSION,
INTERNATIONAL ORIENTEERING FEDERATION,,
RADIOKATU 20, FI-00093 SLU, FINLAND

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ECOLOGICAL IMPACT OF ORIENTEERING

BRIAN-HENRY PARKER
BSc BA
Chairman, IOF Environment Commission

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<u>SUMMARY</u>:

In its classic form orienteering is a sport which takes place largely off-track in terrain which often has conservation value. This gives rise to concern amongst ecologists that there is the potential for damage to flora and fauna. Although the repeated experience of orienteers is that the ecological impact of their sport is low, it is necessary to prove/test this by scientific observation in order to assist land managers and their advisers in making objective judgements affecting orienteering.

Research has been conducted in the three main areas of environmental concern: the trampling of vegetation, the disturbance of large mammals and the disturbance of birds. Some studies are reported in refereed journals but most of the others are only available in documentation with very limited circulation. Those studies which have come to the notice of the IOF are critically reviewed and, for each of the three areas of concern, are used to test the hypothesis that orienteering does cause significant long-term ecological damage.

The conclusion to be drawn from the general vegetation impact studies is that orienteering has low to very low impact with generally rapid recovery. With respect to sensitive vegetation, the sport takes precautionary measures and no evidence of significant long-term damage has been reported. The hypothesis is rejected.

With respect to the disturbance of large mammals the sport takes precautionary action and no evidence of long-term detriment has been reported. The hypothesis is rejected.

The disturbance of breeding birds is more problematic. Research information is very limited. A major study indicated that all 54 breeding species present were unaffected by orienteering. Another study showed that prolonged disturbance, such as the parking of cars over or adjacent to nests, can cause nest abandonment but the ephemeral disturbance from orienteering competition does not. One further but faulted study was unable to determine whether a reported reduction in a bird population was due to severe weather or orienteering, although precautionary action assumes the latter. To date there is no valid evidence of significant long-term damage to birds, to support the hypothesis. Whether there is sufficient evidence to reject the hypothesis is a matter of subjective judgement. Given the available evidence, the starting point for any discussion should be that the sport appears to be non-damaging to breeding birds.

REQUEST FOR INFORMATION

This report reviews those studies and observations which have been brought to the notice of the IOF Environment Commission and which have scientific merit, however modest. If readers are aware of studies which appear to have such merit, irrespective of whether the conclusions are favourable or not towards orienteering, and are absent from this report, the Environment Commission would appreciate receiving details.

The Environment Commission may be contacted through the IOF Website at www.orienteering.org

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1. Introduction

In response to increasing difficulties in obtaining access to countryside for sport and recreation in the United Kingdom, arising from perceptions of the potential for environmental damage, Sidaway (1991), in his guide *Good Conservation Practice for Sport and Recreation,* recommended that sports governing bodies become involved in research. Internationally, as well as in the UK, orienteering federations have responded to environmental pressures by commissioning, encouraging and collaborating in research into the ecological impact of their particular sport. Research has been conducted in the three main areas of environmental concern; the trampling of vegetation, the disturbance of large mammals and the disturbance of birds. This report critically reviews all those studies referred to the International Orienteering Federation and which are considered to be of sufficient merit to make a useful contribution. Most of the studies are unpublished or published in journals with very limited circulation. This review is believed to be the first in which all these studies have been brought together and rigorously examined. For this reason they are considered here in more detail than might be usual, so that their contribution may be better understood.

For each of the three areas of concern the reported studies in this review are used to test the hypothesis, implicit in the application of the Precautionary Principle, that orienteering does cause significant long-term damage. Evidence of significant long-term damage will be sought in order to accept the hypothesis.

2. Trampling of vegetation

There is very extensive reporting of general vegetation trampling research in the literature (Liddle 1997, Chapter 3 et seq.) but very little arising from orienteering studies (for example, Kardell 1974). The concerns about the trampling of vegetation in orienteering competitions are threefold. Firstly, there is the potential for sensitive flora to be damaged by trampling to the extent that individual plants do not survive or recover too slowly and are displaced by more vigorous species. The second concern relates to the visibility of any trampling damage. This may be ephemeral but can offend the sensibilities of onlookers, particularly where the vegetation is considered to have visual merit. On the other hand, if persisting for an extended period, it may be an indication of slow recovery or permanent change. The third concern is that an ephemeral trail created during an orienteering event could be used in the following months by members of the public and be consolidated into a new and unwanted path (Zealand 1990).

Research into the trampling effects of orienteering addresses the first two concerns, the third, if in areas with general public access, is avoided or corrected by pre- or post-event management. The nature of the reported research shows wide variation, arising from two different objectives and the many variables involved. Some studies, particularly those of events with very large entries of over 2000 which might be expected to give rise to measurable general impact, have the objective of monitoring the competition area as a whole. They report the proportion of the total area of vegetation which is damaged, followed by a programme monitoring the recovery. These studies, covering a large area of competition terrain of 15 km^2 or even more, require considerable research effort. Monitoring techniques involving visual estimation and threshold assessment of damage are usually employed. Other studies, particularly those of events with smaller entries below 2000 which are too few to cause measurable impact over wide areas, have the objective of focussing on those parts of the terrain where impact is greatest, where competitors are channelled at control points and the start and finish. With small areas being monitored, more precise techniques of measurement and species differentiation can be used. Some studies concentrate on damage to a localised sensitive species, some on specific communities and others on general vegetation.

There are many countries within the International Orienteering Federation (currently 67) covering a wide range of biogeographical areas with an even wider range of vegetation types. The potential for differing trampling impacts from orienteering across this range of vegetations is considerable, giving, in turn, a large number of options for research studies to meet environmental concerns. Since, at present, the concerns are voiced most strongly in the European countries, it is from this continent that all but one of the studies originate. The outlying study is from Western Australia. The European biogeographical regions from which these studies derive are referred to using the European Environment Agency (2000) definitions; of its nine regions the studies reviewed are associated with four, the Boreal, Continental, Mediterranean and Atlantic regions. Within a region there is further variation as particular habitats are considered. There are obvious differences in the vegetation communities of heathland and the ground cover in forested terrain. There may also be differences between one forested area and another, and between one heath and another. There are many variables within habitats, such as soils, slopes, drainage, height, aspect, latitude, some or all of which may affect the sensitivity of various vegetation species and communities to trampling. Given these factors and the diversity of vegetation communities over which the sport of orienteering takes place and meets with concerns about trampling impact, the number of research studies into trampling is small. Just ten such studies have been identified and these are listed in Table 1.

The emboldened sections of Table 1 represent a matrix of the main parameters, the combination of which distinguishes one study from another. The matrix suggests that studies 1 and 2 are coincident, but it is indicated in the review of those studies that, although there is a substantial measure of similarity between them, their latitudinal difference is significant enough to represent separate conditions. Most studies report the recovery of the trampled areas over one or more growing seasons. In those studies which do not, the degree of vegetation impact is too low for the monitoring of recovery to be practical.

	1	2	3	4	5	6	7	8	9	10
Author(s)	Kardell	Myllyvirta et al.	NCC	Moore and Tacey	Bader et al.	Breckle et al.	Parker	Viti	Douglas	Baldock
Year reported	1974	1998	1981	1987	1998	1989	1994	2001	1989	1992
Number of competitors	9276 2920 1300	10000	2100	30 (Note 1)	102 (Note 1)	250 (Note 1)	2000	890 (Note 1)	1200	1959
Biogeographic region	European Boreal	European Boreal	European Atlantic	Australian Jarra	European Boreal	European Continental	European Atlantic	European Mediterra-nean	European Atlantic	European Atlantic
Country	Sweden	Finland	Scotland	Australia	Sweden	Germany	England	Italy	England	England
Type of habitat	Forest	Forest	Forest	Forest	Forest	Forest	Heath	Forest	Forest	Moor
Vegetation monitored	General	General	General	Lichen on rock	Lichen on wood	General	General	General	General	General (incl. heather)
Whole area monitoring	√	√	√				√ (Note 2)			
Worst impact monitoring				√	√	√	√	√	√	√
Recovery monitored	√	√	√			√	(Note 3)	√	√	√
Quantitative (Q) or Pseudo-quantitative (P)	Q	Q	P (Note 4)	Q	Q	Q	P (Note 4)	P (Note 4)	Q	Q

Table 1 Summary of studies of vegetation impact at orienteering events. The emboldened parameters represent the significant factors which distinguish one study from another.

Notes:

1. These are the numbers of competitors passing through the test plots, otherwise the numbers are event totals.
2. This study included a wide range of sites, including those expected to show greatest impact.
3. Monitoring of recovery planned but observed impact negligible.
4. Pseudo-quantitative measurements are those in which the only measurement recorded is zero damage, either as no damage resulting from the event or as the final condition after recovery from observed but unquantified damage.

2.1 Whole area monitoring of vegetation impact at orienteering events

Three such studies have been identified, in Sweden, Finland and Scotland. The Swedish and Finnish studies were very similar, although conducted more than 20 years apart, each involving very large numbers of competitors, up to 10000. Overall damage was estimated and the recovery rates determined. The Scottish study was of a large event by UK standards but with fewer numbers, 2100, than the Scandinavian events.

2.1.1 Trampling of vegetation at three large events in southern Sweden

A major study of the vegetation impact of three orienteering events in the south of Sweden was conducted in 1972 (Kardell 1974, reported in Liddle 1997). The competitions varied in size from large to very large, with 1300 (Galö), 2920 (Handen) and 9276 (Trånäs) competitors respectively. Surveys immediately following the competitions showed, for the largest event, clear trails made by the orienteers for some 50-100m into and out of the controls. Around the worst affected control points the vegetation within an area of $10m^2$ (equivalent to 1.75m radius) suffered 50-75% damage. Similar damage was reported for the start and finish areas. It was likely that all the damage reported was exacerbated by the wet conditions of the event. An extrapolated estimate of the proportion of the competition terrain likely to have suffered visible damage was 1%. This was calculated assuming all competitors on the same course made the same route choices. This assumption leads to an overestimate for the visible damage figure, which may be compared with the 0.5% estimated visible damage for a similar size event in Finland (Table 2 in the next section). The impact in the two other competitions was significantly lower, due to the lower numbers of competitors and better weather conditions.

