Bats and lighting.

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Abstract

This report summarises studies on bat vision; discusses the function of rods in the bat retina; looks at the sensitivity of bat rods to visible light, their greater tolerance of red visible light, their sensitivity to ultraviolet light; and explores the differences which exist across the species range. It discusses artificial light, including torchlight, security and floodlighting, as reviews regional and national studies undertaken, mainly by Bat Group members. It tabulates surveys specifically undertaken to inform planning applications for floodlighting in London under the Habitats Regulations 1994 and Planning Guidance PPS9. It looks at types of mitigation that have been used in areas frequented by bats. In short, it summarises what we already know, have known for a long time, questions recent departures from good practice, and appeals for a common - sense approach for the future.

Introduction

Bat biologists have interpreted a bat's behaviour in response to light levels as predator avoidance, when there is actually ample evidence to show that their own eye physiology guide's them to exploit low light levels and avoid disorientating bright light. This evidence is acquired from studying bat electroretinograms (a medical test that measures the retinas response to light) used in ophthalmic research.

This has meant that we are constantly disadvantaged when responding to lighting proposals which are near dark corridors or foraging areas known to be of interest to bats. Our unpublished surveys have failed to establish a protocol defining when surveys and mitigation are required for schemes proposing lighting enhancements, such as floodlighting applications for sports pitches, road widening schemes, decorative and security lighting. Each application has to be argued from ‘scratch’ and is dealt with differently.

Recently there has been a surge in lighting applications in the London region, perhaps due, in part, from release of funds from the Heritage and Sports Lottery Fund. Some of these recent schemes have been approved without an ecological assessment, even though sports pitches are usually on floodplains and in river valleys, which also serve as wildlife corridors. No doubt this pressure will increase as the 2012 Olympic Games draw near.

Bat vision

Vision is very important to bats and observations of bat use of vision are well documented. For example, early emerging bats do not usually echolocate when leaving their roost; they use their vision. On moonlit nights they can avoid capture nets, not by using echolocation but by vision (Wang *et al*. 2004). Microchiropteran bats seem to be farsighted, indicating that vision is used predominantly at long ranges, which is where echolocation does not work so well. Highflying migratory bats switch off their echolocation using their vision, and this is often when they fly into wind turbines (Johnson *et al.* 2003).

On-going experiments on microbats suggest that they may rely on vision more than was originally considered (Elköf and Jones 2003). They revealed that visual cues were more important to foraging brown long-eared bats *Plecotus auritus* than acoustic ones. There were more feeding attempts at dishes that provided only visual cues, compared with those that provided only sonar cues, suggesting that they preferred to locate food by sight. Various studies have revealed that bat vision works better in dim light. There is a wealth of research on bat use of vision, morphological differences including eye shape and size, presence of certain light detecting genes and sensitivity to ultra violet (UV) light as outlined below.

Rods and cones

The human retina, is packed with two types of receptor cells called rods and cones (names reflecting their shape). Cones work in bright light and register detail. Cone - like structures (receptor cells with pedicles) are present in some aerial hawking insectivorous bats such as greater white-lined bat *Saccopteryx bilineata*, lesser white-lined bat *Saccopteryx leptura* and long-nosed bat *Rhynconycteris naso* (Suthers 1970, Chase 1970). Presumably these are early emerging species. Most bats have no cones at all and some nocturnal animals just a few. Rods work in low light, detecting basic motion and basic visual information. The rods are more sensitive to faint light than are the cones.

Based on focal distance and diameter of the dilated pupil, Dietrich and Dodt (1970) calculated that the light - gathering power of the mouse-eared bat *Myotis myotis* is 4-5 times that of man. This suggests that bats can readily use visual cues at dusk, when they normally emerge from their roosts, and probably also under nocturnal conditions (Ellins and Masterson 1974).

