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Contents

Peer-Review Report

Peer Review of "The Loch Ness Monster: If It's Real, Could It Be an Eel?"

Don Jellyman[1], PhD

[1] National Institute of Water and Atmosphere, Auckland, New Zealand

Related Articles:

Companion article: https://preprints.jmir.org/preprint/49063

Companion article: https://bio.jmirx.org/2023/1/e50618/

Companion article: https://bio.jmirx.org/2023/1/e49063/

(JMIRx Bio 2023;1:e50621) doi:10.2196/50621

KEYWORDS

European eel; Anguilla anguilla; probability distribution; Loch Ness; folk zoology; unknown animals; cryptozoology

This is a peer-review report submitted for the paper "The Loch Ness Monster: If It's Real, Could It Be an Eel?"

Round 1 Review

General Assessment

This paper [1] is an interesting assessment that verifies the obvious—that any monster of ~6 m cannot be an eel (*Anguilla anguilla*), although there is a reasonable likelihood that eels of ~1 m could account for some of the "sightings" of elongate animals in the loch. However, even though the outcome is unsurprising, the author approaches the subject in a rigorous and systematic way. As such, the manuscript is of value in eliminating eels as possible candidate species for the mythical monster.

The manuscript is well-written and referenced.

Essential Revisions That Are Required to Verify the Manuscript

Nil.

Other Suggestions to Improve the Manuscript

Nil.

Decision

Verified: The content is academically sound, only minor amendments (if any) are suggested.

Conflicts of Interest

None declared.

Editorial Notice

This paper was peer-reviewed by the Plan P Hashtag Community partner #PeerRef.

Reference

1. Foxon F. The Loch Ness monster: if it's real, could it be an eel? JMIRx Bio 2023:e49063. [doi: 10.2196/49063]

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Peer-Review Report

Peer Review of “The Loch Ness Monster: If It’s Real, Could It Be an Eel?”

Derek W Evans[1]

Agri-Food and Biosciences Institute, Belfast, United Kingdom

Related Articles:

Companion article: https://preprints.jmir.org/preprint/49063

Companion article: https://bio.jmirx.org/2023/1/e50618/

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(JMIRx Bio 2023;1:e50624) doi:10.2196/50624

KEYWORDS

European eel; Anguilla anguilla; probability distribution; Loch Ness; folk zoology; unknown animals; cryptozoology

This is a peer-review report submitted for the paper “The Loch Ness Monster: If It’s Real, Could It Be an Eel?”

Round 1 Review

General Assessment

Interesting paper [1] and a useful attempt at answering a cryptozoological question using real data, although some of the data used is not quite relevant to the cold waters of Ness. There was no Figure 2 included with the manuscript. A description of eel behavior outlining how they do not swim upward and out of the water akin to “Nessie” breaching would be useful.

Essential Revisions That Are Required to Verify the Manuscript

A map of locations. Corrected inclusion of Figure 2. Some wider eel biometric data such as that to be found in any of the International Council for the Exploration of the Sea Working Group on Eels’ annual reports; reference to The Eel by Tesch and Thorpe [2] for comments on eel behavior and comments on biometry.

Other Suggestions to Improve the Manuscript

Inclusion of some images of very large 1 m plus eels for comparative purposes.

Decision

Verified with reservations: The content is academically sound but has shortcomings that could be improved by further studies or minor revisions based on the edits suggested above.

Round 2 Review

The great inclusions and revisions certainly make the paper a finished article and a genuinely interesting read—print as seen.

Decision Changed

Verified.

Conflicts of Interest

None declared.

Editorial Notice

This paper was peer-reviewed by the Plan P Hashtag Community partner #PeerRef.

References

1. Foxon F. The Loch Ness monster: if it's real, could it be an eel? JMIRx Bio 2023:e49063. [doi: 10.2196/49063]
2. Tesch FW, Thorpe JE, editors. The Eel. Hoboken, NJ: John Wiley & Sons; 2003:1-71.

