Fisheries and Oceans Canada | Pêches et Océans Canada
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Canadian Science Advisory Secretariat (CSAS)

Research Document 2026/014

Newfoundland and Labrador Region

Results of Comparative Fishing Between the CCGS *John Cabot* and MV *Calvert* in the Newfoundland and Labrador Region in Spring 2023-2024

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January 2026

Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/
DFO.CSAS-SCAS.MPO@dfo-mpo.gc.ca

ISSN 1919-5044
ISBN 978-0-660-97896-3 Cat. No. Fs70-5/2026-014E-PDF

Correct citation for this publication:

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.

Aussi disponible en français :

Trueman, S., Wheeland, L., Novaczek, E., Munro, H. et Nguyen, T. 2026. Résultats de la pêche comparative du NGCC John Cabot *et du NM* Calvert *dans la région de Terre-Neuve-et-Labrador au printemps de 2023 et 2024. Secr. can. des avis sci. du MPO. Doc. de rech. 2026/014. iv + 117 p.*

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ABSTRACT

Multispecies bottom trawl surveys are conducted annually in the spring and fall in the Newfoundland and Labrador (NL) Region using a Campelen 1800 survey trawl aboard Canadian Coast Guard Ships (CCGSs). These surveys are used to estimate the distribution and abundance of many fish and invertebrate species, to determine species life history characteristics, and form the basis of a number of ecosystem indicators. Through a collaborative agreement between Fisheries and Oceans Canada (DFO) and the Atlantic Groundfish Council, comparative fishing was undertaken between an industry trawler, Marine Vessel (MV) *Calvert,* and the CCGS *John Cabot* to determine comparability of the MV *Calvert* for potential use supporting or complementing DFO survey capacity. Analysis and review of data collected during paired fishing operations in 2023–24 are used to quantify differences in catchability between the MV *Calvert* and the current CCGSs in spring in North Atlantic Fisheries Organization (NAFO) Divisions 3LNO. Conversion factor analysis was completed for all taxa where sufficient data was collected, and functional groups. Data collected were sufficient to estimate conversions for seven taxa, and determine no conversion is required for 26 taxa. All other taxa had insufficient data to determine if a conversion factor is appropriate. No conversion is required for all seven functional groups.

1. INTRODUCTION

The Fisheries and Oceans Canada (DFO) Newfoundland and Labrador (NL) spring multispecies survey covers Northwest Atlantic Fisheries Organization (NAFO) Divisions 3LNOPs, including the Grand Bank (Div. 3LNO) and Southern Newfoundland (subDiv. 3Ps). Data from these surveys are used to inform stock assessment and fisheries management, ecosystem assessments, species at risk, marine conservation monitoring, and a variety of research programs. These surveys are currently completed by Offshore Fishery Science Vessels (OFSVs) from the Canadian Coast Guard (CCG): Canadian Coast Guard Ship (CCGS) *Capt. Jacques Cartier* (hereafter the "*Cartier*") and CCGS *John Cabot* (hereafter the "*Cabot* (CAB)") fishing a standard Campelen 1800 survey trawl as described in Walsh et al. (2009) with the modifications described in Wheeland et al. (2024b).

Extensive comparative fishing was completed between the new Offshore Fisheries Science Vessels (OFSVs) with previous CCG vessels (*CCGS Teleost* and *CCGS Alfred Needler*) used in the survey to determine differences in relative catchability to ensure the continuation of critical time series (DFO 2024, DFO 2025, Trueman et al. 2025a, Trueman et al. 2025b, Trueman et al. 2025c. Comparative fishing involves fishing old and new vessels side by side to quantify differences in catch size and composition (full details on the comparative fishing protocol in NL can be found in Wheeland et al. 2024b). In addition to the new OFSVs, and in response to recent challenges of vessel availability in the NL region, a two year collective agreement was established with DFO, and the Atlantic Groundfish Council to make use of their industry trawler the Marine Vessel (MV) *Calvert* (hereafter, the "*Calvert* (CAL)") to help support the DFO NL multispecies survey program. Therefore, the comparative fishing program was expanded to include development of conversion factors between the *Cabot* and the *Calvert*, both fishing the modified Campelen 1800 survey trawl (see Table 1 for a comparison of vessel characteristics). The information presented here outlines the results of comparative fishing between the *Calvert* and the *Cabot* in NAFO Div. 3LNO that occurred across spring 2023–24.

2. METHODS

A shadow survey (Thiess et al. 2017; DFO 2025) was implemented for NAFO Div. 3LNO in the spring of 2023 – 24; paired sets with the Calvert were undertaken during the standard multispecies survey completed by the Cabot, at regular survey stations chosen according to the stratified random design. Not all allocated survey sets were completed as paired tows given the Calvert was only active for a portion of the survey season (one three week trip in each year). For each paired tow, the vessels fished as close together in space and time as operationally feasible as per the guidelines outlined in Wheeland et al. 2024b. Distance between tows within a pair ranged from 0.05–1.47 nautical miles (Nm), but was 0.47 ± 0.23 Nm (± standard deviation) on average. Depth difference within a pair average 3.45 ± 5.27 m (0–31 m range). A total of 121 paired tows (Figure 1) were completed across the spring of 2023 (N = 36) and 2024 (N = 85).

Trawl geometry and performance was monitored on both vessels using sensors which measure factors such as door spread, wing spread, and trawl opening height. At shallow depths (<~200 m) the door and wing spread of the Calvert was generally comparable to those of the Cabot, and the opening was generally lower. In deeper waters (>~200 m) the door and wing spread of the Calvert was smaller, and opening higher compared to the Cabot. The door and wing spread of the Calvert did not increase with depth to the same degree as expected based on normal trawl behaviour; this is attributed to the heavier warps on the Calvert, and results in a

slightly narrower swept area for the Calvert with depth than the Cabot, with the difference between the vessels increasing with increasing depth.

At-sea observations and post-hoc examination of trawl measurements revealed significant issues with trawl performance, with unstable or collapsed trawl doors evident in some sets on the Calvert. Issues were more pronounced with increasing depth. Instability of the doors was attributed to the heavier trawl warps used on the Calvert relative to the standard survey rigging. In some cases, short increases in speed were used by the vessel's crew to right the doors, however this led to tow speed exceeding acceptable survey limits and these sets were removed from the comparative dataset.

Adjustments to the survey's standardized scope ratio (i.e., ratio of warp length to fishing depth) were largely able to compensate for this during the 2024 program. These adjustments were made incrementally (e.g., decreasing by 10% then 15% and so on) as an ad hoc approach to improving trawl performance and tow standardization during an ongoing program. Adjustments were informed by a protocol provided by a DFO gear technician, and adjusted at-sea by the chief scientist and vessel crew based on field observations.

Overall, the scope ratio was decreased (i.e., less warp for given depth) by as much as 27%; larger adjustments were needed at greater depths, while sets <150 m depth could generally be successfully completed with the standard scope ratio (Figure 2). These adjustments introduce variation within the paired tows, however, as conversion factors are estimated based only on sets where overall trawl geometry met standardized criteria for opening size and speed, and showed stable trawl performance, the impact here is considered minimal.

As a result of gear instability, 18 paired sets from 2023 and 18 paired sets from 2024 were removed from analyses. One additional pair was removed based on paired tow criteria defined in Wheeland et al. (2024a). The final paired tow count included in conversion factor estimation was 84 pairs: five in Div. 3O, 50 in Div. 3N, and 29 in Div. 3L (Figure 1).

2.1. CONVERSTION FACTOR ANALYSIS

For species with sufficient size data (minimum 25 paired tows), a suite of 13 binomial (Table 2) and beta-binomial models (Table 3) with various assumptions were used to estimate size-disaggregated conversion factors for catch numbers by length. For those species with no size information, size aggregated analysis was completed to determine a conversion for abundance and biomass (minimum 15 paired tows). The conversion factors are defined as an estimate of relative catch efficiency (ρ), or catch efficiency at length ρ(l), with the conversion factor being the ratio of catchabilities between the *Cabot* and the *Calvert*. When ρ<1 indicates the *Calvert* caught a greater amount, while a ρ>1 indicates the *Calvert* caught less. If ρ=1, conversion of catches between vessels is not required. A full description of model specifics and the data analysis framework for comparative fishing is outlined in Trueman et al. 2025a.

Size aggregated analysis was also completed for functional groups: large benthivores, medium benthivores, small benthivores, piscivores, plank-piscivores, planktivores, and shellfish. Full details on species within each functional group can be found in Munro et al. (In press*).* Catch weight and numbers of all species within a group were summed for each set to give a functional group weight and number by set. These conversions are intended to be used at the grouped level only and are not applicable to any single species within a group.

2.2. SPATIAL CONSIDERATIONS

Seabed characteristics of the comparative fishing strata completed with the *Calvert* were compared to the characteristics of the total spring survey area in NAFO Div. 3LNO to assess

whether the comparative fishing program was carried out on a representative subsample of the survey strata. Seabed characteristics included in this analysis are depth (GEBCO 2023) and terrain attributes (slope, ruggedness, and benthic position index); bottom current velocity (Tyberghein et al. 2012; Assis et al. 2017); and modeled dominant substrate (E. Novaczek, unpublished data). These variables are described in detail in Trueman et al. (2025).

Summary statistics were calculated for each variable using the zonal statistics to table tool in ArcGIS Pro for the Div. 3LNO spring survey area (strata within NAFO Div. 3LNO up to 732 m). This was repeated for the subset of survey strata where more than two successful paired sets were completed alongside the *Calvert*. This comparison is limited to quantitative variables, and therefore categorical information on substrate and geomorphology were not included.

2.3. SPECIES COMPOSITION REPRESENTATION OF THE PAIRED SETS

Within each functional group, species composition reported within the paired sets was compared to that observed in the survey in divisions 3LNO recent time period (2017 – 20) in order to determine if paired tows captured a composition representative of that normally encountered in the recent time period.

Using Vegan (Oksanen et al. 2022) in R (4.4.0), community composition was examined using Non-metric MultiDimensional Scaling (nMDS) for each functional group with all comparative fishing sets and recent survey sets. Bray-Curtis distance matrix was calculated using square root transformed and Wisconsin standardized catch weights. Results were visualized to ensure overlap of paired sets with historical data. Associated species scores were included alongside community composition of sets. More details of the analysis are available in Munro et al. (In press).

3. RESULTS & DISCUSSION

3.1. TRAWL GEOMETRY & PERFORMANCE

As trawl monitoring data from the *Calvert* could not be exported for post-processing, the door spread, wing spread and opening of the trawl were estimated from print outs of at-sea monitoring plots. In contrast, values described here for the *Cabot* are summarized from exported datafiles. Therefore, there is a difference in accuracy and precision of absolute values between the two vessels; this is not considered to impact interpretation of trends, but we caution against over-interpretation of absolute differences.

Due to technical issues, there was no trawl opening data recorded for 33 sets on the *Calvert* in 2024. Trawl geometry on the *Calvert* differed with depth in comparison to the *Cabot* (Figure 3). At shallow depths (<200 m) the door and wing spread of the *Calvert* was generally comparable to those of the *Cabot*, and the opening was generally lower. In deeper waters (>200 m) the door and wing spread of the *Calvert* was smaller, and opening higher compared to the *Cabot.* The door and wing spread of the *Calvert* when fishing in deeper waters was more narrow than expected trawl behaviour and this is attributed to the heavier warps on the *Calvert*. All sets that were considered successful and used in the estimation of conversion factors had trawl geometry measurements and average tow speed within the standard range of values typically applied to the multispecies survey data when the Campelen trawl is used on the CCG vessels for the NL surveys. Further work would be required to refine specific ranges of expected trawl geometry measurements for the Campelen when fished by the *Calvert.*

3.2. SPATIAL ANALYSIS

Twenty-two strata were completed (i.e., two or more successful paired sets) during the *Calvert* comparative fishing efforts of 2023 – 24. For the tested terrain variables (depth, slope, ruggedness, benthic position index (BPI), current velocity, and substrate) the mean and range of the comparative fishing strata have substantial overlap with the full survey area (Figure 4). There is very mild truncation of some variables, including ruggedness and the low broad BPI. Average depth is slightly shallower and average current velocity is slightly lower for the comparative fishing areas when compared to the full Div. 3LNO spring survey area. For substrates, muddy habitats may be slightly under-represented and gravel habitats may be slightly over-represented. The completed strata generally include flat, shallow bank habitats made up of sandy and gravelly bottom types, which are representative of the majority of the NAFO Div. 3LNO spring survey area up to 732 m depth.

3.3. CONVERSION FACTORS

Size disaggregated analysis was completed for eight species which met the minimum set requirement: Atlantic Cod (*Gadus morhua*), American Plaice (*Hippoglossoides plattesoides*), Yellowtail Flounder (*Myzopsetta ferruginea*), Redfish (*Sebastes spp.*), Thorny Skate (*Amblyraja radiata*), Snow Crab (*Chinoecetes opilio*), and Toad Crab (*Hyas spp.*). Size analysis was also completed for three species for which the sample size was just under the cut off (23 or 24 paired sets): Witch Flounder (*Glyptocephalus cynoglossus*), Greenland Halibut (*Reinhardtius hippoglossoides*), and Striped Wolffish (*Anarhichas lupus*). The three additional species were included due to their commercial and/or conservation importance. A brief overview of results for each species is provided below, and further details are provided in Table 4 to Table 6 and Appendix 1.

Size aggregated analysis was completed for 42 species, though results were not conclusive for all taxa analyzed. Results of size aggregated analysis are too numerous to provide a detailed assessment for each taxa, and therefore all results are provided in Table 7 and Appendix 2.

A time effect was found in the residuals for all shrimp (single species and groupings) analyzed using size aggregated models. The residual patterns coincided with the time of shift change on the vessels, and therefore is likely associated with a difference in sampling between the shifts at-sea. This effect was most evident in the abundance models, though residual patterns from the biomass model show some patterns to support a shift effect. Therefore, only data collected from noon to midnight were used to estimate size aggregated analysis for all shrimp taxa. This reduction in data did not leave enough sets to complete size disaggregated analysis for Striped Shrimp (*Pandalus montagui*). Notably, sample size would have been insufficient to estimate conversion factors for Northern Shrimp (*Pandalus borealis*) irrespective of this issue.

3.3.1. ATLANTIC COD

Atlantic Cod were caught in 57 sets across NAFO Div. 3LNO, with a length range of 9–101 cm (total length) represented in the catch. There was evidence to support the selection of BI1, BB1 or BB4 as the final model, though regardless of model selected confidence intervals (CIs) overlapped with one for all models indicating equal catchability between vessels. The length frequency comparisons show more Atlantic Cod caught by the *Calvert* for fish 30–60 cm, however assessing the catch map comparisons this appears to be from one large set in Div. 3L. The final model selected was BI1, and no issues were found in the residuals or station effect distribution for the model. Therefore the conclusion for Atlantic Cod is that no conversion factor is required, which is further supported by the size aggregated analysis where no significant conversion was found for abundance and biomass.

3.3.2. AMERICAN PLAICE

American Plaice were caught in 74 sets across Div. 3LNO with a length range of 6–69 cm represented in the catch. Best model by ΔBIC was BB1 and by ΔAIC was BB5. For both models CIs overlap with one for the whole function, except for BB5 for fish <10 cm. Length sensitivity tests show that reducing the length range eliminated the length effect, and BB1 was selected as the best model for the 1–99 and 2.5–97.5 percentile ranges. Size aggregated analysis for abundance and biomass found no significant conversion required for either. Therefore, BB1 was selected as the final model based on size disaggregated analysis, resulting in no significant conversion for American Plaice.

3.3.3. YELLOWTAIL FLOUNDER

Yellowtail Flounder were caught in 52 sets across NAFO Div. 3LNO, with a length range of 6–54 cm represented in the catch. There was evidence to support BB1 and BB4 for conversion at length for Yellowtail Flounder. Both models lead to similar calibrations, though BB1 shows a small overcorrection for <15 cm fish. Length sensitivity tests showed that the length effect becomes negligible as the length range analyzed is reduced. A significant year effect was found in the residuals for both BB1 and BB4, however this is likely due to a difference in sample size and spatial distribution of sets each year, and not indictive of a true year effect. For bulk abundance and biomass, a significant conversion was found for both metrics. Based on all the evidence presented, BB1 was selected as the final model selected from size disaggregated analysis, and a conversion of 0.76 ± 0.10 should be applied to abundance at length to Yellowtail Flounder. Biomass should be derived from converted abundance at length with the application of a length:weight relationship following Wheeland et al. (2024a).

3.3.4. REDFISH

Redfish were caught in 25 sets with a length range of 6–48 cm represented in the catch. Majority of the sets were from 3N (n = 20) with only four sets in Div. 3L and one in Div. 3O. There was evidence to support BB1 or BB5 as the best model, however both models result in CIs overlapping with one and therefore both result in no significant length-based conversion. Analysis of abundance and biomass also resulted in no significant conversion and therefore no conversion factor is required for Redfish.

3.3.5. THORNY SKATE

Thorny Skate were caught in 49 sets across NAFO Div. 3LNO, with a length range of 13–93 cm represented in the catch. The two top model contenders were BI1 and BI3, and both models CIs overlapped with one for the whole length range. The final model chosen was BI1, with no length effect. Though a significant year effect was found in the residuals, this is likely an outcome of a much lower sample size in 2023 (n = 4) compared to 2024 (n = 45). No significant conversion was found for abundance or biomass in the size aggregated analysis. Therefore, no conversion is required for Thorny Skate.

3.3.6. WITCH FLOUNDER

Witch Flounder were only caught in 24 sets, 23 of which were in Div. 3N, one in Div. 3L and none in Div. 3O. Size disaggregated analysis was still completed despite the set number being below the analysis cut off. Regardless, it was determined there was insufficient data to make a conclusion from the results and therefore it is not possible to determine if a conversion at length is required for Witch Flounder. Given restricted spatial coverage of catches for this species, and known sensitivity of conversion factors across space for flatfish on the Grand Bank (Cadigan et

al. 2023), conversion factor conclusions for Witch Flounder here are only considered appropriate for application to Div. 3NO. Data are insufficient to inform on Div. 3L for this species. No significant conversion was found for aggregated abundance and biomass for Div. 3NO.

3.3.7. GREENLAND HALIBUT

Greenland Halibut were only caught in 23 sets across NAFO Div. 3LN, with 17 sets in Div. 3N and six in Div. 3L. Models BI3 and BB1 were selected as candidates for best model based on ΔBIC<1 between the two models. In both cases, CIs overlapped with one for majority of the function, except for a small section of BI3. Assessing the 1–99 percentile length range showed continued close contention between BI3 and BB1, and the 2.5–97.5 range shifts to BI3 and BB4 being the best models. The magnitude of CIs and limited sample size do not provide a high degree of confidence in these data, and therefore at this time it is not possible to determine if Greenland Halibut catch require a conversion at length between the *Calvert* and *Cabot*. Size aggregated analysis resulted in no significant conversion required for both abundance and biomass, and therefore it can be concluded that no conversion factor is required for bulk metrics between the two vessels.

3.3.8. STRIPED WOLFFISH

Striped wolffish were only caught in 23 sets across NAFO Div. 3LNO, with a length range of 10–98 cm represented in the catch. Though there was enough data to run the size-based models and select a best fit, the amount of data per set was not enough to make a conclusion based on low catch sizes at length. Additionally, a significant time and diurnal effect was found in the residuals, which based on the limited sampling is likely not a true effect but cannot be investigated further with the available data. Therefore, only the results of the size aggregated analysis are considered conclusive, with no conversion required for bulk abundance and biomass.

3.3.9. SNOW CRAB

Snow Crab were caught in 53 sets across NAFO Div. 3LNO, with a carapace width of 10–138 mm represented in the catch. Of those 53 sets, 26 were in each Div. 3L and Div. 3N, while only one set was from Div. 3O. The best model selected was BI1, resulting in no significant conversion. Size aggregated analysis agreed with this conclusion as no significant conversion was found for bulk abundance and biomass. Therefore, no conversion factor is required for Snow Crab catch between the *Cabot* and the *Calvert*.

3.3.10. STRIPED SHRIMP

With using only data collected from noon to midnight there was no longer enough paired sets (N = 23) to consider a size effect for a conversion factor for Striped Shrimp. Only size aggregated models for abundance and biomass were assessed, and no significant conversion was found for either metric. Therefore no conversion is required for Striped Shrimp between the Cabot and Calvert in NAFO Div. 3LNO.

3.3.11. TOAD CRAB

Toad Crab were caught in 64 sets across NAFO Div. 3LNO, with a carapace length range of 12–95 mm represented in the catch. Though BI4 was selected as the best model, with a significant length effect, the shape and width of the CIs raised concerns of the biological accuracy of the results. Length sensitivity tests revealed that even with reduced length ranges,

the model output remains a consistent shape. The model diagnostics for BI4 of the full length range did not indicate any issues in the residuals or station effect for the model. However, in the size aggregated models there did appear to be some issues in the residuals for time, similar to what was observed with the shrimp data. Overall, there is a high amount of uncertainty associated with these data and the same mitigation used for shrimp was not used here as there was not a clear residual pattern to fully attribute the uncertainty to only a shift effect. Therefore, it is not possible to determine if a conversion factor is required for Toad Crab.

3.3.12. FUNCTIONAL GROUPS

There were no significant conversions estimated for any of the functional groups examined (Table 8, Appendix 3). The shift effect found in shrimp taxa was also evident in the shellfish functional group analysis, and therefore only data collected from noon to midnight was used for conversion factor estimation for that functional group. Species composition within comparative fishing sets were broadly representative of the survey in the previous time period.

4. CONCLUSIONS

The data obtained during the *Calvert* comparative fishing program were sufficient to test for differences in relative catch efficiency between the *Calvert* and *Cabot* in spring for NAFO Div. 3LNO. Significant conversion factors were estimated for seven taxa, none with a significant length effect. Twenty six taxa showed no significant difference in relative catchability, and all other taxa had insufficient data to determine if a conversion factor is appropriate. No significant conversion was found for any of the seven functional groups.

Of the commercial species examined, a significant conversion was only identified for Yellowtail Flounder. This is likely a result of increased herding of this species by the heavier warps used on the *Calvert*.

Results presented here are valid for NAFO Div. 3LNO in the spring between the *Calvert* and *Cabot* only. Any extension of these conversions will require sufficient evidence to support their use outside this established range (e.g., Wheeland et al. 2024a).

Any future work with the *Calvert* fishing the Campelen survey trawl would need to use a scope ratio different from the standard for CCG vessels given the heavier warps. While the adjustments made in 2024 can inform this scope ratio, further work may be required to refine or confirm it, especially for deeper depths where sample size here is limited.

Conversion factors estimated here are reflective of how each vessel was fished at the time of paired tows, and would not be applicable following any major change in fishing protocol or rigging

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6. TABLES

Table 1. Comparison of vessel and trawl characteristics on the CCGS John Cabot and MV Calvert.

Characteristic	*CCGS John Cabot*	*MV Calvert*
Year launched	2020	2020
Length (m)	63	74
Beam (m)	16	16
Gross Tonnage	2,672	3,800
Warp diameter (mm)/weight (kg/m)	25.4 mm/2.84 kg	32 mm/6.31 kg
Distance between gallow blocks (m)	7.9 m	8.9 m
Power (hp)	3020 hp	6437 hp
Winch system	Scantrol Autotrawl	Scantrol Autotrawl
Trawl monitoring system	Scanbas v.7.4	Scanbas 365 (bridge) Scanbas v.7.4 (data recording)
Trawl	Modified Campelen 1800 Survey Trawl	Modified Campelen 1800 Survey Trawl

Table 2. A set of binomial models with various assumptions for the length effect and station effect in the relative catch efficiency. A smoothing length effect can be considered and the station effect can be added to the intercept, without interaction with the length effect, or added to both the intercept and smoother to allow for interaction between the two effects.

Model	$\boldsymbol{log(\rho)}$	**Length Effect**	**Station Effect**
$BI0$	β_0	constant	not considered
$BI1$	$\beta_0 + \delta_{0,i}$	constant	intercept
$BI2$	$\mathbf{X}_f^T\boldsymbol{\beta}_f + \mathbf{X}_r^T\mathbf{b}$	smoothing	not considered
$BI3$	$\mathbf{X}_f^T\boldsymbol{\beta}_f + \mathbf{X}_r^T\mathbf{b} + \delta_{0,i}$	smoothing	intercept
$BI4$	$\mathbf{X}_f^T(\boldsymbol{\beta}_f + \boldsymbol{\delta}_i) + \mathbf{X}_r^T(\mathbf{b} + \boldsymbol{\epsilon}_i)$	smoothing	intercept, smoother

Table 3. A set of beta-binomial models with various assumptions for the length effect and station effect in the relative catch efficiency, and the length effect on the variance parameter. A smoothing length effect can be considered in both the conversion factor and the variance parameter. A possible station effect can be added to the intercept, without interaction with the length effect, or added to both the intercept and the smoother to allow for interaction between the two effects.

Model	$\boldsymbol{log(\rho)}$	$\boldsymbol{log(\phi)}$	**Length Effects**	**Station Effect**
$BB0$	β_0	γ_0	constant/constant	not considered
$BB1$	$\beta_0 + \delta_{0,i}$	γ_0	constant/constant	intercept
$BB2$	$\mathbf{X}_f^T\boldsymbol{\beta}_f + \mathbf{X}_r^T\mathbf{b}$	γ_0	smoothing/constant	not considered
$BB3$	$\mathbf{X}_f^T\boldsymbol{\beta}_f + \mathbf{X}_r^T\mathbf{b}$	$\mathbf{X}_f^T\boldsymbol{\gamma} + \mathbf{X}_r^T\mathbf{g}$	smoothing/smoothing	not considered
$BB4$	$\mathbf{X}_f^T\boldsymbol{\beta}_f + \mathbf{X}_r^T\mathbf{b} + \delta_{0,i}$	γ_0	smoothing/constant	intercept
$BB5$	$\mathbf{X}_f^T\boldsymbol{\beta}_f + \mathbf{X}_r^T\mathbf{b} + \delta_{0,i}$	$\mathbf{X}_f^T\boldsymbol{\gamma} + \mathbf{X}_r^T\mathbf{g}$	smoothing/smoothing	intercept
$BB6$	$\mathbf{X}_f^T(\boldsymbol{\beta}_f + \boldsymbol{\delta}_i) + \mathbf{X}_r^T(\mathbf{b} + \boldsymbol{\epsilon}_i)$	γ_0	smoothing/constant	intercept, smoother

Model	$log(\rho)$	$log(\phi)$	Length Effects	Station Effect
$BB7$	$\mathbf{X}_f^T(\boldsymbol{\beta}_f + \boldsymbol{\delta}_i) + \mathbf{X}_r^T(\mathbf{b} + \boldsymbol{\epsilon}_i)$	$\mathbf{X}_f^T\boldsymbol{\gamma} + \mathbf{X}_r^T\mathbf{g}$	smoothing/smoothing	intercept, smoother

Table 4. Relative evidence for length-disaggregated binomial and beta-binomial models for the CCGS John Cabot and Marine Vessel (MV) Calvert comparative fishing analysis based on the AIC/BIC and delta (Δ) values compared to lowest AIC/BIC per species. Entries with '–' indicate models that did not converge. BB6 did not converge for any species and is not included in the table.