Light sampling and emergence times

Our own observations of dusk roost emergence indicate that bats undertake light sampling in the early part of the evening and that prevailing light levels may be a better indication of emergence than time after sunset (Entwistle *et al*.1996). Many bat species including barbastelle *Barbastella barbastellus*, long-eared bats *Plecotus* species and Daubenton’s bat *Myotis daubentonii,* fly internally within their roost voids (barns, churches, caves, culverts and under bridges) prior to their emergence from the building or structure. As light levels dim they will venture out, briefly fly around their point of exit, may pick off a few insects and then return to the roost.

These sorties will be repeated until eventually an exiting bat leaves in a direct manner along its flight path in pursuit of the evenings foraging. Early commentators on this behaviour suggested this was a safeguard from predators. Erkhert (1982) attributes light sampling of pond bat *Myotis dasycneme*, as predator avoidance rather than as a function of physiology.

Delayed emergence can occur during very high pressure systems, which intensify and prolong sunsets (e.g. author’s studies at South Norwood Country Park, 2004; Seething Wells, 2003; Cannon Hill Common, 2005). This can delay emergence considerably and can skew conclusions as to how far bats have travelled from their roost. A finely balanced combination of sunlight, high pressure, dry air dust particles and cloud cover can create a prolonged sunset. Whilst watching bats emerging from a hibernaculum (Tovey and Fure 2003), pressure reached 1,027 millibars, forming a temperature inversion. A band of warm air was able to trap the dust particles in the atmosphere (MaCaskill 2003), delaying pipistrelle emergence to fifty minutes after sunset. When this occurs, a reading of around fourteen lux on a light meter is a more accurate predictor of pipistrelle emergence, than minutes after sunset. Below one lux (moonlight) is necessary for Daubenton's emergence (author's data, 2006)

Emergence times varied considerably amongst bat species. Light tolerance has been estimated by measuring the luminance of light stimuli required to provoke electroretinogram responses in three species of Vespertilionidae: the mouse-eared bat (Dietrich and Dodt 1970)*;* serotine *Eptesicus serotinus* (Bornschein 1961, cited in Elköf 2005); and big brown bat *Eptesicus fuscus* (Hope and Bhatnagar 1980) and three species of Phyllostomidae: vampire bat *Desmodus rotundus*; short-tailed fruit bat *Carollia perspicillata* ; and Jamaican fruit bat *Artibeus jamaicensis* (Hope and Bhatnagar 1980). Among the vespertilionids, the big brown bat showed the highest light tolerance, whilst among the phyllostomids, which generally responded to lower luminance levels than the vespertilionids, the Jamaican fruit bat showed the highest tolerance to light. This reflects the time at which these species normally emerge in the evening, and to what extent they are exposed to bright light (Hope and Bhatnagar 1979).

As may be expected from a retina consisting predominantly of rods, the visual sensitivity generally declines as the ambient illumination increases towards daylight. This indicates that the bat eyes work better in dim light than in bright light. This has been verified behaviourally by Bradbury and Nottebohm (1969), who found that the little brown bat avoids obstacles better under ambient illuminations resembling dusk, than they do in bright daylight. The eyes of Microchiroptera work well under low ambient illumination, although the sensitivity to different light levels and the ability of brightness discrimination vary considerably between the different families and species (Eklöf 2005).

Ultraviolet light

Recently, it has become clear that bats from Central and South America that feed on the nectar from flowers can see ultraviolet light, which is more abundant at dawn and dusk. The colour-blind long-tongued nectar bat *Glossophaga soricina* is sensitive to UV down to a wavelength of 310 nm (York *et al* 2003). As bats generally lack cone pigments in their eyes, the flower bats capture the ultraviolet with the rhodopsin of their rod pigments. The researchers discovered this ability while keeping the bats in an environment with computer - controlled artificial flowers equipped with small signal lights. Flower - visiting bats seem to need UV vision, because the flowers they visit in the rainforest are characterised by a strong reflection of light at night.These bats can see ultraviolet due to the fact that a UV filter is lacking from their eye lenses. Normally, the UV absorbing lens protects a mammal's eye from UV radiation. UV light not only damages the retinal cells, but also it causes an out-of-focus image on the retina of the eye. Studies of vespertilionid bat species (see below), demonstrate that short wave frequency light (UV) is most disturbing to them.

