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Age of enlightenment: long-term effects of outdoor aesthetic lights on bats in churches

Jens Rydell, Johan Eklöf and Sonia Sánchez-Navarro

Article citation details
R. Soc. open sci. **4**: 161077.
http://dx.doi.org/10.1098/rsos.161077

Review timeline

Original submission:	4 January 2017
1st revised submission:	29 March 2017
2nd revised submission:	15 May 2017
3rd revised submission:	12 July 2017
Final acceptance:	12 July 2017

Note: Reports are unedited and appear as submitted by the referee. The review history appears in chronological order.

Note: This manuscript was transferred from another Royal Society journal without peer review.

Review History

RSOS-161077.R0 (Original submission)

Review form: Reviewer 1 (Steve Langton)

Is the manuscript scientifically sound in its present form?
No

Are the interpretations and conclusions justified by the results?
Yes

Is the language acceptable?
Yes

Is it clear how to access all supporting data?
Yes

Do you have any ethical concerns with this paper?
No

Have you any concerns about statistical analyses in this paper?
Yes

Recommendation?
Accept with minor revision (please list in comments)

Comments to the Author(s)
An important contribution to the literature on bats and lighting that is well worth publishing. However, the current analysis needs revision since you have used only techniques for unpaired data, even though you describe the study as 'essentially a pairwise comparison'. In addition, Figures 2 and 3 look superb, but aren't actually very good at conveying information to the reader; they need replacing by more functional conventional barcharts, either stacked with respect to the categories of bat presence, or separate bars with standard errors. (See Appendix A.)

Review form: Reviewer 2

Is the manuscript scientifically sound in its present form?
No

Are the interpretations and conclusions justified by the results?
Yes

Is the language acceptable?
Yes

Is it clear how to access all supporting data?
No

Do you have any ethical concerns with this paper?
No

Have you any concerns about statistical analyses in this paper?
Yes

Recommendation?
Major revision is needed (please make suggestions in comments)

Comments to the Author(s)
Age of enlightenment: effects of aesthetic lights on brown long-eared bats in churches

Rydell et al.

General:
This is a short and clear paper, which provides useful information on a subject of great conservation importance. It shows that artificial illumination of historical buildings, churches essentially, is detrimental to Plecotus bats in Sweden, as long as all building walls and sides are lit. The analysis is based on both longitudinal data (churches previously unlit that have been equipped with floodlights in between, and how this correlates with abandonment by bats) and a comparison of contemporaneous lit vs unlit churches in terms of occupancy by bats. Although these findings have clear implications for bat conservation management, the analysis might be a bit too much simplistic. In effect, merely splitting the churches in two categories (lit vs unlit) might mask further underlying mechanisms that may be as detrimental to bats as light

installation. In particular, church illumination often takes place simultaneously to general restoration work, and the transformation of attics and roofs might under some circumstances represent a greater risk than equipping the building with floodlights. I am quite convinced that the authors are right in blaming artificial lights but in the absence of information about that other potentially confounding factors such architectural change it is difficult to be conclusive. I thus suggest the authors to provide more information on renovation history.

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Perhaps the title should make clear that this is about outdoor aesthetic lights.

Introduction
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51– Should be "For nocturnal animals such as most bats"
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- Emergence from roost - Downs et al 2003 Biol. Cons. 111: 247-252
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101 – Good that this is noted, but perhaps address this point in the discussion. There is some evidence that tree cover can mitigate negative lighting effects on bats, e.g.:

- Mathews et al 2014 Phil. Trans. R. Soc. Lond. B 370
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Materials and methods:
– needs something about the statistics and software, even if they were very basic.

Results:
Figs 2/3 – A nice graphic, but it is difficult to extract the actual numbers of churches from it. Is the % of churches with bats indicated by the end point of the church roof?

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Discussion
Very good – nice caveats regarding other disturbance linked to lighting, such as renovation, but I would like to see real data on that. Try also to better assess the possible effect of other confounding factors, ruling them out from rationale if no data at hand.

Decision letter (RSOS-161077)

08-Mar-2017

Dear Dr Rydell,

The editors assigned to your paper ("Age of enlightenment: effects of esthetic lights on brown long-eared bats in churches") have now received comments from reviewers. We would like you to revise your paper in accordance with the referee and Associate Editor suggestions which can be found below (not including confidential reports to the Editor). Please note this decision does not guarantee eventual acceptance.