All survey sites were monitored for two years to note the nature and rate of recovery of the damaged vegetation. The vegetation of the largest event, which had suffered the most severe immediate damage, showed rapid recovery. After 1.5 to 2 growing seasons, the vegetation cover at 90% of the sampled areas had recovered to Damage Class 1. This designation represents zero to slight damage, the latter set such that a person unaware that a competition had taken place and not focussing on specific sites would not register vegetation damage in the terrain. The more severe damage category, Damage Class 3, vegetation completely worn away, would be expected to apply to some of the control sites. At this large event no control site remained in the Class 3 category after the two seasons recovery period.

In the intermediate-sized event terrain the vegetation recovered less quickly, with 70% of the affected vegetation cover recovering to Damage Class 1 after two growing seasons. The vegetation in the smallest event showed near total recovery after one growing season. In these two events the proportion of control sites remaining in the Damage Class 3 category was 2-4%. The researcher noted the susceptibilities to trampling of different species and was able to derive approximate carrying capacities, these being the maximum number of competitors crossing the vegetation without causing immediate clearly visible damage. For the different vegetations he concluded that that the least susceptible could carry 400 competitors and the most susceptible, lichenose rock, 50 competitors. He also deduced a carrying capacity for *Vaccinium myrtillus* and Sphagnum moss cover of 100 on drier sites, reducing to 50 in wetter sites. Overall he concluded that:

> Biological damages to vegetation are mainly theoretical. General conceptions of vegetation damage and eroding effects due to orienteering and other recreational use of forests are often very subjective and inconsistent. It may occur that the vegetation damage caused by an orienteering competition may seem considerable immediately after the event, but the capacity for recovery of different vegetation types seems to be so good that the damages are almost invisible after 1-2 growing seasons. From this point of view there seems to be little reason for restricting orienteering competitions. (Kardell 1974)

Attention was also given to potential damage to recently planted saplings. In the Handen competition some 2400 of the 2920 competitors crossed, from various directions, a clearing newly planted with 15,000 spruce saplings. The researcher reported a total of 13 saplings suffering minor root damage, with no sapling being destroyed. Damage to pine saplings was also studied in the 9276 competitors Trånäs event and similar results obtained. Kardell concluded that “the damage to saplings and tree roots done by orienteers was so minimal that it can only have a theoretical significance to the economic interest of the landowner”.

Kardell’s report may be critically reviewed. Of necessity, in order for the study to monitor the substantial areas of the competitions, his research method could not be fully rigorous. It was based on visual observations with uncertainties arising from the presence of leaf litter (which presumably obscured to some unquantified extent the presence or absence of underlying vegetation). His conclusion that biological damage to vegetation is theoretical is not entirely clear, perhaps suffering in the translation from Swedish. This may mean that the recovered vegetation showed no change to the balance of species or simply be a reference to pre-event predictions of long-term impact not being realised. This triple specific study was the first in a field where no previous data existed and was of value because it gave land managers a general indication of the likely levels of trampling damage and recovery from the large events. However, it leads to unanswered questions about the many variables in such studies. Differences in the extent of damage and rate of recovery were reported for three different sites with different weather conditions. The suggestion that weather is a major variable invites further investigation. The overall impact figure from the total competitor entry is a generalisation; an indication of how this figure was made up across different vegetation and different competitor numbers would have been more informative. Despite these and other questions the study offers general reassurances about vegetation damage from orienteering in Scandinavia. However, because of uncertainties as to the extent to which the results may depend on terrain, climate and other factors, rather than species, care should be exercised in transferring its findings to a different biogeographical region.

2.1.2 Trampling of vegetation at a large event in Finland

A vegetation impact study very similar to the Swedish research reviewed in the last section took place in Finland in the mid-1990s. The annual Jukola orienteering relay event in mid-June attracts around 10,000 runners. The timing of the event had generated some criticism amongst conservationists and forest authorities because it coincided with the reproduction period of avian and mammalian fauna, and of much of the flora. To meet the concerns about vegetation trampling in Finnish terrain, notwithstanding the Swedish research carried out two decades earlier, an impact study was carried out at the 1995 event. The state of the vegetation in the 12 km^2 competition terrain was surveyed immediately after the event and at intervals for the following eighteen months (Myllyvirta, Henriksson and Aalto 1998). Using similar methods to Kardell damage to vegetation was monitored and used to estimate the areas of the competition terrain in which visible traces of the orienteering event were present. The results are summarised in Table 2.

Time lapsed since competition	% of 12 km^2 competition terrain in which traces of the event are visible
Immediately after	0.5%
3 months	0.3%
1 year	0.15%
1½ years	0.1%

Table 2 Percentage of vegetation-damaged terrain at different times following the Jukola Relay, Finland (Ibid.).

Once again, lichenose rock was found to be the most sensitive because of its weakest capacity for recovery. However, the total impact on such terrain was minor because the natural route choices of the competitors were over the flatter bilberry/moss-covered ground between the rocky outcrops, rather than traversing the exposed rock, which is more hazardous to run across. Similar findings to the Swedish work were made with respect to the relative durability to trampling of different vegetations, the *Vaccinium*/Sphagnum cover being rated as durable against trampling stress. This was not quantified, nor was the reported durability against trampling and recovery of pasture vegetation. The competition centre was located on a field which had extended occupation by 40,000 people during the competition but it was reported that “the area recovered rapidly after the competition” (Ibid.).

At first sight this study appears to replicate that for the largest event of the Swedish study by Kardell some twenty years earlier. Certainly, the experimenters’ findings closely match. However, although both took place in nominally the same biogeographical region, the Finnish event was some five degrees of latitude further north, equivalent to the distance between southern England and central Scotland. It might be expected that this latitudinal separation and also Finland’s more continental location would result in climatic differences which could be reflected in the vegetation cover and/or its susceptibility to trampling. The Finnish study therefore both consolidates and extends the earlier data from Sweden.

The particular feature of this Jukola study is that it monitored the immediate and long-term effect on vegetation of a an orienteering event with exceptionally large participation (~10,000) and derived figures for the totally affected area of terrain, rather than more detailed measurements focussed on a few high-use control sites. As such it has practical application for forest recreation management in Scandinavia. The same caution as for the Swedish study needs to be expressed about the applicability of the study outside the Scandinavian boreal biographical region.

2.1.3 Trampling of vegetation at a large event in southern Scotland

In August 1981 a major multi-day bi-annual orienteering event, the Scottish 6-Days, took place in the Galloway region of Scotland with the participation of over 2000 competitors. The Nature Conservancy Council, the then governmental organisation responsible for nature conservation in the UK, took a close interest in the series of events, monitoring their immediate environmental impact and re-visiting the main sites a year later (NCC 1982). It is reported that, during the negotiations in the initial planning stages of the event, sensitive areas, particularly sand dunes and peat bogs with the protective designation of Site of Special Scientific Interest (SSSI), were declared out of bounds as a precaution against potential damage. The habitats used by the event and examined by the NCC ecologists were woodland, moorland and acid grassland.

The immediate impact of the event was much less than had been expected. The general pattern of damage consisted of trampling across a broad front. The level of trampling was reported as low to moderate except at bottlenecks, where the laying of new paths through bracken and tall grass was clearly visible. However, within one year all traces of additional paths had gone, even at bottlenecks. As the event took place in August it was unlikely that it had any effect on herbaceous species, particularly the vernal plants of the woodland habitat and there were no indications of damage by the following spring. The report concluded that:

> In general, it is difficult to find any evidence of permanent adverse effects on vegetation of the orienteering event, which was surprising when considering the number of contestants. However, their pattern of use throughout the sites studied indicates that many areas were subjected to no more than 100-200 visits because of the nature of the sport. (NCC 1982)

The report further recommended the acceptance that:

> SSSIs offer some of the best orienteering conditions and that large events may be compatible with conservation interests on some sites. (Ibid.)

In reviewing this report it may be noted that the research method was simple and pseudo-quantitative. The visual assessments of trampling were on some undefined scale of ‘low to moderate’ and the areal extent of visual trampling damage was not reported. However, the final conclusions were that the trampling effects after a year had reduced to zero, this being a quantitative observation. The comment in the report that, ‘in general, it was difficult to find any evidence of permanent adverse effects’ is presumed to be a misstatement, in that, had any such permanent adverse effects been found, they would certainly have been highlighted. It can be assumed that the investigators saw no evidence of long-term adverse effects. Despite the modest scope of the study, it was conducted by the Nature Conservancy Council (later evolving in Scotland to Scottish Natural Heritage) and their wide area observations over varied terrain reporting complete recovery of trampled vegetation after a major event is of significance for land managers. As it was conducted in a different biogeographical region from those reviewed above it usefully complements the existing data .

2.2 Focussed monitoring of vegetation impact at orienteering events

Where the overall effect on vegetation is light, due to the nature of the terrain or the relatively small size of the event, it is not practicable to attempt to monitor general impact. In such cases, experimental procedures focus on sites where damage is expected to be concentrated, either because the vegetation is sensitive or because the design of the courses brings sufficient numbers of competitors together, such as at common control points.

Two studies of the impact on sensitive vegetation are reported, both on damage to lichen but on different substrates, one rock and the other decaying logs, and in different biogeographical realms, one in Australia and the other in Sweden. Lichen, although widespread, is considered to be vulnerable to damage because of its extremely low growth rates.

The remaining five studies on various vegetation communities focussed on the maximum localised impact expected at the events being monitored. These five studies cover five different habitats and a range of vegetation types.

2.2.1 Trampling of lichen on rock in Australia

At the instigation of the Western Australia Department of land Conservation and Land Management a study was set in place to determine the impact of orienteering on lichen-covered rocks (Moore and Tacey 1987). A low outcrop of lichenose granite was chosen for the test and a control point placed so that the natural direction of approach by the orienteers was across the outcrop. The lichen cover was assessed over an area of $40m^2$ before and after the event. A total of 30 competitors passed through the control.

The researchers noted the area of crusteose lichen disturbed and rated the degree of disturbance on a scale from foot imprints being visible to bare substrate being exposed. They concluded that less than 1% of the lichen had been disturbed and that a relatively rapid recovery was expected due to its small extent and the high density of surrounding lichen.

The study appears to have been conducted with meticulous detail. However, it has one weakness, in that the competitors were not observed at the test site and that it cannot be confirmed that all 30 competitors passing through the control also passed across the monitored area, although this is highly likely. This work gives a result not inconsistent with that reported above by Kardell (1974) despite the very great biogeographical separation. He suggested a limit of 50 competitors across lichenose rocks before damage becomes visible. In this case a close inspection after 30 competitors shows less than 1% damage. Since the percentage damage at the threshold of visibility is not stated in either work, the correlation between them cannot be precisely stated.

