

Effect of New Research Vessels on Biomass and Abundance Indices Used in Ecosystem Summaries in Newfoundland Region

Hannah Munro, Mariano Koen-Alonso, Kathleen Ryan, Krista Baker,
Laura Wheeland, Chelsea Malayny

Science Branch
Fisheries and Oceans Canada
P.O. Box 5667
St. John's, NL
A1A 1L9

2026

**Canadian Technical Report of
Fisheries and Aquatic Sciences 3805**



Fisheries and Oceans
Canada

Pêches et Océans
Canada

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

Technical reports contain scientific and technical information that contributes to existing knowledge but which is not normally appropriate for primary literature. Technical reports are directed primarily toward a worldwide audience and have an international distribution. No restriction is placed on subject matter and the series reflects the broad interests and policies of Fisheries and Oceans Canada, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in the data base *Aquatic Sciences and Fisheries Abstracts*.

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. Il 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 3805

2026

Effect of New Research Vessels on Biomass and Abundance Indices Used in Ecosystem
Summaries in Newfoundland Region

by

Hannah Munro, Mariano Koen-Alonso, Kathleen Ryan, Krista Baker,
Laura Wheeland, Chelsea Malayny

Science Branch
Fisheries and Oceans Canada
P.O. Box 5667
St. John's, NL
A1A 1L9

© His Majesty the King in Right of Canada, as represented by the Minister of the Department of Fisheries and Oceans Canada, 2026

This work is licensed under the [Open Government Licence](#)

Cat. No. Fs97-6/3805E-PDF ISBN 978-0-662-74850-2 ISSN 1488-5379

<https://doi.org/10.60825/xbsm-1707>

Correct citation for this publication:

Munro, H., Koen-Alonso, M., Ryan, K., Baker, K., Wheeland, L., Malayny, C. 2026. Effect of New Research Vessels on Biomass and Abundance Indices Used in Ecosystem Summaries in Newfoundland Region. Can. Tech. Rep. Fish. Aquat. Sci. 3805: vii + 148 p.
<https://doi.org/10.60825/xbsm-1707>

TABLE OF CONTENTS

INTRODUCTION	1
METHODS.....	3
MAGNITUDE OF CONVERSION FACTORS	3
APPLICATION OF CONVERSION FACTORS	4
SPATIOTEMPORAL MODELS.....	5
ABUNDANCE.....	6
RESULTS AND DISCUSSION.....	6
MAGNITUDE OF CONVERSION FACTORS	6
APPLICATION OF CONVERSION FACTORS TO TIME SERIES.....	7
SPATIOTEMPORAL MODELS.....	7
COMPARISON OF METHODS	9
ABUNDANCE.....	9
CONCLUSIONS.....	10
REFERENCES CITED.....	12
TABLES & FIGURES.....	16
APPENDIX A	65

LIST OF TABLES

Table 1. Accepted size-aggregated biomass and abundance (abund) conversion factors (ρ) for species by vessel (AN – Needler, TEL – Teleost) and season with associated species code used within DFO NL region, functional group (FG) for species (LB - Large Benthivore, MB - Medium Benthivore, LB - Large Benthivore, PI - Piscivore, PP - Planktivore, PL - Planktivore, SF - Shellfish), NAFO divisions where conversion factor can be applied, and reference (ref) for origin of conversion factor.	16
Table 2. Accepted functional group level conversion factors (ρ) by vessel and season with Ecosystem Production Unit (EPU)/NAFO divisions that species must be aggregated by. Needler and Teleost come from Munro et al. 2026 and Calvert from Trueman et al. 2026b.	28
Table 3. Names and formulas for models used.	31
Table 4. Summary of ΔAIC values for models by Season - Ecosystem Production Unit (EPU) and functional group (LB - Large Benthivore, MB - Medium Benthivore, SB - Small Benthivore, PI - Piscivore, PP - Planktivore, PL - Planktivore, SF – Shellfish)	32

LIST OF FIGURES

Figure 1. Map of the Ecosystem Production Units (EPUs), NAFO Divisions, and Multispecies Bottom Trawl Survey Strata in the Newfoundland and Labrador Region.	34
Figure 2. Timing within multispecies bottom trawl survey season of data included in spatiotemporal models by NAFO division and season with comparative fishing sets (purple), spring survey (light grey), and fall survey (darker grey).	35
Figure 3. Unweighted distribution of biomass conversion factors (ρ) for Needler (AN:CAB) for Div. 2J3KL in fall survey, Calvert (CAL:CAX) for Div. 3LNO in fall survey, and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys. The black vertical line and associated value is the unweighted mean.	36
Figure 4. Distribution of biomass conversion factors (ρ) weighted by the average biomass index for 1996 – 2019 for Needler (AN:CAB) for Div. 2J3KL in fall survey, Calvert (CAL:CAX) for Div. 3LNO in fall survey, and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys. The black vertical line and associated value is the weighted mean.	37
Figure 5. Distribution of biomass conversion factors (ρ) weighted by the average biomass index for 1996 – 2019 for Needler (AN:CAB) for Div. 2J3KL in fall, Calvert (CAL:CAX) for Div. 3LNO in fall survey, and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys by functional group. The black vertical line and associated value is the weighted mean.	38
Figure 6. Distribution of biomass conversion factors (ρ) weighted by the average biomass index for 1996 – 2019 for Needler (AN:CAB) for Div. 2J3KL in fall survey and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys by EPU. Due to lack of conversion factors in Div. 3NO in the fall for AN:CAB the 3LNO Fall EPU reflects conversion factors for 3L only and additional Div. 3LNOPs for AN:CAB these plots are blank. Calvert was not included as all conversions were for single EPU and season. The black vertical line and associated value is the weighted mean.	39
Figure 7. RV Biomass index by functional group, for the original (yellow), converted at species level (converted, blue) and converted using functional group level conversions (converted-FG, light blue) in 2H for the fall. Vertical bars indicate the 95% confidence intervals.	40
Figure 8. RV Biomass index by functional group, for the original (yellow), converted at species level (converted, blue) and converted using functional group level conversions (converted-FG, light blue) in Div. 2J3K for the fall. The vertical bars indicate the 95% confidence intervals.	41
Figure 9. RV Biomass index by functional group, for the original (yellow), converted at species level (converted, blue) and converted using functional group level conversions (converted-FG, light blue) in Div. 2J3KL for the fall. The vertical bars indicate the 95% confidence intervals.	42
Figure 10. Comparison of total research vessel (RV) survey biomass broken down by functional group for Div. 2H in the fall using species level conversions.	43
Figure 11. Comparison of total research vessel (RV) survey biomass broken down by functional group for Div. 2J3K in the fall using species level conversions.	44
Figure 12. Comparison of total research vessel (RV) survey biomass broken down by functional group for Div. 2J3KL in the fall using species level conversions.	45
Figure 13. Total research vessel (RV) survey biomass across all three regions (Div. 2H, 2J3K, and 2J3KL) and three time series and the 95% confidence intervals.	46

Figure 14. Conditional effects for vessel from models for each functional group in Div. 2J3K Fall. Blue lines show mean and shaded ribbons show 95% CI. Vessel: 30 – CCGS Wilfred Templeman, 34 – CCGS Alfred Needler, 39 – CCGS Teleost , 76 – CCGS Captain Jacques Cartier, 77 – CCGS John Cabot.	47
Figure 15. Conditional effects for vessel from models for each functional group in Div. 3LNO Fall. Blue lines show mean and shaded ribbons show 95% CI. Vessel: 30 – CCGS Wilfred Templeman, 34 – CCGS Alfred Needler, 39 – CCGS Teleost , 76 – CCGS Captain Jacques Cartier, 77 – CCGS John Cabot.	48
Figure 16. Conditional effects for vessel from models for each functional group in Div. 3LNO Spring. Blue lines show mean and shaded ribbons show 95% CI. Vessel: 30 – CCGS Wilfred Templeman, 34 – CCGS Alfred Needler, 39 – CCGS Teleost, 77 – CCGS John Cabot.	49
Figure 17. Conditional vessel effects from models for each functional group in SubDiv. 3Ps Spring. Blue lines show mean and shaded ribbons show 95% CI. Vessel: 30 – CCGS Wilfred Templeman, 34 – CCGS Alfred Needler, 39 – CCGS Teleost, 77 – CCGS John Cabot.	50
Figure 18. Mean percent overlap of vessel effects form models for each functional group and EPU season. Color of cells reflect mean percent with value reported within cell. Grey cells reflect vessel pair combinations that did not exist in the model. Vessel: 30 – CCGS Wilfred Templeman, 34 – CCGS Alfred Needler, 39 – CCGS Teleost, 76 – CCGS Captain Jacques Cartier, 77 – CCGS John Cabot. Functional group: LB - Large Benthivore, MB - Medium Benthivore, SB – Small Benthivore, PI - Piscivore, PP - Plankpisivore, PL - Planktivore, SF - Shellfish)	51
Figure 19. Comparison of directionality and magnitude of vessel impacts (ρ) across approaches by functional group, where multiple approaches can be applied. Approaches/sources include: estimated rho (ρ)at functional groups level (Munro et al. 2026) with 95CI and including non-significant conversions (blue); weighted-mean and 95CI for species level accepted conversion factors (light blue); pseudo-rho derived from model parameter estimates (green) comparing the old vessel to Cabot (triangle) or Cartier (square). Included regions and new vessel include Div. 2J3K Fall for Needler and Teleost, and Div. 3LNO Spring for Teleost. Functional group (LB - Large Benthivore, MB - Medium Benthivore, SB – Small Benthivore, PI - Piscivore, PP - Plankpisivore, PL - Planktivore, SF - Shellfish). Other regions and vessel pairs not as conversion factors not available.	52
Figure 20. Unweighted distribution of abundance conversion factors (ρ) for Needler (AN:CAB) for Div. 2J3KL in fall survey, Calvert (CAL:CAX) for Div. 3LNO in fall survey, and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys. The black vertical line and associated value is the unweighted mean.	53
Figure 21. Distribution of abundance conversion factors (ρ) weighted by the average biomass index for 1996 – 2019 for Needler (AN:CAB) for Div. 2J3KL in fall survey, Calvert (CAL:CAX) for Div. 3LNO in fall survey, and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys. The black vertical line and associated value is the weighted mean.	54
Figure 22. Distribution of abundance conversion factors (ρ) weighted by the average biomass index for 1996 – 2019 for Needler (AN:CAB) for Div. 2J3KL in fall, Calvert (CAL:CAX) for Div. 3LNO in fall survey, and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys by functional group. The black vertical line and associated value is the weighted mean.	55
Figure 23. Distribution of abundance conversion factors (ρ) weighted by the average biomass index for 1996 – 2019 for Needler (AN:CAB) for Div. 2J3KL in fall survey and Teleost	

(TEL:CAX) in Div. 2HJ3K in fall and Div. 3LNO spring surveys by EPU. Due to lack of conversion factors in Div. 3NO in the fall for AN:CAB the 3LNO Fall EPU reflects conversion factors for 3L only and additional Div. 3LNOPs for AN:CAB these plots are blank. Calvert was not included as all conversions were for single EPU and season. The black vertical line and associated value is the weighted mean.	56
Figure 24. RV abundance index by functional group, for the original (yellow), converted at species level (converted, blue) and converted using functional group level conversions (converted-FG, light blue) in Div. 2H for the fall. Vertical bars indicate the 95% confidence intervals.	57
Figure 25. RV abundance index by functional group, for the original (yellow), converted at species level (converted, blue) and converted using functional group level conversions (converted-FG, light blue) in Div. 2J3K for the fall. The vertical bars indicate the 95% confidence intervals.	58
Figure 26. RV abundance index by functional group, for the original (yellow), converted at species level (converted, blue) and converted using functional group level conversions (converted-FG, light blue) in Div. 2J3KL for the fall. The vertical bars indicate the 95% confidence intervals.	59
Figure 27. Comparison of total research vessel (RV) abundance broken down by functional group for Div. 2H in the fall converted using species level conversion factors.	60
Figure 28. Comparison of total research vessel (RV) abundance broken down by functional group for Div. 2J3K in the fall using species level conversion factors.	61
Figure 29. Comparison of total research vessel (RV) abundance broken down by functional group for 2J3KL in the fall using species level conversion factors.	62
Figure 30. Proportion of records of catch in each survey year converted by season and NAFO Division. Catch records are converted using size aggregated conversion factors (red), size based conversion factors (blue), or not converted as there are no conversion factors available (green).	63
Figure 31. Proportion of catch weight in a survey year converted by season and NAFO Division. Catch records are converted using size aggregated conversion factors (red), size based conversion factors (blue), or not converted as there are no conversion factors available (green).	64

ABSTRACT

Munro, H., Koen-Alonso, M., Ryan, K., Baker, K., Wheeland, L., Malayny, C. 2026. Effect of New Research Vessels on Biomass and Abundance Indices Used in Ecosystem Summaries in Newfoundland Region. Can. Tech. Rep. Fish. Aquat. Sci. 3805: vii + 148 p.

<https://doi.org/10.60825/xbsm-1707>

Ecosystem summaries in the Newfoundland and Labrador (NL) Region rely on data from the spring and fall multispecies bottom trawl surveys to provide information on ecosystem trends and environmental conditions for stock assessment processes. Between 2021 and 2023 the vessels that conduct these surveys, the Canadian Coast Guard Ship (CCGS) *Teleost* (“Teleost”) and CCGS *Alfred Needler* (“Needler”) were replaced with the new offshore fishing science vessels, the CCGS *John Cabot* (“Cabot”) and CCGS *Captain Jacques Cartier* (“Cartier”). Comparative fishing was conducted to compare the relative fishing performance between new and old vessels and a series of peer review processes accepted conversion factors for many species and functional groups for a large portion of the NL survey region. However, comparative fishing could not be completed for all survey/vessel area combinations, leaving spatial gaps and raising concerns about potential biases in ecosystem indices when analyzing timeseries that span both new and older survey vessels. The implications of these gaps were evaluated using three complementary approaches: (1) analysis of the distribution and magnitude of existing conversion factors, (2) application of available conversions to historical biomass indices, and (3) spatiotemporal modelling to estimate vessel effects where conversion factors are unavailable. Across analyses, the impact of the new vessels was small and where larger differences in catchability are known for specific species, they have limited influence on overall ecosystem indicator trends when aggregating biomass at the functional group level or total community level. Converted and unconverted time series showed strong overlap in trends and confidence intervals, and spatiotemporal models indicated that vessel effects in data poor regions were minor. Collectively, these results demonstrate that ecosystem-level indicators remain robust despite incomplete conversion coverage. It is therefore recommended to apply species-level conversion factors where available and to assume similar catchability between old and new vessels where no conversion factors exists. This approach aligns with those previously applied in the region and maintains time series continuity with similar levels of uncertainty for the ecosystem-level analyses.

RÉSUMÉ

Munro, H., Koen-Alonso, M., Ryan, K., Baker, K., Wheeland, L., Malayny, C. 2026. Effect of New Research Vessels on Biomass and Abundance Indices Used in Ecosystem Summaries in Newfoundland Region. Can. Tech. Rep. Fish. Aquat. Sci. 3805: vii + 148 p.

<https://doi.org/10.60825/xbsm-1707>

Les synthèses sur les écosystèmes de la région de Terre-Neuve-et-Labrador (NL) s'appuient sur les données issues des campagnes de sondage au chalut de fond multispécifique menées au printemps et à l'automne afin de fournir des informations sur les tendances des écosystèmes et les conditions environnementales dans le cadre des processus d'évaluation des stocks. Entre 2021 et 2023, les navires chargés de ces campagnes, le navire de la Garde côtière canadienne (NGCC) *Teleost* (« Teleost ») et le NGCC *Alfred Needler* (« Needler »), ont été remplacés par les nouveaux navires de recherche halieutique hauturiers, le NGCC *John Cabot* (« Cabot ») et le NGCC *Capitaine Jacques Cartier* (« Cartier »). Des campagnes de pêche comparatives ont été menées afin de comparer les performances de pêche relatives entre les nouveaux et les anciens navires, et une série de processus d'examen par les pairs a permis d'établir des facteurs de conversion valides pour de nombreuses espèces et groupes fonctionnels couvrant une grande partie de la zone d'étude de Terre-Neuve. Cependant, ces campagnes comparatives n'ont pas pu être menées à bien pour toutes les combinaisons « zone d'étude/navire », ce qui a laissé des lacunes spatiales et soulevé des inquiétudes quant à d'éventuels biais dans les indices écosystémiques lors de l'analyse de séries chronologiques couvrant à la fois les nouveaux et les anciens navires de campagne. Les implications de ces lacunes ont été évaluées à l'aide de trois approches complémentaires : (1) l'analyse de la répartition et de l'ampleur des facteurs de conversion existants, (2) l'application des conversions disponibles aux indices historiques de biomasse, et (3) la modélisation spatio-temporelle pour estimer les effets des navires lorsque les facteurs de conversion ne sont pas disponibles. Dans l'ensemble des analyses, l'impact des nouveaux navires s'est avéré faible et, lorsque des différences plus importantes de capturabilité sont connues pour certaines espèces spécifiques, celles-ci n'ont qu'une influence limitée sur les tendances globales des indicateurs écosystémiques lors de l'agrégation de la biomasse au niveau des groupes fonctionnels ou de l'ensemble de la communauté. Les séries chronologiques converties et non converties ont montré un fort chevauchement au niveau des tendances et des intervalles de confiance, et les modèles spatio-temporels ont indiqué que les effets liés aux navires dans les régions où les données sont insuffisantes étaient mineurs. Dans l'ensemble, ces résultats démontrent que les indicateurs au niveau de l'écosystème restent robustes malgré une couverture incomplète de la conversion. Il est donc recommandé d'appliquer des facteurs de conversion au niveau des espèces lorsqu'ils sont disponibles et de supposer une capturabilité similaire entre les anciens et les nouveaux navires en l'absence de facteurs de conversion. Cette approche s'aligne sur celles précédemment appliquées dans la région et préserve la continuité des séries chronologiques avec des niveaux d'incertitude similaires pour les analyses au niveau de l'écosystème.

INTRODUCTION

Fisheries and Oceans Canada (DFO), Newfoundland and Labrador (NL) Region fall and spring multispecies bottom trawl surveys are key data sources for the work of DFO Science branch in the region. Since the introduction of the Campelen 1800 trawl as the survey gear in the mid-1990s, these surveys have been conducted by the Canadian Coast Guard Ship (CCGS) *Teleost* (“Teleost”) and CCGS *Alfred Needler* (“Needler”), and in early years CCGS *Wilfred Templeman* (“Templeman”), which was the sister vessel of the Needler. The Teleost and Needler have been replaced by new offshore fishing science vessels, the CCGS *John Cabot* (“Cabot”) and CCGS *Captain Jacques Cartier* (“Cartier”) and work was conducted to evaluate differences in relative catchability between new and old vessels by way of comparative fishing (Wheeland et al. 2024b). These analyses allowed quantifying the differences in relative catchability between vessels and estimating conversion factors to correct catches for any differences that may exist between new and old vessels, ensuring the continuity of time series catch data within the region (DFO 2024a, DFO 2025b).

The first peer-review process for the NL Comparative Fishing program occurred in July 2023, where data collected in 2021 and 2022 were analyzed and conversion factors for a number of species across a subset of the region were accepted (DFO 2024a, Trueman et al. 2025a). This meeting adopted conversion factors between the Teleost and the new vessels in the Northwest Atlantic Fisheries Organization (NAFO) Divisions (Div.) 2HJ3KL for surveys conducted in the fall, and between the Needler and the new vessels in Div. 3KL for surveys conducted in the fall. This process also concluded that sample size and/or spatial coverage of comparative fishing between the Needler and new vessels in Div. 3NO in the fall surveys, and Div. 3LNO and subdivision (Subdiv.) 3Ps in the spring surveys, was insufficient to calculate conversion factors for those areas. Additional analyses following this peer-review process took place at respective stock assessments (DFO 2024b, DFO 2025a) for Atlantic Cod (*Gadus morhua*; Wheeland and Trueman 2024), Snow Crab (*Chionoecetes opilio*, Trueman et al. 2026a) and Northern Shrimp (*Pandalus borealis*; Le Corre et al. 2026).

A second dedicated comparative fishing peer-review process for the NL Region occurred in April of 2024, as additional comparative fishing was completed in 2023 to supplement gaps from the 2021–22 program. The meeting adopted conversion factors for deep-water species that previously did not have sufficient data between the Teleost and the new vessels in Div. 2HJ3KL for fall surveys (Trueman et al. 2025b), conversion factors for species in Div. 3LNO between Teleost and the new vessels for spring surveys (Trueman et al. 2025c), and for species grouped at the level of fish functional groups – a designation used in ecosystem summaries to group species by general feeding habit and size –, for Div. 2HJ3KL between the Needler, Teleost and new vessels in the fall surveys, and Div. 3LNO between Teleost and the new vessels in the spring surveys (DFO 2025b, Munro et al. 2026). Additional comparative fishing occurred between Cabot and Marine Vessel (MV) *Calvert* (“Calvert”), an industry trawler and the sister ship to the Teleost in the spring of 2023 and 2024 in Div. 3LNO. Conversion factors for this vessel pairing were adopted in a third dedicated comparative fishing peer-review process that occurred in March 2025 (DFO 2025c, Trueman et al. 2026b). No difference in catchability was found across functional groups.

Data from DFO-NL multispecies bottom trawl surveys are a key input for the production of ecosystem summaries for the ecosystem units in the NL Bioregion (Koen-Alonso et al. 2019, NAFO 2014, Pepin et al. 2014). These ecosystem summaries are integrated into stock assessment processes in the region and inform work of the Scientific Council of NAFO. The

data are used to analyze the structure and trends of the fish community, food consumption by fish functional groups, diet composition and consumption by key predators, and estimates of predation mortality. These summaries act as a synoptic assessment of the state of the ecosystem, how it is changing, and how different ecosystem-level pressures might influence the stocks that are being assessed. Furthermore, ecosystem summaries/assessments closely linked to advisory and peer-review processes have been identified as foundational elements for the implementation of ecosystem approaches to fisheries management (EAFM) in DFO (Pepin et al. 2023, Wheeland et al. 2026), and engagement sessions with stakeholders and rightsholders have shown that their development is seen by many as an integral component of any national strategy for EAFM implementation in Canada (<https://www.dfo-mpo.gc.ca/about-notre-sujet/publications/fisheries-peches/ecosystem-approach-proche-ecosystemique/index-eng.html>).

Ecosystem summaries in the NL Region rely on biomass and abundance data for all finfish and commercial shellfish surveyed across the entire region, and results are typically summarized at the Ecosystem Production Unit (EPU) level (Koen-Alonso and Cuff 2018). An EPU encompasses a relatively well-defined functional ecosystem, and represents the spatial scale best suited for integrated ecosystem management plans (Government of Canada 2024; Koen-Alonso et al. 2019; Pepin et al. 2014). The NL Region constitutes a single bioregion that includes four EPUs: the Labrador Shelf (Div. 2GH); Newfoundland Shelf (Div. 2J3K); Grand Bank (Div. 3LNO); and Southern Newfoundland (SubDiv. 3Ps) (Figure 1; NAFO 2015, Pepin et al. 2014). These summaries typically include trend analyses for biomass, abundance, and biomass-abundance ratio as a proxy for fish size. Data are presented at the level of the entire fish community sampled by the bottom trawl survey, and broken down into fish functional groups which have been defined based on general feeding habits and fish size (i.e., Small, Medium, and Large Benthivores, Piscivores, Planktivores, Planktivores, and Shellfish) (Dempsey et al. 2017, DFO 2012, NAFO 2010). These data are also used to estimate total consumption by the fish community and functional groups, and to scale diets of key predators to the functional group level for the estimation of predation indices for Snow Crab, Northern Shrimp, and Capelin (*Mallotus villosus*) (Le Corre et al. 2025, Lewis et al. 2025, Pantin et al. 2024).

Due to several problems throughout the Comparative Fishing program (DFO 2024a, DFO 2025b, DFO 2025c) it was not possible to complete analysis for all vessel combinations, NAFO divisions, species and seasons, leaving several gaps where survey data cannot be converted. To help with these gaps, conversion factors were also developed at the functional group level to support ecosystem-based analyses (Munro et al. 2026). A more significant issue is the spatial gap, with some areas/EPUs lacking conversion factors due to insufficient comparative fishing sampling within them, as is the case for comparisons between Needler and new vessels in Div. 3NO for fall and Div. 3LNO spring surveys, and SubDiv. 3Ps for spring surveys for both vessels.

These spatial gaps may limit our ability to reliably interpret patterns and shifts in fish community structure and predation over time, and impact our ability to provide advice on ecosystem-based trends. To address these challenges, we used multiple approaches to evaluate the effects of the vessel changes on the estimation of the indices used in the ecosystem analyses, including:

1. Summarizing the magnitude of known conversion factors for relevant vessel pairs to contextualize how large or small the unknown conversion factors could be expected to be.

2. Application of estimated conversion factors where available to compare the converted and unconverted biomass indices – including the estimated uncertainties – to evaluate the likely impact of conversion factors on the characterization of trends over time.
3. Application of spatiotemporal models to examine vessel effects on density of catch across the region.

Results of these three approaches were considered in conjunction to each other to determine whether the impact of a change in vessels may alter our understanding of ecosystem-level trends, and/or constrain our ability to integrate past and future data for ecosystem-level time series. This report focuses on biomass indices, but tests some of the assumptions for abundance. These results will allow us to evaluate whether the uncertainty added by the introduction of new vessels, and the absence of some conversion factors, would be expected to be impactful to ecosystem-level analyses.

METHODS

MAGNITUDE OF CONVERSION FACTORS

The distribution of magnitude of conversion factors here summarizes available conversion factors for fish and commercial shellfish in the NL Region which are provided in Table 1 with relevant species codes, areas, and season. Conversion factors for non-commercial invertebrates are available in some areas but not considered here as these taxa are not currently included in ecosystem summaries. Total biomass in ecosystem summaries only considers fish and commercial shellfish corresponding to the sum of biomass of the seven functional groups. Distributions are shown using the values of the estimated conversion factors (unweighted distribution), and using these values weighed by the biomass of the corresponding species (weighted distribution) to represent the likely impacts of conversion factors at the aggregated community level (e.g. total biomass trends). The biomass used for each species was the mean biomass for 1996 - 2019 within the corresponding NAFO Division. These distributions are also presented grouped by functional group. For the Needler, these distributions were only calculated for the fall surveys in Div. 2J3KL as there are few conversion factors for other areas or for spring. All season/EPU combinations are explored for the Teleost. Conversions between Calvert and new vessels are included in case the Calvert is ever used in the future for survey sets.

Conversion factors are presented as p , the estimated relative catch efficiency of old vs new vessels. When $p < 1$, the new vessel caught more fish than the old vessels, whereas $p > 1$ indicates that old vessels tended to catch more fish. If p does not significantly differ from 1, there is deemed to be no difference in catchability between the two vessels. For species with size-based estimated conversion factors, the size-aggregated conversion factors are used in this analysis, and are reported in Table 1. The use of size-aggregated conversion factors for species with accepted size-length conversions is only used in this analysis. We applied the same assumption about significance as all size-aggregated conversion factors for consistency, as this is an analysis looking for large impacts on catchability and the size-aggregated conversions take in to account the entire size range.

For unweighted distributions, a conversion factor was counted once for each division that it applied to, and once for 'operational species', the lowest taxonomic level reported within ecosystem summaries representing the lowest level of consistent identification within data across time series (Wells et al. 2019, Munro et al. 2026) (e.g. Threebeard Rockling [*Gaidropsarus* spp.] and Fourbeard Rockling [*Enchelyopus cimbrius*] are counted as two species despite one conversion factor being estimated for the two operational species

combined). When calculating weighted distributions, the average biomass was calculated from the STRAP (weighted average based on random-stratified survey designed; Smith and Somerton 1981) or the 1996-2019 average of unconverted data for the corresponding region. In the case of Snow Crab, to account for low catchability in the survey trawl, biomass is scaled using scaling factors calculated using Delury depletion regression analysis on fishery catch rate data from logbooks for each Crab Assessment Division, using the same rationale applied to the scaling of exploitable biomass of Snow Crab during assessments (Mullowney et al. 2018). Catchability is not corrected for other species as it is a relative index rather than absolute estimate of population size. This average biomass value was used to weight each conversion factor in order to represent the average contribution of the species/group to the overall biomass of the community across the entire time series. This does not account for changes in relative contribution of any species over time, for example, the increase in Atlantic Cod in Div. 2J3K since the 1990's or the decline in Northern Shrimp during the same time period (Koen-Alonso and Cuff 2018). This approach therefore provides a picture of the broad-scale impacts and not the inter-annual impacts. All distributions are presented with the associated mean. This approach represents a coarse metric intended to characterize the general magnitude of conversion factors within the community, and to inform the evaluation of the likely impact of the lack of conversion factors for some species and/or areas.

APPLICATION OF CONVERSION FACTORS

Indices of biomass and abundance (not shown in this report, see Koen-Alonso and Cuff 2018, or NAFO 2024 p 60-69 for examples) are estimated using STRAP (as above) from catch data from the DFO-NL fall and spring multispecies bottom trawl surveys from 1995 to 2019 (Smith and Somerton 1981; Rideout et al. 2025). This is the time period of the old vessels fishing the Campelen trawl in this Region, and does not include any years with new vessels. Available conversions have been applied to both biomass and abundances of catches within each set for each species. For some species, this conversion factor was estimated at a higher taxonomic level than species due to limited sample size or issues with reliable identification (e.g. eelpouts). For species with size-based conversions, conversions were applied following the methods used for stock specific analyses (DFO 2025a, Wheeland et al. 2024a), ensuring ecosystem analyses and stock assessments use consistent values. In the case of Toad Crab (*Hyas* spp.), there are not enough historical size-based data to apply the size-based conversion, so data were converted using size-aggregated conversion factors.

The conversion factors calculated for the Needler were used to convert catch data from the Templeman, its sister ship. Previous comparative fishing in the mid 2000's looked at seven species in Div. 3NO and SubDiv. 3Ps (American Plaice [*Hippoglossoides platessoides*], Atlantic Cod, Redfish [*Sebastes* spp.], Greenland Halibut [*Reinhardtius hippoglossoides*], Thorny Skate [*Amblyraja radiata*], Witch Flounder [*Glyptocephalus cynoglossus*], and Yellowtail Flounder [*Myxopsetta ferruginea*]), and found there were no significant differences in the relative catchability between the two vessels (Cadigan et al. 2006). This is the approach that has been taken across the region when dealing with the conversion of Templeman data (Wheeland et al. 2024a). The Calvert conversions are not used as there are currently only comparative fishing data for Calvert and no survey data.

Conversion factors, calculated using the same methods as single species level but at the functional group level (Munro et al. 2026) were also applied (Table 1), and a second converted time series, 'conversion - FG', was created using the same assumptions and methods as the species-level conversions.

After applying the available conversion factors, the historical time series (i.e., unconverted series) were reconstructed and plotted with the converted time series with associated 95% confidence intervals. The 95% confidence intervals were estimated assuming a gamma distribution (Regular et al. 2022). Due to the geographic gaps in conversion factors for the southern portions of the survey area (Div. 3NOPs), only Div. 2H, Div. 2J3K, and Div. 2J3KL were examined in this comparison. For this analysis, the grouping of Div. 2J3KL, which includes the northern portion of the Div. 3LNO EPU into Div. 2J3K, is included – as data are often presented at this geographic resolution for stocks where limits include the mixing area of Div. 3L. In Div. 2H, the year 2001 was removed from the converted data set as the majority of the sets during this survey year were conducted by Needler and we only have conversion factors for Teleost for that division.

SPATIOTEMPORAL MODELS

Spatiotemporal models were used to evaluate the significance of vessel effects at the functional group level for those regions/seasons where conversion factors were not available. Models used catch data from the DFO-NL fall and spring multispecies bottom trawl surveys from 1995 to 2024 (Rideout et al. 2025), in addition to the comparative fishing catch data from 2021 to 2023 (Silver et al. 2024, Wheeland et al. 2024a, Wheeland et al. 2024b,). This analysis did not include any of the comparative fishing data from the Calvert due to the limited temporal and spatial coverage. This time series includes catch data collected prior to new vessels being introduced and new vessel data available at the time of analysis. Data from comparative fishing are generally not treated as survey data because they do not follow the random-stratified design used in surveys, instead targeting specific regions, and can differ in timing from the standard survey. However, since the same sampling protocols were followed, these data can still be used in spatiotemporal models that account for spatial and temporal variation. The one factor not included in model was timing within season; generally the survey occurs at the same time each year within each division but differed slightly for some divisions during comparative fishing (Figure 2). Comparative fishing sampling occurred almost a month earlier in Div. 3K than normal in 2022 but standard survey sampling was also early in 2023. Comparative fishing sampling was also early in 2023 in Div. 3N during the spring survey, and was almost a month late in SubDiv. 3Ps. Data from five research vessels – Templeman, Needler, Teleost, Cabot, and Cartier – are included in the analysis. The analysis was completed separately for each EPU and season (i.e., 3Ps Spring, 3LNO Spring, and 3LNO Fall) because relative catchability and therefore conversion factors can differ between areas and seasons.

Methods follow those previously applied to Snow Crab in the region (Trueman et al. 2026a). Various spatiotemporal models were built in R 4.4.3 (R Core Team 2025) using the package *sdmTMB* (Anderson et al. 2024) and applied to unconverted catch data to assess the impacts of a vessel effect to differences in biomass density. This was done by modeling the biomass density for each of the seven functional groups separately. Models included vessel effect, survey year, and log(depth) as fixed effects (Table 3). For fitting models, a Stochastic Partial Differential Equations (SPDE) mesh with a cutoff of 20 km was used (see Appendix A for plots of meshes for each functional group – region combination). All models assumed a Tweedie response distribution and included spatial random fields and independent and identically distributed spatiotemporal random fields, along with component-specific effects of anisotropy to account for directional spatial correlation. A Tweedie distribution was selected as it showed the most consistent convergence across all functional groups in early explorations of analysis and made exploration of vessel effects more straight forward. The best model was determined

based on model diagnostic checks and Akaike information criterion (AIC) (Akaike 1973). The “sanity” function in *sdmTMB* was used to ensure the maximum gradient log-likelihood with respect to all fixed effects was < 0.001 , that the Hessian was positive definite, and that no random field marginal standard deviations were < 0.01 (Anderson et al. 2024). Diagnostics including residuals by fixed effects and spatiotemporal mapping of residuals were examined for all top models (Appendix A). Spatial residuals were calculated using the R package *sdmTMBextra* (Anderson et al. 2023), where Markov chain Monte Carlo (MCMC) sampling is used to estimate random effects, and fixed effects are estimated at their maximum likelihood values.

ABUNDANCE

The conversion factor magnitude analysis, and the analysis of the application of conversion factors to time series in EPU's Div. 2H, Div. 2J3K, and Div. 2J3KL described above, were also conducted for abundance data using the corresponding abundance conversion factors (Table 1, Table 2). Due to the consistency in the results between biomass and abundance data in these analyses, and the operational and capacity constraints linked to the implementation of spatiotemporal models, these models were not repeated for abundance data.

RESULTS AND DISCUSSION

MAGNITUDE OF CONVERSION FACTORS

Across the entire NL Region, the conversion factors for biomass had similar average catchability values between new and old vessels with ρ centered around 1 for both the Needler, Calvert, and Teleost and the new vessels (Figure 3). Results were similar when conversion factors were weighted by biomass (Figure 4). This consistency is due to the fact that many taxa, including the most common ones, tend to have conversion factors of 1 or near 1 (e.g., Atlantic Cod $\rho = 1$ for both vessels and Redfish $\rho = 1.1$ and $\rho = 1$ for the Needler and Teleost respectively), whereas some of the conversion factors that differ most from 1 apply to taxa that are less common, and therefore also had lower impacts on the weighted biomass distribution (e.g., Threebeard and Fourbeard Rockling $\rho = 0.69$ and Daubed Shanny [*Lumpenus maculatus*] $\rho = 1.5$ for Teleost). The exception is the Needler, where Snow Crab and Yellowtail Flounder account for a large proportion of the biomass, and have size-aggregated conversion factors of 0.83 and 1.27, respectively. While these are the size-aggregated conversion factors which assume an identical size composition across catches, the mean ratio of converted catches using size-based conversions to original catch are 0.99 and 1.15 respectively, and 0.87 and 1.23 when weighted for catch weight. The general agreement between size-based and size-aggregated approaches gives the same picture of magnitude of impact. Also of note is the Teleost size-aggregated conversion factor for Snow Crab, which applies to Div. 2HJ3KLNO and is 0.65. While this differs from 1, shrimp dominates the shellfish functional group in the more northern regions (Div. 2HJ) and have conversion factors of 1.08 and 1 for Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*P. montagu*) respectively for the Teleost. Overall, these results indicate that the application of conversion factors would be expected to have relatively small impacts on overall biomass and on aggregated biomass metrics at functional group level, but can have more discernible impacts at the individual species level.

This expectation mostly stands when conversion factors are examined at the functional group level (Figure 5), but conversion factors of individual species are shown to have a greater impact in those cases where species with conversion factors deviating from 1 dominate a given functional group. This can be seen with Shellfish for the Needler, where Snow Crab have a size-aggregated conversion factor of 1.21 and the functional group average is 1.21. Due to the spatial range of the Needler conversions only capturing Div. 3KL, shrimp did not account for a large proportion of the weighted mean as these conversion factors cover a more southern region where shrimp are less common and Snow Crab account for a larger proportion of the biomass within the functional group.

When the conversion factors are examined by EPU, a similar pattern exists as when broken down by functional group (Figure 6). For Teleost conversions, the weighted mean by EPU is within 5% of 1, ranging from 0.99-1.05, and the weighted mean by EPU for Needler is larger, ranging from 1.05-1.13. For these plots, the conversion factors for Needler in season-EPU combinations: Fall 2H, Spring 3LNO, and Spring 3Ps were excluded as there were a limited number of species with estimated conversion factors. It is important to recognize that Fall 3LNO represents primarily conversion factors for species and catches in Div. 3L, as there was insufficient sampling of Div. 3NO to estimate conversion factors, though some special cases were made with supporting analysis for Yellowtail Flounder, Atlantic Cod, and Snow Crab (Trueman et al. 2025a, Trueman et al. 2026a, Wheeland and Trueman 2024).

APPLICATION OF CONVERSION FACTORS TO TIME SERIES

In general, across all three regions (Div. 2H, Div. 2J3K, and Div. 2J3KL) considered, the converted and original time series are similar, with 95% confidence intervals overlapping in most years at the functional groups level (Figure 7 - Figure 9). The largest differences are seen for Medium Benthivores in Div. 2H with the functional group level conversions (Figure 7) and Small Benthivores in Div. 2J3KL with both conversions (Figure 9). While there are differences, they show the same trends, just shifted up in the case of Medium Benthivores in Div. 2H or down in the case of Small Benthivores in Div. 2J3KL. The composition of the total biomass across all regions show the same patterns across time between original and when converted with species level conversion factors (Figure 10 - Figure 12), suggesting that shifts in trends seen in some regions have minimal impact when looking at the larger community composition. At the total biomass level, all-time series show a virtually complete overlap (Figure 13). These results indicate that the characterization of general biomass trends and fish community structure over time is not meaningfully impacted by the application of conversion factors.

SPATIOTEMPORAL MODELS

Predicting biomass density of functional groups in space and time requires consideration of depth effects in the models; excluding these substantially erodes model performance (i.e. $\Delta AIC > 38$ but generally $\Delta AIC > 100$) (Table 4). Including or excluding vessel effects to model configuration generally rendered models that were closely ranked, with ΔAIC s of < 5 in most cases. The overall results across all these models (i.e. across functional groups and regions) indicate an even split in the best models between those with and without vessel effects, which indicates that the inclusion of vessel effect can improve the fit in some cases, but only in few occasions the improvement appears substantive (i.e. $\Delta AIC > 10$). A $\Delta AIC > 10$ is chosen based on models that differ by more than 10 are considered strong support that inclusion of vessel effects impacts fit of the model, understanding that a difference of 4 - 7 has less support, and

less than 2 having no support (Burnham and Anderson 2002). The higher ΔAIC is used as these models are sensitive to vessels effects, as there are five vessels and not just the comparison of the Needler and Teleost to the Cabot and Cartier used in the recent conversion factor analysis. These exceptions are Planktivores in Fall Div. 2J3K, Plankpiscivores and Shellfish in Fall Div. 3LNO, Large Benthivores in Div. 3LNO Spring, and Small Benthivores in SubDiv. 3Ps which all had ΔAIC of greater than 10 which contained a vessel effect.

Amongst all models, the magnitude of the vessel effect is generally small relative to the uncertainty surrounding the observations, with high overlap of confidence intervals between all vessels (Figure 14 - Figure 17). There is generally a similar magnitude between Cabot and Cartier to older vessels. Although vessel effects may be important, this does not imply that all vessels differ significantly from one another. The analysis is intended to evaluate differences between the new vessels (Cabot and Cartier) and the old vessels (Needler and Teleost). The Templeman was included because it forms part of the same time series. The overlap of the conditional effects is one way to evaluate the magnitude of the vessel effect, with overlaps greater than 50% indicating no difference, greater than 25% marginal difference, and less than 25% an important difference (Cumming and Finch 2005). The mean overlap between all vessels is generally above 50% and all are above 25% with exception of Templeman in Div. 3LNO Spring for Planktivores (Figure 16, Figure 18).

In Fall Div. 2J3K, for five of the seven functional groups, the top models included a vessel effect. This region has been surveyed by five vessels during the time series. The magnitude of these effects is small with high level of variation within vessels and high level of overlap of all 95% confidence intervals (Figure 14). The strongest support for inclusion of vessel is for Planktivores, where the top model included vessel effects and the next closest had a ΔAIC of 15.8. For the top model, the strongest vessel effect is between Templeman and the new vessels where conditional effects of vessel still overlap by more than 69% and for all other vessel pairing it is greater than 81% (Figure 18). Although a difference between Teleost and the new vessels was observed (80-90% overlap), this difference is of similar magnitude to that observed between the two new vessels themselves (90%) (Figure 18).

In Div. 3LNO during the fall, for three of the seven functional groups the top model included a vessel effect with ΔAIC of 11.12 and 21.67 for Plankpiscivore and Shellfish respectively. For Plankpiscivores, the three older vessels are fairly similar (overlap of 85-98%) but the Cabot and Cartier differ slightly and differ from each other (overlap of 72%). The greatest difference was between the Cartier and Templeman (overlap of 34%) and Cartier and Teleost (overlap of 38%) (Figure 15, Figure 18). It is also important to note that the general assumption is that the Cabot and Cartier are interchangeable and with this assumption the mean overlap between the new vessels combined and Teleost would be greater than 50%. In the case of Shellfish, confidence intervals on vessel effect have large overlap of confidence intervals (greater than 79%) with the greatest differences between Templeman and Cartier (Figure 18). Even in this case, there is a substantial overlap among the 95% confidence intervals, suggesting that while vessel effect is noticeable in the graph, it is small with respect to the variability in the data.

In Div. 3LNO during the spring, for five of the seven functional groups the top model included a vessel effect with the largest ΔAIC of 15.4 for Large Benthivores. Here, the Templeman differs from the other vessels, but again the overlap among the 95% confidence intervals is greater than 50% (Figure 16, Figure 18). Despite only having a ΔAIC of 3.42, the vessel effects in the Planktivore model had very low overlap (<14%) for Templeman compared to all other vessels (Figure 18).

Finally, in SubDiv. 3Ps, Small Benthivores were the only functional group with the top model that contained a vessel effect. In this case, Teleost and Cabot are similar with 94% overlap, but

overlap between Cabot and Templeman (55%) and Needler (42%) being lower (Figure 18) but still greater than 24%. All other vessel effects have large overlap in 95% confidence intervals (Figure 17, Figure 18).

In all of these cases, while the vessel effects exist, they remain small with the overlap of the 95% confidence intervals, and often similar effects are being observed between the new vessels as between new and old vessels.

COMPARISON OF METHODS

When comparing the general trends of vessel effects from the spatiotemporal models to the accepted functional group conversion factors and weighted means in Div. 2J3K in the fall and Div. 3LNO in the spring, there is a general consensus of results (Figure 19). This approach looks at the estimated rho's for functional groups including those that are not significant, which provides information on directionality of relationship even if not significant. Across all functional groups and all regions/new vessel pairs, the estimated vessel effects as pseudo-rhos from the models (ratio of parameter estimates of new vs old vessels for each new vessel vs Teleost or Neddler) fall within the confidence intervals of the functional groups level rhos with the exception of Small Benthivores in Div. 2J3K for Needler. However, the pseudo-rho is similar to the weighted mean of the species level conversion factors for Div. 2J3K Small Benthivores, which suggests that the species composition of this diverse functional group may have led to this discrepancy. Similarly, the weighted means also overlap with the functional group level rhos with the exception of Shellfish in Div. 2J3K for Needler. This is likely driven by the application of scaling factors to Snow Crab catches which are not considered in the functional group level rhos. In Div. 3LNO, many of the species-level conversion factors were 1 which led to many weighted averages being 1 and therefore no associated 95% confidence intervals.

With the similarity in results between these approaches, it would indicate that in the absence of conversion factors, inferences solely based on spatiotemporal models would be a reliable approach to evaluate the likely impact of vessel effects on functional group biomass trends. It follows that, for areas like Div. 3LNO in the fall and spring, and SubDiv. 3Ps in the spring (which do not have conversion factors), the similarities in the results between models with and without vessel effects indicate that, given the small magnitude of the estimated vessel effects when the best model included them, the lack of consideration of these effects (analogous to the lack of conversion factors) would not be expected to be a major drawback for reliably characterizing the changes in functional group biomass over time.

ABUNDANCE

Ecosystem summaries provide information on abundance trends over time in addition to biomass trends. As biomass and abundance are closely linked and typically show similar trends, we assume that similar results to those observed for biomass would occur from examining the impacts of conversion factors to indices of abundance at the functional group level.

The analysis of distribution/magnitude of conversion factors (Figure 20 - Figure 23) showed similar trends. Due to their small size and high abundance, shrimp dominate the weighted distributions for Shellfish (Figure 22), as Northern Shrimp have conversion of 0.91 for Needler and 1.16 for Teleost in the Fall. Similar trends were observed when conversion factors were applied to time series of abundance as observed for biomass (Figure 24 - Figure 26). The total abundance shows similar trends across time, but with a slight shift in magnitude driven by the shrimp conversion factors discussed above (Figure 27 - Figure 29).

The alignment of these results with the results for biomass supports the assumption that the converted and unconverted survey abundance timeseries follows a similar pattern to biomass and therefore the same assumptions can be applied to abundance indices going forward, with species-level conversions being applied where available and assuming no conversion for areas and species with no available conversion factors as long as analysis is focused at the broad ecosystem level.

CONCLUSIONS

Changes in vessel and modifications to gear impact catchability of some species, and this results in changes in biomass estimates, but those changes mostly become important when considering indices at the individual species level. Considering the analyses presented here together, the emerging pattern indicates that when aggregating species into functional groups or total biomass, the impact of the vessel changes on the time series is on average low.

The majority of estimated conversion factors for biomass and abundance for the change to the Cabot and Cartier fishing the modified Campelen trawl are either 1 or generally contained within a 10% range of 1 (i.e. 0.9 - 1.1). As a result, unweighted means for the conversion factors suggest that changes from the older vessels are generally less than 10%. This becomes even more pronounced when looking at weighted distribution, which accounts for how common species contribute to aggregated biomass and abundance metrics and total biomass. When applying the conversion factors, the converted time series generally overlap with the original unconverted time series and consistently fall within their 95% confidence intervals. There are a few exceptions, but even these showed the same trends across time and do not impact our understanding of ecosystem-level structure and dynamics.

For EPU with no estimated conversion factors, spatiotemporal models for biomass suggest the estimated vessel effects are minor. Although, recent work has revisited assumptions of similar catchability between older vessels (Rideout et al. 2025) as a consequence of the recent comparative fishing analyses (DFO 2025b), and found vessel-related differences, these differences are unlikely to significantly influence the overall biomass trends at the EPU scale. Effectively, assuming similar catchability between the older vessels implied that the uncertainty associated with variability in catchability between them represented an operationally acceptable level of uncertainty for differences in catchability between vessels. This assumption is supported by the spatiotemporal models where the scale of vessel effects are small compared to the 95% confidence intervals. The results here indicate that at the functional group or total survey biomass level, the differences in catchability between old and new vessels also falls within this operationally acceptable level of uncertainty. Consequently, if no conversion factors exist, assuming no differences between new and old vessels would be expected to render ecosystem-scale time series that remain within previously accepted levels of uncertainty. Therefore, in the absence of conversion factors, assuming similar catchability between old and new vessels for the time series presented here provides a reasonable path forward for producing continuous ecosystem-level times series across these vessel changes, and using these for interpreting ecosystem-level changes.

Based on these analyses and results, we recommend that moving forward the indices for functional groups be constructed using the species-level conversion factors where available, while assuming similar catchability between old and new vessels for those cases without conversion factors. The rationale for the application of species-level conversion factors and not functional group level conversion factors is that species level conversions align with the

implementation for converting time series used for stock assessments. The species-level conversion factors also allow the composition of functional groups to vary across time, and for functional groups to be examined at the species level. The functional group level conversion factors provide an understanding the impact of less common species which we do not have conversion factors for. Assuming a conversion factor of one, these species have minimal overall impact when only species level conversions are applied and should be comparable to the functional group level conversion factors. Following this approach, most of the records and corresponding weights are converted in Div. 2HJ3KL, whereas most records, and therefore most of the catch weight, for fall in Div. 3NO and spring in Div. 3LNOPs remain unconverted (Figure 30, Figure 31). This increased uncertainty for the latter should be considered in interpretation going forward. Within the areas with no species level conversion factors, there are also no functional group level conversions with the exception of catches from Teleost in Div. 3LNO Spring which represent only a few years (Figure 30, Figure 31). This proposed way forward will allow maintaining the continuity of the existing ecosystem-level time series (i.e. functional groups, total biomass, fish community structure) without jeopardizing our ability to reliably characterize the structure and trends of ecosystem indicators.

REFERENCES CITED

- Akaike, H. 1973. Information theory as an extension of the maximum likelihood principle. In: Second International Symposium on Information Theory. Akademiai Kiado, Budapest. pp. 267–281.
- Anderson, S.C. 2023. sdmTMBextra: Extra functions for working with ‘sdmTMB’ models. R package version 0.0.4. <https://github.com/pbs-assess/sdmTMBextra>.
- Anderson, S.C., Ward, E.J., English, P.A., Barnett, L.A.K., and Thorson, J.T. 2024. [sdmTMB: an R package for fast, flexible, and user-friendly generalized linear mixed effects models with spatial and spatiotemporal random fields](#). bioRxiv 2022.03.24.485545.
- Burnham, K.P., and Anderson, D.R. 2002. [Model Selection and Inference: A Practical Information-Theoretic Approach](#). 2nd Edition, Springer-Verlag, New York.
- Cadigan, N.G., Walsh, S.J., and Brodie, W.B. 2006. [Relative efficiency of the Wilfred Templeman and Alfred Needler research vessels using a Campelen 1800 Shrimp Trawl in NAFO Subdivision 3Ps and Divisions 3LN](#). DFO. Can. Sci. Advis. Sec. Res. Doc. 2006/085.
- Cumming, G., and Finch, S. 2005. Inference by eye: Confidence intervals and how to read pictures of data. Am. Psychol., 60(2),pp 170–180.
- Dempsey, D.P., Koen-Alonso, M., Gentleman, W.C., and Pepin, P. 2017. [Compilation and discussion of driver, pressure, and state indicators for the Grand Bank ecosystem, Northwest Atlantic](#). Ecol. Indic., 75, pp 331-339.
- DFO. 2012. [Results and recommendations from the Ecosystem Research Initiative – Newfoundland and Labrador’s Expanded Research on Ecosystem Relevant but Under Surveyed Splicers](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/058.
- DFO. 2024a. [Newfoundland & Labrador Comparative Fishing Analysis – Part 1](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2024/002.
- DFO. 2024b. [NAFO Subdivision 3Ps Atlantic cod \(*Gadus morhua*\) Stock Assessment in 2023](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2024/016.
- DFO. 2025a. [Assessment of Newfoundland and Labrador \(Divisions 2HJ3KLNOP4R\) Snow Crab in 2023](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2025/031.
- DFO. 2025b. [Newfoundland and Labrador Comparative Fishing Analysis – Part II](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2025/037.
- DFO. 2025c. [Newfoundland and Labrador Comparative Fishing Analysis – MV Calvert](#). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2025/045.
- Government of Canada. 2024. Ecosystem Production Units in the Northwest Atlantic Ocean. Open Government Portal. <https://open.canada.ca/data/en/dataset/9a515ef8-0e2a-479e-9b25-55658eae30be>.
- Koen-Alonso, M., and Cuff, A. 2018. Status and trends of the fish community in the Newfoundland Shelf (NAFO Div. 2J3K), Grand Bank (NAFO Div. 3LNO) and Southern Newfoundland Shelf (NAFO Div. 3Ps) Ecosystem Production Units. NAFO SCR Doc. 18/070.

- Koen-Alonso, M., Pepin, P., Fogarty, M.J., Kenny, A., and Kenchington, E. 2019. [The Northwest Atlantic Fisheries Organization Roadmap for the development and implementation of an Ecosystem Approach to Fisheries: structure, state of development, and challenges](#). Mar. Policy, 100: 342-352.
- Le Corre, N., Baker, K.D., Coffey, W., Malayny, C., Sullivan, D., Belanger, D., Cyr, F., Koen-Alonso, M., and Munro, H. 2026. [Assessment of Northern Shrimp \(*Pandalus borealis*\) in Shrimp Fishing Areas 4–6 in 2023](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2026/035. v + 148 p.
- Lewis, R.S., Murphy, H.M., Adamack, A.T., Munro, H., Koen-Alonso, M., and Bourne, C.M. 2025. [Assessment of Capelin \(*Mallotus villosus*\) in NAFO Divisions 2J + 3KL to 2024](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2025/061. iv + 38 p.
- Mullowney, D., Coffey, W., Baker, K., Evans, G., Fiander, D., Colbourne, E., Maddock Parsons, D., Koen-Alonso, M., and Wells, N. 2018. [An Assessment of Newfoundland and Labrador Snow Crab \(*Chionoecetes opilio*\) in 2016](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2017/081. viii + 172 p.
- Munro, H., Trueman, S., Novaczek, E., and Wheeland, L. 2026. [Functional group conversion factors in support of ecosystem analyses in the Newfoundland and Labrador Region](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2026/030. iv + 106 p.
- NAFO. 2010. Report of the NAFO Scientific Council on Ecosystem Approaches to Fisheries Management (WGEAFM). Serial No. N5815. NAFO SCS Doc. No. 10/9. 101p.
- NAFO. 2014. Report of the 7th Meeting of the NAFO Scientific Council (SC) Working Group on Ecosystem Science and Assessment (WGESA). Serial No. N6410. NAFO SCS Doc. No. 14/023. 126p.
- NAFO. 2015. Report of the 8th Meeting of the NAFO Scientific Council (SC) Working Group on Ecosystem Science and Assessment (WGESA). Serial No. N6549. NAFO SCS Doc. No. 15/19. 176p.
- NAFO. 2024. Report of the Scientific Council Working Group on Ecosystem Science and Assessment, 12–21 November 2024, Halifax, Canada. Serial No. N7604. NAFO SCS Doc. No. 24/20. 101p.
- Pantin, J.R., Coffey, W., Mullowney, D., Baker, K.D., Cyr, F., and Koen-Alonso, M. 2024. [Assessment of Newfoundland and Labrador Snow Crab \(*Chionoecetes opilio*\) in 2021](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2024/055. viii + 172 p.
- Pepin, P., Higdon, J., Koen-Alonso, M., Fogarty, M., and Ollerhead, N. 2014. Application of ecoregion analysis to the identification of Ecosystem Production Units (EPU) in the NAFO Convention Area. NAFO SCR Doc. 14/069.
- Pepin, P., Koen-Alonso, M., Boudreau, S.A., Cogliati, K.M., den Heyer, C.E., Edwards, A.M., Hedges, K.J., and Plourde, S. 2023. [Fisheries and Oceans Canada's Ecosystem Approach to Fisheries Management Working Group: case study synthesis and lessons learned](#). Can. Tech. Rep. Fish. Aquat. Sci. 3553: v + 67 p.
- R Core Team. 2025. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.
- Regular, P.M., Koen-Alonso, M., Yalcin, S., Perreault, A.M.J., and Wheeland, L.J. 2022. Approximating uncertainty around indices from stratified-random trawl surveys using the Gamma distribution. NAFO SCR Doc. 22/043.

- Rideout, R.M., Wheeland, L., Perreault, A., Regular, P., Skanes, K., Trueman, S., Simms, L., and Makrides, J. 2025. Canadian (Newfoundland And Labrador Region) Multi-Species Research Vessel Bottom Trawl Survey Report for Surveys Conducted in 2024. NAFO SCR Doc. 25/028.
- Silver, K., Makrides, J., Trueman, S., and Wheeland, L. 2024. [Overview of Trips and Sets in the 2021-2023 Comparative Fishing Program in the Newfoundland and Labrador Region](#). Can. Data Rep. Fish. Aquat. Sci. 1406: viii + 97 p.
- Smith, S.J., and Somerton, G.D. 1981. [STRAP: a user-oriented computer analysis system for groundfish research trawl survey data](#). Can. Tech. Rep. Fish. Aquat. Sci. 1030. iv + 66 p.
- Trueman, S., Wheeland, L., Benoît, H., Munro, H., Nguyen, T., Novaczek, E., Skanes, K., Walsh, S., and Yin, Y. 2025a. [Results of comparative fishing between the CCGS Teleost and CCGS Alfred Needler with the CCGS John Cabot and CCGS Capt. Jacques Cartier in the Newfoundland and Labrador Region in 2021 and 2022](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2025/021. v + 237 p.
- Trueman, S., Nguyen, T., Silver, K., Skanes, K., and Wheeland, L. 2025b. [Further Results of Comparative Fishing Between the Canadian Coast Guard Ship \(CCGS\) Teleost and CCGS Capt Jacques Cartier/John Cabot in the Newfoundland and Labrador Region in Fall, with a Focus on Deep Water Species](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2025/052. iv + 94 p.
- Trueman, S., Novaczek, E., Silver, K., and Wheeland, L. 2025c. [Results of Comparative Fishing Between the Canadian Coast Guard Ship \(CCGS\) Teleost and the CCGS John Cabot in the Newfoundland and Labrador Region in Spring 2023](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2025/067. iv + 114 p.
- Trueman, S., Wheeland, L., Pantin, J., Baker, K., and Mulletowney, D. 2026a. [On the relative catchability of Snow Crab in the Newfoundland and Labrador multispecies trawl surveys](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2026/008. iv + 41 p.
- Trueman, S., Wheeland, L., Novaczek, E., Munro, H., and Nguyen, T. 2026b. [Results of Comparative Fishing Between the CCGS John Cabot and MV Calvert in the Newfoundland and Labrador Region in Spring 2023-2024](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2026/014. iv + 115 p.
- Wells, N.J., Pretty, C., Warren, M., Novaczek, E., and Koen-Alonso, M. 2021. [Average Relative Density of Fish Species and Functional Groups in the Newfoundland and Labrador Shelves Bioregion from 1981-2017](#). Can. Tech. Rep. Fish. Aquat. Sci. 3427: viii + 76 p.
- Wheeland, L., and Trueman, S. 2024. [On the relative catchability of Atlantic cod in the Newfoundland and Labrador multispecies trawl surveys](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2024/038. iv + 21 p.
- Wheeland, L., Perreault, A., Rideout, R.M., Skanes, K.R., Le Corre, N., Trueman, S., Regular, P.M., Simpson, M.R., Maddock Parsons, D., Hatefi, F., and Adamack, A.T. 2024a. Application of Conversion Factors in the Canadian (Newfoundland And Labrador Region) Spring And Autumn Multi-Species RV Bottom Trawl Surveys. NAFO SCR Doc. 24/037.
- Wheeland, L., Skanes, K., and Trueman, S. 2024b. [Summary of Comparative Fishing Data Collected in Newfoundland & Labrador from 2021 - 2022](#). Can. Tech. Rep. Fish. Aquat. Sci. 3579: iv + 132 p.

