

## **Basic reporting**

In terms of language, this article is well written, and apart from a couple of minor instances, it is clear, unambiguous and technically correct.

The Introduction requires extensive revising as lacks focus and there is too much space is given to details that are not relevant to the study. Information on the distribution of lumpfish in North America is lacking, and there are still many gaps in this subject in other regions, thus giving a status of the knowledge in other regions is important. Relevant publications which examine lumpfish distribution are not referenced anywhere in the publication (see general comments).

The Figures, while relevant, need substantial improvement (see general comments).

## **Experimental design**

The study relies on pre-collected data from national fisheries surveys and are thus, the source of the data is considered reliable and appropriate. However, the authors “outsource” the methods to other publications, While this is appropriate for much of the methods, key aspects such as the collection of temperature data needs to be better described. One of the questions asked “determine if and how water temperature has affected lumpfish distribution over time”, the authors do not explicitly investigate this, but focus on latitude, which I presume they assume acts as a proxy for temperature; given the complex oceanographic conditions in the Gulf of Maine, I doubt this is the case. There are also results which are not described in the Methods section.

## **Validity of the findings**

I have serious doubts over the conclusions drawn from the data and that the data is over-interpreted.

I think this manuscript has great potential and to document basic information on the distribution of lumpfish in the Gulf of Maine, where information on this species is severely lacking. However, I would feel this manuscript needs substantial work before it can be published. The data has been stretched beyond what it can realistically tell us about the distribution, basically, sample size from year to year is too low to detect changes in distribution. I also have concerns about the interpretation of any movement north given the geographical layout of the Gulf of Maine. Moving directly north would take you further into the Gulf of Maine and given the complex nature of the ocean currents which enter and flow through the Gulf of Maine, I expect things are not that simple. Any claim that they are moving north in response to temperature should be supported by temperature data, and where exactly are they moving too, are they moving further into the gulf, or along it, some distribution maps showing the change would be helpful.

My recommendation with the manuscript, given the sparse data, is move away from detecting changes over time collate the data and describe where lumpfish are found and not found, describe

the depths and temperature at which lumpfish are caught and explore the maturity data. Given that the survey extends beyond the Gulf of Maine, consider expanding the study area.

Given the extensive revision required, I would recommend rejection, but I would encourage the authors to revise and resubmit given the interesting nature of the study.

## Introduction

The Introduction requires extensive revising as lacks focus and there is too much space is given to details that are not relevant to the study.

The section on lumpfish aquaculture should be substantially reduced.

As this study focuses on the distribution of lumpfish, the current status of knowledge of distribution in other areas should be presented. This would inform of the reader of what to expect from lumpfish in the GOM. There are several publications which describe lumpfish spatial and depth distribution in other regions which are not referred to in any part of the manuscript these include Eriksen et al. (2014), Kennedy et al. (2016), Kennedy & Jónsson (2017) which provide important information of distribution and information on temperature and depths they inhabit.

Eriksen E, Durif CMF, Prozorkevich D. 2014 Lumpfish (*Cyclopterus lumpus*) in the Barents Sea: development of biomass and abundance indices, and spatial distribution. ICES Journal of Marine Science 71, 2398–2402. (doi:<https://doi.org/10.1093/icesjms/fsu059>)

Kennedy J, Jónsson SP, Ólafsson HG, Kasper JM. 2016 Observations of vertical movements and depth distribution of migrating female lumpfish (*Cyclopterus lumpus*) in Iceland from data storage tags and trawl surveys. ICES Journal of Marine Science 73, 1160–1169. (doi:[10.1093/icesjms/fsv244](https://doi.org/10.1093/icesjms/fsv244))

Kennedy J, Jónsson S. 2017 Do biomass indices from Icelandic groundfish surveys reflect changes in the population of female lumpfish (*Cyclopterus lumpus*)? Fisheries Research 194, 22–30. (doi:[10.1016/j.fishres.2017.05.006](https://doi.org/10.1016/j.fishres.2017.05.006))

Line 43. Who gives this “data-poor” designation?

Line 52. Data poor is somewhat ambiguous. There is a useful categorisation from ICES, ([https://www.hafogvatn.is/static/files/2023/introduction\\_to\\_the\\_advice\\_on\\_fishing\\_opportunities\\_2022.pdf](https://www.hafogvatn.is/static/files/2023/introduction_to_the_advice_on_fishing_opportunities_2022.pdf)). Lumpfish as a species is not data poor, be more specific, the lumpfish population in the Gulf of Maine is data poor.

Line 52-76. This section needs to be substantially reduced. The information is also a little outdated as the production of lumpfish is now decreasing and there are substantial problems with welfare and mortality see Garcia de Leaniz et al. 2021

Garcia de Leaniz C et al. 2021 Addressing the welfare needs of farmed lumpfish: Knowledge gaps, challenges and solutions. Reviews in Aquaculture. (doi:[10.1111/raq.12589](https://doi.org/10.1111/raq.12589))

Line 73-76. This section is poorly worded. I get the point that there are specific fisheries that target lumpfish solely for aquaculture. However, the wording is ambiguous and could be interpreted as fishing for aquaculture is the only fishery for lumpfish, whereas there are fisheries for lumpfish in several countries which are for human consumption.

Line 78. I presume you mean that fishing for lumpfish is not regulated.

Line 79-81. The information for Powell is based upon old information, which does require some updating, but it is understandable that this has been referenced. If you look at the stock assessment reports for lumpfish in Norway and Iceland, it is clear that the stock can rise and fall within 2-3 years implying a much shorter generation time.