Please submit a copy of your revised paper within three weeks (i.e. by the 31-Mar-2017). If we do not hear from you within this time then it will be assumed that the paper has been withdrawn. In exceptional circumstances, extensions may be possible if agreed with the Editorial Office in advance.We do not allow multiple rounds of revision so we urge you to make every effort to fully address all of the comments at this stage. If deemed necessary by the Editors, your manuscript will be sent back to one or more of the original reviewers for assessment. If the original reviewers are not available we may invite new reviewers.

To revise your manuscript, log into http://mc.manuscriptcentral.com/rsos and enter your Author Centre, where you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions," click on "Create a Revision." Your manuscript number has been appended to denote a revision. Revise your manuscript and upload a new version through your Author Centre.

When submitting your revised manuscript, you must respond to the comments made by the referees and upload a file "Response to Referees" in "Section 6 - File Upload". Please use this to document how you have responded to the comments, and the adjustments you have made. In order to expedite the processing of the revised manuscript, please be as specific as possible in your response.

In addition to addressing all of the reviewers' and editor's comments please also ensure that your revised manuscript contains the following sections as appropriate before the reference list:

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If your study uses humans or animals please include details of the ethical approval received, including the name of the committee that granted approval. For human studies please also detail whether informed consent was obtained. For field studies on animals please include details of all permissions, licences and/or approvals granted to carry out the fieldwork.

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If you wish to submit your supporting data or code to Dryad (http://datadryad.org/), or modify your current submission to dryad, please use the following link:
http://datadryad.org/submit?journalID=RSOS&manu=RSOS-161077

• Competing interests
Please declare any financial or non-financial competing interests, or state that you have no competing interests.

• Authors' contributions
All submissions, other than those with a single author, must include an Authors' Contributions section which individually lists the specific contribution of each author. The list of Authors should meet all of the following criteria; 1) substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approval of the version to be published.

All contributors who do not meet all of these criteria should be included in the acknowledgements.

We suggest the following format:
AB carried out the molecular lab work, participated in data analysis, carried out sequence alignments, participated in the design of the study and drafted the manuscript; CD carried out the statistical analyses; EF collected field data; GH conceived of the study, designed the study, coordinated the study and helped draft the manuscript. All authors gave final approval for publication.

• Acknowledgements
Please acknowledge anyone who contributed to the study but did not meet the authorship criteria.

• Funding statement
Please list the source of funding for each author.

Once again, thank you for submitting your manuscript to Royal Society Open Science and I look forward to receiving your revision. If you have any questions at all, please do not hesitate to get in touch.

Yours sincerely,
Alice Power
Editorial Coordinator
Royal Society Open Science

on behalf of Kevin Padian
Subject Editor, Royal Society Open Science
openscience@royalsociety.org

Comments to Author:

Reviewers' Comments to Author:
Reviewer: 1

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Author's Response to Decision Letter for (RSOS-161077)

See Appendix B.

RSOS-161077.R1 (Revision)

Review form: Reviewer 2

Is the manuscript scientifically sound in its present form?
No

Are the interpretations and conclusions justified by the results?
No

Is the language acceptable?
Yes

Is it clear how to access all supporting data?
Not Applicable

Do you have any ethical concerns with this paper?
No

Have you any concerns about statistical analyses in this paper?
No

Recommendation?
Major revision is needed (please make suggestions in comments)

Comments to the Author(s)
First, I must say I am not satisfied with the way the authors replied to reviewers' comments in general. They should have detailed the operated changes in their 'rebuttal' letter in a more specific way. This means the reviewer is redirected to the whole text that must thus be appraised in full a second time. Time demanding...

Second, although the new version is certainly ameliorated, I think there remains a serious problem: no quantitative data is provided regarding renovation work which was probably carried out between the two very distant temporal surveys at several churches (and not

necessarily in parallel to floodlight installation). I had suggested to add such quantitative information. If not available currently, it can certainly be retrieved from parish and/or community registers. Without info about this potential confounding factor, the authors cannot be conclusive in my opinion. I therefore urge them to complete their dataset and analysis by incorporating this crucial info.

Third, at the least the main objectives of the comparison should be made clearer in the introduction, with framing some general questioning of the sort:

"Given the potential impact of exterior lighting installations on the persistence of bat colonies in churches, we undertook a study to address the following questions:
1) Does the frequency of colony presence differ between churches lit by flood lights and churches that were not lit?
2) Do the frequencies of colony presence differ between churches that were once dark, but subsequently lit, and churches that have remained dark over time?