2.2.2 Trampling of lichen and fungi on decaying spruce logs in Sweden

A number of woodland key habitats have been identified in Sweden (Nitare and Noren 1992). They comprise features which are present in natural stages of forest, such as old and dead trees, which are often absent from managed forests. These features are important contributors to biodiversity in that they support many 'red-listed' (threatened or care-demanding) species. An example is fallen spruce tree trunks (referred to as downed logs) in various states of decay which support listed lichen and fungi.

A study of the effect of an orienteering event on downed spruce logs and decomposed tree stumps was conducted in 1997 in Northern Sweden (Bader, Fries and Jonnson 1998). The study was based on ten spruce logs and three stumps with a control marker positioned so that the approaching competitors had to pass over or round the logs. The coverage of bark and mosses was measured on 2m sections of the logs before and after the event. A total of 102 competitors passed through the control site. For each competitor the number, route across the logs and which, if any, sections of log were stepped on were noted. These routes are shown in Figure 1.

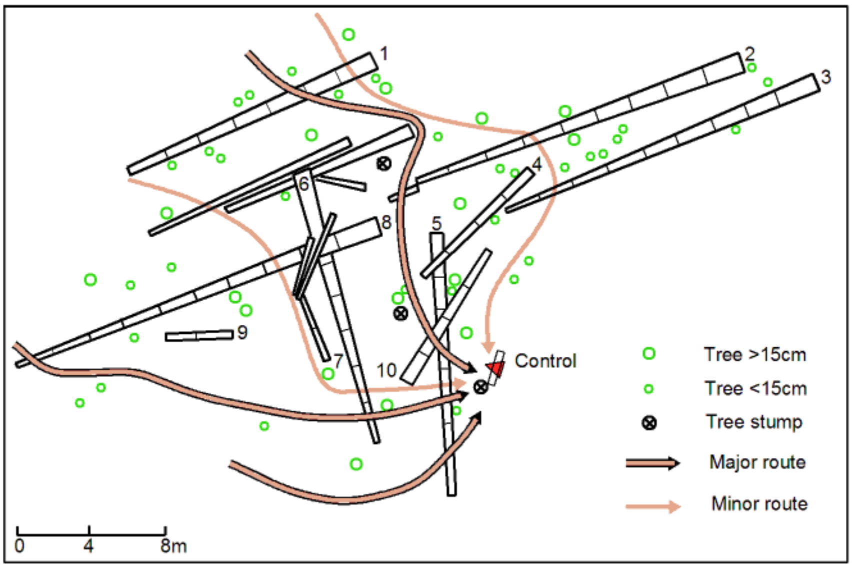

Figure 1 Routes taken by orienteering competitors through a cluster of downed spruce logs at an event in Northern Sweden. The map is simplified from the original (Bader et al. 1999).

The study concluded that the 102 runners caused only minor damage to the logs and none to the stumps and this "must be considered as almost negligible from a nature and conservation point of view" (Ibid.). A further conclusion was that no red-listed or common species of fungi or mosses that were recorded before the competition had disappeared from the logs in the study area.

This was a carefully constructed and conducted study. The authors point out its single and small scale nature, but it contributes to a hitherto data deficient area of conservation concern. The authors caution that changing parameters such as the height of the logs and the age of the competitors could alter the readiness to step on the logs.

2.2.3 Vegetation trampling on a mid-European forest sandy podsol.

The 1984 German University Orienteering Championships were held on the widespread sandy area of the 'Senne' near Bielefeld. A detailed synecological survey of plant species in a 2 x 2m area around two control sites was conducted before the event, immediately following it and at annual intervals for a further three years (Breckle, Breckle and Breckle 1989). Both sites were in wooded terrain on a sandy podsol soil where the herbaceous layer was considered vulnerable because of their small roots and the softness of the soil. The herbaceous composition was different at the two sites. One site was dominated by hair grass *Avenella (*now termed *Deschampsia) flexuosa* with bilberry *Vaccinium myrtillus* and the other by hair grass and chickweed wintergreen *Trientalis europaea*. The number of competitors passing through the sites did not exceed 250.

The research method involved counting the number of above-ground plant stems. Immediately following the event all species were still present at the two sites, but in reduced numbers and with some partly or heavily damaged. The damage was restricted to above-ground plant parts. Some species were more affected than others, thus altering the balance between the species. A year later this balance had been restored and numbers had recovered to almost the same levels as immediately before the event. Monitoring over the next three years showed much greater changes with some species doubling their numbers. The researchers concluded that there were long-term changes affecting the whole area, from acidification and from a storm which thinned the pine canopy and increased light levels on the forest floor. They also concluded that the changes due to the orienteering event, concentrated at the control sites, were minor, short-term perturbations.

The researchers rightly cautioned against their limited study being used, by itself, for generalisations. However, they considered that their results, coupled with other observations reported from differently structured biotopes, forests and woodlands, allowed them to state that there are "no objections from the scientific view-point of environmental ecology" (Ibid.) to orienteering events conducted to recognised environmental standards.

Although small scale, this study from a sandy podsolic mid-European forest is of importance because it adds evidence of rapid regeneration of a number of herbaceous species. The authors generalisation about the low impact of orienteering, their supposedly taking into consideration other studies, may be noted as agreeing with other conclusions but cannot be accorded any more authoritative status, because they have not referenced and analysed these other studies or considered other variables.

2.2.4 Vegetation trampling on sandy heathland in southern England

The British Relays Orienteering 1994 Championships was held on 20 March on the Ambersham Common SSSI near Midhurst, West Sussex. This is an area of lowland heath dominated by heather *Calluna vulgaris* and bell heather *Erica cinerea* on leached podsolic soils over Lower Greensand but with considerable encroachment of self-seeded Scots pine *Pinus sylvestra* and Norway spruce *Picea abies*, making most of the area semi-wooded. With 2000 competitors taking part, English Nature (the successor body to the Nature Conservancy Council in England) was concerned about the potential for trampling damage to vegetation. A joint study was set up between English Nature and the British Orienteering Federation to monitor sites where damage might be expected (Parker 1994). A total of 16 sites were selected, covering a range of parameters. Some sites were wetter and hence expected to show more impact. Some sites were to be in areas dominated by bracken, others by heather. Some sites were to be on slopes as well as on flatter terrain. The monitoring technique was to be photographic, supported by visual observations, immediately before and immediately following the event. It was intended that the recovery of sites showing impact would be further monitored at suitable intervals (nominally 3, 6 and 12 months after the event) until they had returned to their pre-event condition, or stabilised at a new condition.

It was expected, following a very wet winter, that the underfoot conditions would show significant impact at the heavily used sites and those on slopes. This proved not to be so. The heavily used sites, dominated by pine leaf litter, spruce leaf litter and dead bracken fronds respectively, showed negligible impact. At two slopes small trails had appeared at the steep base sections, these faint trails being similar to deer tracks. At a steep mossy bank site, expected to be more severely affected, the evidence of passage was faint and only visible on close inspection. At a marsh site, expected to be heavily impacted, a detailed examination revealed that most competitors had recognised the faint firmer terrain within the general marsh. A few had traversed the wetter parts of the marsh and footmarks were to be seen but these were well separated; they did not appear to have significantly disturbed the vegetation and were expected to disappear quickly. At all sites the impact was substantially less than expected.

English Nature reported that “impact was kept to an absolute minimum over the whole of the Common” and abandoned the recovery monitoring programme, considering that it was “pointless to take any further photographs to monitor the after effects of the British Relay Championships.” (Savage 1994)

This study produced a significant result of negligible impact over a wide range of vegetation types and sites within the area, some 16 sites being monitored. It has been suggested that the sandy nature of the subsoil might account for the minimal impact in that such a soil would drain more readily and be more resistant to its displacement and the disturbance of vegetation rooted within it. It is possible that locally elevated areas might have had some benefit from this mechanism but a substantial number of the monitored sites were wet, following heavy rain which had left standing water in much of the area.

2.2.5 Trampling of vegetation in montane forest in Italy

A study similar to that reported for Ambersham Common above was carried out in a different biogeographical region, in Italy at the Italian short distance orienteering championships held in June 2000 in Liguria (Viti 2001). This was a two-day competition with 445 competitors each day, making 890 in all across areas common to both days. The monitoring method was photographic, supported by visual observations.

The results of the before- and after-event survey were that no trampling effects were discernible in the forest, both in the competition terrain and the start and warm-up areas, nor at a spectator control. Significant trampling of the grass cover did occur in the finish field where the 890 competitors were funnelled into a narrow lane before crossing the finish, thus creating a visible path. The recovery of this area was to be monitored after 6 and 12 months. The 6 month monitoring was abandoned because of snow cover. The 12 month monitoring showed complete recovery with the finish funnel path no longer visible (Viti 2002).

This study was sited in the Mediterranean Sclerophyll biogeographical region but, by virtue of its altitude (1500m) in a montane environment, the vegetation may be more characteristic of terrain further north in Europe, although climatic differences may be significant. The study was modest in scope and may be critically commented upon for the same reasons as the general studies reviewed above. Notwithstanding its simplicity and its essentially pseudo-quantitative methodology, because of its different biogeographical location it adds usefully to the available data.

2.2.6 Trampling of vegetation in the forest and heathland of the New Forest in southern England

The New Forest, recently designated as a National Park, consists of lowland heath with extensive wooded inclosures (sic). A major orienteering event with a participation limit is permitted in the New Forest each November and in 1988 it took place in 11 km^2 of the Forest known as Denny Lodge. The event had 1200 entrants. A detailed study was carried out of a number of parameters associated with the event, the more important of which were vegetation trampling and deer reaction (Douglas 1989).

With the cooperation of the planners, an extensive series of transects were located across representative samples of different vegetation types and positioned so as to intersect a number of courses. The transects were 3m in width, so as to guarantee capturing at least one footfall, and totalled in length some 2500m overall. A setback occurred with the programme of monitoring for pre-event condition, which was disrupted by the passing of the deer hunt through the area on the day before the competition. This caused considerable ground disturbance, with holes 16cm diameter to 52cm deep on the crown of the wetter clay rides, and resulting in a planned series of soil compaction measurements having to be abandoned. On the day of the competition the transects had to be checked to note changes made by the hunt. With the aid of 17 research assistants transects were monitored during the competition to record crossings by orienteers, deer and others. Immediately following the competition the vegetation conditions within the transects were monitored and this was repeated at intervals until a year had elapsed.