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Peer-Review Report

Commentary on "A Gene Therapy for Hereditary Nonpolyposis Colorectal Cancer using CRISPR-Cas9 Nickase (Preprint)"

Chunbao Sun[1], MSc

Tulane University, New Orleans, LA, United States

Related Article:

Companion article: https://www.biorxiv.org/content/10.1101/2023.06.20.545835v1

(JMIRx Bio 2023;1:e54743) doi:10.2196/54743

KEYWORDS

gene; gene therapy; hereditary; colorectal cancer; cancer; nonpolyposis; inherited disorder; genetic mutation; DNA; colectomy; disease progression; prevention; tumor; quality of life

This is a peer-review report submitted for the preprint "A Gene Therapy for Hereditary Nonpolyposis Colorectal Cancer using CRISPR-Cas9 Nickase.". The authors of that preprint declined to address the peer-reviewer comments and did not proceed to resubmit a Version-of-Record for publication and curation in JMIRx-Bio. In these cases JMIRx-branded journals acting as overlay journals for preprints may publish peer-reviews as commentaries.

Round 1 Review

General Comments

This paper [1] investigates a gene therapy for hereditary nonpolyposis colorectal cancer using clustered regularly interspaced short palindromic repeats (CRISPR)–Cas9 nickase. Overall, it is a good exploratory article, with a background of the combination of CRISPR–Cas9 nickase and gene therapy for hereditary nonpolyposis colorectal cancer, and the research idea is special and novel, but the methodology is only a survey, and the understanding may not bring enough depth to the study. You can try to apply the results of the survey to improve the specific utility and multipurpose use of the study's cell phone app, which can increase the significance of the study.

Specific Comments

Major Comments

1. In terms of the starting point of the study, some of the text in Figure 1 is too small, and even partially obscured by the graphic, to be readable.

2. Figure 2 is too similar in the color scheme of the individual bars, which makes readability and visibility less desirable.

3. Figure 3 is, theoretically, not supposed to be a drawn graph but an actual electrophoretic run of the gel by DNA—a real strip chart trajectory.

4. The compiling, analyzing, and drawing of the work is well done, and it is a very good report. If you can add your own research, revised ideas and approaches to data, and details, you can definitely improve the innovation of the article.

Conflicts of Interest

None declared.

Editorial Notice

The authors of the preprint under review declined the opportunity to revise the preprint in response to the feedback in the peer reviews and publish it in the journal *JMIRx Bio*. The editors thank the peer reviewers for providing their feedback on this preprint.

Reference

1. Kannan S, Man JJ. A Gene Therapy for Hereditary Nonpolyposis Colorectal Cancer using CRISPR-Cas9 Nickase. bioRxiv Preprint posted online June 22, 2023. [FREE Full text] [doi: 10.1101/2023.06.20.545835]

Abbreviations

CRISPR: clustered regularly interspaced short palindromic repeats

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Authors' Response to Peer Reviews

Authors' Response to Peer Reviews of "The Loch Ness Monster: If It's Real, Could It Be an Eel?"

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(JMIRx Bio 2023;1:e50618) doi:10.2196/50618

KEYWORDS

European eel; Anguilla anguilla; probability distribution; Loch Ness; folk zoology; unknown animals; cryptozoology

This is authors' response to peer-review reports for "The Loch Ness Monster: If It's Real, Could It Be an Eel?"

Round 1 Review

Response to Dr Don Jellyman [1]

I thank Jellyman for their polite and complimentary comments on the manuscript [2]. Because no essential revisions or other suggestions were requested by Jellyman, I have not made revisions to the manuscript in response to their review.

Response to Dr Derek W Evans [3]

I also thank Evans for their careful consideration of the manuscript.

Evans notes that "some of the data used is not quite relevant to the cold waters of Ness." This is an important limitation. Accordingly, I have expanded the limitations paragraph of the Discussion section to read: "environmental conditions such as temperature and available biomass impact eel growth and length, therefore comparisons to other environments such as Zeeschelde may not be appropriate, i.e., some of the data cited may not be relevant to the relatively cold waters of Loch Ness."