Empirical Studies

Bat workers participate in the National Waterways Daubenton's Survey NWDS (part of the National Bat Monitoring Programme run by the Bat Conservation Trust). Part of the protocol for this includes a torchlight scan of the water surface to verify bat passes. In a research project undertaken to establish whether this light actually repelled some of the bats, Monhemius, (2001) found that the reduced number of Daubenton's passes when using torchlight was significant. The most accurate count was achieved with a red filter on the torch used to count bats. She concluded that in order to count this species accurately the torch should only be turned on once a bat is heard on the bat detector, for a minimal period, and should be held stationary rather than scanning the surface of the water.

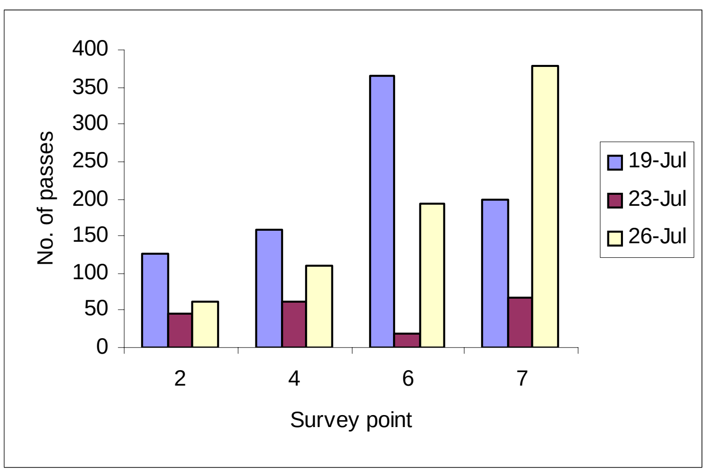
During my own NWD Survey, along the Thames between Richmond and Kingston bridges are several potential "light barriers" that might affect the foraging activity of Daubenton's bats. At Teddington, the Lock itself is brightly lit and few bats have been recorded at this location. At the last three NWD recording stations along the river at Kingston upon Thames, few bats are found now that waterside and bridge lighting has increased (Table 1). Daubenton's bats particularly have not been recorded on the Kingston side of the river at these three stations, which are monitored by the author, despite their presence at all others. It is known they overfly the brightly lit bridge, as one was hit by a car (perhaps dazzled by headlights) and taken by the driver to Putney RSPCA (2004). It is only upstream of Ravens Ait that Daubenton's bats begin to use the river again for foraging in any number (Fure 2004).

Table 1 Daubenton's Waterway Survey numbers of passes as approaching Kingston town centre (includes 'unsure species' passes over water)

Position	2000 2 visits		2002 2 visits		2004 2 visits		2005 2 visits	
Opposite Steven's Eyot	0	0	0	0	4	0	0	1
First plane tree after Boaters Inn	0	0	0	0	1	3	0	3
At 'No mooring' sign	0	0	0	0	2	7	5	0
After seat in memory of Ernest Leggett	**0**	**2**	**0**	**0**	**1**	**2**	**3**	**0**
In front of two lime trees	**0**	**0**	**9**	**0**	**10**	**4**	**10**	**3**
On lower path in front of large plane tree	**16**	**27**	**0**	**0**	**6**	**3**	**12**	**2**
Thameside, opposite parking ticket machine at rear of Osiers Court	**1**	**0**	**0**	**0**	**8**	**2**	**0**	**0**
Lower portion of John Lewis shop's frontage	0	0	0	0	0	0	0	0
South of Kingston road bridge	0	0	0	0	0	0	0	0
Between Woolworths and Bradford & Bingley	0	1	2	0	0	0	0	0