The vegetation survey showed that the majority of sites had recovered within two weeks. The most heavily used and also the most sensitive sites still showed signs of change after six months but, apart from two sites, had fully recovered within a year. These two sites, one a sandy site with moss and lichen, the other an earthbank covered with bracken *Pteridium aquilinum*, had recovered to the point where they appeared indistinguishable from similar surrounding terrain and the change was only apparent to those who had detailed knowledge of the pre-event condition. Overall the researcher considered that "vegetation damage was very localised and similar in intensity to that caused by ponies and deer" (Ibid., 18). One site not monitored by transect was the start area (technically the pre-start) where all the competitors assembled before being called into start lanes. This site, a forest glade, had a far heavier loading than any part of the competition terrain and showed about 80% trampling damage after the competition but, within five months had recovered to the point where "it was impossible to distinguish the glade from other similar sites" (Ibid., 12).

This study was the first major research project into the environmental impact of orienteering in the United Kingdom, commissioned to investigate assertions that orienteering in the New Forest causes disturbance, damage and stress. In reviewing this work, it is noted that the research was site- and activity-specific, focussing on the impact of an orienteering event on the natural environment of the New Forest, without intending to correlate results with data from elsewhere. A range of vegetation types and sites were monitored with the 2.5km of transects from sensitive vegetations (moss, lichen and bog sites) to heavily trampled sites (including close-grazed turf, rides and leaf litter sites). Of the two sites showing incomplete recovery a year after the event, that with detached lichen and moss was known to have a low recovery rate. The other site showing recovery to about half height was an earthbank covered with bracken *Pteridium aquilinum*. This finding is surprising as bracken is a pest species generally considered to be vigorous and persistent and the event took place in November when the bracken was dying back. It may be that the profile of the earthbank caused enhanced foot impact and soil compaction which retarded the next season's growth. It is worth noting that, using the Swedish scale of visual damage, both of these slow recovery sites would be graded as Damage Class 1, not discernable unless the previous condition is known.

The researcher was careful to draw a distinction between her work on a single-day disturbance event and the numerous studies on continuous use or repetitive use experiments (e.g. Bayfield 1979, Liddle 1975). She also noted that the carrying capacity of vegetation depended on the intensity, duration and frequency of the disturbance, together with the plant species, soil type and depth, slope and wetness. Although these environmental factors featured in the choice of transects, in order to monitor a range of vegetation types and habitats, there was no reporting of damage/loading ratios for these variables. The conclusions of the study appear to be over-simplified, effectively reducing the input variable for loading to a single fixed figure – 1200 competitors. Since 17 observers noted the actual numbers of competitors crossing the transects, it is surprising that they did not feature in a quantitative analysis of the impacts. The overall conclusion is that the event with 1200 competitors caused low or negligible impact except where competitors were concentrated at a few sites. The vegetation at these sites, bar two, recovered within a growing season or less. At these two sites, the carrying capacities were exceeded by amounts, which were unspecified, from a number of competitors, which was specified. Notwithstanding these comments, the New Forest terrain shows significant differences in species and soils from the similar elevation lowland heath of the Ambersham Common SSSI and this study usefully complements the data from the latter.

An unexpected bonus arising from this study is that, although it was designed to be orienteering-specific, other activities entered into the observations. In particular, the disruption caused by the deer hunt passing through the test sites on the day before the orienteering event had to be overcome (for which the researcher deserves credit). However, it resulted in observations on the substantial environmental impact of the hunt on the fabric of the Forest. This is of particular interest because a management report the previous year (New Forest Review Group 1988) had concluded that orienteering placed stressful demands on the New Forest and recommended reduced access for the sport, whereas it made no recommendation to restrict hunting, on the grounds that the Review Group had received no formal evidence that the hunts were ecologically damaging.

2.2.7 Trampling of vegetation on moorland in southwest England

In September 1992 a large two-day orienteering event took place on the Burrator Reservoir catchment in the Dartmoor National Park over an area known as Crazy Well. The area is a mosaic of grassland, bracken, valley and blanket bog and heath areas which include some stands of old heather. The blanket bog and old heather areas were considered to be susceptible to trampling and placed out-of-bounds by the Dartmoor National Park Authority (DNPA), which also imposed a limit of 1200 competitors on the event in order to minimise potential damage and disruption.

The DNPA decided that its ecologists would monitor the event to assess its impact on the vegetation and paths. They noted that the area is much used by ramblers and grazed by sheep, ponies and cattle, resulting in many paths with the loss of some vegetative cover, and this would need to be considered in the post-event monitoring of recovery of any damage. Over a six day period, three days immediately prior to the event and three days immediately after, vegetation cover measurements were made in eleven transects set up close to control sites or along paths expected to be used by competitors. The vegetation cover in all transects was predominantly grass, in some cases complete and others with patches of bare soil. The DNPA ecologists had a particular interest in the susceptibility of heather to trampling and noted the presence and condition of any individual heather plants within the transects.

The researcher reported that damage due to the competition was localised but measurable in eight of the eleven transects showing usable results (one transect showed 0% damage and two transects were rejected for reasons unstated). The conclusions were that the study showed "some evidence to suggest that the event had little physical impact on the vegetation throughout the moorland used, but did cause damage in localised areas" (Baldock 1992).

The wording of the conclusion that the event caused vegetation damage invites critical analysis of the detail within the report. Although the monitoring process appears to have been conducted with precision, the results show serious anomalies which are not reflected in the reported interpretations and conclusions. The most evident anomaly is seen in Figure 2, which plots vegetation loss against competitor numbers for the three categories of site monitored.

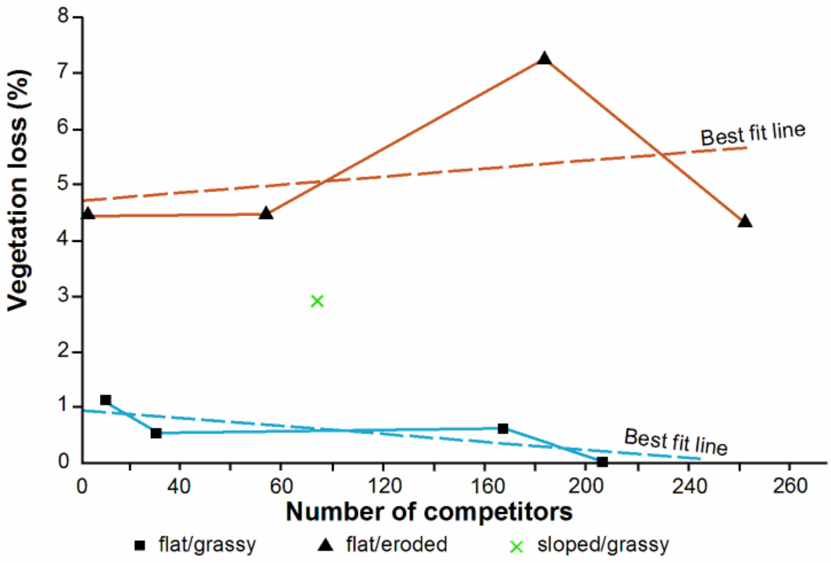

Figure 2 Vegetation loss versus competitor numbers at a Dartmoor orienteering event (Baldock 1992). The regression lines are not in the original report but have been added in this analysis.

The logical basis of any theory of vegetation impact is that, either there is no effect or, if there is an effect, it increases with loading. Neither of the two clusters of results in Figure 2 show any correlation with logical expectation. Indeed, the ‘flat/grassy’ results suggest *declining* damage with increasing competitor numbers. This is a physical impossibility at a single site and illogical as a general finding. Furthermore, both this set of results and that for ‘flat/eroded’ appear to be independent of loading with significant threshold damage values. Baldock’s conclusion that the data indicate that the percentage vegetation cover lost was more closely linked to the type of vegetation and slope than to the number of competitors was not further qualified and does not stand scrutiny. There are two possible explanations for the anomalies of Figure 2. One is that they are an artefact of statistical variation; the other is that the transects were additionally trampled by grazing animals and/or walkers not connected with the event. An indication of this latter possibility is the statement in the report that one transect had 5% manure cover prior to the event and this had increased by the immediate post-event survey a few days later. Therefore, the vegetation loss levels reported (within the range 0-7%, averaging 3%) cannot, with confidence, be assigned wholly to the orienteering event. Perhaps the only reliable conclusion to be formed from this study is that an event with 1200 competitors took place and monitoring indicated low levels of vegetation damage at some sites.

Further anomalies arise with the further study reporting recovery. All the transects were re-visited at 7 and 12 months after the event and the recovery of the vegetation assessed (Baldock 1993). He concluded that “in general, the areas of vegetation loss recorded immediately after the event have recovered well in the subsequent 12 months, even allowing for the other multiple uses of this moorland”. He does not further analyse the final figures but it is possible to do so from data within the body of the report. The caution about other multiple uses of the moor certainly applies two of the transects, one with evidence of grazing animals and the other at a stile where a path crosses a fence. Both of these showed cover continuing to decline after the event. Overall, ignoring these two suspect transects, there was a net gain in vegetation cover 12 months after the orienteering event compared with the cover just prior to the event, amounting to 10.0 ± 9.2 %. It may be postulated that this gain arose from some stimulating mechanism provided by the transient effect of the orienteering event. More likely it was a gain arising from a better than usual growing season during the wet summer of 1993 but the researcher’s decision not to establish experimental controls makes this hypothesis impossible to test. It is also possible that the gain was not real but an artefact of statistical variation.

Notwithstanding the shortcomings of the report this Dartmoor study complements the data about vegetation recovery from other habitats and indicates a generally low impact on vegetation from a large event in a moorland ecosystem, the final conclusion being that the event "appears to have had minimal long-term impact on the vegetation at this site" (Baldock 1993). The study has been considered here in detail because it was conducted by the DNPA ecologists who are also, in effect, the arbiters of whether recreations formally seeking access to Dartmoor are approved and, if so, what restrictions should be applied.

It is important to note that the study was intended to be the first of a series, monitoring orienteering events on Dartmoor with the aim of producing "detailed and accurate information about the effects on vegetation with varying terrain, participant numbers, time of year and type of event. Conclusions from these studies will then be used . . . to formulate policies for future events. It is important to view this report as the first step in the information collection process" (Baldock 1992). However, further research has not been carried out, presumably because it has been recognised that the vegetation damage levels from orienteering are low and short-term.