As far as we know this is the first study of the long-term consequences of the installation of aesthetic lights on buildings with bat colonies."

The fact that the study has pioneer character in a very important conservation field and in addition uses long-term data may justify publication despite the caveats described under point 2, but the whole would benefit for a better guidance of the reader about the intentions of the article.

Decision letter (RSOS-161077.R1)

03-May-2017

Dear Dr Rydell:

Manuscript ID RSOS-161077.R1 entitled "Age of enlightenment: long-term effects of outdoor aesthetic lights on bats in churches" which you submitted to Royal Society Open Science, has been reviewed. The comments of the reviewer(s) are included at the bottom of this letter.

Please submit a copy of your revised paper within three weeks (i.e. by the 26-May-2017). If we do not hear from you within this time then it will be assumed that the paper has been withdrawn. In exceptional circumstances, extensions may be possible if agreed with the Editorial Office in advance.

Please ensure that you fully address the concerns of the referees and explicitly describe how you have addressed these in your point-by-point response. We do not generally allow multiple rounds of revision so we urge you to make every effort to fully address all of the comments at this stage. If deemed necessary by the Editors, your manuscript will be sent back to one or more of the original reviewers for assessment. If the original reviewers are not available we may invite new reviewers.

To revise your manuscript, log into http://mc.manuscriptcentral.com/rsos and enter your Author Centre, where you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions," click on "Create a Revision." Your manuscript number has been appended to denote a revision. Revise your manuscript and upload a new version through your Author Centre.

When submitting your revised manuscript, you must respond to the comments made by the referees and upload a file "Response to Referees" in "Section 6 - File Upload". Please use this to

document how you have responded to the comments, and the adjustments you have made. In order to expedite the processing of the revised manuscript, please be as specific as possible in your response.

In addition to addressing all of the reviewers' and editor's comments please also ensure that your revised manuscript contains the following sections before the reference list:

• Ethics statement
If your study uses humans or animals please include details of the ethical approval received, including the name of the committee that granted approval. For human studies please also detail whether informed consent was obtained. For field studies on animals please include details of all permissions, licences and/or approvals granted to carry out the fieldwork.

• Data accessibility
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• Competing interests
Please declare any financial or non-financial competing interests, or state that you have no competing interests.
• Authors' contributions
All submissions, other than those with a single author, must include an Authors' Contributions section which individually lists the specific contribution of each author. The list of Authors should meet all of the following criteria; 1) substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approval of the version to be published.

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AB carried out the molecular lab work, participated in data analysis, carried out sequence alignments, participated in the design of the study and drafted the manuscript; CD carried out the statistical analyses; EF collected field data; GH conceived of the study, designed the study, coordinated the study and helped draft the manuscript. All authors gave final approval for publication.

• Acknowledgements
Please acknowledge anyone who contributed to the study but did not meet the authorship criteria.

• Funding statement
Please list the source of funding for each author.

Once again, thank you for submitting your manuscript to Royal Society Open Science and I look forward to receiving your revision. If you have any questions at all, please do not hesitate to get in touch.

Sincerely,
Andrew Dunn
Senior Publishing Editor
Royal Society Open Science
openscience@royalsociety.org

on behalf of Kevin Padian
Subject Editor, Royal Society Open Science
openscience@royalsociety.org

Comments to Author:
Reviewer: 2

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The fact that the study has pioneer character in a very important conservation field and in addition uses long-term data may justify publication despite the caveats described under point 2, but the whole would benefit for a better guidance of the reader about the intentions of the article.

Author's Response to Decision Letter for (RSOS-161077.R1)

See Appendix C.

RSOS-161077.R2 (Revision)

Review form: Reviewer 3 (Gareth Jones)

Is the manuscript scientifically sound in its present form?
Yes

Are the interpretations and conclusions justified by the results?
Yes

Is the language acceptable?
Yes

Is it clear how to access all supporting data?
Yes

Do you have any ethical concerns with this paper?
No

Have you any concerns about statistical analyses in this paper?
No

Recommendation?
Accept with minor revision (please list in comments)