In summer 2004, The National Trust invited the Surrey Bat Group to carry out surveys at Claremont Landscape Garden, Esher (TQ130633), in order to assess the impact on bat activity of annual open-air concerts held in the grounds. It was decided to conduct surveys using bat detectors on three evenings, before, during and after the concerts. Concerts, followed by firework displays, were held in the Garden on the evenings of 22, 23 and 24 July 2004. Bat surveys were conducted on 19, 23 and 26 July 2004, between 21.00 and 22.30.Heterodyne bat detectors were used to record the number of bat passes at these points during each ten minute period throughout the survey.
To check that bat passes were not missed by surveyors on the night of the concert owing to the loudness of the music, the number of passes heard by the surveyor directly in front of the stage was compared with the number recorded on the minidisk. Numbers of bat passes at all survey points were much lower on the night of the concert than on the other two nights. It seems that the bats (mainly Daubenton's) had moved feeding site, possibly as a result of the floodlighting of the island and western side of the lake (Table 2).

Table 2. To show the total number of bat passes during the survey period at each survey point after Surrey Bat Group, 2004 (23 July is the night of the concert).



The conclusion that it is the lighting and not the noise which causes most disturbance to bats is consistent with Mann *et al*. (2002). They found that human activity in caves can affect bats adversely especially bats that assemble in maternity colonies. They assessed the responses of 1,000 *Myotis velifer* by manipulating noise and light intensity. They found that light intensity affected bat behaviour most. All bat responses were highest in trials with high light intensity and lowest with no light. Perhaps every bat group now has their own local examples.

The Lancashire Bat Group found, during surveys of a canoe pool, that Daubenton's bats were deterred from feeding over the water when it was in use, though they foraged on nights when the lake was not floodlit (Graham 1996). Street lights have been found to cause a decrease in the numbers of Daubenton's bats and cause them to alter their flightpaths (Jones 2000). Similar studies are outlined in Table 3. Some show a continuously lit portion of a park remaining unused by bats where others highlight a with/without lights comparison.

I have only found the Natterer's bat *M. nattereri* at few locations in our region feeding in areas devoid of lighting such as : Surbiton Fishponds (2003); Seething Wells (2001-03); Thames at Hampton Water Works (2001); Canbury Gardens (2003); and a SW London park (dawn swarm, 2005). Infrared filming (Hoare 2004) showed Natterer's bats first emergence from their roost 57 minutes after sunset. It is rarely that surveyors wait as long as an hour after sunset for bats to appear during emergence surveys.

At the Seething Wells Public Inquiries between 1998 and 2003, unchallenged evidence was given regarding the effect of lighting on bats on their foraging areas and commuting routes (presented by Guest 1998) and effect on roosts (presented by Fure 2004). The inspector upheld the evidence on both occasions and the appeals were dismissed. This was one of the few areas on which all parties were agreed, and it was hoped that written evidence, would have an 'independence' which could be used as a standard of accepted 'best practice'. In 2004, this evidence was cited by an inspector during a separate UDP Inquiry, to designate Seething Wells Metropolitan Open Land (UDP Inspector's Report 2001).

Table 3: Reduction of bat activity in London parks and open spaces due to the effects of light spillage from offsite sources, Authors data1999-2005

Unpublished survey results: Brightly lit portions of open space where no bats were found in otherwise busy foraging areas.:	**Fairlop Country Park** 2004 Golf Course Driving range Details: Whilst bats fed around the lake within the tree canopy, they were not found over the illuminated sections of golf course
	Claybury Park 2005 Security Lighting Small numbers of bats are found near the woodland and pond areas, but not near the newly developed areas.
	Goodmayes Park 2005 Halogen security lighting Bat activity is restricted to the northern and central avenues of trees and the water body north of the bridge.
	Valentines Park 2005 Security, neon and floodlighting Three areas of the park are affected by lighting : two affect the perimeter, but the hotel lighting penetrates deep into the park (Fig. 3-4)
	Epsom Common 2003 Golf course driving range lighting restricts the movement of bats across Rushett Farm
With/without	**Wimbledon Park** 2005 Floodlighting around the athletics stadium affects the activity of 4 species of bat on the nights when it is used
With/without	**Kingston Recreation ground** 1999-2003 Reduced bat activity, especially absence of Natterer's bats when the football stadium is in use.
Without With (no data)	**Muswell Hill** bat swarming and feeding area.