Wheeland, L., Benoit, H.P., Edwards, A.M., Mazur, M., Regular, P.M., Robertson, M.D., Wor, C., Holt, C.A., Burton, M.A., Rideout, R.M., Neville, V.K., Boudreau, S.A., Varkey, D., Tai, T.C., Forrest, R.R., and Koen-Alonso, M. 2026. [Proceedings of the Technical Expertise in Stock Assessment \(TESA\) National Workshop on 'Methods for incorporating ecosystem information into single-species stock assessment models', 24-27 November 2025, St. John's, NL](#). Can. Tech. Rep. Fish. Aquat. Sci. 3798: vi + 56 p.

TABLES & FIGURES

Table 1. Accepted size-aggregated biomass and abundance (abund) conversion factors (p) for species by vessel (AN – Needler, TEL – Teleost) and season with associated species code used within DFO NL region, functional group (FG) for species (LB - Large Benthivore, MB - Medium Benthivore, LB - Large Benthivore, PI - Piscivore, PP - Planktivore, PL - Planktivore, SF - Shellfish), NAFO divisions where conversion factor can be applied, and reference (ref) for origin of conversion factor.

DFO NL Species Code	Vessel Season	NAFO Division	Common Name	Scientific Name	FG	Biomass (p)	Abund (p)	ref
90	AN Fall	3KL	Thorny Skate	<i>Raja radiata</i>	LB	1*	1*	1
91	AN Fall	3KL	Smooth Skate	<i>Raja senta</i>	MB	1	1	4
187	AN Fall	3KL	Capelin	<i>Mallotus villosus</i>	PL	1	1	1
272	AN Fall	3KL	Lanternfish	Myctophidae	PL	1	1	1
316	AN Fall	3KL	Barracudina	Paralepididae	PI	0.59	1	1
323	AN Fall	3KL	Lancetfish	Alepisauridae	PI	0.59	1	1
324	AN Fall	3KL	Shortnosed Lancetfish	<i>Alepisaurus brevirostris</i>	PI	0.59	1	1
325	AN Fall	3KL	Longnose Lancetfish	<i>Alepisaurus ferox</i>	PI	0.59	1	1
438	AN Fall	2HJ3KLNO	Atlantic Cod	<i>Gadus morhua</i>	PI	1*	1*	1, 2
451	AN Fall	3KL	Arctic Cod	<i>Boreogadus saida</i>	PP	1	1	1
453	AN Fall	3KL	Threebeard Rockling	<i>Gaidropsarus</i> spp.	SB	0.71	1	1
461	AN Fall	3KL	Fourbeard Rockling	<i>Enchelyopus cimbrius</i>	SB	0.71	1	1
474	AN Fall	3KL	Roughhead Grenadier	<i>Macrourus berglax</i>	LB	1	1	1
700	AN Fall	3KL	Striped Wolffish	<i>Anarhichas lupus</i>	LB	1*	1*	1
701	AN Fall	3KL	Spottled Wolffish	<i>Anarhichas minor</i>	LB	1	1	1
717	AN Fall	3KL	Daubed Shanny	<i>Lumpenus maculatus</i>	SB	0.52	0.55	1
721	AN Fall	3KL	Wrymouth	<i>Cryptacanthodes maculatus</i>	LB	0.55	0.56	1

DFO NL Species Code	Vessel Season	NAFO Division	Common Name	Scientific Name	FG	Biomass (ρ)	Abund (ρ)	ref
726	AN Fall	3KL	Eelpout	<i>Lycodes</i> spp.	MB	0.83	0.72	4
727	AN Fall	3KL	Esmark's Eelpout	<i>Lycodes esmarki</i>	MB	0.83	0.72	4
729	AN Fall	3KL	Arctic Eelpout	<i>Lycodes reticulatus</i>	MB	0.83	0.72	4
730	AN Fall	3KL	Vahl's Eelpout	<i>Lycodes vahliei</i>	MB	0.83	0.72	4
744	AN Fall	3KL	Ocean Pout	<i>Macrozoarces americanus</i>	LB	0.83	0.72	4
745	AN Fall	3KL	Soft Eelpout	<i>Melanostigma atlanticum</i>	SB	0.83	0.72	4
746	AN Fall	3KL	Fish Doctor	<i>Gymnelis viridis</i>	MB	0.83	0.72	4
794	AN Fall	3KL	Redfish	<i>Sebastes mentella</i>	PP	1*	0.81*	1
810	AN Fall	3KL	Hookear Sculpin	<i>Artediellus</i> spp.	SB	0.47	0.71	4
813	AN Fall	3KL	Mailed Sculpin	<i>Triglops</i> spp.	SB	0.47	0.71	4
817	AN Fall	3KL	Ribbed Sculpin	<i>Myoxocephalus</i> spp.	MB	0.47	0.71	4
819	AN Fall	3KL	Shorthorn Sculpin	<i>Myoxocephalus scorpius</i>	MB	0.47	0.71	4
820	AN Fall	3KL	Longhorn Sculpin	<i>Myoxocephalus octodecemspinosus</i>	MB	0.47	0.71	4
822	AN Fall	3KL	Arctic Sculpin	<i>Myoxocephalus scorpioides</i>	SB	0.47	0.71	4
823	AN Fall	3KL	Arctic Staghorn Sculpin	<i>Gymnocanthus tricuspis</i>	SB	0.47	0.71	4
828	AN Fall	3KL	Pallid Sculpin	<i>Cottunculus thompsonii</i>	SB	0.47	0.71	4
829	AN Fall	3KL	Polar Sculpin	<i>Cottunculus microps</i>	SB	0.47	0.71	4
830	AN Fall	3KL	Twohorn Sculpin	<i>Icelus</i> spp.	SB	0.47	0.71	4
832	AN Fall	3KL	Spatulate Sculpin	<i>Icelus spatula</i>	SB	0.47	0.71	4
836	AN Fall	3KL	Northern Alligatorfish	<i>Agonus decagonus</i>	SB	1	1	1

DFO NL Species Code	Vessel Season	NAFO Division	Common Name	Scientific Name	FG	Biomass (ρ)	Abund (ρ)	ref
837	AN Fall	3KL	Arctic Alligatorfish	<i>Aspidophoroides olriki</i>	SB	1	1	1
838	AN Fall	3KL	Common Alligatorfish	<i>Aspidophoroides monopterygius</i>	SB	1	1	1
853	AN Fall	3KL	Seasnail	Liparidae	SB	1	1	1
863	AN Fall	3KL	Seasnail	<i>Careproctus</i> spp.	PP	1	1	1
889	AN Fall	3KL	American Plaice	<i>Hippoglossoides platessoides</i>	LB	1*	1*	1
890	AN Fall	3KL	Witch Flounder	<i>Glyptocephalus cynoglossus</i>	MB	1*	1*	1
891	AN Fall	3KLNO	Yellowtail Flounder	<i>Myxopsetta ferruginea</i>	MB	1.27*	1.27*	1
892	AN Fall	3KL	Greenland Halibut	<i>Reinhardtius hippoglossoides</i>	PI	1*	1*	1
8111	AN Fall	3KL	Northern Shrimp	<i>Pandalus borealis</i>	SF	0.82*	1*	1
8112	AN Fall	3KL	Stripped Shrimp	<i>Pandalus montagui</i>	SF	1	1	1
8213	AN Fall	2HJ3KLNO	Snow Crab	<i>Chionoecetes opilio</i>	SF	0.83*	0.72*	1, 3
438	AN Spring	3LNOPs	Atlantic Cod	<i>Gadus morhua</i>	PI	1	1	2
891	AN Spring	3LNOPs	Yellowtail Flounder	<i>Myxopsetta ferruginea</i>	MB	1.27*	1.27*	1
12	TEL Fall	2HJ3KL	Atlantic Hagfish	<i>Myxine glutinosa</i>	LB	2.13	1	4
27	TEL Fall	2HJ3KL	Black Dogfish	<i>Centroscyllium fabricii</i>	PI	1	1	4
56	TEL Fall	2HJ3KL	Deepsea Cat Shark	<i>Apristurus profundorum</i>	MB	1.64	1.63	4
90	TEL Fall	2HJ3KL	Thorny Skate	<i>Raja radiata</i>	LB	1*	1*	1
91	TEL Fall	2HJ3KL	Smooth Skate	<i>Raja senta</i>	MB	1	1	4
164	TEL Fall	2HJ3KL	Smoothhead	Alepocephalidae	LB	1	1	4

DFO NL Species Code	Vessel Season	NAFO Division	Common Name	Scientific Name	FG	Biomass (ρ)	Abund (ρ)	ref
168	TEL Fall	2HJ3KL	Atlantic Gymnast	<i>Xenodermichthys copei</i>	SB	1	1	4
187	TEL Fall	2HJ3KL	Capelin	<i>Mallotus villosus</i>	PL	1.48	1.45	1
202	TEL Fall	2HJ3KL	Goitre Blacksmelt	<i>Bathylagus euryops</i>	SB	1	1	4
227	TEL Fall	2HJ3KL	Viperfish	<i>Chauliodus sloani</i>	PI	0.65	0.66	4
230	TEL Fall	2HJ3KL	Boa Dragonfish	<i>Stomias boa</i>	PI	1	1	4
272	TEL Fall	2HJ3KL	Lanternfish	Myctophidae	PL	1	1	4
300	TEL Fall	2HJ3KL	Scopelosaurus	Scopelosauridae	PP	0.4	1	4
303	TEL Fall	2HJ3KL	Loosejaw	Malacosteidae	SB	1	1	4
316	TEL Fall	2HJ3KL	Baracudina	Paralepididae	PI	1	1	4
323	TEL Fall	2HJ3KL	Lancetfish	Alepisauridae	PI	1	1	4
324	TEL Fall	2HJ3KL	Shortnosed Lancetfish	<i>Alepisaurus brevirostris</i>	PI	1	1	4
325	TEL Fall	2HJ3KL	Longnose Lancetfish	<i>Alepisaurus ferox</i>	PI	1	1	4
368	TEL Fall	2HJ3KL	Atlantic Snipe Eel	<i>Nemichthys scolopaceus</i>	LB	1	1	4
369	TEL Fall	2HJ3KL	Shortnose Snipe Eel	<i>Serrivomer beani</i>	MB	1	1	4
373	TEL Fall	2HJ3KL	Longnose Eel	<i>Synaphobranchus kaupi</i>	MB	1.32	1.2	4
386	TEL Fall	2HJ3KL	Snubnosed Spiny Eel	<i>Notacanthus chemnitzii</i>	LB	1	1	4
432	TEL Fall	2HJ3KL	Blue Hake	<i>Antimora rostrata</i>	MB	1	1	4
438	TEL Fall	2HJ3KLNO	Atlantic Cod	<i>Gadus morhua</i>	PI	1*	1*	1,2

DFO NL Species Code	Vessel Season	NAFO Division	Common Name	Scientific Name	FG	Biomass (ρ)	Abund (ρ)	ref
451	TEL Fall	2HJ3KL	Arctic Cod	<i>Boreogadus saida</i>	PP	1	1	1
453	TEL Fall	2HJ3KL	Threebeard Rockling	<i>Gaidropsarus</i> spp.	SB	0.69	1	1
461	TEL Fall	2HJ3KL	Fourbeard Rockling	<i>Enchelyopus cimbrius</i>	SB	0.69	1	1
471	TEL Fall	2HJ3KL	Grenadier	Macrouridae	SB	1	1	4
474	TEL Fall	2HJ3KL	Roughhead Grenadier	<i>Macrourus berglax</i>	LB	1	1	4
478	TEL Fall	2HJ3KL	Common Grenadier	<i>Nezumia bairdi</i>	SB	1	1	4
481	TEL Fall	2HJ3KL	Roundnose Grenadier	<i>Coryphaenoides rupestris</i>	MB	1	1	4
482	TEL Fall	2HJ3KL	Longnose Grenadier	<i>Coelorhynchus carminatus</i>	MB	1	1	4
483	TEL Fall	2HJ3KL	Roughnose Grenadier	<i>Trachyrhynchus murrayi</i>	SB	1	1	4
699	TEL Fall	2HJ3KL	Broadhead Wolffish	<i>Anarhichas denticulatus</i>	LB	1	1	1
700	TEL Fall	2HJ3KL	Striped Wolffish	<i>Anarhichas lupus</i>	LB	1*	1*	1
701	TEL Fall	2HJ3KL	Spotted Wolffish	<i>Anarhichas minor</i>	LB	1*	0.62*	1
711	TEL Fall	2HJ3KL	Fourline Snakeblenny	<i>Eumesogrammus praecisus</i>	SB	1	1	1
717	TEL Fall	2HJ3KL	Daubed Shanny	<i>Lumpenus maculatus</i>	SB	1.50	1	1
726	TEL Fall	2HJ3KL	Eelpout	<i>Lycodes</i> spp.	MB	0.82	0.9	4
727	TEL Fall	2HJ3KL	Esmark's Eelpout	<i>Lycodes esmarki</i>	MB	0.82	0.9	4
729	TEL Fall	2HJ3KL	Arctic Eelpout	<i>Lycodes reticulatus</i>	MB	0.82	0.9	4
730	TEL Fall	2HJ3KL	Vahl's Eelpout	<i>Lycodes vahlii</i>	MB	0.82	0.9	4

DFO NL Species Code	Vessel Season	NAFO Division	Common Name	Scientific Name	FG	Biomass (p)	Abund (p)	ref
744	TEL Fall	2HJ3KL	Ocean Pout	<i>Macrozoarces americanus</i>	LB	0.82	0.9	4
745	TEL Fall	2HJ3KL	Soft Eelpout	<i>Melanostigma atlanticum</i>	SB	0.82	0.9	4
746	TEL Fall	2HJ3KL	Fish Doctor	<i>Gymnelis viridis</i>	MB	0.82	0.9	4
747	TEL Fall	2HJ3KL	Wolf Eel	<i>Lycenchelys</i> spp.	SB	1.77	1	4
794	TEL Fall	2HJ3KL	Redfish	<i>Sebastes mentella</i>	PP	0.88*	1*	1
810	TEL Fall	2HJ3KL	Hookear Sculpin	<i>Artediellus</i> spp.	SB	1	1	4
813	TEL Fall	2HJ3KL	Mailed Sculpin	<i>Triglops</i> spp.	SB	1	1	4
817	TEL Fall	2HJ3KL	Ribbed Sculpin	<i>Myoxocephalus</i> spp.	MB	1	1	4
819	TEL Fall	2HJ3KL	Shorthorn Sculpin	<i>Myoxocephalus scorpius</i>	MB	1	1	4
820	TEL Fall	2HJ3KL	Longhorn Sculpin	<i>Myoxocephalus octodecemspinosus</i>	MB	1	1	4
822	TEL Fall	2HJ3KL	Arctic Sculpin	<i>Myoxocephalus scorpioides</i>	SB	1	1	4
823	TEL Fall	2HJ3KL	Arctic Staghorn Sculpin	<i>Gymnocanthus tricusps</i>	SB	1	1	4
828	TEL Fall	2HJ3KL	Pallid Sculpin	<i>Cottunculus thompsoni</i>	SB	1	1	4
829	TEL Fall	2HJ3KL	Polar Sculpin	<i>Cottunculus microps</i>	SB	1	1	4
830	TEL Fall	2HJ3KL	Twohorn Sculpin	<i>Icelus</i> spp.	SB	1	1	4
832	TEL Fall	2HJ3KL	Spatulate Sculpin	<i>Icelus spatula</i>	SB	1	1	4
836	TEL Fall	2HJ3KL	Northern Alligatorfish	<i>Agonus decagonus</i>	SB	1	1	1

DFO NL Species Code	Vessel Season	NAFO Division	Common Name	Scientific Name	FG	Biomass (ρ)	Abund (ρ)	ref
837	TEL Fall	2HJ3KL	Arctic Alligatorfish	<i>Aspidophoroides olriki</i>	SB	1	1	1
838	TEL Fall	2HJ3KL	Common Alligatorfish	<i>Aspidophoroides monopterygius</i>	SB	1	1	1
843	TEL Fall	2HJ3KL	Lumpsuckers	<i>Eumicrotremus</i> spp.	SB	1	1	4
849	TEL Fall	2HJ3KL	Common Lumpfish	<i>Cyclopterus lumpus</i>	MB	1	1	4
853	TEL Fall	2HJ3KL	Seasnail	Liparidae	SB	1	1	1
863	TEL Fall	2HJ3KL	Seasnail	<i>Careproctus</i> spp.	PP	1	1	1
889	TEL Fall	2HJ3KL	American Plaice	<i>Hippoglossoides platessoides</i>	LB	1*	1*	1
890	TEL Fall	2HJ3KL	Witch Flounder	<i>Glyptocephalus cynoglossus</i>	MB	1*	0.88*	1
892	TEL Fall	2HJ3KL	Greenland Halibut	<i>Reinhardtius hippoglossoides</i>	PI	1*	1*	4
8111	TEL Fall	2HJ3KL	Northern Shrimp	<i>Pandalus borealis</i>	SF	1.08*	1.16*	1
8112	TEL Fall	2HJ3KL	Stripped Shrimp	<i>Pandalus montagui</i>	SF	1	1	1
8213	TEL Fall	2HJ3KLNO	Snow Crab	<i>Chionoecetes opilio</i>	SF	0.65	0.69	1, 3
90	TEL Spring	3LNO	Thorny Skate	<i>Raja radiata</i>	LB	1*	0.83*	5
150	TEL Spring	3LNO	Atlantic Herring	<i>Clupea harengus</i>	PL	1	1	5
187	TEL Spring	3LNO	Capelin	<i>Mallotus villosus</i>	PL	1	1	5
193	TEL Spring	3LNO	Atlantic Argentine	<i>Argentina silus</i>	PL	1.61	1	5
230	TEL Spring	3LNO	Boa Drangonfish	<i>Stomias boa</i>	PI	1	1	5
272	TEL Spring	3LNO	Lanternfish	Myctophidae	PL	1	1	5

DFO NL Species Code	Vessel Season	NAFO Division	Common Name	Scientific Name	FG	Biomass (ρ)	Abund (ρ)	ref
316	TEL Spring	3LNO	Barracudina	Paralepididae	PI	1	1	5
323	TEL Spring	3LNO	Lancetfish	Alepisauridae	PI	1	1	5
324	TEL Spring	3LNO	Shortnosed Lancetfish	<i>Alepisaurus brevirostis</i>	PI	1	1	5
325	TEL Spring	3LNO	Longnose Lancetfish	<i>Alepisaurus ferox</i>	PI	1	1	5
373	TEL Spring	3LNO	Longnose Eel	<i>Synaphobranchus kaupi</i>	MB	1	1.29	5
438	TEL Spring	3LNOPs	Atlantic Cod	<i>Gadus morhua</i>	PI	1	1	2
444	TEL Spring	3LNO	Longfin Hake	<i>Urophycis chesteri</i>	PP	1	1	5
447	TEL Spring	3NOPs	White Hake	<i>Urophycis tenuis</i>	PI	1	1	5
449	TEL Spring	3NOPs	Silver Hake	<i>Merluccius bilinearis</i>	PI	1	1	5
453	TEL Spring	3LNO	Threebeard Rockling	<i>Gaidropsarus</i> spp.	SB	1	1	5
461	TEL Spring	3LNO	Fourbeard Rockling	<i>Enchelyopus cimbrius</i>	SB	1	1	5
471	TEL Spring	3LNO	Grenadier	Macrouridae	SB	1	1	5
474	TEL Spring	3LNO	Roughhead Grenadier	<i>Macrourus berglax</i>	LB	1	1	5
478	TEL Spring	3LNO	Common Grenadier	<i>Nezumia bairdi</i>	SB	1	1	5
481	TEL Spring	3LNO	Roundnose Grenadier	<i>Coryphaenoides rupestris</i>	MB	1	1	5
482	TEL Spring	3LNO	Longnose Grenadier	<i>Coelorhynchus carminatus</i>	MB	1	1	5
483	TEL Spring	3LNO	Roughnose Grenadier	<i>Trachyrhynchus murrayi</i>	SB	1	1	5
694	TEL Spring	3LNO	Sand Lance	<i>Ammodytes dubius</i>	PL	1	1	5

DFO NL Species Code	Vessel Season	NAFO Division	Common Name	Scientific Name	FG	Biomass (ρ)	Abund (ρ)	ref
699	TEL Spring	3LNO	Broadhead Wolfish	<i>Anarhichas denticulatus</i>	LB	1	1	5
700	TEL Spring	3LNO	Striped Wolffish	<i>Anarhichas lupus</i>	LB	1	0.7	5
726	TEL Spring	3LNO	Eelpout	<i>Lycodes</i> spp.	MB	1	1	5
727	TEL Spring	3LNO	Esmark's Eelpout	<i>Lycodes esmarki</i>	MB	1	1	5
729	TEL Spring	3LNO	Arctic Eelpout	<i>Lycodes reticulatus</i>	MB	1	1	5
730	TEL Spring	3LNO	Vahl's Eelpout	<i>Lycodes vahliei</i>	MB	1	1	5
744	TEL Spring	3LNO	Ocean Pout	<i>Macrozoarces americanus</i>	LB	1	1	5
745	TEL Spring	3LNO	Soft Eelpout	<i>Melanostigma atlanticum</i>	SB	1	1	5
794	TEL Spring	3LNO	Redfish	<i>Sebastes mentella</i>	PP	1	1	5
810	TEL Spring	3LNO	Sculpin	<i>Artediellus</i> spp.	SB	1	1	5
836	TEL Spring	3LNO	Northern Alligatorfish	<i>Agonus decagonus</i>	SB	1	1	5
837	TEL Spring	3LNO	Arctic Alligatorfish	<i>Aspidophoroides olriki</i>	SB	1	1	5
838	TEL Spring	3LNO	Common Alligatorfish	<i>Aspidophoroides monopterygius</i>	SB	1	1	5
889	TEL Spring	3LNO	American Plaice	<i>Hippoglossoides platessoides</i>	LB	1	1	5
890	TEL Spring	3LNO	Witch Flounder	<i>Glyptocephalus cynoglossus</i>	MB	1	1	5
891	TEL Spring	3LNO	Yellowtail Flounder	<i>Myxopsetta ferruginea</i>	MB	1	1	5
892	TEL Spring	3LNO	Greenland Halibut	<i>Reinhardtius hippoglossoides</i>	PI	1	1	5
8111	TEL Spring	3LNO	Northern Shrimp	<i>Pandalus borealis</i>	SF	1	1	5

DFO NL Species Code	Vessel Season	NAFO Division	Common Name	Scientific Name	FG	Biomass (ρ)	Abund (ρ)	ref
8112	TEL Spring	3LNO	Striped Shrimp	<i>Pandalus montagui</i>	SF	1	1	5
8213	TEL Spring	3LNOPs	Snow Crab	<i>Chionoecetes opilio</i>	SF	1	1	3
90	CAL Spring	3LNO	Thorny Skate	<i>Raja radiata</i>	LB	1	1	6
187	CAL Spring	3LNO	Capelin	<i>Mallotus villosus</i>	PL	1	1	6
438	CAL Spring	3LNO	Atlantic Cod	<i>Gadus morhua</i>	PI	1	1	6
471	CAL Spring	2HJ3KL	Grenadier	Macrouridae	SB	0.72	1	6
474	CAL Spring	3LNO	Roughhead Grenadier	<i>Macrourus berglax</i>	LB	1	1	6
478	CAL Spring	2HJ3KL	Common Grenadier	<i>Nezumia bairdi</i>	SB	0.72	1	6
481	CAL Spring	2HJ3KL	Roundnose Grenadier	<i>Coryphaenoides rupestris</i>	MB	0.72	1	6
482	CAL Spring	2HJ3KL	Longnose Grenadier	<i>Coelorhynchus carminatus</i>	MB	0.72	1	6
483	CAL Spring	2HJ3KL	Roughnose Grenadier	<i>Trachyrhynchus murrayi</i>	SB	0.72	1	6
700	CAL Spring	3LNO	Striped Wolffish	<i>Anarhichas lupus</i>	LB	1	1	6
727	CAL Spring	3LNO	Esmark's Eelpout	<i>Lycodes esmarki</i>	MB	1	1	6
727	CAL Spring	3LNO	Esmark's Eelpout	<i>Lycodes esmarki</i>	MB	1	1	6
729	CAL Spring	3LNO	Arctic Eelpout	<i>Lycodes reticulatus</i>	MB	1	1	6
730	CAL Spring	3LNO	Vahl's Eelpout	<i>Lycodes vahlii</i>	MB	1	1	6
744	CAL Spring	3LNO	Ocean Pout	<i>Macrozoarces americanus</i>	LB	1	1	6
745	CAL Spring	3LNO	Soft Eelpout	<i>Melanostigma atlanticum</i>	SB	1	1	6

DFO NL Species Code	Vessel Season	NAFO Division	Common Name	Scientific Name	FG	Biomass (ρ)	Abund (ρ)	ref
746	CAL Spring	3LNO	Fish Doctor	<i>Gymnelis viridis</i>	MB	1	1	6
794	CAL Spring	3LNO	Redfish	<i>Sebastes mentella</i>	PP	1	1	6
810	CAL Spring	3LNO	Hookear Sculpin	<i>Artediellus</i> spp.	SB	1	1	6
813	CAL Spring	3LNO	Mailed Sculpin	<i>Triglops</i> spp.	SB	1	1	6
817	CAL Spring	3LNO	Ribbed Sculpin	<i>Myoxocephalus</i> spp.	MB	1	1	6
819	CAL Spring	3LNO	Shorthorn Sculpin	<i>Myoxocephalus scorpius</i>	MB	1	1	6
820	CAL Spring	3LNO	Longhorn Sculpin	<i>Myoxocephalus octodecemspinosus</i>	MB	1	1	6
822	CAL Spring	3LNO	Arctic Sculpin	<i>Myoxocephalus scorpioides</i>	SB	1	1	6
823	CAL Spring	3LNO	Arctic Staghorn Sculpin	<i>Gymnocanthus tricuspis</i>	SB	1	1	6
828	CAL Spring	3LNO	Pallid Sculpin	<i>Cottunculus thompsonii</i>	SB	1	1	6
829	CAL Spring	3LNO	Polar Sculpin	<i>Cottunculus microps</i>	SB	1	1	6
830	CAL Spring	3LNO	Twohorn Sculpin	<i>Icelus</i> spp.	SB	1	1	6
832	CAL Spring	3LNO	Spatulate Sculpin	<i>Icelus spatula</i>	SB	1	1	6
836	CAL Spring	3LNO	Northern Alligatorfish	<i>Agonus decagonus</i>	SB	1	1	6
837	CAL Spring	3LNO	Arctic Alligatorfish	<i>Aspidophoroides olriki</i>	SB	1	1	6
838	CAL Spring	3LNO	Common Alligatorfish	<i>Aspidophoroides monopterygius</i>	SB	1	1	6
889	CAL Spring	3LNO	American Plaice	<i>Hippoglossoides platessoides</i>	LB	1	1	6

DFO NL Species Code	Vessel Season	NAFO Division	Common Name	Scientific Name	FG	Biomass (ρ)	Abund (ρ)	ref
890	CAL Spring	3LNO	Witch Flounder	<i>Glyptocephalus cynoglossus</i>	MB	1	1	6
891	CAL Spring	3LNO	Yellowtail Flounder	<i>Myxopsetta ferruginea</i>	MB	0.84*	0.78*	6
892	CAL Spring	3LNO	Greenland Halibut	<i>Reinhardtius hippoglossoides</i>	PI	1	1	6
8213	CAL Spring	3LNO	Snow Crab	<i>Chionoecetes opilio</i>	SF	1	1	6

* Species with size-based conversion that is used when converting catch data

- 1 – Trueman, S., Wheeland, L., Benoît, H., Munro, H., Nguyen, T., Novaczek, E., Skanes, K., Walsh, S., and Yin, Y. 2025. Results of comparative fishing between the CCGS Teleost and CCGS Alfred Needler with the CCGS John Cabot and CCGS Capt. Jacques Cartier in the Newfoundland and Labrador Region in 2021 and 2022. DFO Can. Sci. Advis. Sec. Res. Doc. 2025/021. v + 237 p.
- 2 – Wheeland, L. and Trueman, S. 2024. On the relative catchability of Atlantic cod in the Newfoundland and Labrador multispecies trawl surveys. DFO Can. Sci. Advis. Sec. Res. Doc. 2024/038. iv + 21 p.
- 3 – Trueman, S., Wheeland, L., Pantin, J., Baker, K. and Mullowney, D. 2026. On the relative catchability of Snow Crab in the Newfoundland and Labrador multispecies trawl surveys. DFO Can. Sci. Advis. Sec. Res. Doc. 2026/008. iv + 41 p.
- 4 – Trueman, S., Nguyen, T., Silver, K., Skanes, K., and Wheeland, L. 2025. Further Results of Comparative Fishing Between the Canadian Coast Guard Ship (CGSS) Teleost and CCGS Capt Jacques Cartier/John Cabot in the Newfoundland and Labrador Region in Fall, with a Focus on Deep Water Species. DFO Can. Sci. Advis. Sec. Res. Doc. 2025/052. iv + 94 p. 2
- 5 – Trueman, S., Novaczek, E., Silver, K., and Wheeland, L. 2025. Results of Comparative Fishing Between the Canadian Coast Guard Ship (CCGS) Teleost and the CCGS John Cabot in the Newfoundland and Labrador Region in Spring 2023. DFO Can. Sci. Advis. Sec. Res. Doc. 2025/067. iv + 114 p.
- 6 – Trueman, S., Wheeland, L., Novaczek, E., Munro, H., and Nguyen, T. 2026. Results of Comparative Fishing Between the CCGS John Cabot and MV Calvert in the Newfoundland and Labrador Region in Spring 2023-2024. DFO Can. Sci. Advis. Sec. Res. Doc. 2026/014. iv + 115 p.

Table 2. Accepted functional group level conversion factors (ρ) by vessel and season with Ecosystem Production Unit (EPU)/NAFO divisions that species must be aggregated by. Needler and Teleost come from Munro et al. 2026 and Calvert from Trueman et al. 2026b.

Functional Group	Vessel Season	EPU/NAFO Division	Biomass (ρ)	Abundance (ρ)
Large Benthivore	Needler Fall	2J3K	1	1
Large Benthivore	Needler Fall	2J3KL	1	1
Medium Benthivore	Needler Fall	2J3K	0.89	0.78
Medium Benthivore	Needler Fall	2J3KL	0.98	0.87
Small Benthivore	Needler Fall	2J3K	0.66	0.77
Small Benthivore	Needler Fall	2J3KL	0.62	0.65
Piscivore	Needler Fall	2J3K	1	0.91
Piscivore	Needler Fall	2J3KL	1	0.91
Planktivore	Needler Fall	2J3K	1	1
Planktivore	Needler Fall	2J3KL	1	0.85
Planktivores	Needler Fall	2J3K	1	1
Planktivores	Needler Fall	2J3KL	1	1
Shellfish	Needler Fall	2J3K	0.81	0.75
Shellfish	Needler Fall	2J3KL	0.79	0.64
Large Benthivore	Teleost Fall	2H	1	1
Large Benthivore	Teleost Fall	2J3K	1	1
Large Benthivore	Teleost Fall	2J3KL	1	1
Medium Benthivore	Teleost Fall	2H	0.8	1
Medium Benthivore	Teleost Fall	2J3K	1	1
Medium Benthivore	Teleost Fall	2J3KL	1	1
Small Benthivore	Teleost Fall	2H	1	1
Small Benthivore	Teleost Fall	2J3K	1	1.17

Functional Group	Vessel Season	EPU/NAFO Division	Biomass (ρ)	Abundance (ρ)
Small Benthivore	Teleost Fall	2J3KL	1	1.18
Piscivore	Teleost Fall	2H	1	1
Piscivore	Teleost Fall	2J3K	1	1
Piscivore	Teleost Fall	2J3KL	1	1
Planktivore	Teleost Fall	2H	1	1
Planktivore	Teleost Fall	2J3K	0.88	1
Planktivore	Teleost Fall	2J3KL	0.88	1
Planktivores	Teleost Fall	2H	1	1
Planktivores	Teleost Fall	2J3K	1.25	1.28
Planktivores	Teleost Fall	2J3KL	1.24	1.29
Shellfish	Teleost Fall	2H	1	1
Shellfish	Teleost Fall	2J3K	1	1.24
Shellfish	Teleost Fall	2J3KL	1	1.23
Large Benthivore	Teleost Spring	3LNO	1	1
Medium Benthivore	Teleost Spring	3LNO	1.15	1
Small Benthivore	Teleost Spring	3LNO	1	1
Piscivore	Teleost Spring	3LNO	1	1
Planktivore	Teleost Spring	3LNO	1	1
Planktivores	Teleost Spring	3LNO	1	1
Shellfish	Teleost Spring	3LNO	1	1
Large Benthivore	Calvert Spring	3LNO	1	1
Medium Benthivore	Calvert Spring	3LNO	1	1
Small Benthivore	Calvert Spring	3LNO	1	1

Functional Group	Vessel Season	EPU/NAFO Division	Biomass (ρ)	Abundance (ρ)
Piscivore	Calvert Spring	3LNO	1	1
Planktivore	Calvert Spring	3LNO	1	1
Planktivores	Calvert Spring	3LNO	1	1
Shellfish	Calvert Spring	3LNO	1	1

Table 3. Names and formulas for models used.

Name	Model formula
VesselDepth	density ~ VESSEL + s(log_depth) + year_factor + 0
Vessel	density ~ VESSEL+ year_factor + 0
Depth	density ~ s(log_depth) + year_factor + 0
Base	density ~ year_factor + 0

Table 4. Summary of ΔAIC values for models by Season - Ecosystem Production Unit (EPU) and functional group (LB - Large Benthivore, MB - Medium Benthivore, SB - Small Benthivore, PI - Piscivore, PP - Planktivore, PL - Planktivore, SF – Shellfish)

Season EPU	Functional Group	Model-VesselDepth	Model-Vessel	Model-Depth	Model-Base
Fall 2J3K	LB	0	364.4	9	371.96
Fall 2J3K	MB	0	868.62	2.5	868.41
Fall 2J3K	SB	5.44	561.09	0	556.13
Fall 2J3K	PI	0	885.06	7.78	897.69
Fall 2J3K	PP	0	2240.44	4.98	2238.6
Fall 2J3K	PL	0	74.22	15.8	89.24
Fall 2J3K	SF	3.01	911.06	0	908.07
Fall 3LNO	LB	0.15	140.61	0	145.17
Fall 3LNO	MB	1.79	1005.1	0	1092.43
Fall 3LNO	SB	5.34	1013.1	0	1028.75
Fall 3LNO	PI	0	370.4	2.68	409.32
Fall 3LNO	PP	0	2332.46	11.12	*
Fall 3LNO	PL	3.42	38.89	0	42.02
Fall 3LNO	SH	0	755.19	21.67	810.71
Spring 3LNO	LB	0	90.56	15.4	105.07
Spring 3LNO	MB	0	757.88	0.8	758.26
Spring 3LNO	SB	5.19	1036.53	0	1031.18
Spring 3LNO	PI	0.7	315.81	0	315.62
Spring 3LNO	PP	0	1009.76	0.81	1012.58
Spring 3LNO	PL	0	360.18	9.13	368.69
Spring 3LNO	SH	0	361.31	3.25	364.11
Spring 3Ps	LB	1.08	247.87	0	245.64

Season EPU	Functional Group	Model-VesselDepth	Model-Vessel	Model-Depth	Model-Base
Spring 3Ps	MB	2.32	74.21	0	71.42
Spring 3Ps	SB	0	477.88	11.02	485.87
Spring 3Ps	PI	4.97	497.44	0	492.1
Spring 3Ps	PP	4.13	1292.29	0	1286.44
Spring 3Ps	PL	3.26	102.05	0	98.96
Spring 3Ps	SH	5.59	504.04	0	498.63

* Model did not pass sanity check or did not converge

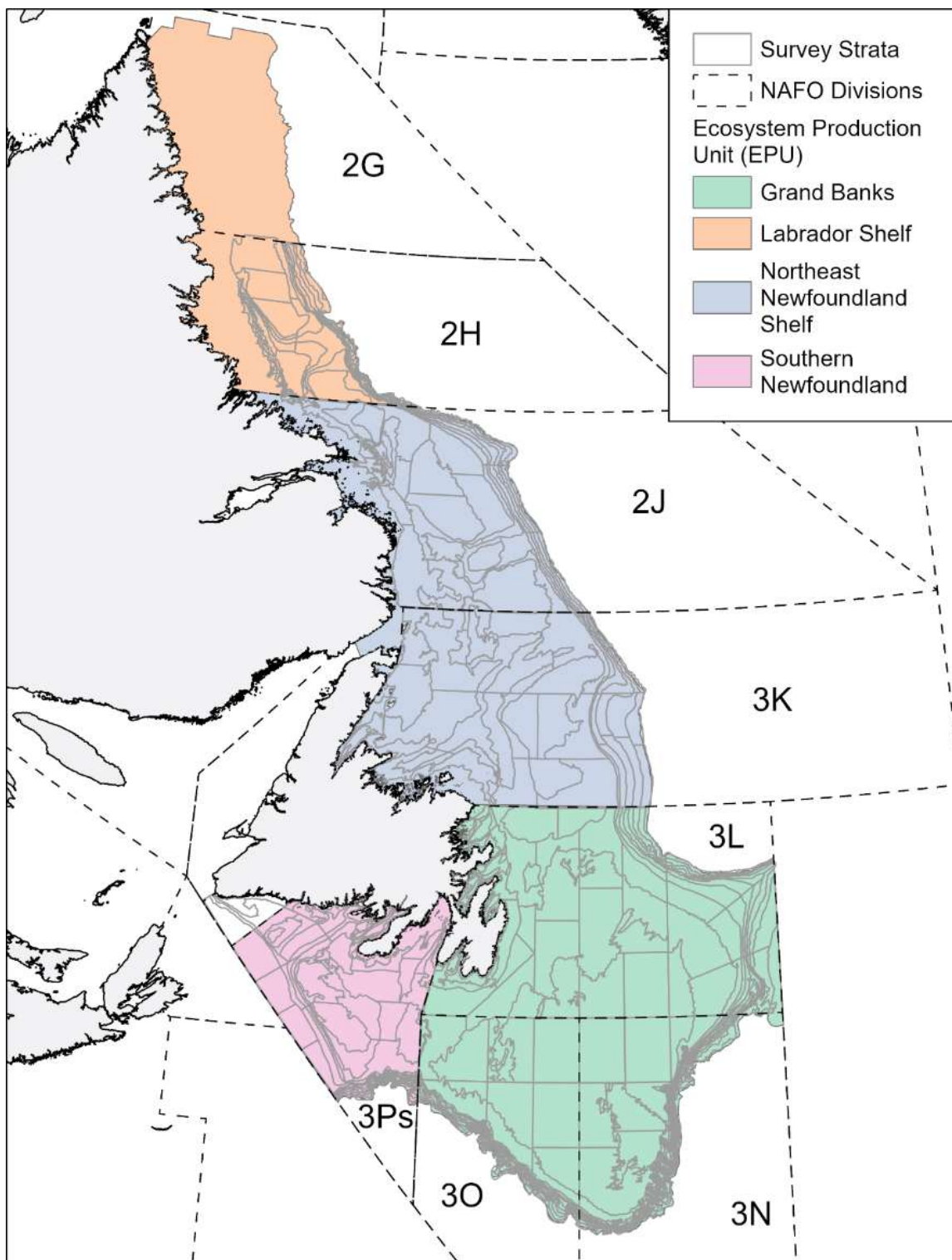


Figure 1. Map of the Ecosystem Production Units (EPUs), NAFO Divisions, and Multispecies Bottom Trawl Survey Strata in the Newfoundland and Labrador Region.

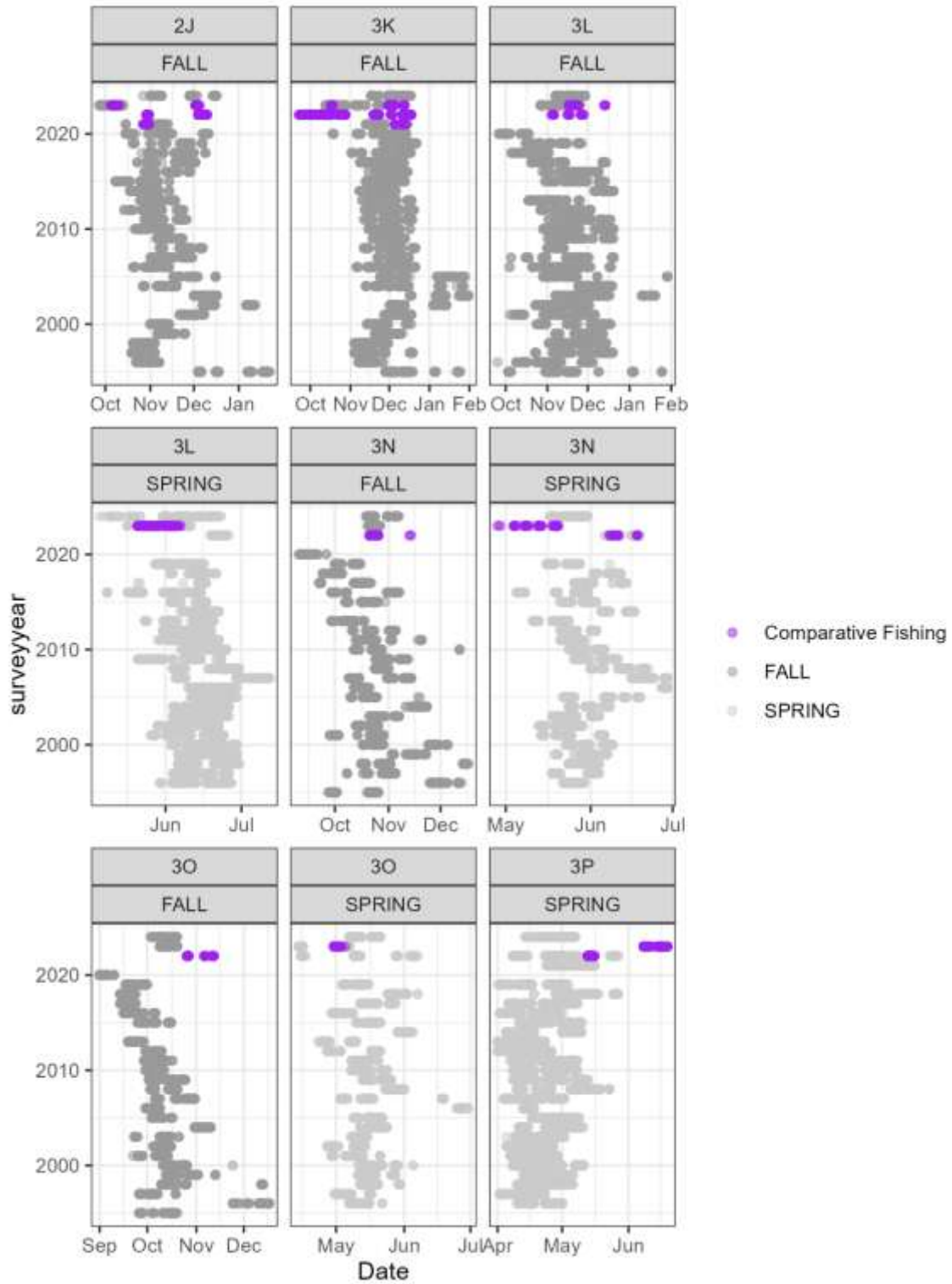


Figure 2. Timing within multispecies bottom trawl survey season of data included in spatiotemporal models by NAFO division and season with comparative fishing sets (purple), spring survey (light grey), and fall survey (darker grey).

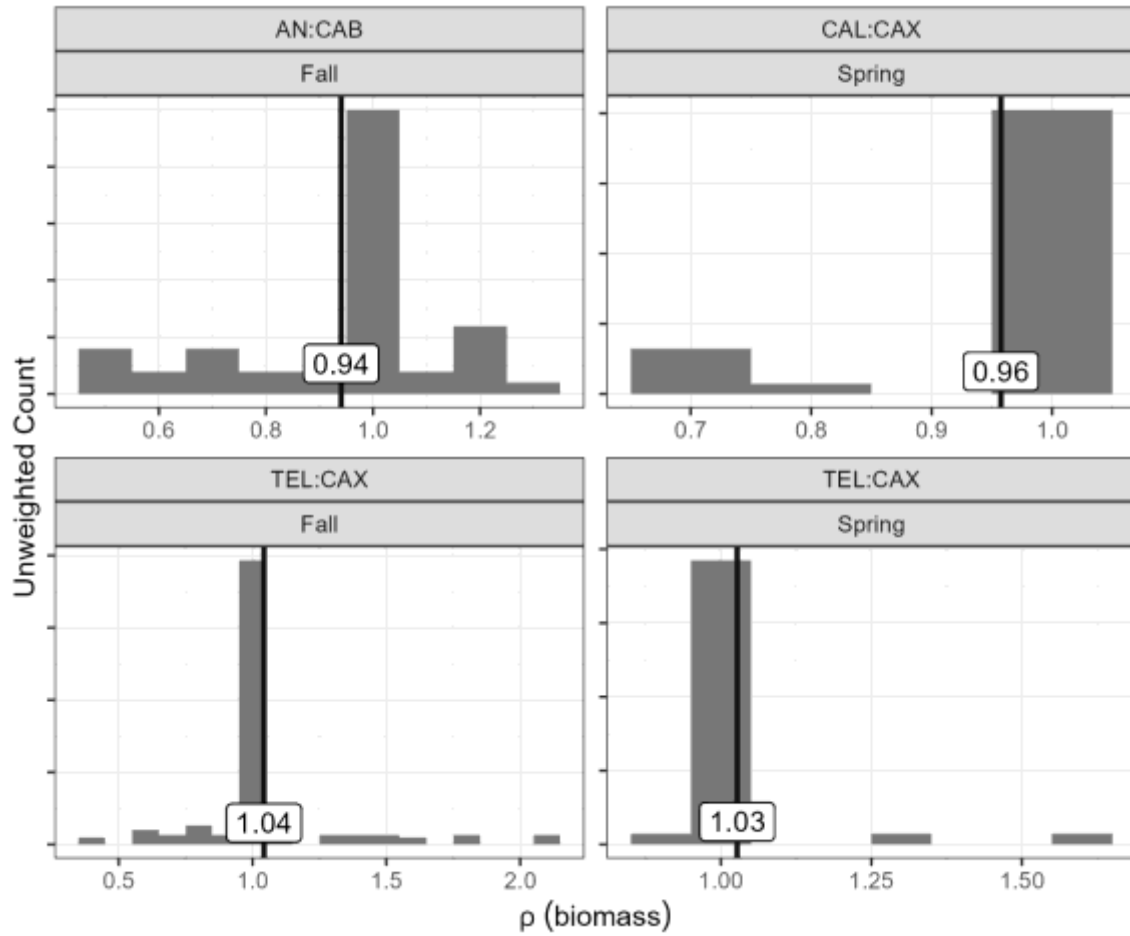


Figure 3. Unweighted distribution of biomass conversion factors (ρ) for Needler (AN:CAB) for Div. 2J3KL in fall survey, Calvert (CAL:CAX) for Div. 3LNO in fall survey, and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys. The black vertical line and associated value is the unweighted mean.

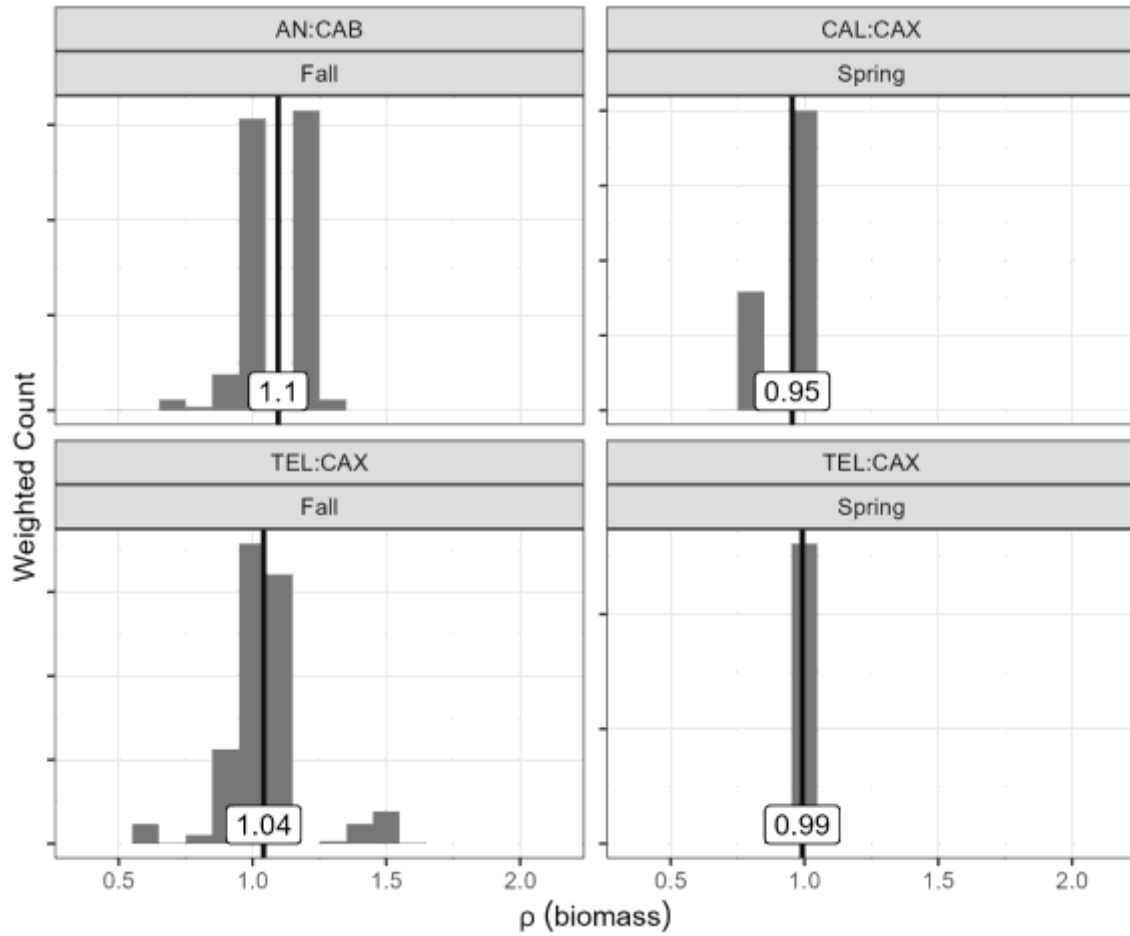


Figure 4. Distribution of biomass conversion factors (ρ) weighted by the average biomass index for 1996 – 2019 for Needler (AN:CAB) for Div. 2J3KL in fall survey, Calvert (CAL:CAX) for Div. 3LNO in fall survey, and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys. The black vertical line and associated value is the weighted mean.

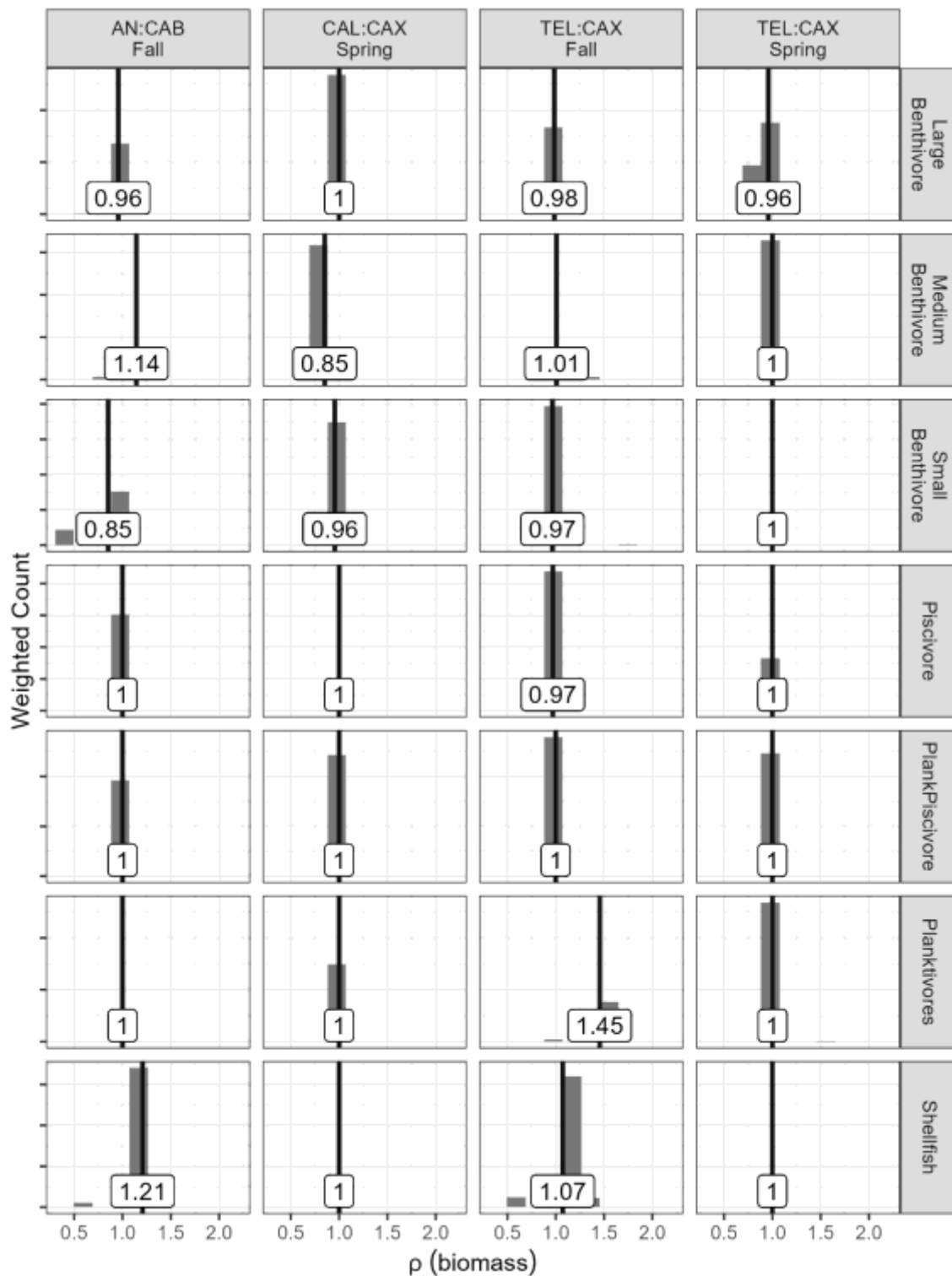


Figure 5. Distribution of biomass conversion factors (ρ) weighted by the average biomass index for 1996 – 2019 for Needler (AN:CAB) for Div. 2J3KL in fall, Calvert (CAL:CAX) for Div. 3LNO in fall survey, and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys by functional group. The black vertical line and associated value is the weighted mean.