I apologize for causing some confusion around "Figure 2." In the manuscript, I refer in multiple places to a "Figure 2" and a "Figure 4" that never appear in the text (eg, "Oliver et al. (2015, Figure 2)" and "Meulenbroek et al (2020, Figure 4)"). What I meant by these references were the respective figures in those publications (ie, "Figure 2 of Oliver et al (2015)" and "Figure 4 of Meulenbroek et al (2020)"). I see how my original wording was entirely confusing, and I apologize for not making this at all clear. Correspondingly, I have revised the wording of the manuscript throughout as follows: "Oliver et al (2015, Figure 2)" → Figure 2 of Oliver et al (2015)"; "Simon (2007, Figure 2(b))" → "Figure 2(b) of Simon (2007)"; "Melia et al (2006, Fig. 2)" → "Fig 2 of Melia et al (2006)"; "(Macnamara et al, 2014, Fig 2)" → "(Fig 2 of Macnamara et al, 2014)"; and "Meulenbroek et al (2020, Figure 4)" → "Figure 4 of Meulenbroek et al (2020)."

I hope that these changes to the figure references above now make it clear that I was citing figures within other published works, rather than a missing figure in my own manuscript.

Evans requested that I reference *The Eel* by Tesch and Thorpe [4]. In this revision, I have included additional comments with citations to three chapters of *The Eel*, including Kloppmann [5] (Chapter 1: Body Structure and Function, in *The Eel*) in the Introduction of the manuscript (third paragraph); Tesch and Thorpe [6] (Chapter 2: Developmental Stages and Distribution of the Eel Species, in *The Eel*) in the Discussion of the manuscript (third paragraph); and Tesch and Thorpe [7] (Chapter 3: Post-larval Ecology and Behaviour, in *The Eel*) in the Discussion of the manuscript (second paragraph).

Another suggestion was made to cite the work of the International Council for the Exploration of the Sea Working Group on Eels on eel biometric data, of which I note Evans is a member and so has extensive knowledge of this body of literature. To this end, I have added to the manuscript citations to the latest Report to ICES on the Eel Stock, Fishery and Other Impacts in UK, 2020-2021, from the Joint EIFAAC/ICES/GFCM Working Group on Eels (WGEEL) Country Reports 2020-2021 [8]. I use biometric data from this report to compare Mackal's [9] eel lengths in Loch Ness to those collected elsewhere in Scotland in the same decade (Discussion, first paragraph) and to estimate ages of 1- and 6-meter eel specimens based on eel growth rates from a Scottish river (Discussion, second paragraph).

Finally, Evans requested a map of locations, which I have now provided links to in the online Supplementary Information (mentioned at the end of the Methods section), and inclusion of some images of very large 1-meter plus eels for comparative purposes, which I have now also provided links to in the online Supplementary Information (mentioned in the Discussion; because I do not own the copyrights for these images, I do not feel comfortable reproducing them directly in the manuscript).

I hope that these changes are satisfactory and that the reviewer feels that the manuscript may now be verified without reservations. I am grateful for the reviewers' feedback, and I believe that their recommendations have greatly improved the manuscript. Accordingly, I have added Evans and Jellyman to the Acknowledgments sections of the manuscript to express my appreciation.

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1. Jellyman D. Peer review of "The Loch Ness Monster: If It's Real, Could It Be an Eel?". JMIRx Bio 2023:e50621. [doi: 10.2196/50621]
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9. Mackal R. The Monsters of Loch Ness. London, UK: Macdonald and Jane's; 1976.

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Original Paper

The Loch Ness Monster: If It's Real, Could It Be an Eel?

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Related Articles:

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Companion article: https://bio.jmirx.org/2023/1/e50621/

Companion article: https://bio.jmirx.org/2023/1/e50618/

Abstract

Background: Previous studies have estimated the size, mass, and population of hypothetical unknown animals in a large oligotrophic freshwater loch in Scotland based on biomass and other observational considerations. The "eel hypothesis" proposes that the anthrozoological phenomenon at Loch Ness can be explained in part by observations of large specimens of European eel (*Anguilla anguilla*), as these animals are most compatible with morphological, behavioral, and environmental considerations.

Objective: This study expands upon the "eel hypothesis" and related literature by estimating the probability of observing eels at least as large as have been proposed, using catch data from Loch Ness and other freshwater bodies in Europe.