Unfortunately, it is members of the public, and not our statutory authorities, who seem to be constantly fighting a rearguard action against those developers who want to illuminate our open spaces. Successes include: Ham Lands LNR, floodlights1998 and subsequent appeal dismissed; Ham Lands floodlighting, 2001 and subsequent appeal dismissed; and Hart's Boatyard (Site of Metropolitan Importance), 2003 and 2004 appeals dismissed, but with modifications a 2005 appeal was allowed. The desire to light up current dark open spaces and "dark corridors" is highlighted by current proposals including: Kneller Gardens proposals, 2005; Bishop's Park by Fulham Football Club 2005 and Barnes Sports Fields adjacent to the WWT London Wetland Centre (Site of Special Scientific Interest), 2001; and possible illumination of Richmond Bridge (Fig.1) (Site of Metropolitan Importance), 2005.

In summary, bats lack cones in their eyes. Rods allow bats' eyes to receive more light. They are reliant on vision not only when travelling, but also for certain types of feeding as in gleaning (e.g. brown long-eared bat). Bat vision works best in dim light. This vision can be interrupted by greater luminance, thus causing disruption in natural patterns of movement and foraging. This light sensitivity varies between species, but generally tolerance of red visual light is greater than white light. Infrared light has less impact and we can use this to watch and film bats. Some species lack ultraviolet filters in their eyes which means their eyes would be damaged if they emerged during the day.

Emergence times from roosts appear to provide a surrogate for the differing light tolerance through the range of species. Those bats which emerge late in the evening such as *Plecotus* and *Myotis*, particularly the Natterer's bat, have a reduced tolerance to lighting. As intensity of light increases, even species which are relatively light tolerant are delayed in emergence from their roost. Where bat species are found, care should be taken to ensure that roosts, foraging areas, and corridors for movement of these species are not affected by light pollution.

Light avoidance by bats has been interpreted as a predator- evading strategy. This is only partly true and failure to appreciate the wider impact of light pollution on bat behaviour may affect the conservation of a protected species. Physiological and empirical evidence indicates that planning applications should require surveys and demand remediation in 100% of cases.

Why and when are bat surveys requested?

All British bats are included on Schedule 5 of the 1981 Wildlife and Countryside Act (as amended). This Act was amended by the Countryside and Rights of Way Act 2000. Under this Act, it is an offence:

- to intentionally or recklessly damage, destroy or obstruct access to any structure or place used (by bats) for shelter or protection
- to intentionally kill, injure or take bats
- to intentionally or recklessly disturb bats whilst in their roosts
- to sell, barter or exchange bats (live or dead, whole or in part)
- to publish an advert to buy or sell a wild bat

All British bats are also included on Schedule 2 of the Conservation (Natural Habitats) Regulations 1994 (otherwise known as the Habitats Regulations). Under this legislation it is an offence:

- to deliberately kill or take bats
- to deliberately disturb bats
- to damage or destroy the breeding or resting place of any bat

As bats reuse roosts, legal opinion is that the roost is protected whether the bats are present or not.

Under current planning guidance (PPS9) the Government expects all planning authorities to give very careful consideration to whether an operation is likely to damage the special interest features of a SSSI, and, to consult Natural England. A planning authority should be able to demonstrate that it has clearly considered the likely effects of an operation, and therefore whether it is duty bound to notify Natural England as required by the Act. The planning authority should bear in mind the possibility that certain developments may affect a site some distance away. For example, a wetland site might have its water table lowered as a result of water abstraction some considerable distance away; presumably offsite floodlighting should be considered to have a similar impact.On Page 7 of the Guidance it is stated 'that, before planning permission is granted, adequate mitigation measures are put in place'. Table 4 outlines some of the examples where lighting surveys have been undertaken in the London region.