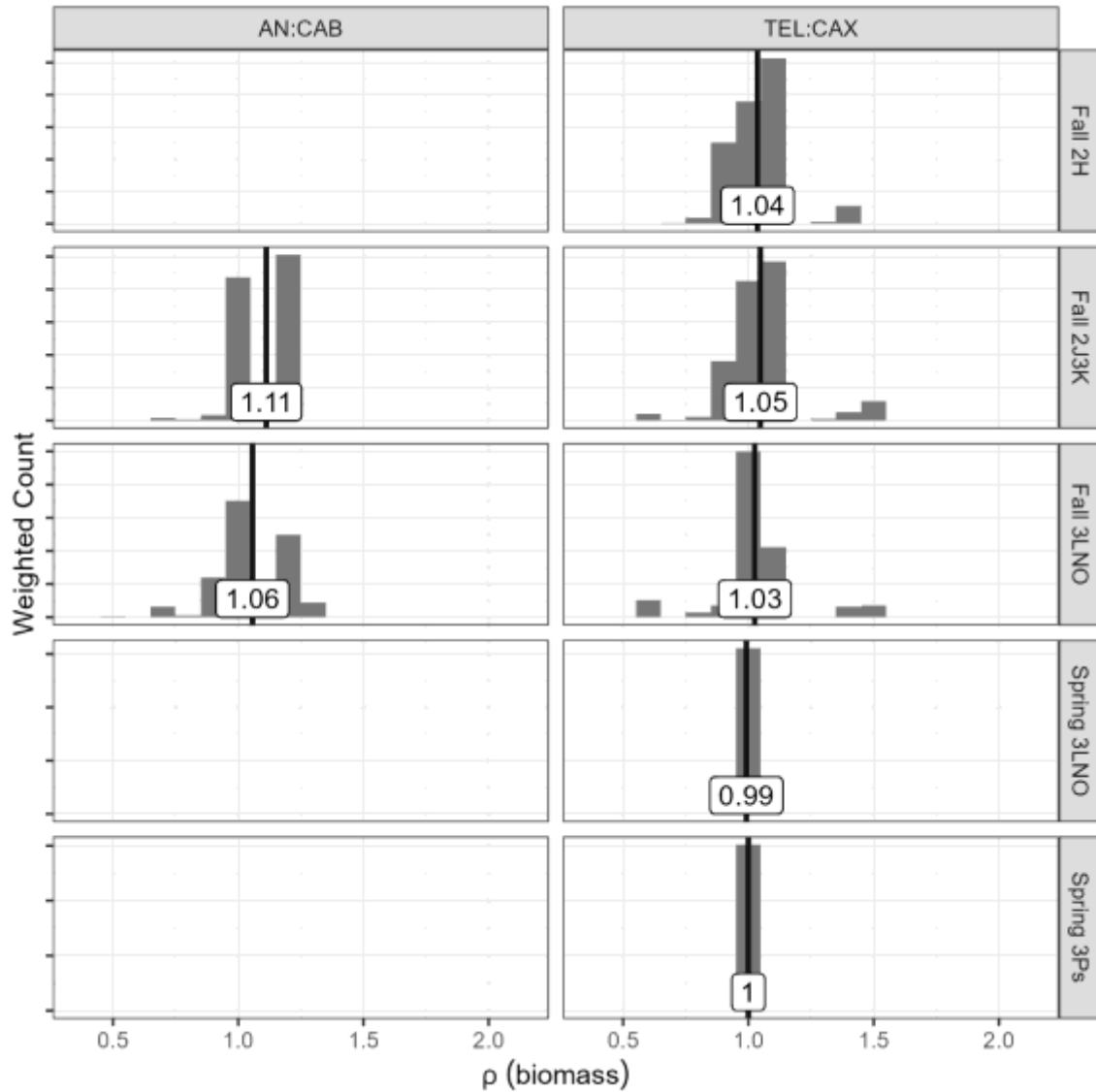


Figure 6. Distribution of biomass conversion factors (ρ) weighted by the average biomass index for 1996 – 2019 for Needler (AN:CAB) for Div. 2J3KL in fall survey and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys by EPU. Due to lack of conversion factors in Div. 3NO in the fall for AN:CAB the 3LNO Fall EPU reflects conversion factors for 3L only and additional Div. 3LNOPs for AN:CAB these plots are blank. Calvert was not included as all conversions were for single EPU and season. The black vertical line and associated value is the weighted mean.

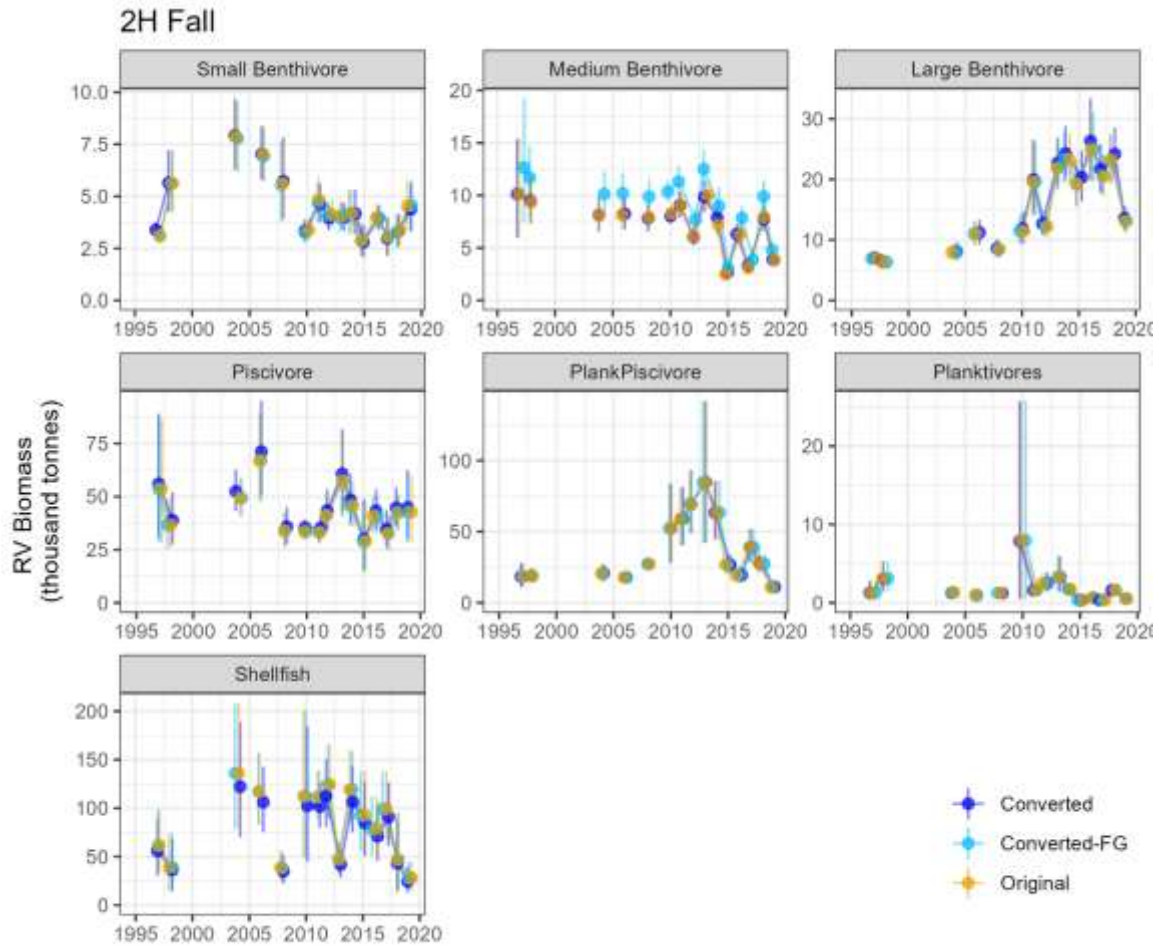


Figure 7. RV Biomass index by functional group, for the original (yellow), converted at species level (converted, blue) and converted using functional group level conversions (converted-FG, light blue) in 2H for the fall. Vertical bars indicate the 95% confidence intervals.

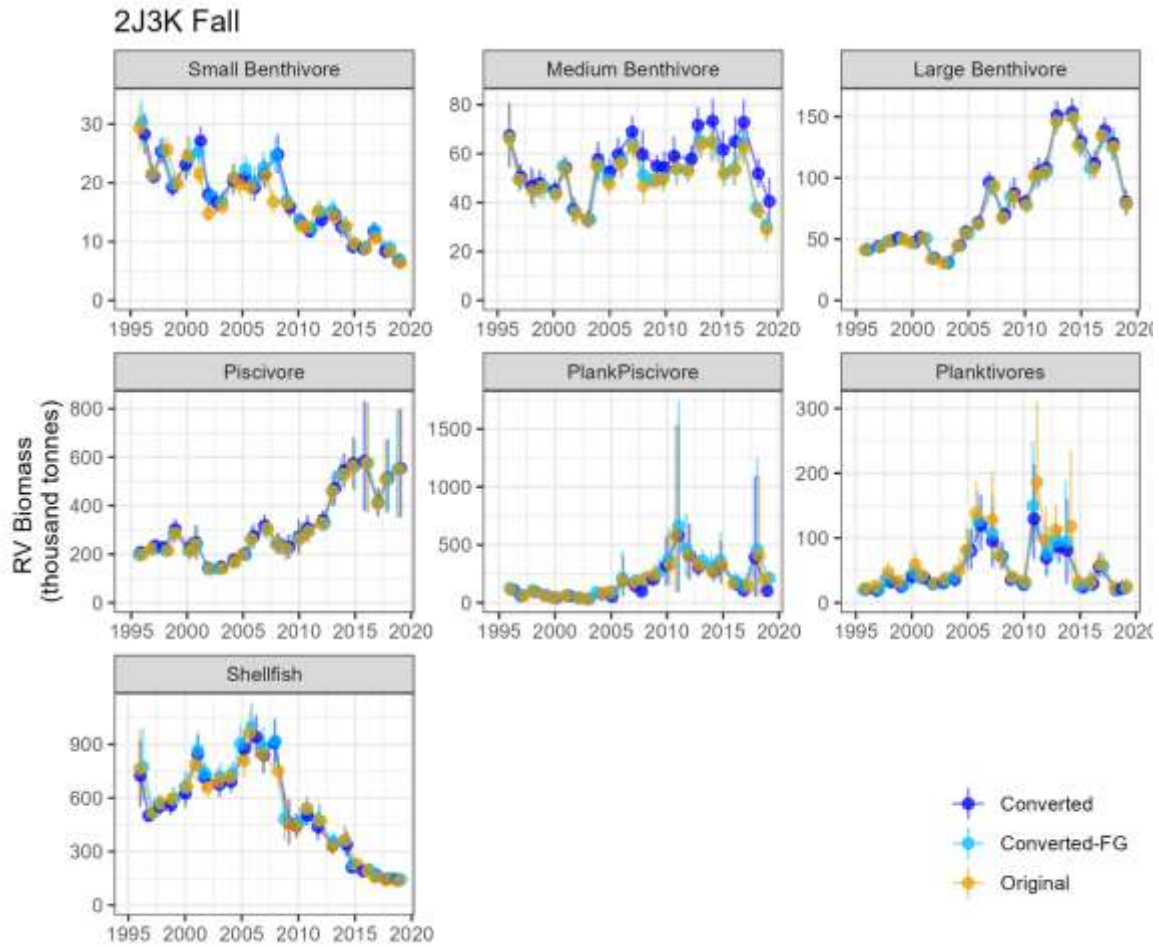


Figure 8. RV Biomass index by functional group, for the original (yellow), converted at species level (converted, blue) and converted using functional group level conversions (converted-FG, light blue) in Div. 2J3K for the fall. The vertical bars indicate the 95% confidence intervals.

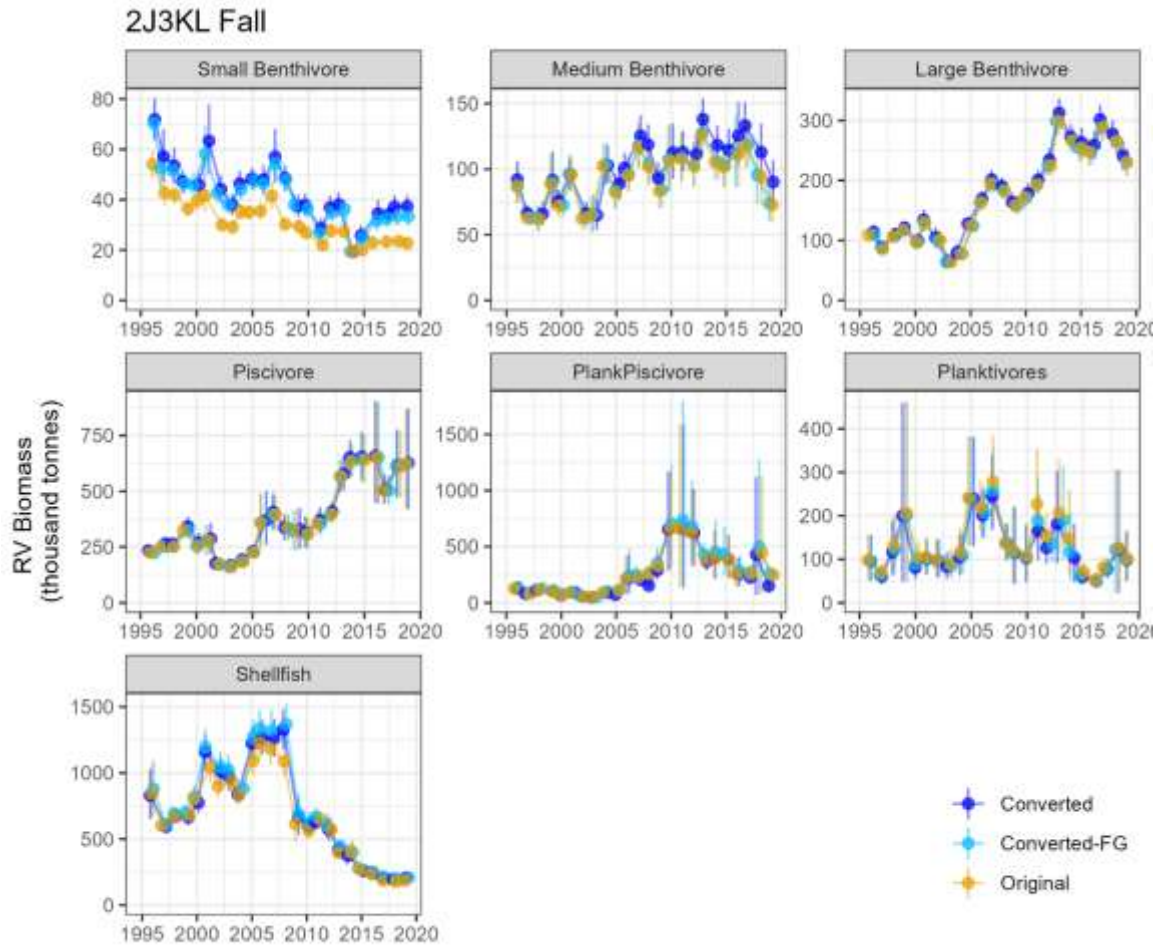


Figure 9. RV Biomass index by functional group, for the original (yellow), converted at species level (converted, blue) and converted using functional group level conversions (converted-FG, light blue) in Div. 2J3KL for the fall. The vertical bars indicate the 95% confidence intervals.

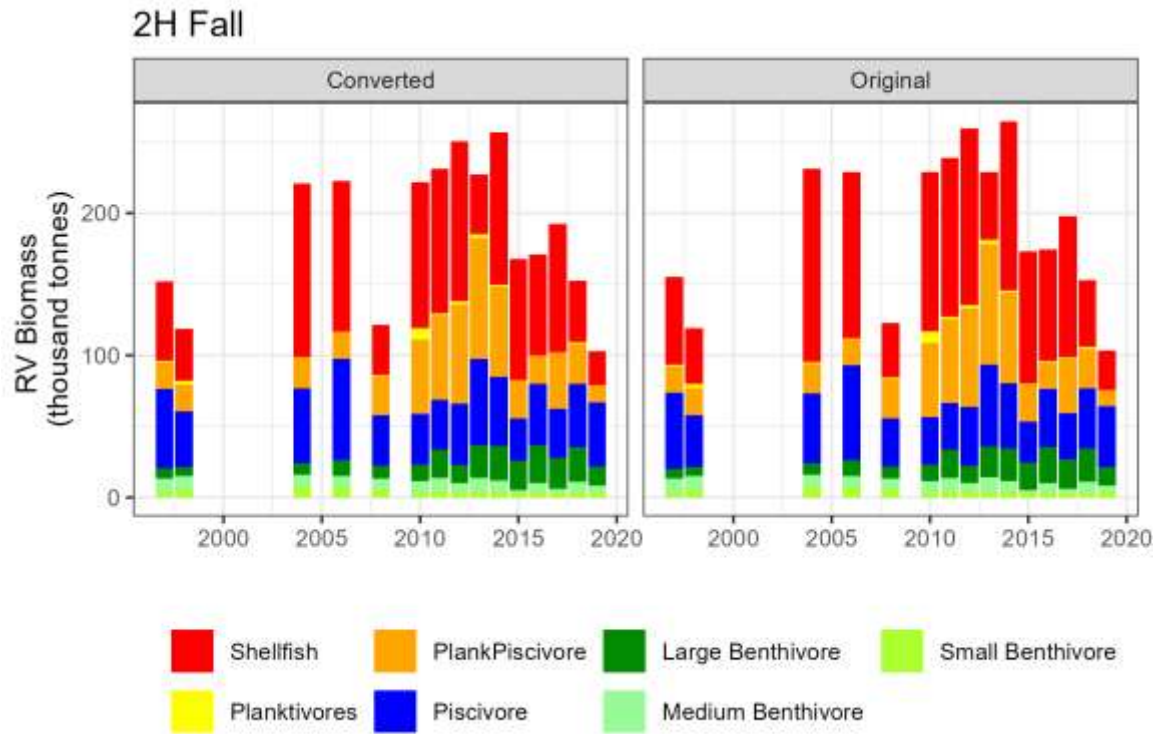


Figure 10. Comparison of total research vessel (RV) survey biomass broken down by functional group for Div. 2H in the fall using species level conversions.

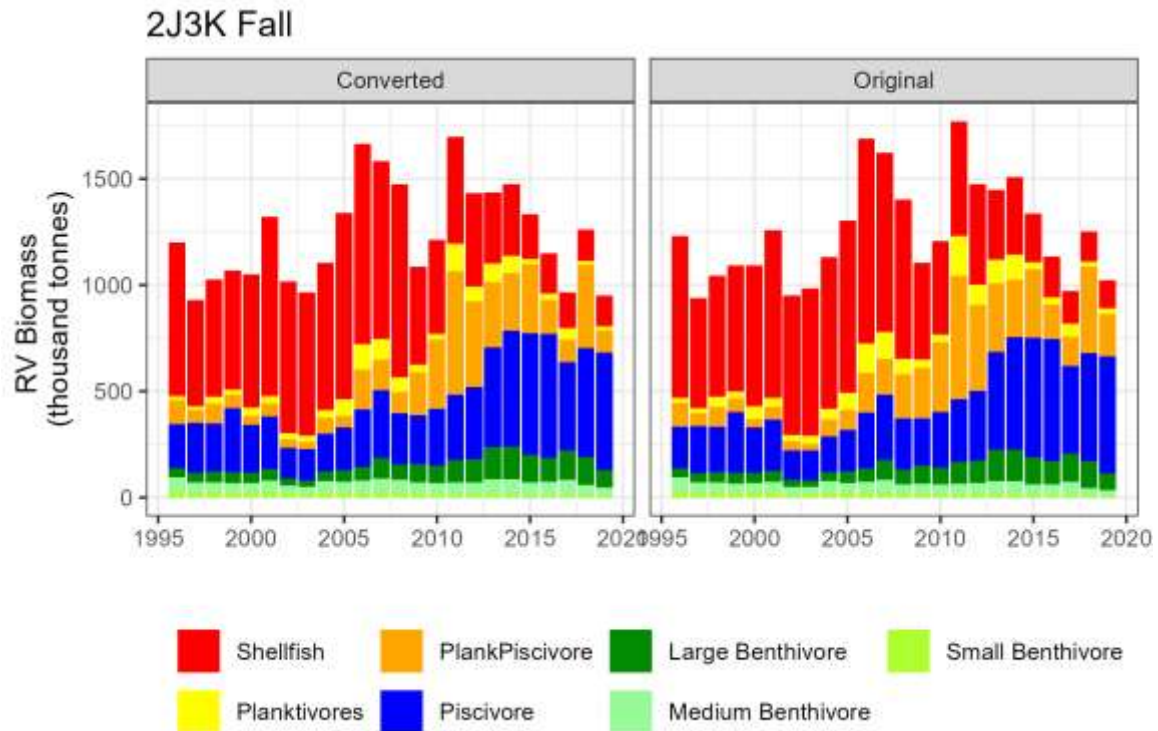


Figure 11. Comparison of total research vessel (RV) survey biomass broken down by functional group for Div. 2J3K in the fall using species level conversions.

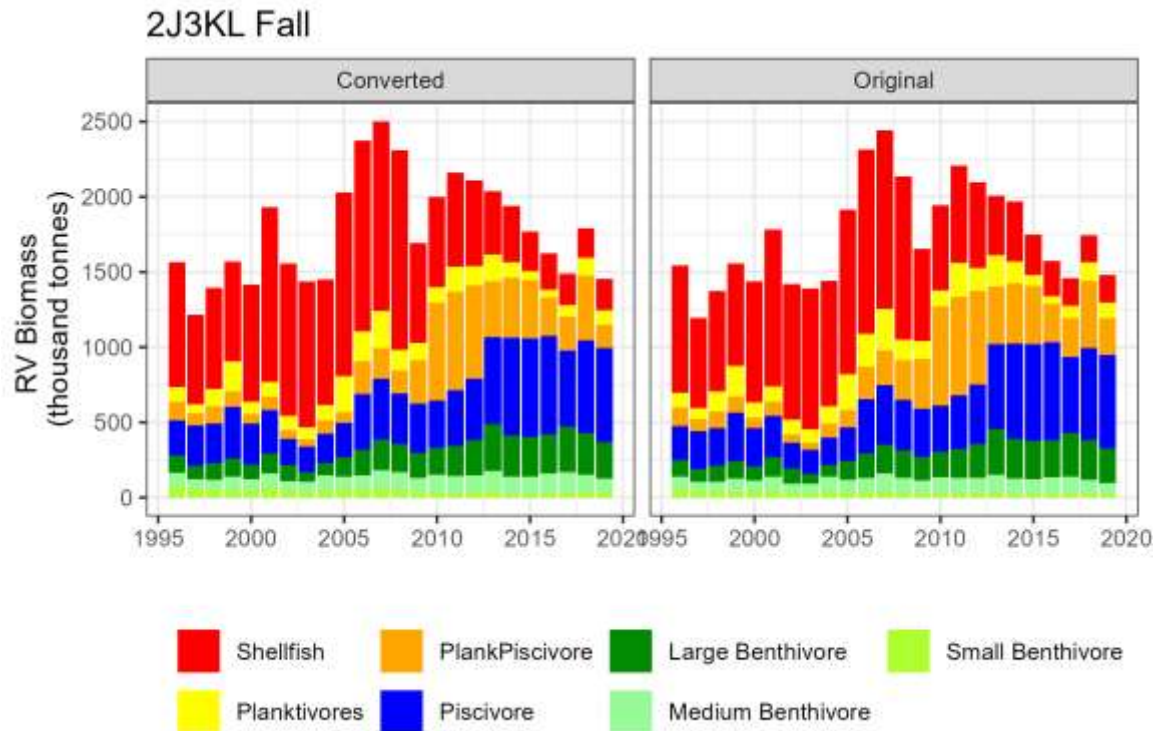


Figure 12. Comparison of total research vessel (RV) survey biomass broken down by functional group for Div. 2J3KL in the fall using species level conversions.

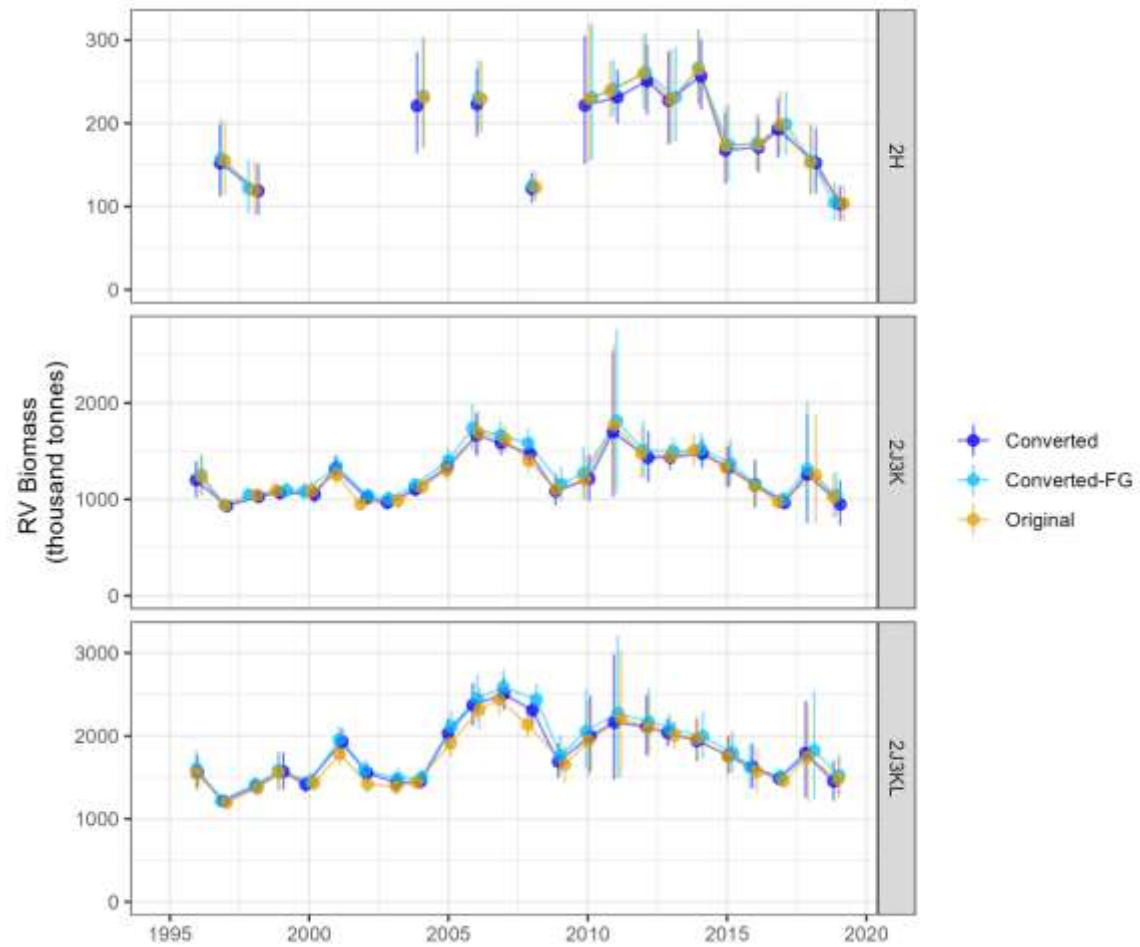


Figure 13. Total research vessel (RV) survey biomass across all three regions (Div. 2H, 2J3K, and 2J3KL) and three time series and the 95% confidence intervals.

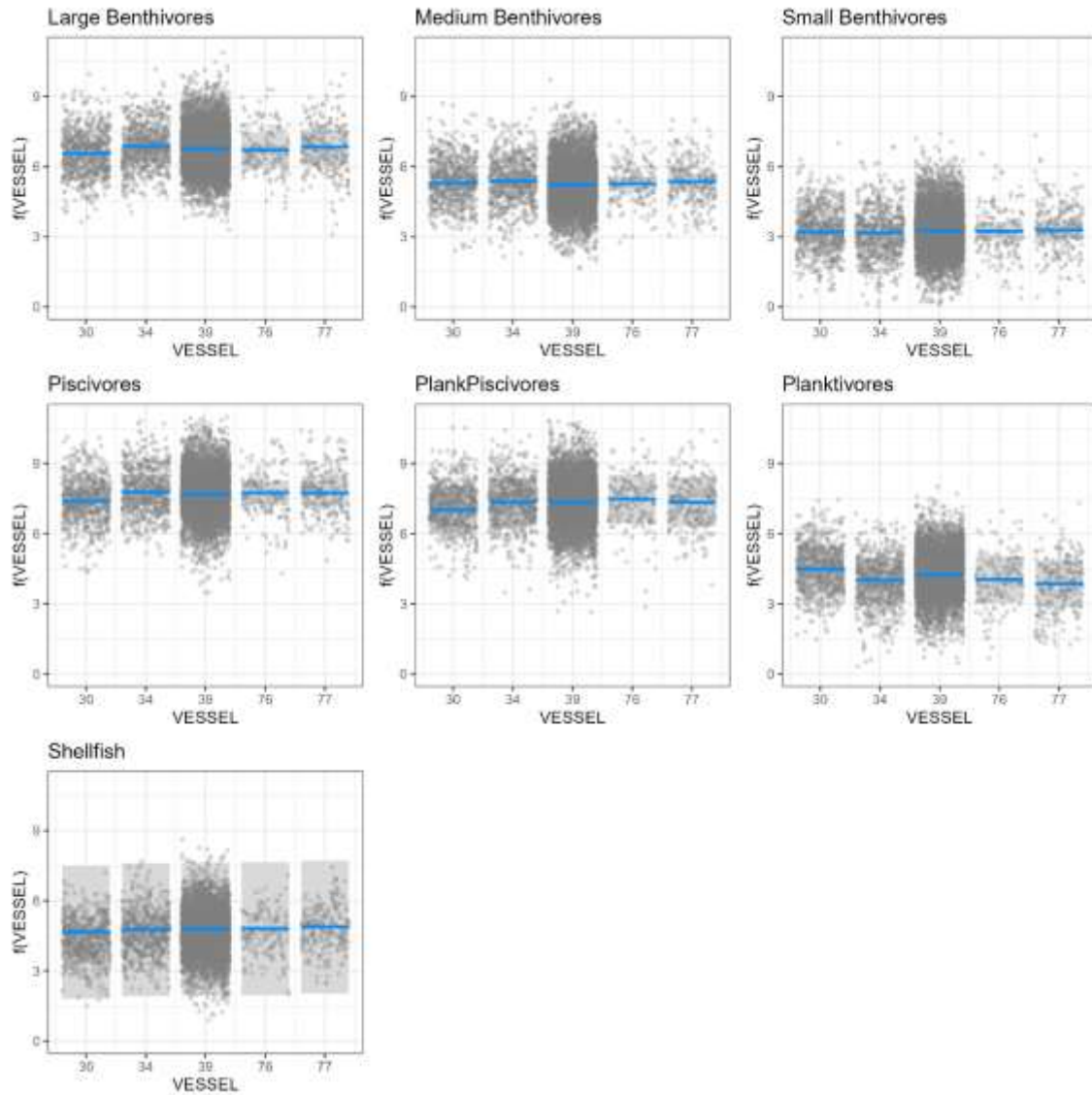


Figure 14. Conditional effects for vessel from models for each functional group in Div. 2J3K Fall. Blue lines show mean and shaded ribbons show 95% CI. Vessel: 30 – CCGS Wilfred Templeman, 34 – CCGS Alfred Needler, 39 – CCGS Teleost , 76 – CCGS Captain Jacques Cartier, 77 – CCGS John Cabot.

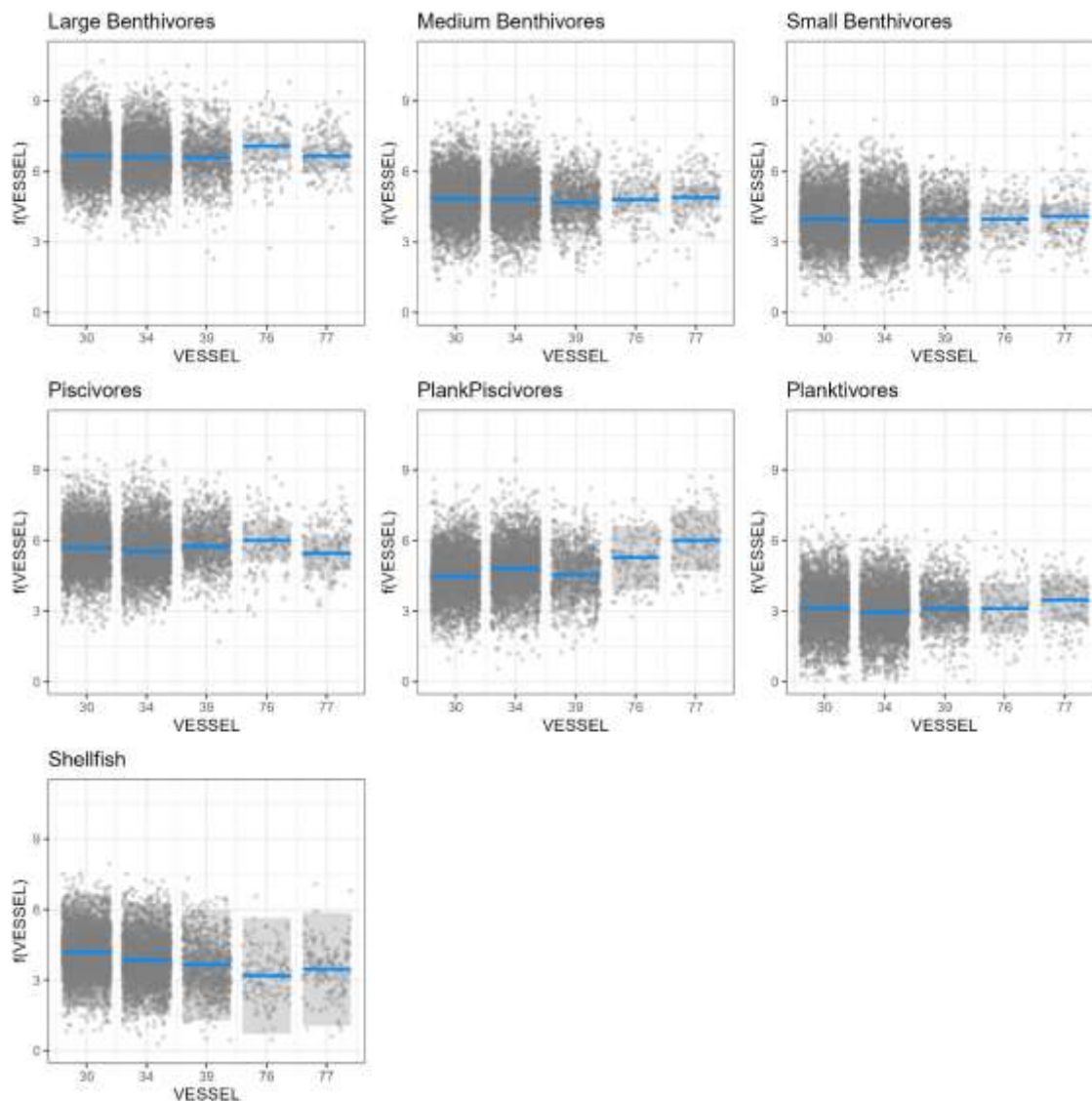


Figure 15. Conditional effects for vessel from models for each functional group in Div. 3LNO Fall. Blue lines show mean and shaded ribbons show 95% CI. Vessel: 30 – CCGS Wilfred Templeman, 34 – CCGS Alfred Needler, 39 – CCGS Teleost, 76 – CCGS Captain Jacques Cartier, 77 – CCGS John Cabot.

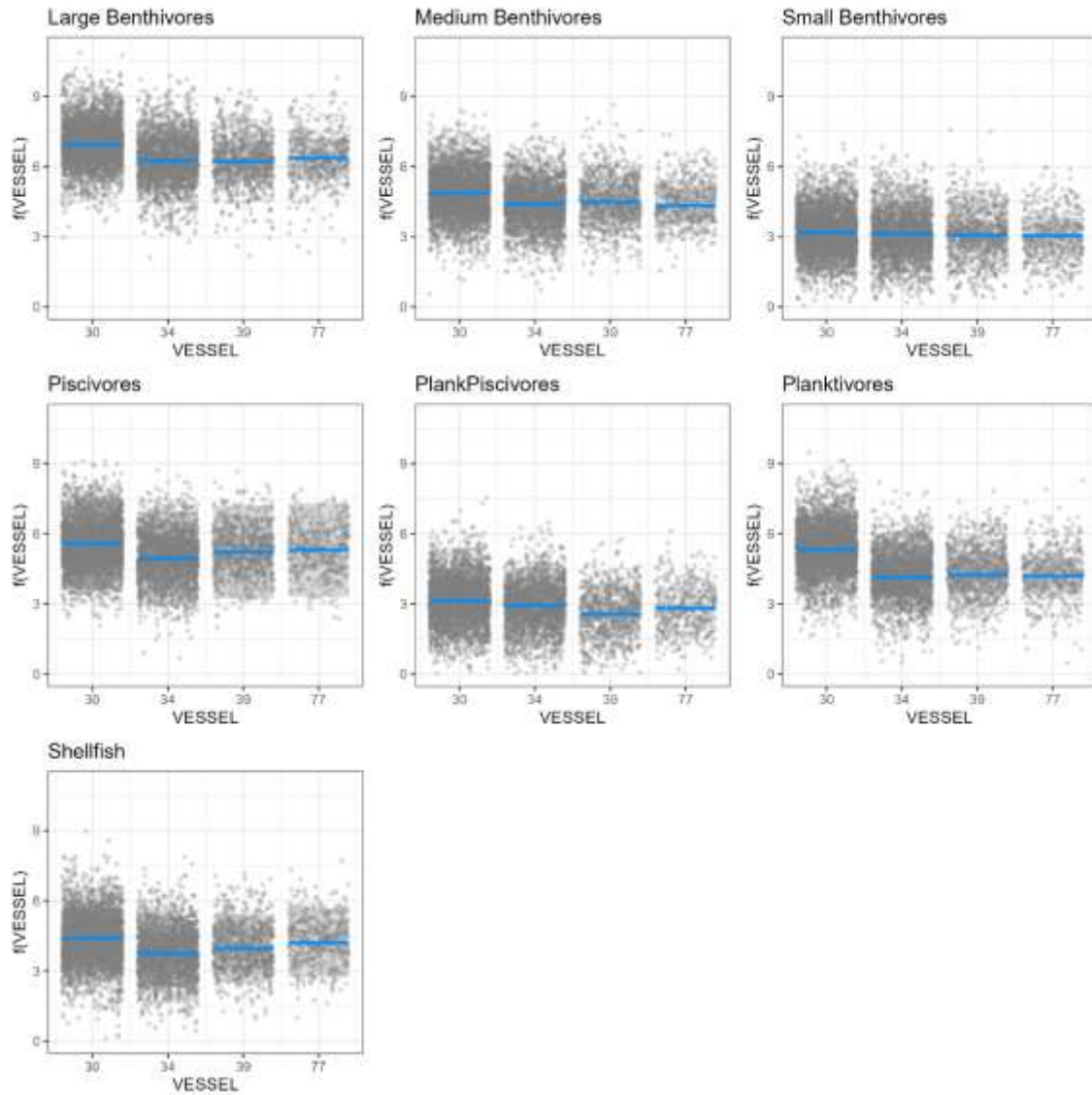


Figure 16. Conditional effects for vessel from models for each functional group in Div. 3LNO Spring. Blue lines show mean and shaded ribbons show 95% CI. Vessel: 30 – CCGS Wilfred Templeman, 34 – CCGS Alfred Needler, 39 – CCGS Teleost, 77 – CCGS John Cabot.

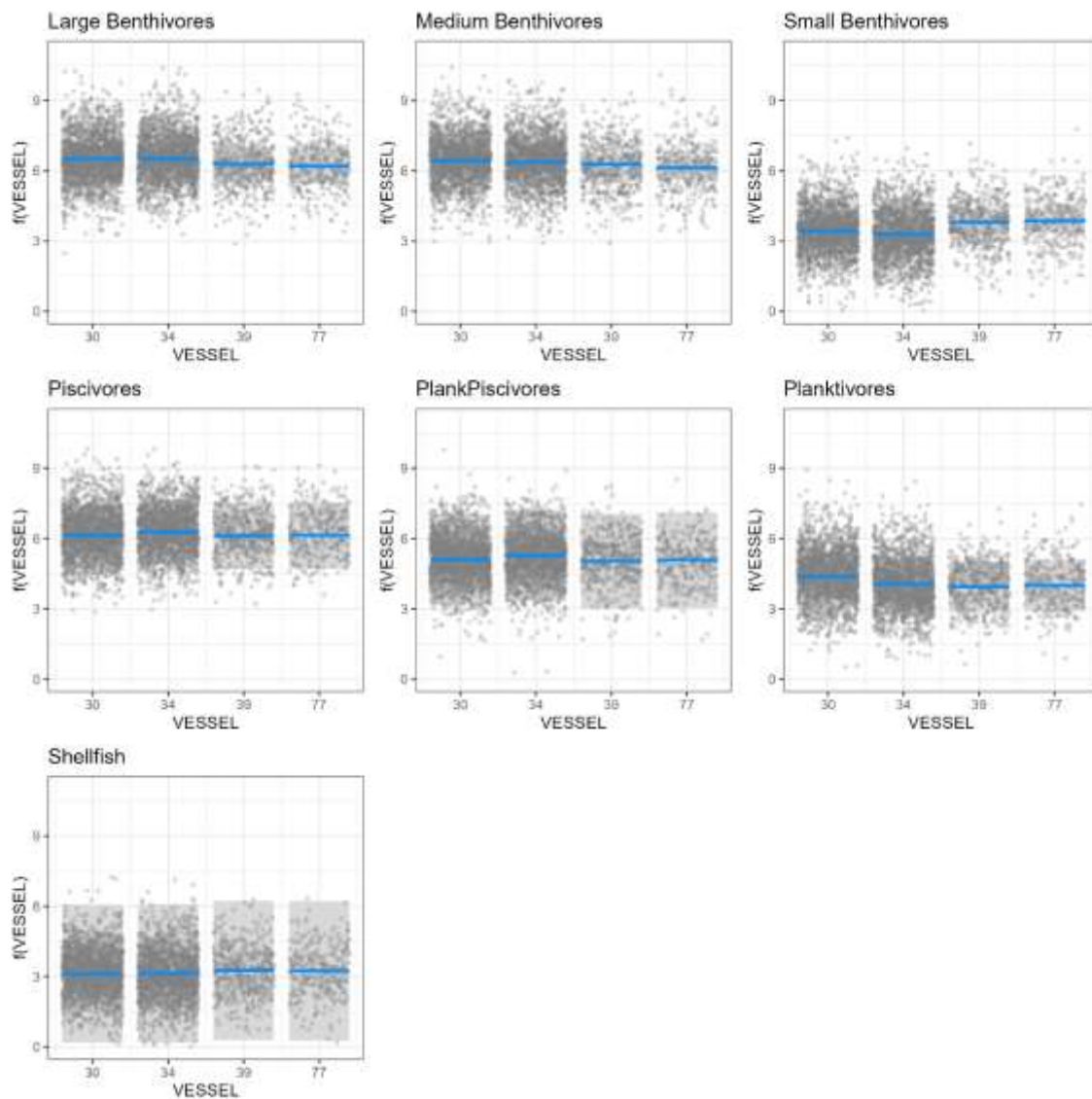


Figure 17. Conditional vessel effects from models for each functional group in SubDiv. 3Ps Spring. Blue lines show mean and shaded ribbons show 95% CI. Vessel: 30 – CCGS Wilfred Templeman, 34 – CCGS Alfred Needler, 39 – CCGS Teleost, 77 – CCGS John Cabot.

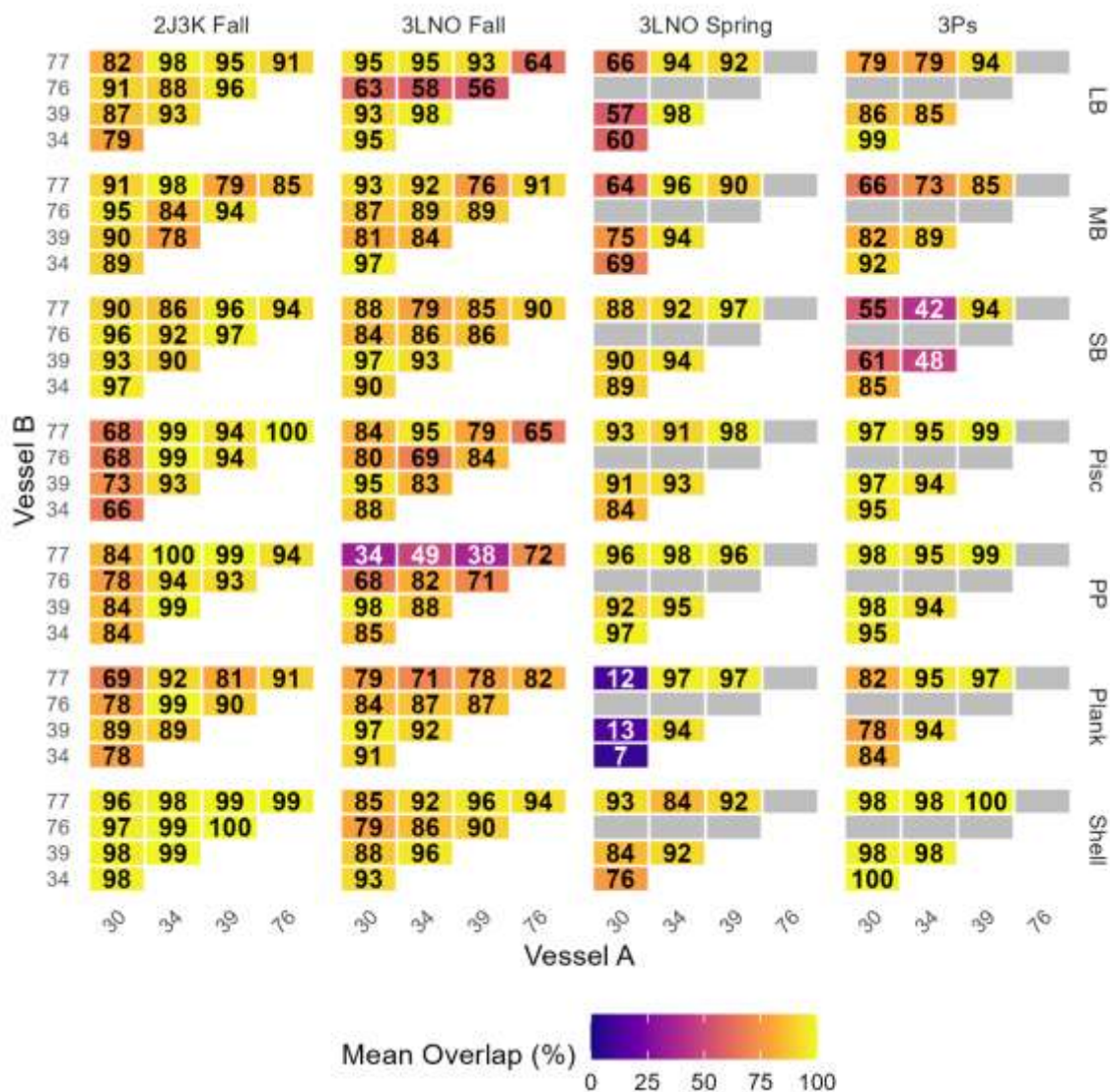


Figure 18. Mean percent overlap of vessel effects form models for each functional group and EPU season. Color of cells reflect mean percent with value reported within cell. Grey cells reflect vessel pair combinations that did not exist in the model. Vessel: 30 – CCGS Wilfred Templeman, 34 – CCGS Alfred Needler, 39 – CCGS Teleost, 76 – CCGS Captain Jacques Cartier, 77 – CCGS John Cabot. Functional group: LB - Large Benthivore, MB - Medium Benthivore, SB – Small Benthivore, PI - Piscivore, PP - Planktivore, PL - Planktivore, SF - Shellfish)

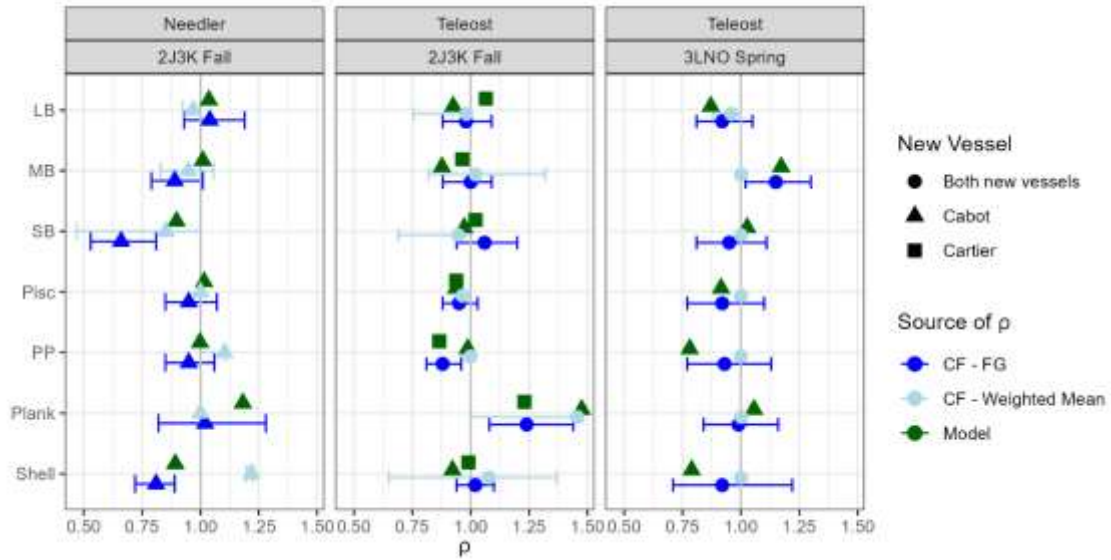


Figure 19. Comparison of directionality and magnitude of vessel impacts (ρ) across approaches by functional group, where multiple approaches can be applied. Approaches/sources include: estimated ρ at functional groups level (Munro et al. 2026) with 95CI and including non-significant conversions (blue); weighted-mean and 95CI for species level accepted conversion factors (light blue); pseudo- ρ derived from model parameter estimates (green) comparing the old vessel to Cabot (triangle) or Cartier (square). Included regions and new vessel include Div. 2J3K Fall for Needler and Teleost, and Div. 3LNO Spring for Teleost. Functional group (LB - Large Benthivore, MB - Medium Benthivore, SB - Small Benthivore, PI - Piscivore, PP - Planktivore, PL - Planktivore, SF - Shellfish). Other regions and vessel pairs not as conversion factors not available.

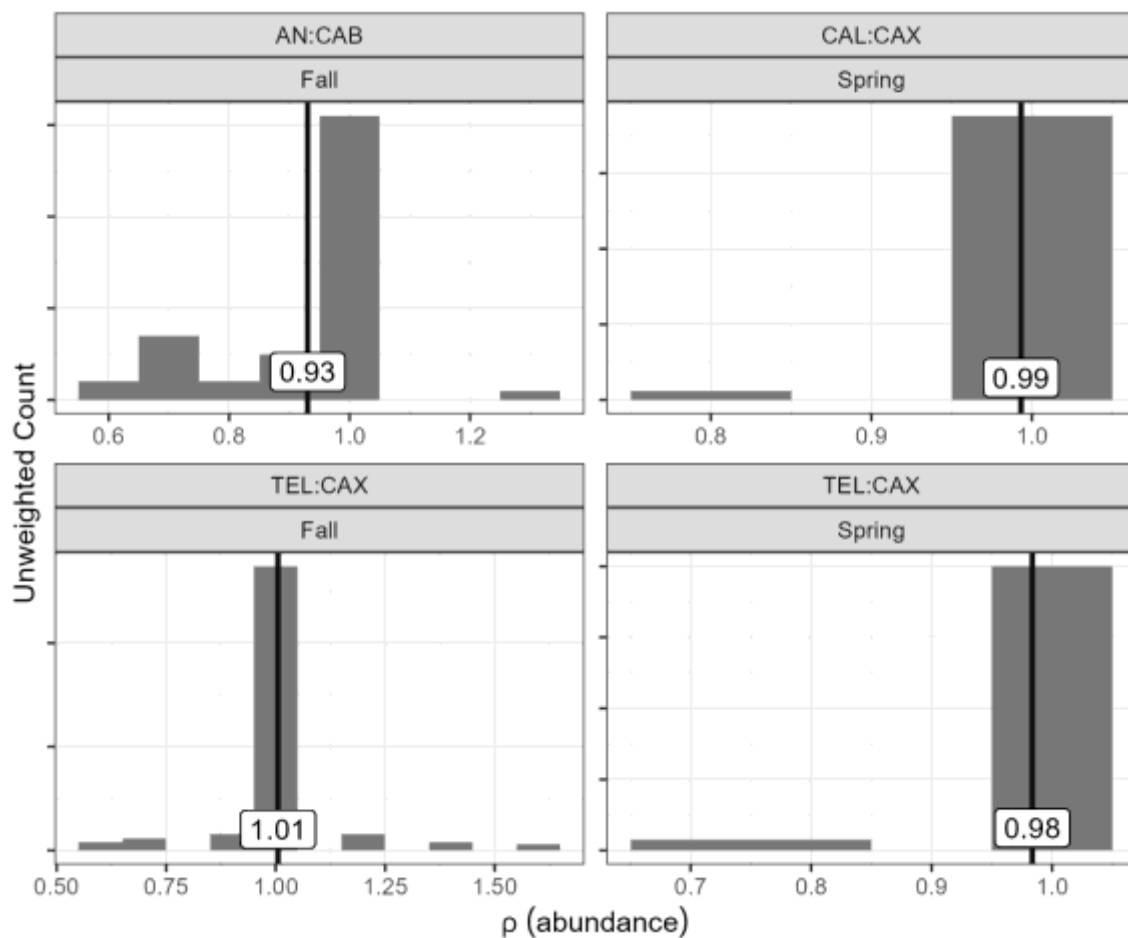


Figure 20. Unweighted distribution of abundance conversion factors (p) for Needler (AN:CAB) for Div. 2J3KL in fall survey, Calvert (CAL:CAX) for Div. 3LNO in fall survey, and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys. The black vertical line and associated value is the unweighted mean.

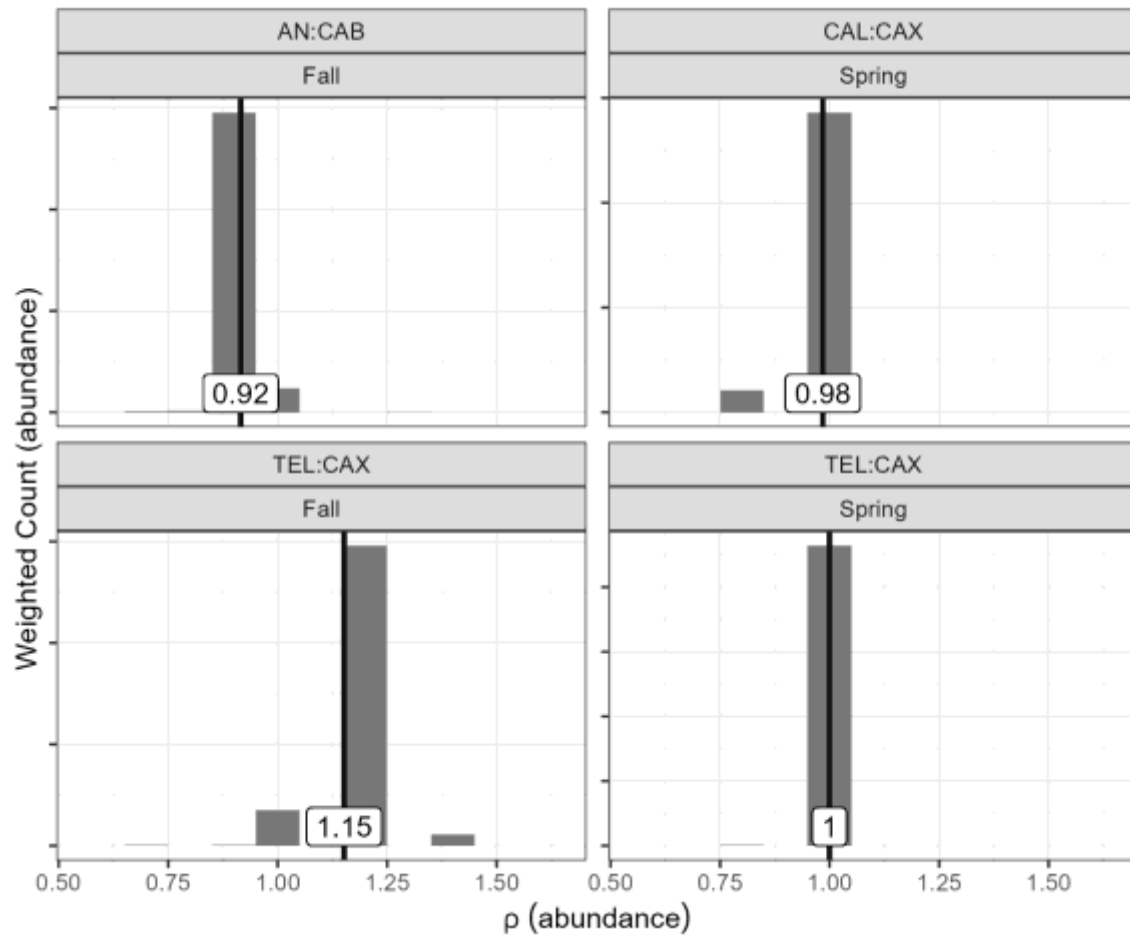


Figure 21. Distribution of abundance conversion factors (p) weighted by the average biomass index for 1996 – 2019 for Needler (AN:CAB) for Div. 2J3KL in fall survey, Calvert (CAL:CAX) for Div. 3LNO in fall survey, and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys. The black vertical line and associated value is the weighted mean.

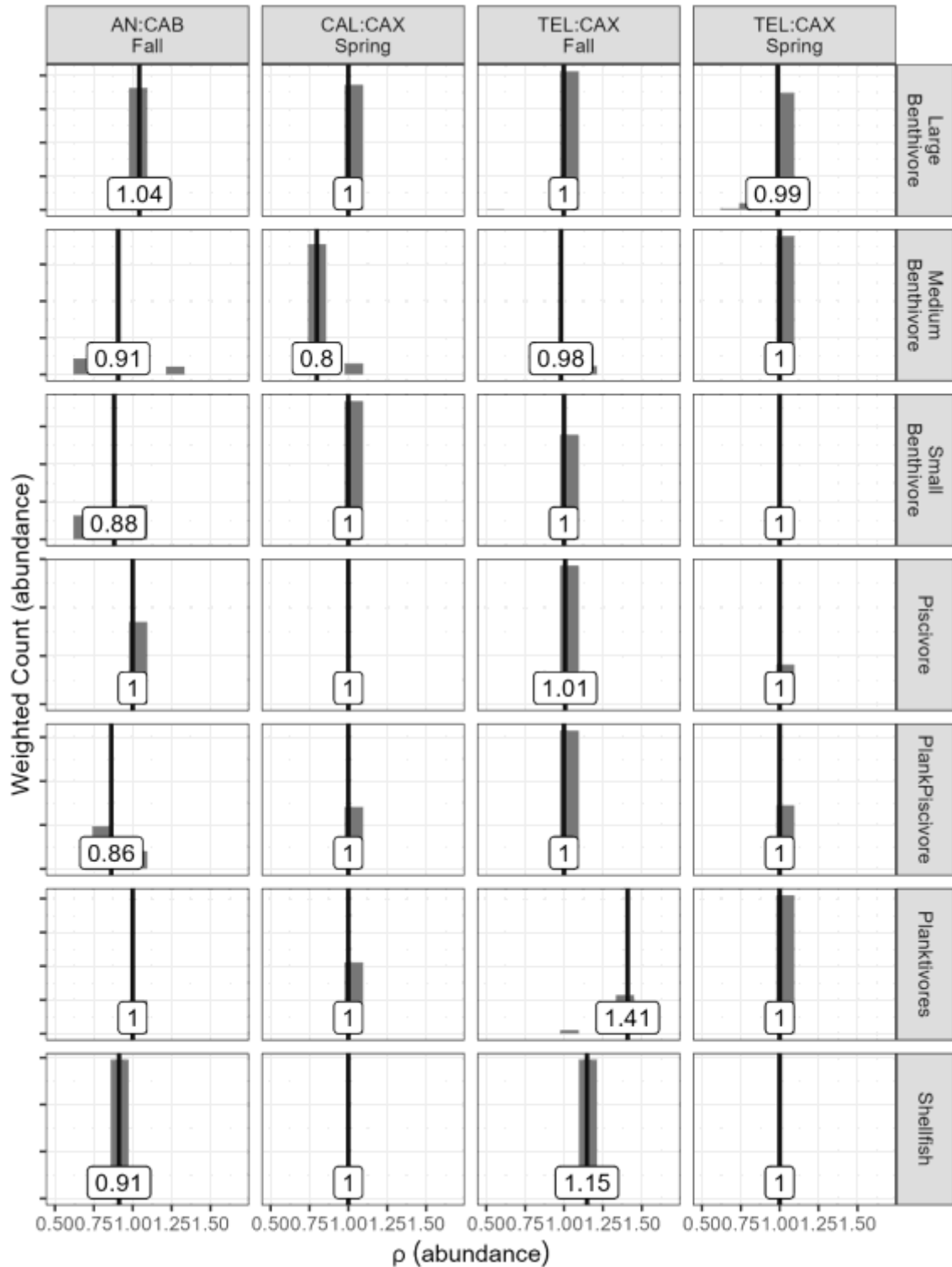


Figure 22. Distribution of abundance conversion factors (p) weighted by the average biomass index for 1996 – 2019 for Needler (AN:CAB) for Div. 2J3KL in fall, Calvert (CAL:CAX) for Div. 3LNO in fall survey, and Teleost (TEL:CAX) in Div. 2HJ3KL in fall and Div. 3LNO spring surveys by functional group. The black vertical line and associated value is the weighted mean.