Methods: Skew normal and generalized extreme value distributions were fitted to eel body length distributions to estimate cumulative distribution functions from which probabilities were obtained.

Results: The chances of finding a large eel in Loch Ness are around 1 in 50,000 for a 1-meter specimen, which is reasonable given the loch's fish stock and suggests some sightings of smaller unknown animals may be accounted for by large eels. However, the probability of finding a specimen upward of 6 meters is essentially zero; therefore, eels probably do not account for sightings of larger animals.

Conclusions: The existence of exceedingly large eels in the loch is not likely based on purely statistical considerations. (Reviewed by the Plan P #PeerRef Community).

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KEYWORDS

European eel; Anguilla anguilla; probability distribution; Loch Ness; folk zoology; unknown animals; cryptozoology

Introduction

Loch Ness is a large oligotrophic freshwater loch located along the Great Glen Fault in Scotland. Since the 1930s, purported sightings of unknown animals in the loch have featured prominently in popular media, but to date, no specimen has been obtained despite numerous efforts, making the probability of such animals unlikely.

The authenticity and interpretations of photographs and films allegedly depicting unknown animals in Loch Ness have been seriously doubted [1-5]. In the 20th century, systematic searches with submersibles, sector-scanning sonar surveys, hydrophones, underwater photography, long-lining, and trawling undertaken by the Loch Ness Investigation Bureau [6], the Academy of Applied Science (AAS) [7-12], and the Loch Ness and Morar

Project [13] have returned only ambiguous sonar signals, low-quality photographs, and unidentifiable sound recordings.

In the 1970s, a sample of European eels (*Anguilla anguilla*) was collected from Loch Ness with baited traps. The distribution of eel masses was skewed, which led biologist Roy Mackal [6] to conclude that large eels may exist in the loch. Eel body structure and function are characterized by an elongated body form, a single pair of pectoral fins, strong musculature and high-amplitude winding movement, and a durable integument with a thick epidermis and dark chromatophores [14].

Mackal [6] noted that large eels would therefore be consistent with eyewitness descriptions of Loch Ness animals including reports of an elongated head-neck, pectoral fins, extreme flexion, and dark integument [15,16]. This explanation has also been reviewed by naturalists Adrian Shine and David Martin of the Loch Ness and Morar Project, who noted that eels migrate via the River Ness and that most “sightings” occur near river mouths [16].

An environmental DNA (eDNA) study conducted at the loch in 2018 detected extraordinary amounts of mitochondrial DNA and nuclear DNA from eels [17], prompting principal investigator Neil Gemmell to further suggest the possibility of large eels in the loch [18]. A large eel-shaped animal was recently filmed in the River Ness by the Ness Fishery Board [19].

Simon [20] suggests that the physiologically possible maximum length of *A. anguilla* is 0.5-1.3 meters, which is not particularly monstrous. Using wave mechanics, LeBlond and Collins [21] estimated the size of the subject depicted in the infamous “Surgeon’s Photograph” at Loch Ness at 0.6-2.4 meters.

Much larger estimates have been made. Based on their “flipper” photograph, Scott and Rines [7] estimated a total body length of 15-20 meters for an unknown Loch Ness animal. These estimates seem inconsistent with Loch Ness biomass calculations. Sheldon and Kerr [22,23] estimated a population of 156 if the individual mass of a hypothetical unknown animal in Loch Ness is 100 kilograms and suggested just one individual can exist if its mass is 2000-3000 kilograms. Scheider and Wallis [24] estimated that the loch may support 157 animals of 100 kilograms each and 10 animals of 1500 kilograms each.

Finally, in an article titled “If there are any, could there be many?” Carl Sagan [25] used collision physics and suggested that a population of 300 animals that were 10 meters in size each would be consistent with AAS observations. Thus, if there are any, there may be many. If it’s real, could it be an eel? The aim of this study is to estimate the probability of finding various sizes of eel in Loch Ness based on available catch data.

Methods

Data

Data on the mass distribution of *A. anguilla* in Loch Ness were taken from 129 eels caught between 1970 and 1971 under the supervision of the Loch Ness Investigation Bureau and described in Mackal [6].

