An Pilot Survey of Glow-worms (*Lampyris noctiluca*) on the Wessex Downs (UK)

Lucas Wilkins

July 2026

Abstract

Here we present the results of a pilot glow-worm survey along the Ridgeway, a path that runs along northern edge of the Wessex downs. We discuss the potential effects of population fragmentation by roads, historical human activity and artificial lighting, and lay out a plan for a more thorough survey in 2027 that should yield more conclusive results.

1 Introduction

The common glowworm *Lampyris noctiluca* are nocturnal beetles, well known for the bioluminecent signals of the females. The adult females are laviform and therefore flightless, emerging from underground burrows during twilight, staying in close to them but moving to higher ground to signal. Upon mating they stop their signaling behavior.

The Ridgeway is an ancient thoroughfare in Southern England, approximately 140km in length, starting in Avebury, Wiltshire and ending at Ivinghoe Beacon, Buckinghamshire. In the area we surveyed it runs along the Northmost edge of the chalk hills comprising the Wessex Downs, neighboring the lower lying clay planes of the Vale of the White Horse. The path varies in width between about 5m and 20m, and is bordered by tall grass, hedgerows or both. In this section it passes through predominantly arable land and is inaccessible to traffic other than farm vehicles. This makes it both a good habitat for *Lampyris noctiluca*, and a natural transect.

The habitat along the surveyed section of the Ridgeway is largely consistent, but the occurrence of glow-worms is variable. There are many possible reasons for this.

Agricultural activity has the potential to affect populations through the use of pesticides that affect either the glow-worms or their food (principally snails), or via mechanical disturbance during harvesting or plowing. Roads are often a barrier for the movement of animals between different areas [1], and as the females are slow and flightless we would expect them to have a significant effect.

Artificial Lighting at Night (ALAN) is known to affect many animals, including insects [2] and glow-worms specifically have been shown to be detrimentally affected in a lab setting [3]. The type of lighting that most affect glow-worms is likely different to other species. Glow worms have two major adaptions that would effect this: they have green-blue opponency which likely serves to distinguish between their mates and other sources of light [4], and they have a pronotal shield that they can extend over their eyes, reducing light intensity, and modifying its' spectral distribution [5]. The western half of the transect lies within a dark-skies area, it runs closer to populated areas (Wantage, and Harwell Science Park) towards the east.

The grass around the path along the Ridgeway is cut in the months in which the glow-worms display. Whilst this didn't appear to prevent their display, there were a number of glow-worms that were obscured by the layer of cut grass that was left over from cutting. Additional factors that might be relevant include exposure to wind, predation, and geographical features such as slopes.

2 Methods

Counts of the number of visible (glowing) females were made along sections of the Ridgeway, between 10pm and 11pm. As it would be impossible to cover the entirety of the area with the resources at hand, different sections were visited on different days. One section, located directly east of Sparsholt Firs, was visited regularly to provide a temporal control for the others.

Glow worms were counted in sections distinguished by natural geographic features. It would have been preferable to record individual locations or pick sections with even lengths, and this has lead to narrow spikes in the histogram for sections that were comparatively small. Unfortunately, as an extemporaneous survey that extended making a entry for the national glow worm survey, our initial recordings began, and therefore continued, with their recording methodology.

2.1 Analysis

The counts were used along with the length to obtain a density of observations, and the counts at the control site were linearly interpolated to get a comparable estimate. This, of course, assumes that time-course of emergence is consistent across the different sections. Whilst this affected the density numerically, it did not appear to have any qualitative effect on the overall results (see figure 6).

Some parts of the survey deviated from the main path (see figure 6). For presentation, the recorded paths were projected onto intervals along a single route. The density of observations was calculated using the recorded length of survey sections, not its projection onto the main route.

2.2 Lighting

To quantify the extent of artificial lighting we identified the major sources artificial light visible from the Ridgeway, and converted their nearest perimeter into a path expressed in terms of latitude and longitude. Then, for individual locations we calculated the nearest light source and its distance. As light radiates according to the inverse square law, we used the square distance to nearest major light source as a measure of absence of artificial lighting / darkness quality.

Whilst this is rather crude and does not include information about the brightness of the source, it qualitatively captures the differences between sites (see figures 2 and 6). The A34 was excluded from this measure; whilst it is bright and sometimes visible, it passes through a cutting, and in most locations it lies below the horizon.