Comments to the Author(s)
This is an important paper for evidence-based conservation. The effects of artifical lighting on biodiversity have been much researched in recent years, but almost all studies to date have focussed on streetlights, with little consideration of building lighting. The results of this study clearly support the hypothesis that artificial light directed on the outside of historic buildings such as churches can cause bats to desert roost sites. These traditional roost sites my have been occupied for decades or longer, and if bats move to new sites, there is a high chance that their fitness may be lowered. This is important as bats have high levels of protection in Europe, and intentionally disturbing roosting bats can be a criminal offence. The paper will therefore provide evidence that will provide better protection for bat roosts. The study is based on a unique and large long-term data set, but has implications for the conservation of light-sensitive bats worldwide. It also suggests that careful lighting and mitigation may be successful, permitting a win-win situation for both bats and churches. The manuscript has been reviewed before, and the authors have dealt with renovation as a possible confounding variable with care. The writing style is concise and clear, and I have only a few suggestions for further improvement.

1. Is the likelihood of detecting bats in churches dependent on time of the summer, and was the timing of visits (across months) similar in the historic and 2016 datasets?
2. A few suggestions to improve English a) line 126, change ;'spotted' to 'observed'; b) line 261 'rephrase 'On the lighter side' as this is ambiguous in the current context; c) reference 30 should be 'Schoeman'.
3. Around line 222 I would make more of the implications for light-sensitive species. Zeale et al. (2016) showed that light inside churches 'traps' bats (Myotis nattereri) inside roosts. I suspect that the species listed on 222 will be sensitive to external lighting in the same way as Plecotus studied here, and buildings used by these species should not be subjected to external lighting as a precautionary measure.
4. Some of the figure/table legends can be improved. There is no legend to Fig. 1, there is no description of how to interpret the ESM, and the grid lines should be removed from the graphs.

5. The suggested cover image is highly relevant and stunning.

Decision letter (RSOS-161077.R2)

26-Jun-2017

Dear Dr Rydell:

On behalf of the Editors, I am pleased to inform you that your Manuscript RSOS-161077.R2 entitled "Age of enlightenment: long-term effects of outdoor aesthetic lights on bats in churches" has been accepted for publication in Royal Society Open Science subject to minor revision in accordance with the referee suggestions. Please find the referees' comments at the end of this email.

The reviewers and Subject Editor have recommended publication, but also suggest some minor revisions to your manuscript. Therefore, I invite you to respond to the comments and revise your manuscript.

• Ethics statement
If your study uses humans or animals please include details of the ethical approval received, including the name of the committee that granted approval. For human studies please also detail whether informed consent was obtained. For field studies on animals please include details of all permissions, licences and/or approvals granted to carry out the fieldwork.

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If you wish to submit your supporting data or code to Dryad (http://datadryad.org/), or modify your current submission to dryad, please use the following link:
http://datadryad.org/submit?journalID=RSOS&manu=RSOS-161077.R2

• Competing interests
Please declare any financial or non-financial competing interests, or state that you have no competing interests.

• Authors' contributions
All submissions, other than those with a single author, must include an Authors' Contributions section which individually lists the specific contribution of each author. The list of Authors should meet all of the following criteria; 1) substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approval of the version to be published.

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• Acknowledgements
Please acknowledge anyone who contributed to the study but did not meet the authorship criteria.

• Funding statement
Please list the source of funding for each author.

Please note that we cannot publish your manuscript without these end statements included. We have included a screenshot example of the end statements for reference. If you feel that a given heading is not relevant to your paper, please nevertheless include the heading and explicitly state that it is not relevant to your work.

Because the schedule for publication is very tight, it is a condition of publication that you submit the revised version of your manuscript within 7 days (i.e. by the 05-Jul-2017). If you do not think you will be able to meet this date please let me know immediately.

To revise your manuscript, log into https://mc.manuscriptcentral.com/rsos and enter your Author Centre, where you will find your manuscript title listed under "Manuscripts with Decisions". Under "Actions," click on "Create a Revision." You will be unable to make your revisions on the originally submitted version of the manuscript. Instead, revise your manuscript and upload a new version through your Author Centre.

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When uploading your revised files please make sure that you have:

1) A text file of the manuscript (tex, txt, rtf, docx or doc), references, tables (including captions) and figure captions. Do not upload a PDF as your "Main Document".
2) A separate electronic file of each figure (EPS or print-quality PDF preferred (either format should be produced directly from original creation package), or original software format)
3) Included a 100 word media summary of your paper when requested at submission. Please ensure you have entered correct contact details (email, institution and telephone) in your user account
4) Included the raw data to support the claims made in your paper. You can either include your data as electronic supplementary material or upload to a repository and include the relevant doi within your manuscript
5) All supplementary materials accompanying an accepted article will be treated as in their final form. Note that the Royal Society will neither edit nor typeset supplementary material and it will be hosted as provided. Please ensure that the supplementary material includes the paper details where possible (authors, article title, journal name).