Mackal [6] does not provide the length distribution for the sample nor did Mackal [6] directly regress length on mass. Mackal [6] did regress functions of length on mass and maximum circumference but provided only nonlinear equations unsuitable for solving simultaneously. Thus, to convert the mass distribution into a length distribution, the relationship between mass and length in *A. anguilla* captured in Scottish freshwaters from 1986 to 2008 was taken from Figure 2 of Oliver et al [26] as:

$$\log_{10}(1000M) = 3.1586 \log_{10}(100L) – 3.0076 \quad \textbf{(1)}$$

for mass M in kilograms and length L in meters. This equation is used over alternatives such as that in Figure 2(b) of Simon [20] because equation 1 is most relevant to Loch Ness (having been derived from Scottish freshwater).

Rearranging equation 1 gives:

$$L \approx 0.797961M^{0.316596} \quad \textbf{(2)}$$

from which the lengths of eels in Mackal’s [6] sample were estimated.

Analysis

Skew normal and generalized extreme value distributions were fitted to the Loch Ness eel length distribution, and fit parameters were used to estimate the probability density function and cumulative distribution function (CDF).

The probability of finding an eel in Loch Ness at least as long as L was then estimated from the CDF as:

$$P(l < L) = 1 – \mathrm{CDF}(L) \quad \textbf{(3)}$$

For comparison, the above analysis was repeated with publicly available length data on 420 European eels captured in Zeeschelde, Belgium presented in Verhelst et al [27]. Zeeschelde was selected because raw data were available, whereas this is not the case for other published analyses.

All analyses were performed in Python 3.8.8 (Python Software Foundation) with the packages Numpy 1.20.1, Pandas 1.2.4, Matplotlib 3.3.4, and Scipy 1.6.2. All code and data are available on the web [28]. Maps of locations referenced throughout the manuscript in order of reference are also available on the web [28].

Ethical Considerations

This work uses only publicly available secondary data on animal subjects. It did not involve any experiments or interactions with animals and did not compromise their welfare in any manner.

Results

The length distributions for the Loch Ness and Zeeschelde eel samples are shown in the upper plots of Figure 1. The fits were similar for both skew normal and generalized extreme value distributions. The distribution for Loch Ness is evidently skewed toward lower lengths, similar to the length distribution of European eels presented in Figure 2 of Melia et al [29] for eels captured in the Camargue lagoons of France. The Zeeschelde distribution has notably less skew. The length distribution in a sample of eels in Vistonis Lake, Greece was skewed toward higher lengths (see Figure 2 of Macnamara et al [30]), suggesting much variability in eel length skew across different environments.

The probabilities of finding an eel at least as big as L in Loch Ness and in Zeeschelde are shown in the lower plots of Figure 1. Loch Ness has a comparatively low probability of finding larger eels 0.6-0.8 meters in length, and the probability of finding an eel in excess of 1 meter in length is very low for both environments.

Table 1 contains the estimated probabilities for specific lengths of interest. Results were somewhat similar for skew normal and generalized extreme value fits, and for both Loch Ness and Zeeschelde.

While the chance of finding a large eel approximately 1 meter in length in Loch Ness is low (around 1 in 50,000), this is certainly possible given the eel population of the loch: assuming a standing fish stock of 0.55 kg ha^{-1} for Loch Ness [22,23] and given a surface area of 5600 hectares, the total standing fish stock of the loch is approximately 3080 kg. Further assuming that half of this stock is eel mass (plausible given the Loch Ness eDNA study [17]), this would imply 1540 kg of eel in the loch. The average Loch Ness eel mass is 0.1857 kg [6]; therefore, there are over 8000 eels in Loch Ness at a given time. Over the course of a few generations, an eel 1 meter in length may be expected.

However, this is not quite the “monster” postulated. Indeed, the probability of finding a 6-meter eel in Loch Ness is essentially zero—too low for the software used to provide a reliable estimate. Thus, while large eels may account for some eyewitness sightings of large animate objects rising to the loch surface, they are unlikely to account for “sightings” of extraordinarily large animals, which may instead be accounted for by wave phenomena, the occasional stray mammal, or other reasons.