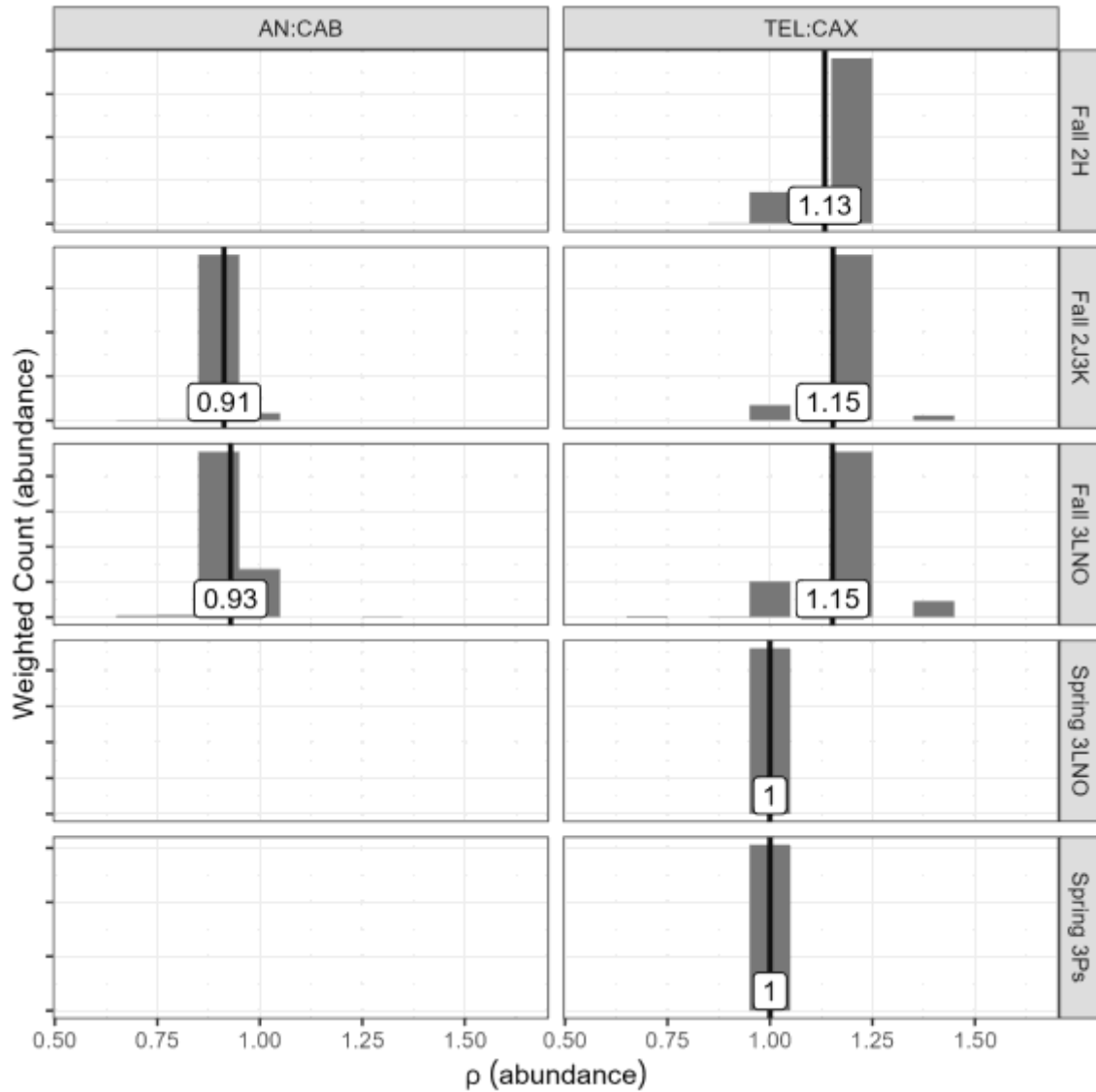


Figure 23. Distribution of abundance conversion factors (p) weighted by the average biomass index for 1996 – 2019 for Needler (AN:CAB) for Div. 2J3KL in fall survey and Teleost (TEL:CAX) in Div. 2HJ3K in fall and Div. 3LNO spring surveys by EPU. Due to lack of conversion factors in Div. 3NO in the fall for AN:CAB the 3LNO Fall EPU reflects conversion factors for 3L only and additional Div. 3LNOPs for AN:CAB these plots are blank. Calvert was not included as all conversions were for single EPU and season. The black vertical line and associated value is the weighted mean.

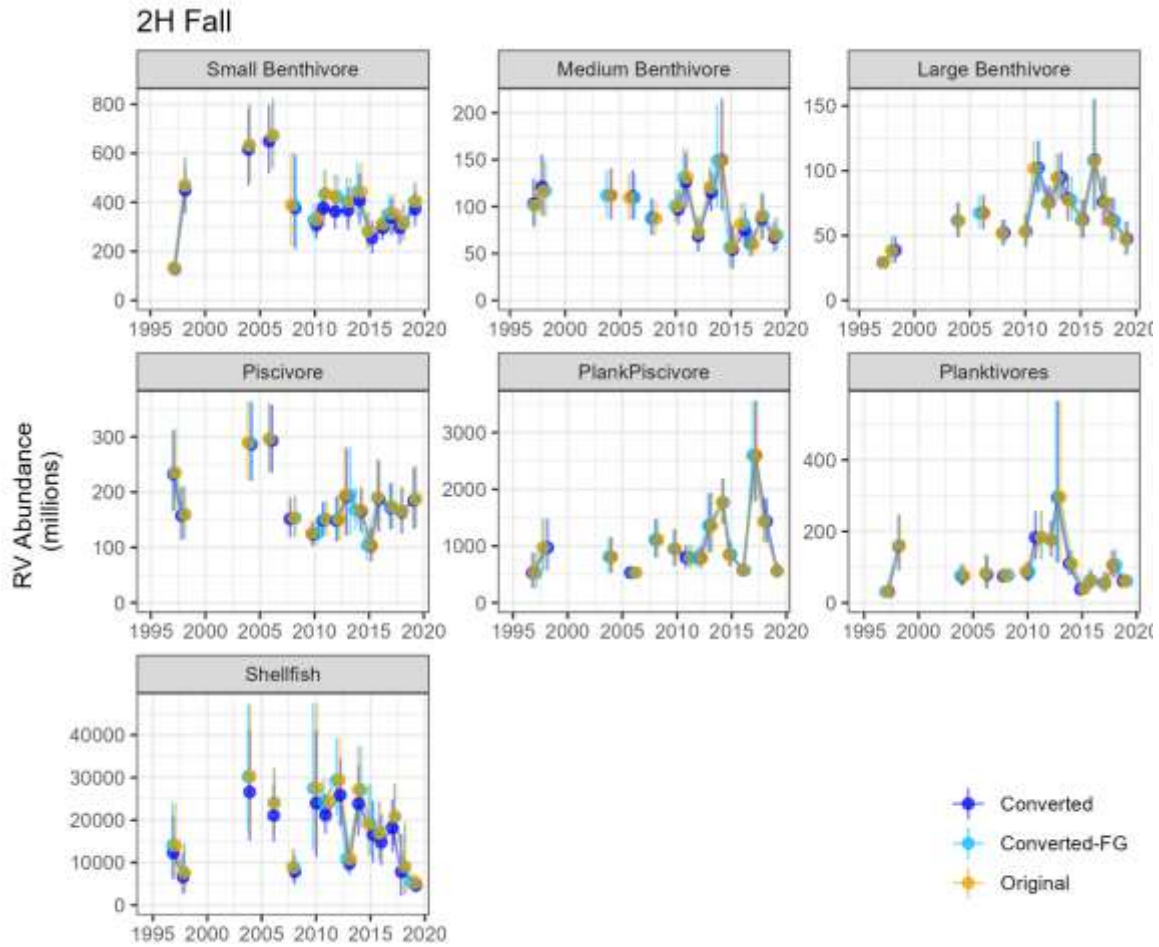


Figure 24. RV abundance index by functional group, for the original (yellow), converted at species level (converted, blue) and converted using functional group level conversions (converted-FG, light blue) in Div. 2H for the fall. Vertical bars indicate the 95% confidence intervals.

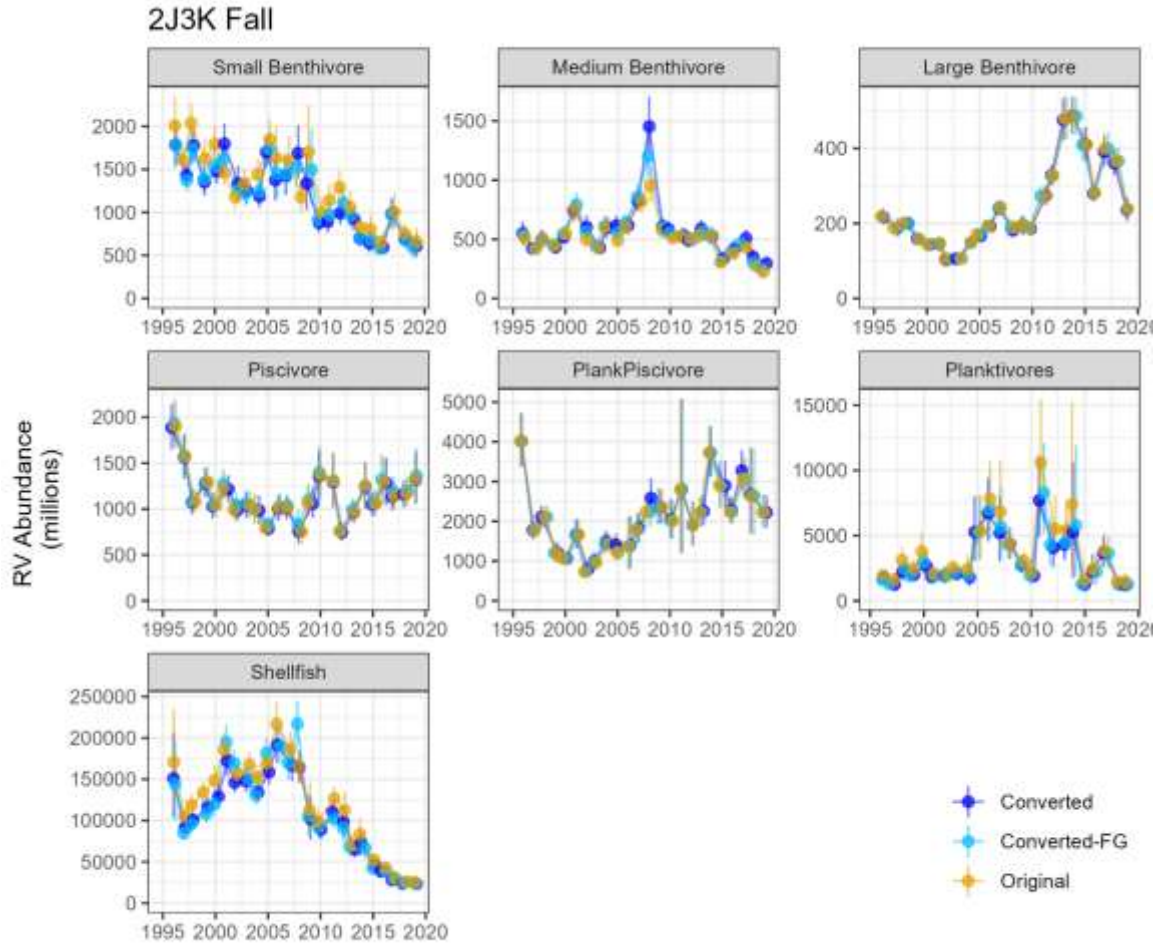


Figure 25. RV abundance index by functional group, for the original (yellow), converted at species level (converted, blue) and converted using functional group level conversions (converted-FG, light blue) in Div. 2J3K for the fall. The vertical bars indicate the 95% confidence intervals.

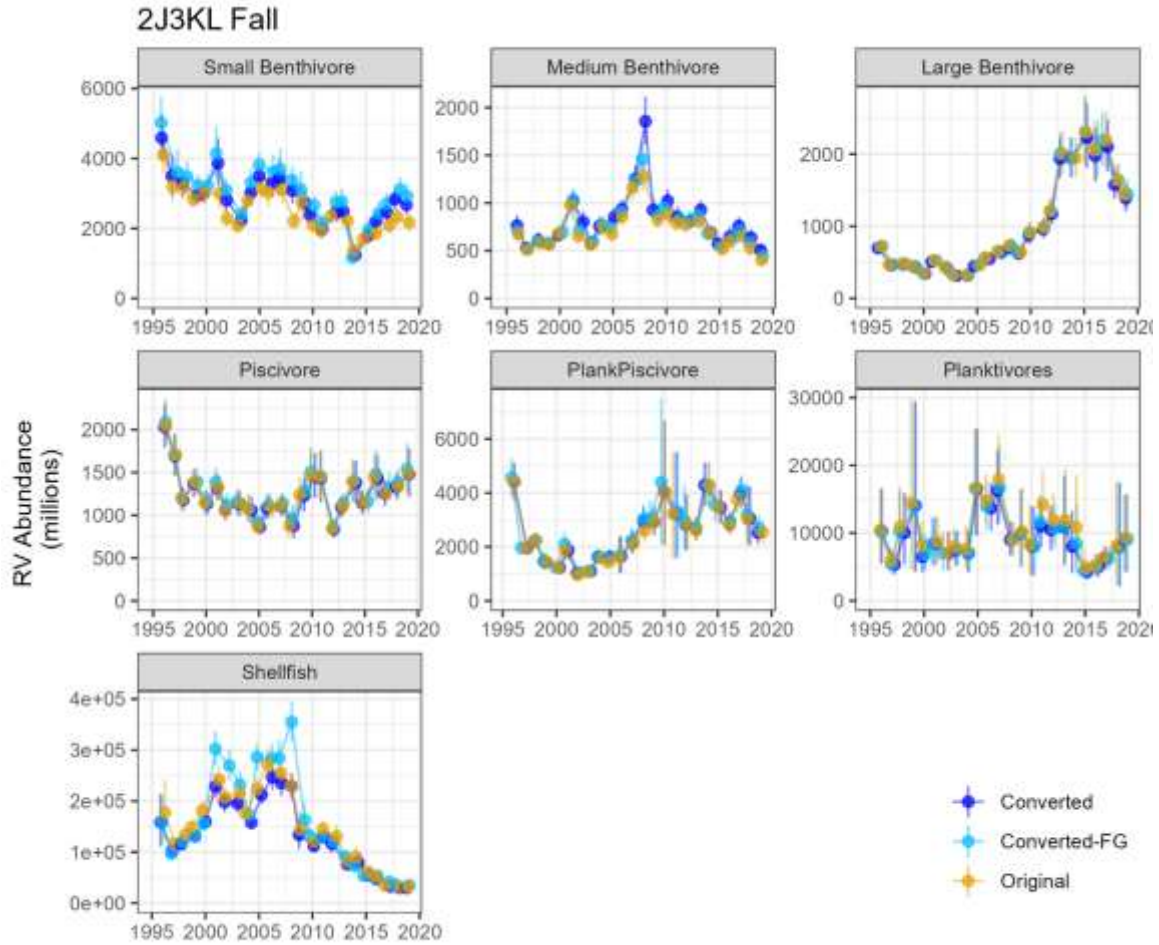


Figure 26. RV abundance index by functional group, for the original (yellow), converted at species level (converted, blue) and converted using functional group level conversions (converted-FG, light blue) in Div. 2J3KL for the fall. The vertical bars indicate the 95% confidence intervals.

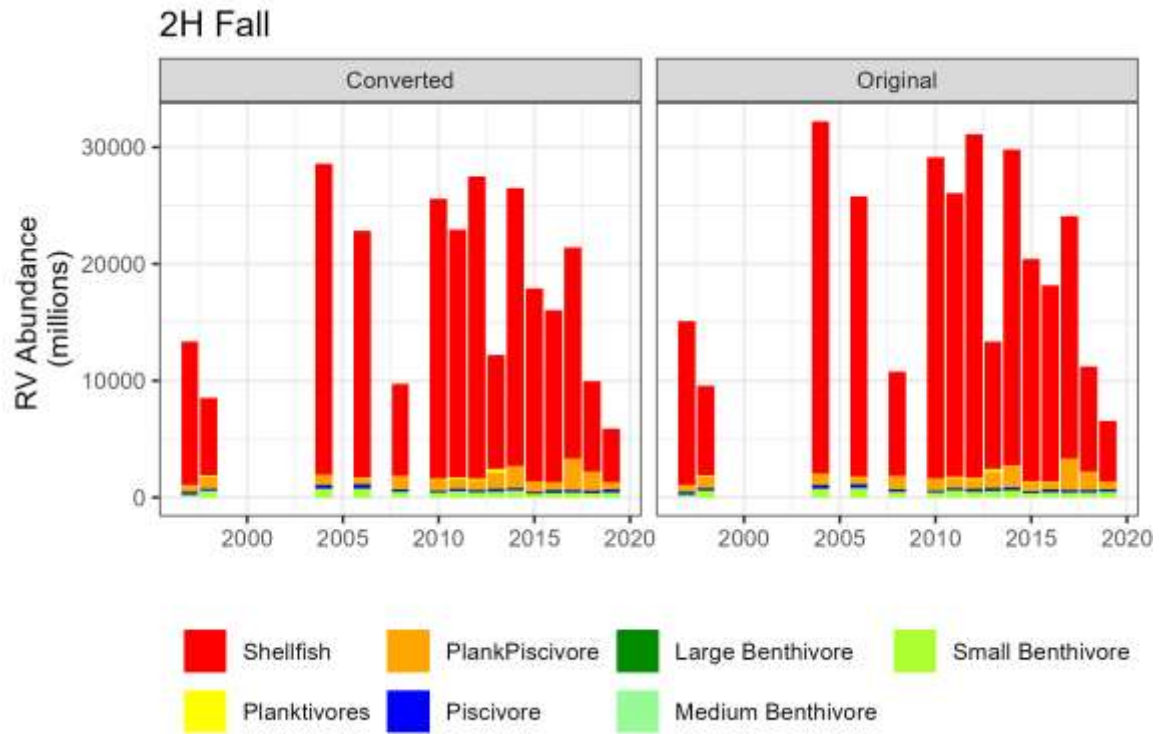


Figure 27. Comparison of total research vessel (RV) abundance broken down by functional group for Div. 2H in the fall converted using species level conversion factors.

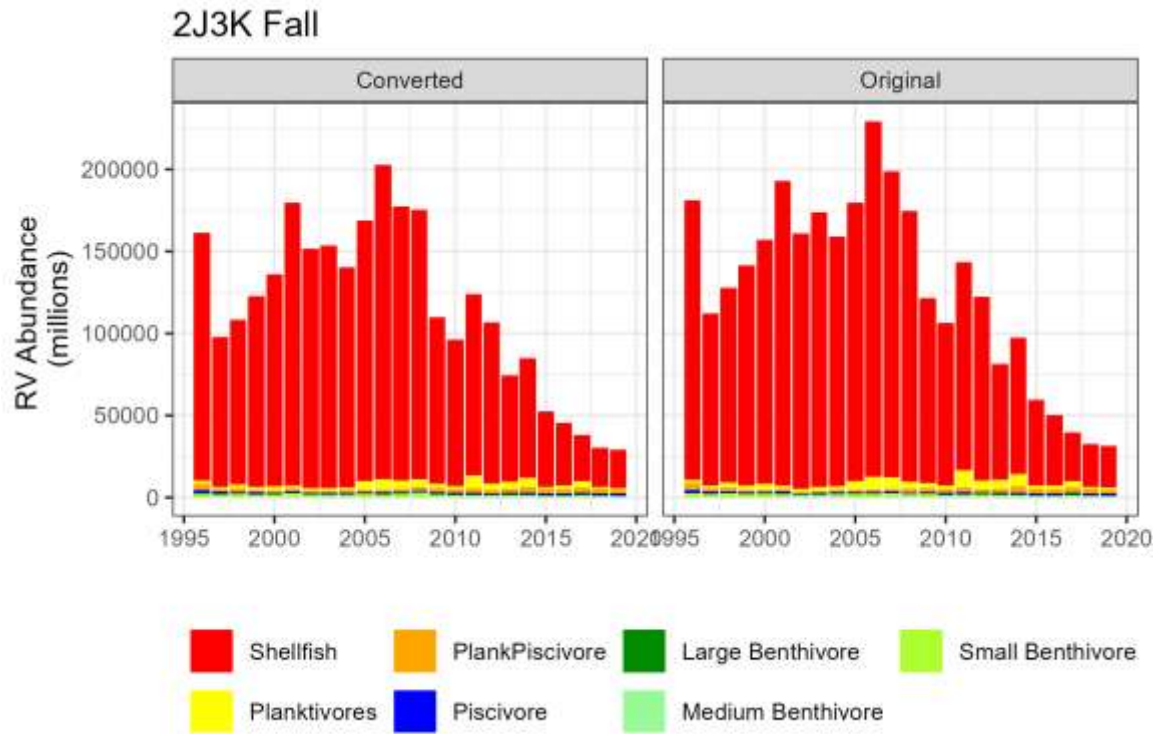


Figure 28. Comparison of total research vessel (RV) abundance broken down by functional group for Div. 2J3K in the fall using species level conversion factors.

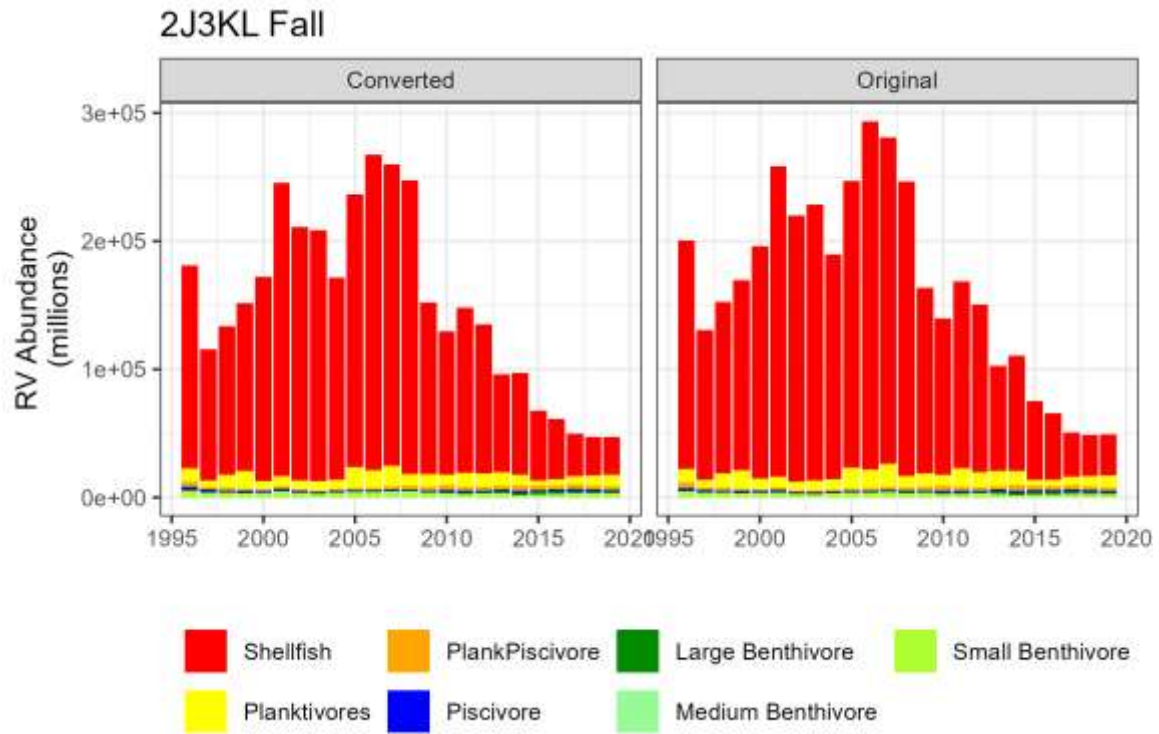


Figure 29. Comparison of total research vessel (RV) abundance broken down by functional group for 2J3KL in the fall using species level conversion factors.

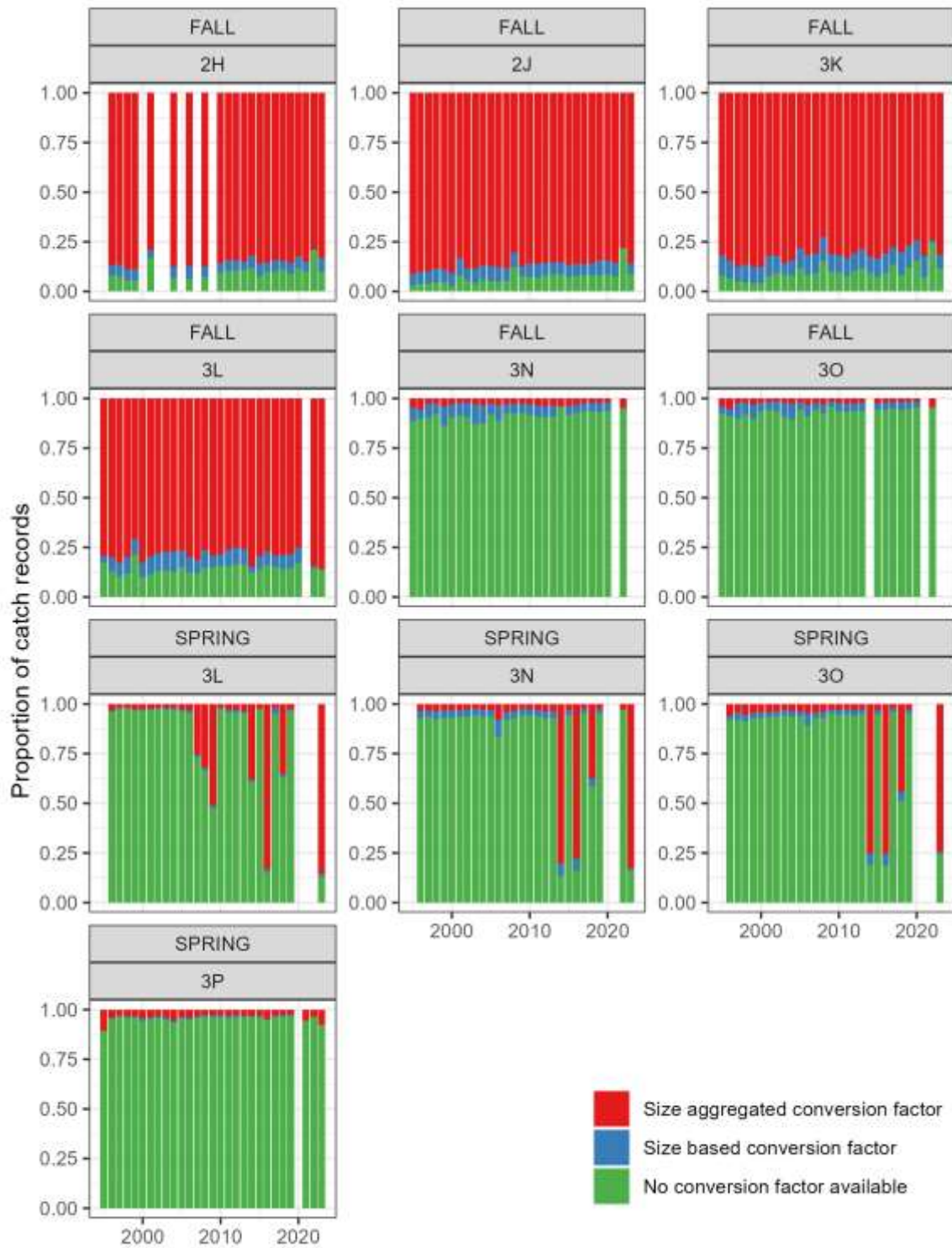


Figure 30. Proportion of records of catch in each survey year converted by season and NAFO Division. Catch records are converted using size aggregated conversion factors (red), size based conversion factors (blue), or not converted as there are no conversion factors available (green).

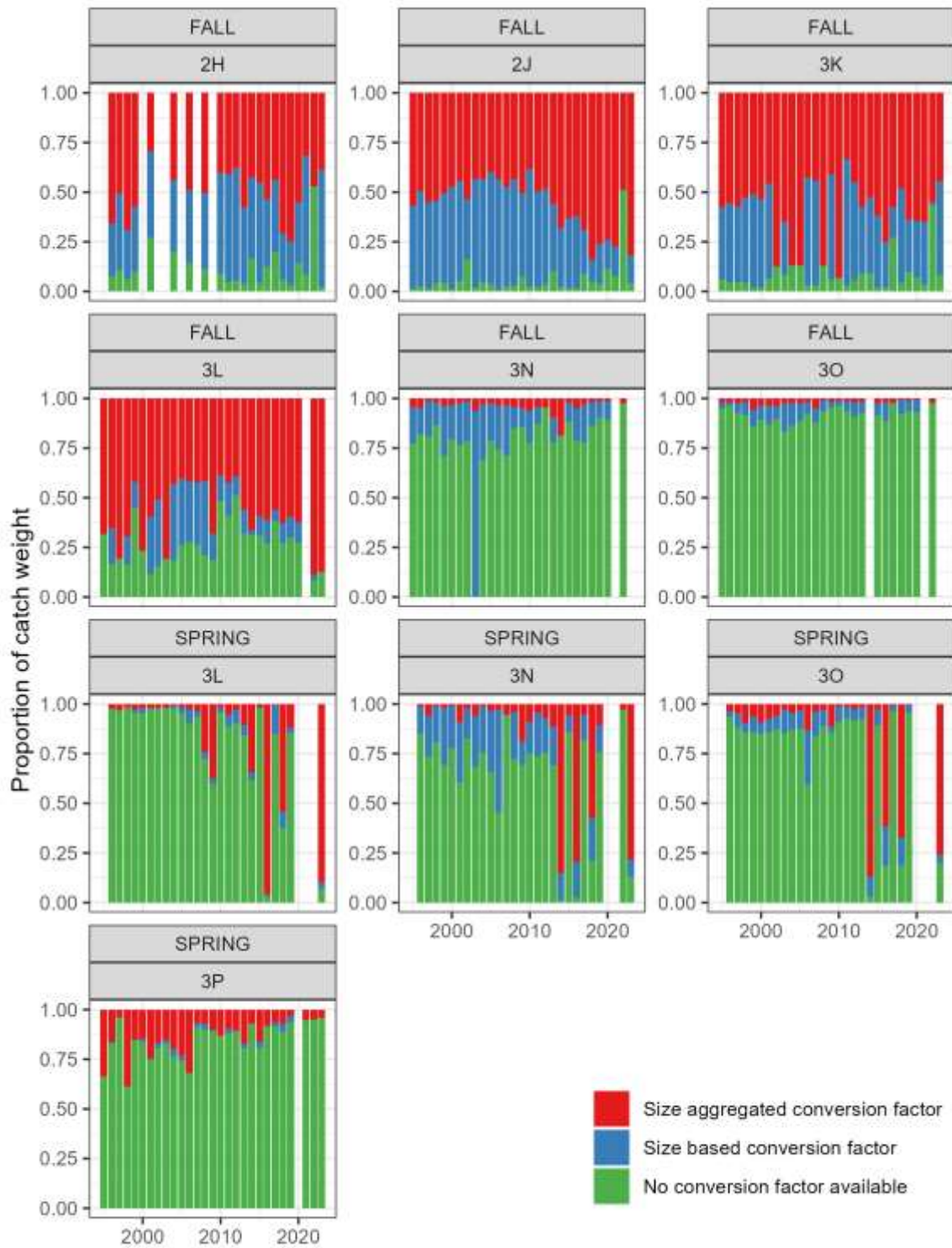


Figure 31. Proportion of catch weight in a survey year converted by season and NAFO Division. Catch records are converted using size aggregated conversion factors (red), size based conversion factors (blue), or not converted as there are no conversion factors available (green).

APPENDIX A

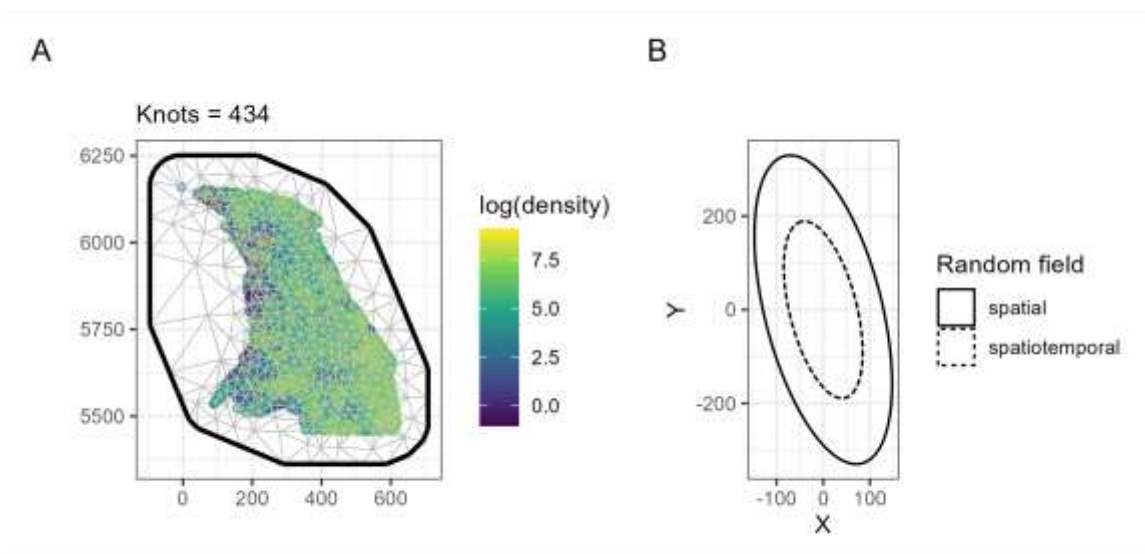


Figure A1. Mesh (A) and anisotropy (B) for model examining density of catch of Large Benthivores in Div. 2J3K Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

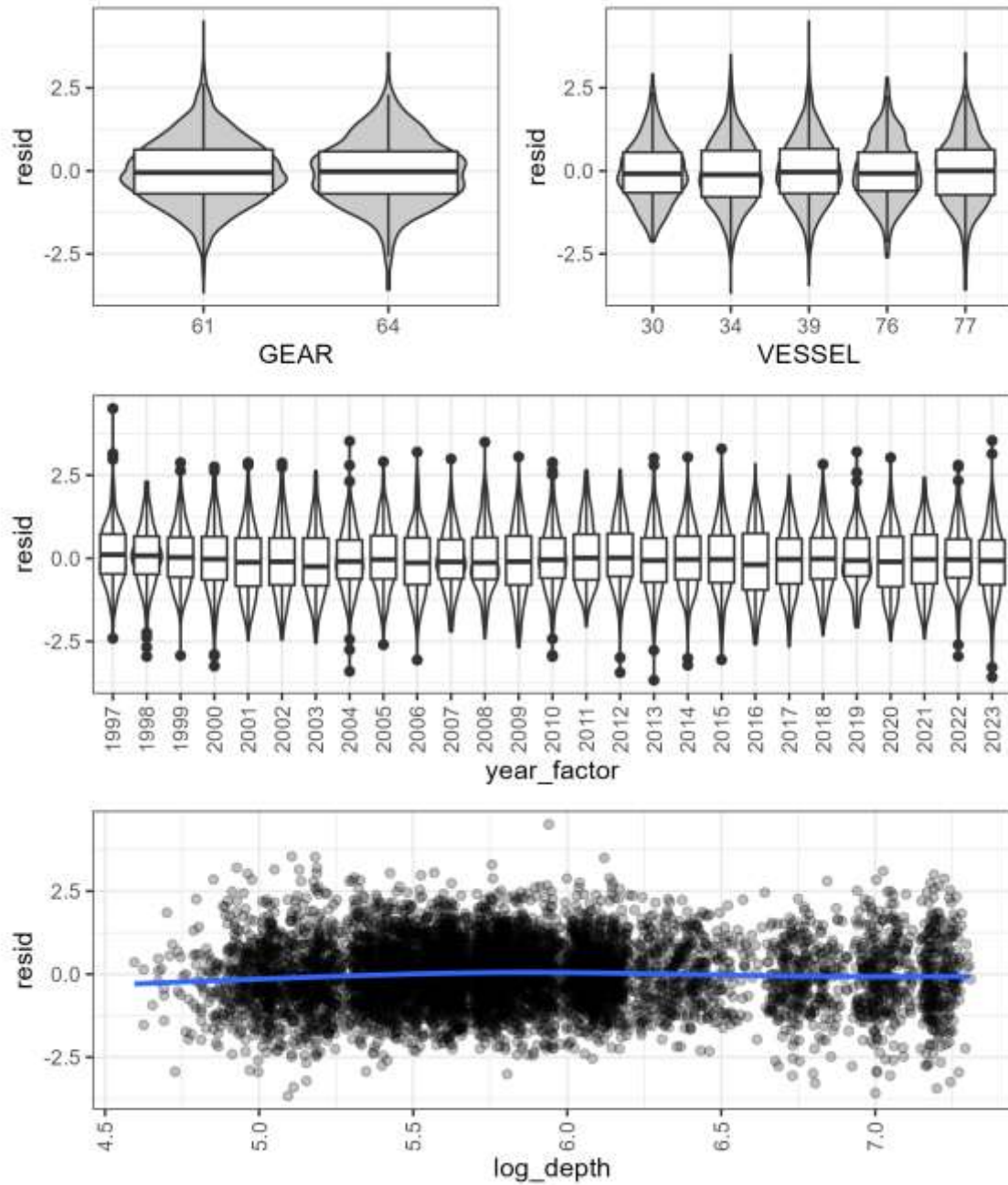


Figure A2. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Large Benthivores in Div. 2J3K Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals

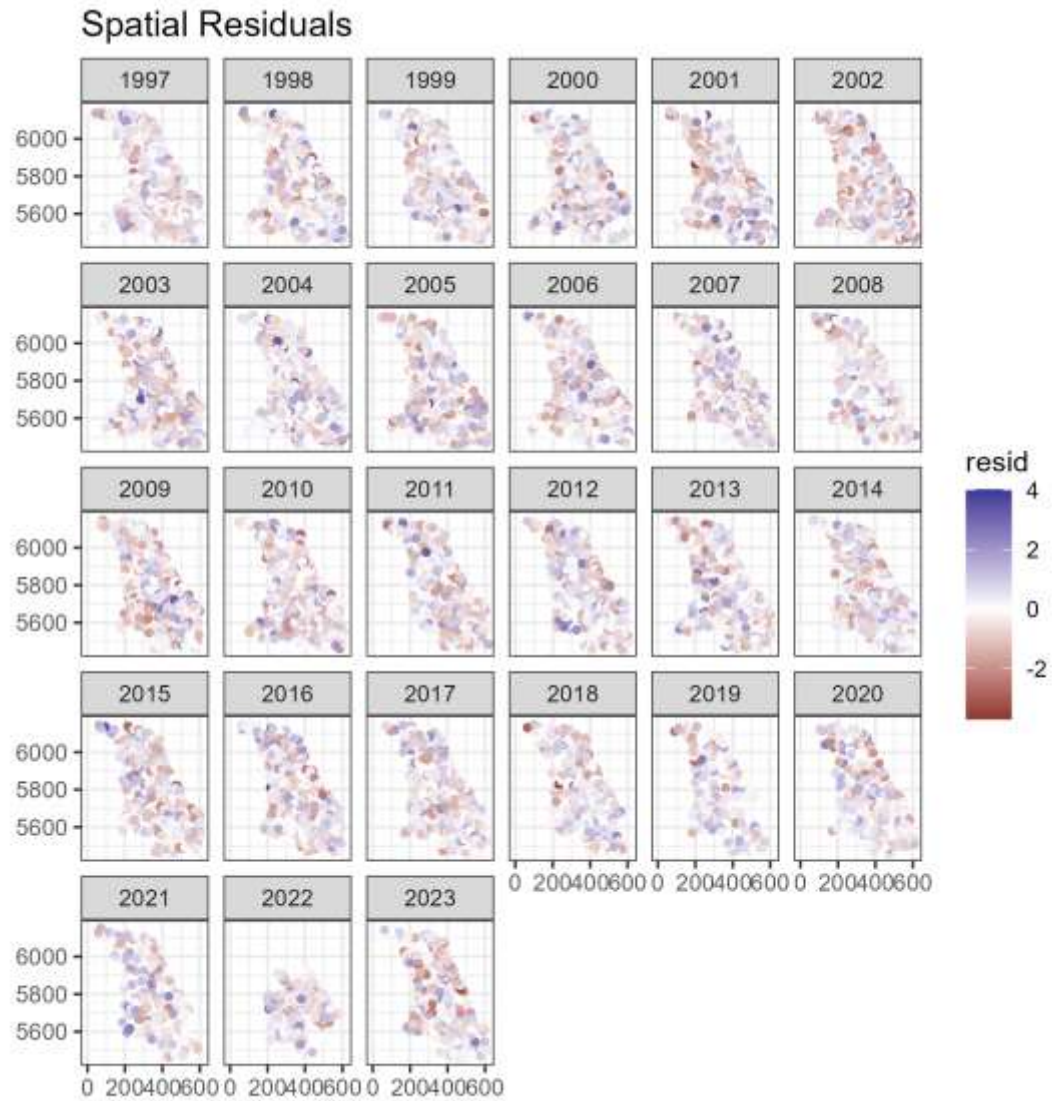


Figure A3. Spatial residuals calculated using MCMC for model examining density of catch of Large Benthivores in Div. 2J3K Fall.

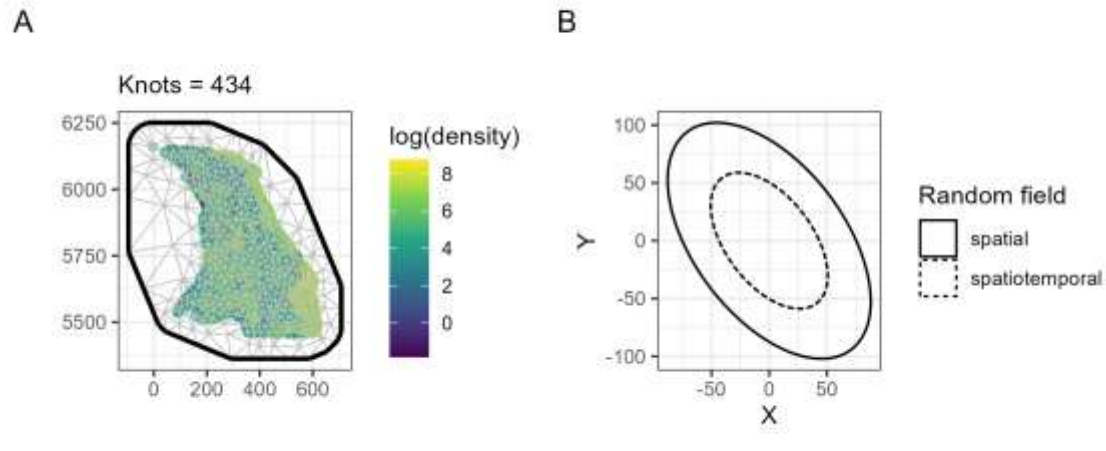


Figure A4. Mesh (A) and anisotropy (B) for model examining density of catch of Medium Benthivores in Div. 2J3K Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

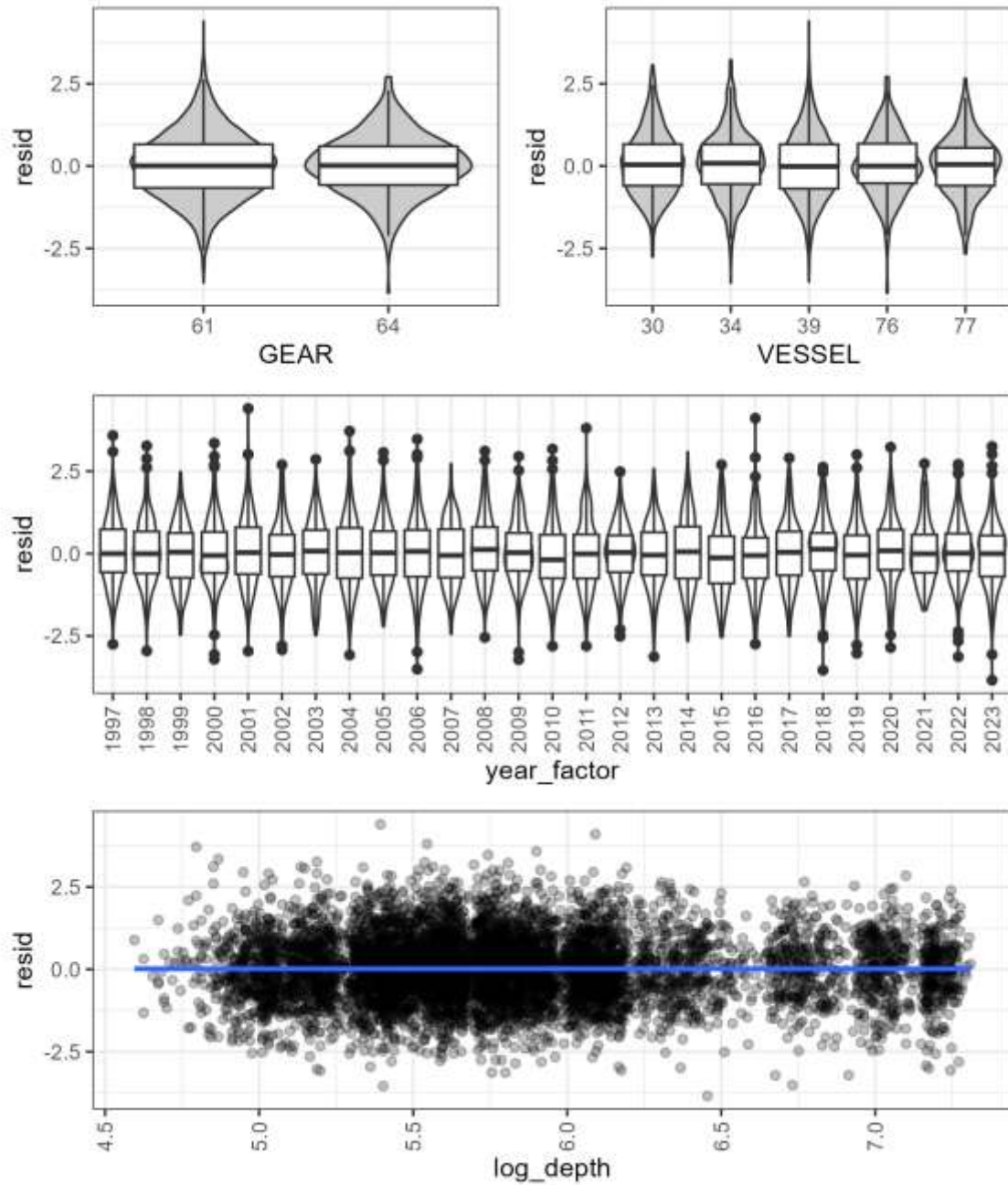


Figure A5. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Medium Benthivores in Div. 2J3K Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals .

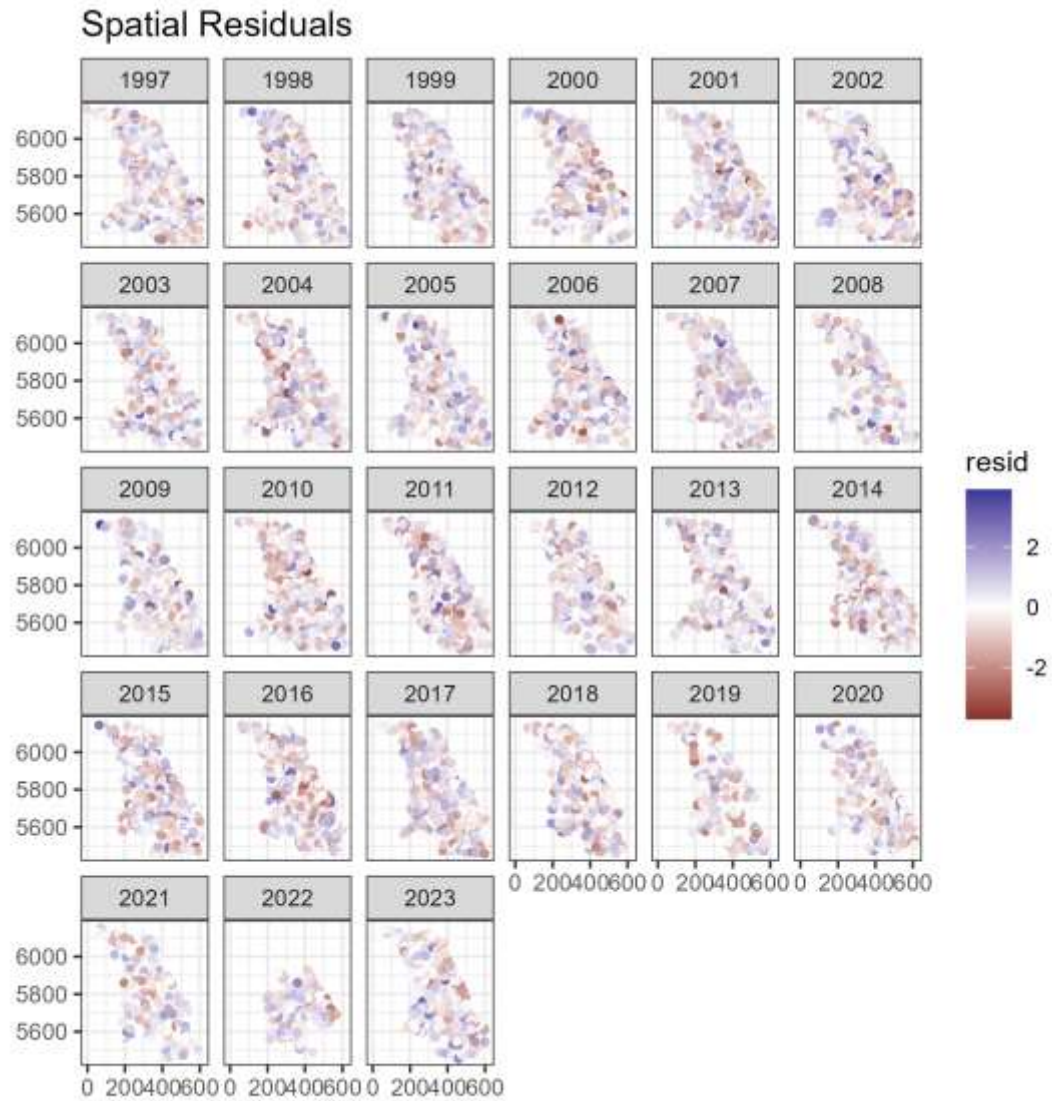


Figure A6. Spatial residuals calculated using MCMC for model examining density of catch of Medium Benthivores in Div. 2J3K Fall.

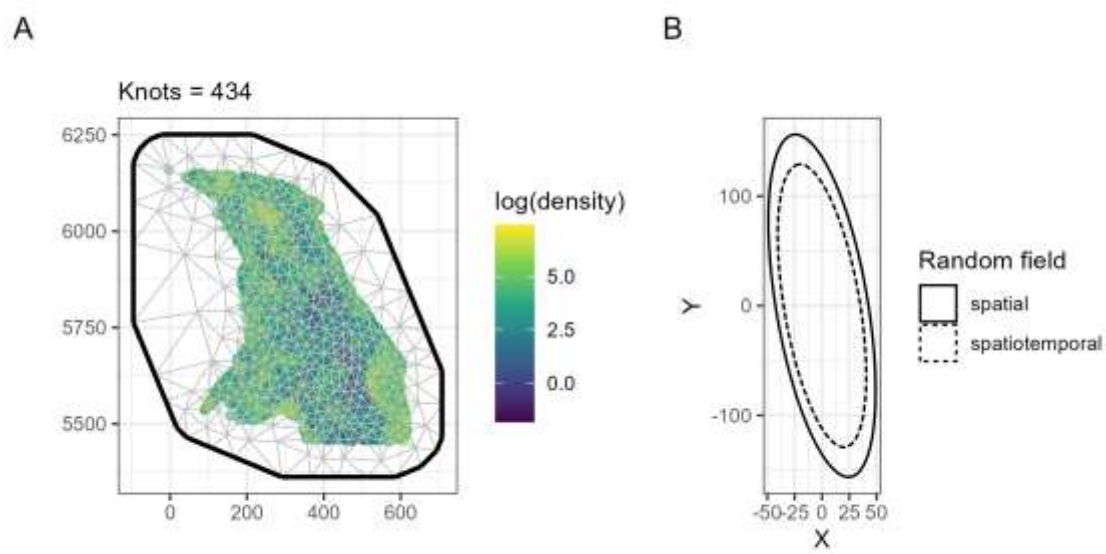


Figure A7. Mesh (A) and anisotropy (B) for model examining density of catch of Small Benthivores in Div. 2J3K Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

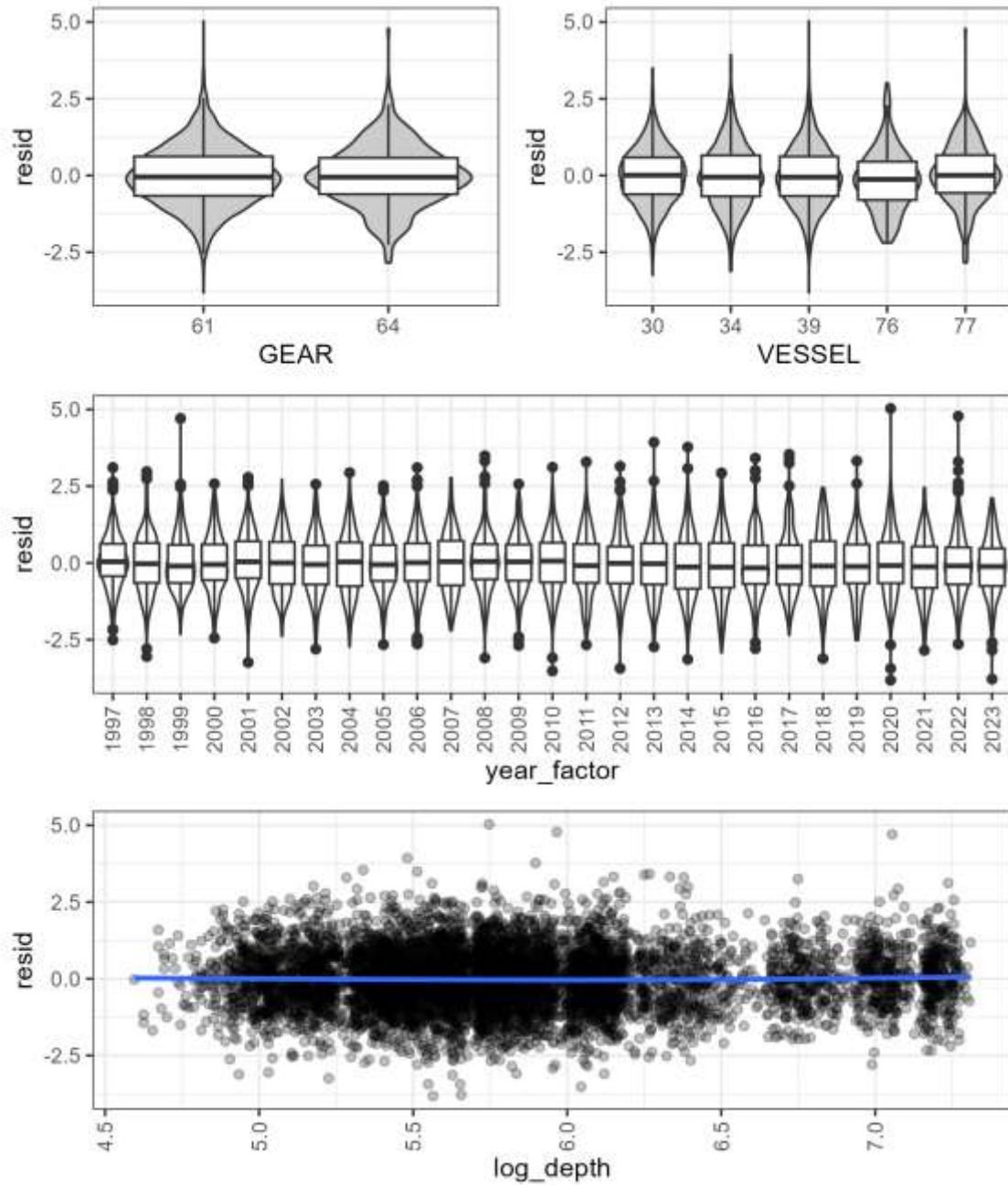


Figure A8. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Small Benthivores in Div. 2J3K Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

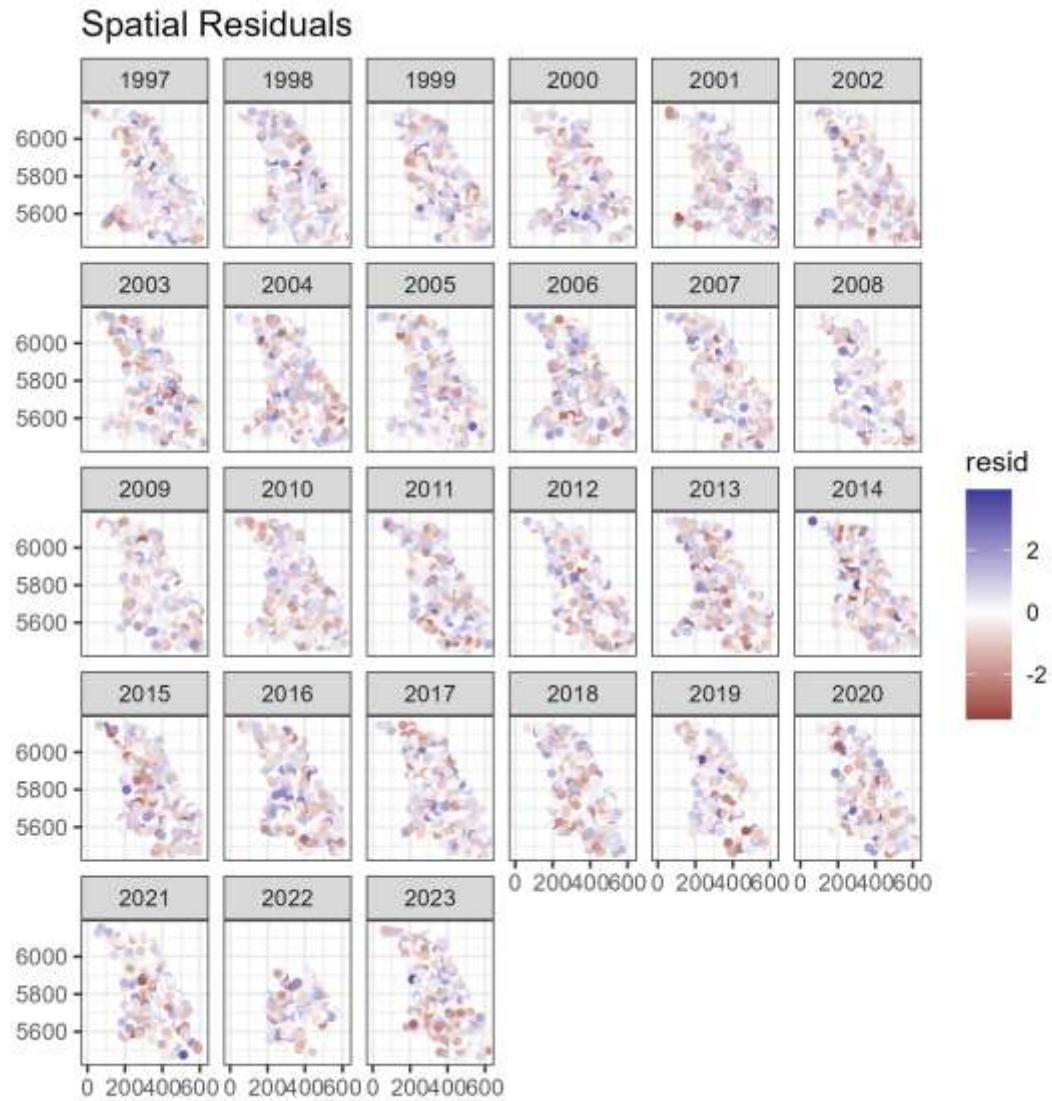


Figure A9. Spatial residuals calculated using MCMC for model examining density of catch of Small Benthivores in Div. 2J3K Fall.