Supplementary files will be published alongside the paper on the journal website and posted on the online figshare repository (https://figshare.com). The heading and legend provided for each supplementary file during the submission process will be used to create the figshare page, so please ensure these are accurate and informative so that your files can be found in searches. Files

on figshare will be made available approximately one week before the accompanying article so that the supplementary material can be attributed a unique DOI.

Once again, thank you for submitting your manuscript to Royal Society Open Science and I look forward to receiving your revision. If you have any questions at all, please do not hesitate to get in touch.

Best wishes

Alice Power
Editorial Coordinator
Royal Society Open Science
openscience@royalsociety.org

on behalf of Kevin Padian
Subject Editor, Royal Society Open Science
openscience@royalsociety.org

Comments to Author:
Reviewer: 3

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Author's Response to Decision Letter for (RSOS-161077.R2)

See Appendix D.

Decision letter (RSOS-161077.R3)

12-Jul-2017

Dear Dr Rydell,

I am pleased to inform you that your manuscript entitled "Age of enlightenment: long-term effects of outdoor aesthetic lights on bats in churches" is now accepted for publication in Royal Society Open Science.

You can expect to receive a proof of your article in the near future. Please contact the editorial office (openscience_proofs@royalsociety.org and openscience@royalsociety.org) to let us know if you are likely to be away from e-mail contact. Due to rapid publication and an extremely tight schedule, if comments are not received, your paper may experience a delay in publication.

Royal Society Open Science operates under a continuous publication model (http://bit.ly/cpFAQ). Your article will be published straight into the next open issue and this will be the final version of the paper. As such, it can be cited immediately by other researchers. As the issue version of your paper will be the only version to be published I would advise you to check your proofs thoroughly as changes cannot be made once the paper is published.

In order to raise the profile of your paper once it is published, we can send through a PDF of your paper to selected colleagues. If you wish to take advantage of this, please reply to this email with the name and email addresses of up to 10 people who you feel would wish to read your article.

On behalf of the Editors of Royal Society Open Science, we look forward to your continued contributions to the Journal.

Best wishes,
Alice Power
Editorial Coordinator
Royal Society Open Science
openscience@royalsociety.org

Appendix A

Comments on 'Age of enlightenment: effects of esthetic lights on brown long-eared bats in churches'

General thoughts

This is a very useful study providing valuable evidence of conservation importance. However, it needs some relatively minor changes to the presentation and discussion, and some more fundamental revision to the statistical analyses. Fortunately, the results are sufficiently clear-cut that the main conclusions are unlikely to be altered by the changes to the analysis.

Specific points

Title, line 26, line 78, line 106: the words 'esthetic', 'esthetical' and 'aesthetical' are all used. I would suggest using 'aesthetic' in all cases, reflecting the most common usage in British English. When first used in the text, it might be sensible to expand on this, explaining the main features of the lights considered. In lines 111-114 you contrast the lights with 'weaker non-directional lights', but it would also be worth distinguishing them from floodlights used for security purposes. The latter are frequently mounted high, illuminating downwards, whereas the lights used for aesthetic reasons in Figure 1 point upwards to illuminate the building. I wonder if this difference is important to the bats. See the comments in ref 9 on 'sky glow'.

Introduction: the introduction is very focussed on predation, whereas other recent papers have described a broader range of impacts from lighting, including positive as well as negative effects. For example, see the recent paper by Lewanzik & Voigt in J. Applied Ecology.

Line 104: 'therefore most of the variation remained constant over the study period'. The word 'therefore' doesn't seem appropriate. Maybe rephrase along the lines of 'it is likely that there is comparatively little temporal variation in habitat and other potential confounding variables'.

Line 143: 'loud' seems an odd word to use in the context of the quiet calls of this species. Perhaps 'relatively loud'?

Statistical issues

Fisher's exact test: according to line 103 the 'study is essentially a pairwise comparison', but all formal testing uses Fisher's exact test, which is not appropriate for paired data. To exploit the power of the pairwise design, McNemar's test is needed. Alternatively, mixed models could be used, with a random term to allow for the pairing; this offers a number of advantages (e.g. paired and unpaired data could be included in the same analysis), but is perhaps excessive given the size of the dataset and the bias in the initial sample. Fisher's exact test is, of course, perfectly valid for analyses using just one of the periods, since there is no pairing of the data.