2.2.8 Discussion of reported research into vegetation trampling at orienteering events

The conclusion to be drawn from the general vegetation impact studies is that orienteering, for events with up to approximately 2500 entrants, has very low impact with rapid recovery. For very large events there is more significant general vegetation impact with sometimes an additional growing season or part season necessary for full recovery to be achieved at the more heavily used sites within the competition terrain. However, given that long-term damage is defined as that persisting for more than ten years, none is reported from any of the studies, including those events with very large entries of 10000 or more. Therefore, with respect to general vegetation impact, the hypothesis that orienteering does cause significant long-term damage is rejected.

In addition to the general vegetation impact on the competition terrain there may be localised areas of more sensitive vegetation sites, such as marshes and lichenose rock. The protection of such areas is normally secured by standard planning procedures which route courses away from them or ensure that carrying capacities are not exceeded. The two studies of lichen both indicated low impact. The one part result which did raise a question of possible long-term damage is the transect containing moss and lichen on a sandy soil at the New Forest event, which had not fully recovered one year after the event.

Whether recovery would have occurred within a decade is unknown. The extent to which this damage is considered significant may be judged by noting that the researcher referred to it only in terms of recommendations for future avoidance and her overall conclusion was that there was very little vegetation damage from the event. With the proviso that there was some uncertainty about this one result, the studies on sensitive vegetation found no significant long-term damage from orienteering to enable the hypothesis to be accepted.

3. <u>Disturbance of large mammals</u>

Liddle (1997) has considered the disturbance of animals and lists a number of recreations against three types of disturbance (Ibid. Table 17.1). Type 1 is the transient disturbance associated with an ephemeral activity. Type 2 is the permanent disturbance arising from habitat modification. Type 3 disturbance is the capture or killing of the animal. Orienteering is an ephemeral activity and is an example of Type 1 disturbance. Table 17.1 in the reference also lists orienteering as a significant Type 2 disturber; this is incorrect and should be accorded zero in this disturbance category.

Concerns about the disturbance of non-avian fauna centre on mammals such as deer. Smaller fauna which are nocturnal or, if abroad in daylight, can retreat to setts, earths, burrows or other shelter are not considered to be significantly at risk from disturbance, although special protection legislation applies in the United Kingdom to badger setts.

A number of studies are reported by Liddle (1997) of the movement of roe and red deer at orienteering events in Denmark. Observations during an event with 700 participants at Pamhule Forest, Denmark produced the eminently predictable result that the deer responded to the presence of the orienteers and sought shelter or left the area. A more useful related study by the same researcher in Kalo Forest, Denmark monitored the movements of seven radio-tagged roe deer. These, when disturbed, sought cover in small, dense plantations or marshes, areas not utilized by the orienteers, within their home ranges and stayed there for two hours until the event was over (Jeppesen 1984). A similar study with red deer had two hinds collared with radios. Both hinds left the orienteering area and crossed open land to a neighbouring plantation, returning to their original range within 24 and 48 hours (Jeppersen 1987). It is suggested in the report that all of these populations are hunted and this could account for the animals' timidity. However, it has to be noted that the reported behaviour of the deer appears to match those of populations in the United Kingdom which are not hunted.

Two additional important studies have been made of the effect of orienteering and other human activities on different deer populations, one in Sweden and the other in the New Forest in southern England.

3.1 Disturbance of elk and deer in Sweden

Sweden has substantial populations of Roe deer *Capreolus capreolus* and elk *Alces alces*. There are approximately one million deer in Sweden. The additional elk population of 250,000 is the highest in any country and 100,000 of these are shot each year (Smorgasbord 2002). Clearly, elk and deer hunting is a major activity whose participants take an interest in any other activity which has the potential for disturbing these animals. A comprehensive study of the effect of orienteering competitions on populations of elk and deer was carried out near the Grimsö Game Research Centre in Sweden (Cederlund, Larsson and Lemnell 1981). The study was a co-operative venture between the Swedish Orienteering Federation, the Hunters Central Association, the Government Conservation Office and the Government Real Estate Office. The behaviour of elk and deer was studied in three competitions: in June 1979 with 1800 participants, in October 1979 with 600 participants and in April 1980 with 2000 participants.

The reactions of elk and deer to disturbance were assessed based on observations of flight length, external signs of stress, physical injury and mortality. The location and movement of the animals were determined by visual observation of marked animals and by radio-location of animals fitted with transmitters. These observations allowed the density and consistency of the population, and its territorial behaviour, to be determined. Some complementary research was carried out to determine the effectiveness of procedures for driving animals from the competition terrain into refuge zones and to test whether tapes used in the competition terrain to delineate out-of-bounds or dangerous features affected animals' flight.

In all three competitions environmental good practice with respect to deer was employed in leaving areas free of the courses to act as deer refuges and in planning the courses so that they progressed in the same general direction to avoid repeated encounters between deer and orienteers appearing from very different directions – known as the 'pinball' effect.

The studies found a significant difference in behaviour between elk and deer. In one test elk took flight at a 'flushing distance' (*using the terminology of bird disturbance*) of about 200m from a confronting, walking small group and moved a 'flight distance', on average around 1300m, before stopping. In another test, 20-30 runners approached from a single direction, flushing the elk at a distance of 200-300m and causing them to take flight for a distance of 1500m. Deer had a similar flushing distance of around 200m but with a much shorter flight length before stopping, an average of 600m. The consequence of this is that, provided that unidirectional course setting is in use, the elk tend to move out of the competition area. Deer, on the other hand, tend to remain in the competition area and seek shelter in small thickets or larger areas set aside as refuges. The observations showed that the elk and deer populations returned to normal within their usual territories within 24 hours. Some elk and deer showed signs of stress. There was no mortality or injury reported.

In the complementary tests with a line of drivers moving forward to drive the animals from the competition area similar results were noted, with elk being flushed at 300m and then taking flight for 1700m and the deer being flushed at 200-300m and then moving 700m. The drive was found to be effective for elk with separations between the drivers of as much as 100m. Deer, however, were as likely to run back through the driving line as run away from it, even with separations between the drivers of as little as 30m. The deer were also seen to clear 1m high obstructions (in this case marker tapes) without difficulty.

This work was a comprehensive and sophisticated study of deer and elk behaviour using radio-location devices. There is a suggestion from the figures that both species, not unexpectedly, regard a line of approaching drivers as more threatening than a group of walkers or runners and take flight further, as a consequence. The key conclusions from the studies are that deer and elk behave differently, the deer remaining in the competition terrain and, for whom, sanctuary areas should be designed into the courses, if not naturally present. The need for parallel, unidirectional courses is made clear. This study makes an important contribution to the knowledge base for two major species.

3.2 Disturbance of deer in the New Forest in southern England

The 1988 orienteering event in the New Forest monitored by Douglas (1989) comprised vegetation trampling observations reported above and extended studies on the sensitivity of the Fallow deer *Dama dama* to the orienteering event, the deer hunt and other human activities. It was intended that the effect of the event on the Fallow deer be monitored by regular checking of the nature of the reaction of the deer to the researcher before and after the event. However, interference by the deer hunt required the monitoring programme to be modified and extended, covering in all a period of 16 months and totalling 72 visits.

Because Fallow deer become accustomed to long-term disturbances that remain within set bounds, the researcher varied the direction of the walks determining deer reaction. This reaction was divided into four categories based on specific actions by the deer, which can then be interpreted as states of nervousness (Table 3).

Category	Reaction	Interpretation
1	Remains on same spot watching	Curious but not bothered
2	Moves to nearest cover, then stands and watches	Considers it wise to take cover
3	Runs away and keeps going	Frightened
4	Puts tail up over back and runs away	Very frightened

Table 3. Deer reaction interpretation according to Douglas (1989)

The researcher reported that the deer appeared normal on both the morning and evening of the orienteering event. During the day, after the first few competitors had passed, the deer moved to unused areas or hid in thick stands of conifers. One deer was hurt by running into a fence during the competition but this incident was seen by a research assistant who reported that the deer was one of a group startled by the appearance of some non-orienteers. The detailed deer reaction measurements showed an elevated reading following the orienteering weekend but this had included the hunt on Saturday before the orienteering event on Sunday. Two further hunt disturbances occurred in the following week but, by three weeks after the event, the deer reaction readings showed full recovery. Since the deer reaction walks showed, not unexpectedly, increased anxiety by deer in the presence and aftermath of the hunt, it was difficult to determine what level of reaction was due to the orienteering event. However, based on her 16 months of observations, Douglas concluded that, had the orienteering event not been compromised by the hunt on the previous day, the deer reaction would have been low, similar to that on a public holiday.

This information about deer disturbance makes an important contribution because it monitors a different species from those in the Swedish study and analyses the deer disturbance and recovery in a quantifiable way. The deer observation reports may be criticised for using over-precise arithmetic averaging of the deer reaction assessments, which are quasi-numerical. For example, two deer reactions of Categories 1 and 3 are averaged to 2.0. Two other deer reactions, both of Category 2, would also average 2.0, but are not necessarily equivalent to the first pair because the categories have not been demonstrated to be linearly spaced. However, although fine detail in the averages may be over-prominent in the tables, the general conclusions about rising and falling of deer reaction in connection with various disturbances appear correctly interpreted.

3.3 Discussion of research into disturbance of large mammals

The reported studies of deer reaction to disturbance by orienteers show that deer readily flee from a disturbance and, if refuge zones are available within or adjacent to the competition area, they will take cover in these and then quickly return to a lowered anxiety level and their normal range after the event. The return to normal behaviour after the New Forest orienteering event was prevented by the deer being disturbed by further hunts. However, the researcher considered that the effect of the orienteering event alone would have been short-lived. Whilst disturbance of deer can expose them to risk, there are few reported examples of deer suffering injury or death as a result of orienteering (Konring 1987, Henderson 1992). These examples may be set against the number of deer-related traffic accidents of 20,000 to 40,000 annually in the United Kingdom (Deer Commission 2001) out of a deer population estimated at 500,000 to 600,000 (Deer Initiative Council 2002).

These results may be used to test the hypothesis that orienteering causes long-term damage to fauna. In the context of fauna it is necessary to discuss the differences between disturbance and damage. If disturbance of fauna is to their long-term detriment, such as reduced population numbers, then it would be proper to refer to 'damage' of fauna. Given the evidence of very low impact on larger mammals from these studies and that orienteering is conducted in accordance with established environmental procedures for mammals it is concluded that, for practical purposes, the hypothesis that the sport is damaging to fauna is unsupported.