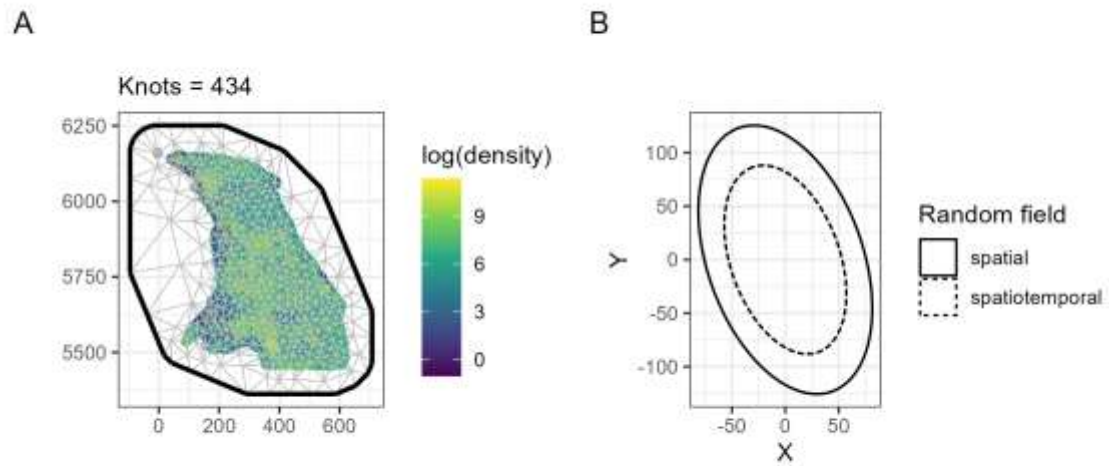


Figure A10. Mesh (A) and anisotropy (B) for model examining density of catch of Piscivores in Div. 2J3K Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

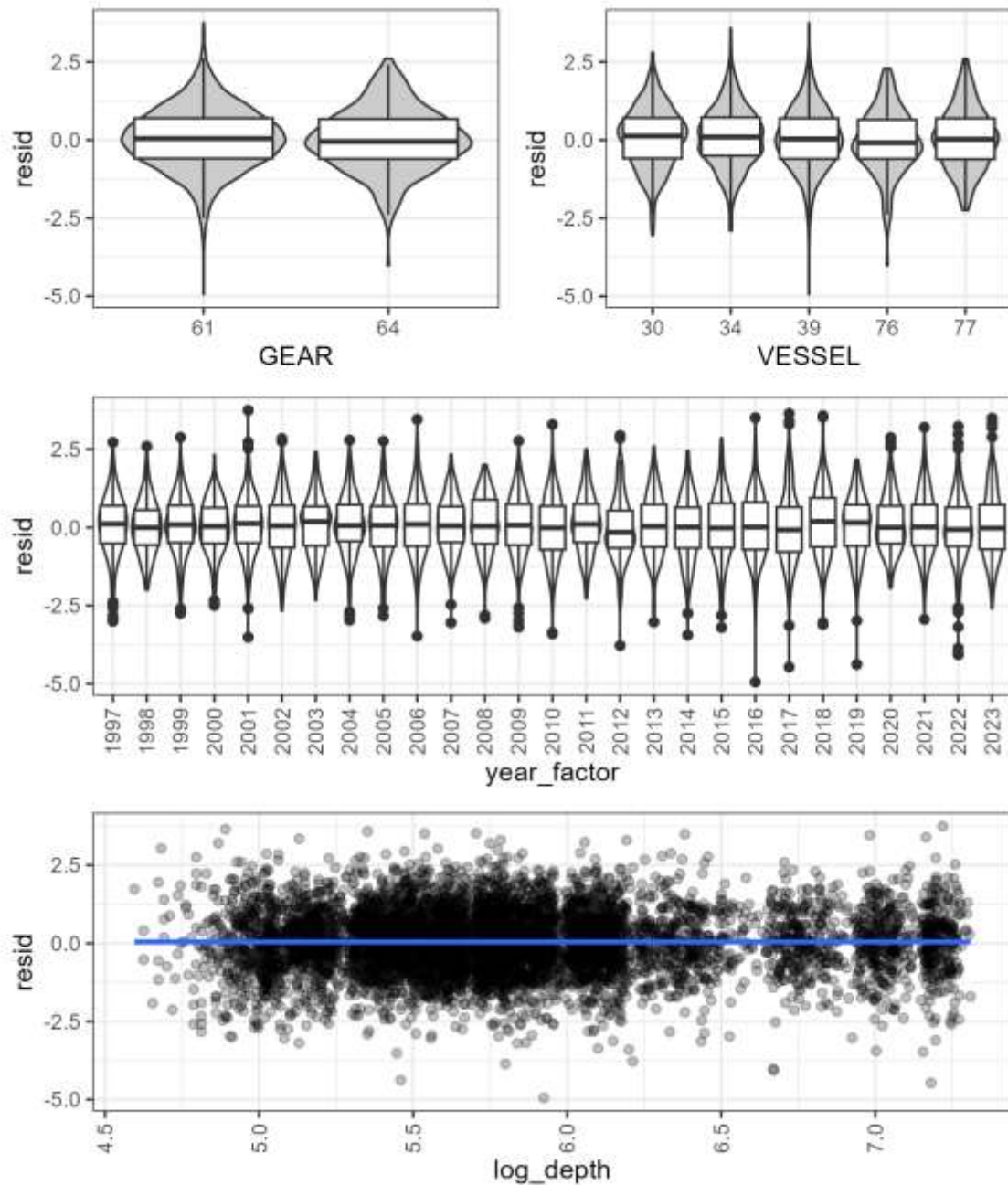


Figure A11. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Piscivores in Div. 2J3K Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals .

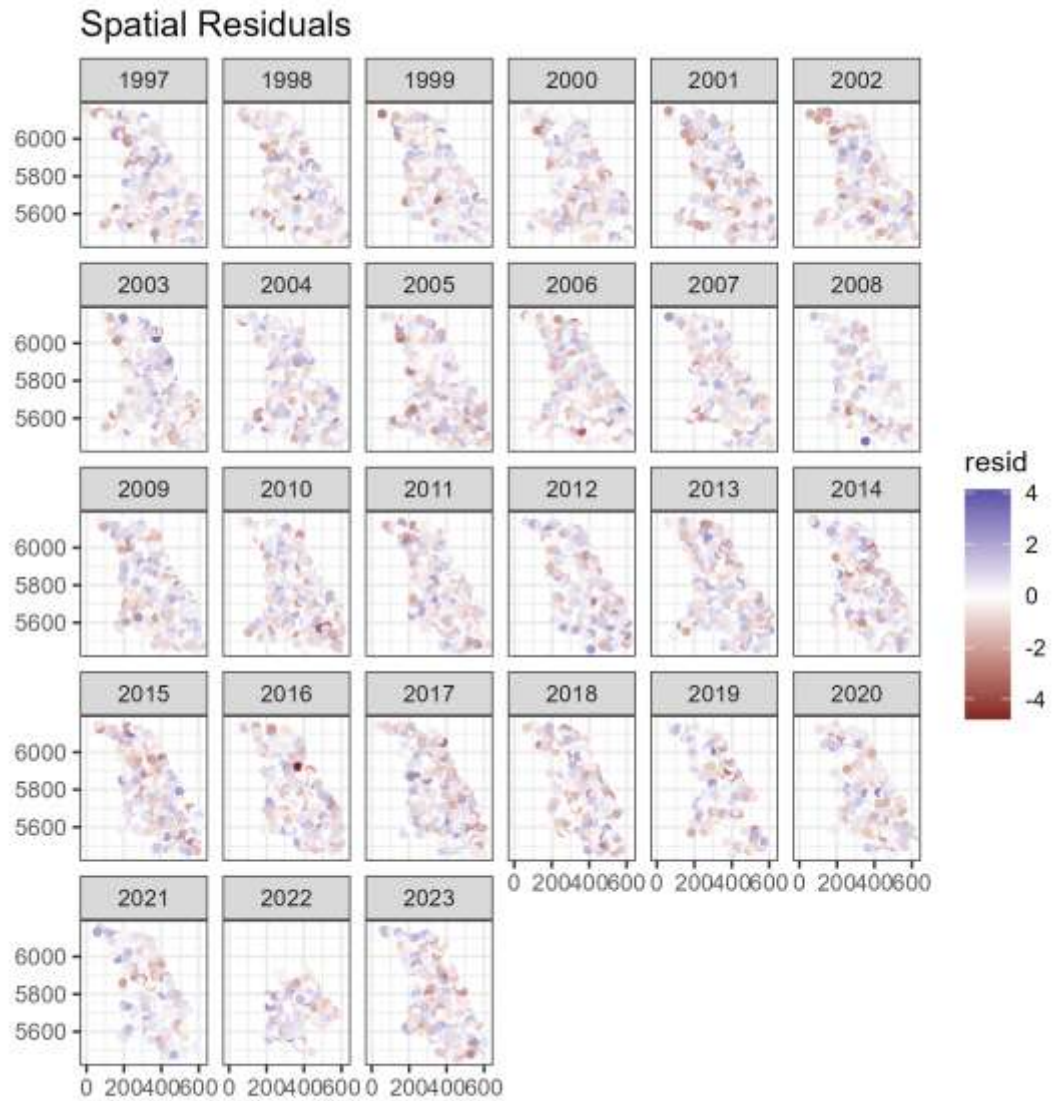


Figure A12. Spatial residuals calculated using MCMC for model examining density of catch of Piscivores in Div. 2J3K Fall.

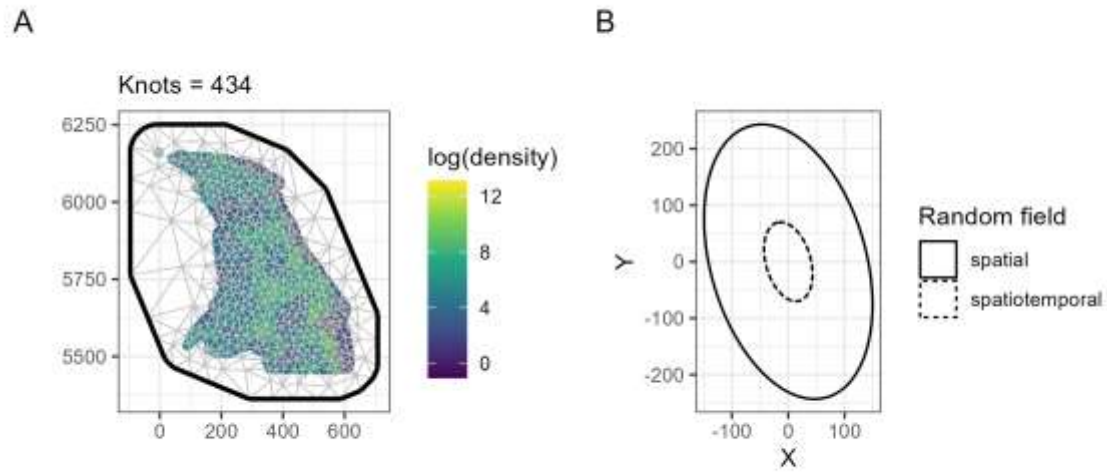


Figure A13. Mesh (A) and anisotropy (B) for model examining density of catch of Planktivores in Div. 2J3K Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

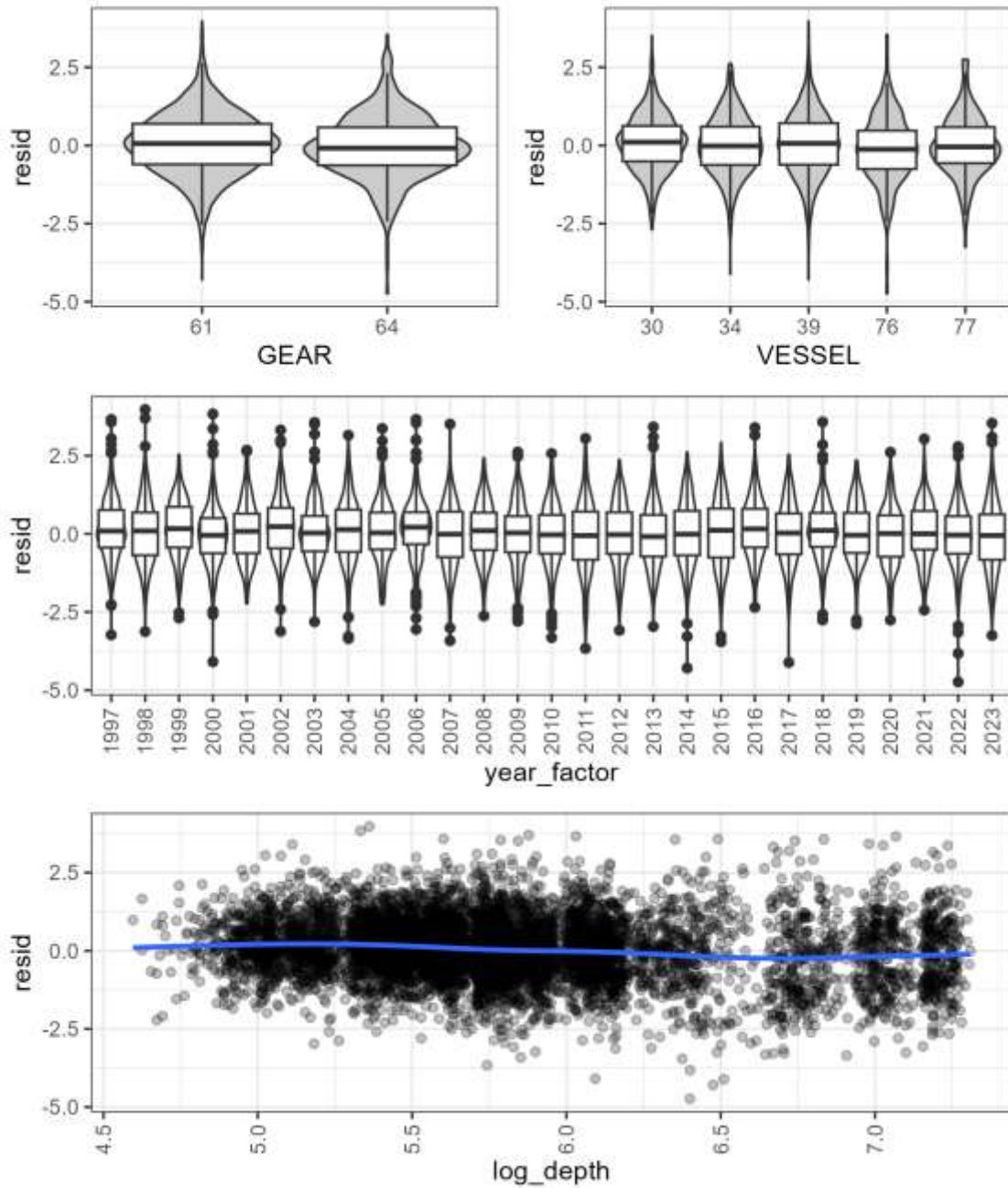


Figure A14. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Planktivores in Div. 2J3K Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

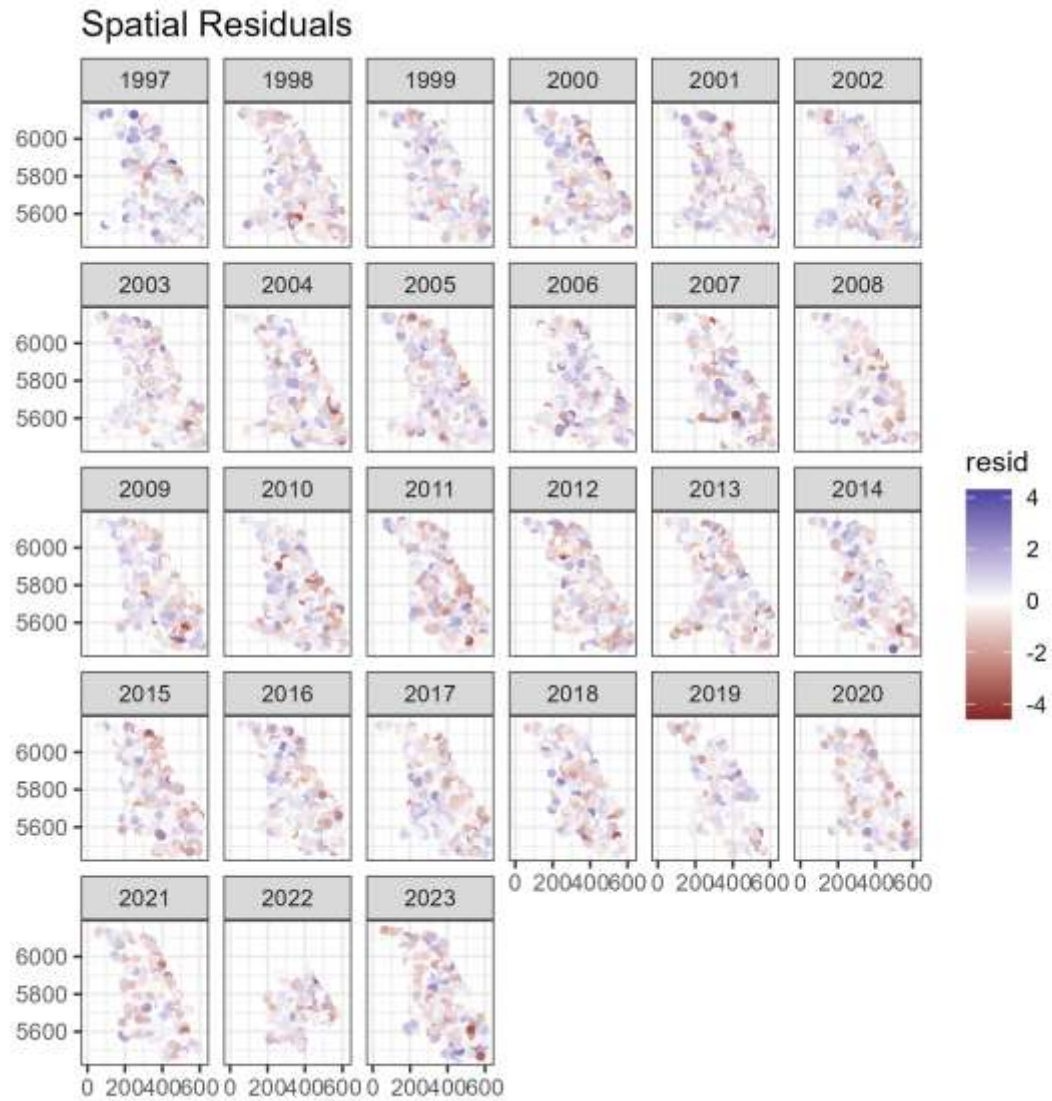


Figure A15. Spatial residuals calculated using MCMC for model examining density of catch of Planktivores in Div. 2J3K Fall.

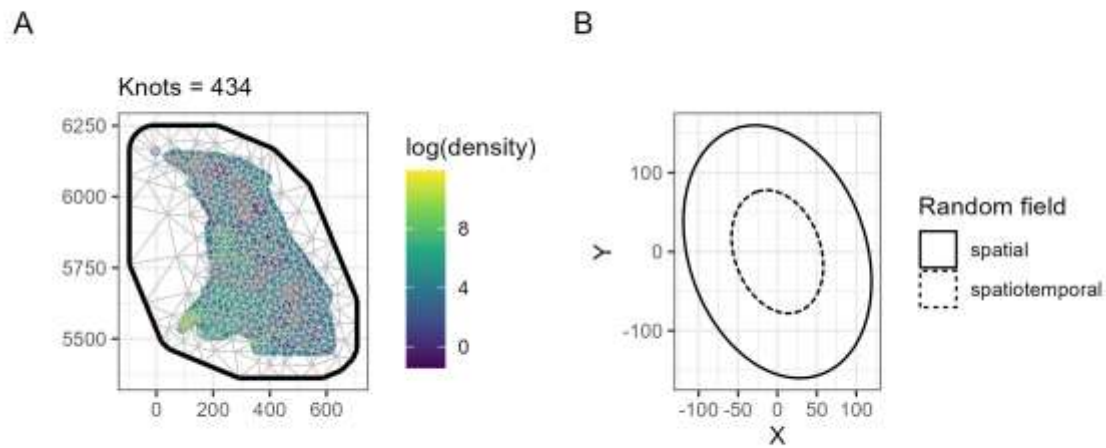


Figure A16. Mesh (A) and anisotropy (B) for model examining density of catch of Planktivores in Div. 2J3K Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

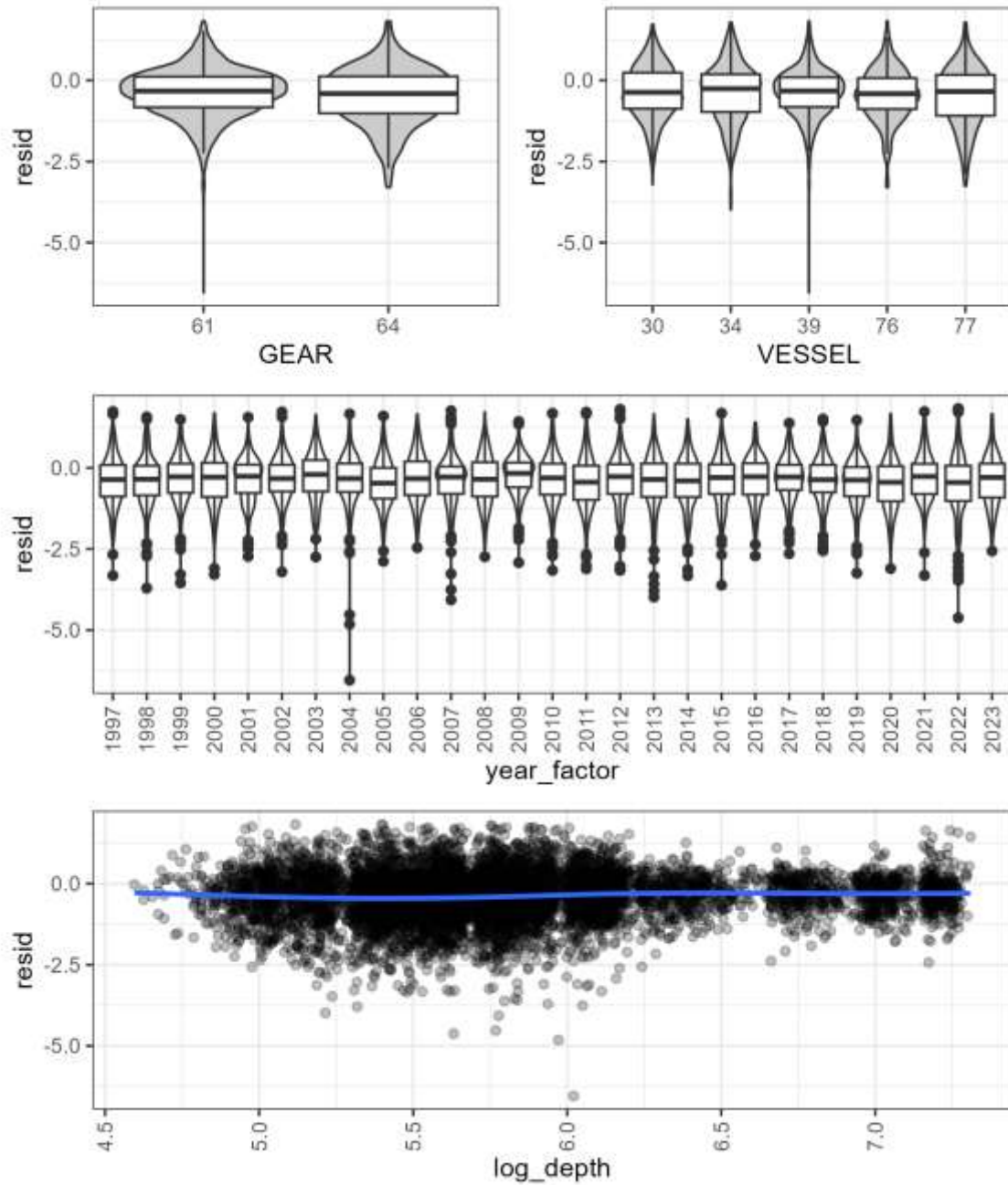


Figure A17. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Planktivores in Div. 2J3K Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

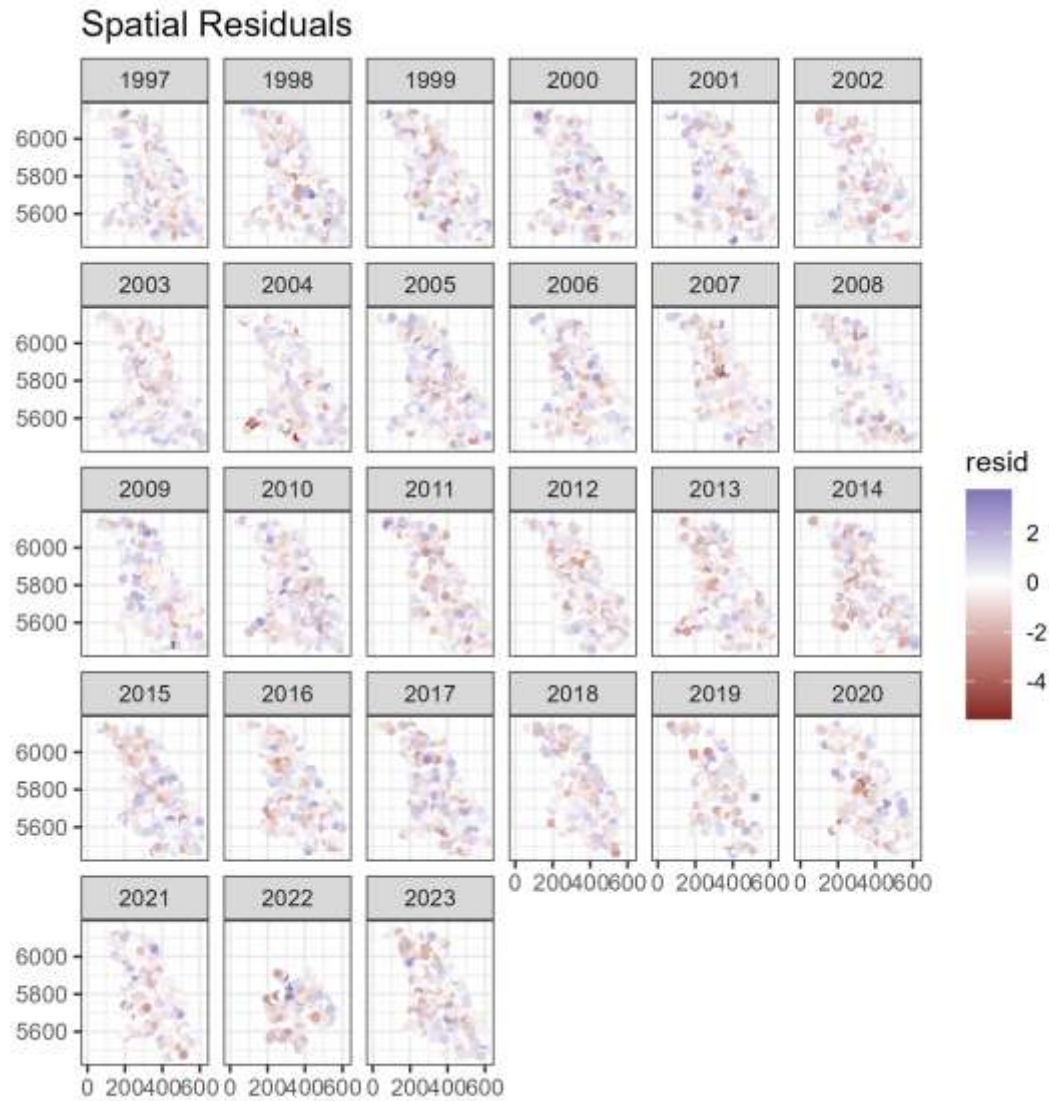


Figure A18. Spatial residuals calculated using MCMC for model examining density of catch of Planktivores in Div. 2J3K Fall.

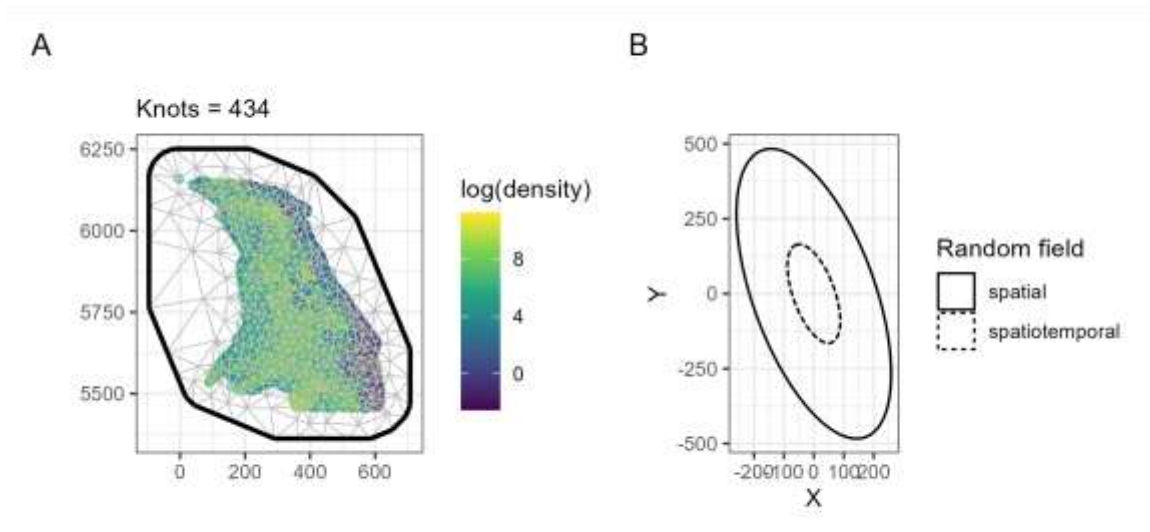


Figure A19. Mesh (A) and anisotropy (B) for model examining density of catch of Shellfish in Div. 2J3K Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

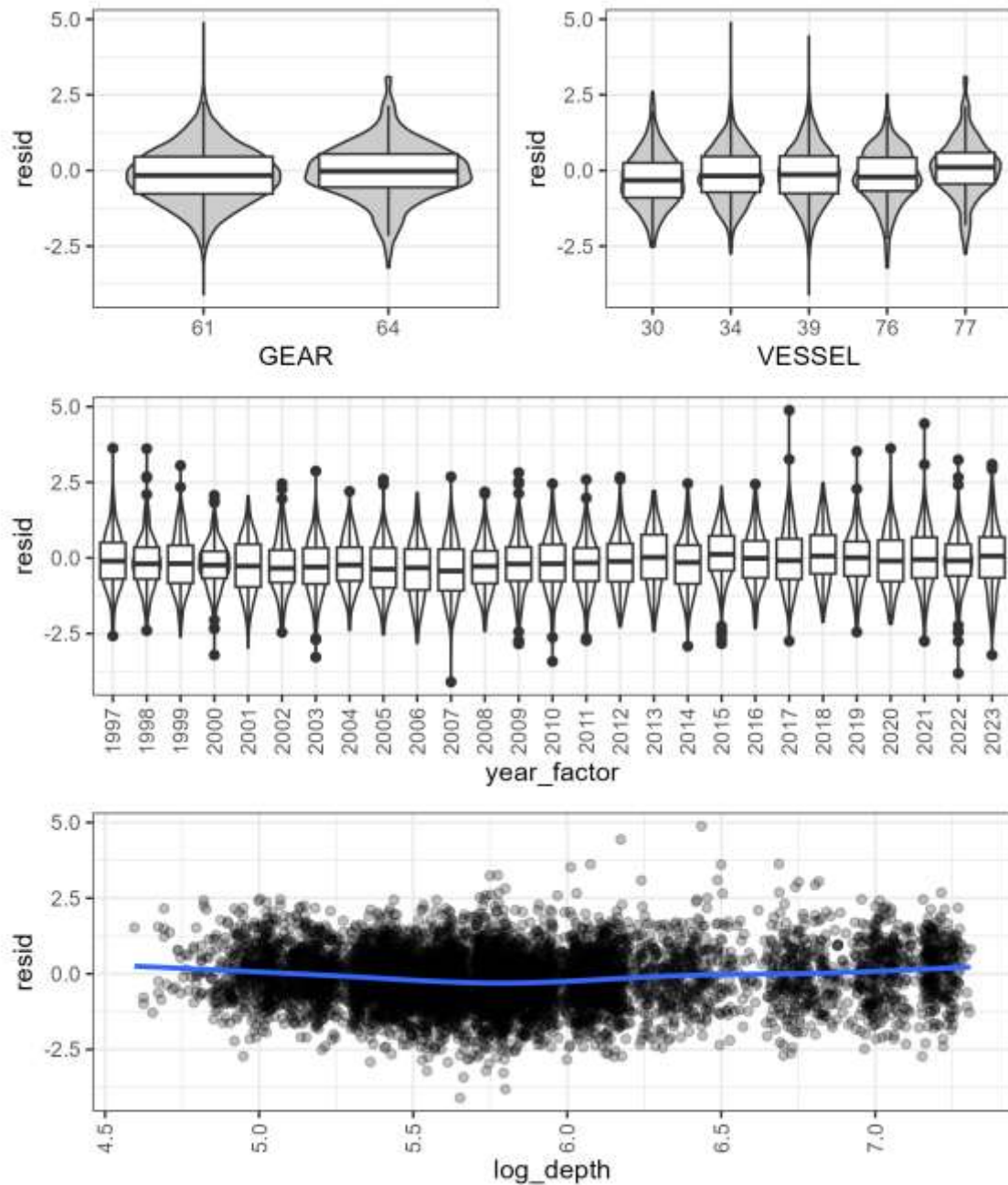


Figure A20. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Shellfish in Div. 2J3K Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals

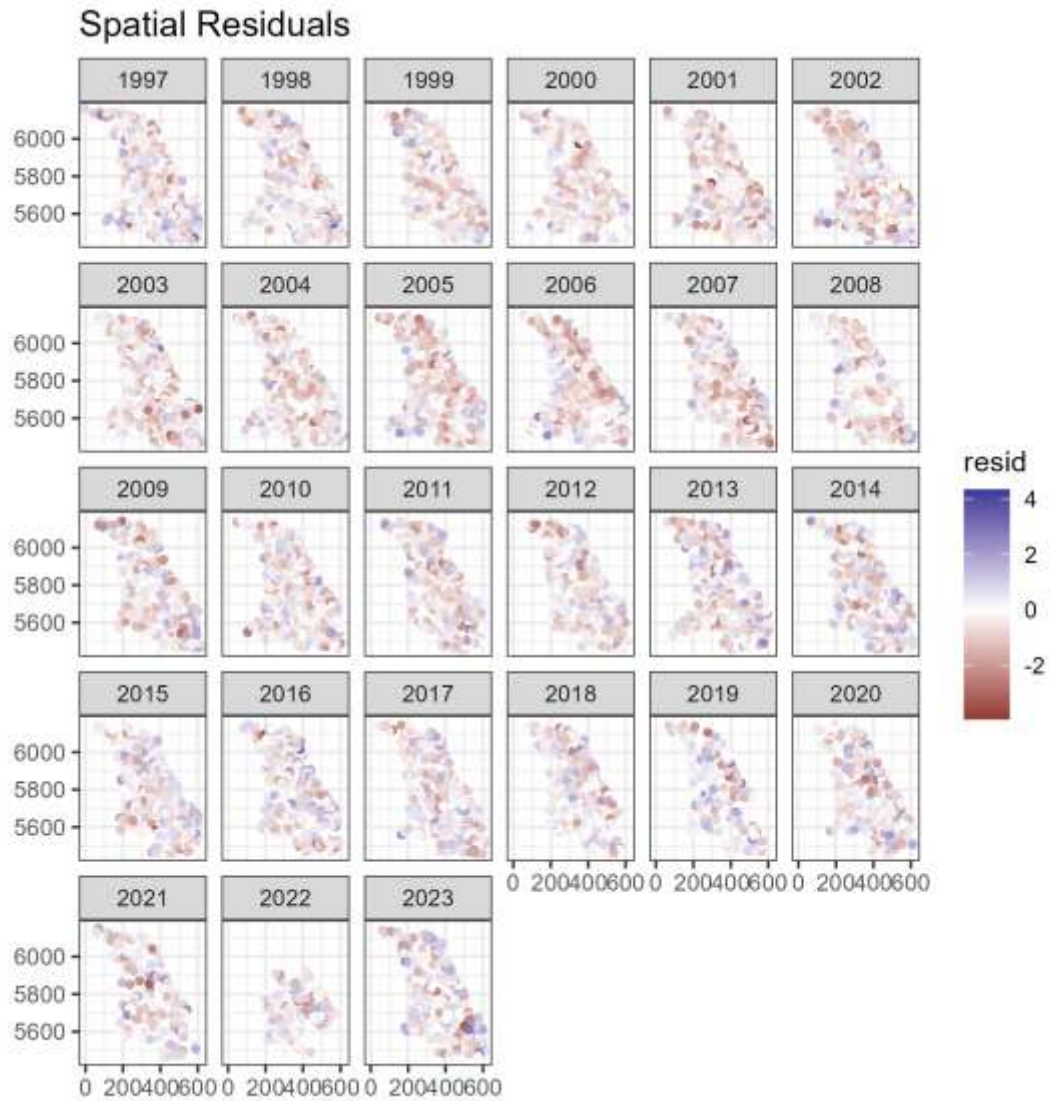


Figure A21. Spatial residuals calculated using MCMC for model examining density of catch of Shellfish in Div. 2J3K Fall.

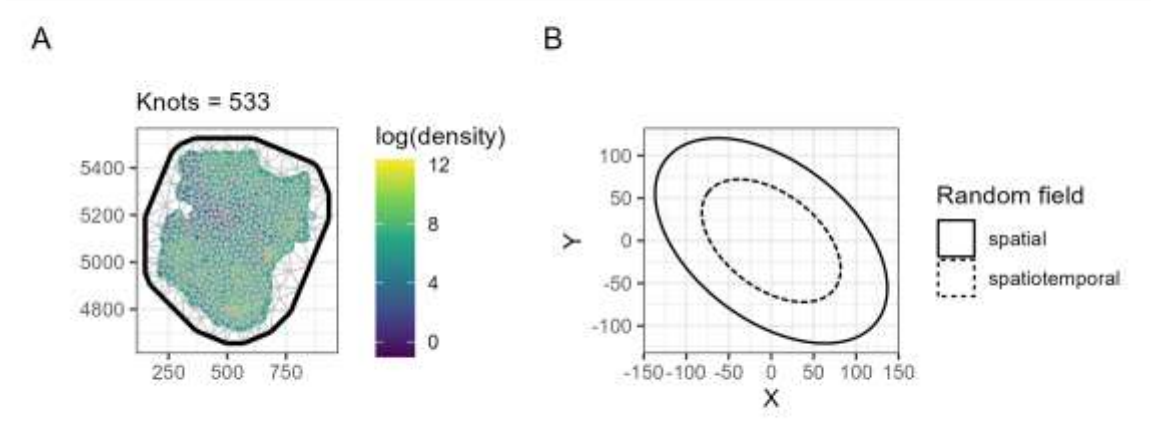


Figure A22. Mesh (A) and anisotropy (B) for model examining density of catch of Large Benthivores in Div. 3LNO Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

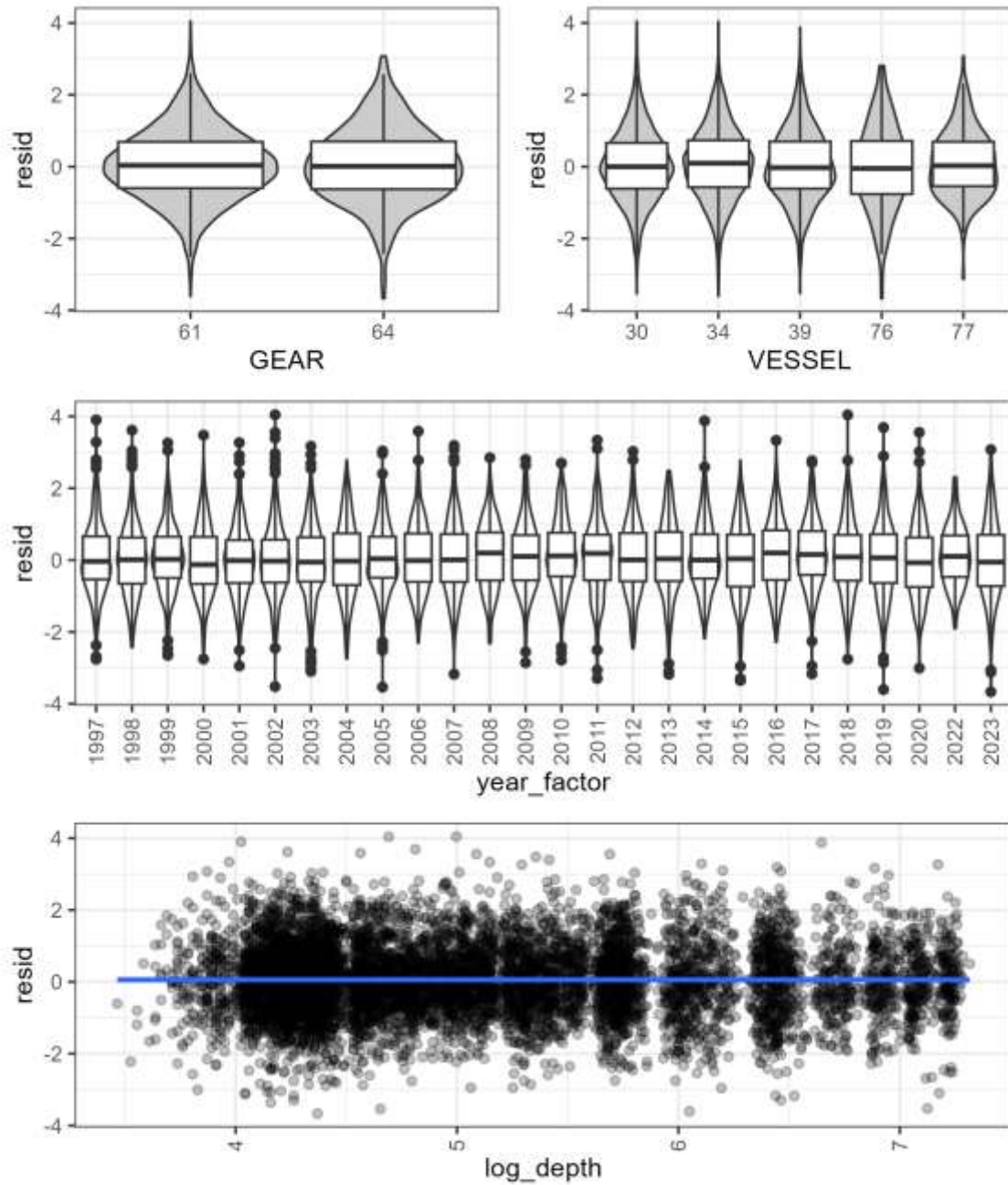


Figure A23. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Large Benthivores in Div. 3LNO Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

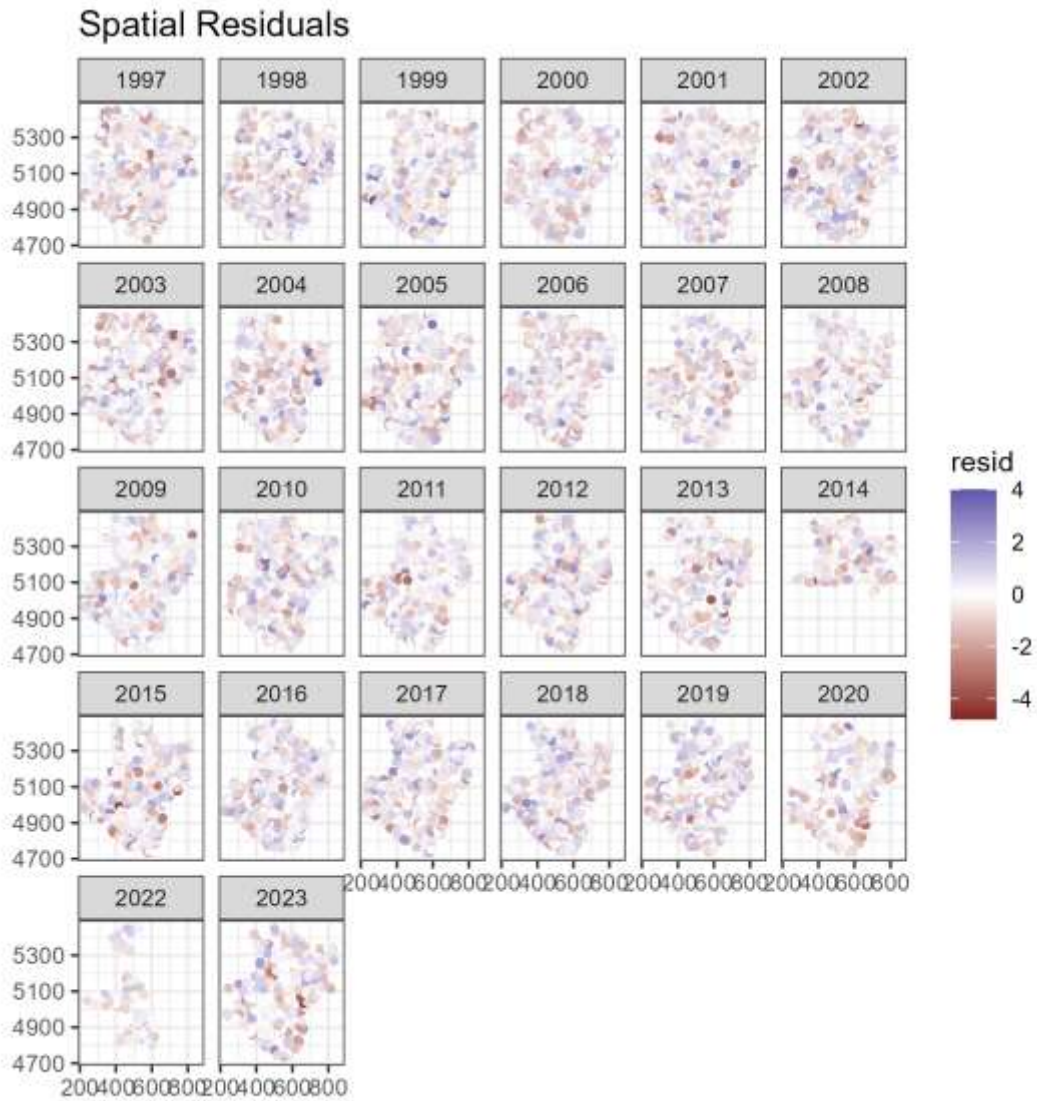


Figure A24. Spatial residuals calculated using MCMC for model examining density of catch of Large Benthivores in Div. 3LNO Fall.

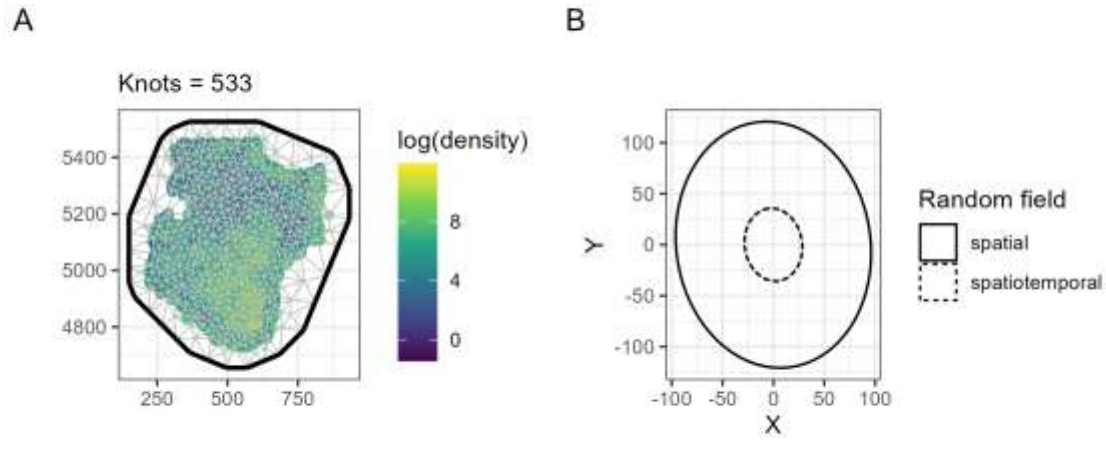


Figure A25. Mesh (A) and anisotropy (B) for model examining density of catch of Medium Benthivores in Div. 3LNO Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

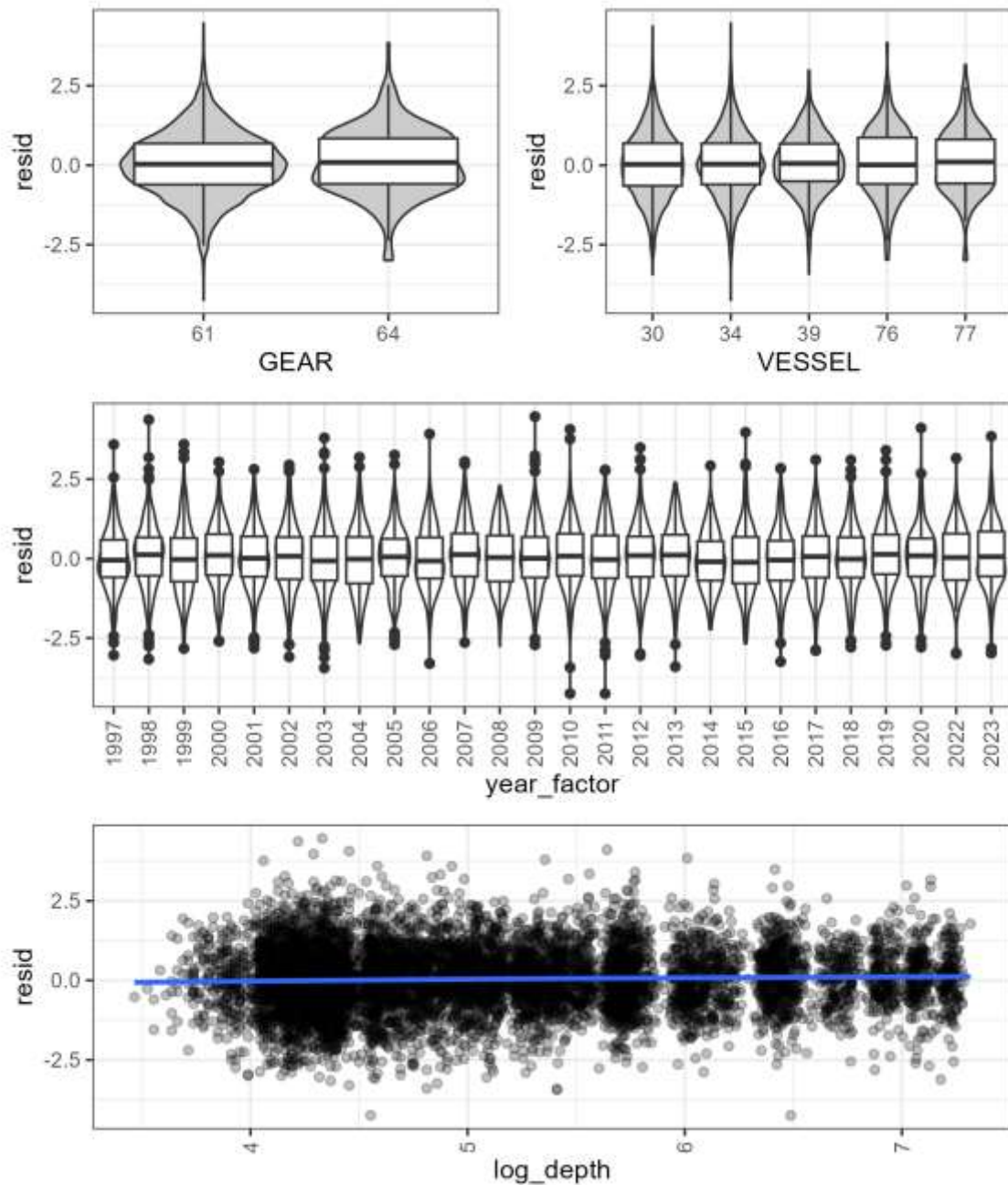


Figure A26. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Medium Benthivores in Div. 3LNO Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals

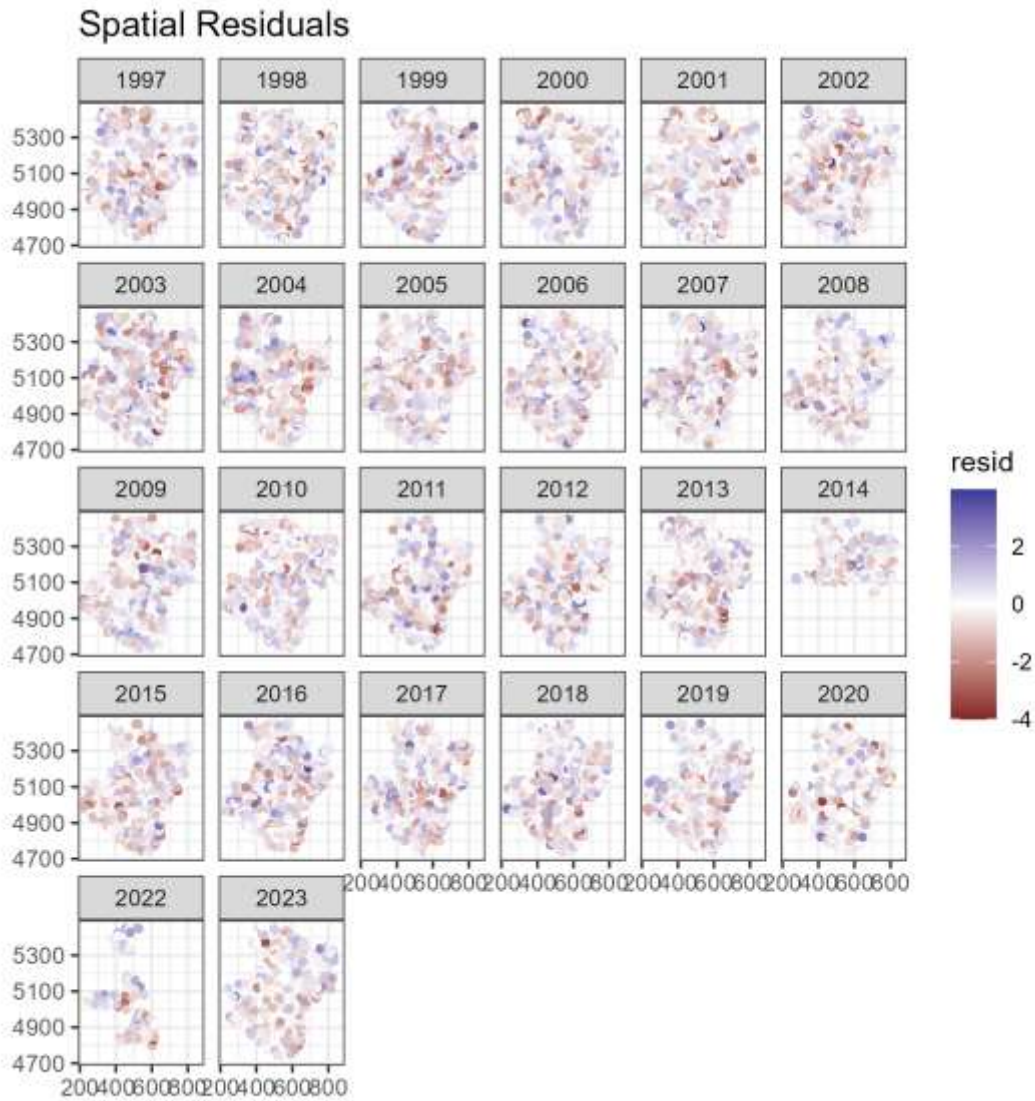


Figure A27. Spatial residuals calculated using MCMC for model examining density of catch of Medium Benthivores in Div. 3LNO Fall.