3 Results

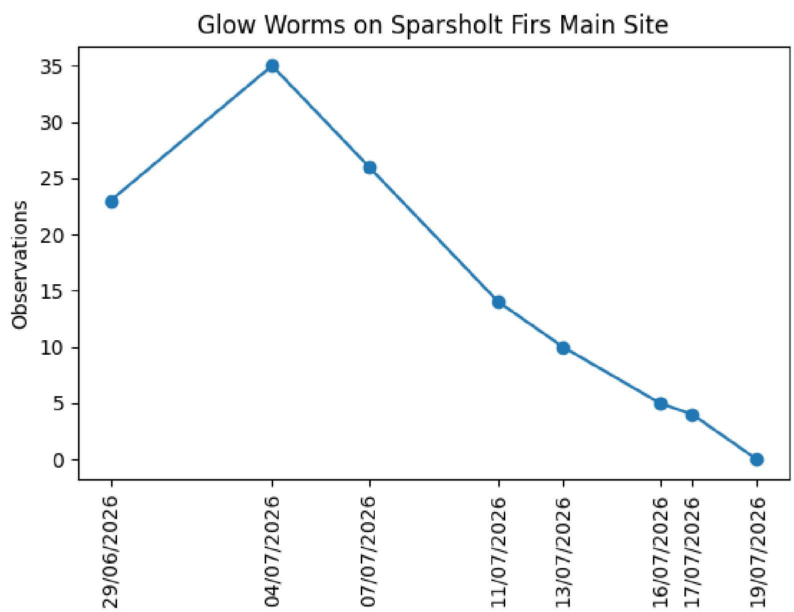

Figure 1: Timeseries of observations at the Sparsholt Firs site, showing a peak at the start of July and a steady decline. Whilst we did not mark any glow worms, it was evident from their locations we were recording the same glow worms on different nights, suggesting that the ones that remained later on were unsuccessful in mating.

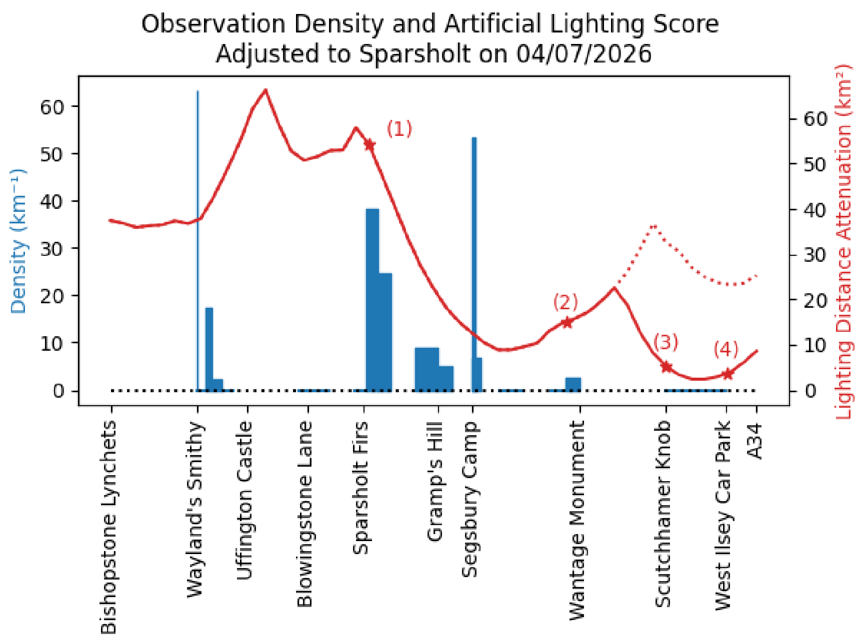

Figure 2: Observed density of glow worms with temporal correction to the Sparsholt site. The blue histogram shows the density of observations and the red line shows a measure of darkness quality and the numbered points show the positions of the photographs in figure 6. The dashed red line shows the measure of darkness quality, as it would be if Harwell science campus was not present. The two sharpest peaks in density correspond to locations that are perpendicular to the main path. These areas were recorded on an ad hoc basis and included only the areas where glow worms were present, therefore, the density is inflated relative to sections decided by geographical features.