4. <u>Disturbance of birds</u>

The most widespread reason, in space and time, for access restrictions on orienteering and other formal activities using semi-natural countryside is the potential for disturbing breeding birds and reducing their breeding success. In the United Kingdom evidence to the House of Commons Environment Committee by the Chief Executive of English Nature, the governmental organisation responsible for nature conservation in England, with respect to access to the countryside for recreation, stated that "the most contentious area remains disturbance on breeding birds" (Langslow1995).

A number of ad hoc observations have been carried out with respect to the disturbance or potential disturbance of birds by orienteering. For example, in the Jukola 1995 relay at Sipoo in Finland with 10,000 entrants concern was expressed about nesting capercaillie *Tetrao urogallus*. The organisers cooperated with local ornithologists to mark the nests in the forest before the competition and the courses were adjusted to avoid the nest sites. One nest was overlooked and, during the competition, some 2500 competitors passed within "a very short distance" (Myllyvirta et al. 1998). However, whilst this and similar observations have practical value in event organisation, they cannot qualify as objective research.

Two research studies on the impact of orienteering on breeding birds have been identified and are reviewed in detail. One is a carefully conducted scientific study by professional ornithologists and has merit, the other, by an amateur ornithologist, is less reliable.

4.1 Disturbance of breeding birds at Brandon Park in Suffolk

In 1991 the British Orienteering Federation, concerned at the increasing restriction of its activities in the stated interests of protecting nesting birds and at the lack of meaningful data on the effect of orienteering on nesting birds, commissioned an environmental consultancy to carry out an independent comprehensive survey at an event (Goodall and Gregory 1991). The event chosen was in Brandon Park, a section of Thetford Forest in Suffolk in May 1991. There were 480 competitors.

The aim of the study was to determine whether the orienteering activity affected the breeding bird community. Given that there was an effect, further questions that arise concern its significance, how long it lasts, whether the different species are similarly affected, and whether it relates to the density and duration of the disturbance.

The monitoring of significant disturbance to breeding birds is complex, not least because it is difficult to define significant disturbance. This might be taken to mean disturbance sufficient to cause a breeding attempt to fail; for example, birds abandoning a nesting attempt, a sitting bird driven from a nest for too long a period so that eggs cool, or that young die of exposure, or that the nest is cleared by predation. On the other hand, following a failed breeding attempt, particularly a failure early in the cycle, birds might have a further breeding attempt in the same season, and succeed. Perhaps the 'correct' definition of significant effect is that which would alter the number and condition of birds at the start of the following year's breeding season. However, even if there is clarity about what is meant by significant disturbance, there is considerable difficulty in measuring it. Except in isolated cases (such as the ospreys at Loch Garten, Scotland) the nests themselves cannot be monitored and deductions have to be made from observations of the number of birds and their behaviour, by both sight and sound.

There might be different responses by different species to a failed breeding attempt. Some might leave the area permanently, with the result that the species' numbers fall and stay low. Some might skulk and then begin re-building after an interval, or new individuals might come in to occupy abandoned territories. These cases would show an initial fall in numbers followed by an increase. A third possibility is an increase in numbers after the disturbance, if birds previously inconspicuous while incubating immediately begin to sing or rebuild.

To take into account these and other possibilities, the study adopted the null hypothesis that the orienteering event would have no significant effect on the breeding bird population. The research methods were designed to disprove this, by demonstrating, in the days immediately following the event:

1. a decrease in numbers of birds detected, with the numbers remaining low or returning to pre-event levels, or;
2. an increase in numbers, with the numbers remaining high or returning to pre-event levels, or;
3. a change of activity, such as an increase in the proportion of males singing and/or an increase in the proportion of females seen.

The fieldwork was also designed to detect any intensity-dependent effect by sampling areas with different levels of orienteering activity.

Care has to be taken because changes in bird numbers and behaviour occur naturally. Nest losses and mate losses are common. Additionally, bird behaviour changes throughout the season. An increase in female sightings in an established territory could be due to the hatching of the clutches, or their loss, followed by rebuilding. To control for these natural variations substantial areas not entered by the orienteers were identified and monitored.

The study had to take note of two further complex variables: the different habitats in Brandon Park and the intensity and location of the disturbance from orienteering activity. These are shown in the maps of Figures 3 and 4.

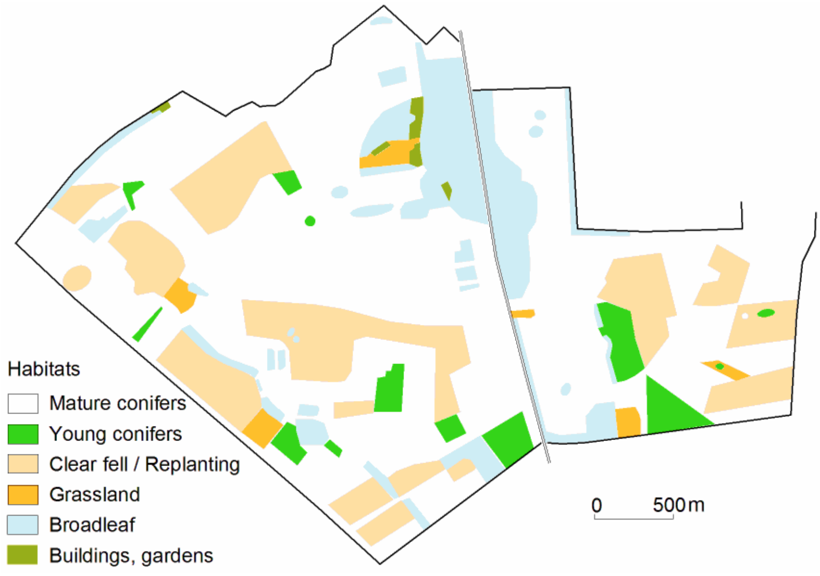

Figure 3. Habitat map, Brandon Park bird study, May 1991 (modified from Goodall and Gregory 1991).

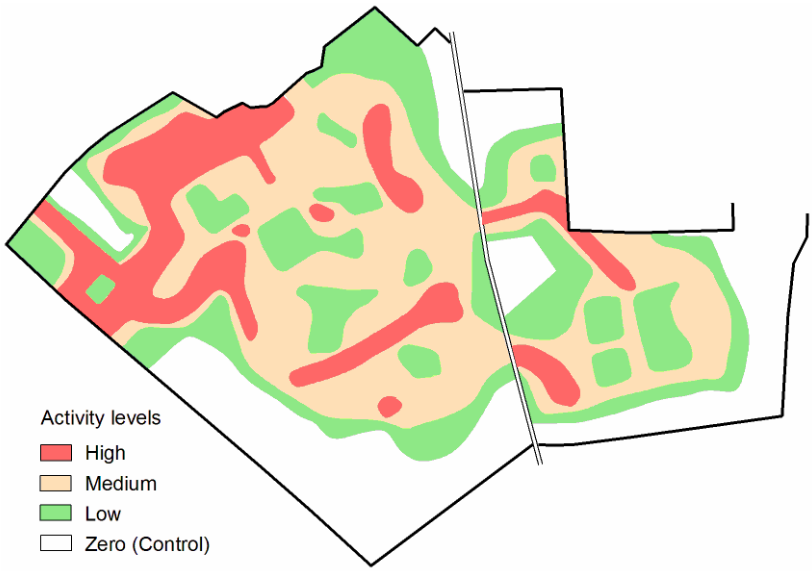

Figure 4. Intensity and location of orienteering impact, Brandon Park bird study, May 1991 (Ibid.).

The intensity map in Figure 4 was prepared from competitors' returns showing the routes they had followed. The activity levels are quantified in the report and are given in Table 4.

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 4. Activity levels at the Brandon Park bird study (Goodall and Gregory1991)

Prior to the event a predicted intensity map was drawn up. This and the habitats map then allowed the researchers to finalise the bird monitoring methodology. It was not required to determine absolute population densities because the survey monitored the same habitat, using the same techniques and the same observers, with a short time interval as the only variable. Three survey techniques were employed: point counts, transects and territory mapping. For the point count survey the observer stood on a marked point for ten minutes and noted the position within a circle of radius of 50m of each species seen or heard, and the general direction of birds located outside 50m. For transect mapping the observers walked at a steady pace along a fixed route, noting the position of all species seen or heard within 50m. For territory mapping the area was extensively monitored and all birds noted for position and activity so as to determine which were holding territories.

The survey took place over a twenty-day period symmetrically spanning the event. A total of 54 species were monitored, comprising canopy-, hole-, scrub- and ground-nesting guilds in roughly equal proportions. About two thirds of the species had individuals within high activity (high potential disturbance) zones. The results of the study were that:

> After intensive survey, none of the methods produced sufficient evidence to reject the original hypothesis, that the orienteering event would have no significant effect on the breeding bird population (Goodall and Gregory 1991, 48).

The authors make the point that that the study area was a lowland pine-dominated habitat with some clear felled areas and young restocks, and small amounts of broadleaf woodland and scrub. Other habitats with different assemblages of species might give different results. Also noted is that this area was used for public recreation, both informal and organised events. The possibility exists that the birds of this, and similar other public access areas, are tolerant of a fairly high level of activity. Additionally, the authors remarked that “this study has demonstrated the possibility that orienteers avoided the more bird-rich (‘forest walk’ and ‘forest fight’) areas and if this preference is true and of general application, it may explain, in part at least, why no disturbance effect could be found" (Ibid., 52).

Because of the importance of this work and the need to demonstrate and discuss the complexity involved in carrying out a bird study of this nature, it has been considered at length in this thesis. It is the most comprehensive study concerning the effect of orienteering on breeding birds. It was rigorously conducted and withstands scientific scrutiny.

The caveats applied by Goodall and Gregory in their conclusions deserve comment. The point about the nature of the habitat and its breeding birds being different from other habitats is valid. The suggestion that a public access forest produces tolerance of high activity in its bird life needs to be qualified. This hypothesis might have validity for birds nesting near tracks and paths, along which nearly all the public activities pass, but not those nesting remote from the paths in clear felled and rough open terrain which is only very exceptionally visited. The study showed these areas had significant orienteering activity but still gave nil returns for disturbance. One of the objectives of the study not achieved was to relate disturbance to dose, except in the sense of disturbance thresholds not reached, in that the activity levels of Table 4 did not produce significant disturbance of the various species.

