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Canadian Technical Report of Fisheries and Aquatic Sciences

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Technical reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page.

Numbers 1-456 in this series were issued as Technical Reports of the Fisheries Research Board of Canada. Numbers 457-714 were issued as Department of the Environment, Fisheries and Marine Service, Research and Development Directorate Technical Reports. Numbers 715-924 were issued as Department of Fisheries and Environment, Fisheries and Marine Service Technical Reports. The current series name was changed with report number 925.

Rapport technique canadien des sciences halieutiques et aquatiques

Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. II n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques de Pêches et Océans Canada, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports techniques peuvent être cités comme des publications à part entière. Le titre exact figure au-dessus du résumé de chaque rapport. Les rapports techniques sont résumés dans la base de données *Résumés des sciences aquatiques et halieutiques.*

Les rapports techniques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre.

Les numéros 1 à 456 de cette série ont été publiés à titre de Rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de Rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de Rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Canadian Technical Report of
Fisheries and Aquatic Sciences nnn

2022

FORMULATING A SPATIO-TEMPORAL APPROACH TO ANALYZE LONGLINE SURVEY DATA FOR THE ATLANTIC HALIBUT FISHERY

by

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ABSTRACT

McDonald, R.R. 2022. Formulating a spatio-temporal approach to analyze longline survey data for the Atlantic Halibut fishery. Can. Tech. Rep. Fish. Aquat. Sci. nnn: vi + 7 p.

GOTTA WRITE THIS.

RÉSUMÉ

McDonald, R.R. 2022. Formulating a spatio-temporal approach to analyze longline survey data for the Atlantic Halibut fishery. Can. Tech. Rep. Fish. Aquat. Sci. nnn: vi + 7 p.

FAUT J'ÉCRIVE ÇA.

1 Introduction

1.1 Storyline

This is the paragraph by paragraph storyline that I will write out more properly soon.

Introduction can be incredibly short from what I can tell, so I should focus very rapidly on the work this is based on.

1- Data on halibut from fixed stations go back to 98, new stratified design prompted new work on creating models to get better indices from this (and find a way of including information from both approaches)

2- Past approaches unable to account for hook competition which had potential to strongly impact catch rates, prompted creation of MEM and later MEMSpa.

3- Approaches lacks temporal component, which motivated this work here. Aim was to create a new approach that could harness improvements from these past approaches, better capture population trends (both spatial and temporal) over time, and incorporate both datasets inside the same framework.

2 Methods

2.1 Study Area

Description (with figures) of entire area, pretty straightforward.

2.2 Survey designs

Explain there are 2 surveys that will be discussed separately, as their implications are different.

2.2.1 Fixed Stations

Explain original reasoning, then describe details (years, number of stations, why they would change year to year, etc.).

2.2.2 Stratified Random Design

Same thing, explain why switch to that

2.3 Data Processing

Data verification done in R to identify mistakes (e.g. NA soak times, more fish caught than hooks, etc.). Describe dataset in general, what is available.

2.4 Persistence of spatial patterns

Describe how persistence is calculated to figure out if changes over time would be captured

2.5 Models

2.5.1 MEM

Describe the MEM as much as possible, indicating its importance and that stuff

2.5.2 MEMSpa

Describe the addition of spatial stuff

2.5.3 Spat-Temp MEM

Describe approaches and choice of approach to incorporate temporal effect (show RMSE, cross-validation output, that type of stuff) leading to choice of random intercepts, and incorporation of vessel effects.

3 Results

3.1 Persistence results

3.2 Fitting MEM, MEMSpa, and Spat Temp MEM to data

Show output of fitting all three of these models to time series

4 Discussion

1- Spatio-temporal MEM is able to capture both the spatial trends in the data but also how those spatial trends vary over time in a way that none of the other models are actually able to do. Gives us an output that is directly comparable to current methods used to obtain index of abundance.

2- Highlight importance of accounting for the non-target species as changing how much the model thinks there are will have a big impact on halibut catch rates.

3- Straightforward from what we obtain to move into getting a biomass estimate from this in similar ways as more traditional methods, as we have the weight of fish in the dataset. Caveat of need to incorporate those uncertainties appropriately.

4- Persistence analysis indicates potential problems with the fixed stations due to multivariate nature of model and impact of non-target species, even if the target species are likely captured fine by the fixed stations.

5- Stratified design is likely to solve these issues given enough time, and already corrects the scale of the time series that includes both datasets.

6- This approach is applicable to literally any longline fishery (give examples). Future research could look at going into more details, instead of just having target non-target, have more fine-scale detail.

APPENDIX A THE FIRST APPENDIX

Appendices can be in one file, or if they are larger than a couple of pages you should add a new file for each new appendix. In the first appendix, you **must** include two special lines of code at the top to tell `csasdown` that you are now numbering sections as appendices. Look in `05_appendices.Rmd` to see these. The last line of your last appendix **must** be another special line of code which tells `csasdown` to end the appendices sections. In this document it can be found at the end of `05_appendices.Rmd`.