Line 164: including the church where lights had been non-functional for many years in the illuminated group seems counter-intuitive.

Line 186: 'md' needs to be written in full (could be either median or mode).

Line 170-175: This seems to be the key evidence presented, but it currently not backed up by any statistical test. This is where McNemar's test is needed to show that the decline is greater in those churches where lighting has been installed, compared to those where it hasn't. Also, since there was some bias in the original selection (line 87), a decline might result from regression to the mean (i.e. natural turnover could bring the upwardly biased sample back down towards the mean).

Hence it is vital to consider these figures in the context of those from the same sample that were unlit, as indeed is done verbally in lines 181-183.

Figures 2 and 3: whilst these figures look very attractive and might be ideal for a press release or infographic, I don't think they are a good way of conveying the information to a scientific audience. Comparing the relative heights of standard bars is much easier for the reader than is the case with complex shapes such as the church silhouettes. Using stacked bars would make it clear that those with fresh remains were a subset of those with colonies present. Also, it is necessary to read the caption to understand the figure properly (I misunderstood it until I read the caption properly), whereas a standard bar chart with a legend and proper labelling of the axes could be easily understood at a glance by a reader flicking through the paper (and of course that is what we all have to do most of the time, due to the volume of published literature).

Supplementary material: the data is a bit messy with lots of question marks and plus symbols. It would be better to convert to numeric or categorical columns as far as possible, with a comment column to explain anything else. Otherwise it is difficult for the reader to be able to understand how the question marks are interpreted, and hence the analyses cannot be easily reproduced. Use a standard date format.

Steve Langton (stats@slangton.org.uk)
25/1/17

Appendix B

Response to reviewers

Our response in red

Reviewers' Comments to Author:
Reviewer: 1

Comments to the Author(s)
An important contribution to the literature on bats and lighting that is well worth publishing. However, the current analysis needs revision since you have used only techniques for unpaired data, even though you describe the study as 'essentially a pairwise comparison'. In addition, Figures 2 and 3 look superb, but aren't actually very good at conveying information to the reader; they need replacing by more functional conventional barcharts, either stacked with respect to the categories of bat presence, or separate bars with standard errors.

Response: Changed as suggested; revised analysis and new figures.

Reviewer: 2

General:
This is a short and clear paper, which provides useful information on a subject of great conservation importance. It shows that artificial illumination of historical buildings, churches essentially, is detrimental to Plecotus bats in Sweden, as long as all building walls and sides are lit. The analysis is based on both longitudinal data (churches previously unlit that have been equipped with floodlights in between, and how this correlates with abandonment by bats) and a comparison of contemporaneous lit vs unlit churches in terms of occupancy by bats. Although these findings have clear implications for bat conservation management, the analysis might be a bit too much simplistic. In effect, merely splitting the churches in two categories (lit vs unlit) might mask further underlying mechanisms that may be as detrimental to bats as light installation. In particular, church illumination often takes place simultaneously to general restoration work, and the transformation of attics and roofs might under some circumstances represent a greater risk than equipping the building with floodlights. I am quite convinced that the authors are right in blaming artificial lights but in the absence of information about that other potentially confounding factors such architectural change it is difficult to be conclusive. I thus suggest the authors to provide more information on renovation history

Response. We have provided some more info on restoration and we have and tried to sharpen th discussion on this point (in discussion)

Title:
Perhaps the title should make clear that this is about outdoor aesthetic lights.

Response. Done

Introduction

35 – "particularly when the lights were applied from all directions." This should be "specifically when the lights were applied from all directions."

Response. No longer applicable because of slight change in the text.

51– Should be "For nocturnal animals such as most bats"

Response. Done

53 – Suggest modification to include ecological processes too. E.g. "and the bats' response to light depends on the species [7], the prevailing conditions [8], and the ecological process involved…" (e.g. emergence from roost, commuting, feeding or drinking). Supporting references would be:

- Emergence from roost - Downs et al 2003 Biol. Cons. 111: 247-252
- Commuting - Hale et al 2015 Global Change Biology 21, 7, 2467–2478
- Feeding - Shoeman 2015 Anim. Cons. 19: 120-130.
- Drinking – Russo et al. 2017 Anim. Cons. In press

Response. References added

101 –

Good that this is noted, but perhaps address this point in the discussion. There is some evidence that tree cover can mitigate negative lighting effects on bats, e.g.:

- Mathews et al 2014 Phil. Trans. R. Soc. Lond. B 370
- Hale et al 2015 Global Change Biology 21, 7, 2467–2478

Response. Potential importance of tree cover near the roost is already included in discussion. The Mathews reference is added there

And possibly

- Jenkins, (1998). Animal behaviour, 56(4), 909-917.