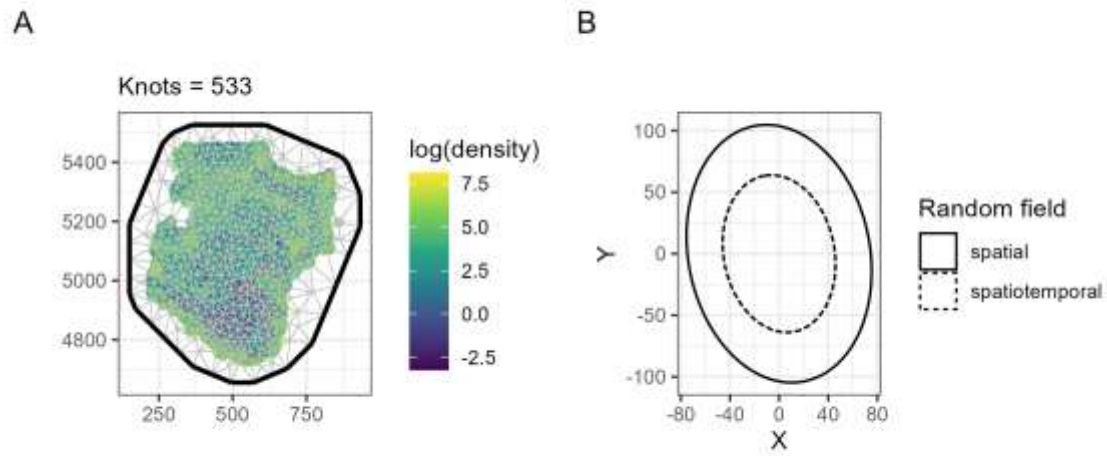


Figure A28. Mesh (A) and anisotropy (B) for model examining density of catch of Small Benthivores in Div. 3LNO Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

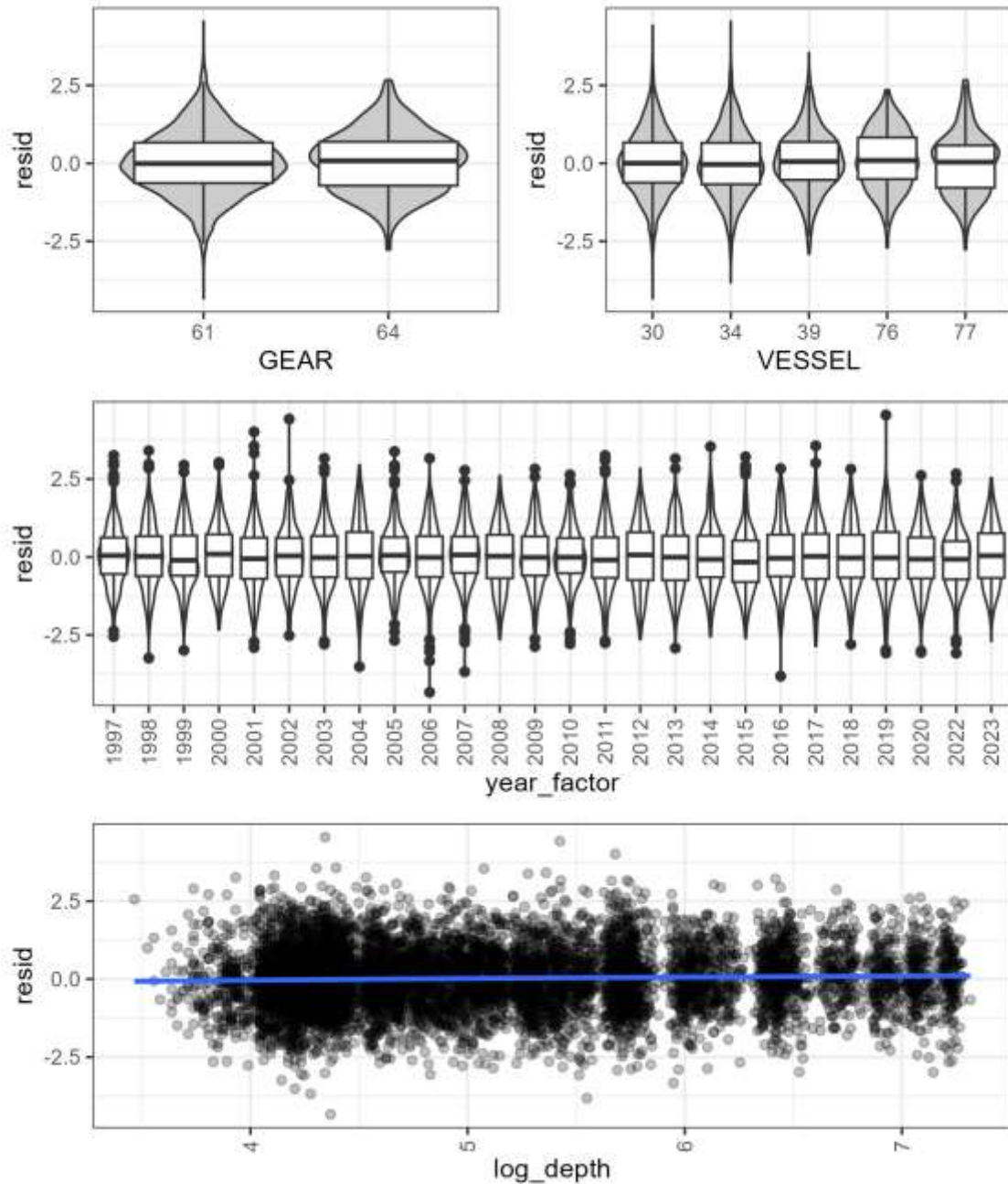


Figure A29. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Small Benthivores in Div. 3LNO Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals

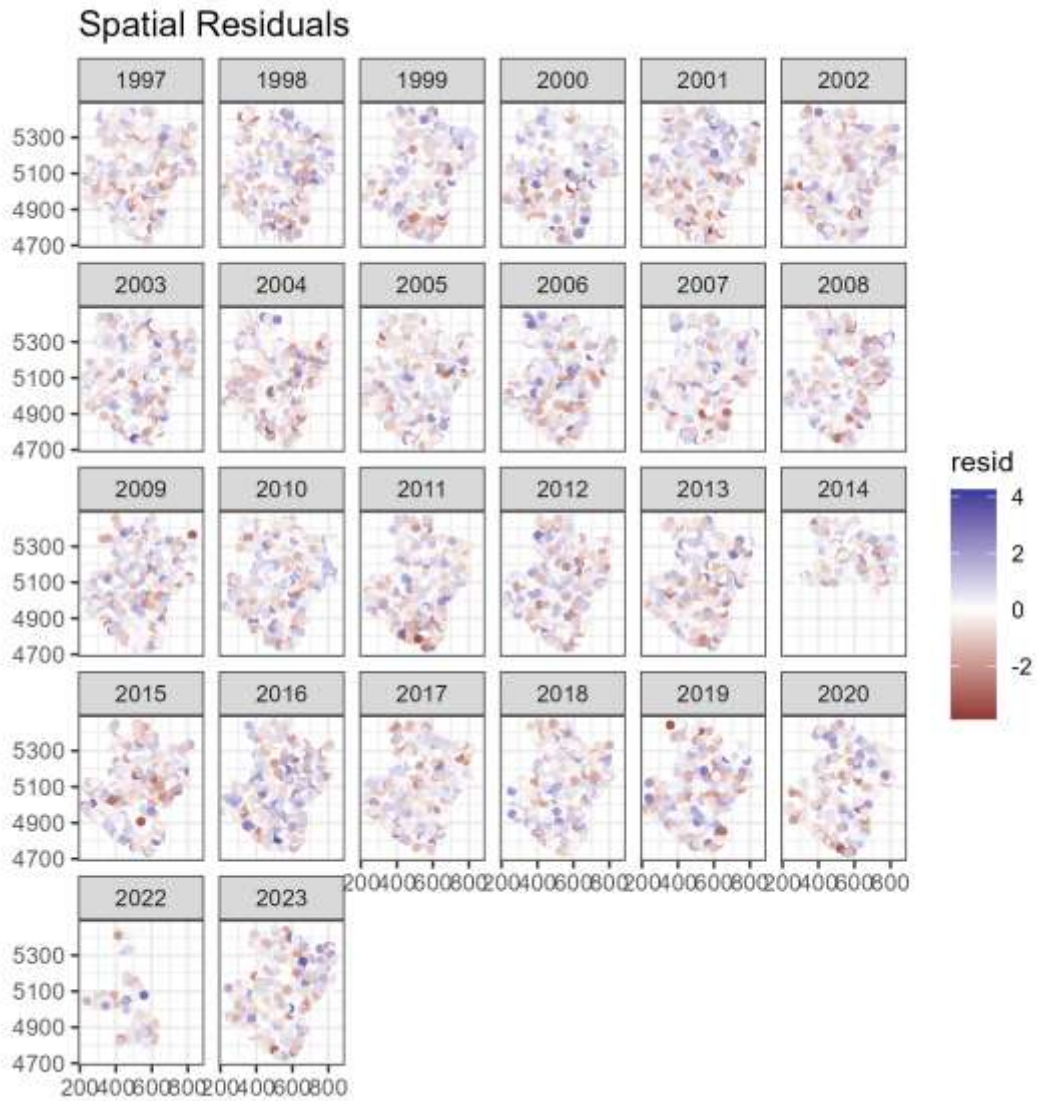


Figure A30. Spatial residuals calculated using MCMC for model examining density of catch of Small Benthivores in Div. 3LNO Fall.

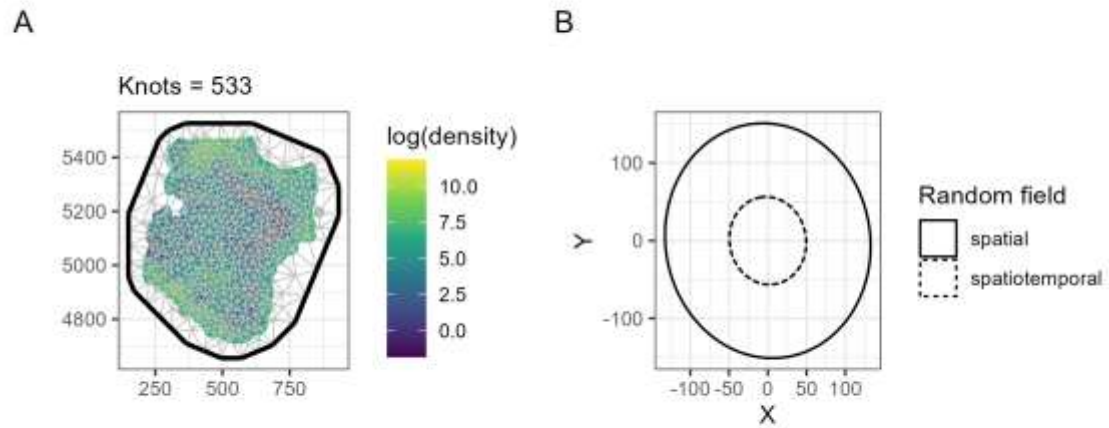


Figure A31. Mesh (A) and anisotropy (B) for model examining density of catch of Piscivores in Div. 3LNO Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

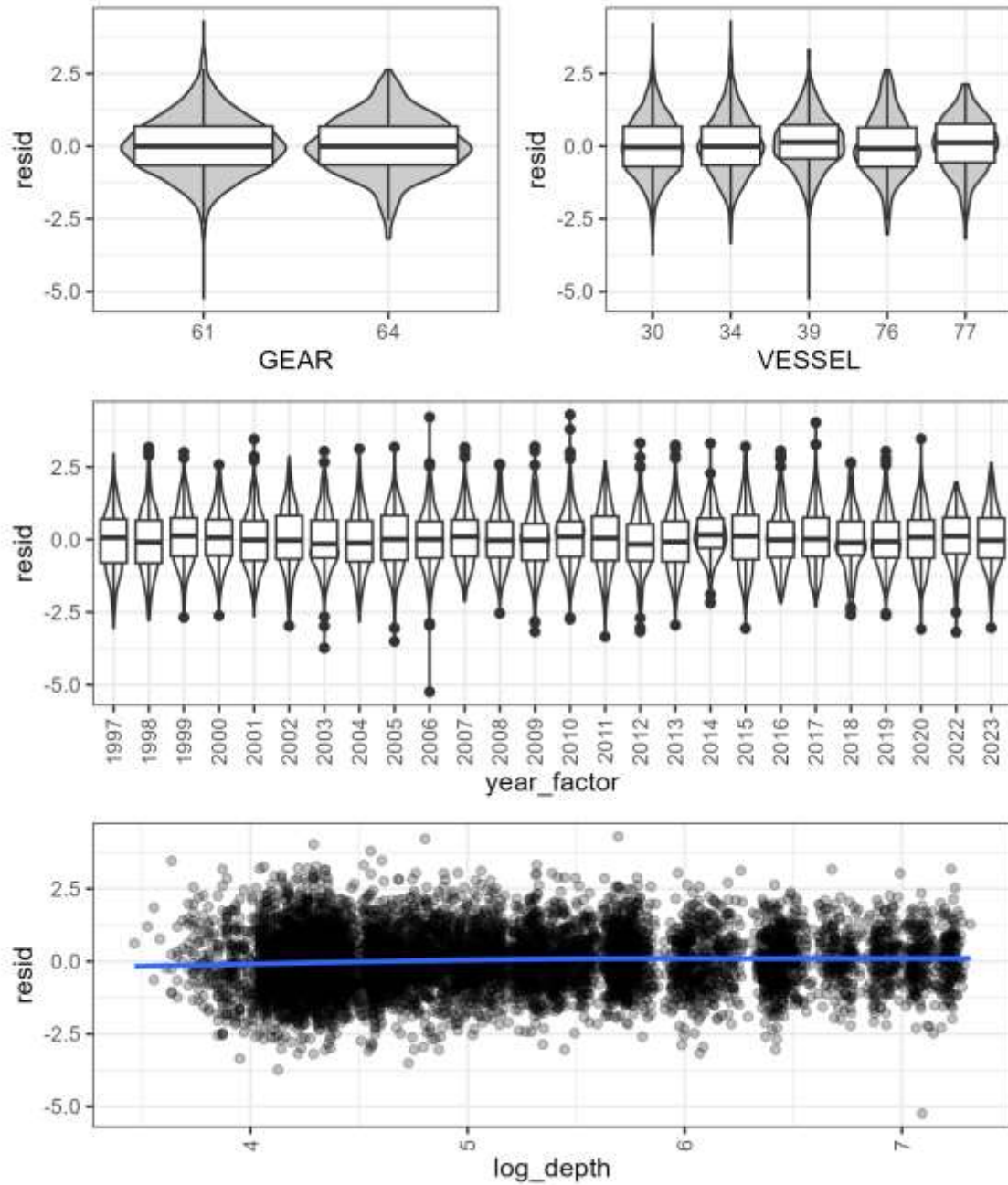


Figure A32. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Piscivores in Div. 3LNO Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals

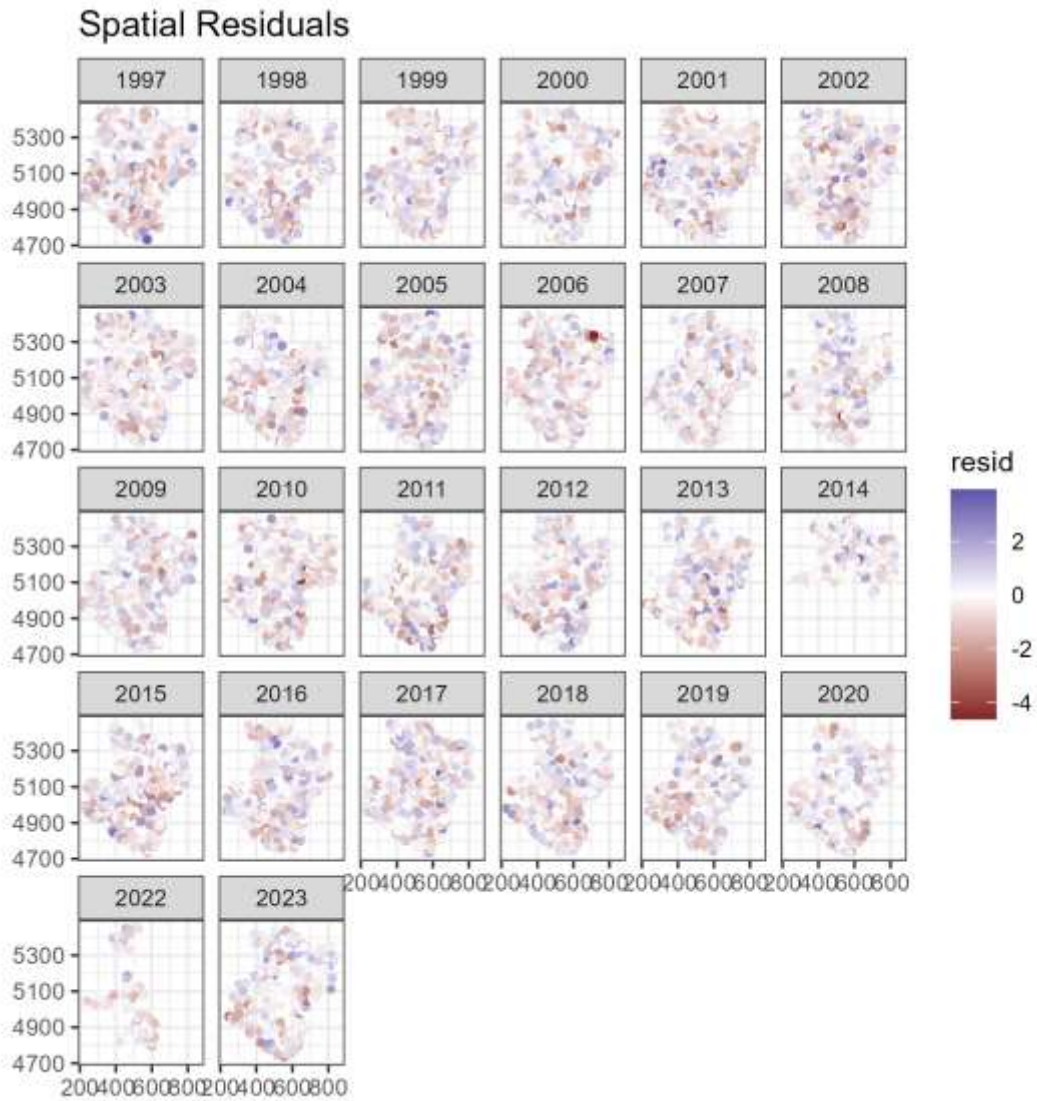


Figure A33. Spatial residuals calculated using MCMC for model examining density of catch of Piscivores in Div. 3LNO Fall.

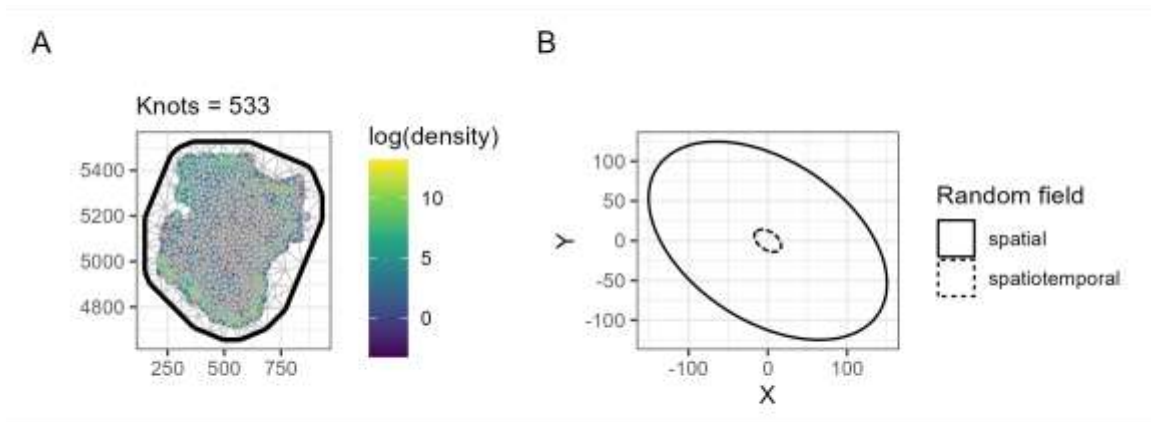


Figure A34. Mesh (A) and anisotropy (B) for model examining density of catch of Planktivores in Div. 3LNO Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

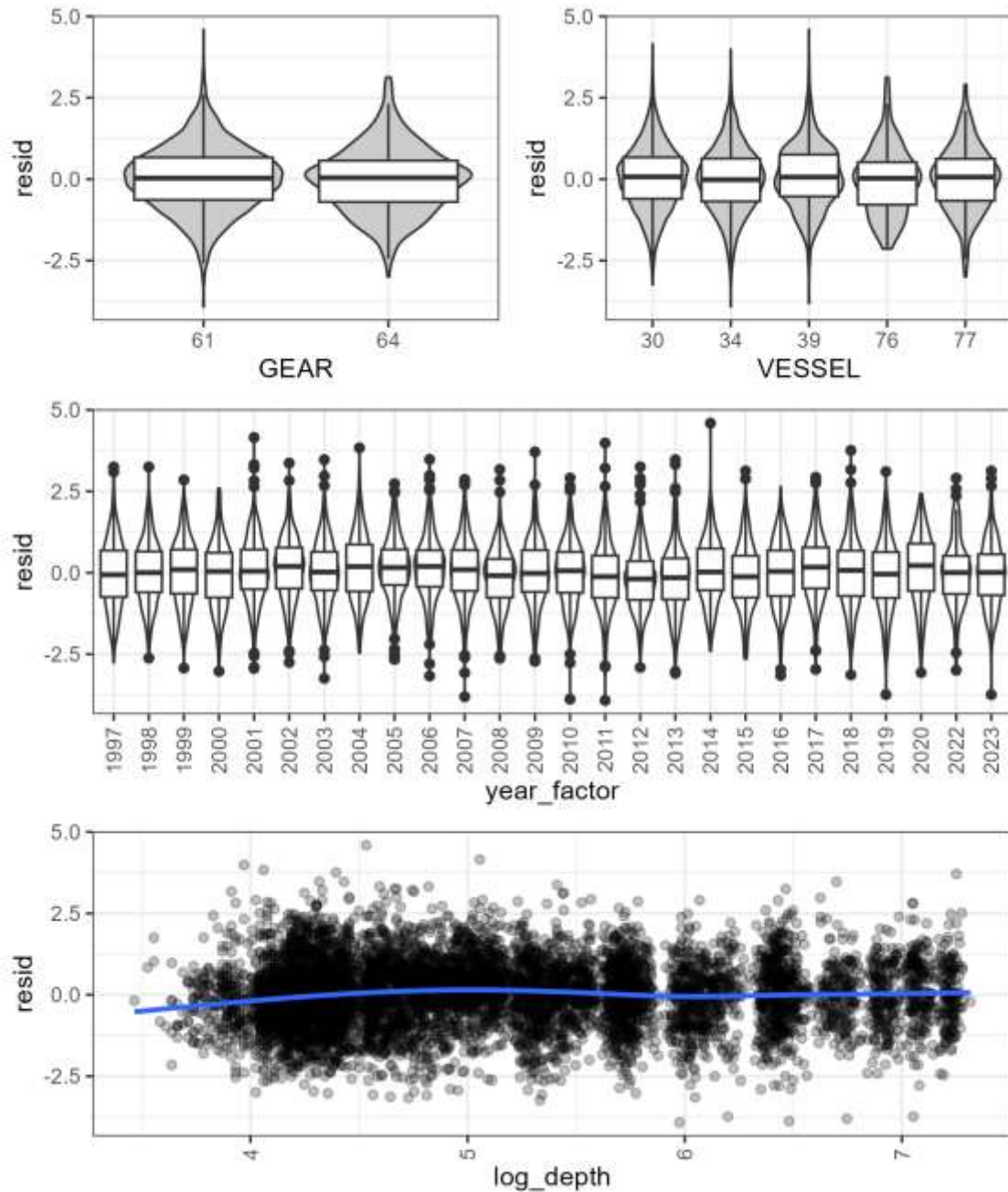


Figure A35. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Planktivores in Div. 3LNO Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

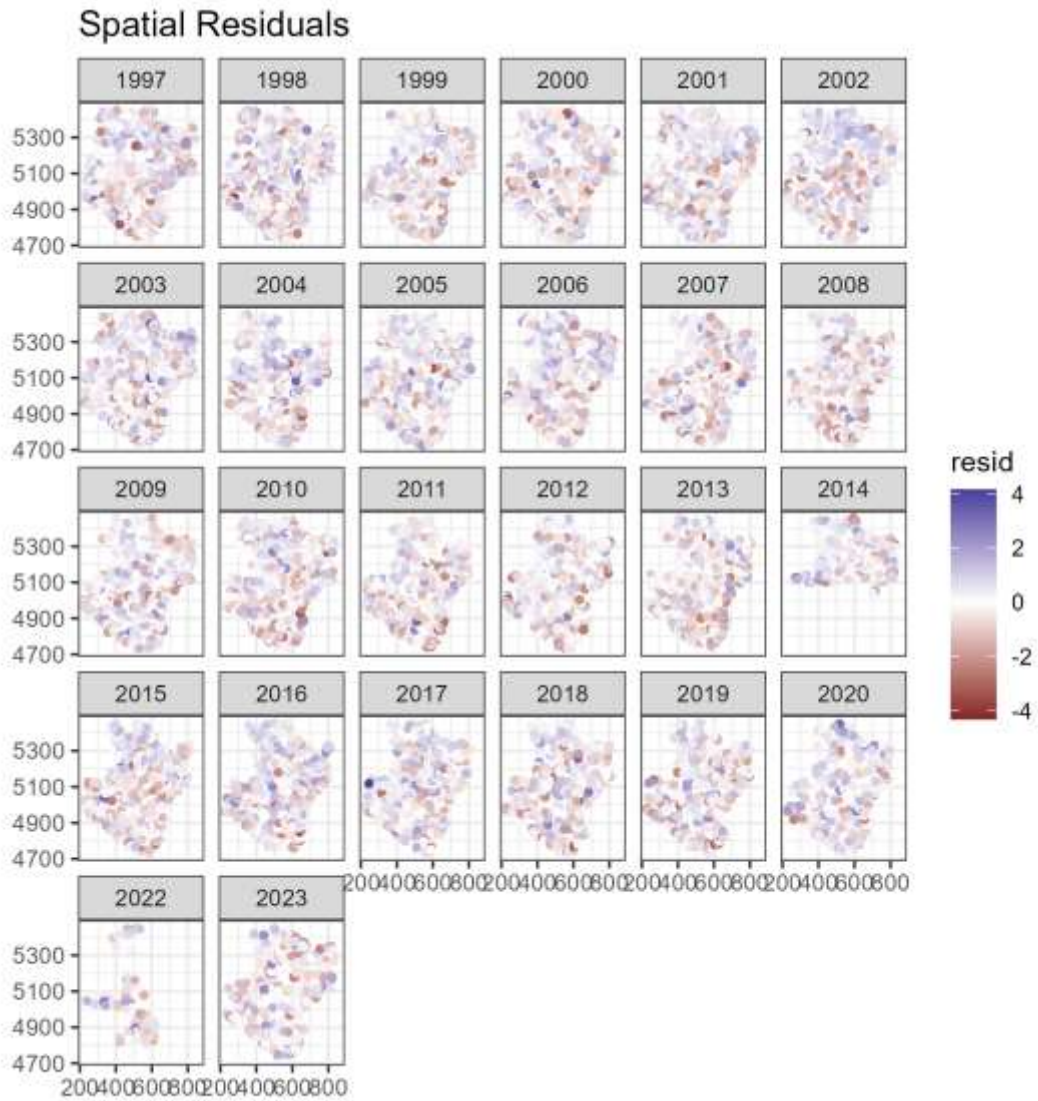


Figure A36. Spatial residuals calculated using MCMC for model examining density of catch of Planktivores in Div. 3LNO Fall.

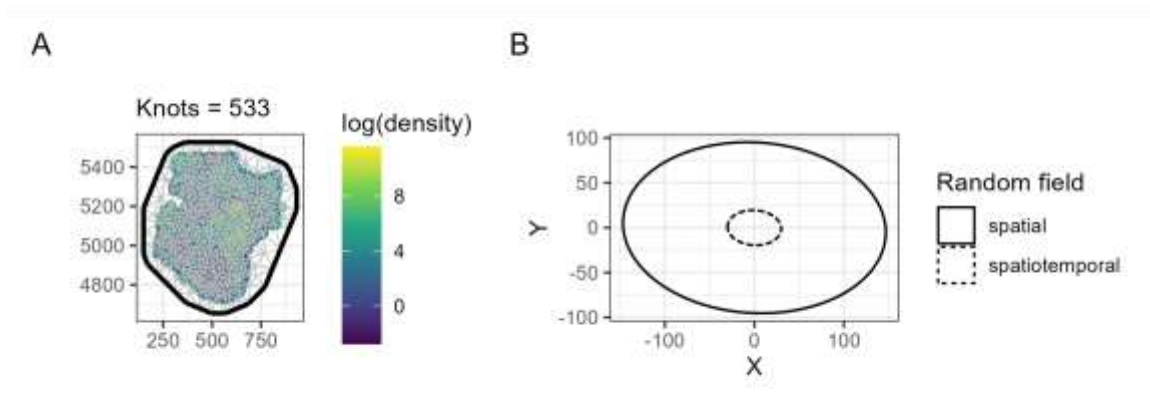


Figure A37. Mesh (A) and anisotropy (B) for model examining density of catch of Planktivores in Div. 3LNO Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

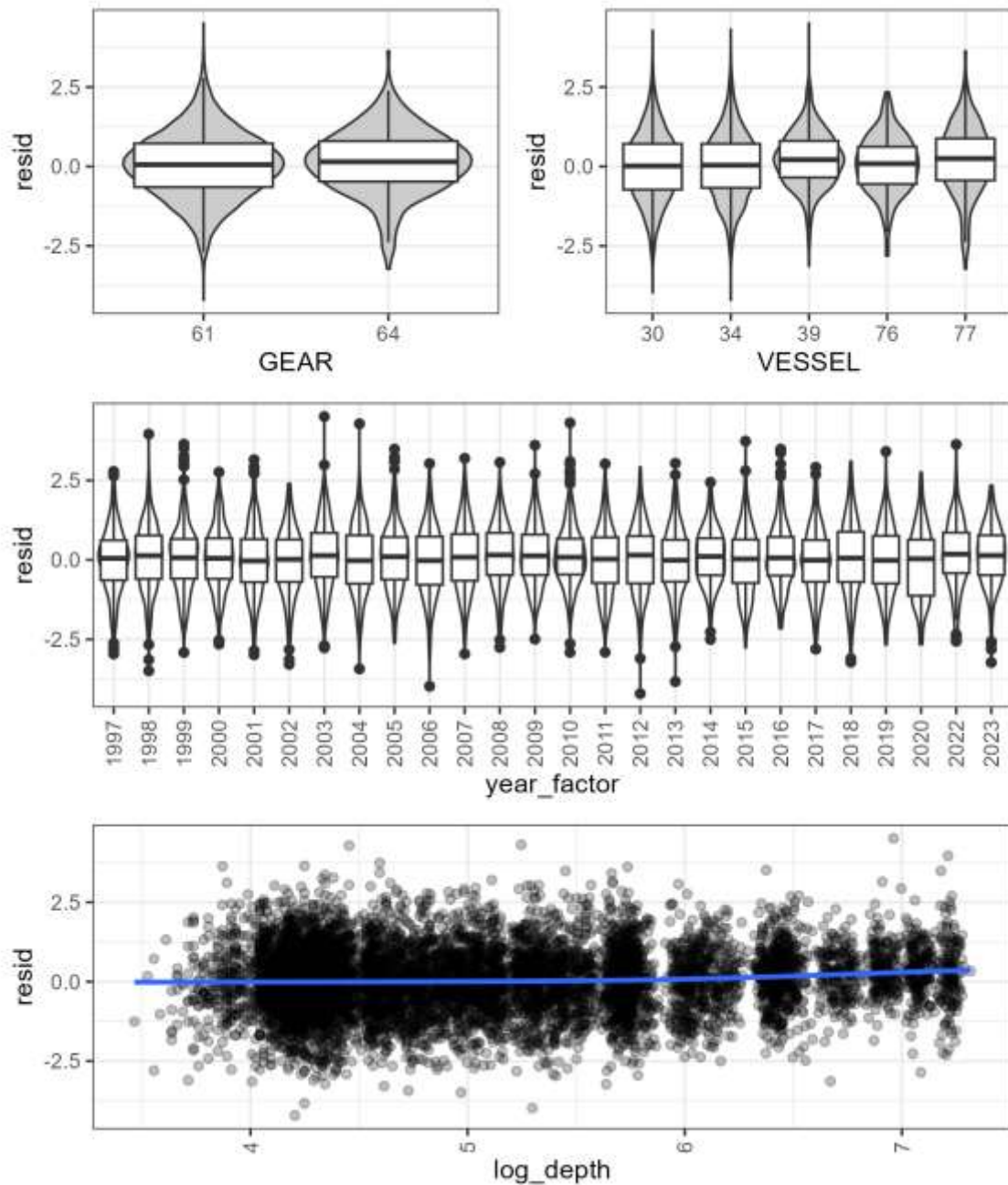


Figure A38. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Planktivores in Div. 3LNO Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residual .

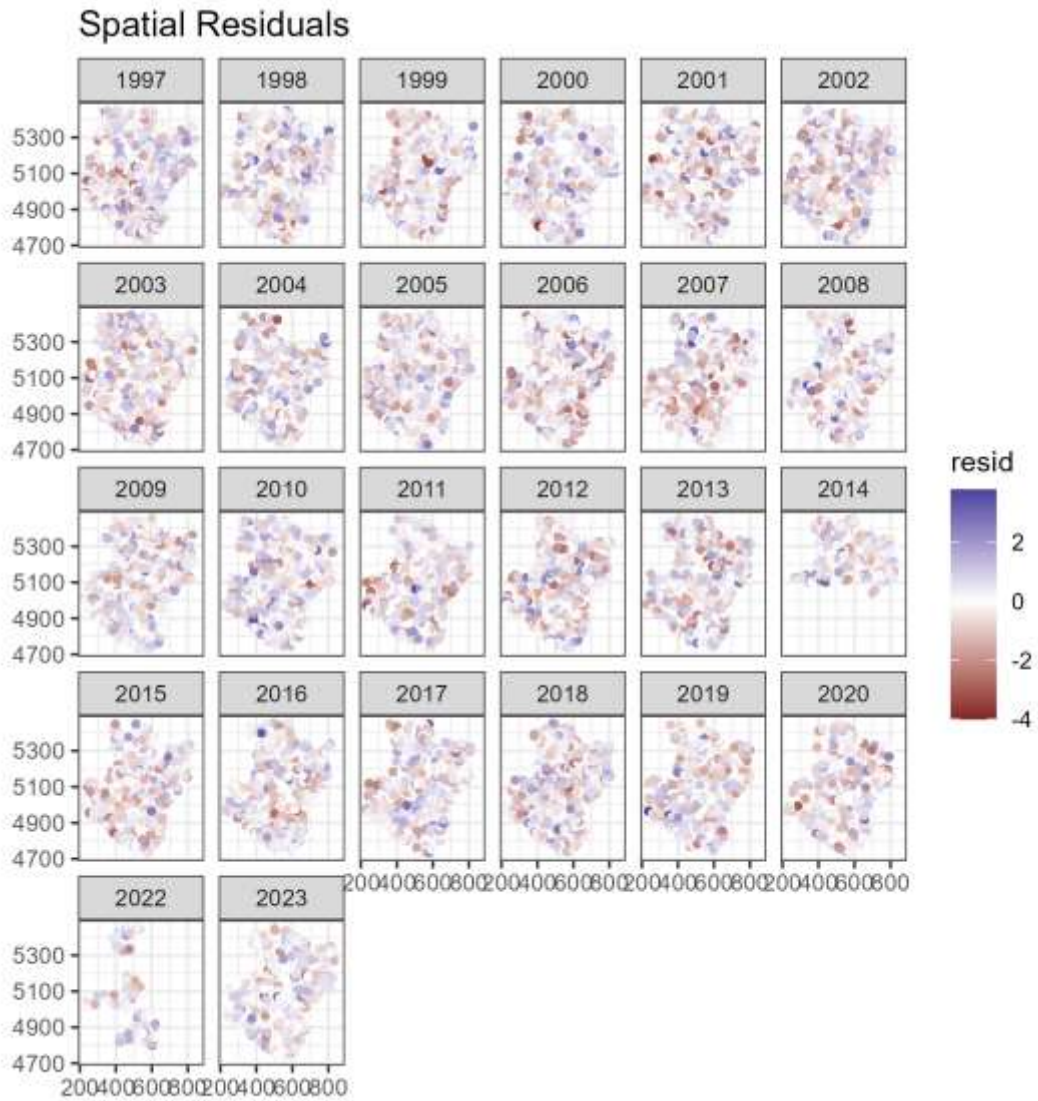


Figure A39. Spatial residuals calculated using MCMC for model examining density of catch of Planktivores in Div. 3LNO Fall.

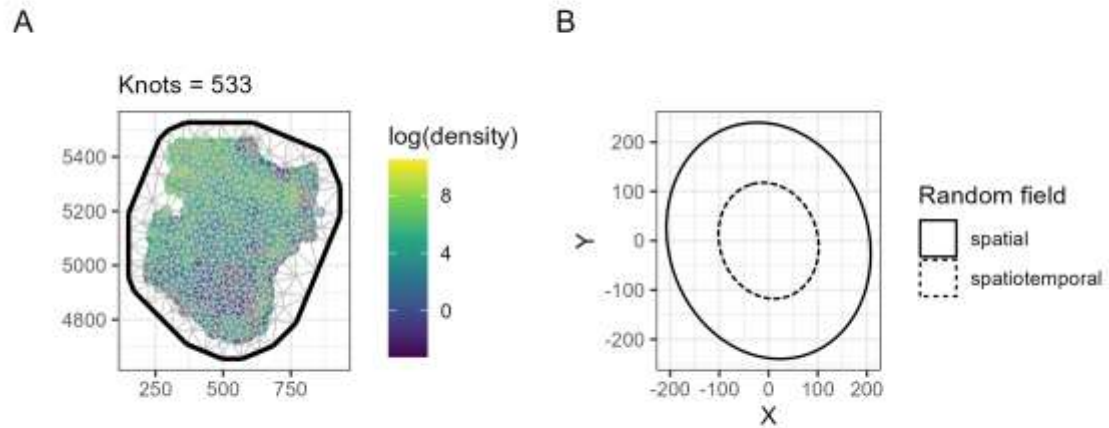


Figure A40. Mesh (A) and anisotropy (B) for model examining density of catch of Shellfish in Div. 3LNO Fall. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

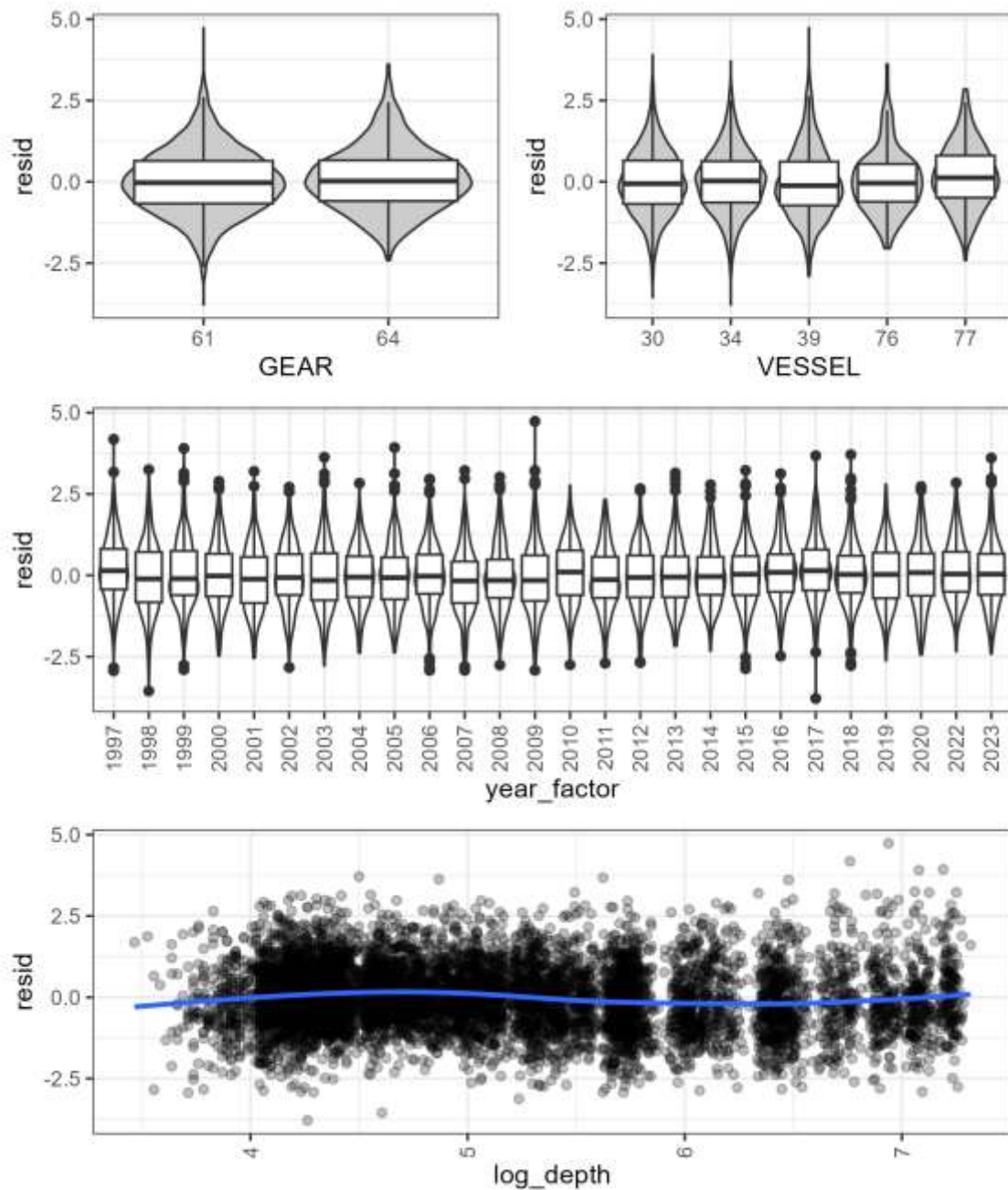


Figure A41. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Shellfish in Div. 3LNO Fall. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

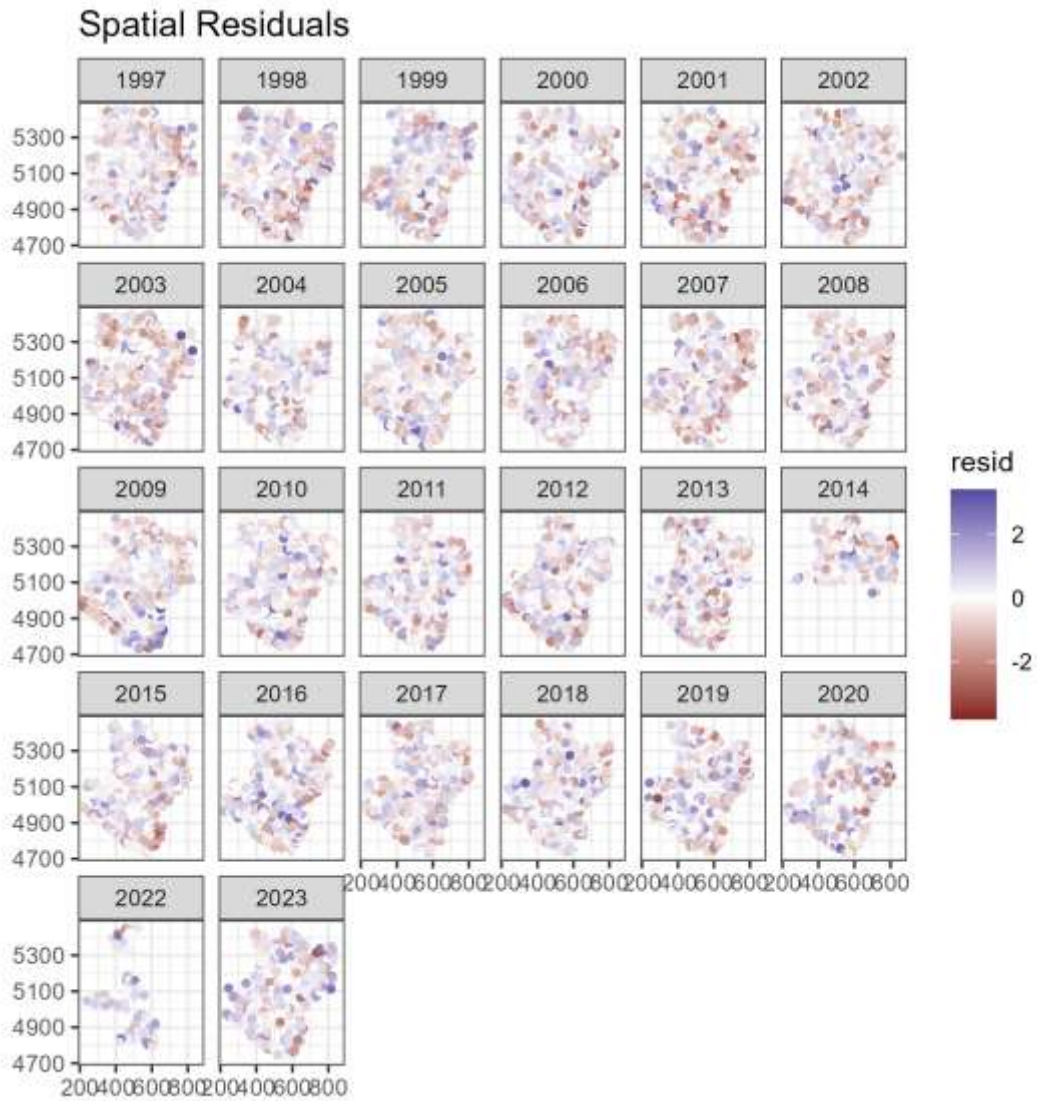


Figure A42. Spatial residuals calculated using MCMC for model examining density of catch of Shellfish in Div. 3LNO Fall.

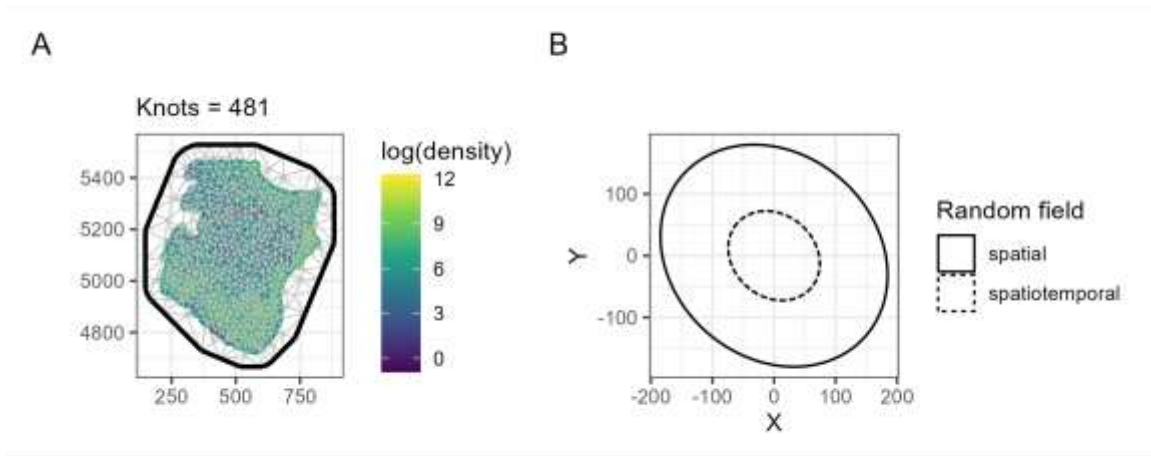


Figure A43. Mesh (A) and anisotropy (B) for model examining density of catch of Large Benthivores in Div. 3LNO Spring. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

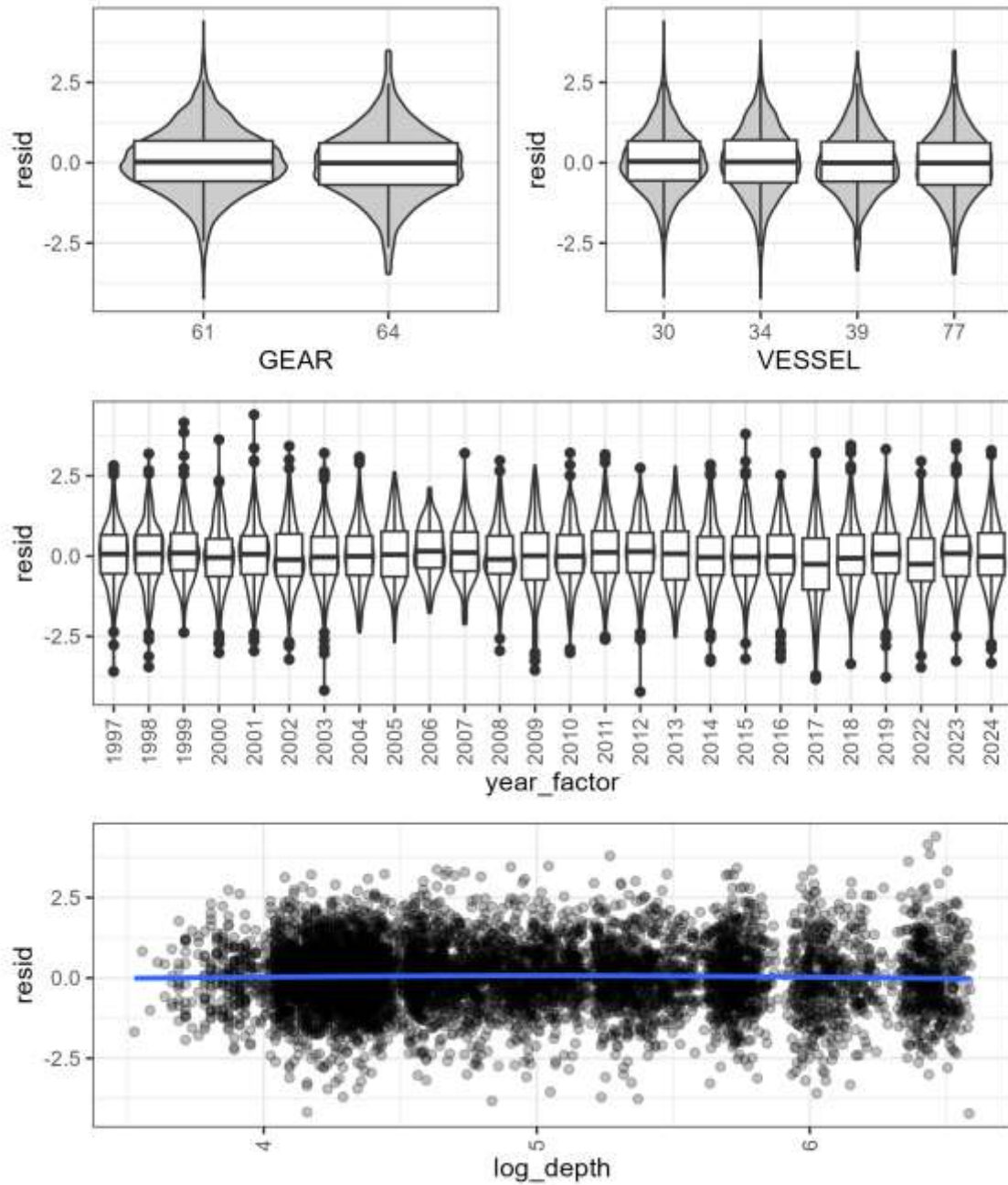


Figure A44. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Large Benthivores in Div. 3LNO Spring. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

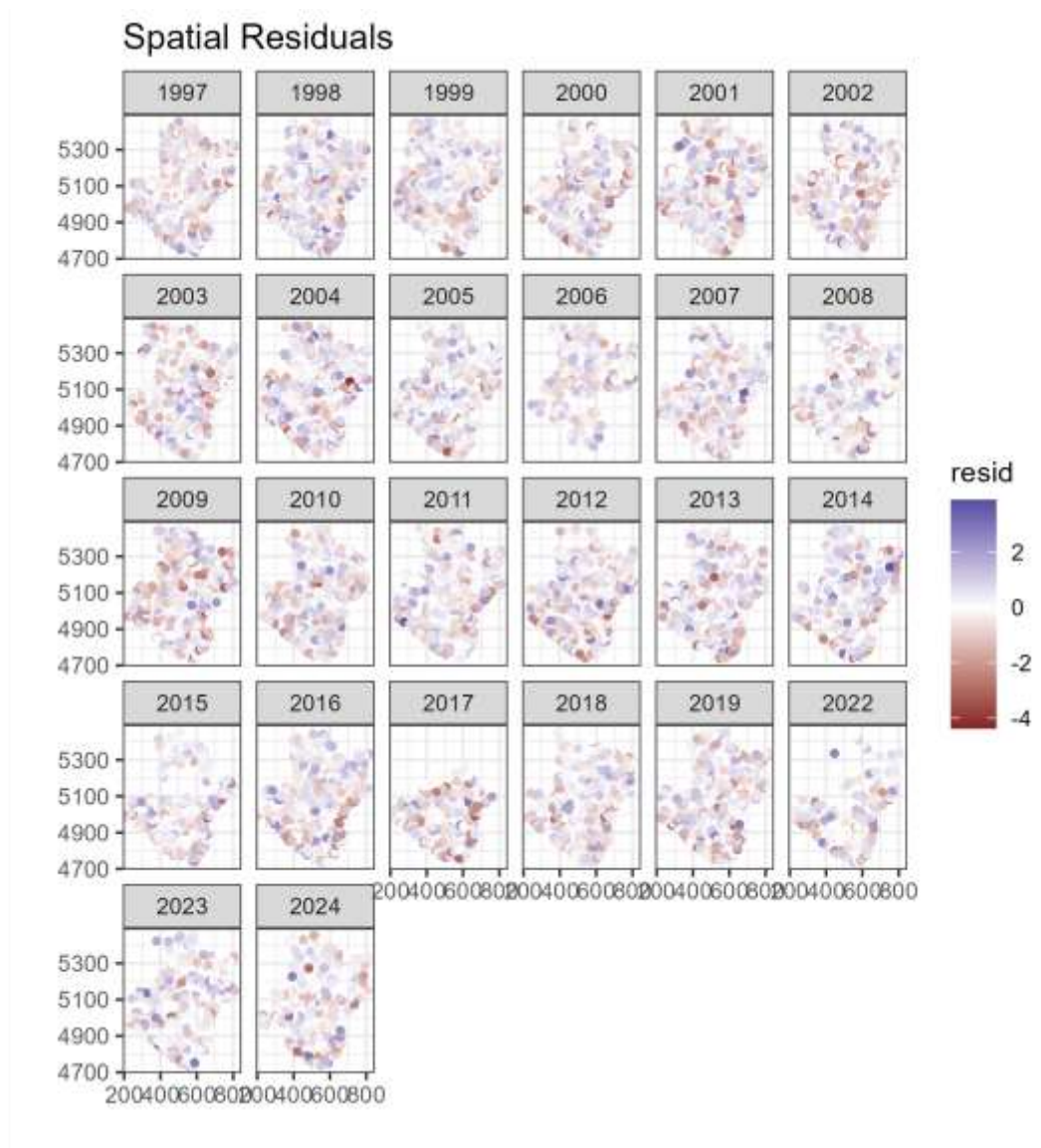


Figure A45. Spatial residuals calculated using MCMC for model examining density of catch of Large Benthivores in Div. 3LNO Spring.