Value	Species	BI0	BI1	BI2	BI3	BI4	BB0	BB1	BB2	BB3	BB4	BB5
AIC	Atlantic Cod	1,540	1,316	1,541	1,317	-	1,432	1,311	1,435	1,438	1,313	1,314
ΔAIC	Atlantic Cod	229	5	230	6	-	121	0	124	127	2	2
BIC	Atlantic Cod	1,547	1,329	1,561	1,344	-	1,445	1,331	1,462	1,478	1,346	1,360
ΔBIC	Atlantic Cod	218	0	232	14	-	116	2	133	149	17	31
AIC	American Plaice	4,222	3,879	4,206	3,861	-	4,078	3,853	4,075	4,076	NA	3,842
ΔAIC	American Plaice	380	37	364	19	-	236	11	233	234	NA	0
BIC	American Plaice	4,228	3,892	4,225	3,887	-	4,091	3,872	4,101	4,115	NA	3,887
ΔBIC	American Plaice	356	20	353	15	-	219	0	229	243	NA	15
AIC	Yellowtail Flounder	5,152	4,359	5,140	4,358	-	4,780	4,329	4,781	4,778	4,330	4,327
ΔAIC	Yellowtail Flounder	825	32	813	31	-	453	2	453	450	2	0
BIC	Yellowtail Flounder	5,158	4,371	5,158	4,381	-	4,792	4,347	4,804	4,813	4,359	4,368
ΔBIC	Yellowtail Flounder	811	24	811	34	-	445	0	457	466	12	21
AIC	Redfish	2,198	1,734	2,166	1,685	-	1,545	1,507	1,543	1,539	1,508	1,495
ΔAIC	Redfish	703	239	671	190	-	50	12	48	44	13	0
BIC	Redfish	2,203	1,744	2,181	1,705	-	1,555	1,522	1,563	1,569	1,533	1,530
ΔBIC	Redfish	681	222	659	183	-	33	0	41	47	11	8
AIC	Thorny Skate	1,140	1,092	1,122	1,092	-	1,135	-	1,124	1,128	-	-
ΔAIC	Thorny Skate	48	0	30	0	-	43	-	32	37	-	-
BIC	Thorny Skate	1,146	1,104	1,141	1,117	-	1,148	-	1,149	1,166	-	-
ΔBIC	Thorny Skate	42	0	37	13	-	43	-	45	62	-	-
AIC	Witch Flounder	202	185	205	189	-	204	-	-	-	-	-
ΔAIC	Witch Flounder	16	0	20	4	-	18	-	-	-	-	-
BIC	Witch Flounder	207	196	221	210	-	214	-	-	-	-	-
ΔBIC	Witch Flounder	11	0	25	14	-	18	-	-	-	-	-
AIC	Greenland Halibut	435	390	409	375	-	394	381	393	397	375	379
ΔAIC	Greenland Halibut	60	15	35	0	-	19	7	19	23	1	5

Value	Species	BI0	BI1	BI2	BI3	BI4	BB0	BB1	BB2	BB3	BB4	BB5
BIC	Greenland Halibut	440	400	425	395	-	404	397	414	428	401	415
ΔBIC	Greenland Halibut	45	5	29	0	-	9	1	19	33	6	20
AIC	Striped Wolffish	283	281	286	284	-	283	282	286	-	284	288
ΔAIC	Striped Wolffish	1	0	4	2	-	2	0	5	-	3	7
BIC	Striped Wolffish	288	293	302	306	-	295	299	309	-	312	327
ΔBIC	Striped Wolffish	0	4	14	18	-	6	10	20	-	24	39
AIC	Snow Crab	801	700	784	704	-	743	700	746	744	704	707
ΔAIC	Snow Crab	101	0	85	4	-	43	0	46	44	4	8
BIC	Snow Crab	807	714	805	731	-	756	720	773	785	738	755
ΔBIC	Snow Crab	94	0	91	17	-	43	7	60	71	24	42
AIC	Toad Crab	2,053	1,644	1,910	1,553	1,191	1,801	1,561	1,765	1,762	1,525	1,524
ΔAIC	Toad Crab	862	453	719	362	0	609	369	574	571	334	333
BIC	Toad Crab	2,059	1,657	1,930	1,580	1,237	1,814	1,580	1,791	1,801	1,558	1,571
ΔBIC	Toad Crab	822	420	692	342	0	576	343	554	564	321	333

Table 5. P-values associated with tests for a smooth effect of depth, and time of day, as well as fixed effects of year, NAFO division, and diurnal period (day/night) on the normalized quantile residuals from the length-disaggregated selected best model.

Common Name	Model	s(Depth)	s(Time)	Year	NAFO Division	Diurnal Period
Atlantic Cod	BI1	0.36	0.99	0.82	0.18	0.66
American Plaice	BB1	0.24	0.76	0.54	0.94	0.85
Yellowtail Flounder	BB1	0.08	0.70	0.04	0.19	0.92
Redfish	BB1	0.96	0.36	0.89	0.70	0.60
Thorny Skate	BI1	0.67	0.29	0.01	0.09	0.17
Witch Flounder	BI1	0.95	0.91	0.05	0.16	0.47
Greenland Halibut	BI3	0.64	0.60	0.32	0.56	0.83
Striped Wolffish	BI0	0.73	<0.01	0.58	0.32	0.01
Snow Crab	BI1	0.86	0.88	0.30	0.22	0.78
Toad Crab	BI4	0.69	0.52	0.30	0.48	0.44

Table 6. Summary of recommendations for species for which length-disaggregated conversion factor models were applied. For species where length was not determined to be significant, rho ± standard error (SE) estimates are provided here. For the species where a length based conversion was found, the percentiles at which a constant conversion is to be applied is also provided.

Species	Model	Determination	Details	Rho	SE Rho	Percentile Lengths
Atlantic Cod	BI1	No conversion required	n/a	-	-	-
American Plaice	BB1	No conversion required	n/a	-	-	-
Yellowtail Flounder	BB1	Conversion required	Length not significant	0.76	0.10	Full length range
Redfish	BB1	No conversion required	n/a	-	-	-
Thorny Skate	BI1	No conversion required	n/a	-	-	-
Witch Flounder	BI1	Insufficient data	n/a	-	-	-
Greenland Halibut	BI3	Insufficient data	n/a	-	-	-
Striped Wolffish	BI0	Insufficient data	n/a	-	-	-
Snow Crab	BI1	No conversion required	n/a	-	-	-
Toad Crab	BI4	Inconclusive	n/a	-	-	-

Table 7. Relative evidence for size-aggregated binomial and beta-binomial models for CCGS John Cabot and MV Calvert spring catch counts based on AIC/BIC values, and estimates of the conversion factor Rho, and approximate 95% confidence intervals, for catches in numbers and in weights for taxa for which length-disaggregated analyses were also undertaken. Recall that a single model was used for catch weights (Tweedie distribution) and thus AIC and BIC values are not shown. Entries with '–' indicate models that did not converge or where results were inconclusive. Species denoted with an asterisk (*) indicate where models were fit using a reduced data set to account for the shift effect found in the residuals when using the full data set.

Species	Code	BI1 (AIC)	BB0 (AIC)	BB1 (AIC)	BI1 (BIC)	BB0 (BIC)	BB1 (BIC)	Model Selected	Rho (CI), numbers	p-value, numbers	Rho (CI), weights	p-value, weights	Recommendation
Atlantic Cod	438	261.55	260.67	262.67	265.64	264.75	268.79	BB0	0.80 (0.60–1.06)	0.12	0.85 (0.58–1.25)	0.41	No conversion
American Plaice	889	527.31	525.33	526.99	531.92	529.94	533.91	BB0	1.05 (0.90–1.24)	0.53	1.05 (0.88–1.25)	0.58	No conversion
Yellowtail Flounder	891	494.65	488.45	488.71	498.55	492.36	494.56	BB0	0.78 (0.63–0.97)	0.02	0.84 (0.70–1.00)	0.05	See length disaggregated results
Redfish	794	209.68	209.17	211.16	212.11	211.60	214.82	BB0	1.21 (0.88–1.65)	0.25	1.27 (0.88–1.84)	0.20	No conversion
Thorny Skate	90	201.94	201.60	203.60	205.72	205.39	209.28	BB0	0.87 (0.70–1.08)	0.20	0.95 (0.75–1.21)	0.67	No conversion
Witch Flounder	890	85.62	84.51	86.51	87.97	86.87	90.05	BB0	1.14 (0.65–2.00)	0.64	1.44 (0.83–2.51)	0.19	No conversion
Greenland Halibut	892	80.43	80.39	82.39	82.70	82.67	85.80	BB0	1.31 (0.88–1.93)	0.18	1.19 (0.73–1.96)	0.48	No conversion
Striped Wolffish	700	75.73	75.42	77.42	78.00	77.69	80.83	BB0	1.07 (0.70–1.62)	0.75	0.78 (0.42–1.45)	0.43	No conversion
Snow Crab	8,213	242.71	241.49	243.49	246.65	245.43	249.40	BB0	0.94 (0.66–1.34)	0.74	1.27 (0.85–1.91)	0.25	No conversion
Toad Crab	8,216	437.97	436.23	438.23	442.29	440.55	444.71	BB0	-	-	-	-	Inconclusive
Striped Shrimp*	8,112	695.69	685.14	684.34	699.74	689.19	690.42	BB0	0.61 (0.33–1.12)	0.11	0.76 (0.44–1.32)	0.33	No conversion
Alligatorfish and Poachers	836	90.77	88.55	90.54	92.76	90.55	93.52	BB0	0.55 (0.26–1.19)	0.13	0.56 (0.27–1.16)	0.12	No conversion
Amphipods and Gammarids	6,930	69.20	71.10	73.09	70.87	72.77	75.59	B1	-	-	-	-	Insufficient data
Annelids and Polychaetes	4,950	37.37	42.17	39.37	40.18	44.97	43.58	B1	-	-	-	-	Insufficient data
Benthic Shrimp*	8,120	387.06	379.33	378.30	390.43	382.71	383.37	BB0	0.57 (0.24–1.33)	0.19	1.44 (0.53–3.91)	0.47	no conversion
Benthopelagic Shrimp*	8,010	465.28	455.83	457.28	469.22	459.77	463.19	BB0	0.81 (0.38–1.73)	0.58	0.58 (0.28–1.20)	0.14	No conversion
Bivalves	3,995	29.57	34.66	36.65	31.11	36.20	38.97	B1	-	-	-	-	Insufficient data
Brittle Stars	8,530	87.82	82.75	84.75	90.81	85.74	89.24	BB0	-	-	-	-	Insufficient data
Capelin	187	905.81	894.13	892.71	910.42	898.74	899.62	BB0	0.99 (0.75–1.31)	0.96	0.84 (0.66–1.07)	0.17	No conversion
Eelpouts	726	180.59	179.60	181.60	184.42	183.43	187.34	BB0	1.30 (0.93–1.82)	0.13	1.13 (0.74–1.72)	0.56	No conversion
Gastropods	3,175	198.73	194.32	196.09	202.06	197.65	201.08	BB0	1.55 (0.92–2.62)	0.10	1.43 (0.77–2.68)	0.26	No conversion

Species	Code	BI1 (AIC)	BB0 (AIC)	BB1 (AIC)	BI1 (BIC)	BB0 (BIC)	BB1 (BIC)	Model Selected	Rho (CI), numbers	p-value, numbers	Rho (CI), weights	p-value, weights	Recommendation
Roughhead Grenadier	474	88.84	88.93	90.92	90.50	90.59	93.42	B1	0.84 (0.59–1.18)	0.31	0.84 (0.63–1.13)	0.26	No conversion
Grenadiers, other	470	102.26	102.38	104.38	103.53	103.65	106.29	B1	0.80 (0.60–1.07)	0.13	0.72 (0.52–0.99)	0.04	Biomass conversion
Atlantic herring	150	26.90	26.90	-	28.32	28.32	-	BB0	-	-	-	-	Insufficient data
Sand Dollars	8,370	495.22	484.77	486.14	499.41	488.96	492.42	BB0	0.80 (0.55–1.15)	0.23	0.78 (0.53–1.18)	0.24	No conversion
Sand Lance	694	792.80	783.24	783.60	797.09	787.53	790.03	BB0					Insufficient data
Icelandic Scallop	4,167	86.99	86.64	88.64	89.79	89.45	92.85	BB0	1.64 (0.98–2.74)	0.06	2.42 (1.38–4.24)	<0.01	Abundance and biomass conversion
Sculpins	810	588.11	585.80	587.76	592.69	590.38	594.63	BB0	0.95 (0.75–1.21)	0.72	1.13 (0.88–1.45)	0.34	No conversion
Sea Anemones	2,165	157.74	154.63	156.55	160.41	157.29	160.55	BB0	0.84 (0.47–1.53)	0.58	1.31 (0.77–2.25)	0.32	No conversion
Sea Cucumbers	8,290	260.06	257.91	259.74	263.44	261.29	264.81	BB0	1.20 (0.78 1.86)	0.40	1.13 (0.69–1.84)	0.62	No conversion
Sea Potatoes	8,791	151.73	148.82	150.66	154.95	152.04	155.49	BB0	2.44 (1.40–4.25)	<0.01	2.65 (1.50–4.68)	<0.01	Abundance and biomass conversion
Cushion Sea Star	8,479	62.51	62.09	64.08	64.18	63.76	66.58	BB0	0.46 (0.20–1.04)	0.06	0.90 (0.41–1.98)	0.79	No conversion
Henricia Sea Star	8,483	77.03	77.65	79.65	79.63	80.24	83.53	B1	-	-	-	-	Insufficient data
Sea Stars (all grouped)	8,390	485.26	480.62	482.55	489.97	485.33	489.62	BB0	1.44 (1.07–1.96)	0.02	2.45 (1.73–3.48)	<0.01	Abundance and biomass conversion
Sea Urchins	8,360	538.66	532.32	534.06	542.89	536.54	540.39	BB0	1.48 (1.03–2.11)	0.03	3.24 (2.16–4.84)	<0.01	Abundance and biomass conversion
Basket Stars	8,540	-	-	-	-	-	-	-	-	-	1.82 (0.84–4.07)	0.15	No conversion
Bryozoans	9,992	-	-	-	-	-	-	-	-	-	-	-	Insufficient data
Comb Jellies	2,250	-	-	-	-	-	-	-	-	-	3.87 (2.51–5.96)	<0.01	Biomass conversion
Soft Corals	8,904	-	-	-	-	-	-	-	-	-	0.92 (0.51–1.68)	0.79	No conversion
Jellyfish	2,040	-	-	-	-	-	-	-			1.01 (0.51–2.00)	0.98	No conversion
Sponge	1,101	-	-	-	-	-	-	-	-	-	0.72 (0.39–1.33)	0.29	No conversion
Tunicates	8,680	-	-	-	-	-	-	-	-	-	1.30 (0.67–2.52)	0.44	No conversion

Table 8. Relative evidence for size-aggregated binomial and beta-binomial models of functional groups for CCGS John Cabot and MV Calvert spring catch counts based on AIC/BIC values, and estimates of the conversion factor Rho, and approximate 95% confidence intervals, for catches in numbers and in weights for taxa for which length-disaggregated analyses were also undertaken. Recall that a single model was used for catch weights (Tweedie distribution) and thus AIC and BIC values are not shown. Entries with '–' indicate models that did not converge or where results were inconclusive. The shellfish functional group used a reduced data set for model fits to account for the shift effect found in the residuals when the full data set was used.

Functional Group	BI1 (AIC)	BB0 (AIC)	BB1 (AIC)	BI1 (BIC)	BB0 (BIC)	BB1 (BIC)	Model Selected	Rho (CI), numbers	p-value, numbers	Rho (CI), weights	p-value, weights	Recommendation
Large benthivores	615.04	613.44	615.15	619.90	618.30	622.44	BB0	1.04 (0.92–1.18)	0.49	0.98 (0.85–1.13)	0.76	No conversion
Medium benthivores	739.03	734.80	736.27	743.89	739.66	743.56	BB0	0.99 (0.84–1.18)	0.93	0.90 (0.77–1.04)	0.16	No conversion
Small benthivores	695.50	690.90	692.57	700.21	695.62	699.64	BB0	0.83 (0.66–1.06)	0.14	1.03 (0.85–1.24)	0.78	No conversion
Piscivores	332.39	331.75	333.75	336.86	336.22	340.45	BB0	0.90 (0.72–1.12)	0.14	1.09 (0.76–1.54)	0.78	No conversion
Plank-piscivores	266.71	264.73	266.50	269.58	267.60	270.80	BB0	1.07 (0.74–1.56)	0.71	1.24 (0.89–1.71)	0.20	No conversion
Planktivores	1,164.44	1,149.78	1,146.94	1,169.28	1,154.61	1,154.20	BB1	1.17 (0.89–1.53)	0.25	1.10 (0.86–1.41)	0.46	No conversion
Shellfish	858.13	851.10	852.85	862.90	855.86	859.99	BB0	0.71 (0.45–1.11)	0.13	0.94 (0.69–1.28)	0.69	No conversion

7. FIGURES

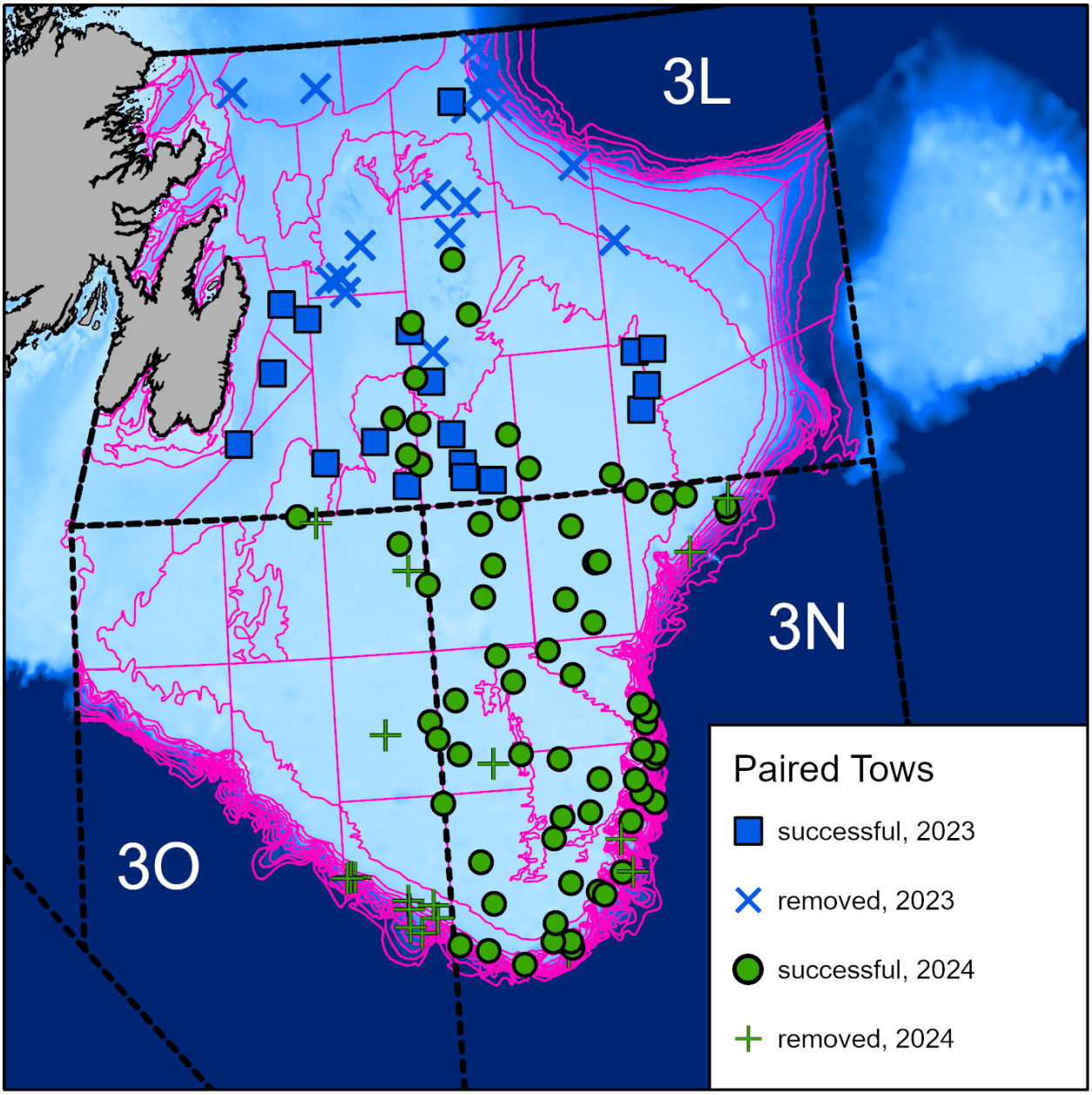

Figure 1. Paired set locations in spring 2023 – 24 in NAFO Divisions 3LNO (black dashed lines) between the Canadian Coast Guard Ship (CCGS) John Cabot and MV Calvert. Blue area with pink outlines shows the DFO Newfoundland and Labrador multispecies survey strata. Green circles show successful paired sets from 2024, and green crosses are sets removed after post hoc analysis. Blue squares show successful paired sets from 2023, and sets removed after post hoc analysis are denoted with a blue X. Note that strata >732 m are not surveyed in spring.

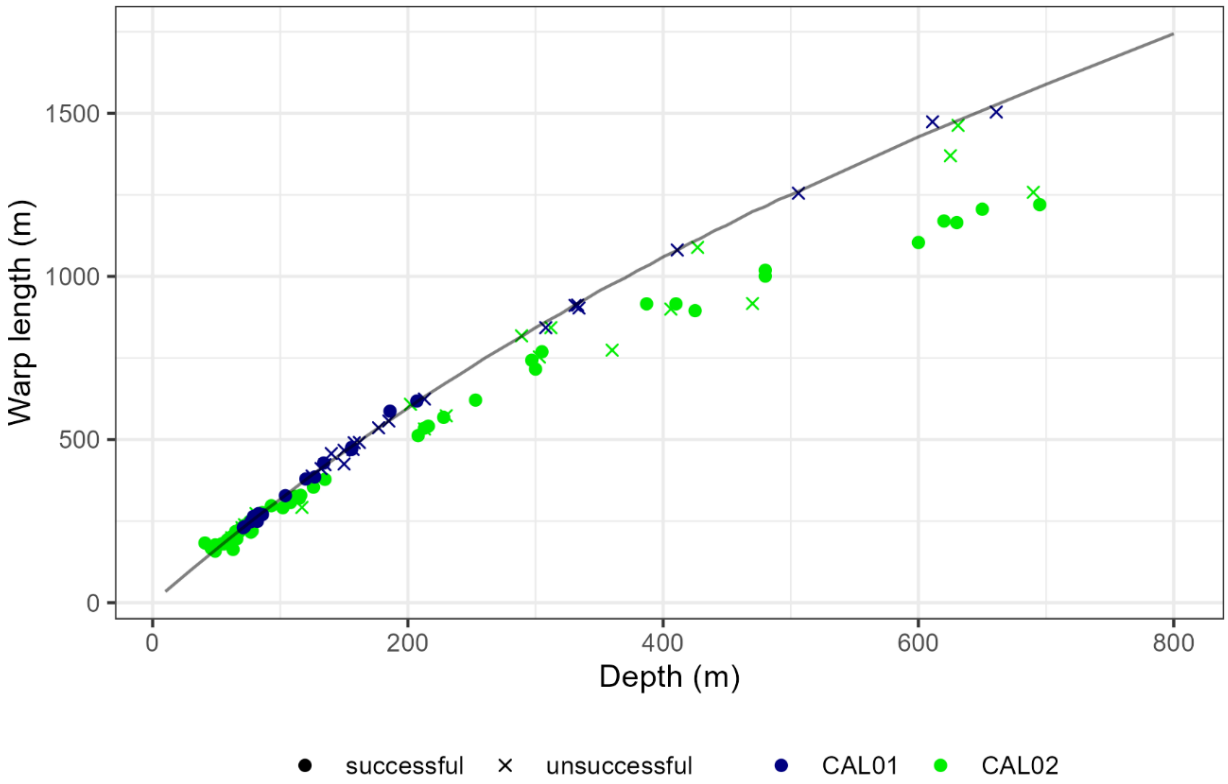

Figure 2. Warp length (m) used at depth (m) for trawl sets on the MV Calvert in 2023 (CAL01- blue) and 2024 (CAL02- green).Sets deemed successful are shown by circles, while unsuccessful sets are indicated by an X. The solid line indicates the standard Campelen scope ratio used on Candian Coast Guard vessels.