Materials and methods:

– needs something about the statistics and software, even if they were very basic.

Response. Done, package specified

Results:

Figs 2/3 – A nice graphic, but it is difficult to extract the actual numbers of churches from it. Is the % of churches with bats indicated by the end point of the church roof?

Response. New figures made.

190 –Not sure the second paragraph in the section Colony sizes and behavior in response to light

should go into the results. These are nice observations of the emergence behaviour that support the key results. However, as there is no clear methodology or empirical data related to the statement on emergence, it should not be in the results, in my opinion, but would be useful in the discussion.

Response. Paragraph moved to discussion as suggested.

Discussion
Very good – nice caveats regarding other disturbance linked to lighting, such as renovation, but I would like to see real data on that. Try also to better assess the possible effect of other confounding factors, ruling them out from rationale if no data at hand.

Response. We have provided some more info on restoration and other potentially confounding factors and we have tried to sharpen the discussion on this point.

Reviewer 3

Comments on 'Age of enlightenment: effects of esthetic lights on brown long-eared bats in churches'
General thoughts
This is a very useful study providing valuable evidence of conservation importance. However, it needs some relatively minor changes to the presentation and discussion, and some more fundamental revision to the statistical analyses. Fortunately, the results are sufficiently clear-cut that the main conclusions are unlikely to be altered by the changes to the analysis.
Specific points
Title, line 26, line 78, line 106: the words 'esthetic', 'esthetical' and 'aesthetical' are all used. I would suggest using 'aesthetic' in all cases, reflecting the most common usage in British English. **Done**
When first used in the text, it might be sensible to expand on this, explaining the main features of the lights considered. In lines 111-114 you contrast the lights with 'weaker non-directional lights', but it would also be worth distinguishing them from floodlights used for security purposes. The latter are frequently mounted high, illuminating downwards, whereas the lights used for aesthetic reasons in Figure 1 point upwards to illuminate the building. I wonder if this difference is important to the bats. See the comments in ref 9 on 'sky glow'. **Done as suggested**
Introduction: the introduction is very focussed on predation, whereas other recent papers have described a broader range of impacts from lighting, including positive as well as negative effects. For example, see the recent paper by Lewanzik & Voigt in J. Applied Ecology. **This and some other refs are included in the slightly expanded intro.**
Line 104: 'therefore most of the variation remained constant over the study period'. The word 'therefore' doesn't seem appropriate. Maybe rephrase along the lines of 'it is likely that there is comparatively little temporal variation in habitat and other potential confounding variables'. **Done with a slight change in wording**
Line 143: 'loud' seems an odd word to use in the context of the quiet calls of this species. Perhaps 'relatively loud'? **Done**
Statistical issues
Fisher's exact test: according to line 103 the 'study is essentially a pairwise comparison', but all formal testing uses Fisher's exact test, which is not appropriate for paired data. To exploit the power of the pairwise design, McNemar's test is needed. Alternatively, mixed models could be used, with a random term to allow for the pairing; this offers a number of advantages (e.g. paired and unpaired data could be included in the same analysis), but is perhaps excessive given the size of the dataset and the bias in the initial sample. Fisher's exact test is, of course, perfectly valid for

analyses using just one of the periods, since there is no pairing of the data. **Reanalysed using McNemar´s test as suggested. Thanks for pointing out this flaw!**

Line 164: including the church where lights had been non-functional for many years in the illuminated group seems counter-intuitive. **We explained why we did so. There could have been other similar cases that we don´t know of, so better to be conservative**.