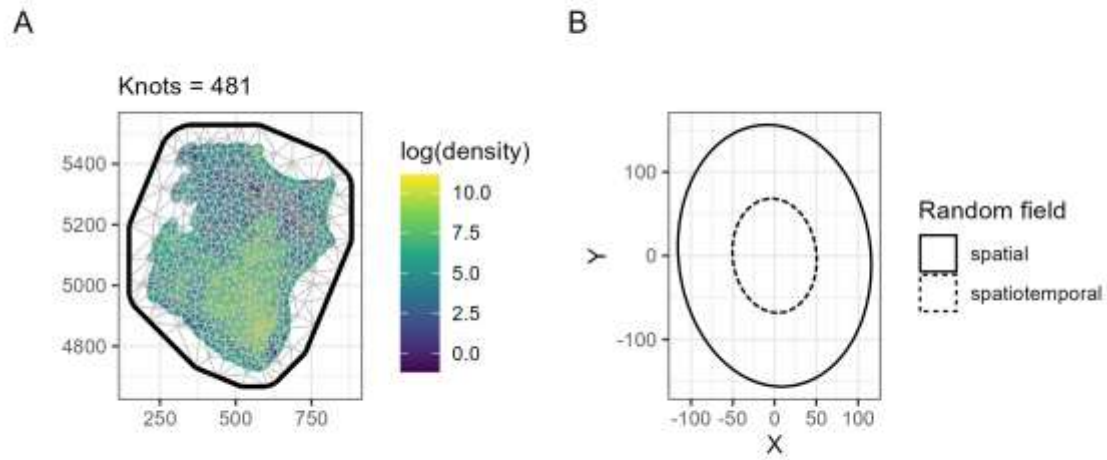


Figure A46. Mesh (A) and anisotropy (B) for model examining density of catch of Medium Benthivores in Div. 3LNO Spring. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

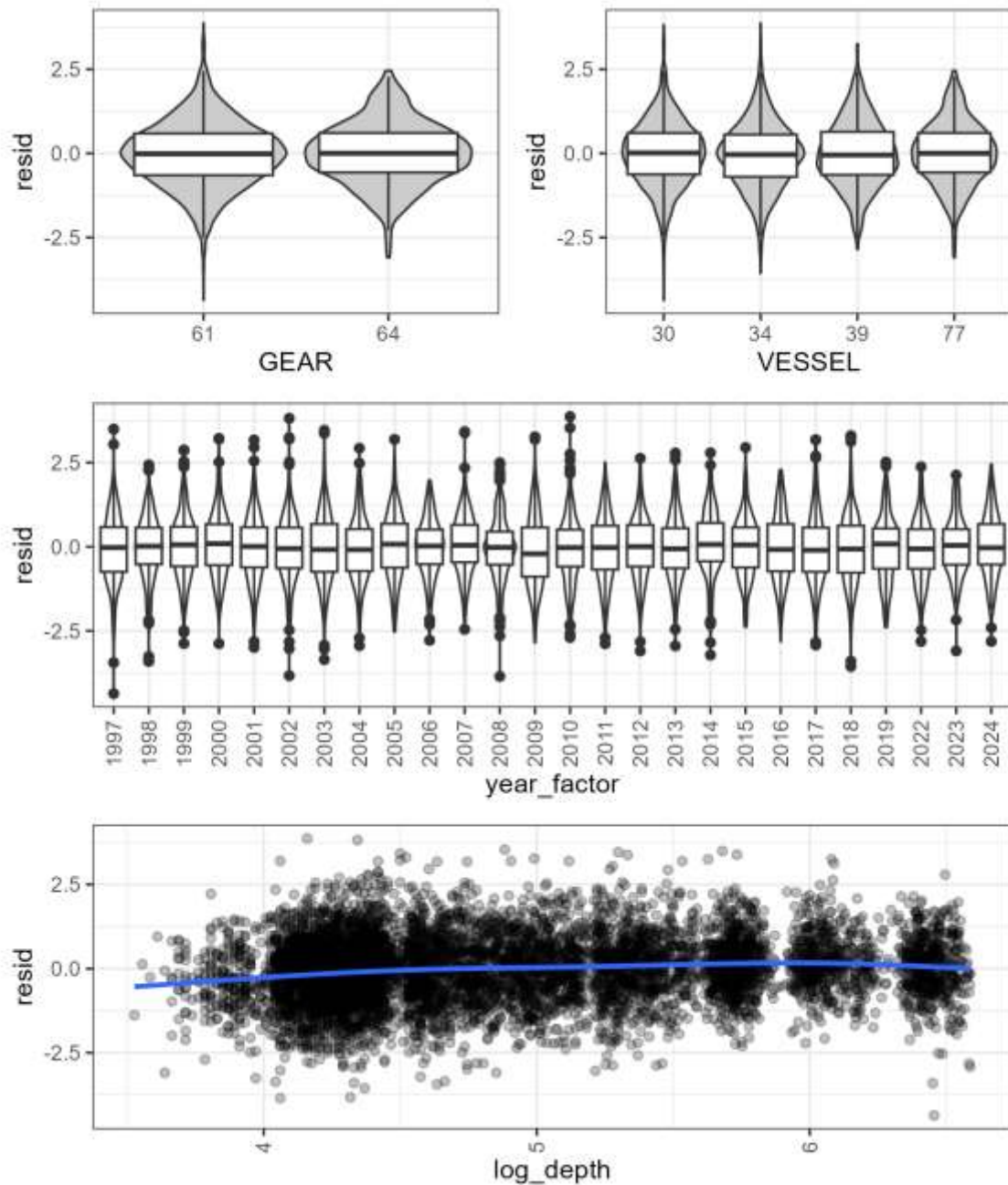


Figure A47. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Medium Benthivores in Div. 3LNO Spring. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

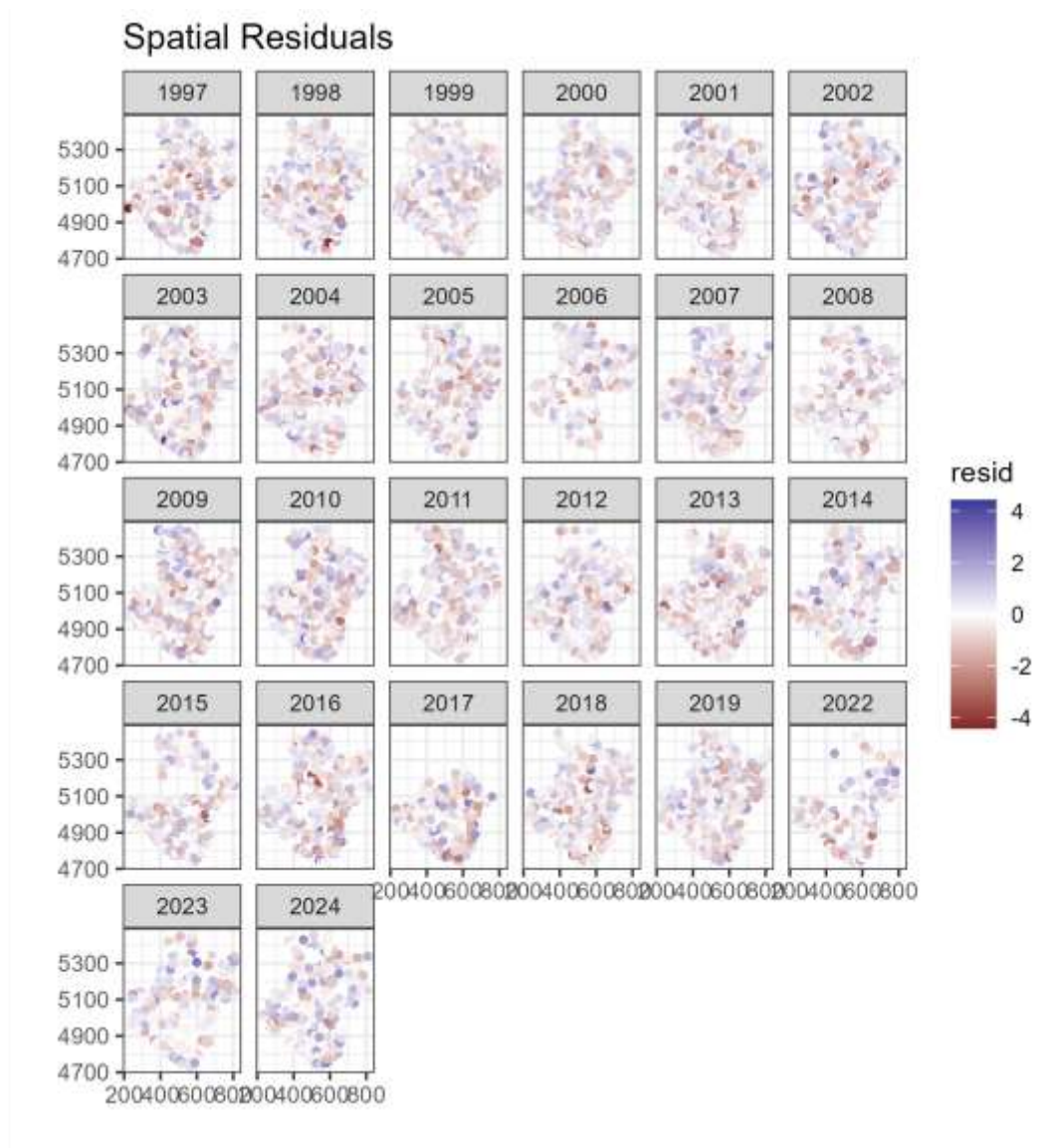


Figure A48. Spatial residuals calculated using MCMC for model examining density of catch of Medium Benthivores in Div. 3LNO Spring.

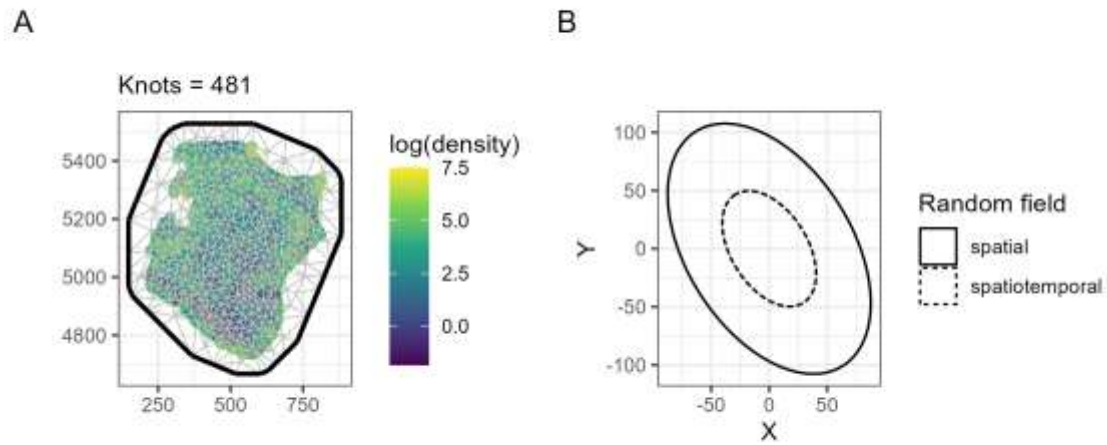


Figure A49. Mesh (A) and anisotropy (B) for model examining density of catch of Small Benthivores in Div. 3LNO Spring. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

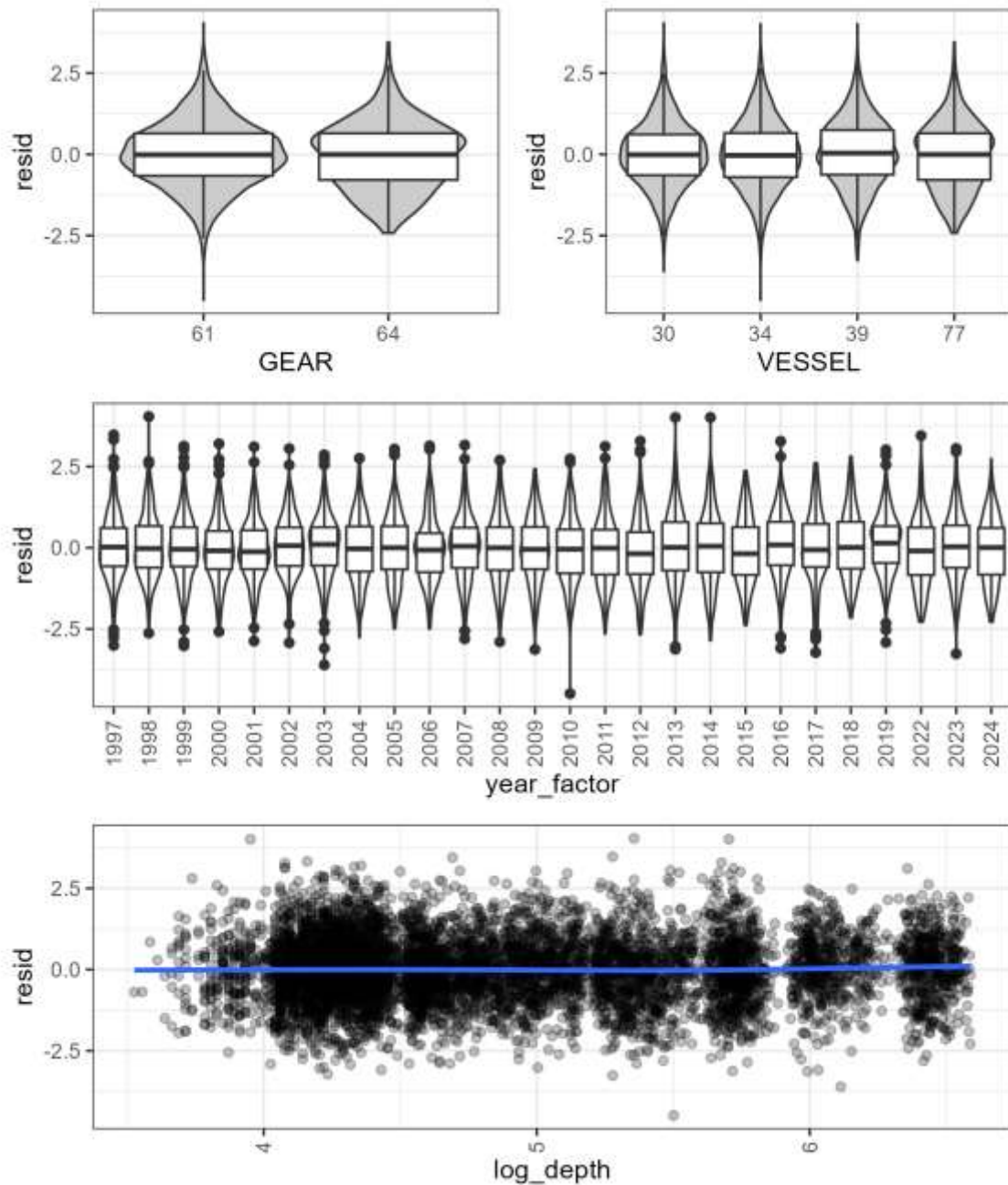


Figure A50. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Small Benthivores in Div. 3LNO Spring. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

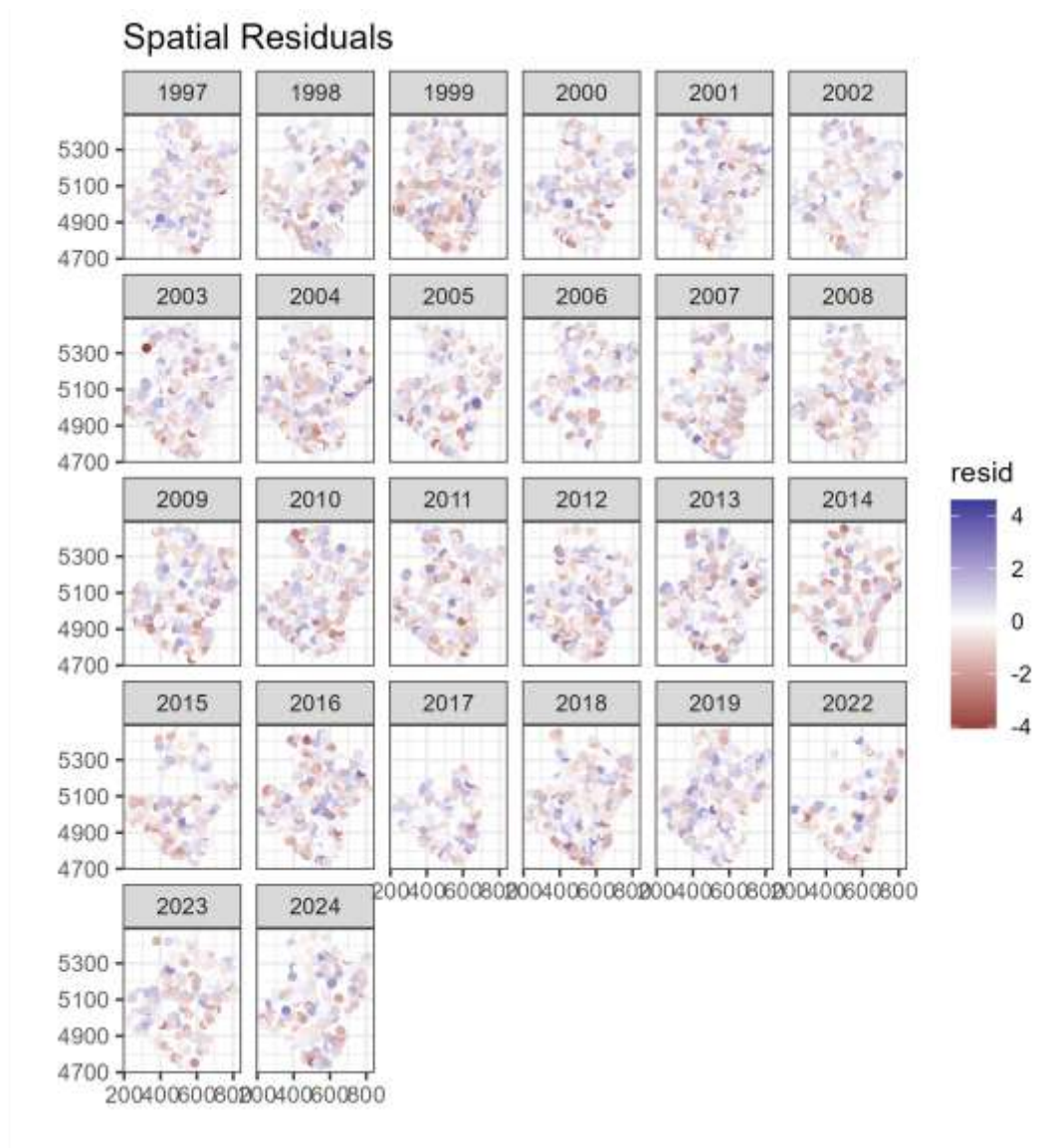


Figure A51. Spatial residuals calculated using MCMC for model examining density of catch of Small Benthivores in Div. 3LNO Spring.

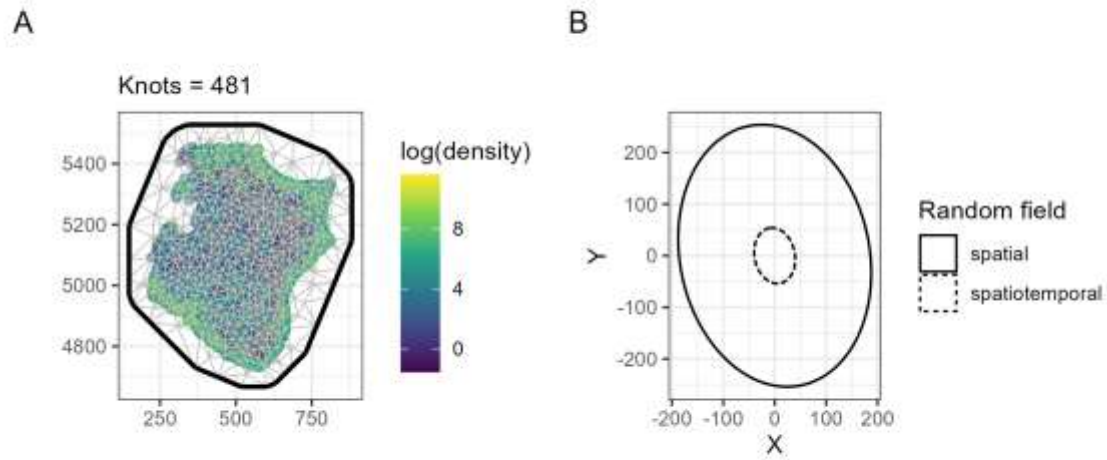


Figure A52. Mesh (A) and anisotropy (B) for model examining density of catch of Piscivores in Div. 3LNO Spring. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

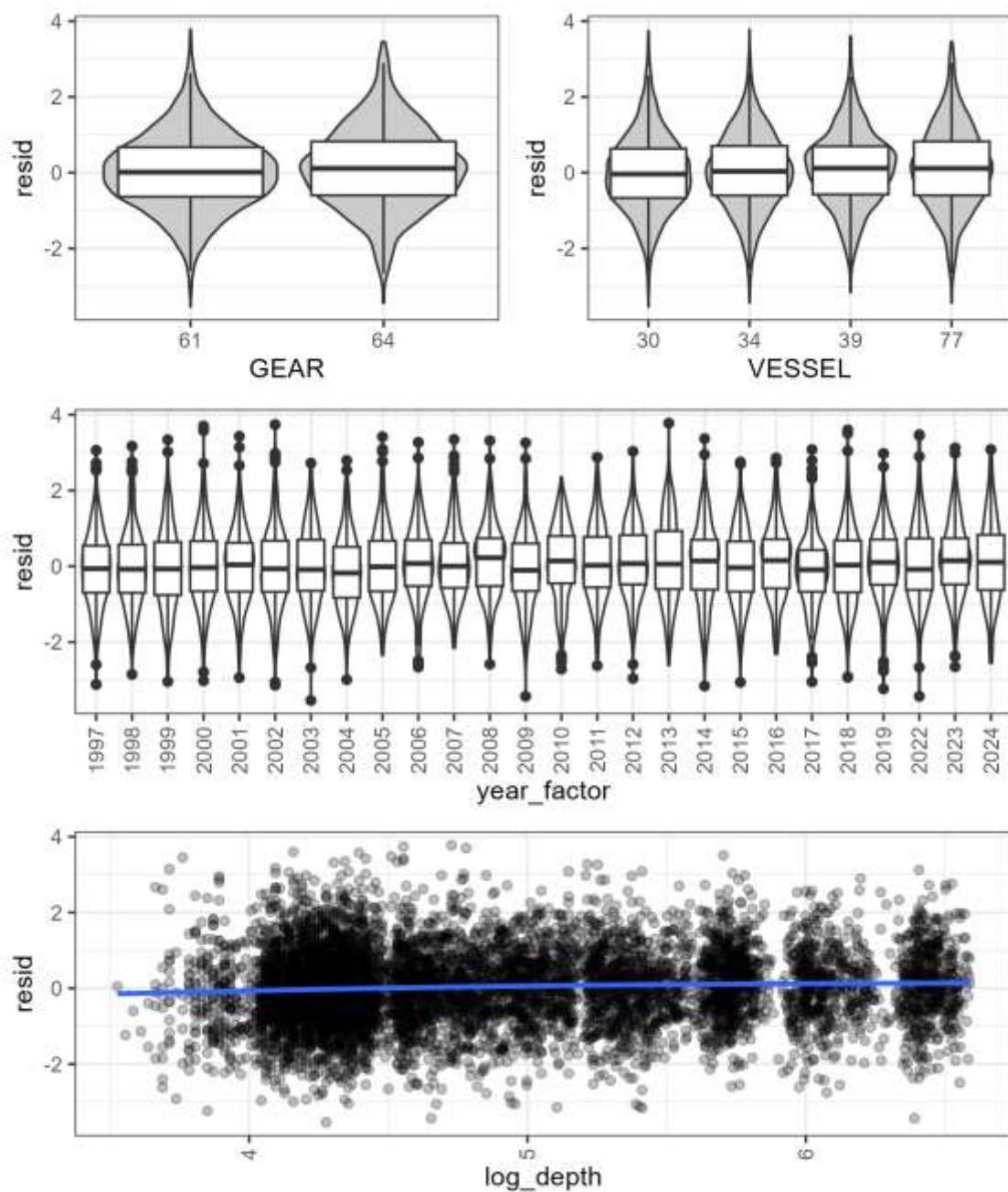


Figure A53. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Piscivores in Div. 3LNO Spring. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

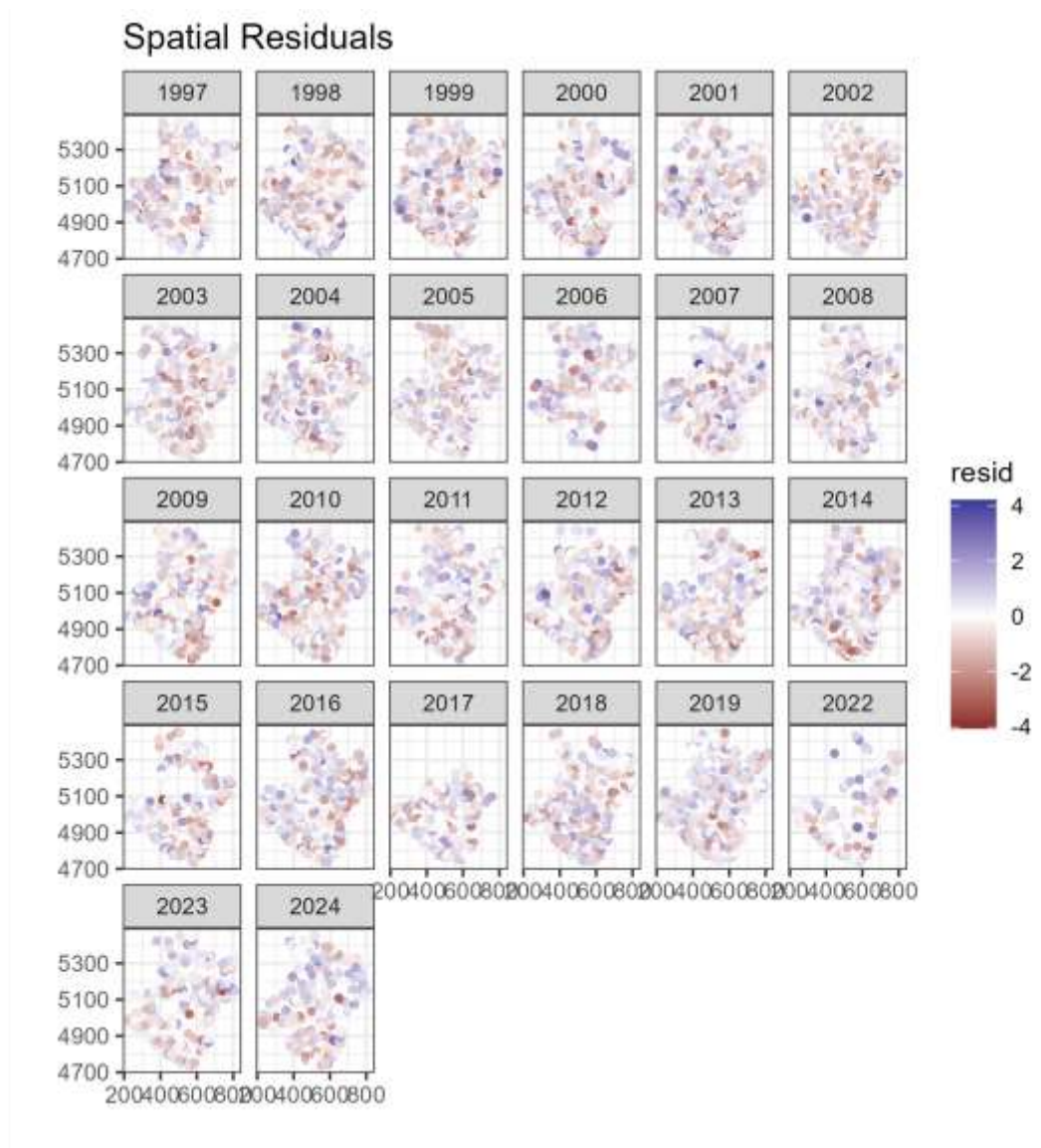


Figure A54. Spatial residuals calculated using MCMC for model examining density of catch of Piscivores in Div. 3LNO Spring.

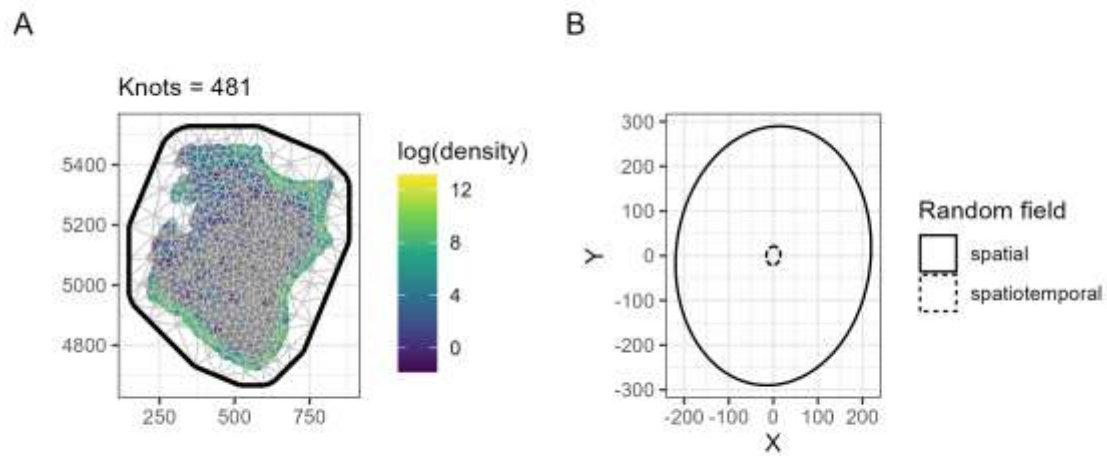


Figure A55. Mesh (A) and anisotropy (B) for model examining density of catch of Plankpiscivores in Div. 3LNO Spring. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

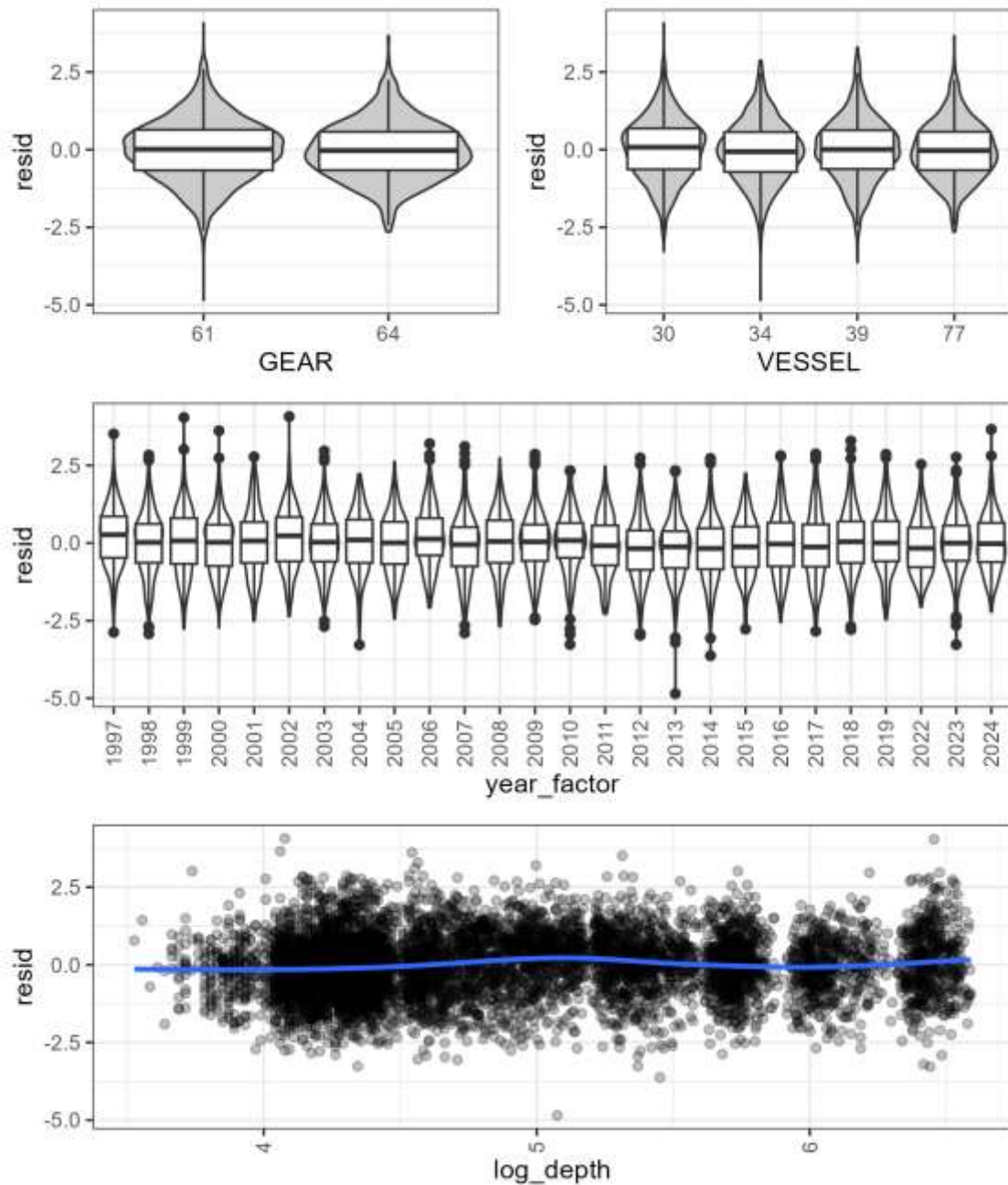


Figure A56. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Planktivores in Div. 3LNO Spring. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

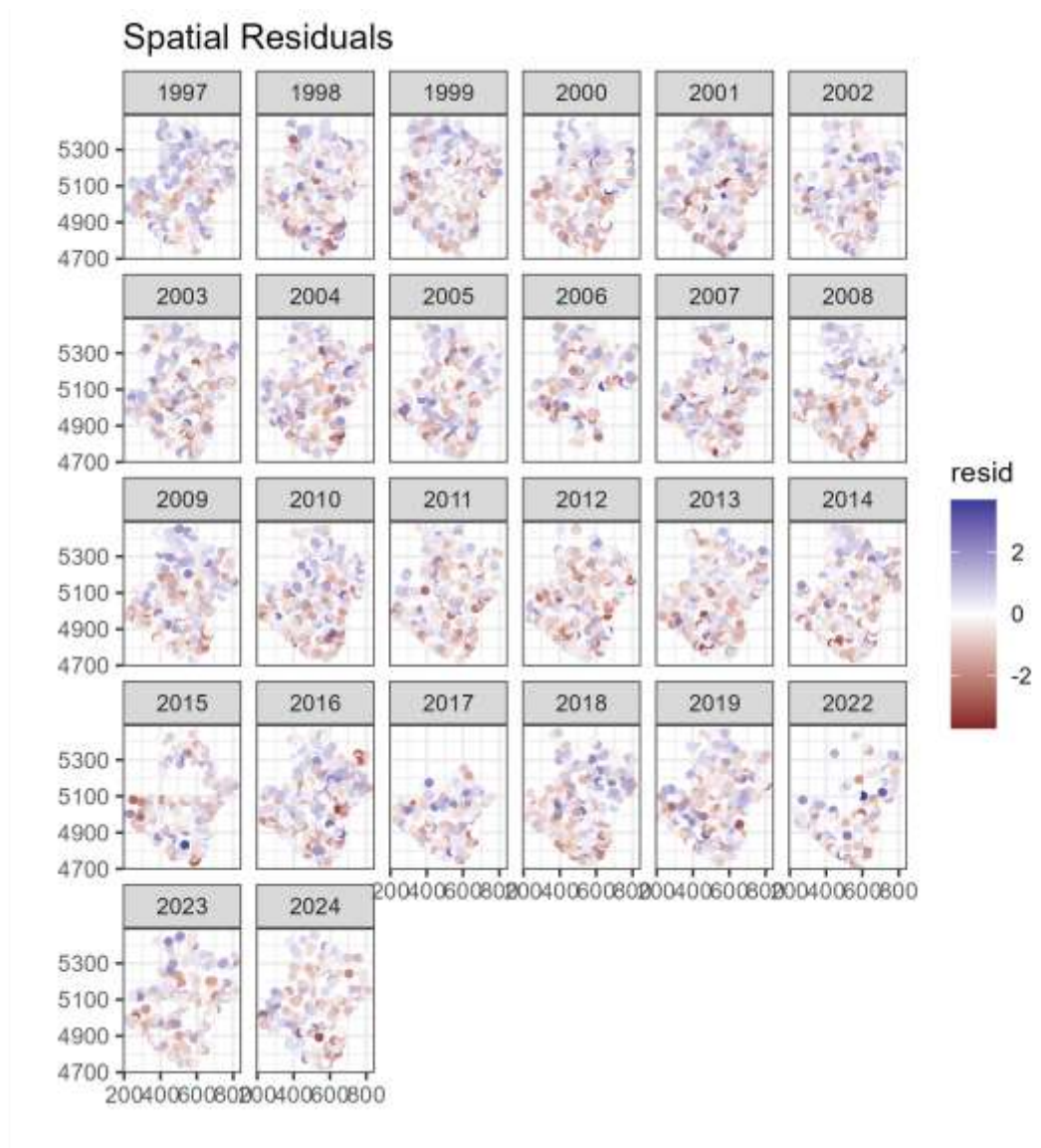


Figure A57. Spatial residuals calculated using MCMC for model examining density of catch of Planktivores in Div. 3LNO Spring.

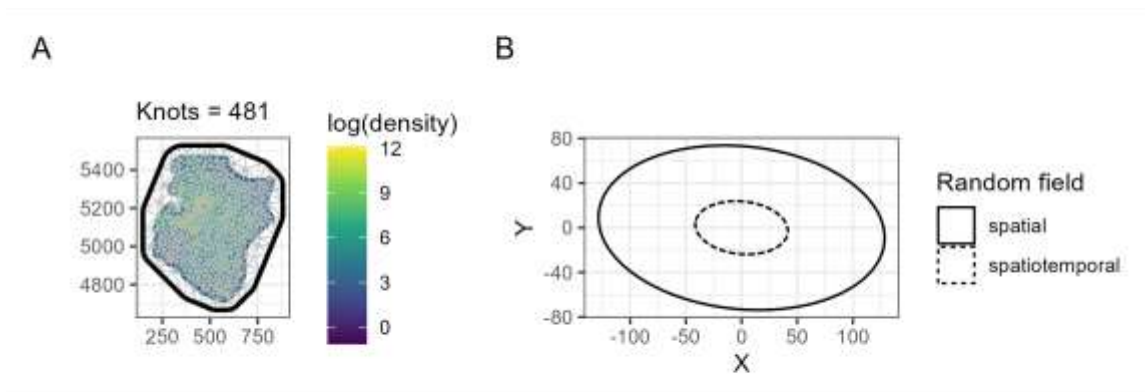


Figure A58. Mesh (A) and anisotropy (B) for model examining density of catch of Planktivores in Div. 3LNO Spring. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

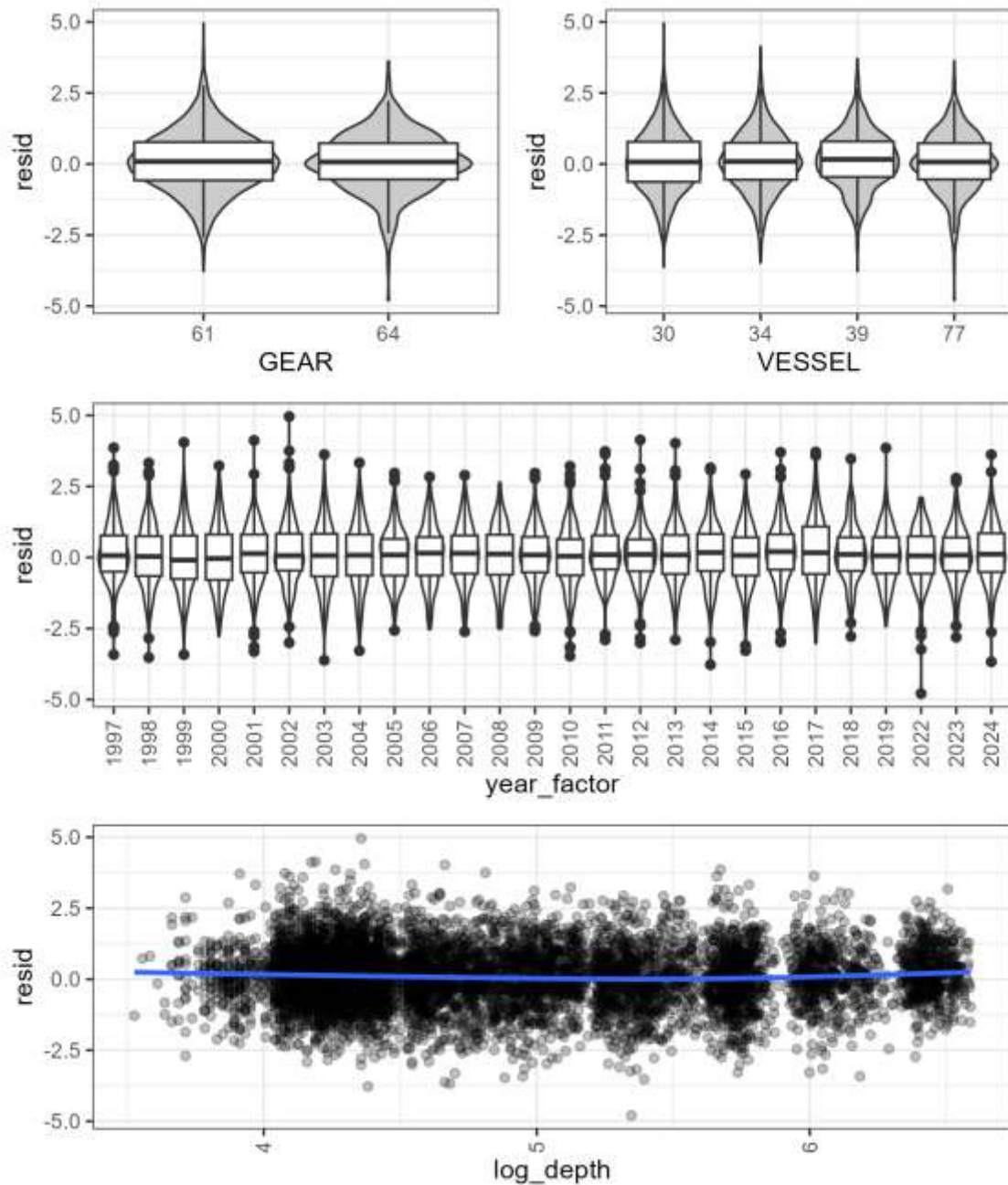


Figure A59. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Planktivores in Div. 3LNO Spring. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

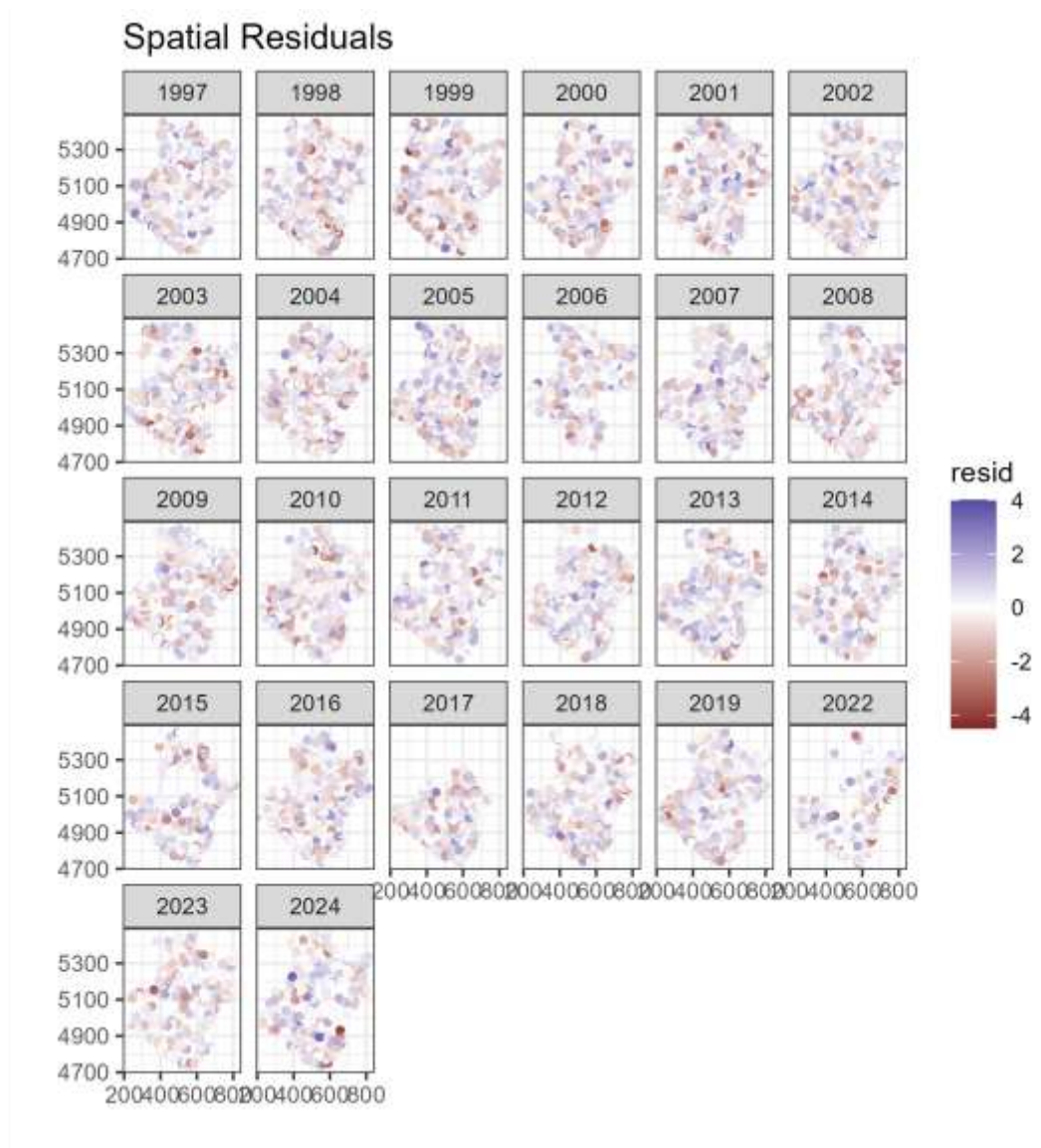


Figure A60. Spatial residuals calculated using MCMC for model examining density of catch of Planktivores in Div. 3LNO Spring.

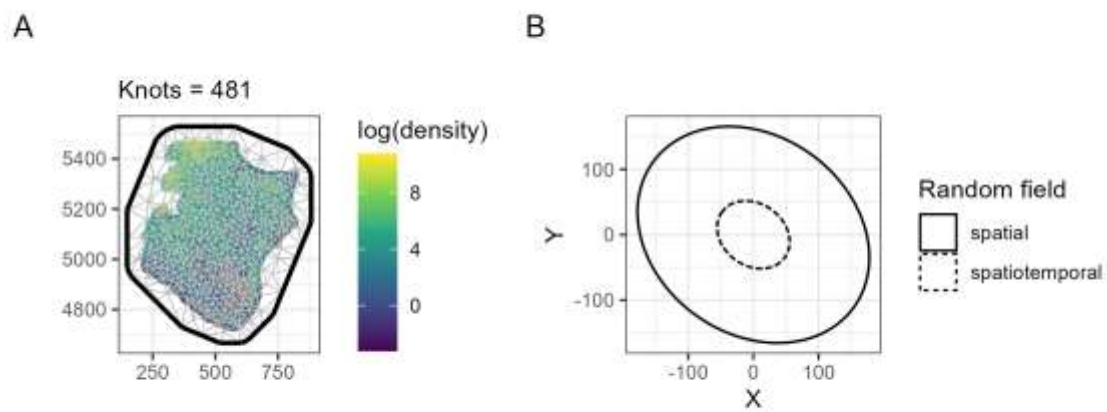


Figure A61. Mesh (A) and anisotropy (B) for model examining density of catch of Shellfish in Div. 3LNO Spring. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

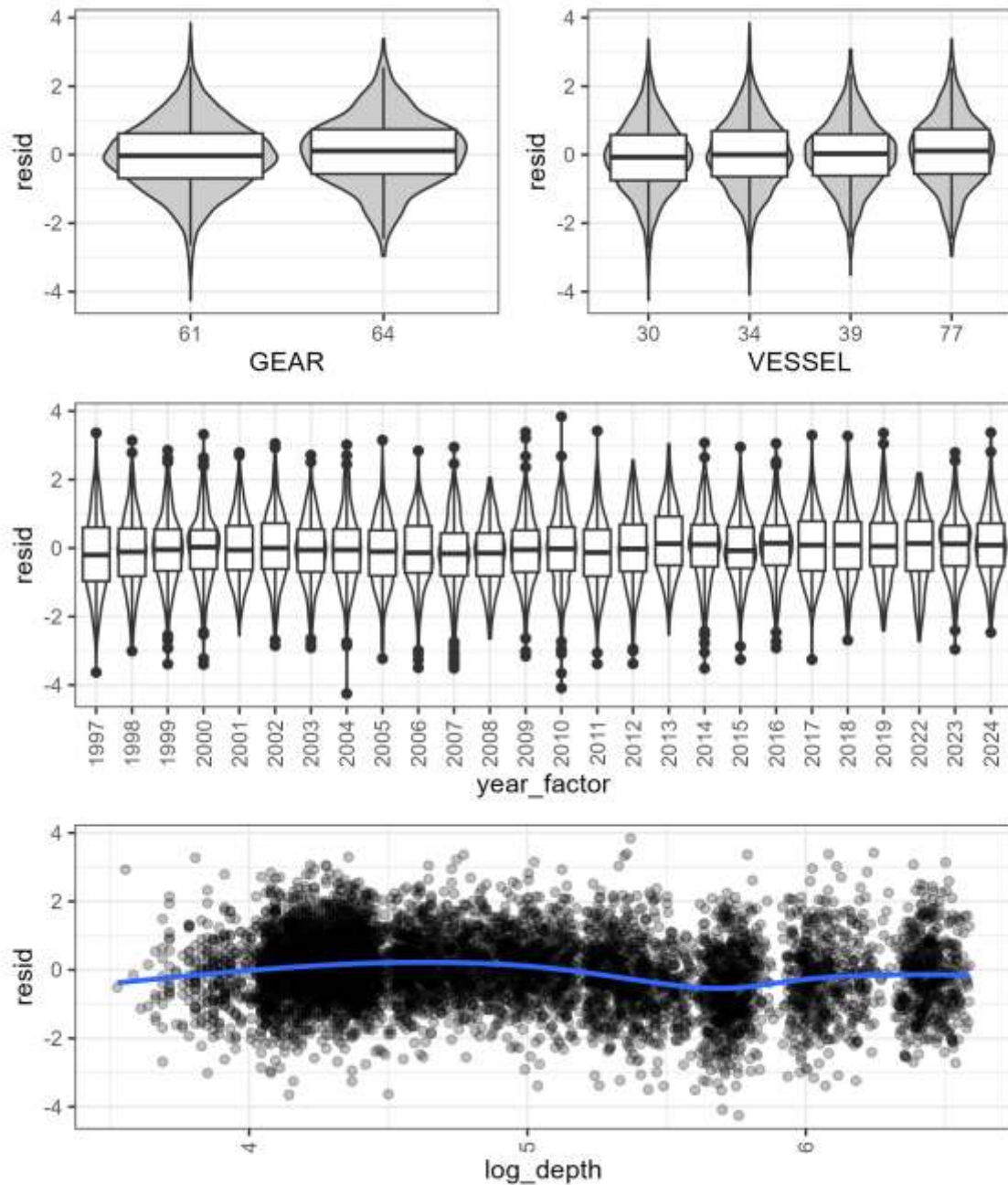


Figure A62. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Shellfish in Div. 3LNO Spring. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals

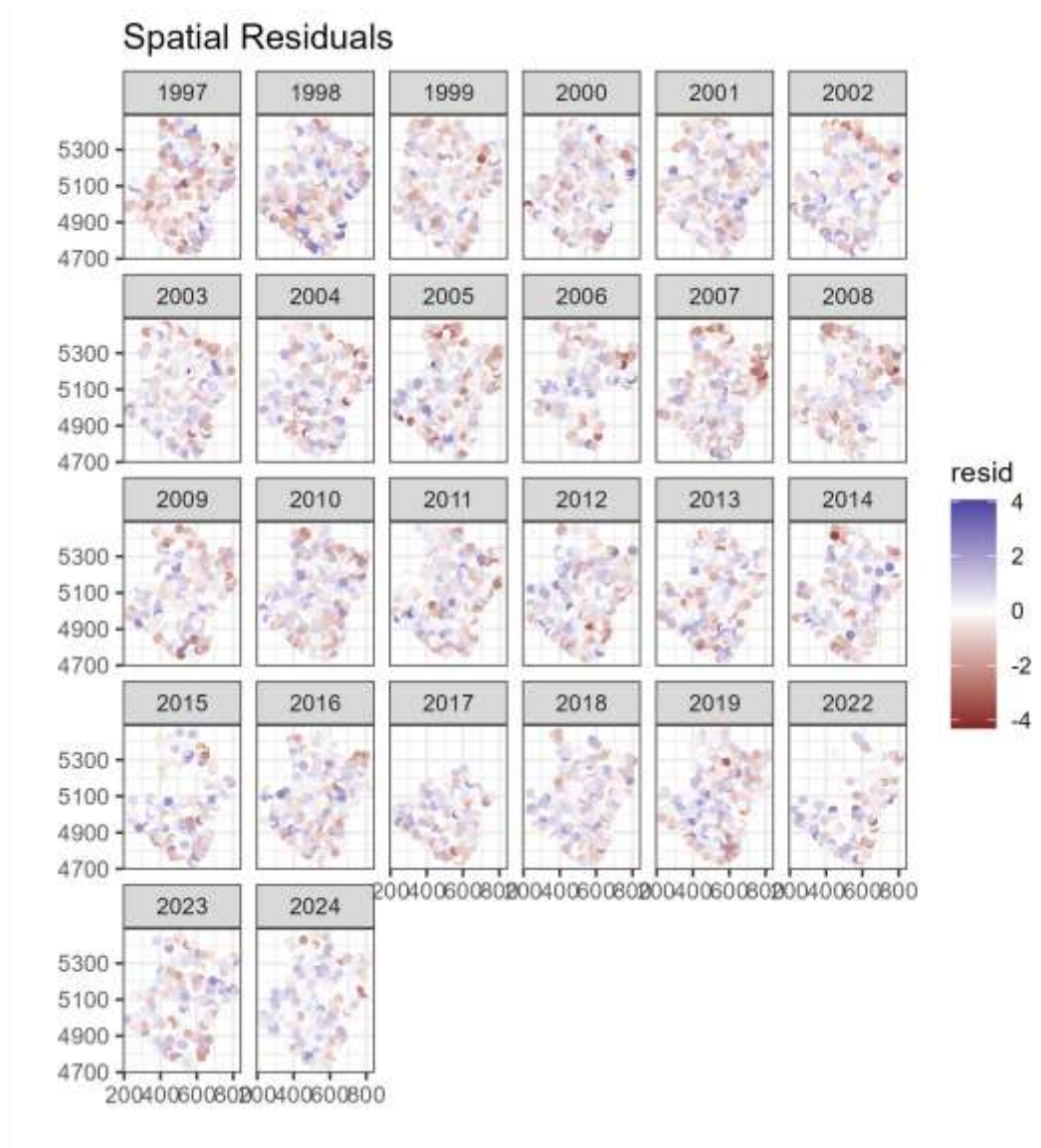


Figure A63. Spatial residuals calculated using MCMC for model examining density of catch of Shellfish in Div. 3LNO Spring.