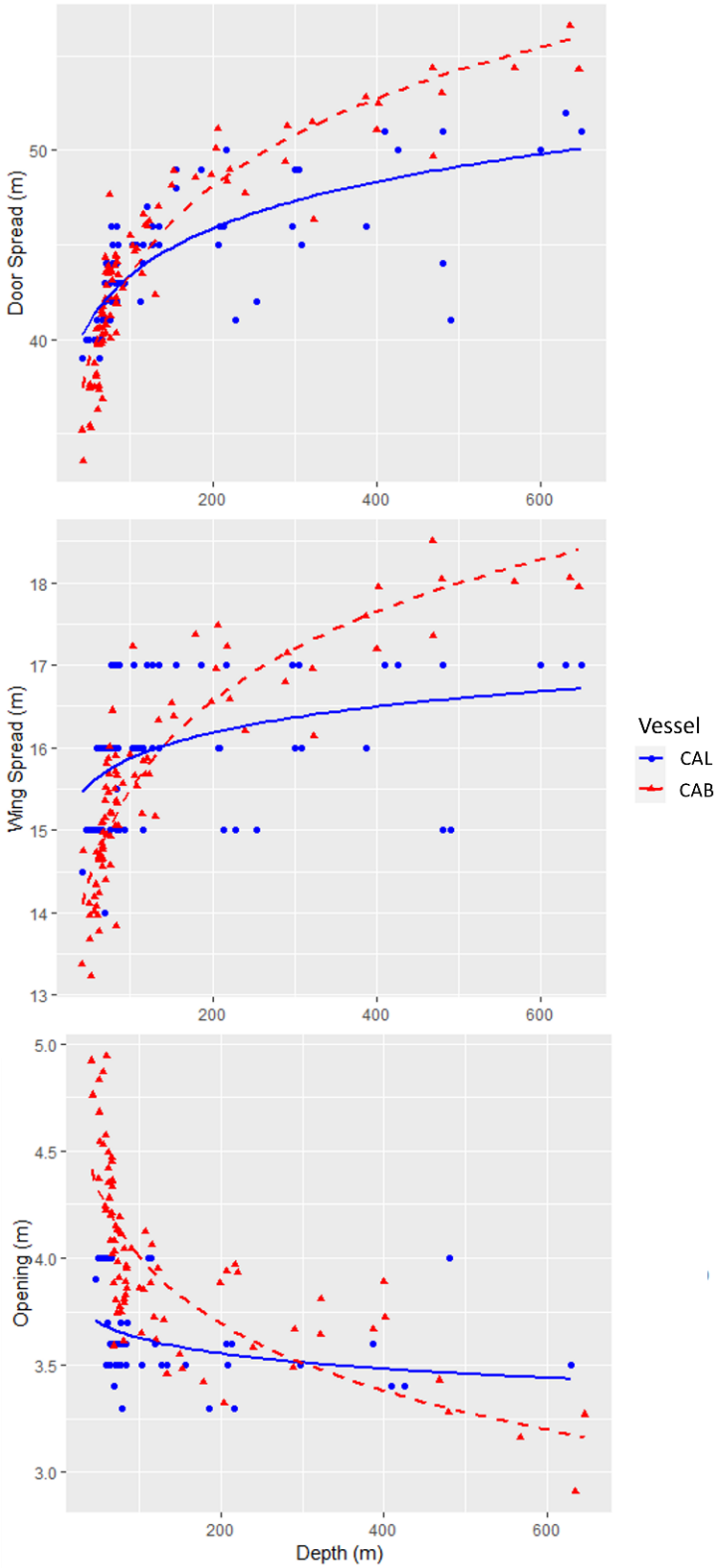

Figure 3. Trawl geometry measurements from the CCGS John Cabot (CAB; red triangles) and MV Calvert (CAL; blue circles) for successful sets. Values for the MV Calvert have been estimated from print outs of trawl monitoring graphs while CCGS John Cabot values are quantified from exported data recordings.

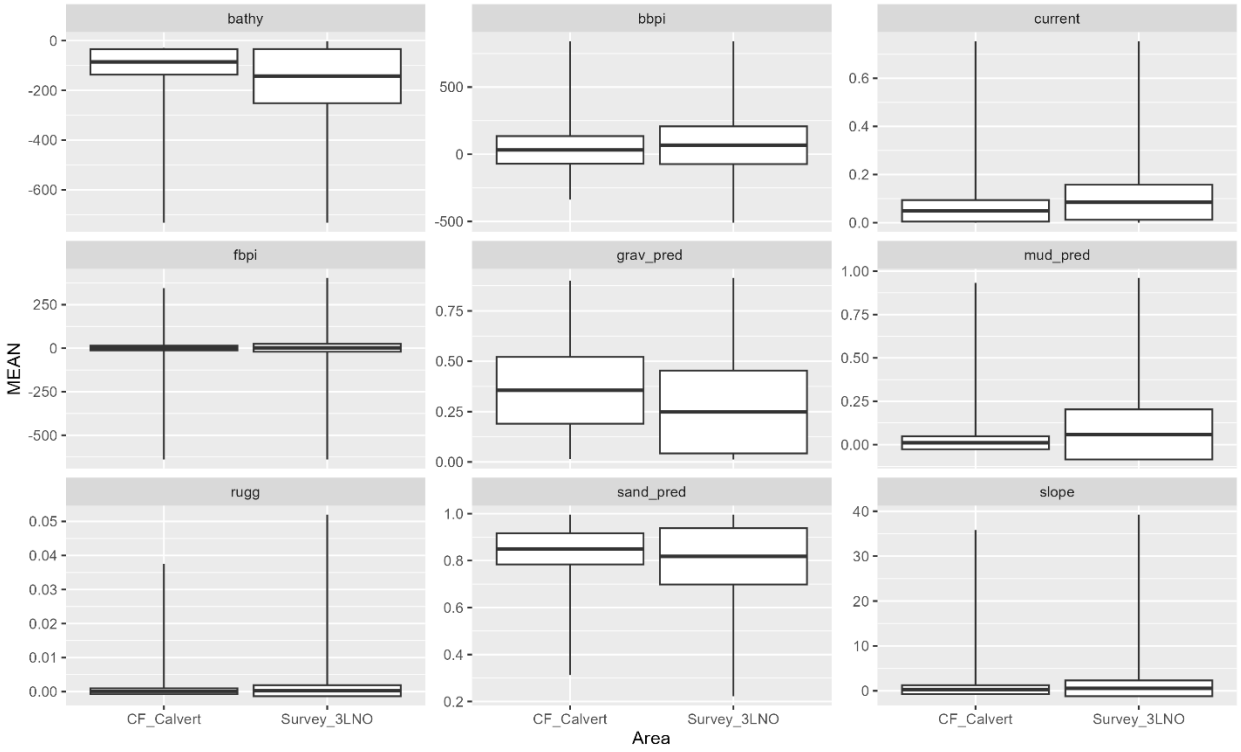

Figure 4. Seabed characteristics of the Newfoundland and Labrador multispecies survey CCGS John Cabot spring survey area in NAFO Divisions 3LNO (Surv_3LNO) and for the comparative fishing (CF) strata completed with the MV Calvert (CF_Calvert), including broad BPI, fine BPI, ruggedness, current (m/s), depth (m), slope, and percent likelihood that sand, gravel, or mud make up the dominant substrate type.

8. APPENDIX 1: SIZE DISAGGREGATED CONVERSION FACTOR RESULTS

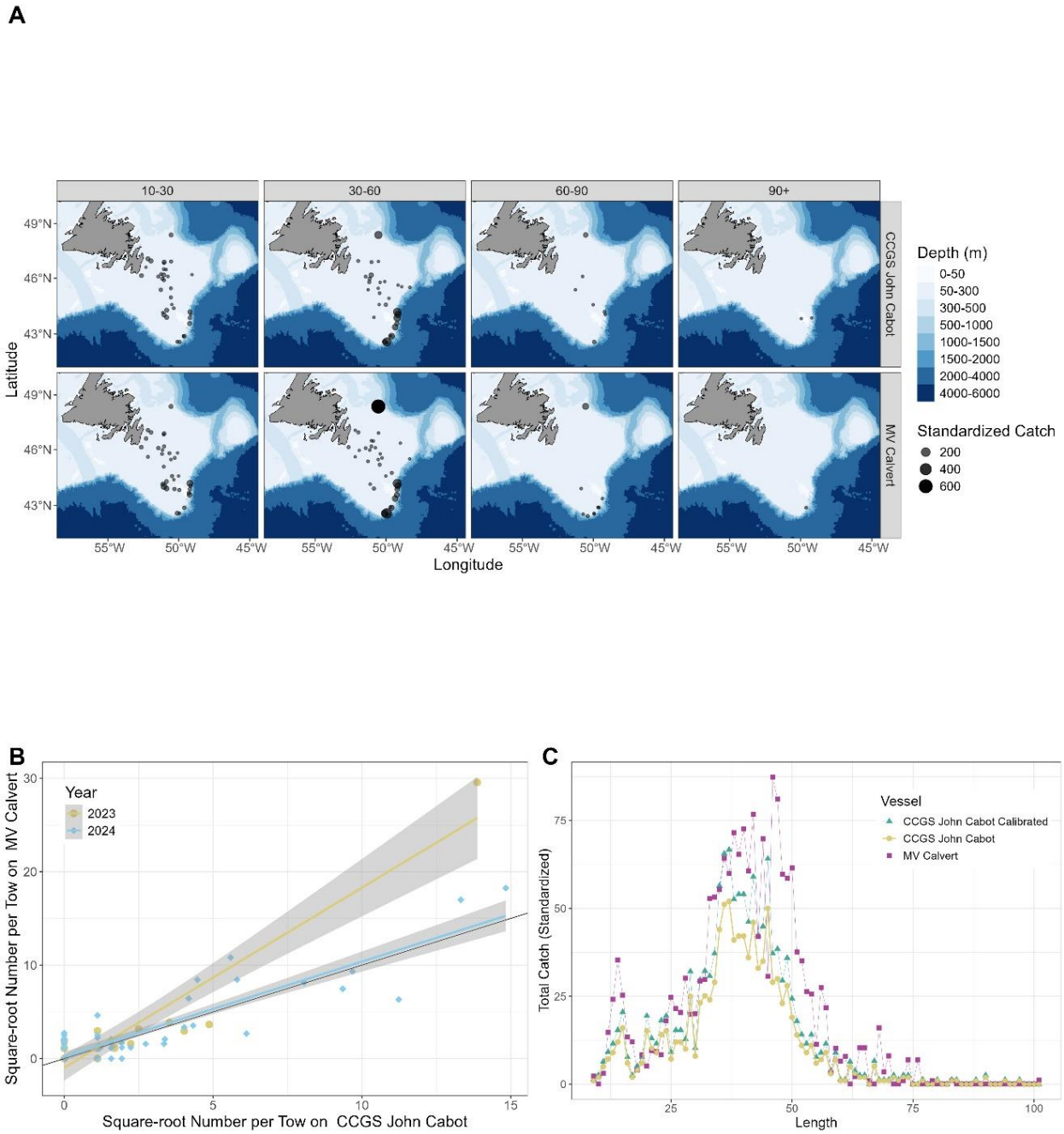

*Figure A1 - 1. Results for length-disaggregated comparative fishing analyses for Atlantic Cod (*Gadus morhua*), between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) map of catches by length group (length in cm specified in top panel) by the CCGS John Cabot (top) and the MV Calvert (bottom) in comparative fishing sets, where circle size is proportional catch weight (B) Biplot of the square-root of CCGS John Cabot catch numbers against the square-root of MV Calvert catch numbers. (C) Total length frequencies for catches made by the CCGS John Cabot (yellow), by the MV Calvert (purple), and CCGS John Cabot catches with the conversion factor applied (green).*

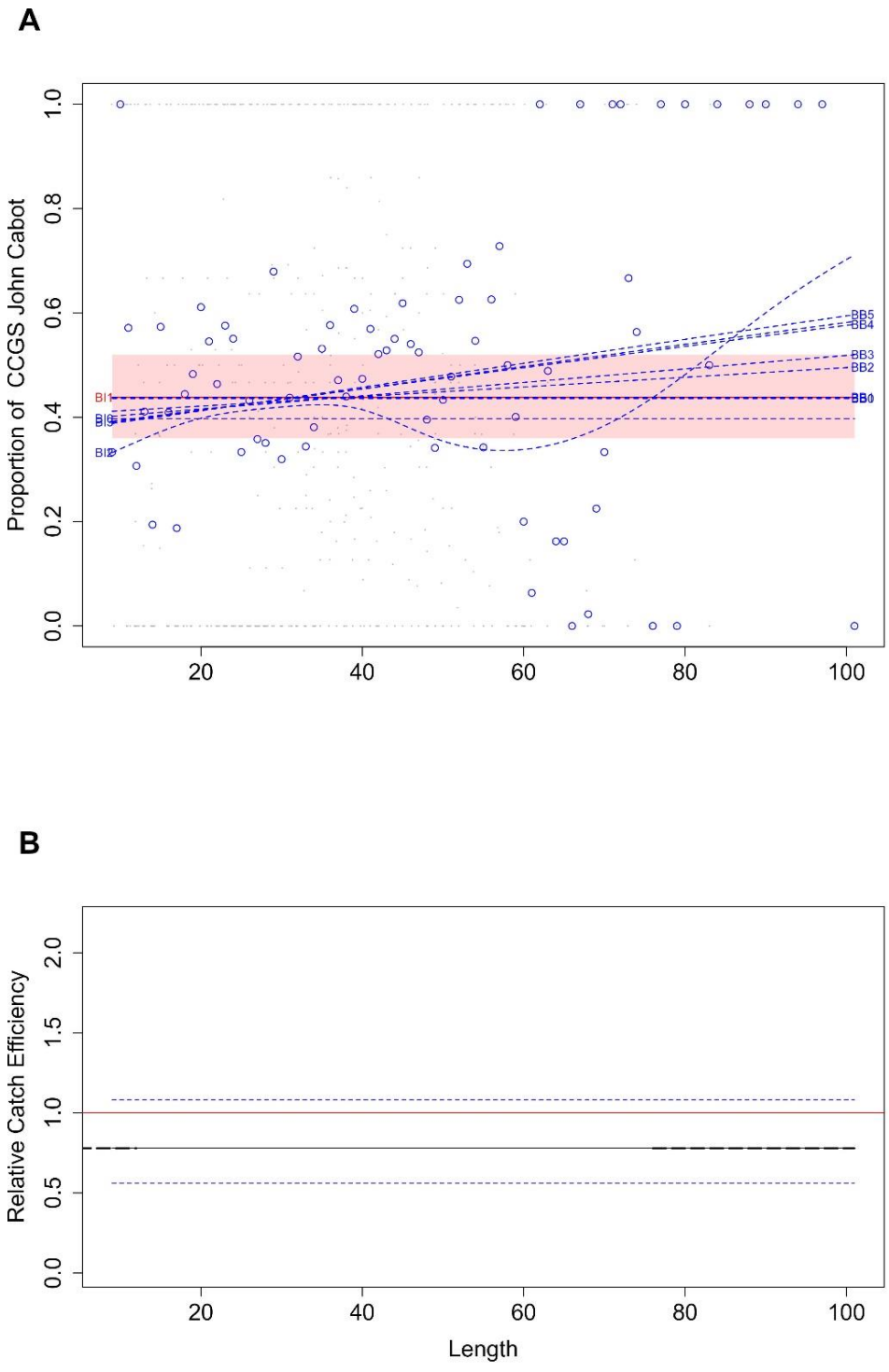

*Figure A1 - 2. Atlantic Cod (*Gadus morhua*) conversion factor, between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) Estimated length-specific catch proportion functions,* $logit(p_{Ai}(l))$*, for each converged model, with the selected model plotted using a red line along with its approximate 95% confidence intervals (CI; shaded area), as well as the length class-specific mean empirical proportion of total catch in a pair made by the CCGS John Cabot (blue dots). (B) Estimated relative catch efficiency (conversion factor) function from the best model (black line) with 95% CI (dashed blue lines). The horizontal red line indicates equivalent efficiency between vessels.*

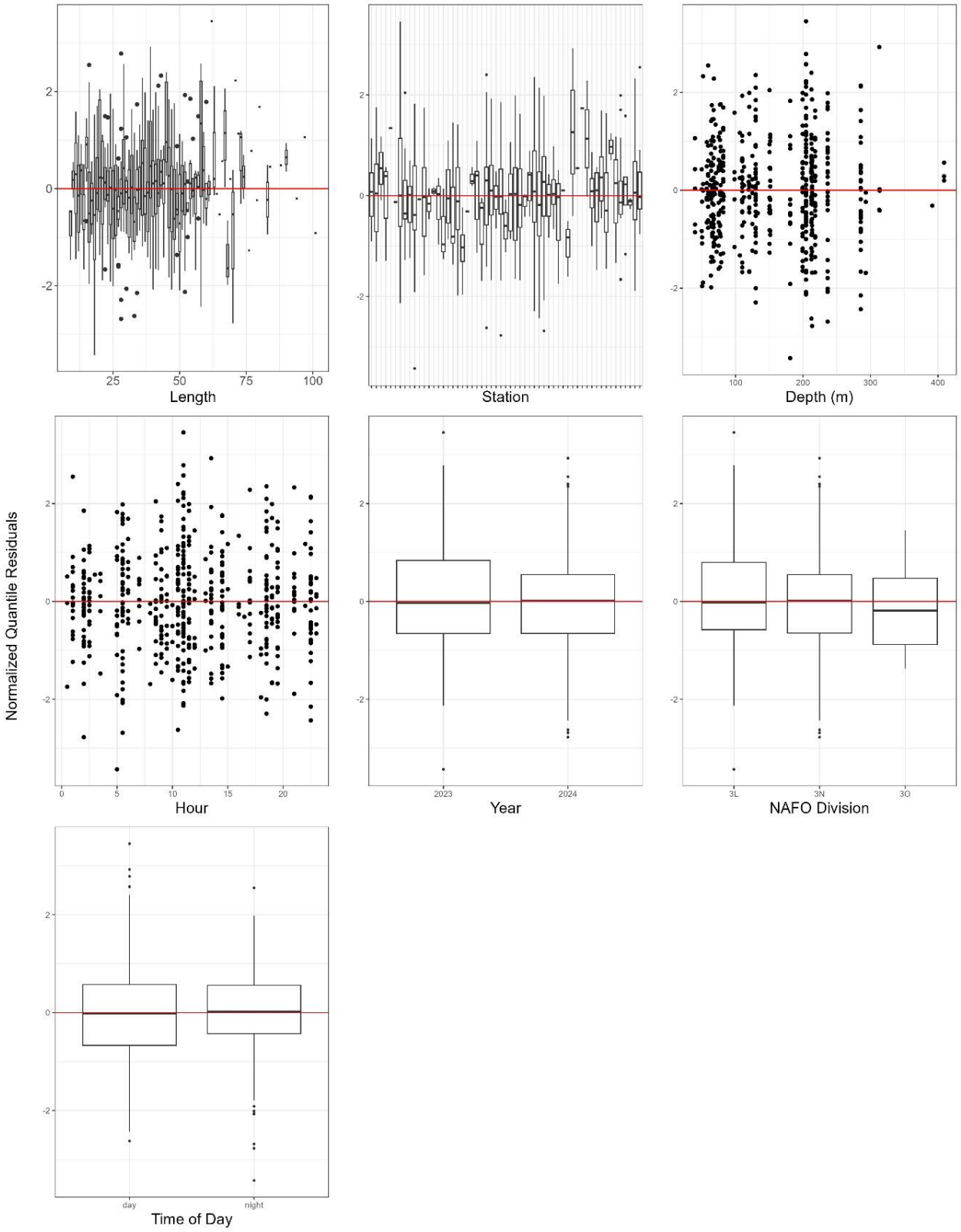

*Figure A1 - 3. Normalized quantile residuals as a function of length, station, depth, hour, year, NAFO division, and diel period for Atlantic Cod (*Gadus morhua*), best model selected for length disaggregated conversion factor analysis for the CCGS John Cabot, and MV Calvert for spring NAFO divisions 3LNO.*

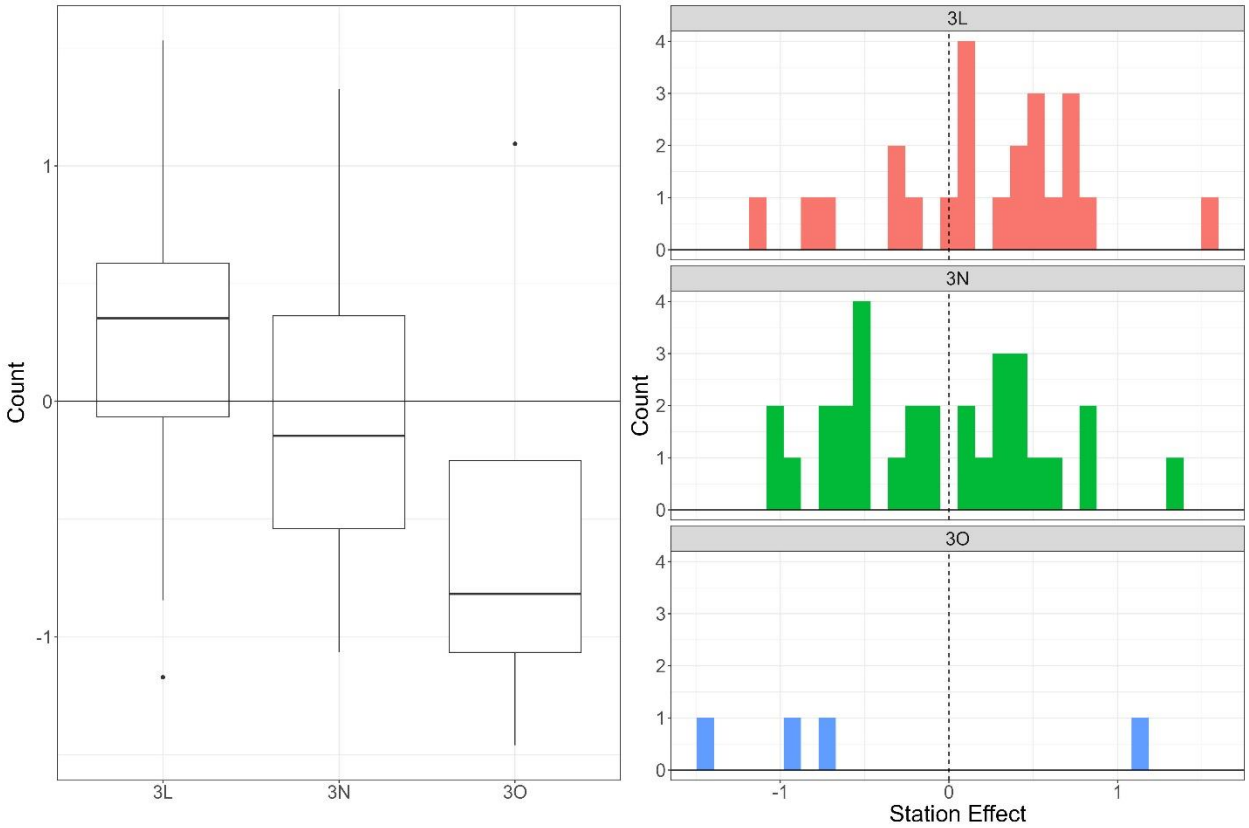

*Figure A1 - 4. Boxplot (left) and histogram (right) of station effect by NAFO division for best model selected for Atlantic Cod (*Gadus morhua*) conversion factor analysis between the CCGS John Cabot and MV Calvert in spring NAFO divisions 3LNO.*

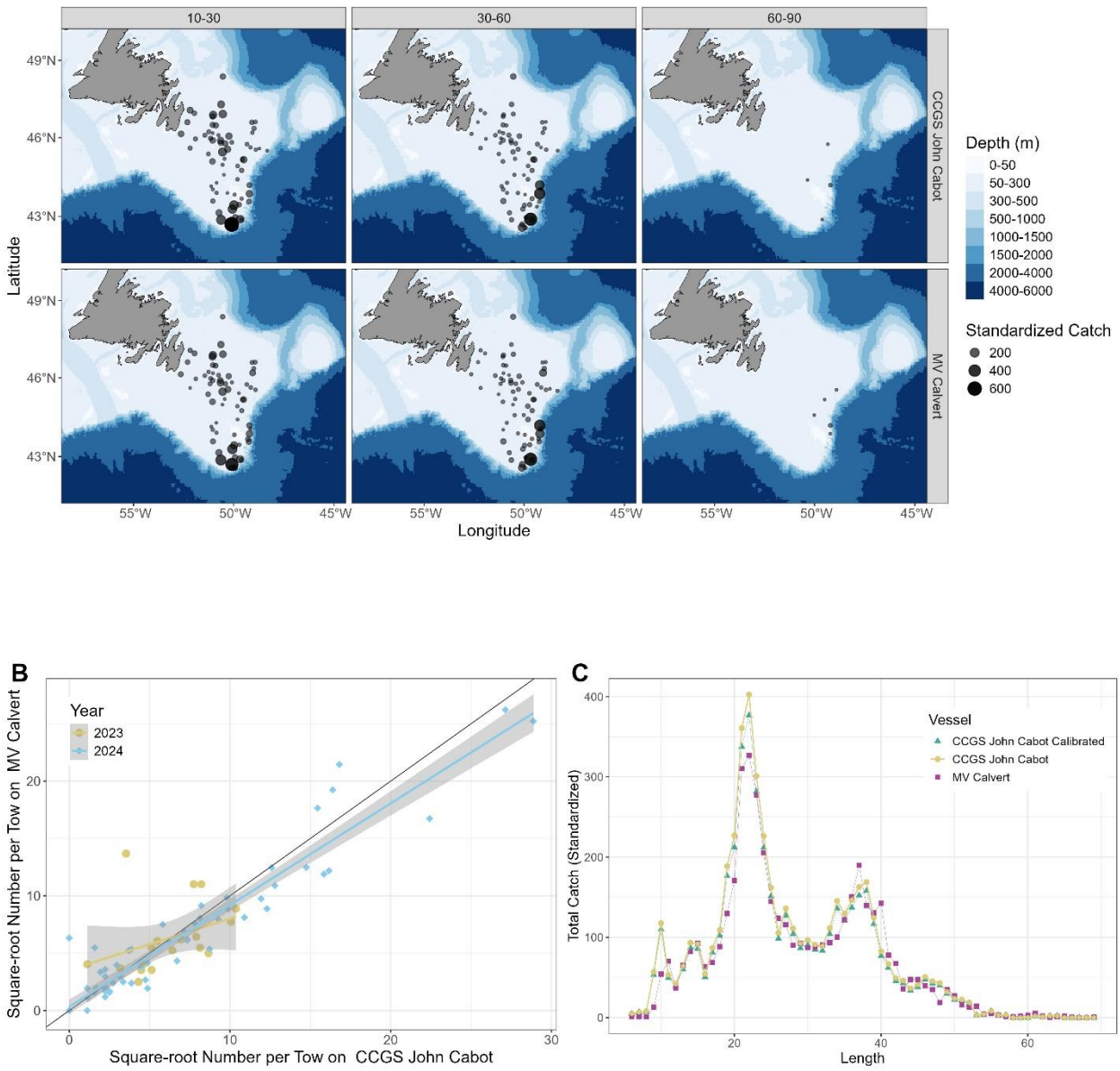

*Figure A1 - 5. Results for length-disaggregated comparative fishing analyses for American Plaice (*Hippoglossoides platessoides*), between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) map of catches by length group (length in cm specified in top panel) by the CCGS John Cabot (top) and the MV Calvert (bottom) in comparative fishing sets, where circle size is proportional catch weight (B) Biplot of the square-root of CCGS John Cabot catch numbers against the square-root of MV Calvert catch numbers. (C) Total length frequencies for catches made by the CCGS John Cabot (yellow), by the MV Calvert (purple), and CCGS John Cabot catches with the conversion factor applied (green).*