The longest section over which glow-worms were consistently observed was east of Sparsholt Firs and up to Segsbury Camp, in this section there were glow-worms at every site visited. Westward From the road at Sparsholt Firs, up to Uffington castle, we made no observations. This is curious as the area seems ideal.

The most populous section (Sparsholt Firs) neighbours a site where no glow-worms were observed, and is separated by a road (B4001). This suggests that this road is significant barrier to movement, and has fragmented the population. When populations are isolated like this, the become more vunerable [1], and we speculate that that this barrier is one factor preventing recovery of a glow-worm population west of the B4001. As there is no part of the female life-cycle in which they can fly, it seems reasonable to make the assumption that glow-worm populations expand relatively slowly, meaning that it is quite plausible that historical human factors, such as the use of pesticides, have had a long lasting effect on the populations.

We recorded a small number of glow-worms around Wantage Monument, but no more to the west of this location. Much like the Sparsholt Firs site there is a road crossing the Ridgeway, we surveyed both sides on the same day. Glow-worms were only present on the eastern side of the road, once again suggesting that roads are a significant barrier for population expansion.

The more Easterly locations were surveyed later in the season, but still whilst glow-worms were displaying at the Sparsholt Firs site. These locations are closer to human activity, and have a much lower index of darkness quality. It is unclear how much of an effect that artificial lighting has on these populations, and it is difficult to say anything conclusive, but the results are at consistent with it playing some role.

3.1 Improvements

There are a couple of things that would need to be improved in any future survey.

Recording only a count over a certain area makes analysis difficult. Whilst considering densities improves the comparability of different sections of the Ridgeway, it is far from ideal. If we frame this in a statistical setting where we are estimating a latent density, the variance of this estimate will be higher for shorter sections, or in other words, we have greater noise where the sections used for counting/recording are shorter. Whilst most sites were recorded only once, simple counting discards information about whether we are counting the same individuals on different days. It would be much better to record the exact location of individuals. It seems that they are spread out enough for a GPS coordinate to identify them in the majority of cases.

Whilst correcting densities based on the time series at a single location is better than nothing, it is no substitution for doing contemporaneous surveys. It could well be the case that different populations appear at different times and/or have different dynamics.

4 2027 Survey

In 2027 we are planning a more thorough survey than 2026, which will require more resources. As before, it will have two components, a transectional component and a temporal component.

4.1 Transectional Survey

We will survey the same section of the Ridgeway, but attempt cover the whole extent in a single night. Ideally, we will do this weekly, starting in mid June. The aim would be to start the survey at a specific time, say 10:30pm, and

It would be preferable that people survey in pairs. 5km is probably the longest that anyone can walk with a slow enough speed to pay attention,

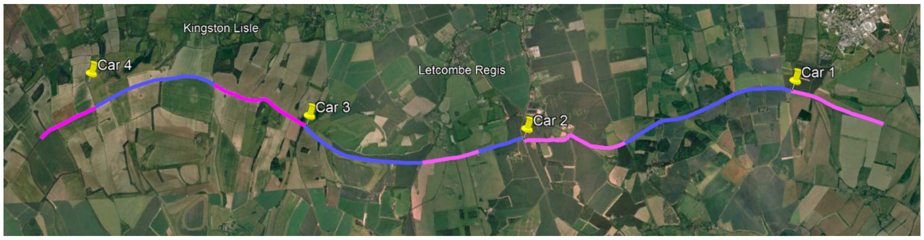

Figure 3: Sections of the Ridgeway between possible pick-up/drop-off locations.

within the time when glow worms will be signalling. It seems logistically possible to achieve this with 4 cars with 5 people in each, for some cars this will entail having specific driver who does not do the walk and relocates to a pick up point. Obviously, this can be re-arranged to suit the participants, but it gives some idea of numbers: ≈ 20 volunteers.

Surveying multiple times will make it possible for different people to visit different sites, so hopefully nobody misses out on seeing glow worms.

4.1.1 Recording

It would be best if we could get GPS coordinates for each sighting, rather than a total count. We should be able to find/make an app that will allow people to do this with their phones.

4.2 Temporal Survey

At the Sparsholt site we will monitor the most populous stretch every day once glow worms appear. Here we will use markers in the ground to record individual females, and make an assessment of the prevalence of males using an LED lure [6]. Whilst the lure does not injure the males, it is preferable to measure the prevalence of males in the most populous section to minimise any disruption. For the recording of female locations, the marker only need serve as a reference for a photograph of the location – one patch of grass looks a lot like the next.