Line 186: 'md' needs to be written in full (could be either median or mode). **Done (median)**

Line 170-175: This seems to be the key evidence presented, but it currently not backed up by any statistical test. This is where McNemar's test is needed to show that the decline is greater in those churches where lighting has been installed, compared to those where it hasn't. Also, since there was some bias in the original selection (line 87), a decline might result from regression to the mean (i.e. natural turnover could bring the upwardly biased sample back down towards the mean).Hence it is vital to consider these figures in the context of those from the same sample that were unlit, as indeed is done verbally in lines 181-183. **Done**

Figures 2 and 3: whilst these figures look very attractive and might be ideal for a press release or infographic, I don't think they are a good way of conveying the information to a scientific audience. Comparing the relative heights of standard bars is much easier for the reader than is the case with complex shapes such as the church silhouettes. Using stacked bars would make it clear that those with fresh remains were a subset of those with colonies present. Also, it is necessary to read the caption to understand the figure properly (I misunderstood it until I read the caption properly), whereas a standard bar chart with a legend and proper labelling of the axes could be easily understood at a glance by a reader flicking through the paper (and of course that is what we all have to do most of the time, due to the volume of published literature). **New figures and figure legends made**

Supplementary material: the data is a bit messy with lots of question marks and plus symbols. It would be better to convert to numeric or categorical columns as far as possible, with a comment column to explain anything else. Otherwise it is difficult for the reader to be able to understand how the question marks are interpreted, and hence the analyses cannot be easily reproduced. **Done**

Use a standard date format**. Done**

Steve Langton (stats@slangton.org.uk)

25/1/17

Appendix C

Dear Reviewer,

Please find our (my) response to your review below.

Response to your comment 1. I am really sorry for this and apologize. Now when I look at my previous response again, I agree that it was kept unnecessarily short and not very informative. I never thought about it then, however, but hopefully learnt something!

Comment 2. Thanks for persisting with this suggestion. We obtained the required information and it resulted in a considerable improvement of the paper, eventually.

The renovation history (after 1980) was obtained for all churches included in the longitudinal comparison. The data were entered in a new table (table 1) which I think is quite informative. It shows significant decline of bats only in churches that were **not** renovated. Renovation can be ruled out as the reason for bat disappearance in all except the five specific cases where bats disappeared from churches at which light installation and renovation coincided.

The result shown in table 1 is commented in a new paragraph of the result section (page 7, line 195-210) and a new paragraph explaining how we obtained and analysed the renovation data is added to the Material and Methods (p. 5-6, line 141-151). The discussion paragraph about renovation has been rewritten totally and the speculative and anecdotal statements removed (new paragraph found on p. 9, line 250-259). A new excel table with the renovation data included has been submitted as ESM.

In the Materials and methods section a short addition on the possible confounding effect of renovation was also added (p. 4, line 91).

Comment 3. Yes, I certainly agree that an addition like this was needed. The specific aim of the paper is now stated in the last paragraph of the intro along the lines you suggested, using two questions (page 3 line 57-61).

Thanks again for critical and constructive reviewing and for being persistent about the need of a quantitative analysis of the effect of renovations. We admit that this addition was indeed crucial and it certainly made our point more convincing.

Sincerely

Jens Rydell

on behalf of the co-authors

Appendix D

Final comments to reviewer

Please find our response in red

1. Is the likelihood of detecting bats in churches dependent on time of the summer, and was the timing of visits (across months) similar in the historic and 2016 datasets?

Reply: Good comment that we have not thought about. A paragraph is added to clarify our view on page 3, line 79-85.

2. A few suggestions to improve English a) line 126, change ;'spotted' to 'observed';
b) line 261 'rephrase 'On the lighter side' as this is ambiguous in the current context;
c) reference 30 should be 'Schoeman'.

Reply: Changes made as suggested except that "spotted" was changed to "recorded" instead of "observed" in order to avoid repetition of "observed".

3. Around line 222 I would make more of the implications for light-sensitive species. Zeale et al. (2016) showed that light inside churches 'traps' bats (Myotis nattereri) inside roosts. I suspect that the species listed on 222 will be sensitive to external lighting in the same way as Plecotus studied here, and buildings used by these species should not be subjected to external lighting as a precautionary measure.

Reply: Agree that this was a missing point. The suggested addition has been made in the discussion, page 9, line 256-260.

4. Some of the figure/table legends can be improved. There is no legend to Fig. 1, there is no description of how to interpret the ESM, and the grid lines should be removed from the graphs.

Reply: Legend to fig 1 is and the grid lines are removed from the graphs as suggested. The ESM consists of an excel table and the very basic statistical tests. I am not sure how "a description of how to interpret" it should be written.

What about this?

The ESM consists of an excel file with all the data used for this study and also include the statistical analyses. This sentence is submitted along with the other files.

Sincerely

Jens Rydell, communicating author