Figure 1. Length distributions for European eels (Anguilla anguilla) captured in Loch Ness, Scotland (left) and in Zeeschelde, Belgium (right). The lower plots show the probability of finding an eel at least as long as L. Dotted lines represent skew normal distribution fits. Dashed lines represent generalized extreme value distribution fits. The number of bins follows the rule provided by Freedman and Diaconis [31].

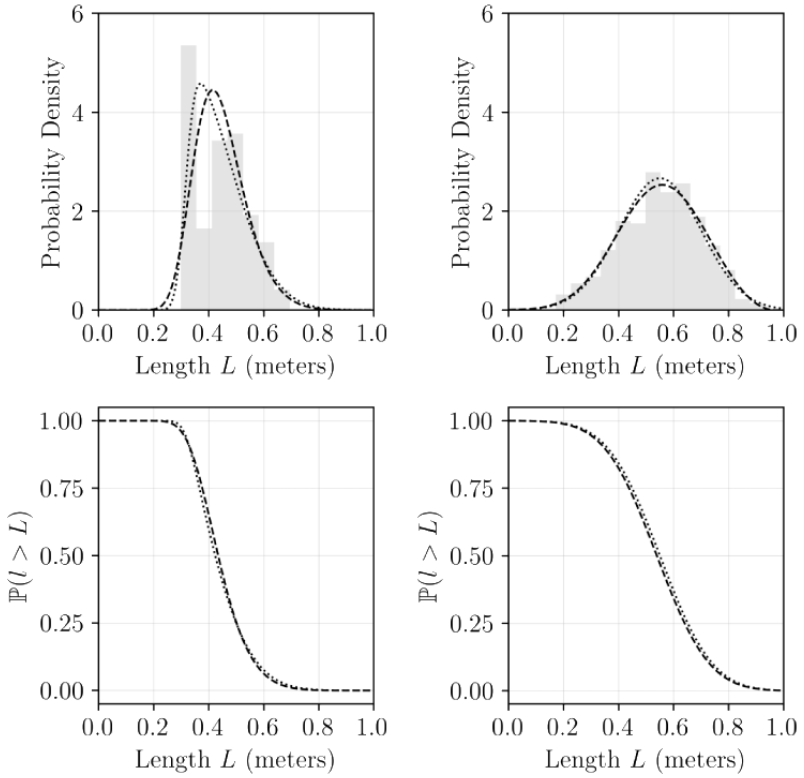

Table 1. Probabilities associated with finding a European eel (Anguilla anguilla) at least as large as length (*L*) in Loch Ness and Zeeschelde for various *L*.

Length (meters)	Loch Ness *P* (*l*>*L*)[a]	Zeeschelde *P* (*l*>*L*)[a]	Note
0.505	• 0.238 • 0.239	• 0.619 • 0.590	Maximum length from sample of 43 European eels in the river Vjosa/Aoos, (Albania/Greece; 2018). Source: Figure 4 of Meulenbroek et al [32]
0.645	• 0.0399 • 0.0294	• 0.264 • 0.240	Maximum length from sample of 129 European eels in Loch Ness, Scotland (1970-1971). Source: Appendix G of Mackal [6]
0.662	• 0.0307 • 0.0216	• 0.228 • 0.206	Maximum length from sample of 199 female yellow European eels in the River Havel system, Germany (2001). Source: Table 3 of Simon [20]
0.784	• 0.00348 • 0.00155	• 0.0592 • 0.0511	Maximum length from sample of 20,108 European eels in the Camargue lagoons, France (1993-2003). Source: Table II of Melia et al [29]
0.932	• 1.20×10^{-4} • 1.13×10^{-5}	• 0.00537 • 0.00443	Maximum length from sample of 420 European eels in Zeeschelde, Belgium (2015-2017). Source: Supplemental Information of Verhelst et al [27]
1.30	• 8.18×10^{-10} • ~0	• 2.71×10^{-7} • 2.20×10^{-7}	Physiologically possible maximum length of female yellow European eel in the River Havel system, Germany. Source: Abstract of Simon [20]
2.40	• 5.55×10^{-16} • ~0	• 2.22×10^{-16} • ~0	Upper size estimate for "Surgeon's Photograph" subject. Source: LeBlond and Collins [21]
6.10	• 6.66×10^{-16} • ~0	• ~0 • ~0	Size estimate for hypothetical unknown animals in Loch Ness ("up to 20 ft."). Source: Chapter XIV of Mackal [6]

[a]The first value in each cell of this column corresponds to the skew normal distribution and the second value corresponds to the generalized extreme value distribution.