Table 4: Selected requests for bat surveys, in the London region, prior to and post lighting applications 2002-2005 (authors data)

	Application Type	**Requested by**	**Specially designed lighting columns**	**Planning conditions on use.**
Requests for bat surveys due to lighting improvements prior to planning permission being granted.	A tennis club Richmond 2002	Local Planning Authority	Yes	Yes, restricted times, near flight line
	A football club Hillingdon 2003	English Nature	No as no bats were found on the night of the surveys.	No information
	A sports club Ealing 2004	LPA	Yes	Spillage restricted due to proximity of bat foraging area
	A school in Muswell Hill 2003	English Nature	Not known	Suggested, Lights off 1 hour after sunset. Spillage restriction
	A park in South Norwood 2004	LPA	No, as no bats were found on the night of the surveys.	

Mitigation.

Use of planning conditions

Conditions are an important way in which planning authorities can influence the design of lighting installations and mitigate their impacts. In relation to lighting, such conditions include: hours of illumination; light levels; column heights; specification and colour treatment for lamps and luminaires; the need for full horizontal cut-off; no distraction to the highway; levels of impact on nearby dwellings; use of demountable columns; retention of screening vegetation; use of planting and bunding to contain lighting effects; erection of demonstration luminaires; and review of lighting impacts after installation. More could be made of the use of light sensors which are activated when they are needed. They are less wasteful of energy, and are considerate of Health and Safety obligations.

Type of lighting

The impact on bats can be minimised by: using low - pressure sodium lamps instead of high - pressure sodium or mercury lamps; fitting mercury lamps with UV filters; maintaining the brightness as low as legally possible; limiting the times during which the lighting can be used to provide some dark periods; directing the lighting to where it is needed to avoid light spillage; and minimising upward lighting to avoid light pollution. 45 per cent of our lighting is currently low pressure strong yellow lighting. These are gradually being replaced with high - pressure sodium lights. In Kingston upon Thames we have a strange mixture in some roads with the high pressure lights over strategic points such as pedestrian crossings. Light can be restricted to selected areas by fitting hoods which direct the light below the horizontal plane, at preferably an angle less than seventy degrees. Limiting the height of lighting columns to eight metres and directing light at a low level reduces the ecological impact of the light. This advice would not apply on highways, where research (Highways Agency, 2005) suggests that taller lighting columns have less impact on bats as they are less likely to suffer road collisions if they have been foraging near lights. Some companies now use sophisticated software such as CalcuLuX, to design lighting solutions. Luminance Pro Lighting Systems Ltd, based in Surrey, has for many years been designing and manufacturing to minimise light spill and subsequent glare to the neighbouring environment. Information can be factored into a design to calculate *vertical illuminance*. Data such as bat flight paths and roosting/hibernation areas may also be incorporated. The results from these calculations are used to adjust the lighting column positions and heights to ensure, if necessary, a suitable compromise between the sport and the environment is reached. This technique requires the selection of luminaires such as HiLux projectors which dramatically reduce light spill and glare outside an intended area, this allows designs to meet these high standards.

The current drive to improve safety by modernising sports facilities in parks and rural areas requires specialist design services: to ensure minimal impact on the environment including the night sky (sky glow). HiLux luminaires are widely used in standard applications such as: sports pitches, athletics tracks and tennis courts as well as being suitable for parks and ‘Areas of Outstanding Natural Beauty’ where facilities for sport and young people are being specified.

Light curfews

A light curfew was imposed as a planning condition on a tennis club in Richmond (author's data 2002).The curfew exists for one hour after sunset throughout April to September to allow bats to complete their passage along a nearby hedgerow. However, residents attest that the lights are turned on regardless of whether or not the tennis courts are in use (a lesson for imposing future conditions). Generally, within the months May to October, areas used by bats should not be illuminated outside after 8.30pm and the lighting of buildings should be limited to special occasions. If it is considered necessary to illuminate a building where roosting or commuting bats pass by, the lights will need to be switched off at bat emergence time and during peak bat activity times (Jones 2000). Road or trackways in areas important for foraging bats should contain stretches left unlit to avoid isolation of bat colonies.

Screen planting and vegetation.