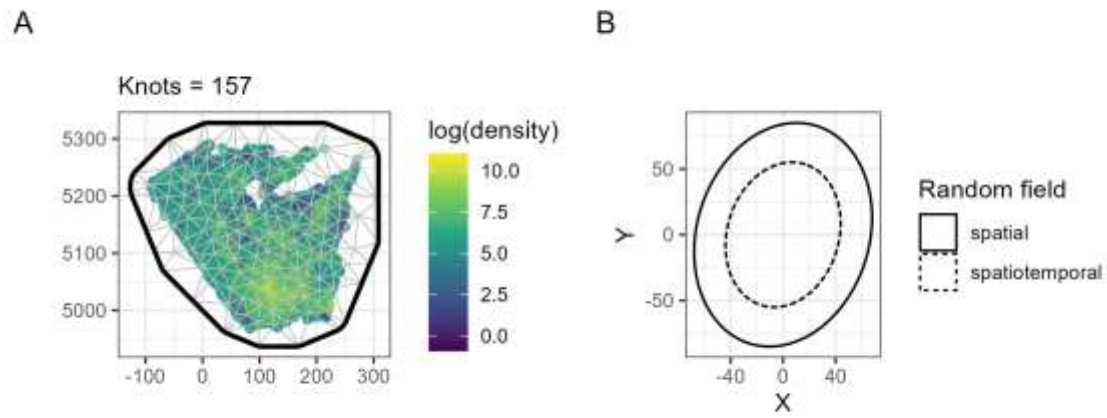


Figure A64. Mesh (A) and anisotropy (B) for model examining density of catch of Large Benthivores in SubDiv. 3Ps. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

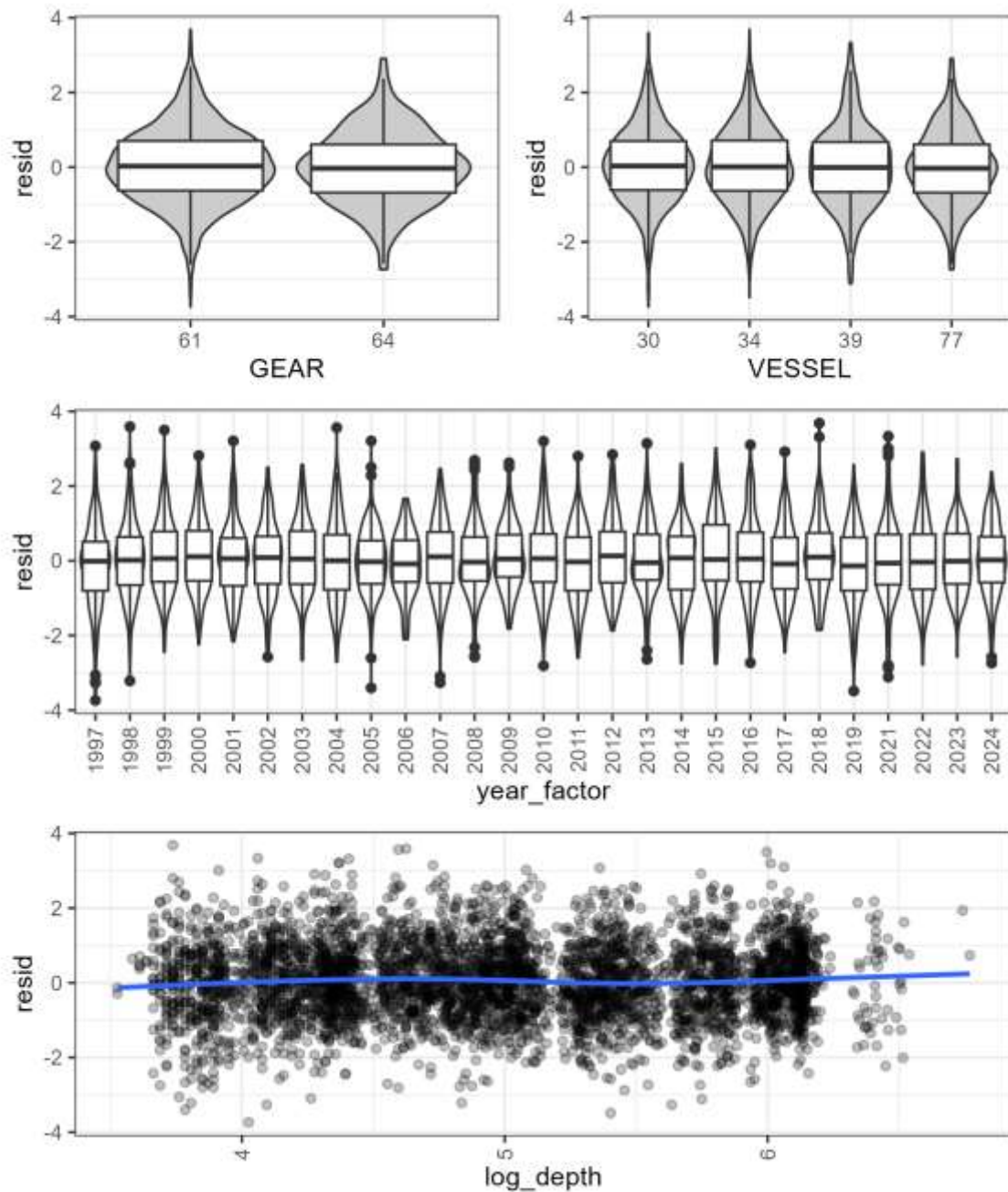


Figure A65. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Large Benthivores in SubDiv. 3Ps. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

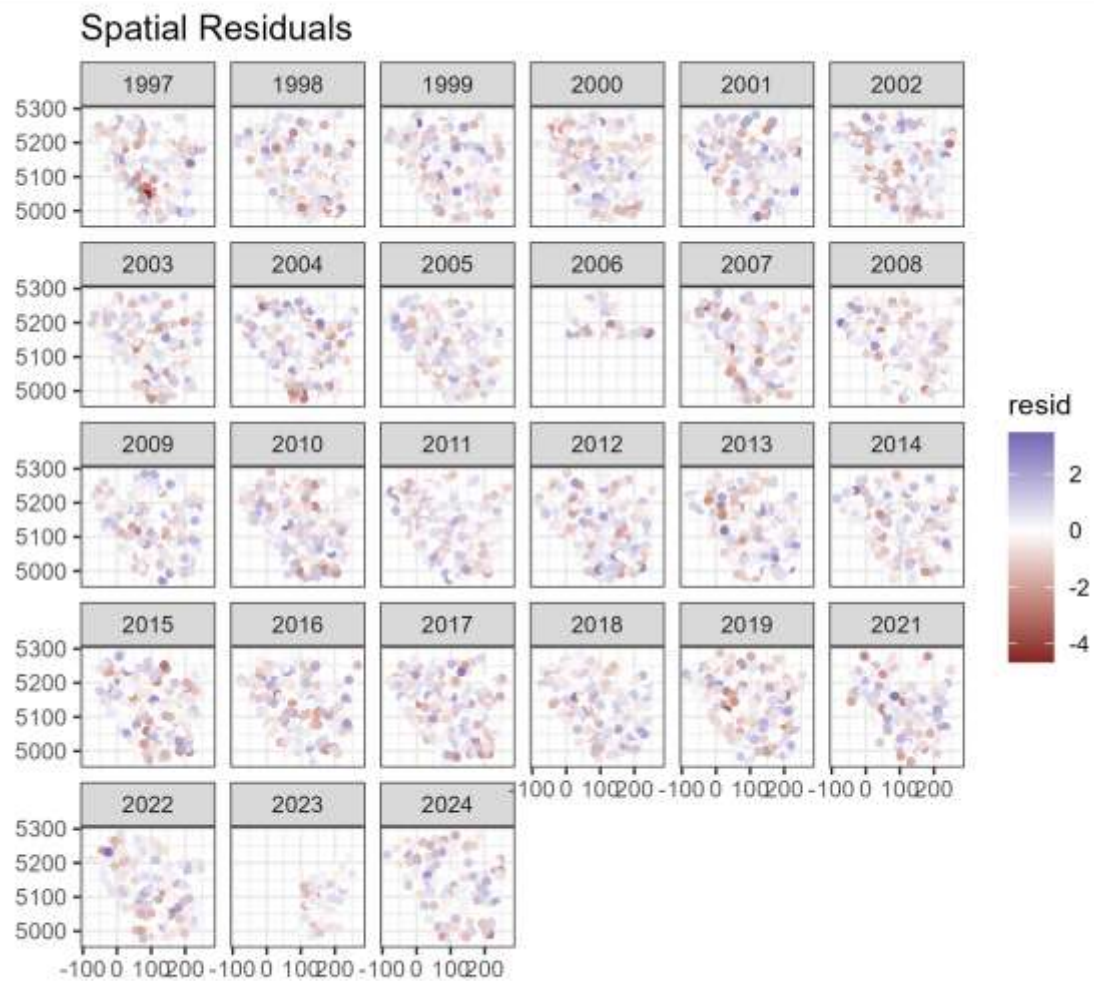


Figure A66. Spatial residuals calculated using MCMC for model examining density of catch of Large Benthivores in SubDiv. 3Ps.

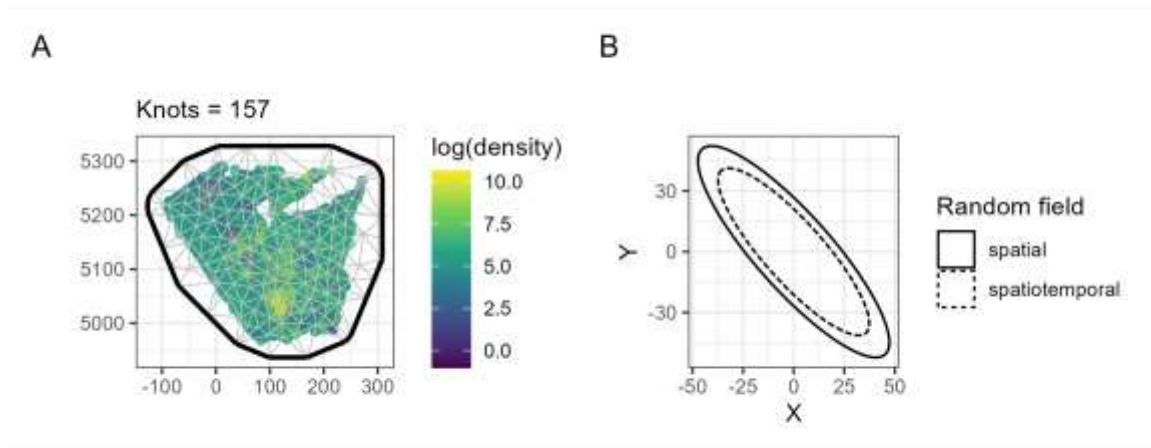


Figure A67. Mesh (A) and anisotropy (B) for model examining density of catch of Medium Benthivores in SubDiv. 3Ps. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

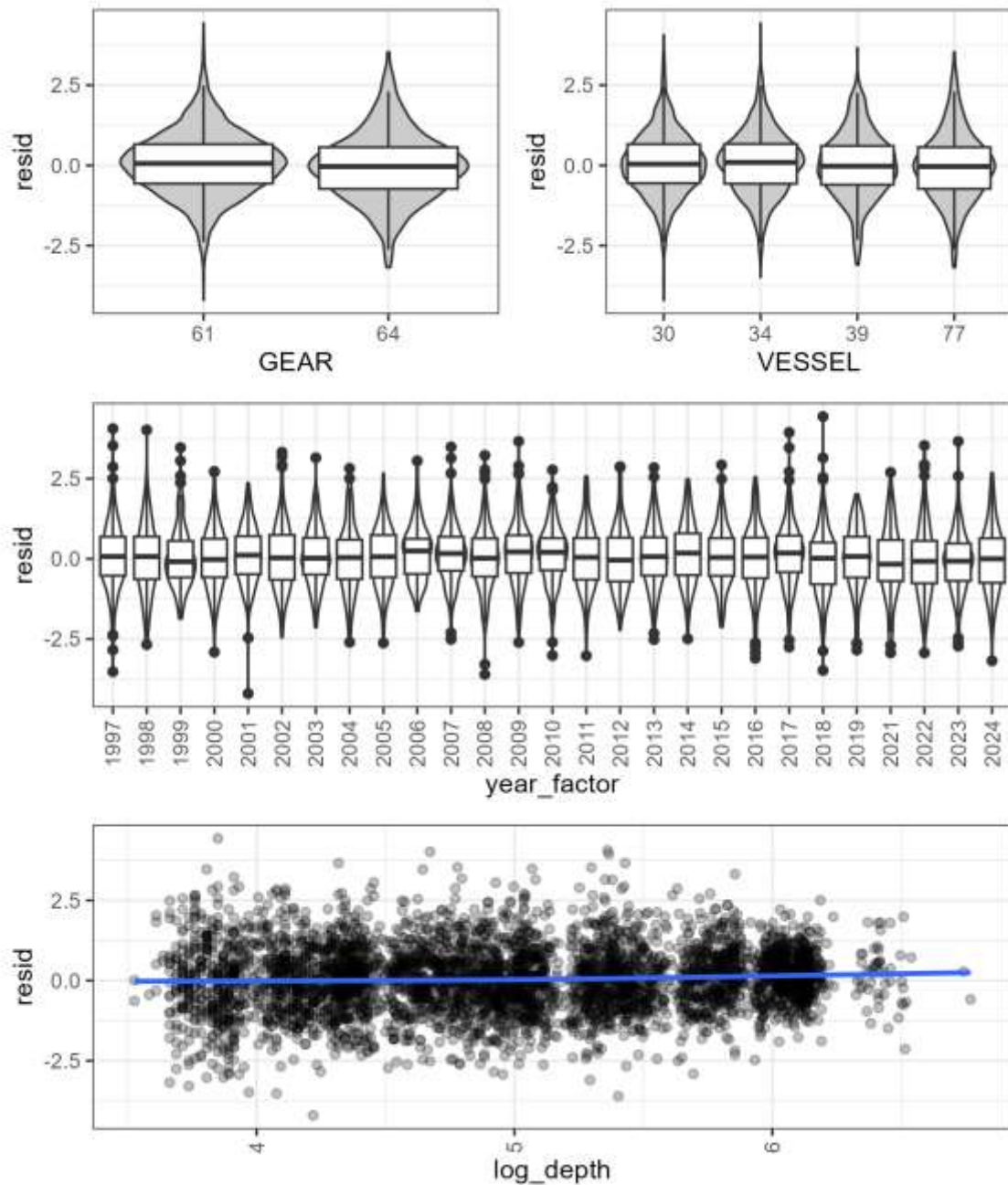


Figure A68. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Medium Benthivores in SubDiv. 3Ps. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

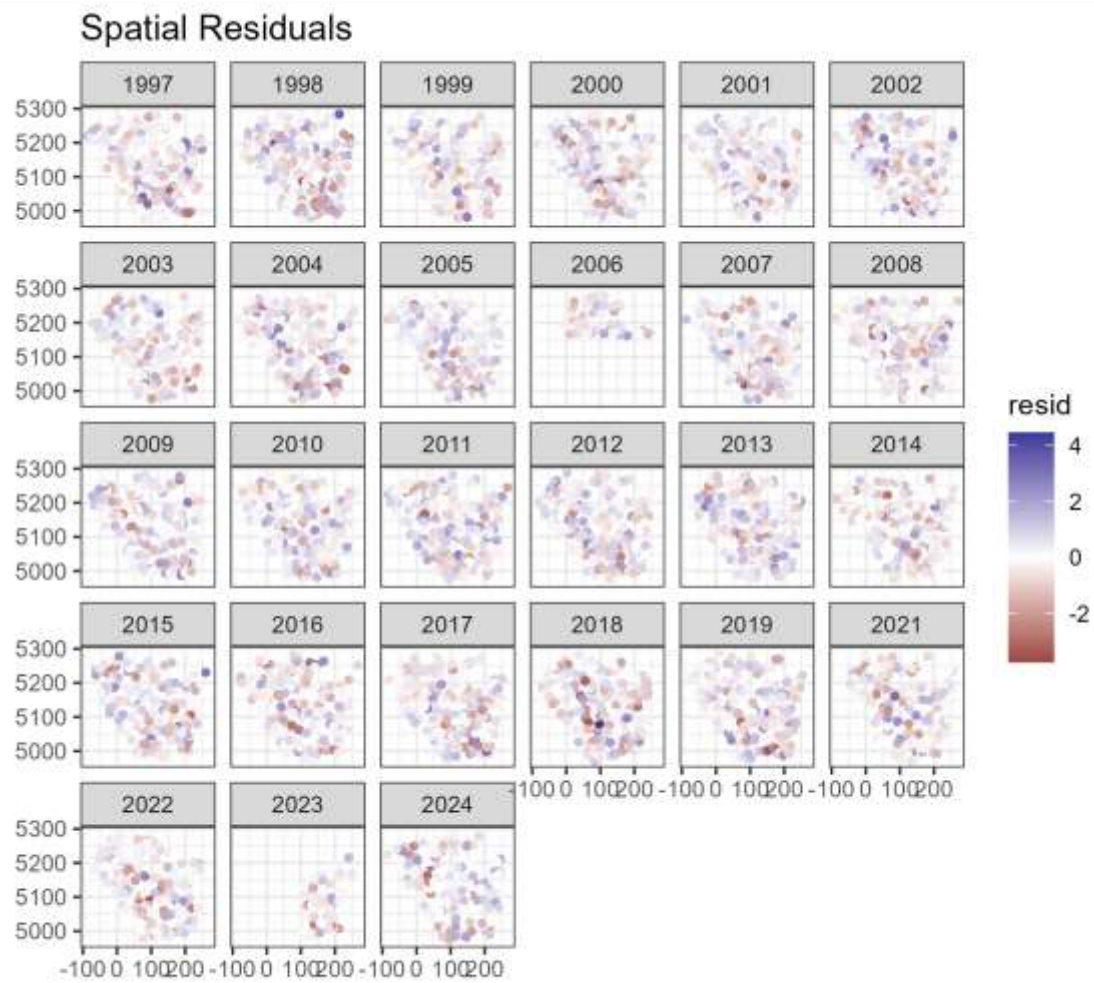


Figure A69. Spatial residuals calculated using MCMC for model examining density of catch of Medium Benthivores in SubDiv. 3Ps.

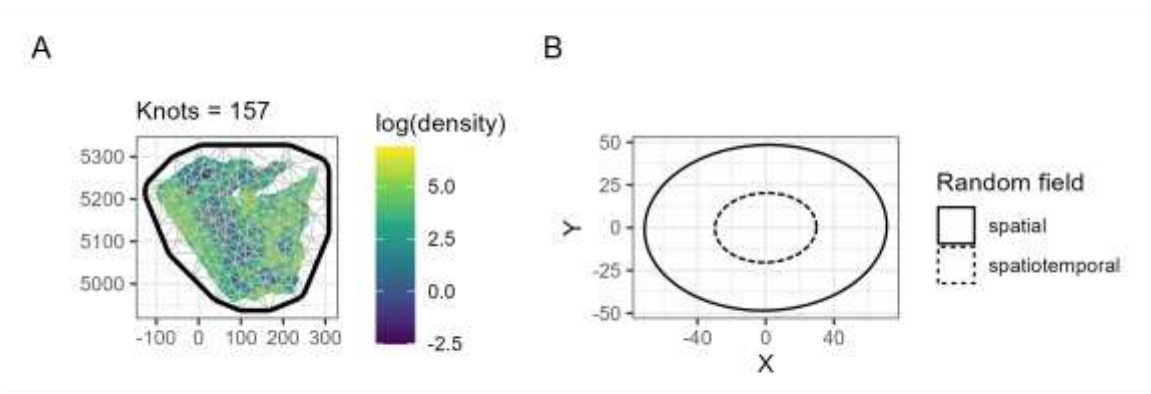


Figure A70. Mesh (A) and anisotropy (B) for model examining density of catch of Small Benthivores in SubDiv. 3Ps. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

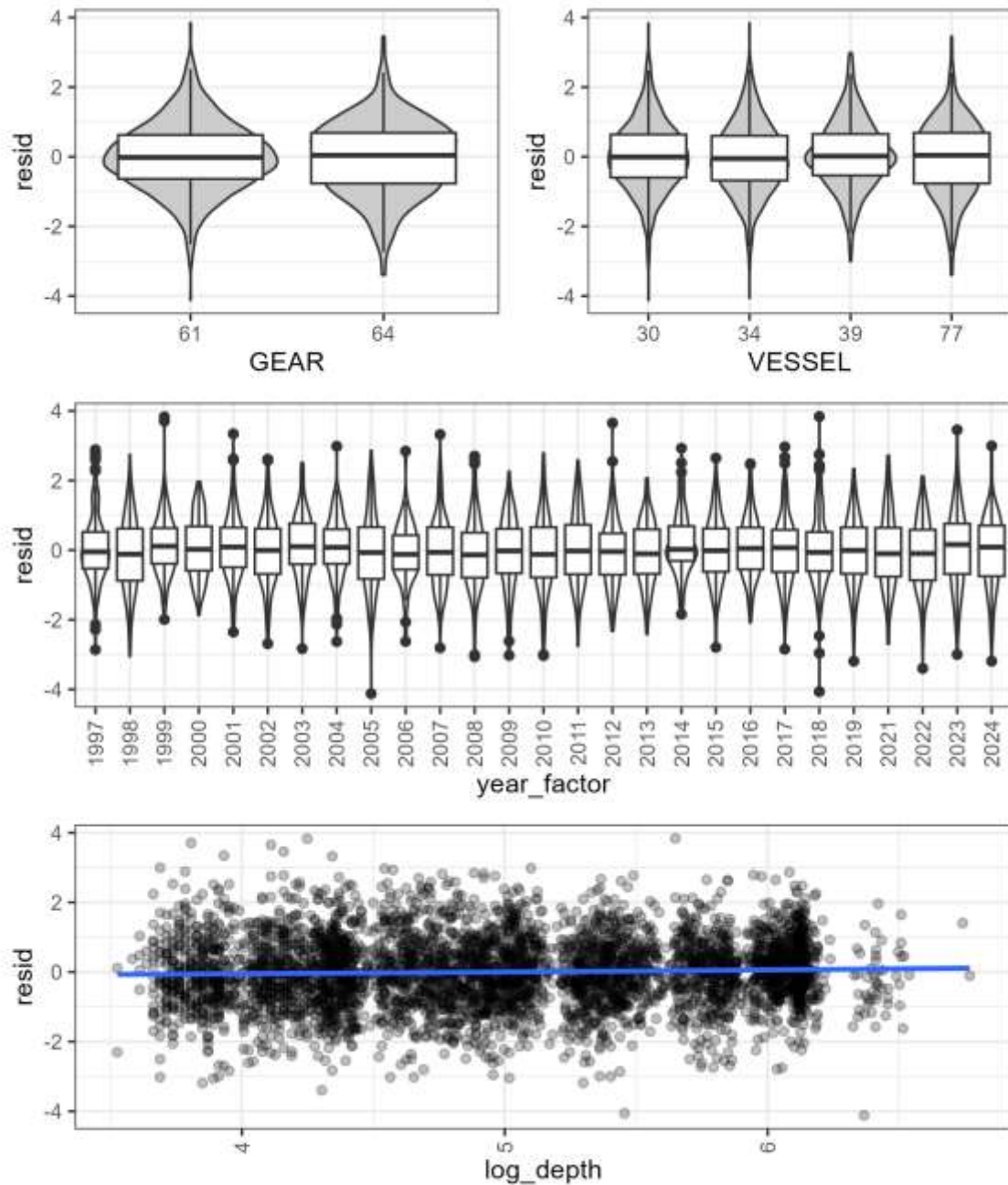


Figure A71. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Small Benthivores in SubDiv. 3Ps. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

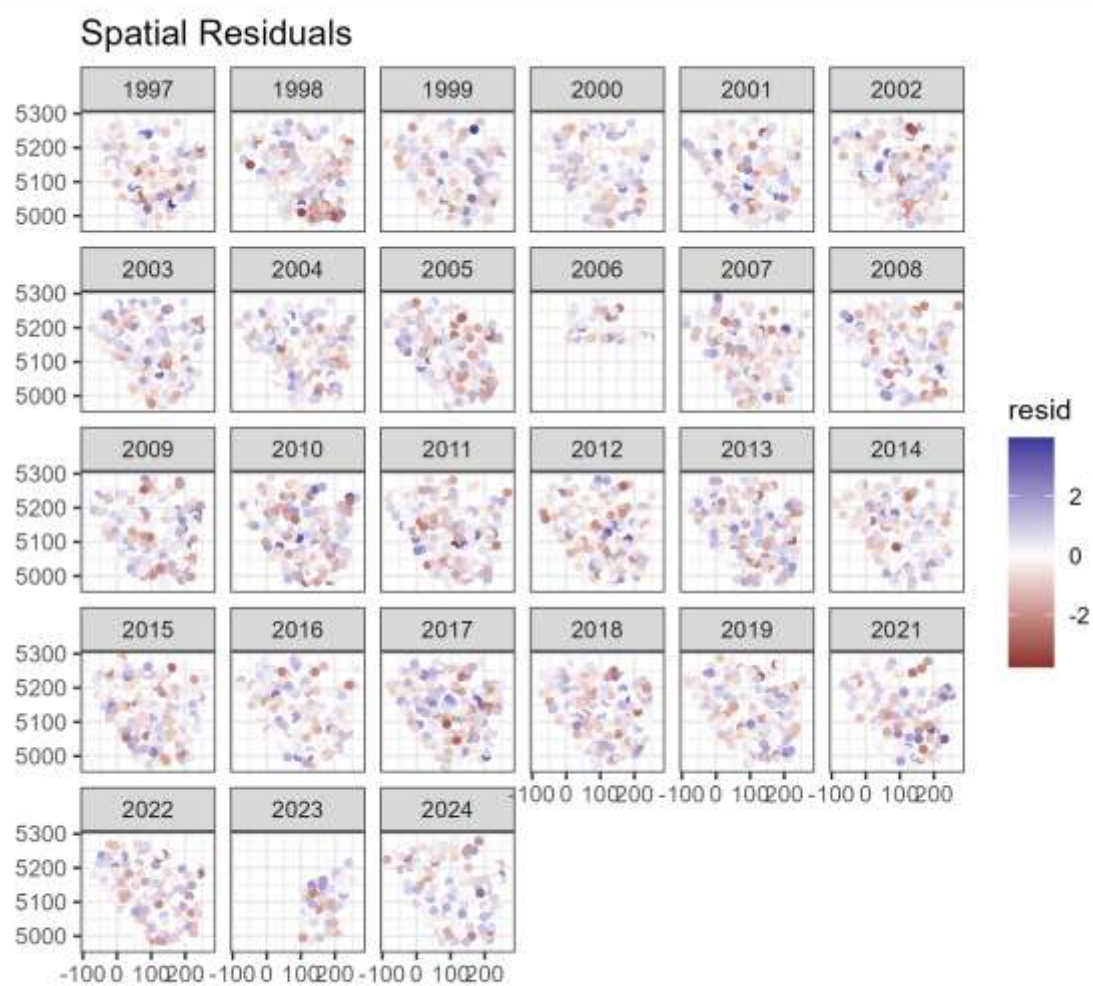
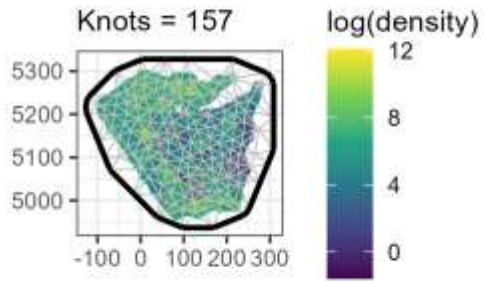


Figure A72. Spatial residuals calculated using MCMC for model examining density of catch of Small Benthivores in SubDiv. 3Ps.

A



B

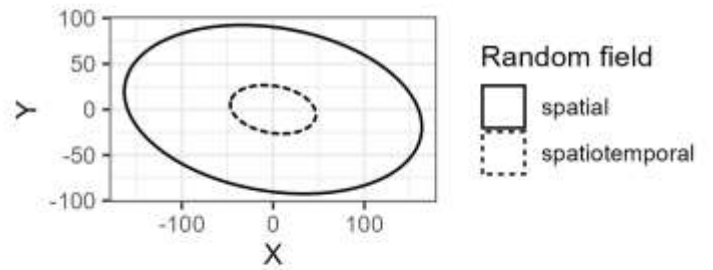


Figure A73. Mesh (A) and anisotropy (B) for model examining density of catch of Piscivores in SubDiv. 3Ps. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km^2 .

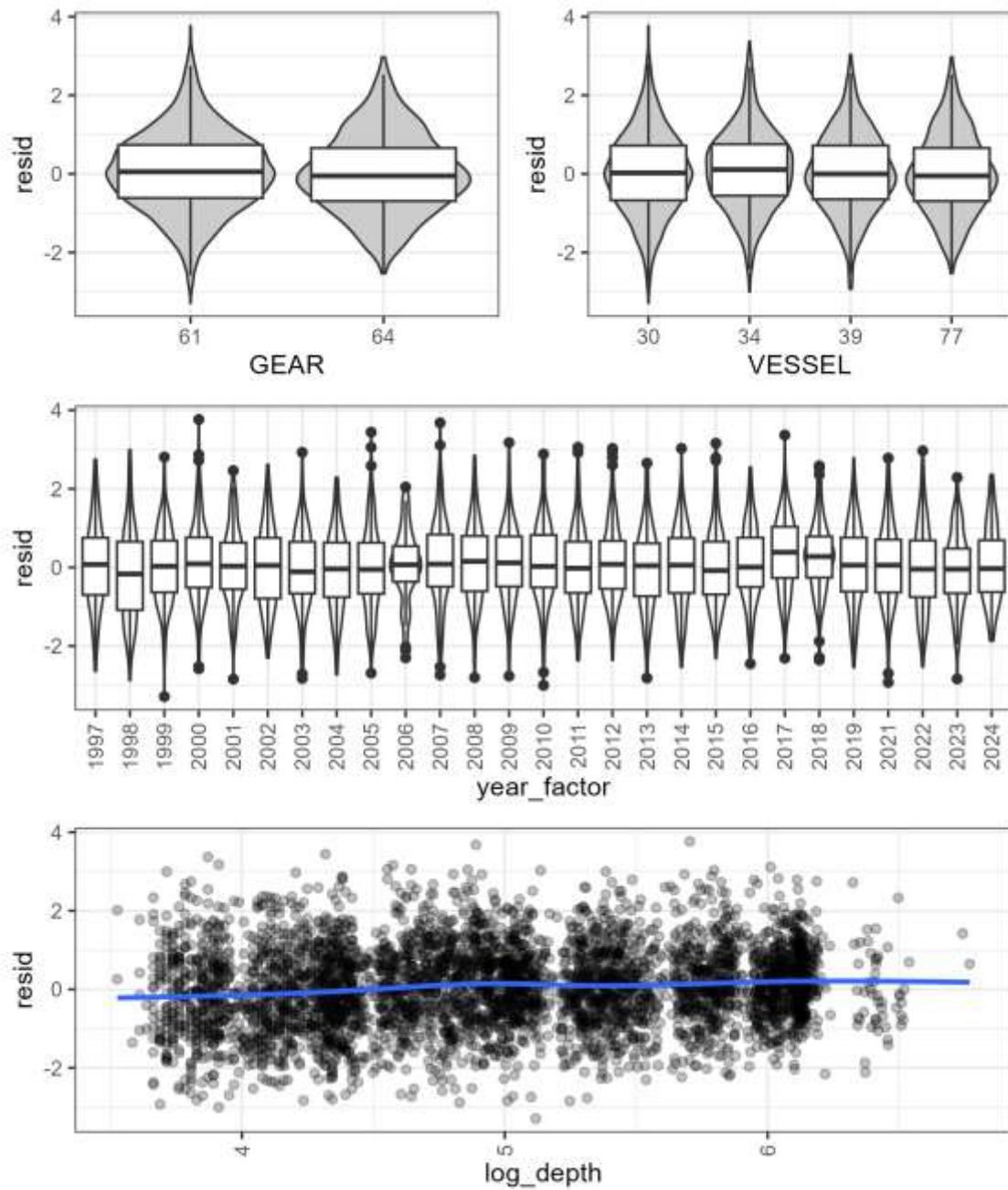


Figure A74. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Piscivores in SubDiv. 3Ps. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

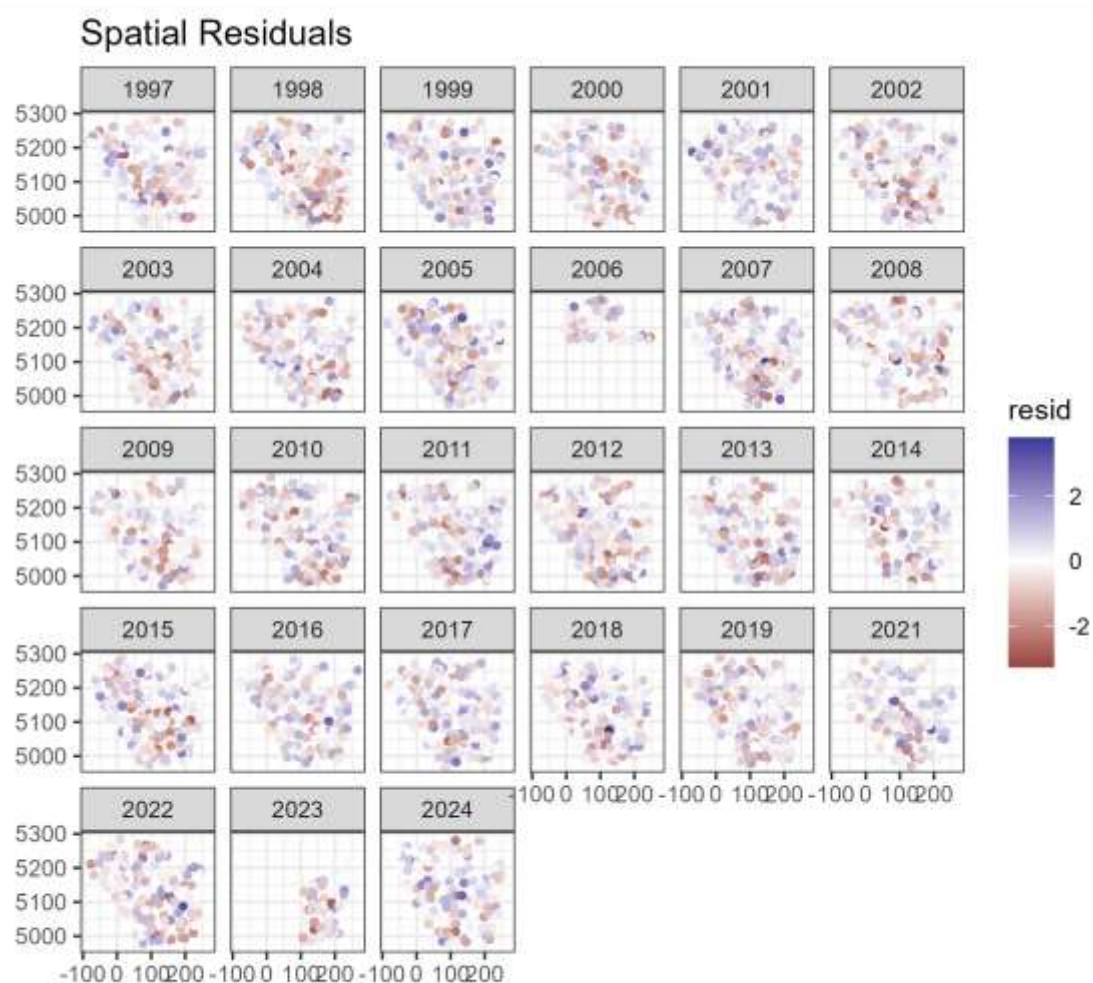


Figure A75. Spatial residuals calculated using MCMC for model examining density of catch of Piscivores in SubDiv. 3Ps.

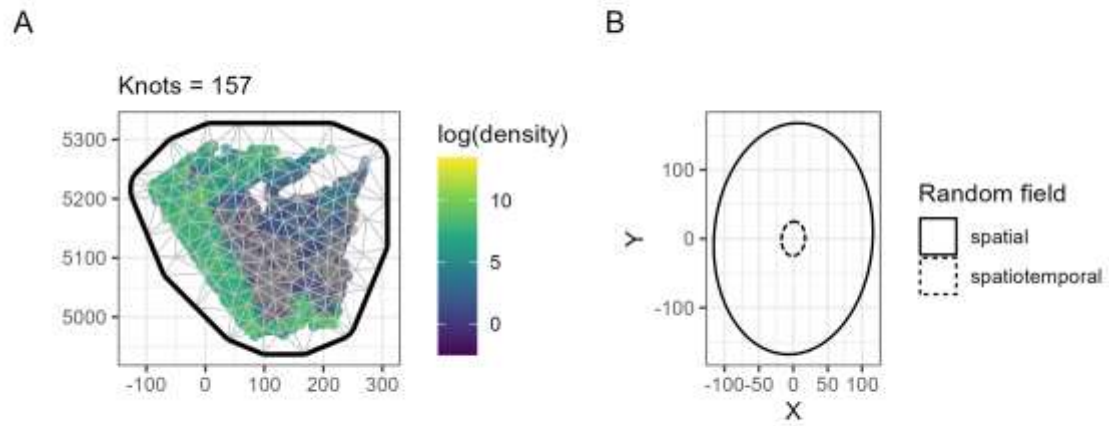


Figure A76. Mesh (A) and anisotropy (B) for model examining density of catch of Planktivores in SubDiv. 3Ps. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

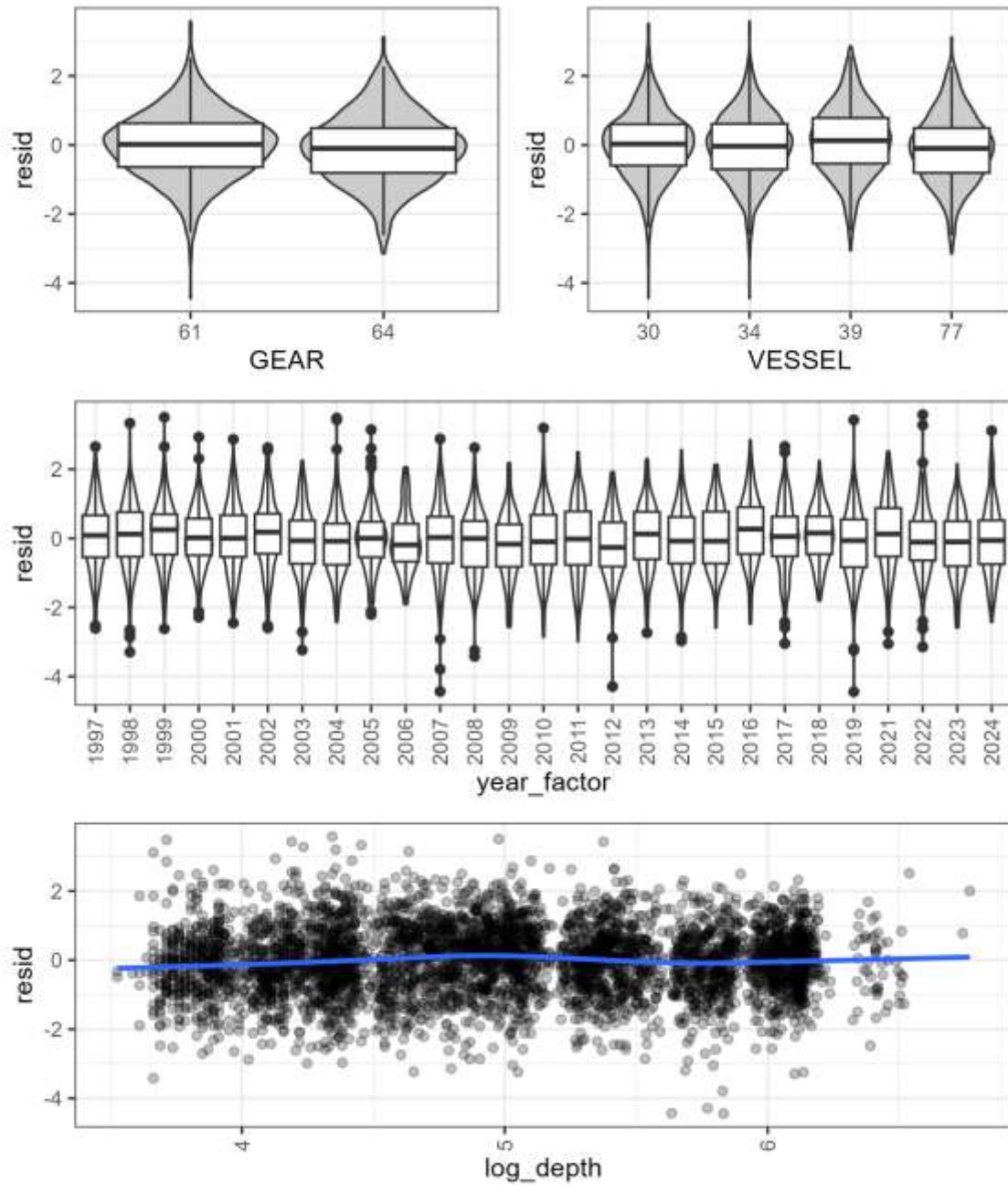


Figure A77. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Planktivores in SubDiv. 3Ps. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

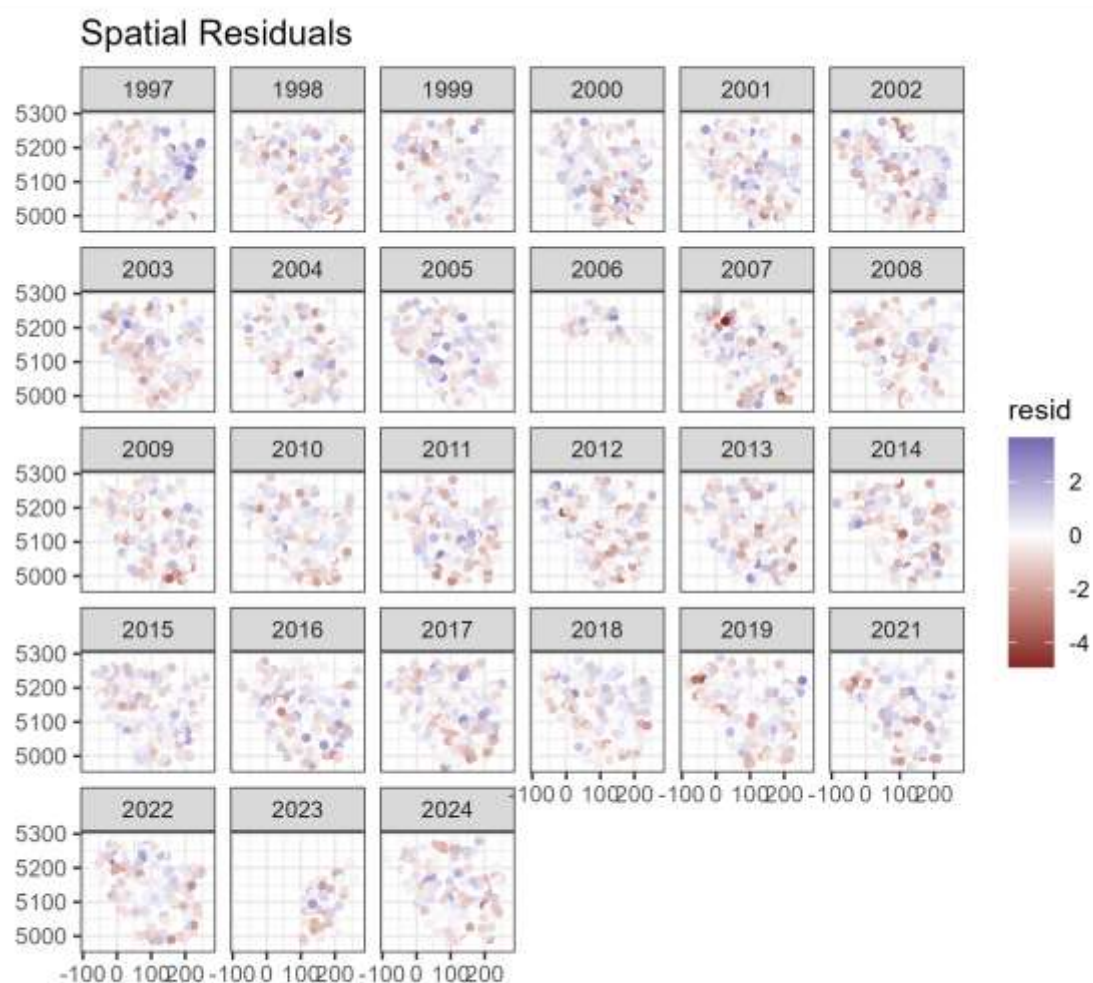


Figure A78. Spatial residuals calculated using MCMC for model examining density of catch of *Planktivores* in SubDiv. 3Ps.

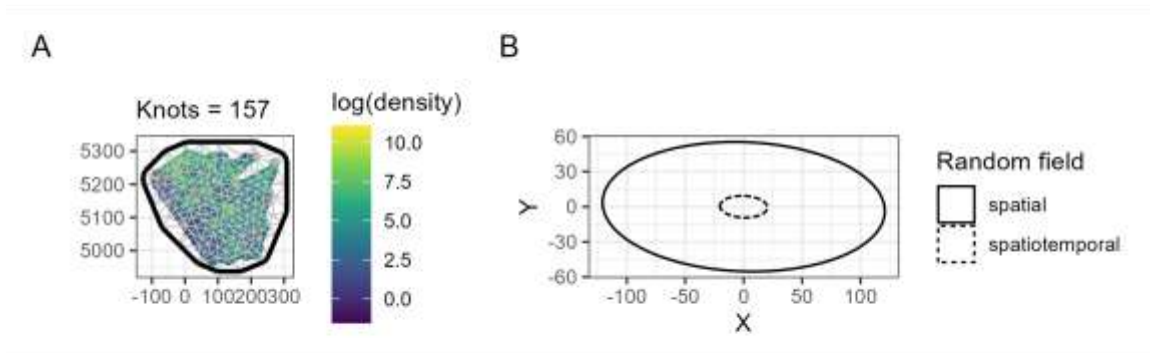


Figure A79. Mesh (A) and anisotropy (B) for model examining density of catch of Planktivores in SubDiv. 3Ps. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

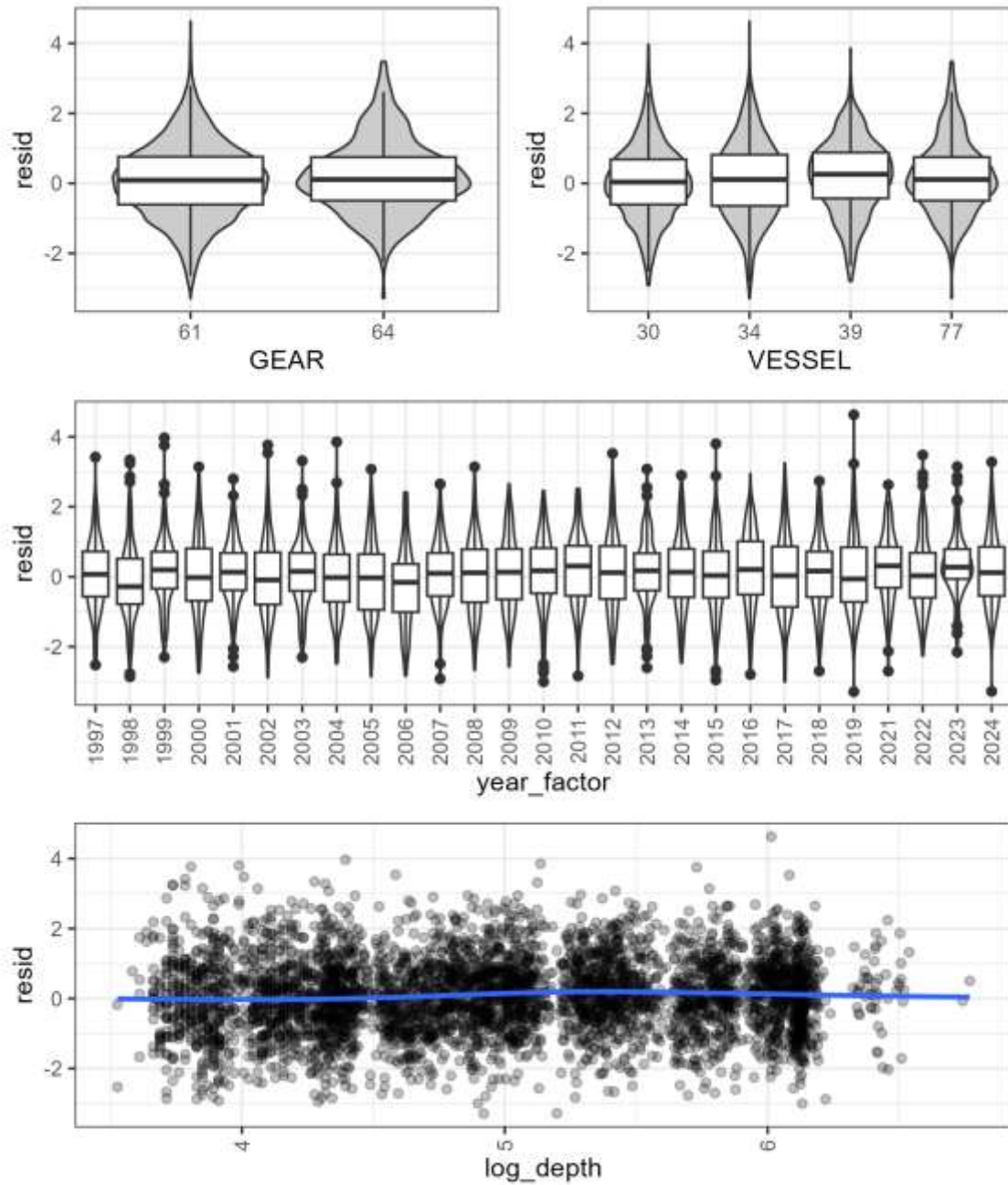


Figure A80. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Planktivores in SubDiv. 3Ps. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

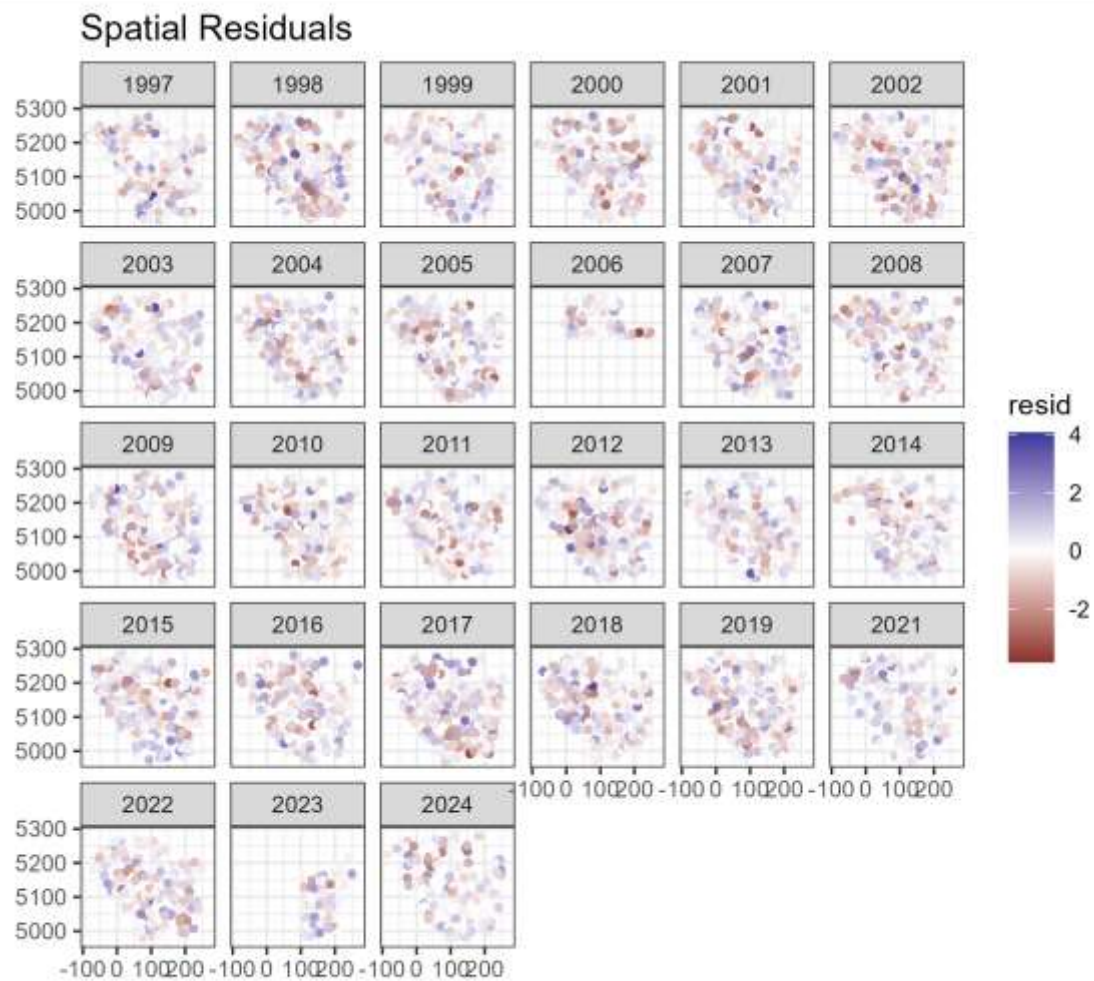


Figure A81. Spatial residuals calculated using MCMC for model examining density of catch of Planktivores in SubDiv. 3Ps.

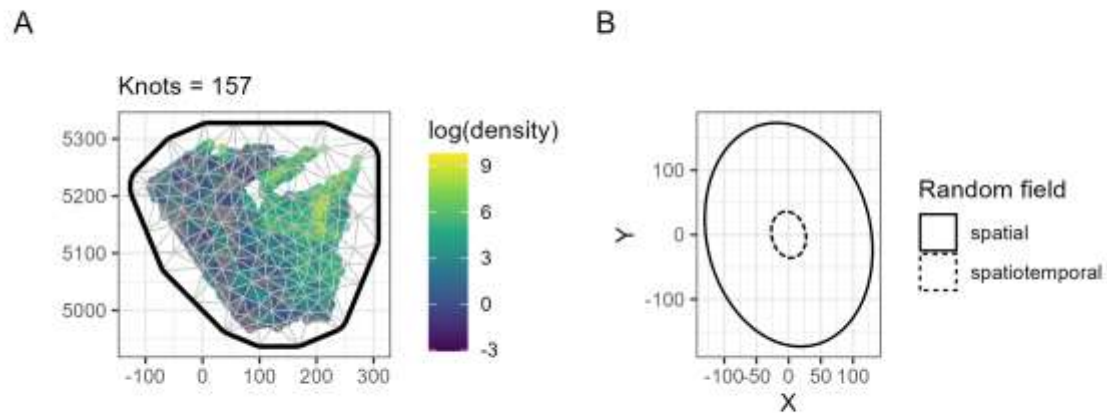


Figure A82. Mesh (A) and anisotropy (B) for model examining density of catch of Shellfish in SubDiv. 3Ps. Points below mesh represent all catch data included in fitting the model. Density is presented on log scale, and kg/km².

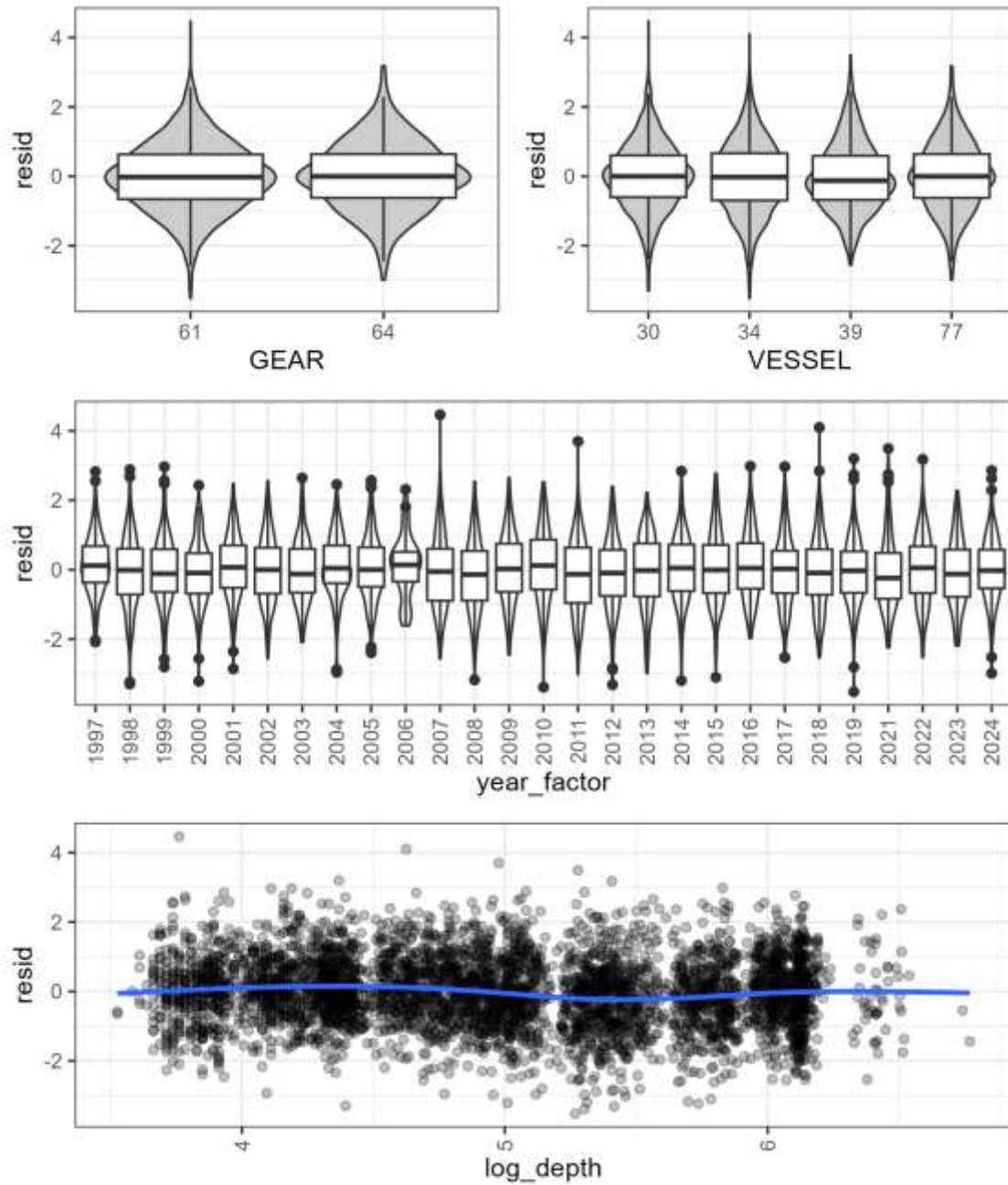


Figure A83. Residuals for vessel, gear, year as a factor, and log depth for model examining density of catch of Shellfish in SubDiv. 3Ps. Grey violin plots to represent the distribution of residual; box plots providing the median and 1st and 3rd quantiles; blue line is general additive model smoother through all residuals.

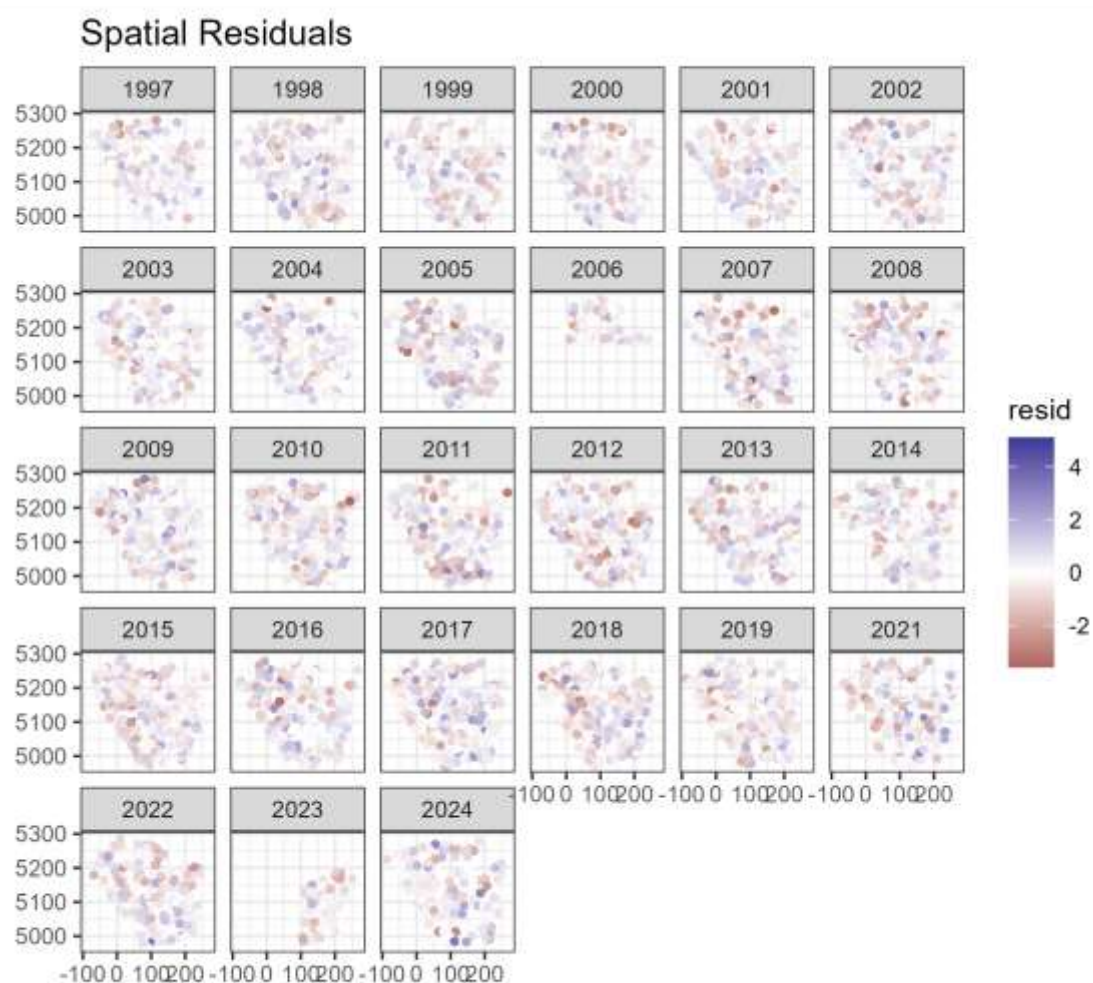


Figure A84. Spatial residuals calculated using MCMC for model examining density of catch of Shellfish in SubDiv. 3Ps.