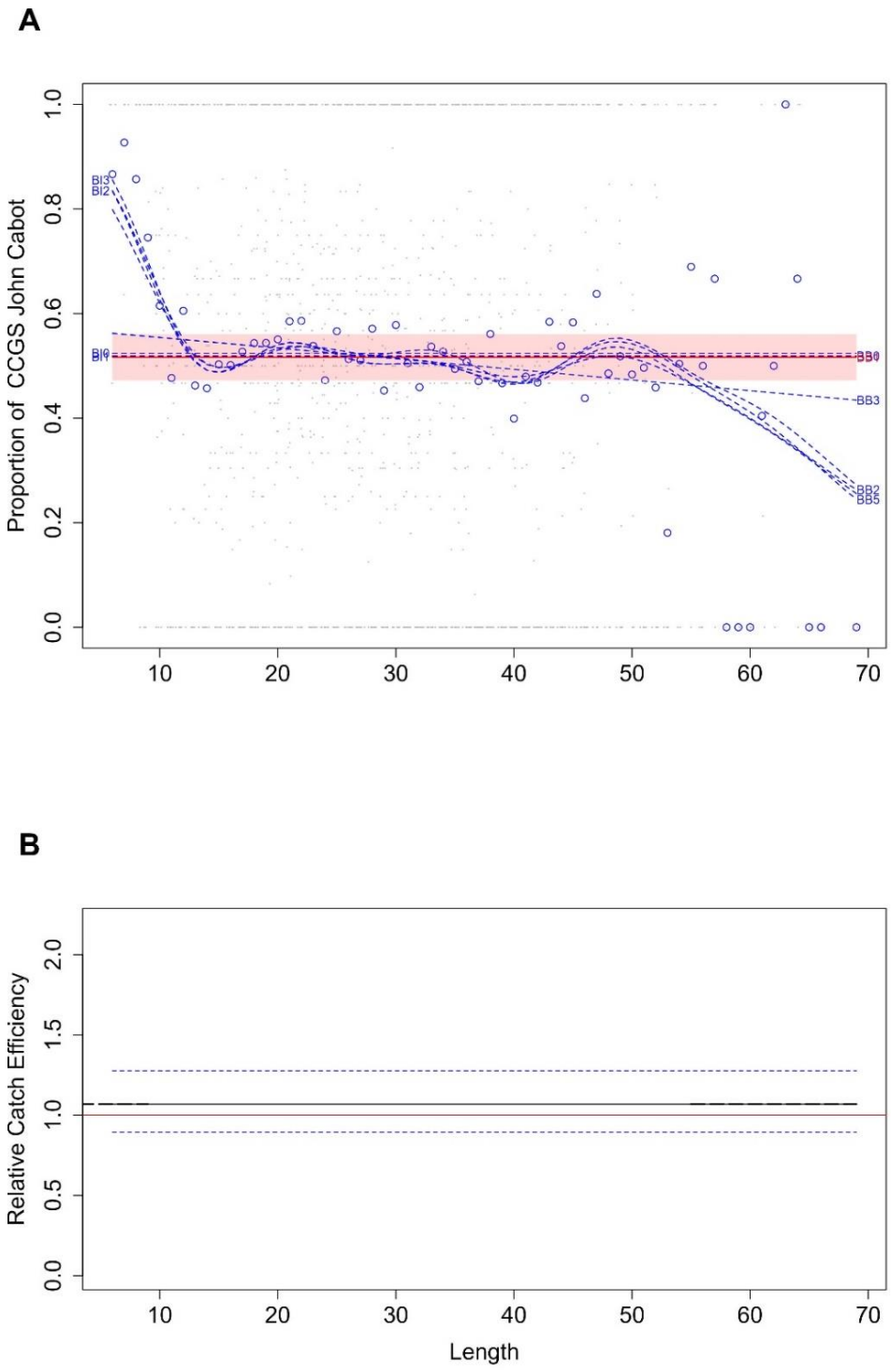

*Figure A1 - 6. American Plaice (*Hippoglossoides platessoides*) conversion factor, between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) Estimated length-specific catch proportion functions, $logit(p_{Ai}(l))$, for each converged model, with the selected model plotted using a red line along with its approximate 95% confidence intervals (CI; shaded area), as well as the length class-specific mean empirical proportion of total catch in a pair made by the CCGS John Cabot (blue dots). (B) Estimated relative catch efficiency (conversion factor) function from the best model (black line) with 95% CI (dashed blue lines). The horizontal red line indicates equivalent efficiency between vessels.*

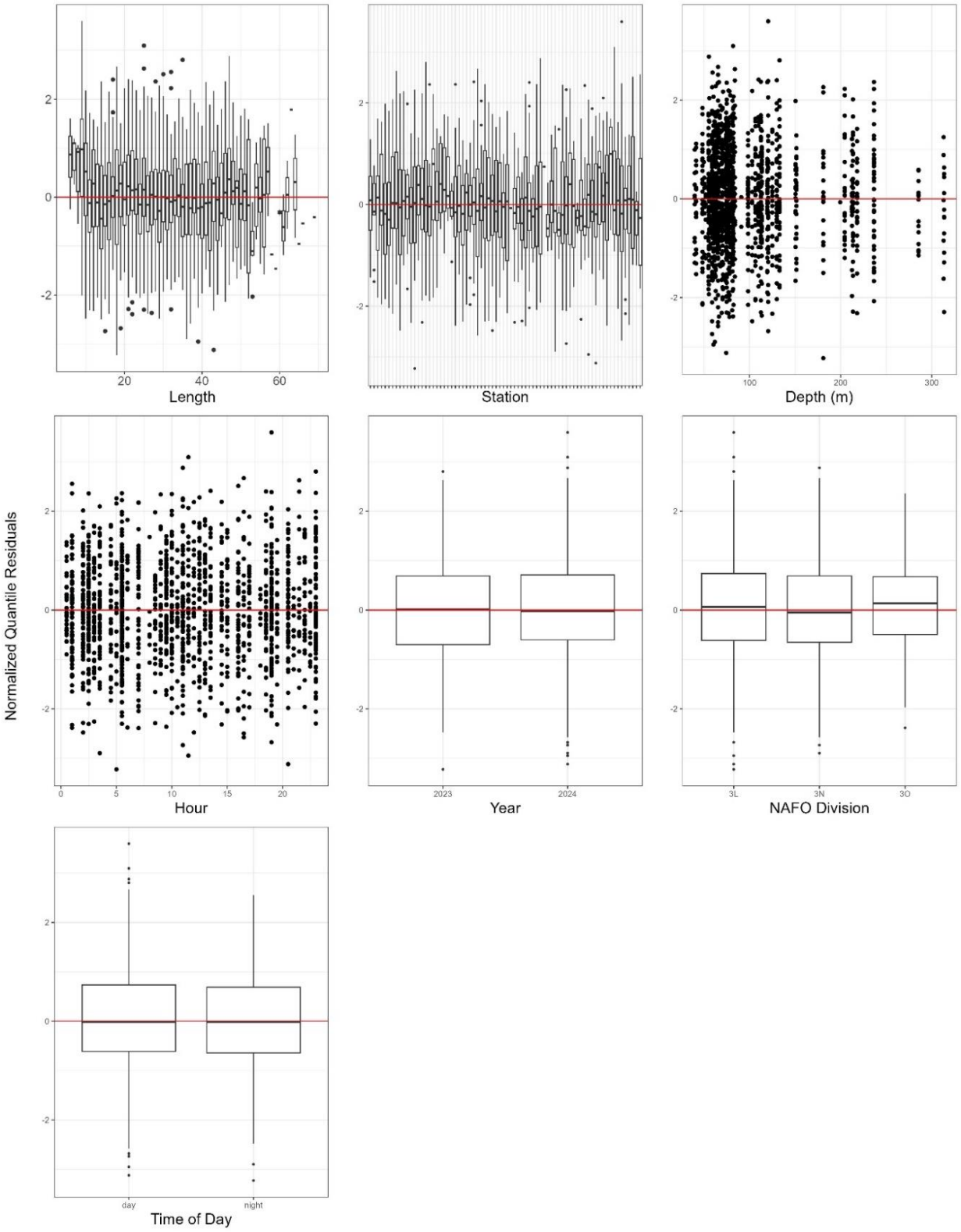

*Figure A1 - 7. Normalized quantile residuals as a function of length, station, depth, hour, year, NAFO division, and diel period for American Plaice (*Hippoglossoides platessoides), *best model selected for length disaggregated conversion factor analysis for the CCGS John Cabot, and MV Calvert for spring NAFO divisions 3LNO.*

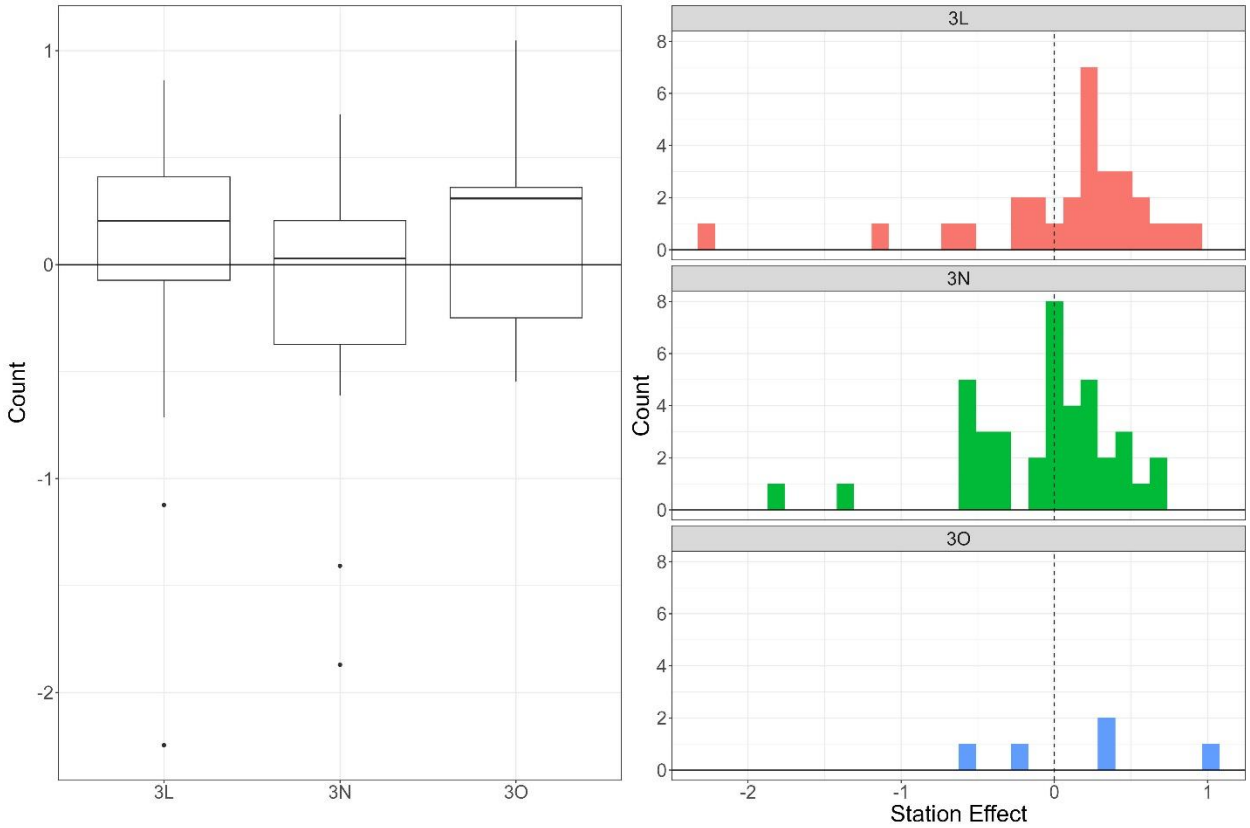

*Figure A1 - 8. Boxplot (left) and histogram (right) of station effect by NAFO division for best model selected for American Plaice (*Hippoglossoides platessoides*) conversion factor analysis between the CCGS John Cabot and MV Calvert in spring NAFO divisions 3LNO.*

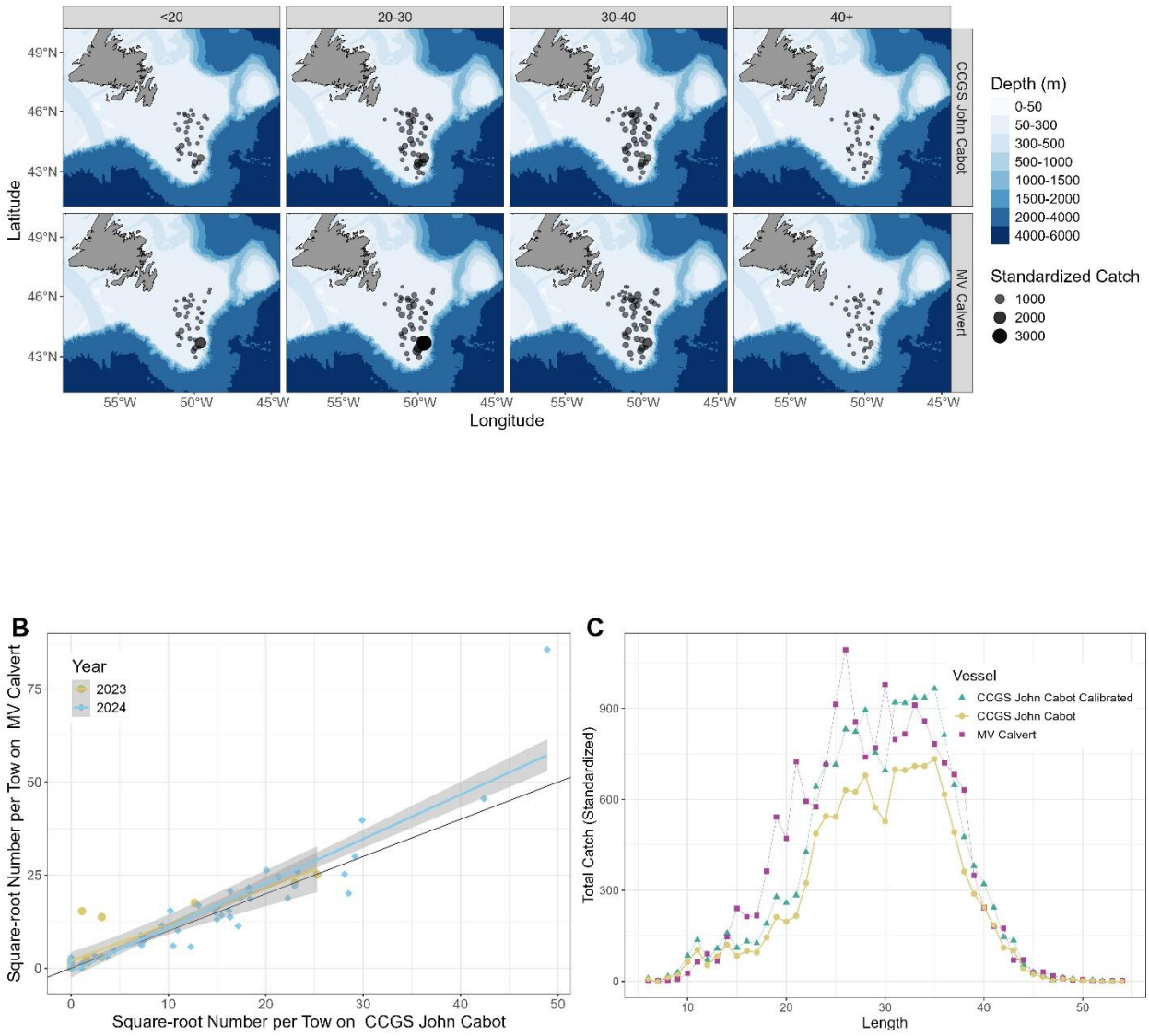

*Figure A1 - 9. Results for length-disaggregated comparative fishing analyses for Yellowtail Flounder (*Myzopsetta ferruginea*), between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) map of catches by length group (length in cm specified in top panel) by the CCGS John Cabot (top) and the MV Calvert (bottom) in comparative fishing sets, where circle size is proportional catch weight (B) Biplot of the square-root of CCGS John Cabot catch numbers against the square-root of MV Calvert catch numbers. (C) Total length frequencies for catches made by the CCGS John Cabot (yellow), by the MV Calvert (purple), and CCGS John Cabot catches with the conversion factor applied (green).*

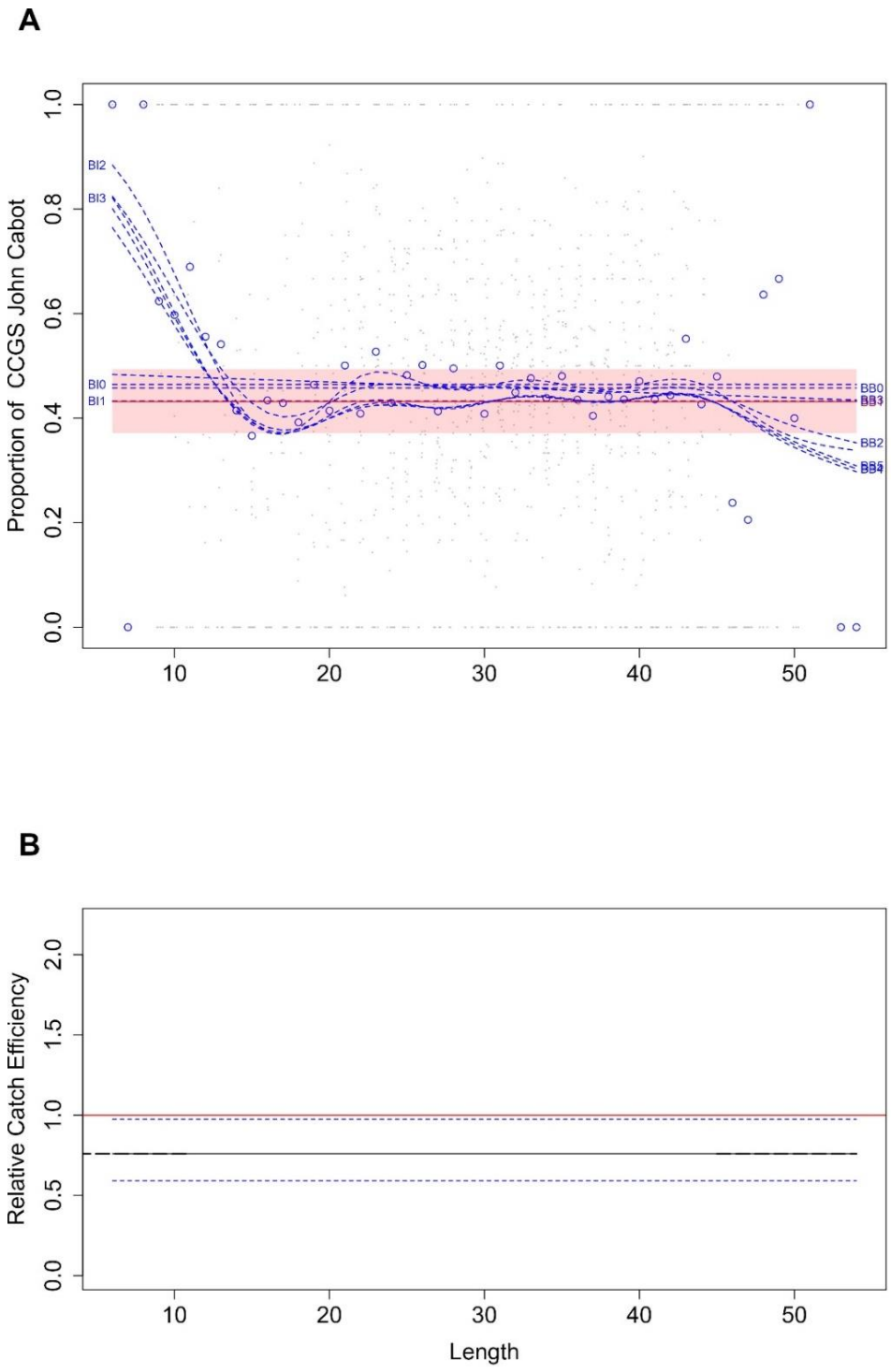

*Figure A1 - 10. Yellowtail Flounder (*Myzopsetta ferruginea*) conversion factor, between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) Estimated length-specific catch proportion functions, $logit(p_{Ai}(l))$, for each converged model, with the selected model plotted using a red line along with its approximate 95% confidence intervals (CI; shaded area), as well as the length class-specific mean empirical proportion of total catch in a pair made by the CCGS John Cabot (blue dots). (B) Estimated relative catch efficiency (conversion factor) function from the best model (black line) with 95% CI (dashed blue lines). The horizontal red line indicates equivalent efficiency between vessels.*

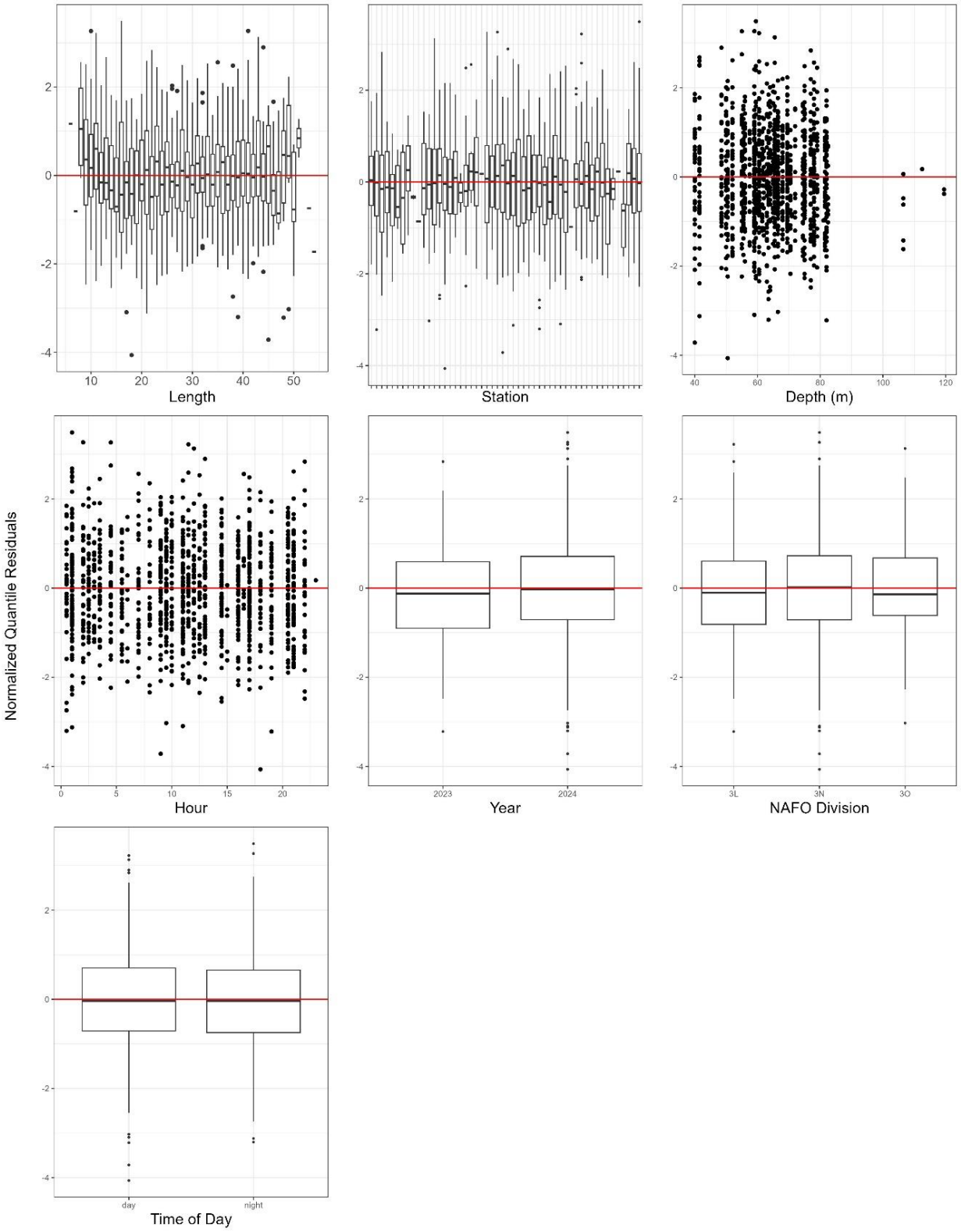

*Figure A1 - 11. Normalized quantile residuals as a function of length, station, depth, hour, year, NAFO division, and diel period for Yellowtail Flounder (*Myzopsetta ferruginea*), best model selected for length disaggregated conversion factor analysis for the CCGS John Cabot, and MV Calvert for spring NAFO divisions 3LNO.*