This can help screen light pollution considerably. For example, light pollution onto a Site of Grade 1 Nature Conservation Importance in Redbridge was made worse when bushes considered to "harbour burglars" were removed (Fig.2). Unfortunately, one of the fastest growing species to shield light pollution is Leyland cypress hedging, so it is best not to remove boundary planting in the first place. Tree canopies and their overhang near waterbodies should be retained for foraging bats as they create dark shadows. Evening emergence of Daubenton's bats and initial foraging is often under willows overhanging water, or structures which cast large shadows. It is well established in literature that this species moves roost frequently especially during the winter, may range widely during their foraging (10-15kms) and may feed throughout the night, yet these principles are never considered when managing waterside trees in London Parks where Daubenton's bats *have not* been recorded. By applying the above ecological principles 'has not been recorded' really means 'the tenacity of the survey was insufficient to find this species'.

By surveying outside of the *usual* recording season, *Myotis* species have been discovered in previously unrecorded sites using many London waterbodies (author's data, Kensington Gardens, 21 October, 2004; Cannon Hill Common 21 October, 2005). Mitigation should always be implemented for those trees with large canopies which are to be felled near water as this will be of potential habitat loss to foraging bats in the early part of the evening when light levels are high. In an urban area the loss may be total as removing waterside trees allows artificial light penetration throughout the night (Fig.3). In any event mitigation for the loss of the prostrate willows should recognise the multiplicity of uses by a large range of species, not just bats, for shelter, feeding, and perching.

A Case study

This is reproduced from the Department of the Environment (Transport and the Regions) to show how mitigation can look in practice. It is a Golf Driving Range, in Binfield, Berkshire where there was an application for planning permission to install floodlights on the club building and along the perimeter fence of the driving range. The local parish council objected on the grounds that the lighting would cause light pollution and disturb the rural, undeveloped character of the landscape. Planning officers eventually approved the application but responded to the concerns of the local community by enforcing a series of conditions designed to prevent light pollution and limit the environmental impacts of the lighting.

Under the conditions, the floodlights are switched off at 9.30pm during the winter months and the levels of illumination close to ground level are restricted to comply with the levels recommended in the Institute of Lighting Engineers (1992). Earth bunds have been constructed around the perimeter of the range and trees planted to reduce overall visibility and the impact of the floodlighting, which is mounted on the driving range building and on 8m columns or fencing posts along both sides of the range. (Fig. 4 Demonstrates light penetration from a Surrey golf course driving range onto a local nature reserve). Bats did not feature in the mitigation for the application at all.

These safeguards may be appropriate for generalist bat species such as pipstrelle, who can cope with light levels above 14 lux. But what of the *Myotis* species such as Daubenton's emerging when light levels fall below 1 lux. Are we tenacious enough in our surveys to even find this species of bat, going out in all seasons of the year, rather than the April to September period. Do we survey late enough in the evening to find Natterer's bats?

Floodlighting should never be appropriate near open water or rivers which act as feeding areas and flyways for bats (and other species). Our rivers should be maintained, without fail, as dark corridors. Even when safeguards for floodlights are put in place, there is no enforcement of restrictions. When new organisations take over premises their obligations under planning consents do not seem to be inherited. I live forty metres from a floodlit athletics stadium and football club. When the lights are in use in the evenings, I can read a newspaper in my bathroom which registers >2 lux on the light meter. On dark winter mornings the floodlights are used during the daytime. These lights impact on the

Hogsmill River corridor, which should be maintained as a dark corridor for wildlife; including its bats, water voles, kingfishers and the small sand martin colony which has used the drainage holes in this catchment since the 1960's.

It is extremely rare to see refusal of floodlighting based on the protection of an area designated for wildlife, but this would be the single most important contribution to many of our local Biodiversity Action Plan targets. When we fail to deal with this issue we ascribe false virtue to the activities contained in many of our species action plans, particularly for bats.

Fig. 1 Richmond Bridge

Fig. 2 Light pollution from the school

Fig. 3 Light pollution over the Lake at from Valentine's Park from 700m.

Fig. 4 Golf driving range across Horton Country Park

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