Figures and tables will now be prepended with the appendix letter:

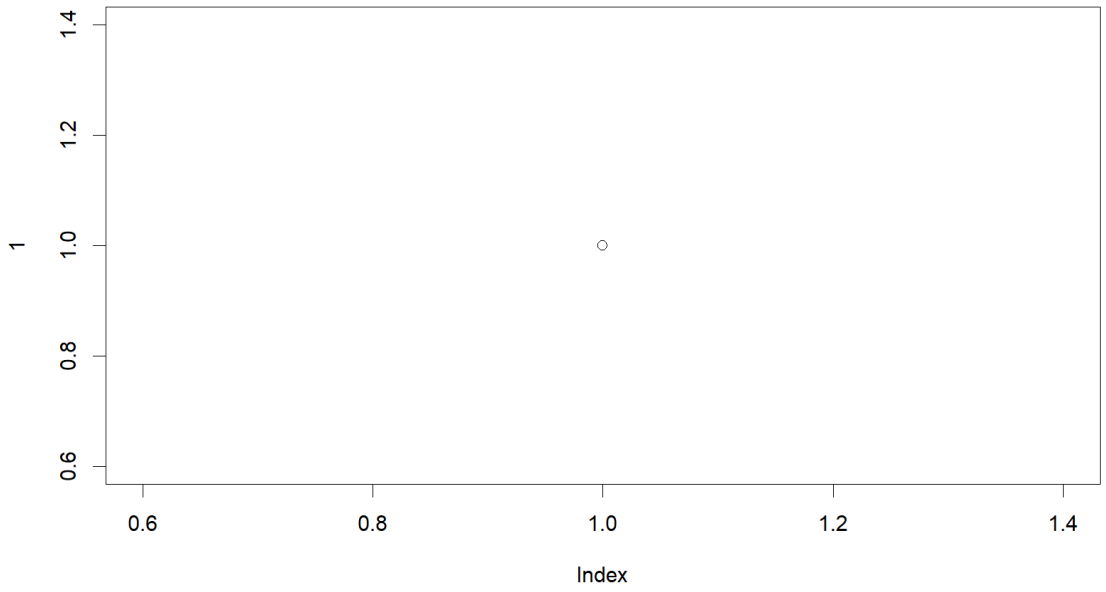

Figure A.1. English version of the test1 figure caption

Table A.1. English verion of the test2 table caption

x	y
a	1
a	2
b	3

Here's an equation. Note that it is automatically given a label on the right side of the page as in the main document, but it has the appendix letter before it. Each appendix will have its own set of equations starting at 1.

$$1 + 1 \tag{A.1}$$

See Equation A.1 for the example equation.

See Figure A.1 for the example appendix figure.

See Table A.1 for the example appendix table.

APPENDIX B THE SECOND APPENDIX, FOR FUN

The label `#app:` in the appendix section headers tell `csasdown` to start a new appendix, and the next letter in the alphabet will be used for the appendix, and prepended to figure and table names. For example, this appendix's whole section header looks like:

```
# THE SECOND APPENDIX, FOR FUN {#app:second-appendix}
```

To illustrate the new labeling of appendices, here are a table and figure:

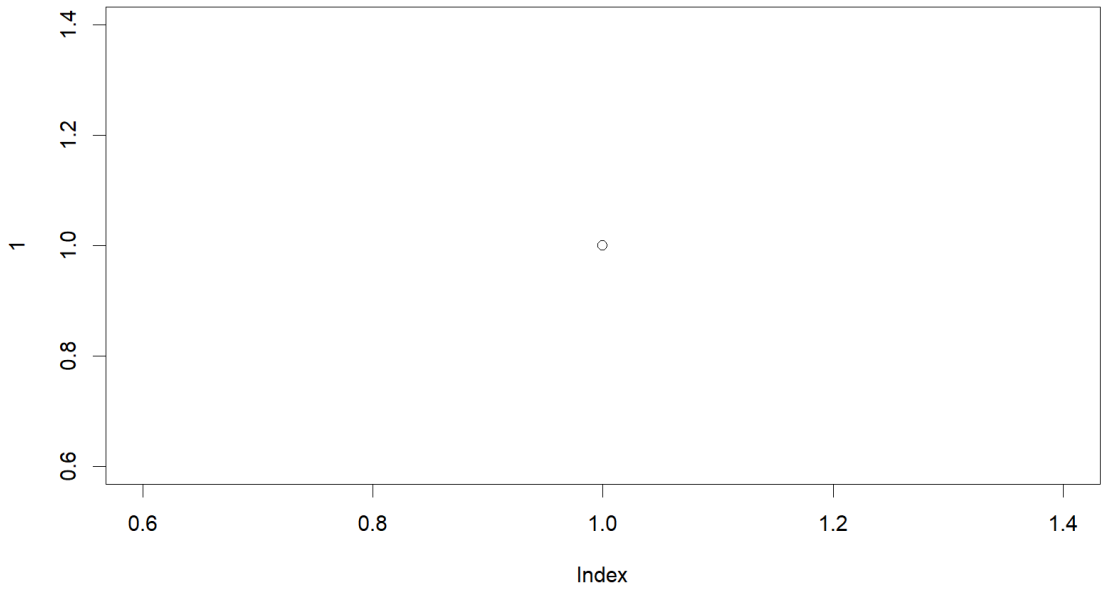

Figure B.1. English version of the test1b figure caption

Table B.1. English verion of the test2b table caption

x	y
a	1
a	2
b	3

And references to them. . .

See Figure B.1 for the example appendix figure.

See Table B.1 for the example appendix table.

5 References