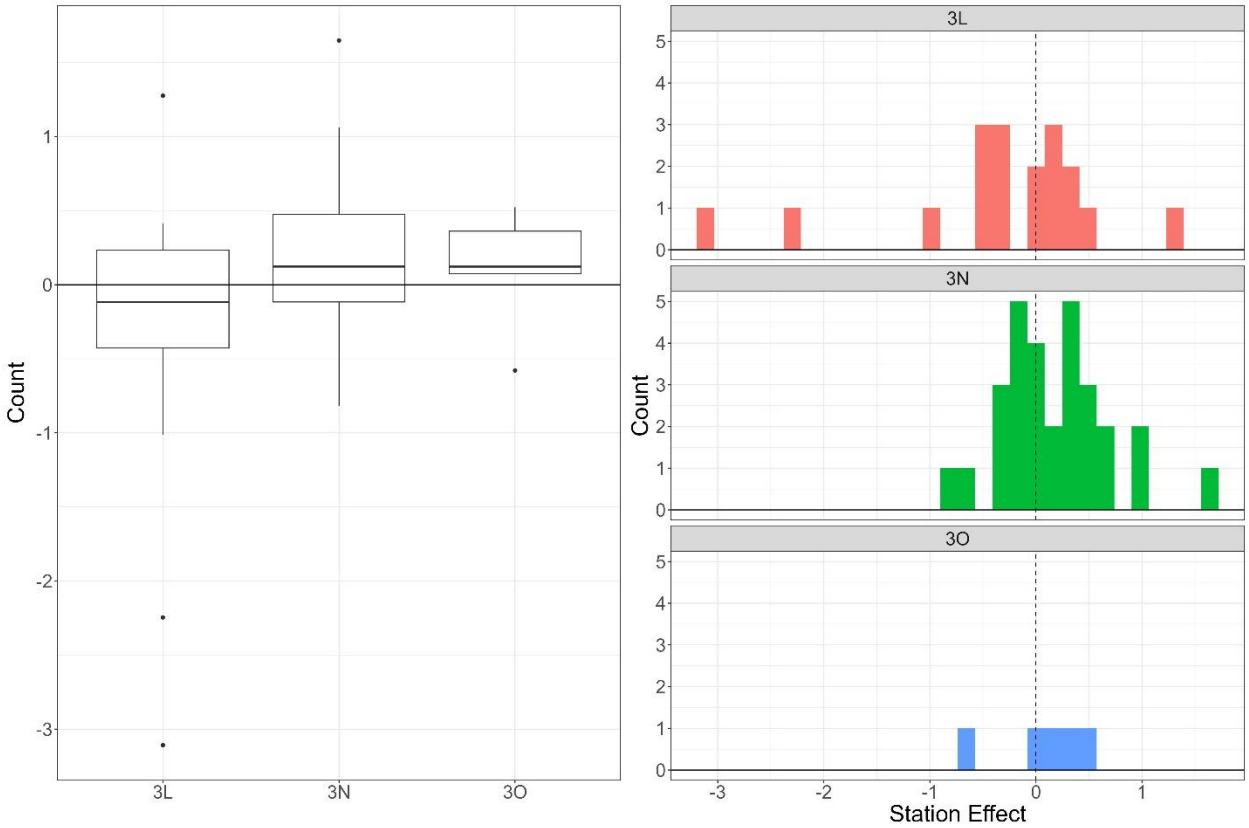

*Figure A1 - 12. Boxplot (left) and histogram (right) of station effect by NAFO division for best model selected for Yellowtail Flounder (*Myzopsetta ferruginea*) conversion factor analysis between the CCGS John Cabot and MV Calvert in spring NAFO divisions 3LNO.*

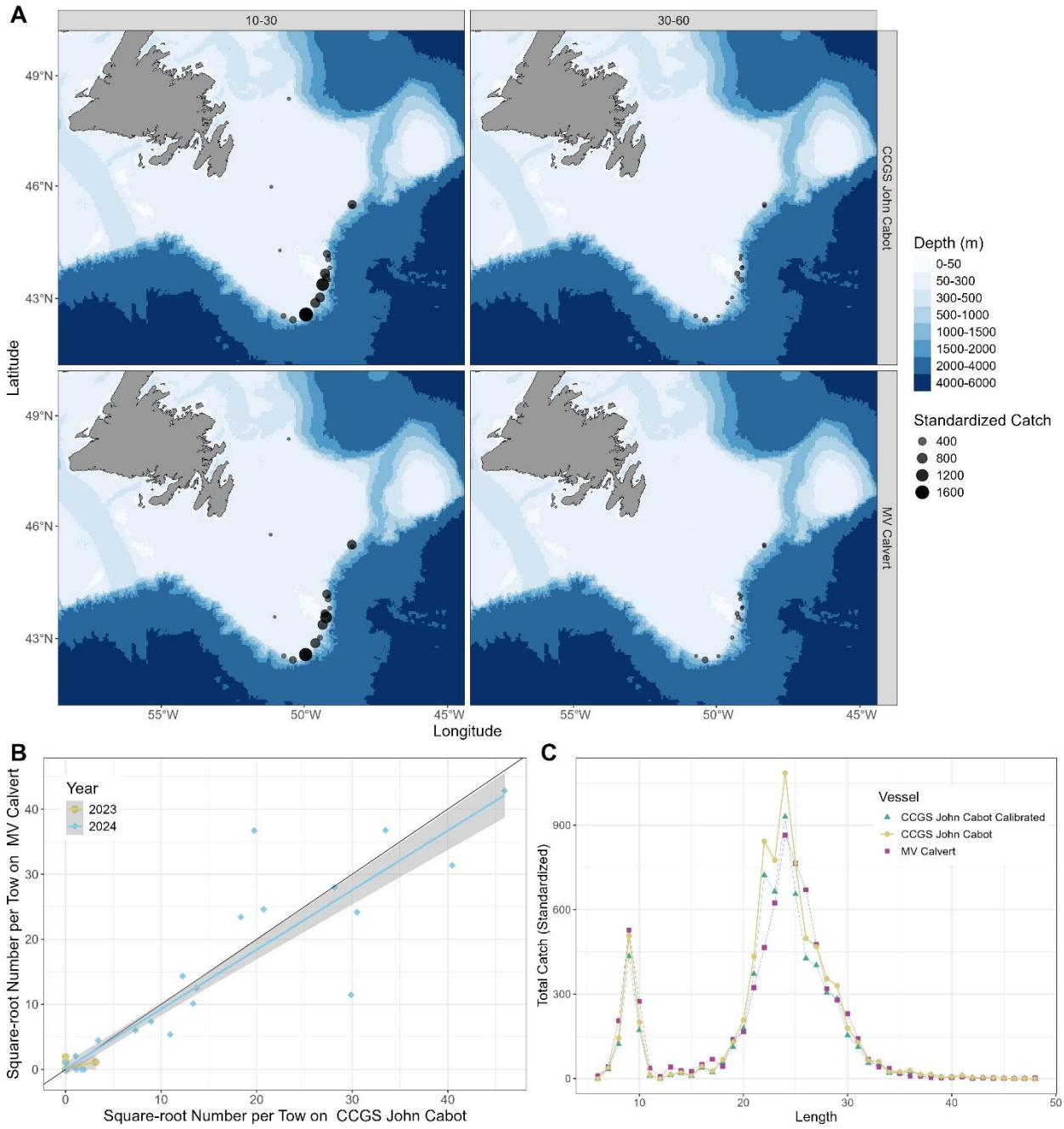

*Figure A1 - 13. Results for length-disaggregated comparative fishing analyses for redfish (*Sebastes mentella & S. fasciatus*), between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) map of catches by length group (length in cm specified in top panel) by the CCGS John Cabot (top) and the MV Calvert (bottom) in comparative fishing sets, where circle size is proportional catch weight (B) Biplot of the square-root of CCGS John Cabot catch numbers against the square-root of MV Calvert catch numbers. (C) Total length frequencies for catches made by the CCGS John Cabot (yellow), by the MV Calvert (purple), and CCGS John Cabot catches with the conversion factor applied (green).*

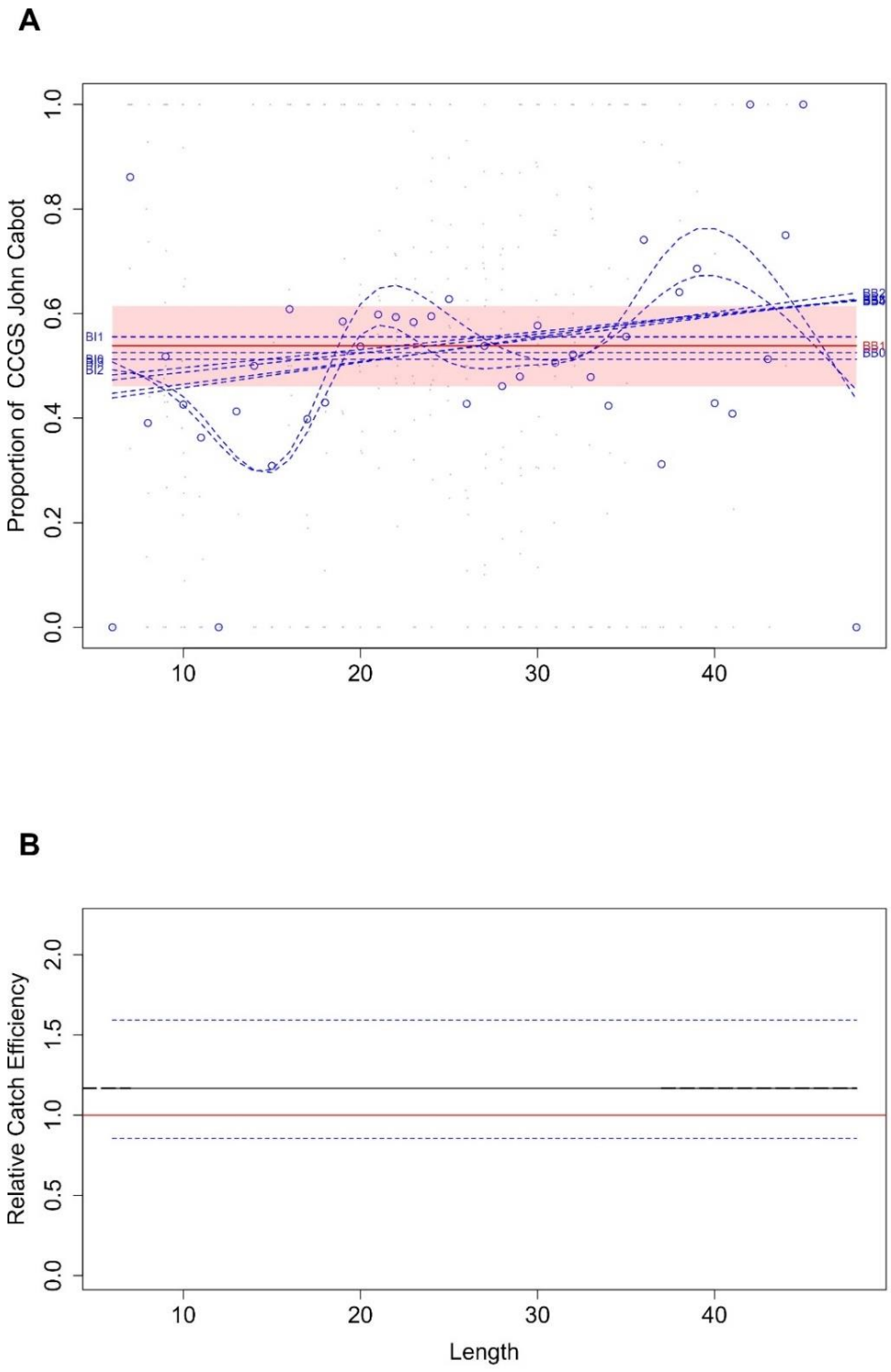

*Figure A1 - 14. Redfish (*Sebastes mentella & S. fasciatus*) conversion factor, between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) Estimated length-specific catch proportion functions, $logit(p_{Ai}(l))$, for each converged model, with the selected model plotted using a red line along with its approximate 95% confidence intervals (CI; shaded area), as well as the length class-specific mean empirical proportion of total catch in a pair made by the CCGS John Cabot (blue dots). (B) Estimated relative catch efficiency (conversion factor) function from the best model (black line) with 95% CI (dashed blue lines). The horizontal red line indicates equivalent efficiency between vessels.*

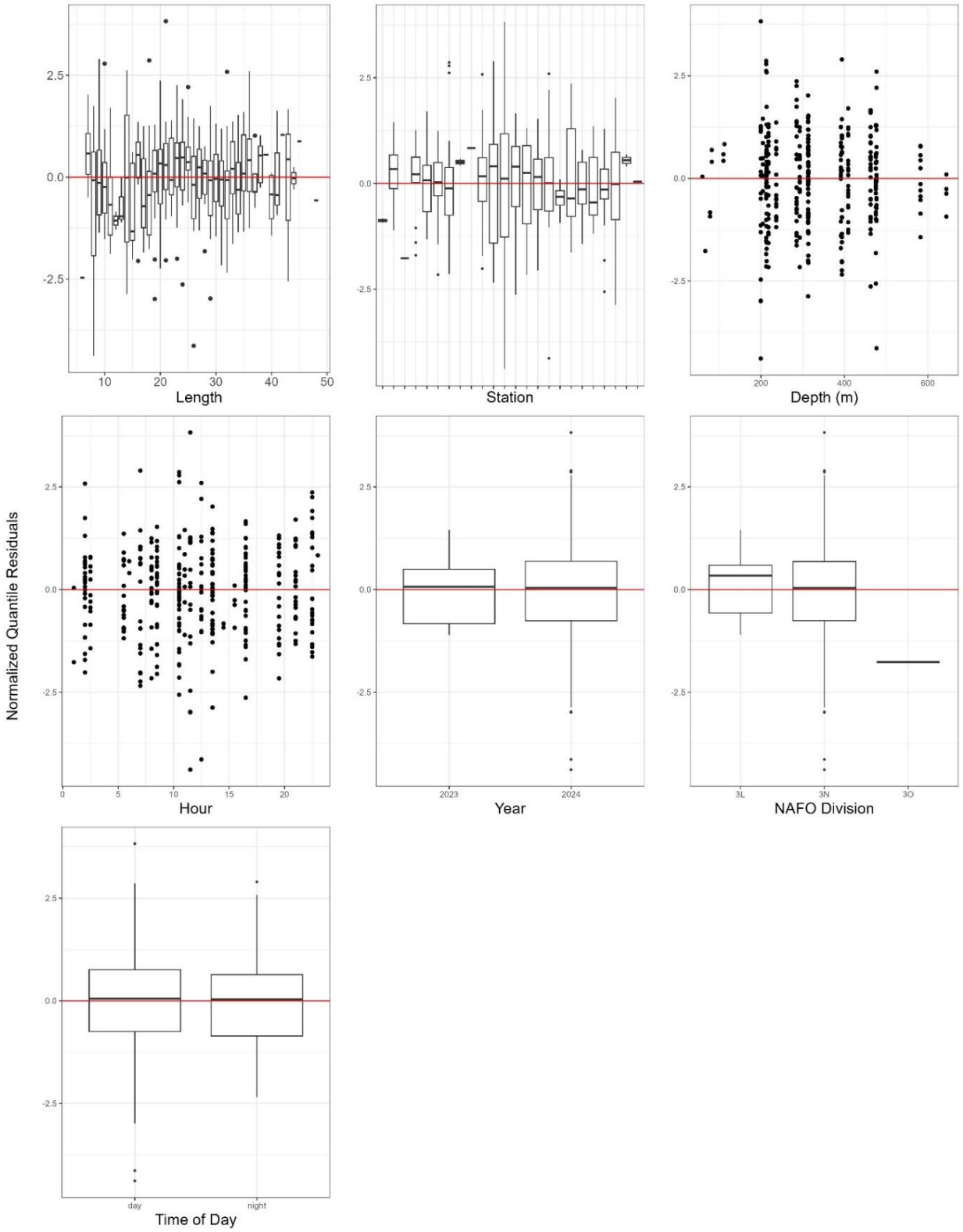

*Figure A1 - 15. Normalized quantile residuals as a function of length, station, depth, hour, year, NAFO division, and diel period for redfish (*Sebastes mentella & S. fasciatus*), best model selected for length disaggregated conversion factor analysis for the CCGS John Cabot, and Marine Vessel (MV) Calvert for spring NAFO divisions 3LNO.*

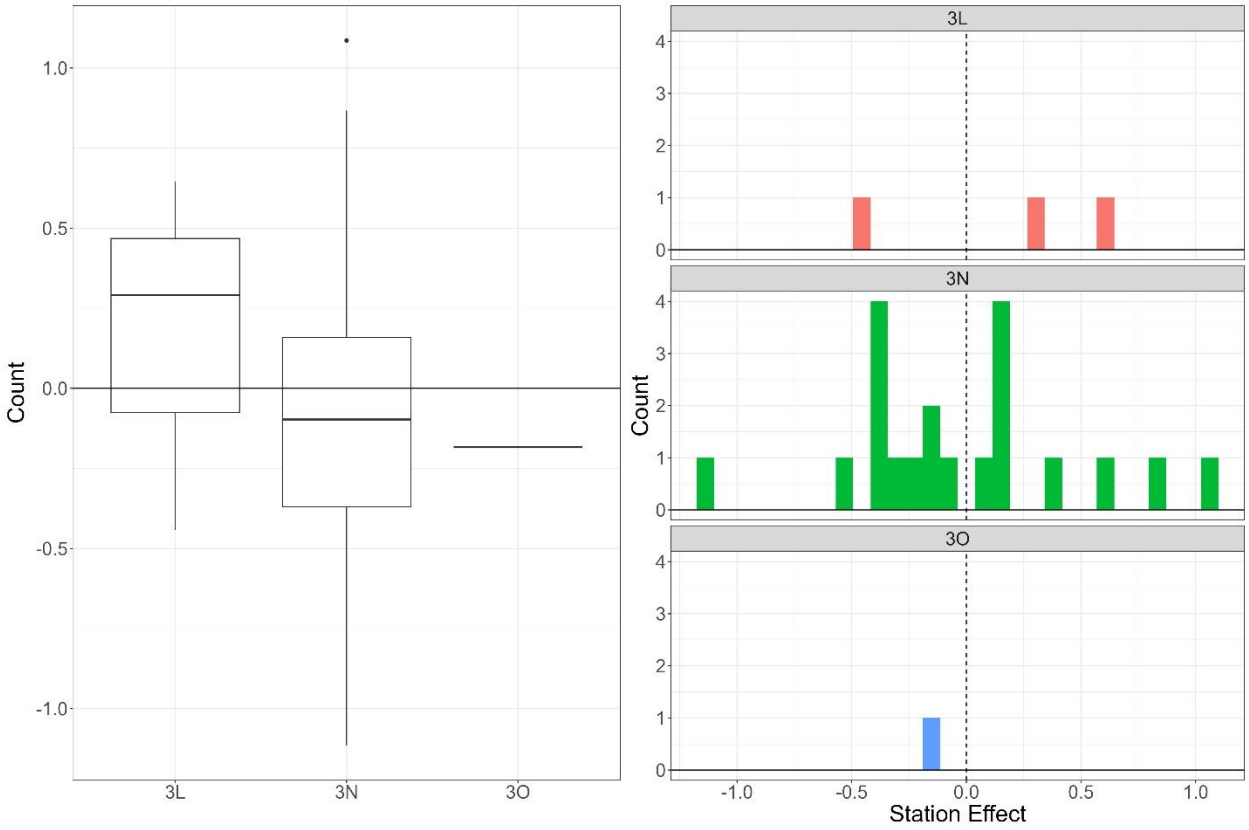

*Figure A1 - 16. Boxplot (left) and histogram (right) of station effect by NAFO division for best model selected for redfish (*Sebastes mentella & S. fasciatus*) conversion factor analysis between the CCGS John Cabot and MV Calvert in spring NAFO divisions 3LNO.*

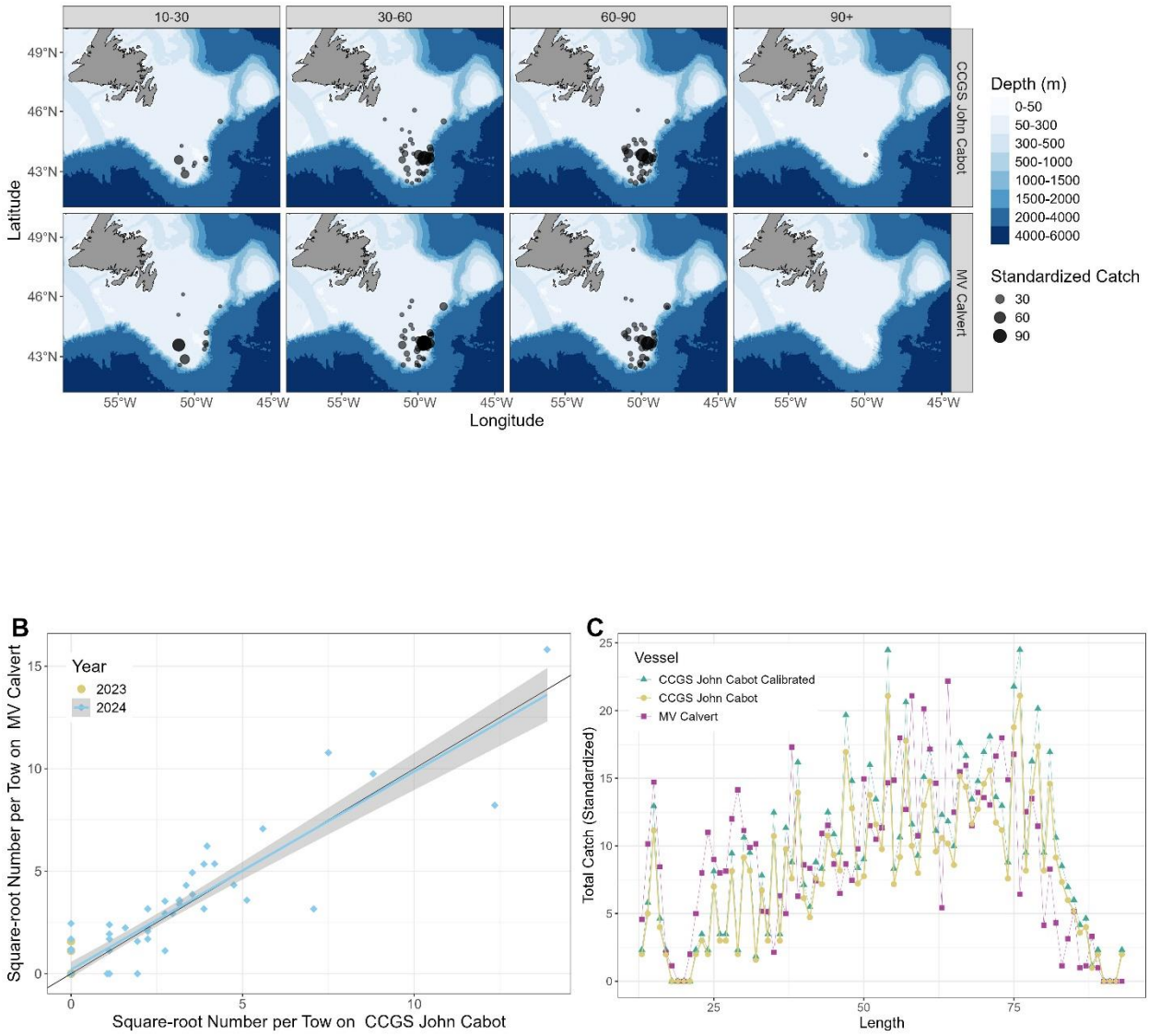

Figure A1 - 17. Results for length-disaggregated comparative fishing analyses for Thorny Skate (Amblyraja radiata)*, between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) map of catches by length group (length in cm specified in top panel) by the CCGS John Cabot (top) and the MV Calvert (bottom) in comparative fishing sets, where circle size is proportional catch weight (B) Biplot of the square-root of CCGS John Cabot catch numbers against the square-root of MV Calvert catch numbers. (C) Total length frequencies for catches made by the CCGS John Cabot (yellow), by the MV Calvert (purple), and CCGS John Cabot catches with the conversion factor applied (green).*

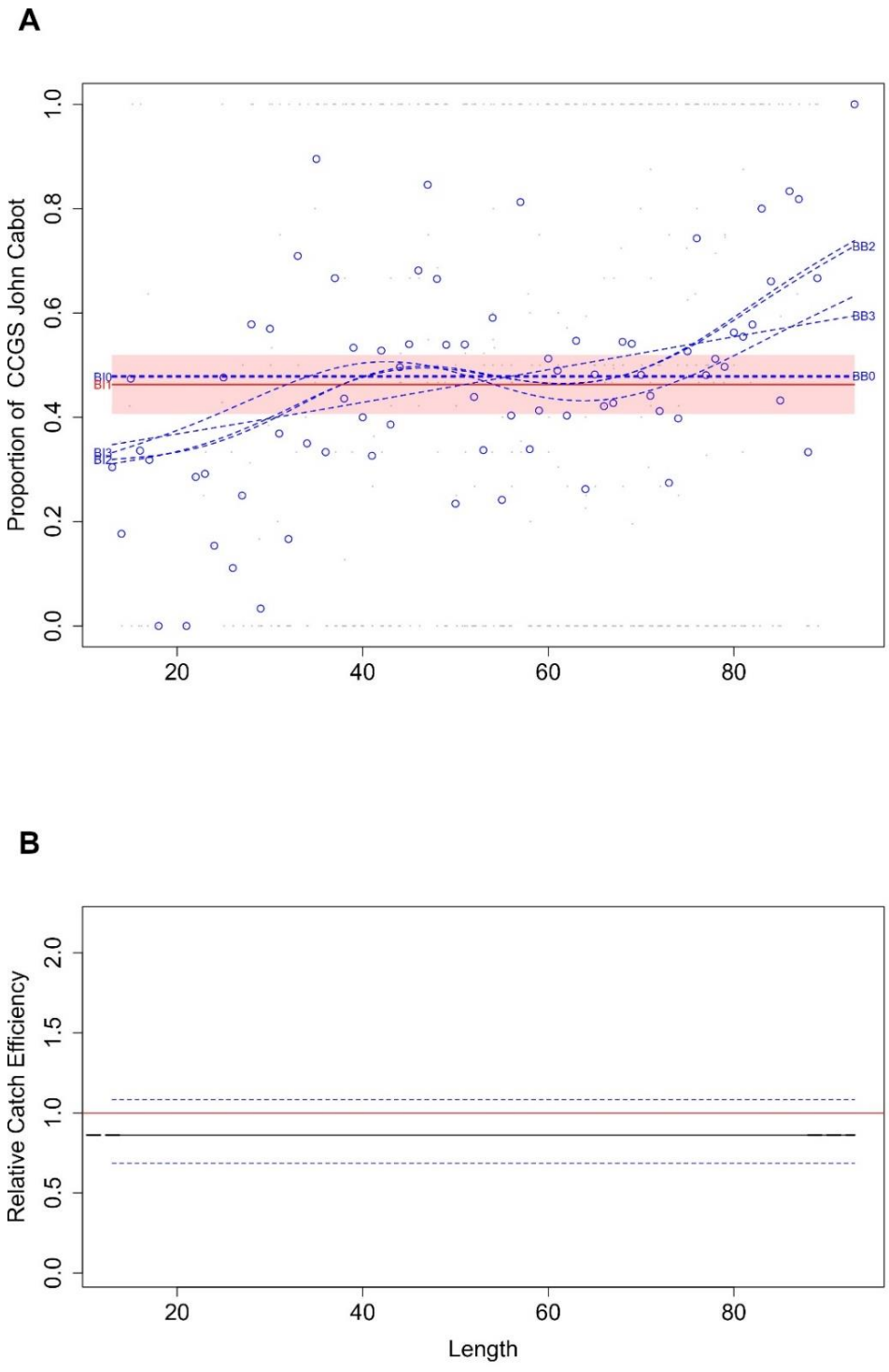

*Figure A1 - 18. Thorny Skate (*Amblyraja radiata*) conversion factor, between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) Estimated length-specific catch proportion functions,* $logit(p_{Ai}(l))$*, for each converged model, with the selected model plotted using a red line along with its approximate 95% confidence intervals (CI; shaded area), as well as the length class-specific mean empirical proportion of total catch in a pair made by the CCGS John Cabot (blue dots). (B) Estimated relative catch efficiency (conversion factor) function from the best model (black line) with 95% CI (dashed blue lines). The horizontal red line indicates equivalent efficiency between vessels.*