An important finding in the body of the report but not drawn out in the conclusions or summary concerned the nesting in the area of a highly protected bird, a species listed in Schedule 1 of the Wildlife and Countryside Act 1981. The disturbance of such a bird whilst it is nesting is an offence under Part 1 of the Act:

> Subject to the provisions of this part, if any person intentionally
>
> (a) disturbs any wild bird included in Schedule 1 whilst it is building a nest, or is in, on or near such a nest containing eggs or young; or
> disturbs dependent young of such a bird he shall be guilty of an offence and liable to a special penalty. (English Nature 1994)

The listed bird in Brandon Park was the Woodlark *Lullua arborea* of which at least four pairs were nesting in the clear felled areas. Following a close study of the courses and the likely routes of the competitors some changes to the courses were applied in order to avoid the Woodlark breeding areas. By chance the prediction of the likely routes chosen by competitors was partly in error and two Woodlark territories received medium levels of activity, with up to 50 competitors crossing each. The post-event survey found no change in activity or number or territories of this species. Goodall and Gregory note that this apparent tolerance of disturbance by the Woodlark is consistent with the findings of Van der Zande (1984) for this species in a sand dune area of the Netherlands. The particular importance of the Brandon Park finding, that two nesting Woodlarks were tolerant of medium orienteering disturbance across their territories, is that it represents a study that cannot be set up by design, because any disturbance that might result to a scheduled bird constitutes an offence under the 1981 Act.

4.2 Disturbance of nesting birds in Drumore Wood, Aberfoyle, Scotland

In June 1987 the Scottish Orienteering Championships were held in Drumore Wood (NS4898), Aberfoyle, This wood is a deciduous enclave, mostly of oak *Quercus robur* and *Q. petraea*, in the predominantly coniferous Loch Ard Forest, part of the Queen Elizabeth Forest Park, in turn part of the proposed Trossachs and Loch Lomond National Park. It attracts the interest of the Scottish Wildlife Trust by virtue of its semi-natural vegetation and breeding birds.

Concerns were expressed by the Scottish Ornithologists' Club that the orienteering event, by virtue of its date and the expected number of participants (ca 1000) could result in "potential problems of damage to the vegetation and particularly of disturbance at a critical period for certain ground-nesting birds, including capercailzie and migratory songbirds" (Brackenridge 1988). Discussion with the Scottish Orienteering Association resulted in the ornithologists carrying out a Common Bird Census in a section of the competition area from late April to early July, spanning the day of the event. In this they were assisted by the orienteers who volunteered maps and information about the courses. The orienteers had no part in the design and carrying out of the census or analysis of the results, which was unfortunate, as subsequent serious errors might have been avoided.

Brackenridge reported that torrential rain coincided with the event on what was one of the wettest days of the summer of 1987 in that part of Scotland. The analysis of the nine visits which made up the bird census showed that some birds did abandon territories about the beginning of June. In particular, out of ten redstart *Phoenicurus phoenicurus* territories located in May, only two or three showed birds to be present after the event. The ground-nesting wood warbler *Phylloscopus sibilatrix*, found singing in two or three sites during May, was found only once after the event. Out of five or six tree pipit *Anthus trivialis* territories, only three were certainly maintained.

In his conclusions Brackenridge did not review the results but did observe that:

> The coincidence of two significant stress factors (prolonged human disturbance in an area unused to this, coupled with the heavy rain) obviously does lessen the ability to lay the blame for the local desertion of territory solely on the orienteering event, without a comparative study in an undisturbed plot nearby (Brackenridge 1988).

Although Brackenridge did not review his findings, it is possible to do so now to a limited extent using territorial information given in the report. The concerns about potential disturbance to birds were stated as applying to ground-nesting species. Of the three species which appeared to have abandoned territories around the date of the event, that most affected, the redstart, is not ground-nesting but hole-nesting (Šťastny 1995). Of the two ground-nesting warblers, the wood warbler abandoned one/two territories out of two/three, whereas the willow warbler *Phylloscopus trochilus*, noted in at least thirteen territories before the event, abandoned none. Overall 22 species were listed as holding 132 territories; of these, 5 ground- and low-nesting species were holding 46 territories.

There are difficulties in correlating the above data with the hypothesis implied in the report that the orienteering event would disturb birds to the extent that some, notably ground-nesting species, would desert territories. The much reduced presence of the hole-nesting Redstart after the event is particularly difficult to reconcile. It is not noted as a species sensitive to disturbance and occurs “in proximity to man” (Šťastny 1995, 340). To ascribe the territorial abandonment of this species to disturbance by orienteers demands considerable caution and further evidence is required to do so with confidence. Such further evidence was available to the researcher but apparently not used. Brackenridge reported that the three redstart territories present after the event were all on the eastern edge of the wood and these are shown on the sample census map in Figure 5. No attempt was made to correlate the territorial changes with the routes followed by the different courses. Had the eastern sector been more lightly visited by competitors, for example, then the supposition that greater disturbance elsewhere caused the abandonment would have carried weight.

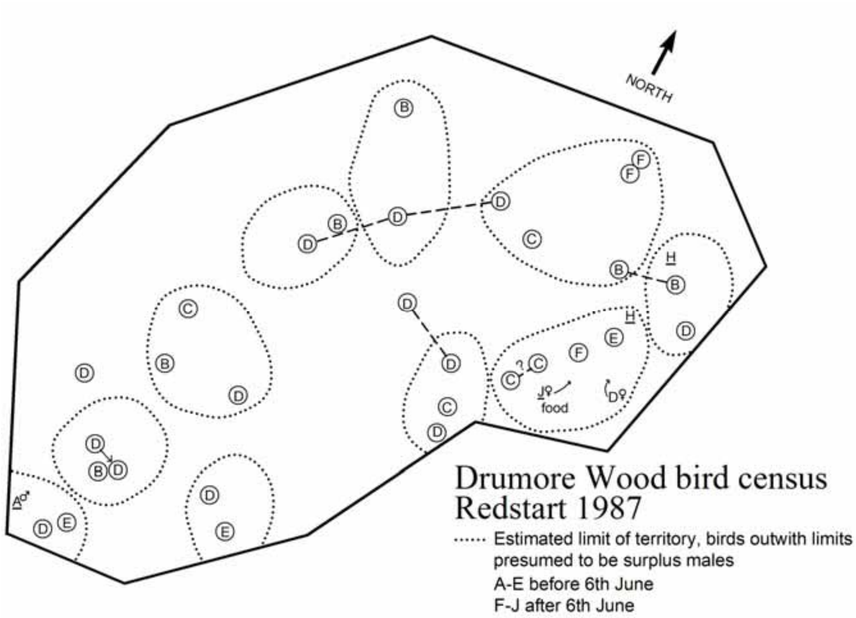

Figure 5. Collected census data for redstart at Drumore Wood (Brackenridge 1988)

The change in the holding of territories by the two ground-nesting species Wood warbler and the willow warbler is not inconsistent with orienteering disturbance. Šťastny states that the wood warbler nest sites are in the shelter of grass or fallen leaves whereas those of the willow warbler are better concealed in brambles or clumps of grass. It could be that the wood warblers nested on ground more suitable for running across by the competitors, who would tend to avoid heavier underfoot vegetation. But the numbers involved, just one or two desertions of territories by wood warblers, are very small and insufficient to give significant support to any particular supposition.

Overall, the abandonment of territories by the five species of ground- and low-nesting birds, those considered vulnerable to disturbance by orienteers, amounted to four territories deserted out of a total of 46. The sharp reduction, eight out of ten, in redstart numbers not thought to be particularly vulnerable to disturbance by orienteers, suggests other agencies. Brackenridge reported that the heavy rainfall must have had a considerable impact on the birds and he acknowledges that the lack of an undisturbed control area in the survey makes it impossible to separate the effects of the two stress factors. However, there appears to be a reluctance in the report, from its presentation and failure to examine critically the results of the census, not to "lay the blame for the local desertion of territory solely on the orienteering event" (Brackenridge 1988). It appears that concerns expressed before the event that it could cause environmental disturbance and damage were underlain by the presumption that it would indeed do so and this has biased the objectivity of the reported work. Despite the flawed nature of the study, the possibility, although unproven, that there was a causal relationship between the abandonment of songbird territories and disturbance by orienteers, has encouraged precautionary action. The Nature Conservancy Council, now Scottish Natural Heritage, following receipt of the report, recommended a policy of no disturbance in Drumore Wood and orienteering events are no longer permitted there.

4.3 Disturbance of nesting Wheatear at Titterstone Clee in Shropshire, England

The upland area of Titterstone Clee in the West Midlands of England supports a population of 40+ migrant wheatear *Oenanthe oenanthe* which is monitored each year by ornithologists. Following an orienteering event with over 1000 competitors on 31 May 1999, at which time the birds were feeding young, the ornithologists reported that four of the nests had been abandoned, due to disturbance by the event.

Investigation showed that these nests were situated in abandoned quarries used by the event for car parking and the competition centre. It was determined that the abandoned nests were under or immediately adjacent to cars and event tentage. Since these were in position for many hours, the disturbance was sufficiently prolonged to cause abandonment. This area had been chosen for good environmental reasons. It minimised the visual impact of the event to other users of the area and it was thought that derelict workings were likely to be of negligible ecological sensitivity. Unfortunately, unbeknown to the orienteers and, indeed, other non-orienteers who also use the area for parking, the wheatear is a ground-nesting bird which nests in holes in rocky ground, such as found in quarries, and even abandoned machinery.

Having been made aware of the problem, the orienteers liaised with the ornithologists to prevent a recurrence. For orienteering events during the wheatear breeding season alternative parking and competition centre locations were identified. Orienteering has since taken place under these arrangements without disturbance of the wheatear. This successful outcome of an ecological problem is cited by recreationists and environmentalists as an example of effective co-operation between different user interests in an area of wildlife and recreational value.

Once the problem had been resolved and the new arrangements shown to be effective, it was realised that rather more ecological information of relevance to disturbance of wheatear and of benefit to orienteers and other recreational users could be derived from the incident. This arises from focussing not on the abandoned nests, for which remedial measures were in place, but on the forty or so other nests in the competition area and which had not been disturbed by the event. Many of these were in areas of high orienteering activity. It was apparent that, if it were possible to quantify the levels of disturbance due to the orienteering activity, then useful research data could be added to the very limited information about ephemeral disturbance of breeding birds in orienteering events.