Discussion

This study used data on the distribution of European eel (*A. anguilla*) masses in an oligotrophic freshwater loch in Scotland to estimate the probability of finding an eel of extraordinary size there. Similar to other eel populations in Europe, the average eel length in Loch Ness is relatively small and highly comparable to biometric data on silver eels (sexually mature *A. anguilla*) collected in the same decade at the Girnock Burn fish trap on the River Dee in Aberdeenshire, Scotland (see Table 5.3 of Bašić et al [33]), suggesting Loch Ness eels are similar to those found elsewhere in the country. The findings of this study suggest that the chance of finding a 1-meter eel in the loch (1 in 50,000) is reasonable given the standing fish stock, and so some eels may account for purported sightings of somewhat large animals at the loch surface. For comparative purposes, Figure 2 shows an image of a female silver eel 1.05 meters in length. Other images of European eels in excess of 1 meter in length are provided on the web [28].

However, these analyses suggest that larger eels upward of 6 meters are highly improbable; therefore, "super" eels are an unlikely explanation for eyewitness reports of the very largest alleged animals at Loch Ness. Marine Scotland Science has reported growth rates of eels on the Girnock tributary of the River Dee in Scotland as high as 35.2 mm yr^{-1} [33]. Assuming a linear rate of growth throughout the life cycle of an eel (in reality, the rate of change of an eel's total length is an exponential decay curve, as described by Tesch and Thorpe [34]), it would take an eel in Scotland almost 30 years at such a growth rate to reach the 1-meter size. Given that the oldest eels can live for a number of decades [34], again it seems likely that approximately 1 meter is a realistic maximum length for eels in Loch Ness; a 6-meter specimen would need to live with constant high growth for almost 200 years, an age close to the longest-living fish, the Greenland shark (*Somniosus microcephalus*).

Though one European eel reportedly (unverified) lived to the grand age of 155 years [35], that specimen did not grow to a remarkable size because eel growth is nonlinear, slowing in older ages. Furthermore, the "breaching" behavior attributed to unknown Loch Ness animals (swimming upward and out of the water) is not a behavior that is characteristic of eels during migration or otherwise [34], especially as such behavior would represent unnecessary energy expenditure in a cold environment with relatively little food.

This analysis is limited by several factors. First, the Loch Ness eel sample used was relatively small at 129. Larger samples across longer time periods may provide more accurate estimates. Second, the assumption of a skew normal distribution would not hold if, for example, a larger sample revealed a bimodal distribution of eel lengths with a small peak at higher lengths. Third, this analysis is based on purely statistical considerations; the biological mechanism behind the physiological possibility of much larger eels is beyond the scope of this study. Some authors have suggested one such mechanism as neoteny [6] (ie, uncontrolled growth of the leptocephalus larva in *A. anguilla* preceding subsequent stages of development [36]). Fourth, environmental conditions such as temperature and available biomass impact eel growth and length; therefore, comparisons to other environments such as Zeeschelde may not be appropriate (ie, some of the data cited may not be relevant to the relatively cold waters of Loch Ness).

In conclusion, while Sagan [25] found that if there are any, there may be many, this study shows that if it's real, it could be an eel, but not a very large one.

Figure 2. 1.05-meter female silver eel. Image courtesy of Dr Derek W Evans from the Agri-Food and Biosciences Institute.

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Data Availability

The data and code generated or analyzed during this study are available on OSF [28].

Conflicts of Interest

None declared.

Editorial Notice

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Abbreviations

AAS: Academy of Applied Science
CDF: cumulative distribution function
eDNA: environmental DNA

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