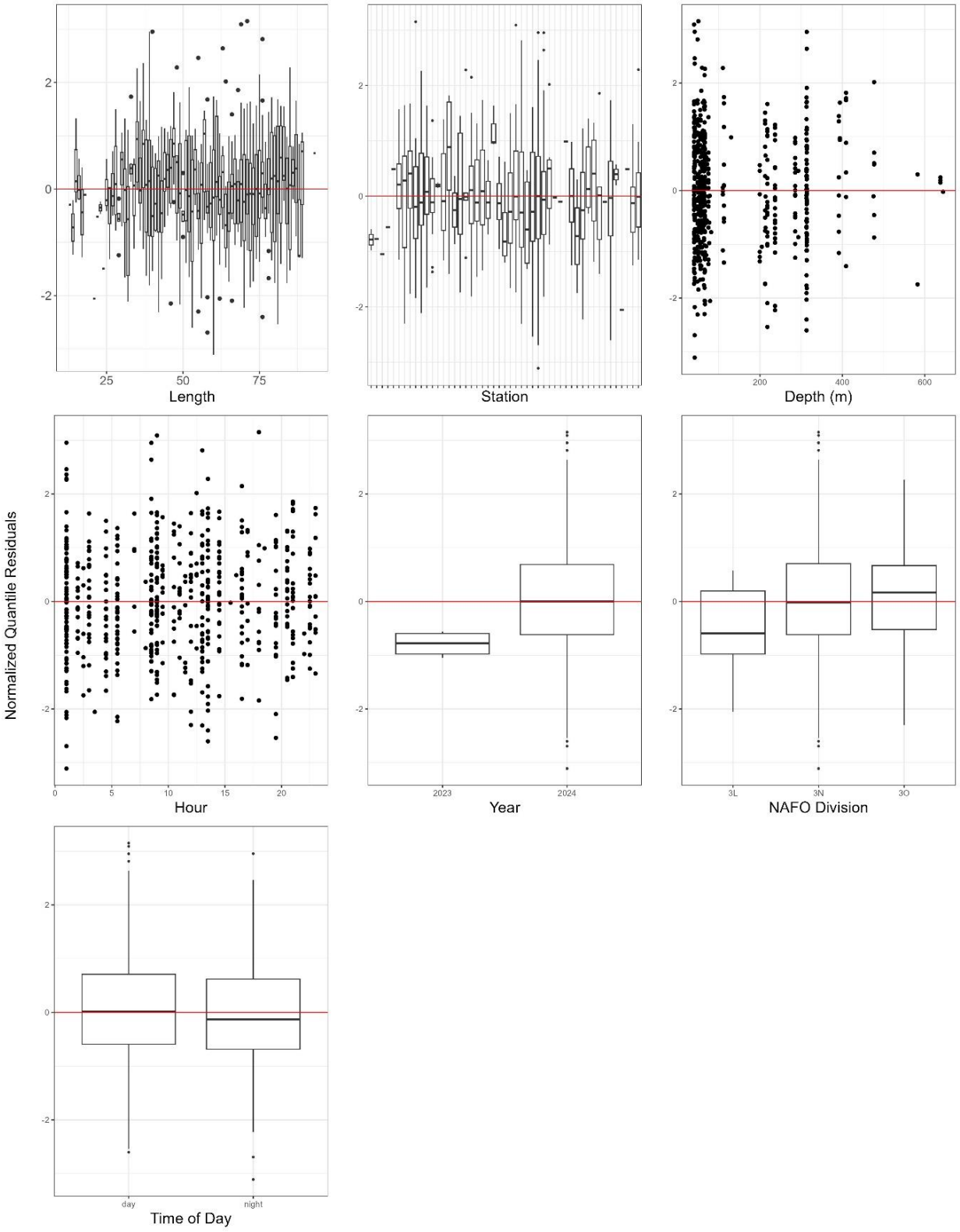

*Figure A1 - 19. Normalized quantile residuals as a function of length, station, depth, hour, year, NAFO division, and diel period for Thorny Skate (*Amblyraja radiata*), best model selected for length disaggregated conversion factor analysis for the CCGS John Cabot, and MV Calvert for spring NAFO divisions 3LNO.*

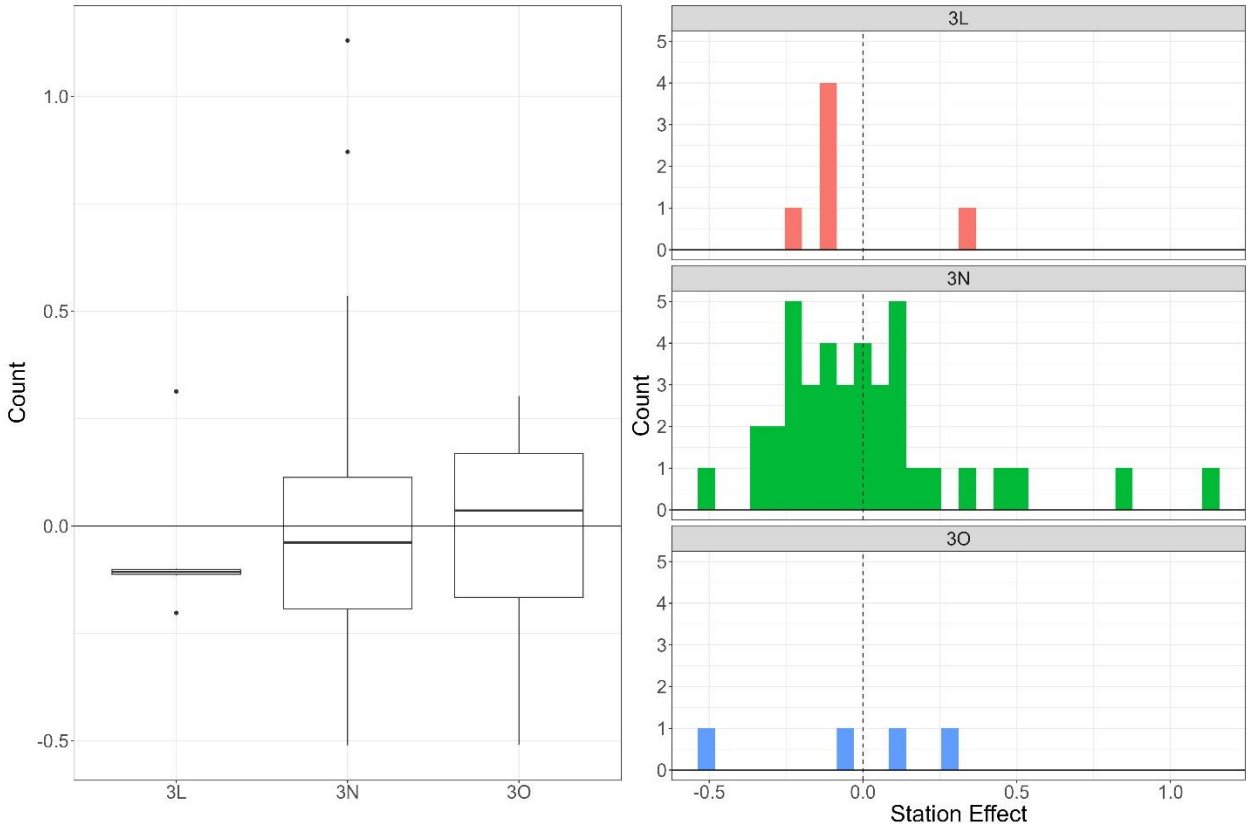

*Figure A1 - 20. Boxplot (left) and histogram (right) of station effect by NAFO division for best model selected for Thorny Skate (*Amblyraja radiata*) conversion factor analysis between the CCGS John Cabot and MV Calvert in spring NAFO divisions 3LNO.*

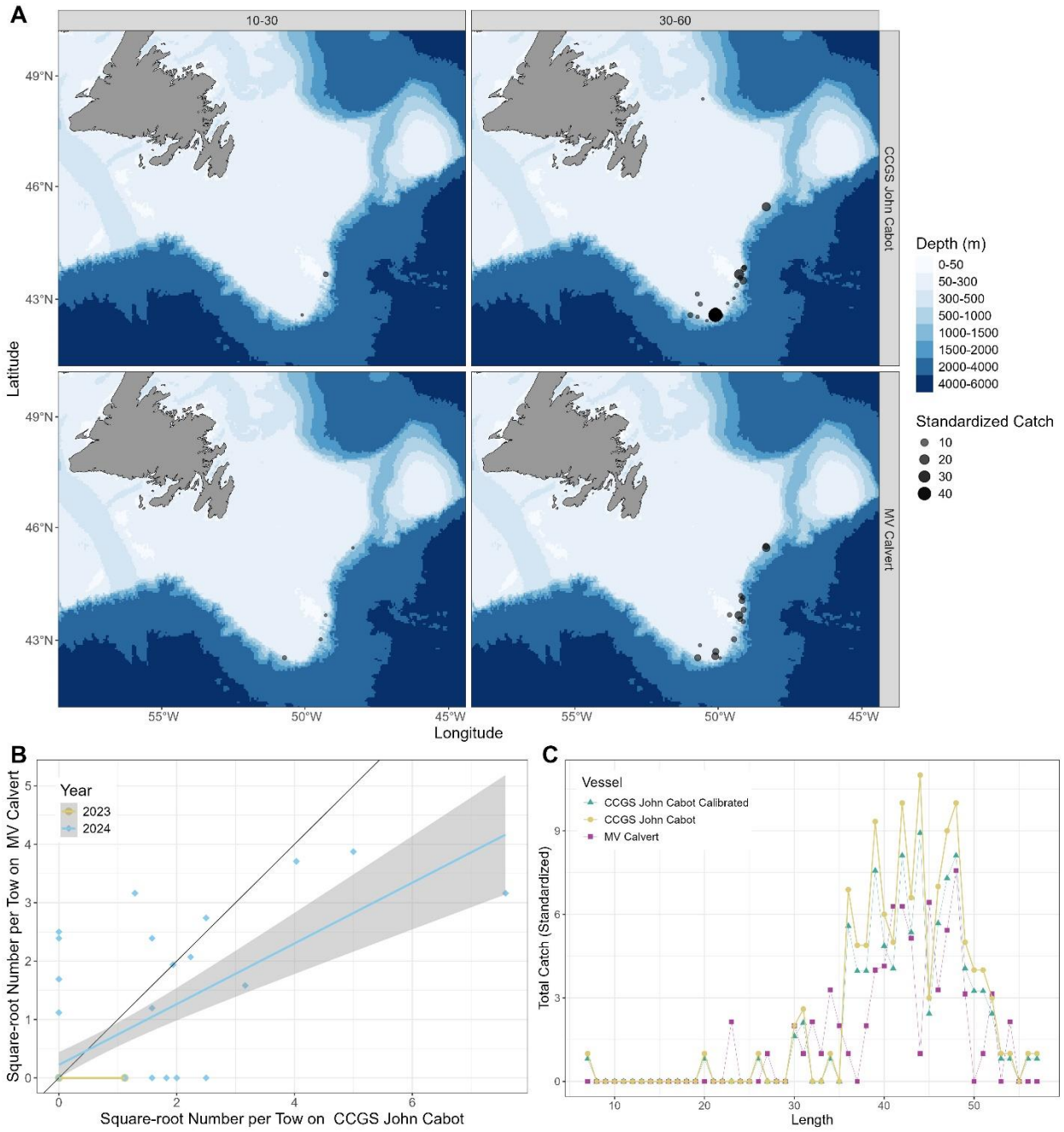

*Figure A1 - 21. Results for length-disaggregated comparative fishing analyses for Witch Flounder (*Glyptocephalus cynoglossus*), between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) map of catches by length group (length in cm specified in top panel) by the CCGS John Cabot (top) and the MV Calvert (bottom) in comparative fishing sets, where circle size is proportional catch weight (B) Biplot of the square-root of CCGS John Cabot catch numbers against the square-root of MV Calvert catch numbers. (C) Total length frequencies for catches made by the CCGS John Cabot (yellow), by the MV Calvert (purple), and CCGS John Cabot catches with the conversion factor applied (green).*

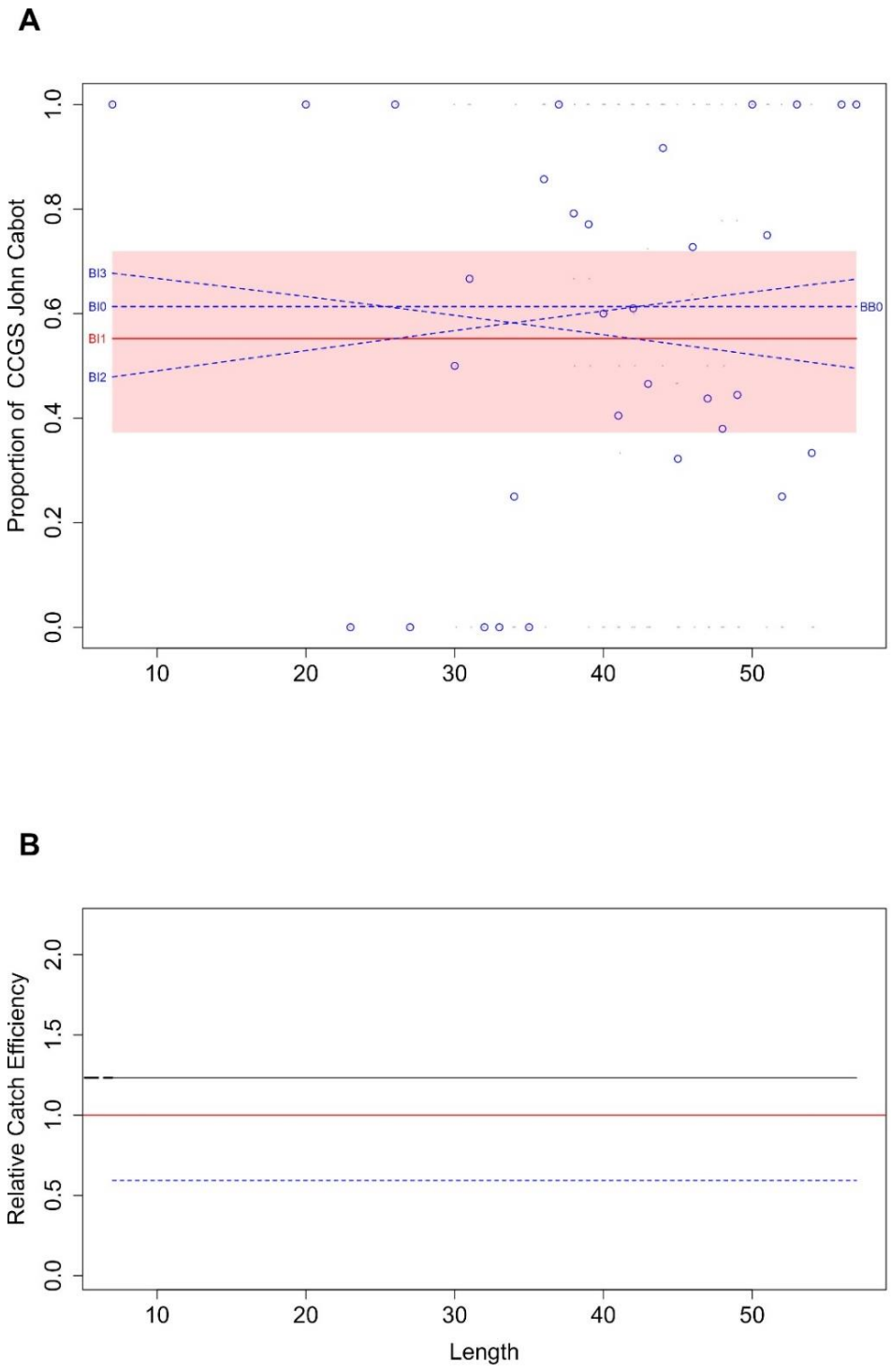

*Figure A1 - 22. Witch Flounder (*Glyptocephalus cynoglossus*) conversion factor, between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) Estimated length-specific catch proportion functions, $logit(p_{Ai}(l))$, for each converged model, with the selected model plotted using a red line along with its approximate 95% confidence intervals (CI; shaded area), as well as the length class-specific mean empirical proportion of total catch in a pair made by the CCGS John Cabot (blue dots). (B) Estimated relative catch efficiency (conversion factor) function from the best model (black line) with 95% CI (dashed blue lines). The horizontal red line indicates equivalent efficiency between vessels.*

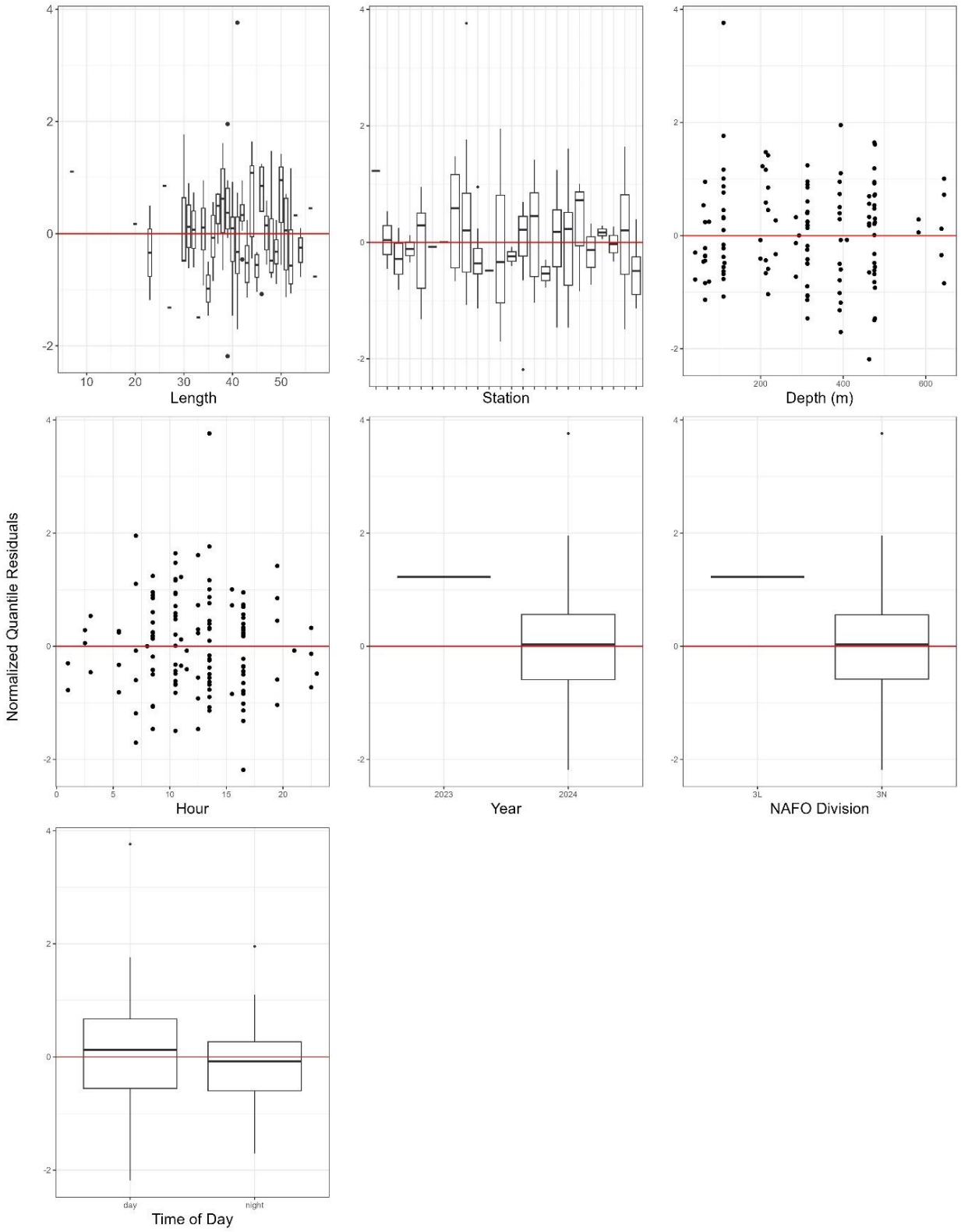

*Figure A1 - 23. Normalized quantile residuals as a function of length, station, depth, hour, year, NAFO division, and diel period for Witch Flounder (*Glyptocephalus cynoglossus*), best model selected for length disaggregated conversion factor analysis for the CCGS John Cabot, and MV Calvert for spring NAFO divisions 3LNO.*

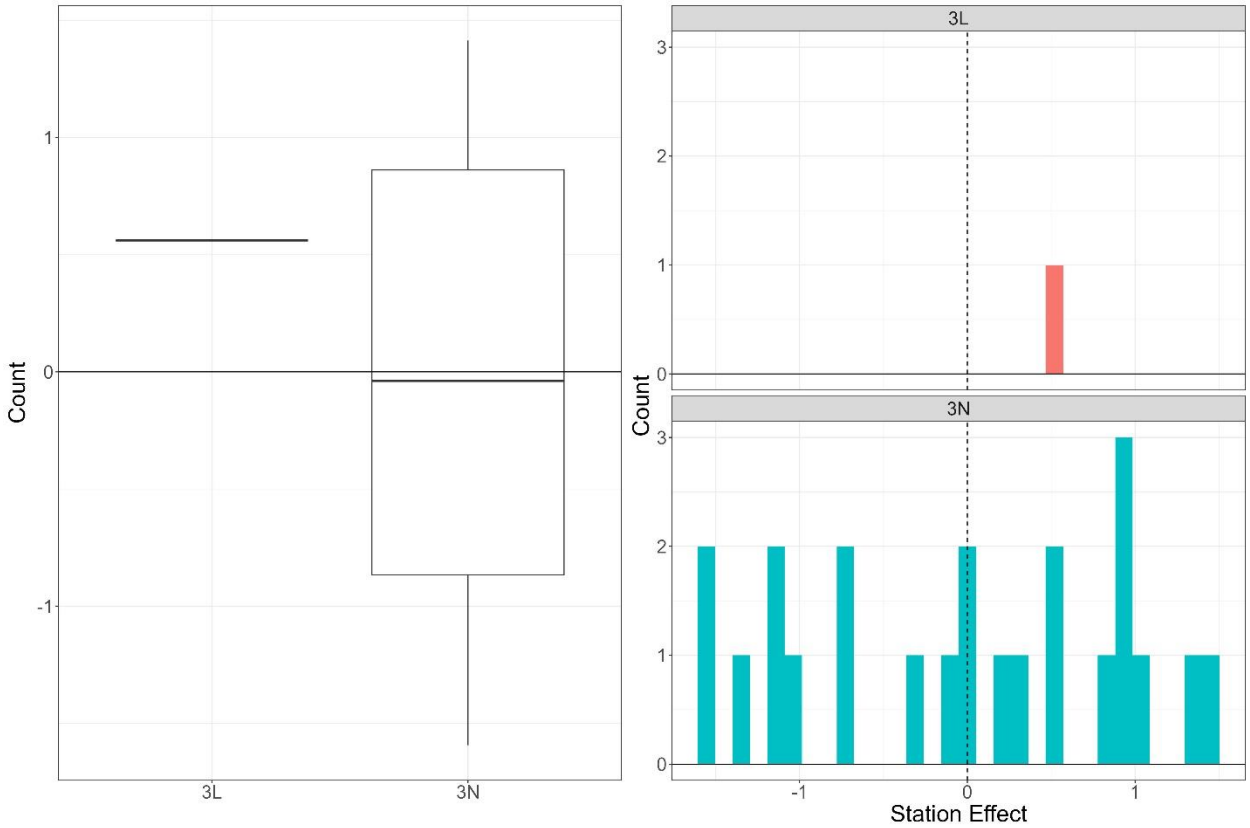

*Figure A1 - 24. Boxplot (left) and histogram (right) of station effect by NAFO division for best model selected for Witch Flounder (*Glyptocephalus cynoglossus*) conversion factor analysis between the CCGS John Cabot and MV Calvert in spring NAFO divisions 3LNO.*