[https://www.hafogvatn.is/static/extras/images/48-hrognkelsi\\_20241431956.pdf](https://www.hafogvatn.is/static/extras/images/48-hrognkelsi_20241431956.pdf)

<https://www.hi.no/resources/Les-hele-radet-for-rognkjeks-2024.pdf>

Line 81-82. This is not true; the fishery targets the most abundant size classes. Comparing the size distribution from a trawl survey and from fishery show an almost identical size distribution (see MFRI 2022 and Kennedy 2021). This is unsurprising as the price of lumpfish does not vary by size, unlike many other species where the price per kg is higher for larger fish.

MFRI 2022 available at [https://www.hafogvatn.is/static/extras/images/tech\\_report-20221313043.pdf](https://www.hafogvatn.is/static/extras/images/tech_report-20221313043.pdf)

Kennedy J. 2021 Measuring lumps: Optimising sampling of the commercial landings of lumpfish (*Cyclopterus lumpus*) in Iceland. Fisheries Research 244, 106130.  
(doi:10.1016/j.fishres.2021.106130)

Line 95. Females only produce two egg batches (see Kennedy 2018)

Kennedy J. 2018 Oocyte size distribution reveals ovary development strategy, number and relative size of egg batches in lumpfish (*Cyclopterus lumpus*). Polar Biology 41, 1091–1103.  
(doi:10.1007/s00300-018-2266-9)

Line 105. “grow quickly”, compared to what?, this is subjective and should be reworded.

Line 109. Can you provide a reference for this statement?

## **Materials and Methods**

Line 105. Can you provide information on how maturity was assessed and details of the maturity scale which was used.

Line 135. Sex and maturity data is mentioned here but none of it is used in the study, why mention it? It would actually be better to use the information in the study.

Line 145 and 172. How was bottom temperature measured? Given the importance of temperature in your study, precise details on how this information was collected is necessary and the reader should not be sent off to read some other reports.

Line 196. The estimates given here give weights, in my experience with lumpfish, are too low for a given length. I checked on fishbase, where I presume these values came from and the values given by the author do not tie in with anything here, perhaps the data from the North Sea where alpha is 0.0630, the authors value is 0.02630. I examined the code from the git repository referenced in the manuscript and the authors use 0.02630, this would thus create inaccuracies through the analysis.

On a related note, I would say the original source of the relationship should be cited.

Line 197-199. These are not ages, age is measured in time (weeks, months, years) but are simply length groups. I do not have access to the reference used to justify these sizes, but the publication is

a science based magazine and not peer reviewed research so I would say that it is not an appropriate sources of information on which to base your study. Saying that, the lengths do seem appropriate e.g. see Albert et al. 2002 and Eriksen et al. 2014 and I would suspect that they refer to young of the year, age 1 and age 2+. I think the presentation of length distribution, from the surveys plus reference to the two mentioned publications would help justify the use of specific lengths to divide into these groups.

Line 205-207. A general additive model would seem more appropriate as the response to temperature is unlikely to be linear.

What is the measurement of effort, hours trawled, number of stations, something else? This survey extends beyond the Gulf of Maine, did you exclude some areas?

## **Results**

I think the authors are missing a very informative piece of the puzzle, they present data where lumpfish was caught, but not where it was not caught. This would be primarily focused on the NEFSC bottom trawl survey. This trawl survey could probably detect the southern limit for lumpfish and for temperatures at which it is no longer present.

Line 228. “which often act as nursery habitats for lumpfish”, provide a reference for this statement.

Line 236-246. I don’t find these results very convincing. In the spring survey, in 37 of the 42 years, less than 10 fish were caught. I would be very wary about basing conclusions on changes in the population distribution on so few fish.

Line 241. Lumpfish are found at warmer bottom depths. This seems to be in conflict to your conclusions, that lumpfish are cold adapted are moving north to escape warmer water. This should be addressed in your Discussion.

Line 246. How did you measure this? it is not in the methods.

## **Discussion**

Given the wide range of fishing gear types used in this study, and especially with the predominance of the trawl data, a Discussion on the validity of these gears, and how this changes through the year is warranted and if they can realistically detect changes in distribution or population abundance. Consider the results from Kennedy & Jónsson (2017) which compares two trawl surveys from different times of the year.

Line 258. Lumpfish are not known to “build” nests.

Line 259-260. It is not impossible that they were spawned out here, but given what is known about lumpfish spawning habits, a more likely explanation as these drifted out here under the influence of ocean currents.

Line 268-269. Given the sparse data that this was based upon, I would disagree.

Line 270-272. The analysis examined latitude not temperature. While at a regional level, temperature does decrease with increasing latitude, at the spatial scale of this survey, it may not be the case. Looking at the data from this survey, I can see that, for stations north

of 41 degrees, that is often no significant effect of latitude on bottom temperature, and some years, there is actually a negative effect. So to say that lumpfish is moving north in response to temperature is a bit premature.

Figure 1

The figure is simply too small, the overall size of the figure should be increased, also a lot of space is wasted by the amount of land in the figure. For those unfamiliar with the area, some shading of the land would help separate land and sea. Also, a zoomed out map would also help to understand where this area sits geographically in relation to north American continent. The distribution of the small lumpfish is probably driven by the currents, it would be helpful to have an additional map showing the direction of the main currents in this area.

Figure 2.

Again, a lot of space is wasted by having so much land in the Figure.

Figure 4

This is not age, it is length group.

Figure 5.

The same comments from previous maps apply here.

Figure 6.

It is unclear why there are four graphs, these need to be properly labelled