5 References

References

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6 Supplementary

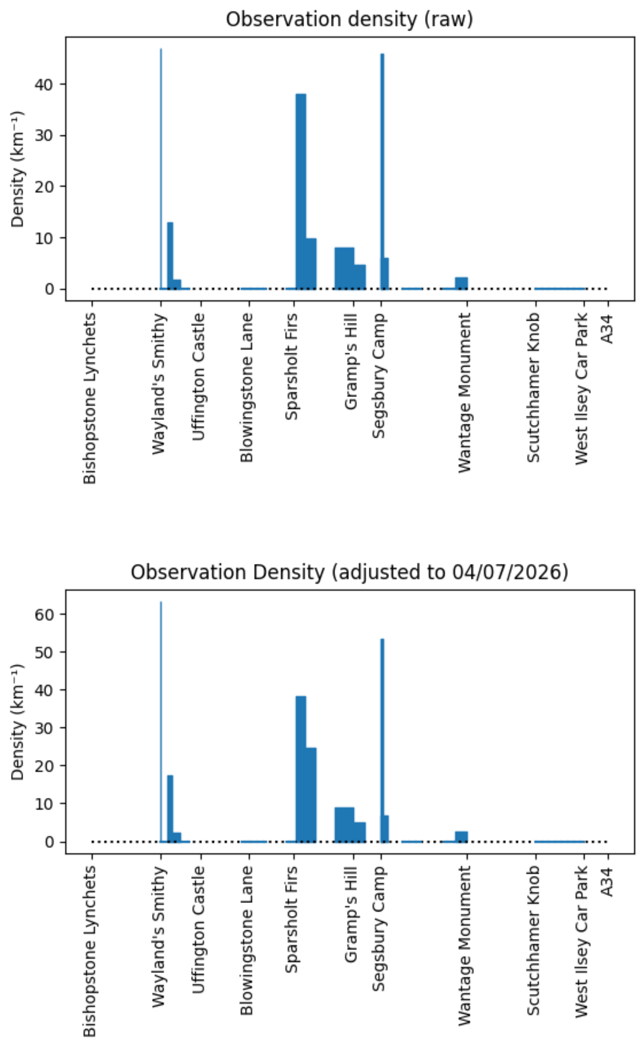

Figure 4: Density of observations with (right) and without (left) the temporal correction.

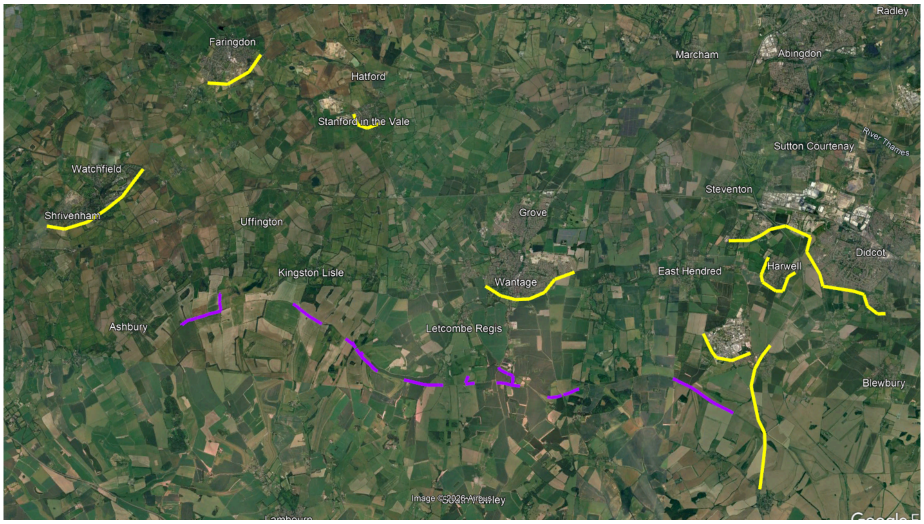

Figure 5: Surveyed locations (purple) and sources of artificial light used for calculating the measure of artificial lighting.

Figure 6: Photos taken along the Ridgeway (marked on 2)