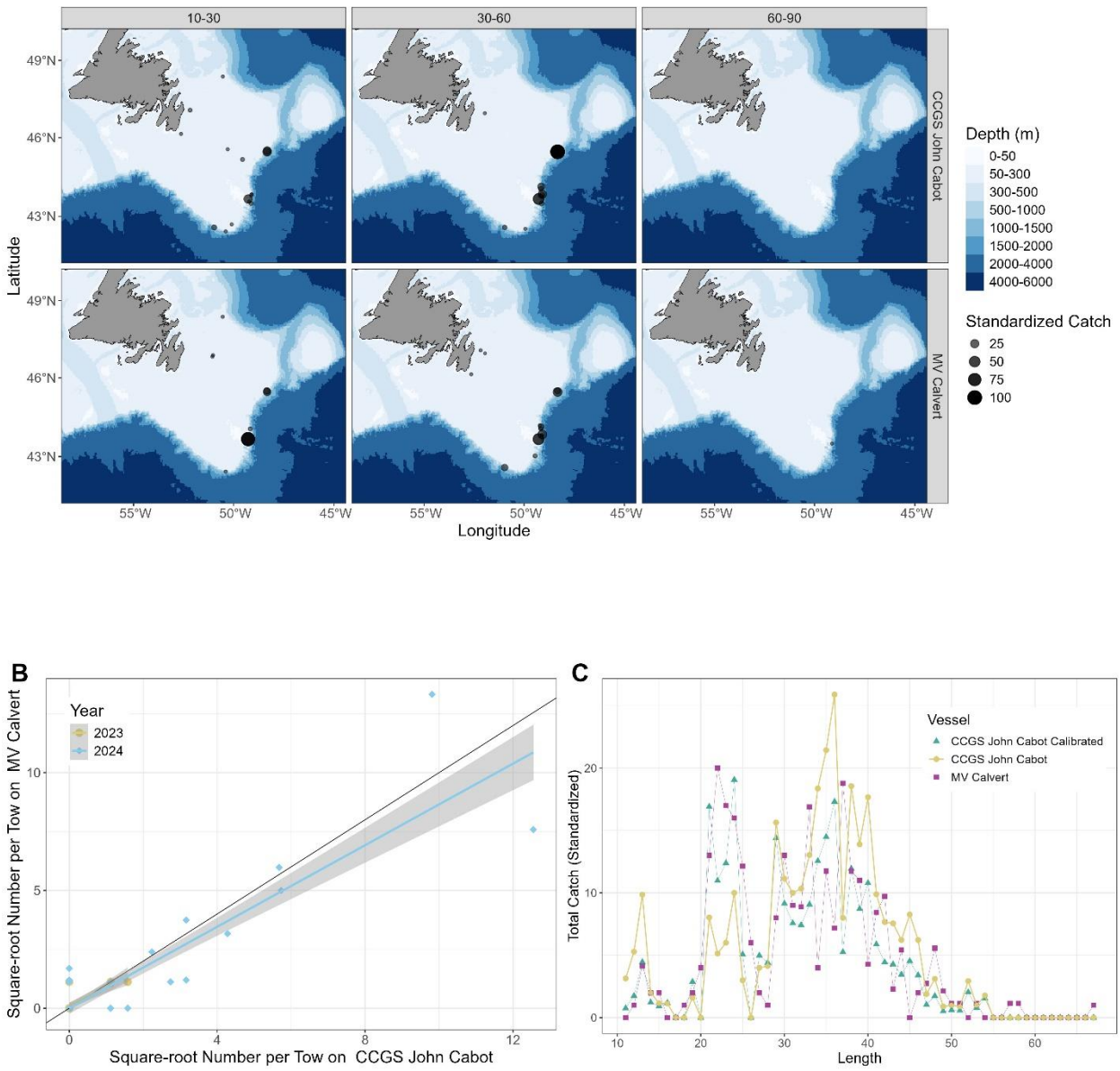

*Figure A1 - 25. Results for length-disaggregated comparative fishing analyses for Greenland Halibut (*Reinhardtius hippoglossoides*), between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) map of catches by length group (length in cm specified in top panel) by the CCGS John Cabot (top) and the MV Calvert (bottom) in comparative fishing sets, where circle size is proportional catch weight (B) Biplot of the square-root of CCGS John Cabot catch numbers against the square-root of MV Calvert catch numbers. (C) Total length frequencies for catches made by the CCGS John Cabot (yellow), by the MV Calvert (purple), and CCGS John Cabot catches with the conversion factor applied (green).*

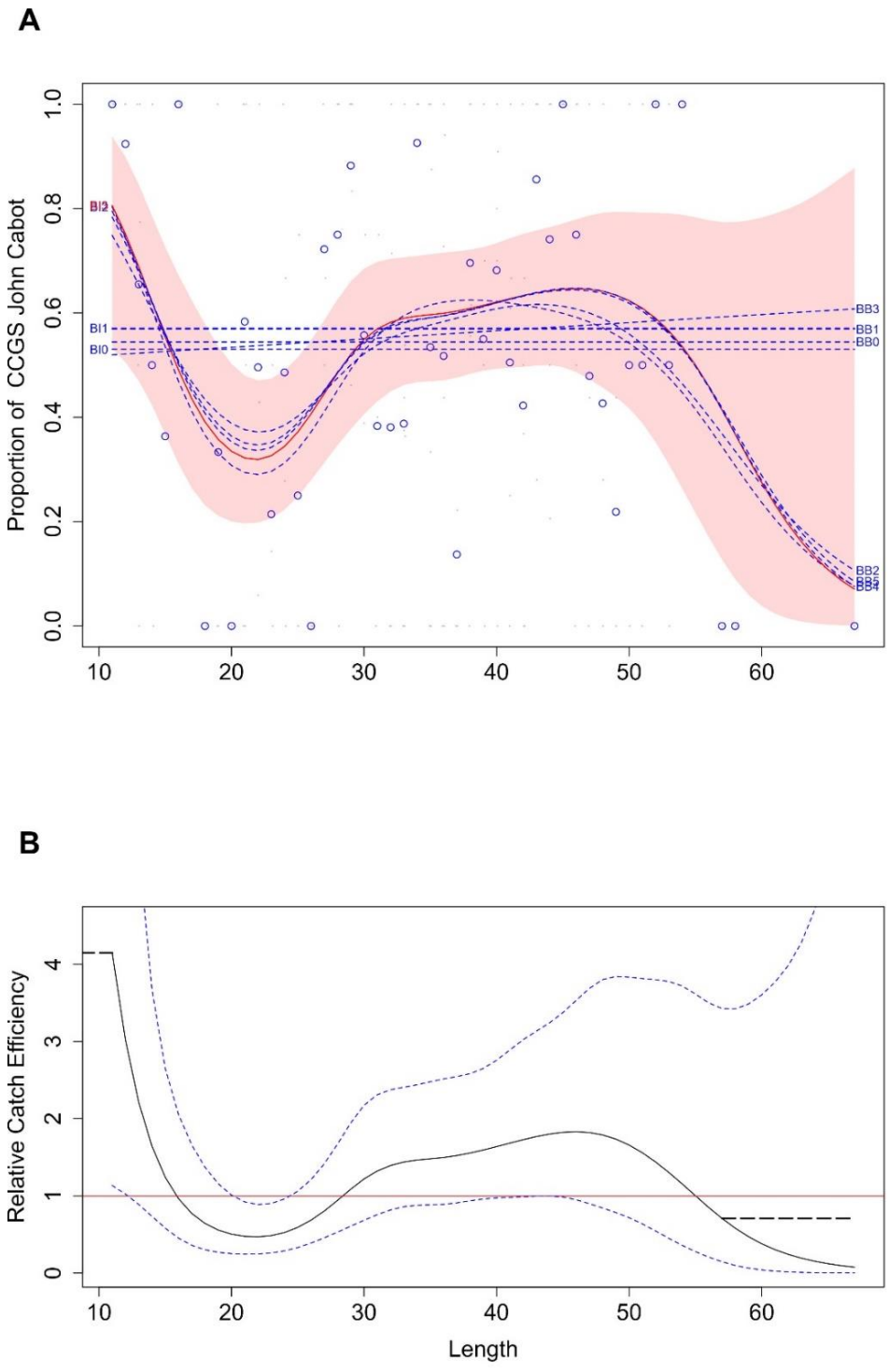

*Figure A1 - 26. Greenland Halibut (*Reinhardtius hippoglossoides*) conversion factor, between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) Estimated length-specific catch proportion functions, $logit(p_{Ai}(l))$, for each converged model, with the selected model plotted using a red line along with its approximate 95% confidence intervals (CI; shaded area), as well as the length class-specific mean empirical proportion of total catch in a pair made by the CCGS John Cabot (blue dots). (B) Estimated relative catch efficiency (conversion factor) function from the best model (black line) with 95% CI (dashed blue lines). The horizontal red line indicates equivalent efficiency between vessels.*

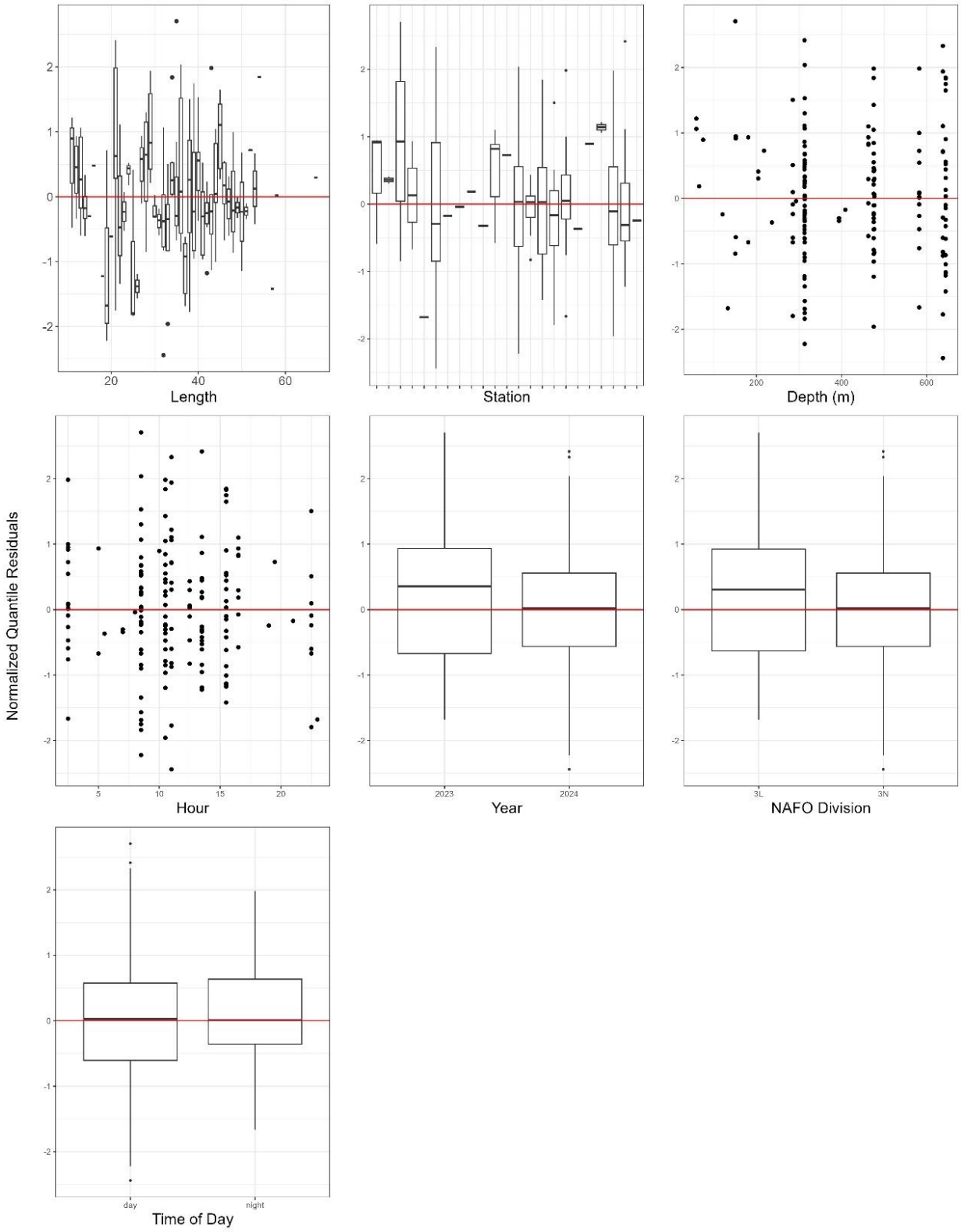

*Figure A1 - 27. Normalized quantile residuals as a function of length, station, depth, hour, year, NAFO division, and diel period for Greenland Halibut (*Reinhardtius hippoglossoides*), best model selected for length disaggregated conversion factor analysis for the CCGS John Cabot, and MV Calvert for spring NAFO divisions 3LNO.*

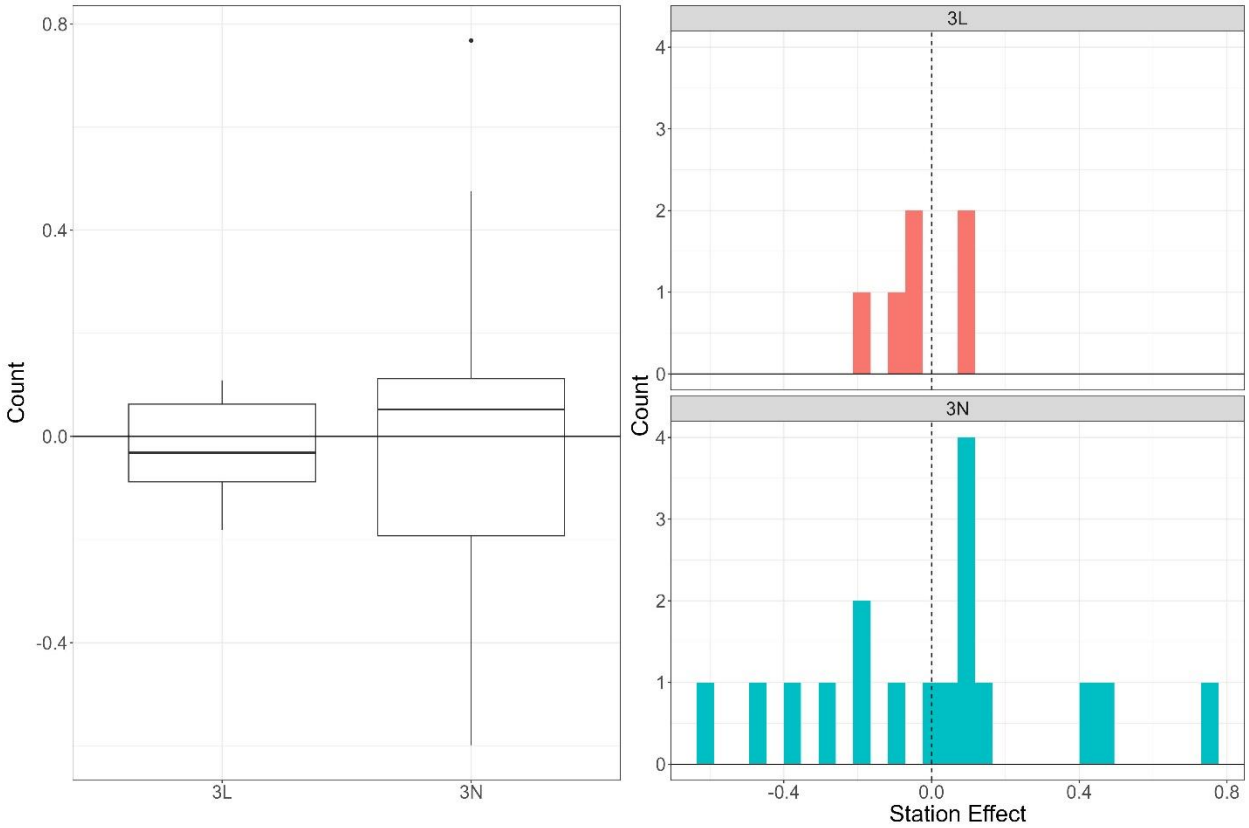

*Figure A1 - 28. Boxplot (left) and histogram (right) of station effect by NAFO division for best model selected for Greenland Halibut (*Reinhardtius hippoglossoides*) conversion factor analysis between the CCGS John Cabot and MV Calvert in spring NAFO divisions 3LNO.*

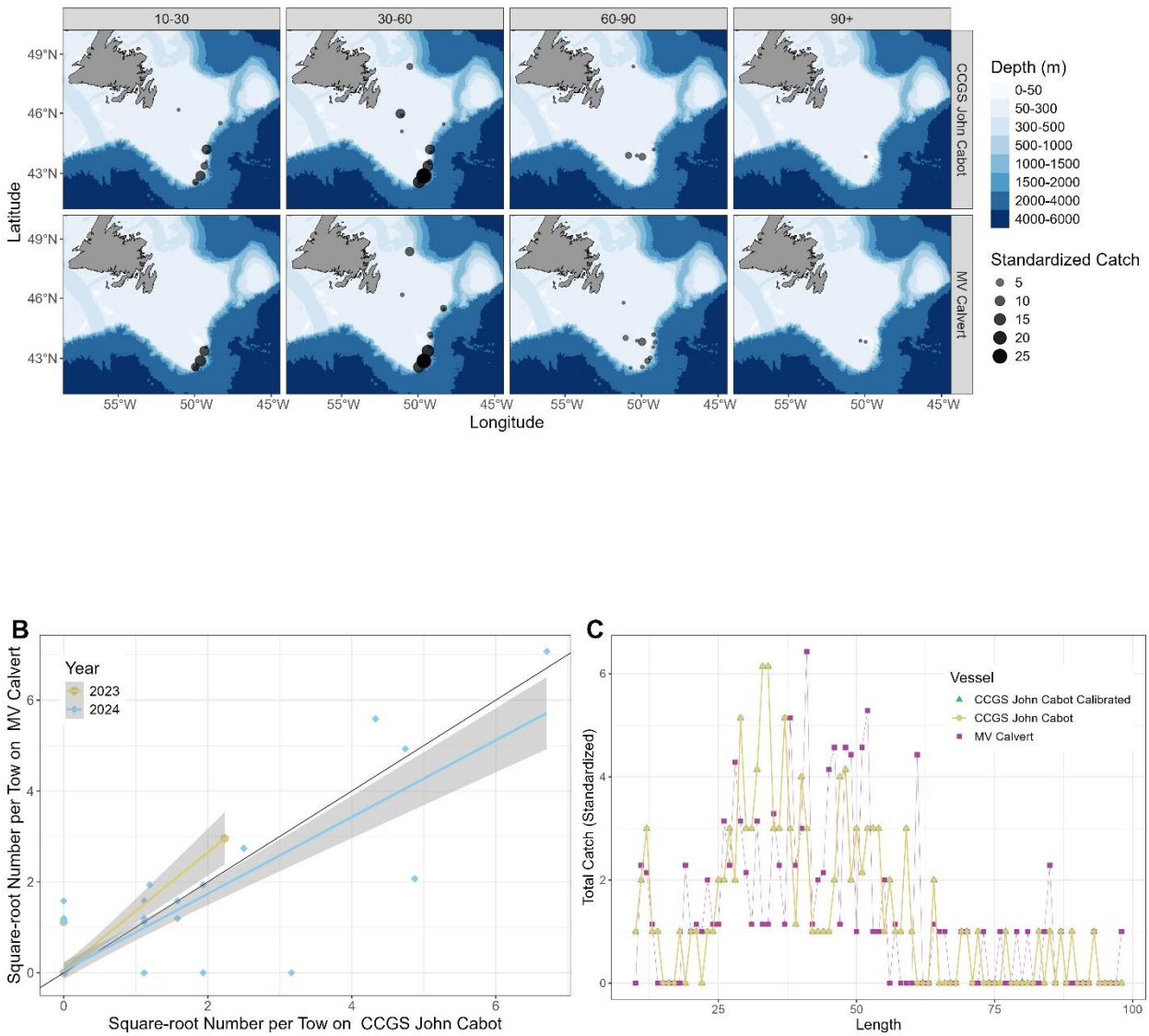

*Figure A1 - 29. Results for length-disaggregated comparative fishing analyses for Striped Wolffish (*Anarhichas lupus*), between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) map of catches by length group (length in cm specified in top panel) by the CCGS John Cabot (top) and the MV Calvert (bottom) in comparative fishing sets, where circle size is proportional catch weight (B) Biplot of the square-root of CCGS John Cabot catch numbers against the square-root of MV Calvert catch numbers. (C) Total length frequencies for catches made by the CCGS John Cabot (yellow), by the MV Calvert (purple), and CCGS John Cabot catches with the conversion factor applied (green).*

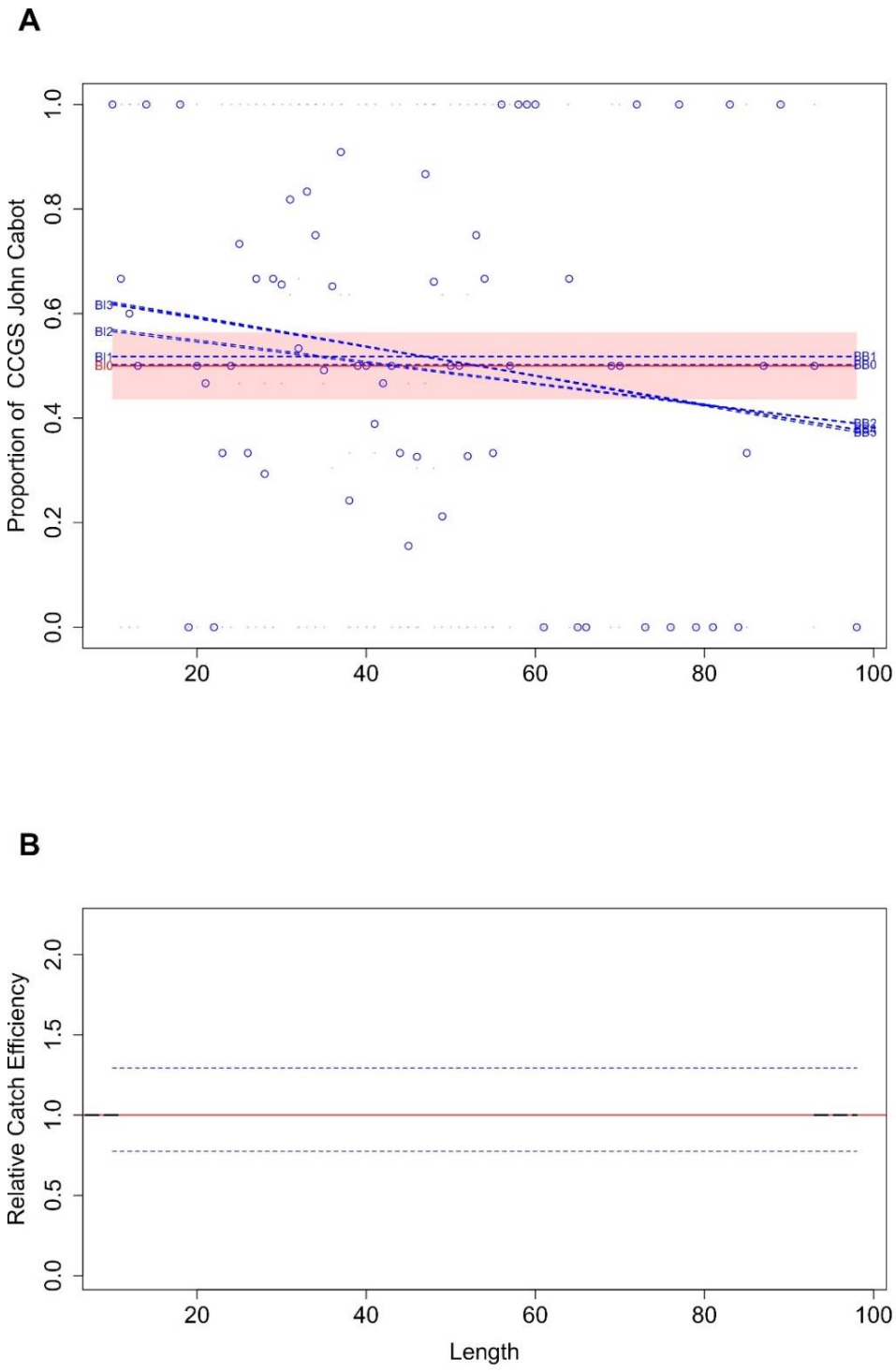

*Figure A1 - 30. Striped Wolffish (*Anarhichas lupus*) conversion factor, between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) Estimated length-specific catch proportion functions,* $logit(p_{Ai}(l))$*, for each converged model, with the selected model plotted using a red line along with its approximate 95% confidence intervals (CI; shaded area), as well as the length class-specific mean empirical proportion of total catch in a pair made by the CCGS John Cabot (blue dots). (B) Estimated relative catch efficiency (conversion factor) function from the best model (black line) with 95% CI (dashed blue lines). The horizontal red line indicates equivalent efficiency between vessels.*

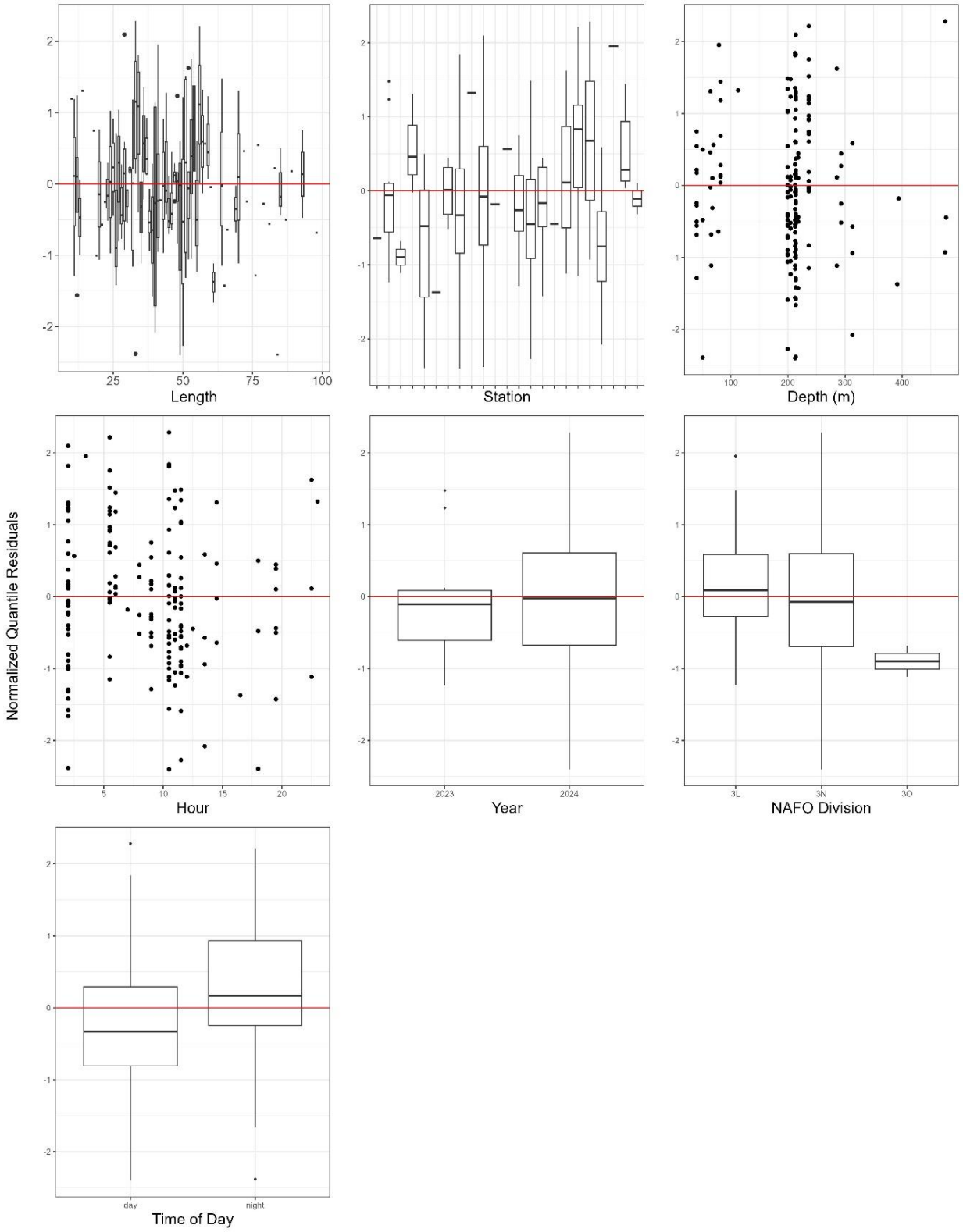

*Figure A1 - 31. Normalized quantile residuals as a function of length, station, depth, hour, year, NAFO division, and diel period for Striped Wolffish (*Anarhichas lupus*), best model selected for length disaggregated conversion factor analysis for the CCGS John Cabot, and MV Calvert for spring NAFO divisions 3LNO.*