An analysis using data recovered from orienteering and ornithological archives is reported by Parker (2005). Detailed information about the control sites, the courses and the numbers of competitors on the courses was obtained from the organising club, Harlequins OC. Information about nest locations was obtained from the ornithologists of the Shropshire Wildlife Trust. The sites were plotted on an enlarged (1:18000) copy of the national Ordnance Survey 1:25000 map. Some sites were located on features marked on the OS map and these could be transferred to the orienteering map (surveyed at 1:7500 and printed at 1:10000). The other sites, not on marked features on the OS map, could be identified and adjusted, where necessary, to rocky ground sites on the orienteering map.

Combining the nest site and course information produced the map reproduced in Figure 6:

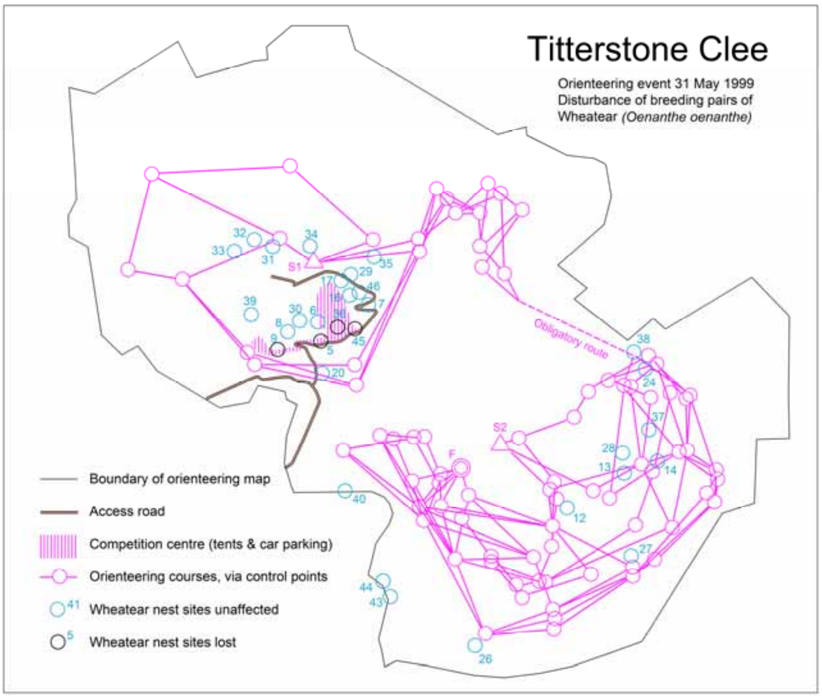

Figure 6. Wheatear nests and outline of the courses at a major orienteering event at Titterstone Clee, 31 May 1999.

To obtain the information about routes followed by the competitors between the control points on the courses, it was not possible to derive this from the orienteers themselves because of the several years elapsed between the event and the analysis. Instead each leg on each course was considered and the most likely route choice determined. Fortunately, Titterstone Clee is an area with detailed terrain testing ground recognition and fine navigation but offering little valid route choice. In legs where paths offered a clear option the positional accuracy of most likely route was better than 5m. Elsewhere off-track the route positional accuracy with respect to nest location was approximately 25m.

The levels of potential disturbance of the birds were determined by using the methods of the Brandon Park bird study, but modified to take account of the doubled numbers of competitors at the Titterstone Clee event. This produced maximum sustained activity rates in the vicinity of nests during the plateau peak of competition as shown in Table 5.

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 5. Maximum sustained activity rates at Titterstone Clee

The top rate of activity is equivalent, were competitors to be evenly spaced, to continuous presence of a competitor within 25m of the nest. Randomness ensures gaps during which, as stated by the ornithologists, the wheatear can ’dodge in to feed their young’. Even so, this activity rate would be considered by most observers as potentially very disturbing and deserving of its ultra high designation.

Analysis of the data showed that five nests were subject to ’Ultra High’ and three nests to ‘Very High’ maximum sustained activity levels, with the remainder at lower levels. All of these nests appeared unaffected by the event and all successfully raised young. The conclusion was that wheatear *Oenanthe oenanthe*, when feeding young, exhibit very considerable tolerance of disturbance. Based on the ornithologists’ advice, this conclusion also extends to wheatear incubating eggs and also to breeding stonechat *Saxicola torquata* which nests in bushes on the Titterstone Clee site.

4.4 Discussion of research into the disturbance of birds by orienteers

The study of the impact of orienteering on birds is a complex issue. The one in-depth study of merit, the Brandon Park research, showed no impact on 54 species from a medium-sized orienteering event and it was unable to reject the null hypothesis that the orienteering event would have no significant effect on the breeding bird population. To what extent this result is likely to be replicated at other sites, at other times and with other species is open to discussion. The event at Titterstone Clee, with twice the number of competitors showed that an additional species, the wheatear *Oenanthe oenanthe,* was tolerant of disturbance levels of more than 200 competitors per hour passing within 25m of the nests. Although not monitored, it is likely, from information given by the ornithologists that the stonechat *Saxicola torquata* on the same site exhibits even more tolerance than does the wheatear. The study also showed that, not unexpectedly, it is possible, in exceptional circumstance, to exceed the tolerance levels of a tolerant species, in this case by pitching tents and parking cars over or immediately adjacent to nest sites and leaving them there for several hours.

Given the above evidence, some land managers might take the view that the restrictions they place on orienteering during bird nesting seasons could be eased. Others might consider that, despite the clear results of the Brandon Park and Titterstone Clee studies, too much uncertainty remains and they would follow the same procedure as at Drumore Wood and, as a precautionary measure, apply the restrictions in full.

Reviewing the hypothesis set in the introduction to this report that orienteering, defined as the running through competition terrain, causes significant long-term damage, in this case to birds, there is no evidence to support it. As to whether there is sufficient evidence to reject the hypothesis is a matter of subjective judgement. Given that the limited evidence so far available indicates that 56 breeding species were, at a particular time and place, unaffected by orienteers, the starting point for any discussion should be that the sport, conducted in accordance with its own environmental procedures, appears to be non-damaging to breeding birds.

5. Further research options

It is apparent from this analysis of research into the environmental impact of orienteering that this is a subject with a great many variables. Therefore, the total of reported research in this field appears sparse. Those managing recreational opportunities in semi-natural countryside may have concerns about the extent to which the lack of objective data on environmental impact is affecting their decision-making on access. Recreationists who consider that their activities are significantly and adversely affected by lack of sound knowledge of their environmental impact regard further research as a prime objective. These views reflect those of analysts:

> The fear of environmental damage by recreationists is still pretty much a presumption, and there has been surprisingly little research undertaken in this area. Until such work has been executed, it is hard to develop a very strong case for exclusion of the public [from nature conservation sites]. (Blunden and Curry 1990, 243)

Some 15 years on, the situation with regard to orienteering-specific research has not advanced to any great extent and these comments remain valid.

Of the three areas of environmental concern discussed in this chapter, the disturbance of large mammals, the trampling of vegetation and the disturbance of birds, it is not likely that further research into the effect of orienteering on large mammals, such as deer, is a prime requirement. The reported studies of the reactions of three internationally widespread species to orienteering disturbance appear to provide sufficient information for current management purposes about the effect of orienteering and similar off-track activities on general deer populations.

With regard to the trampling of vegetation, the conclusions from the studies reviewed point to a generally low impact and rapid regeneration, but there may be reluctance to apply such general observations to specific sites on the grounds that different vegetation communities may have different sensitivities to trampling. The diversity of such communities is extensive. For example, for just woodland alone, Kirkby (1988) identifies as many as twenty communities across the United Kingdom. Additionally, the floristic composition of the field and ground layers within those woodland communities can show further variation arising from significant soil, climate and silviculture differences. Similar considerations apply to heathland and moorland habitats. It is to be expected that there are vegetation communities of conservation value which are widespread in semi-natural countryside and for which data on trampling by orienteering or similar ephemeral activity is absent or scarce. An example of such communities are those in which the dominant component is the heather *Calluna vulgaris* in association with other species, such as bilberry *Vaccinium myrtillus* or western gorse *Ulex gallii*. It appears that the trampling of mature *Calluna* is of research interest and measurements have been carried out (Parker 2005a). It is possible that other trampling research topics with relevance to orienteering could be identified.

With respect to bird disturbance from orienteering activity, research appears to be a clear priority. Formal recreational activities are often severely curtailed in the interests of preventing potential damaging disturbance to bird populations. There are general bans on orienteering during extended bird breeding seasons in many locations. In the United Kingdom, for instance, in the important orienteering area of Cannock Chase, the bird breeding season is deemed to run from April to August (with localised embargoes from the beginning of February) and is likely to extend forward if the trend of milder winters and earlier springs continues to encourage earlier nesting. A similar embargo places the whole of Dartmoor, in south west England, out of bounds to orienteers from the end of February to mid-July. It may be that further research would demonstrate very low disturbance, as at Brandon Park, and that access constraints could be reduced or removed. However, although it might be expected that there should be substantial gains for recreationists from improved clarity on the environmental impact of their activities on birds, there could be a major problem in the unwillingness of conservation bodies to accept studies of the disturbance of birds by ephemeral activities. This arises from their focus of avian research being on long-term viability of bird populations. Such *status* studies do not readily accommodate short-term, one-off disturbances.

Nevertheless, ephemeral potentially disturbing activities do occur and studies of such disturbance cannot be ignored, despite difficulties of correlation. Notwithstanding the possible indifference of conservation bodies in this matter, any research study on the disturbance of birds by orienteering or other ‘pulsed’ activity has to be worth conducting, provided the costs of doing so are low. There is difficulty in justifying significant expenditure from recreational funding if it appears that there is not likely to be return benefit in the short term. Studies which can be carried out at low cost and which yield valid results, however modest, do add to the very incomplete knowledge in this field.

A final caution with respect to researching the ecological impact of orienteering, or any other target activity, is to ensure that the research is not over-focussed and places the observations in context with other recreations and natural impacts. In order to make balanced judgements land managers need to relate any impact that is reported for orienteering to the ecological pressure as a whole on their sites. Also important is that research studies which show no or negligible impact are reported and not abandoned, as is often the case, because they do not provide the expected opportunity for demonstrating data acquisition and analysis skills demanded of dissertation and thesis studies. Nil results have value.

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Note: The annotation of an Environmental Research Paper Number (IOF/Env/ RP***) to certain references indicates that copies of those unpublished and limited circulation documents are held by the International Orienteering Federation and are available for consultation.

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