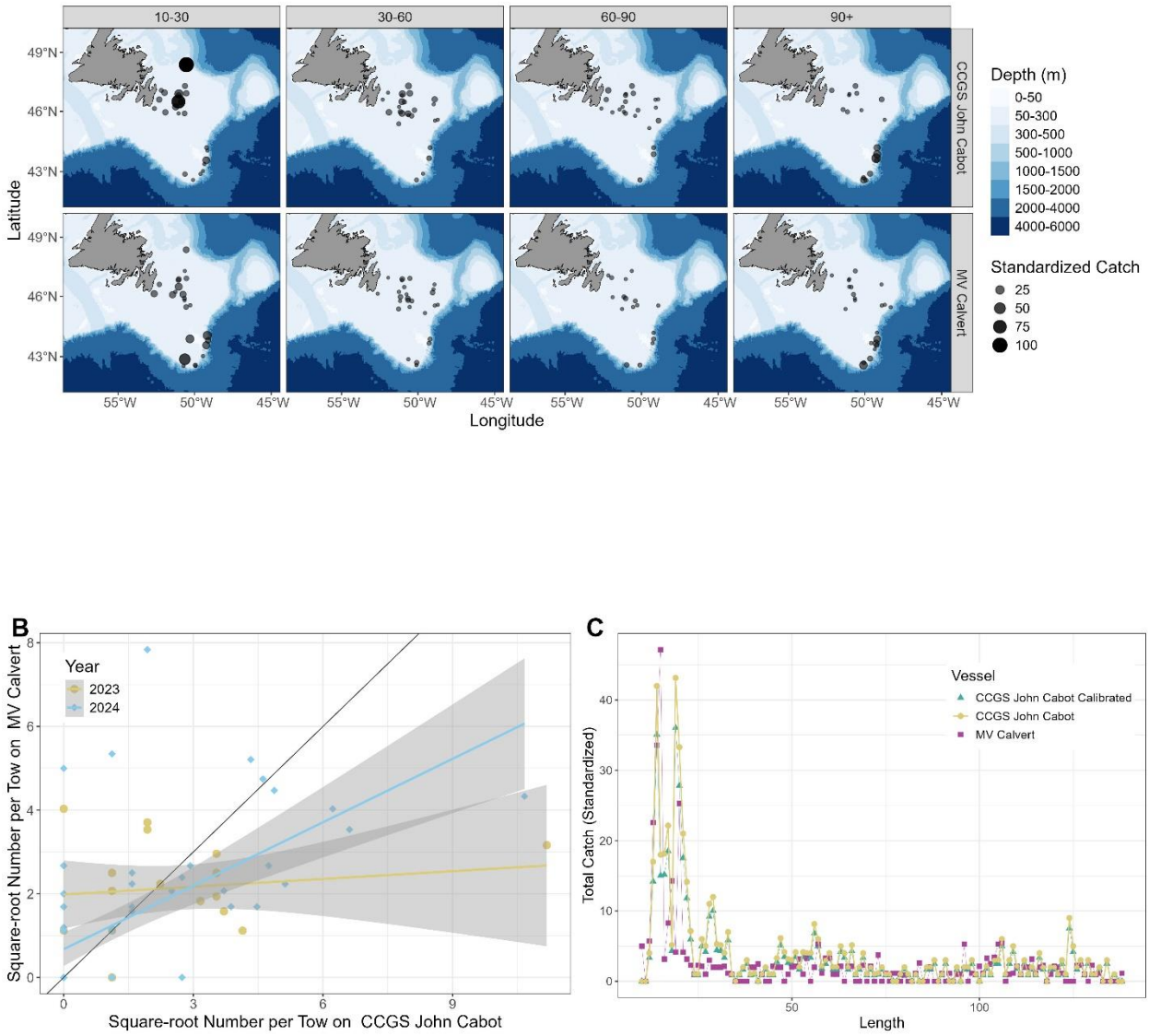

*Figure A1 - 32. Results for length-disaggregated comparative fishing analyses for Snow Crab (*Chionoecetes opilio*), between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) map of catches by length group (length in cm specified in top panel) by the CCGS John Cabot (top) and the MV Calvert (bottom) in comparative fishing sets, where circle size is proportional catch weight (B) Biplot of the square-root of CCGS John Cabot catch numbers against the square-root of MV Calvert catch numbers. (C) Total length frequencies for catches made by the CCGS John Cabot (yellow), by the MV Calvert (purple), and CCGS John Cabot catches with the conversion factor applied (green).*

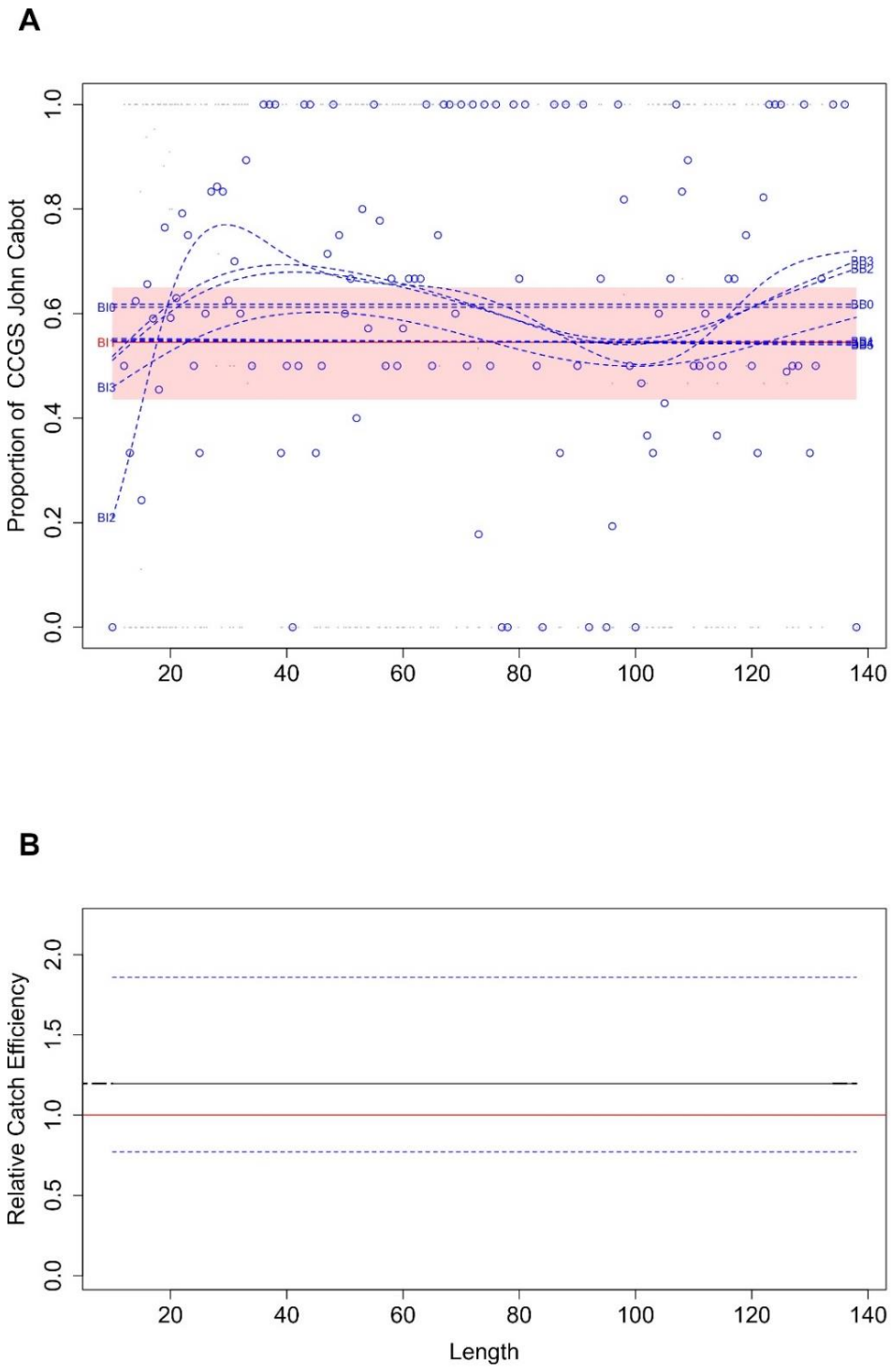

*Figure A1 - 33. Snow Crab (*Chionoecetes opilio*) conversion factor, between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) Estimated length-specific catch proportion functions,* $logit(p_{Ai}(l))$*, for each converged model, with the selected model plotted using a red line along with its approximate 95% confidence intervals (CI; shaded area), as well as the length class-specific mean empirical proportion of total catch in a pair made by the CCGS John Cabot (blue dots). (B) Estimated relative catch efficiency (conversion factor) function from the best model (black line) with 95% CI (dashed blue lines). The horizontal red line indicates equivalent efficiency between vessels.*

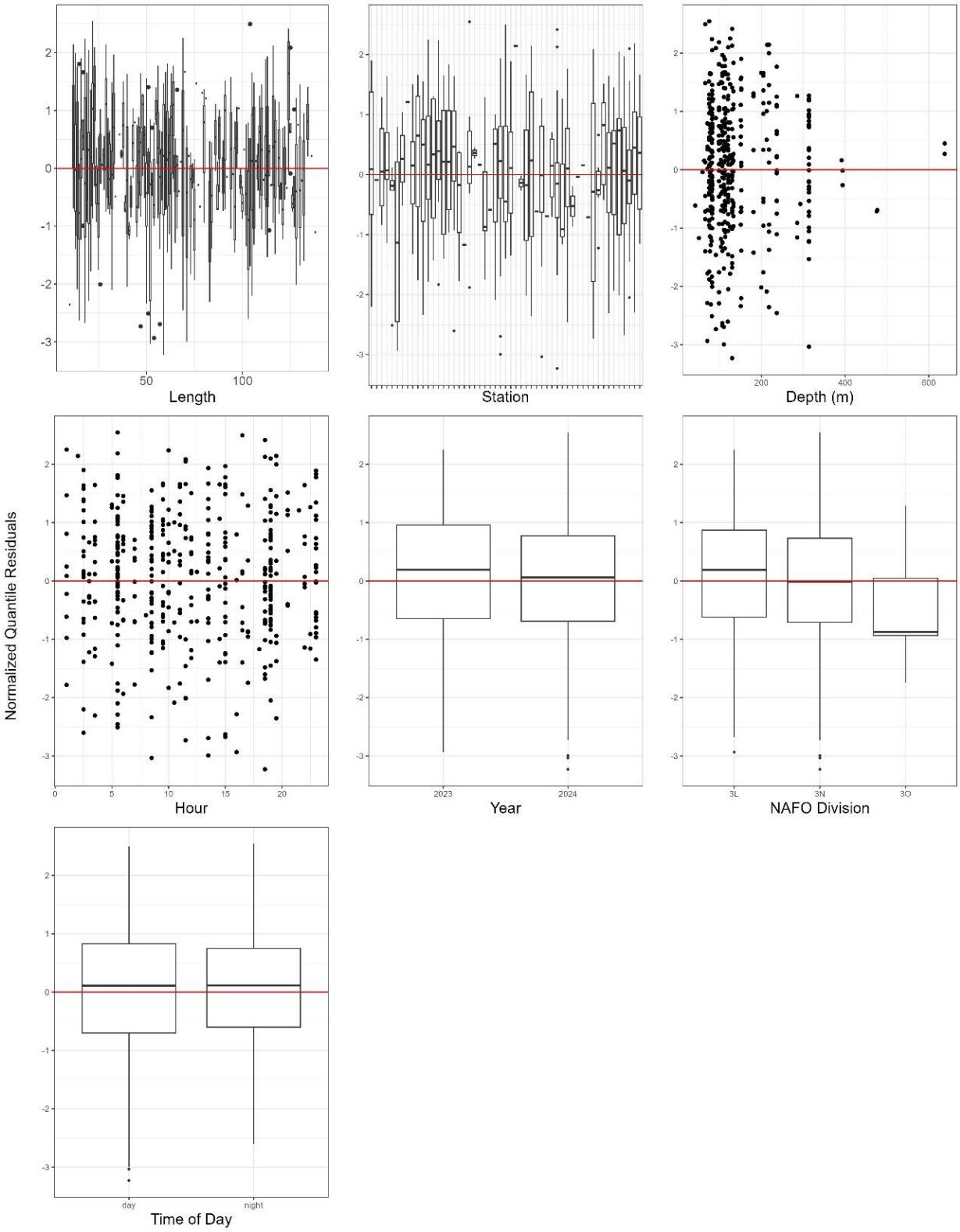

*Figure A1 - 34. Normalized quantile residuals as a function of length, station, depth, hour, year, NAFO division, and diel period for Snow Crab (*Chionoecetes opilio*), best model selected for length disaggregated conversion factor analysis for the CCGS John Cabot, and MV Calvert for spring NAFO divisions 3LNO.*

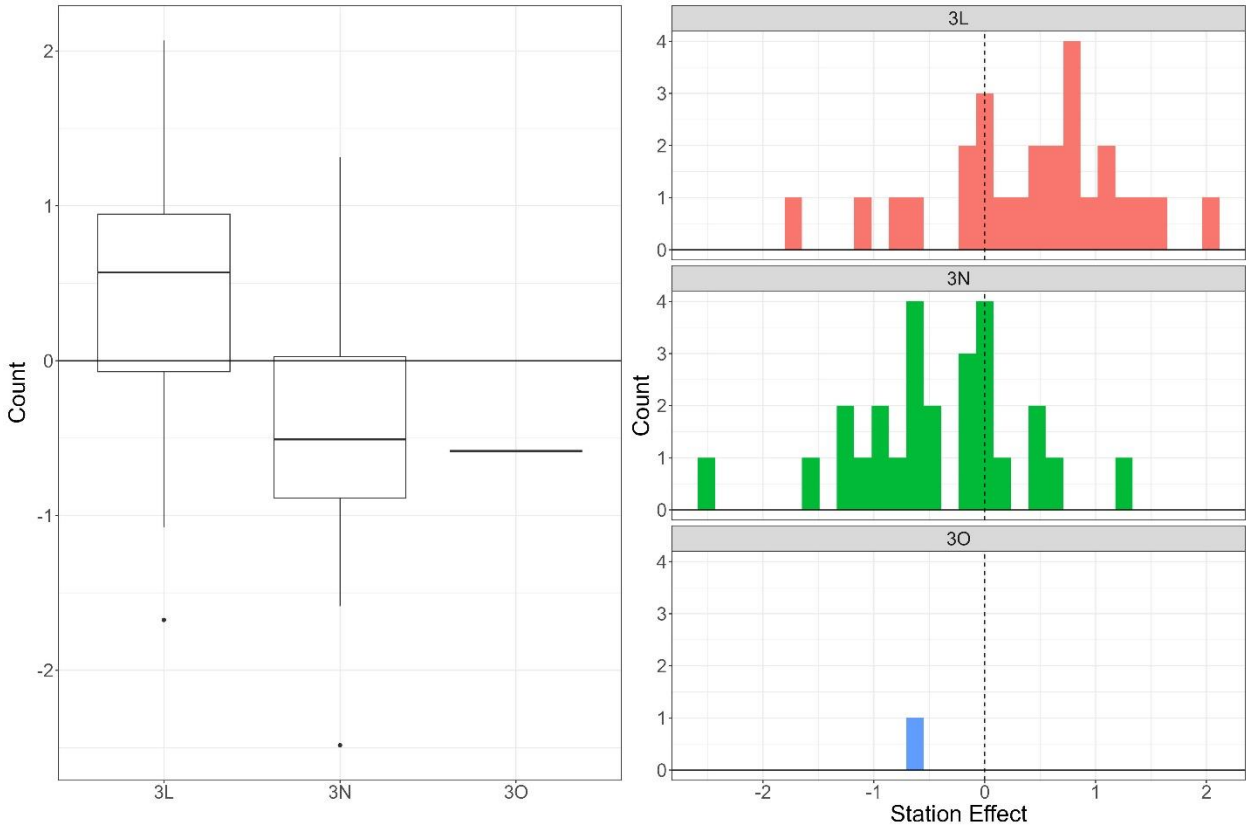

*Figure A1 - 35. Boxplot (left) and histogram (right) of station effect by NAFO division for best model selected for Snow Crab (*Chionoecetes opilio*) conversion factor analysis between the CCGS John Cabot and MV Calvert in spring NAFO divisions 3LNO.*

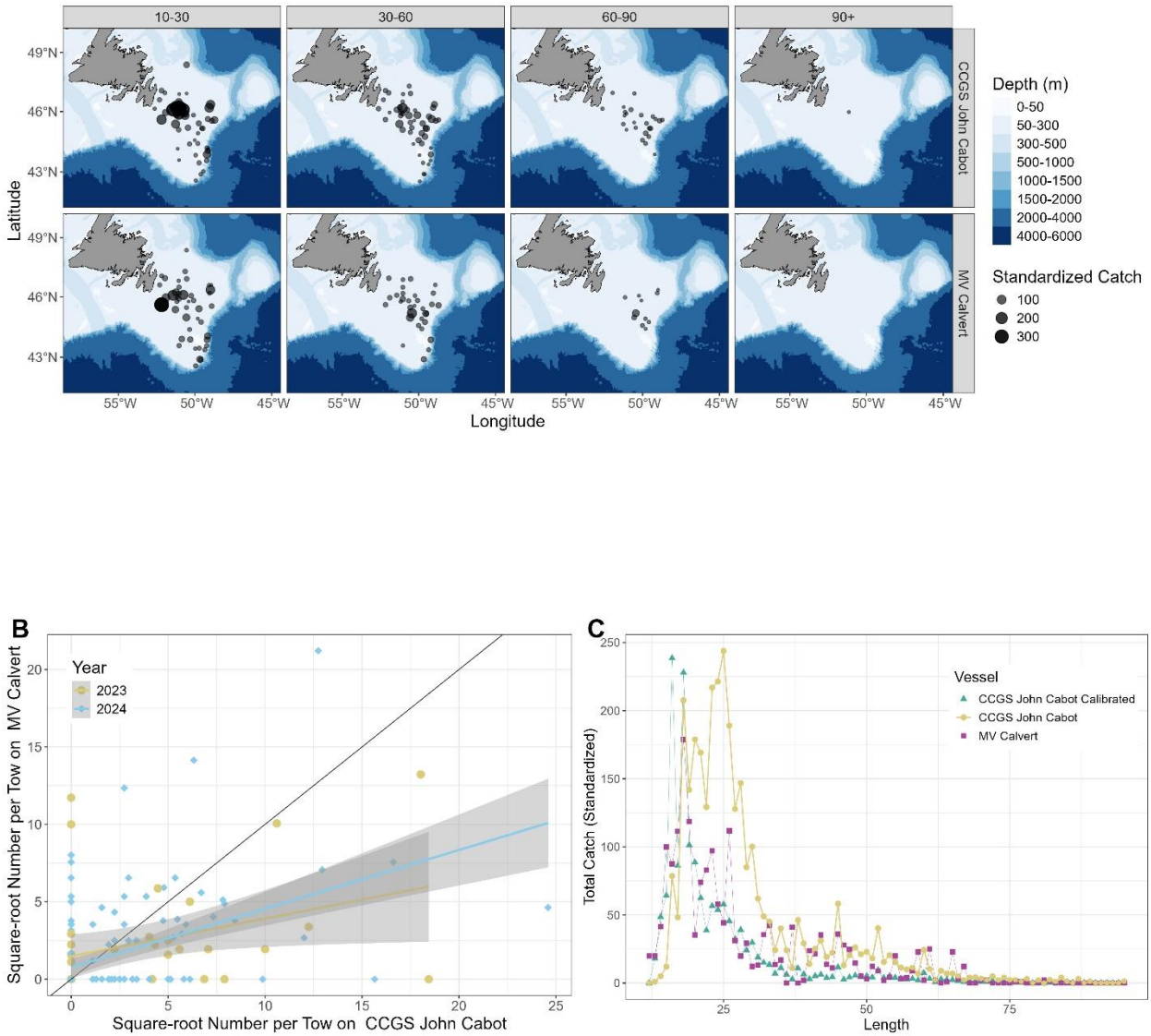

*Figure A1 - 36. Results for length-disaggregated comparative fishing analyses for Toad Crab (*Hyas *sp.), between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) map of catches by length group (length in cm specified in top panel) by the CCGS John Cabot (top) and the MV Calvert (bottom) in comparative fishing sets, where circle size is proportional catch weight (B) Biplot of the square-root of CCGS John Cabot catch numbers against the square-root of MV Calvert catch numbers. (C) Total length frequencies for catches made by the CCGS John Cabot (yellow), by the MV Calvert (purple), and CCGS John Cabot catches with the conversion factor applied (green).*

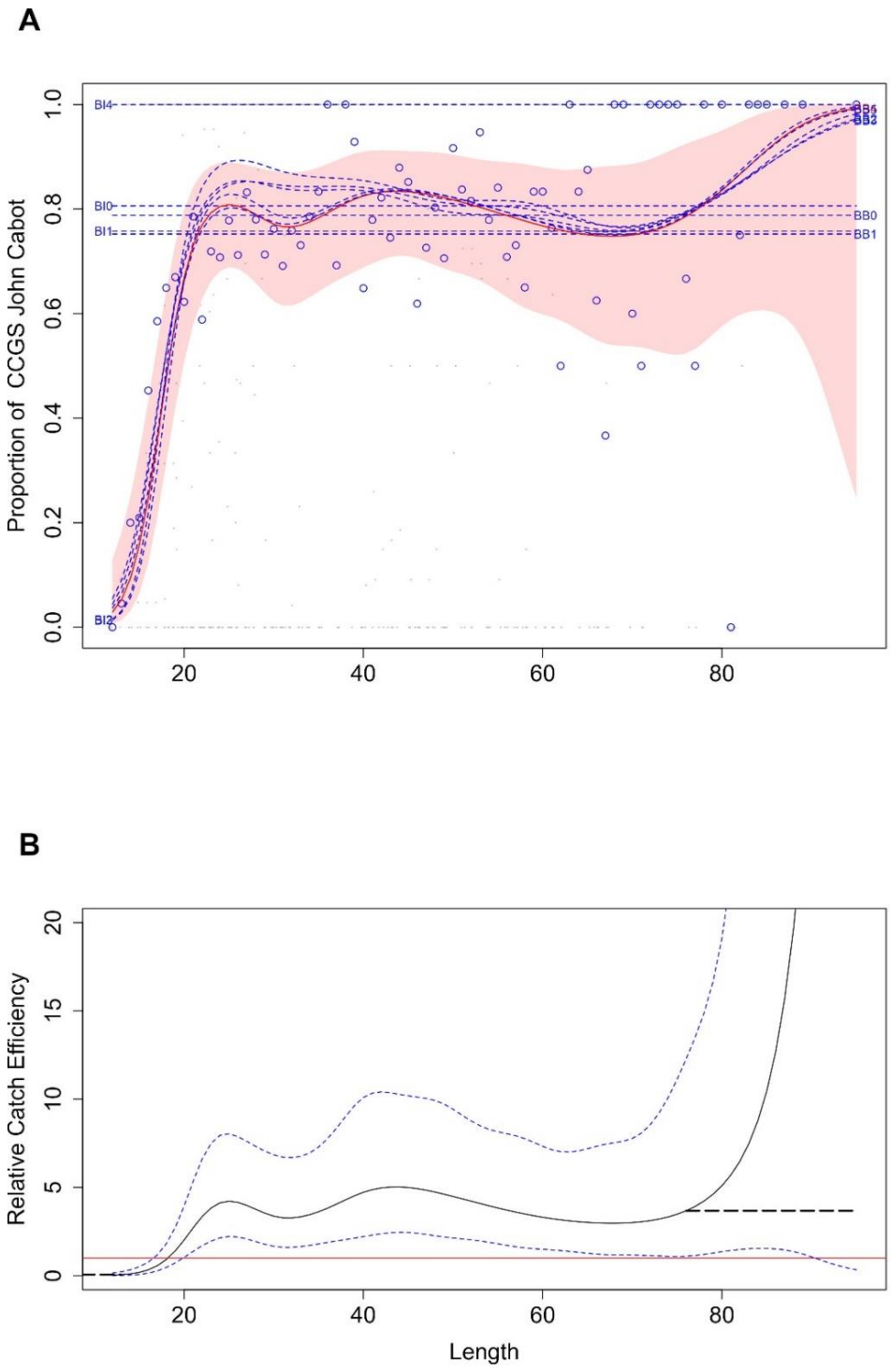

*Figure A1 - 37. Toad Crab (*Hyas *sp.) conversion factor, between the CCGS John Cabot and MV Calvert for spring NAFO divisions 3LNO. (A) Estimated length-specific catch proportion functions, $logit(p_{Ai}(l))$, for each converged model, with the selected model plotted using a red line along with its approximate 95% confidence intervals (CI; shaded area), as well as the length class-specific mean empirical proportion of total catch in a pair made by the CCGS John Cabot (blue dots). (B) Estimated relative catch efficiency (conversion factor) function from the best model (black line) with 95% CI (dashed blue lines). The horizontal red line indicates equivalent efficiency between vessels.*

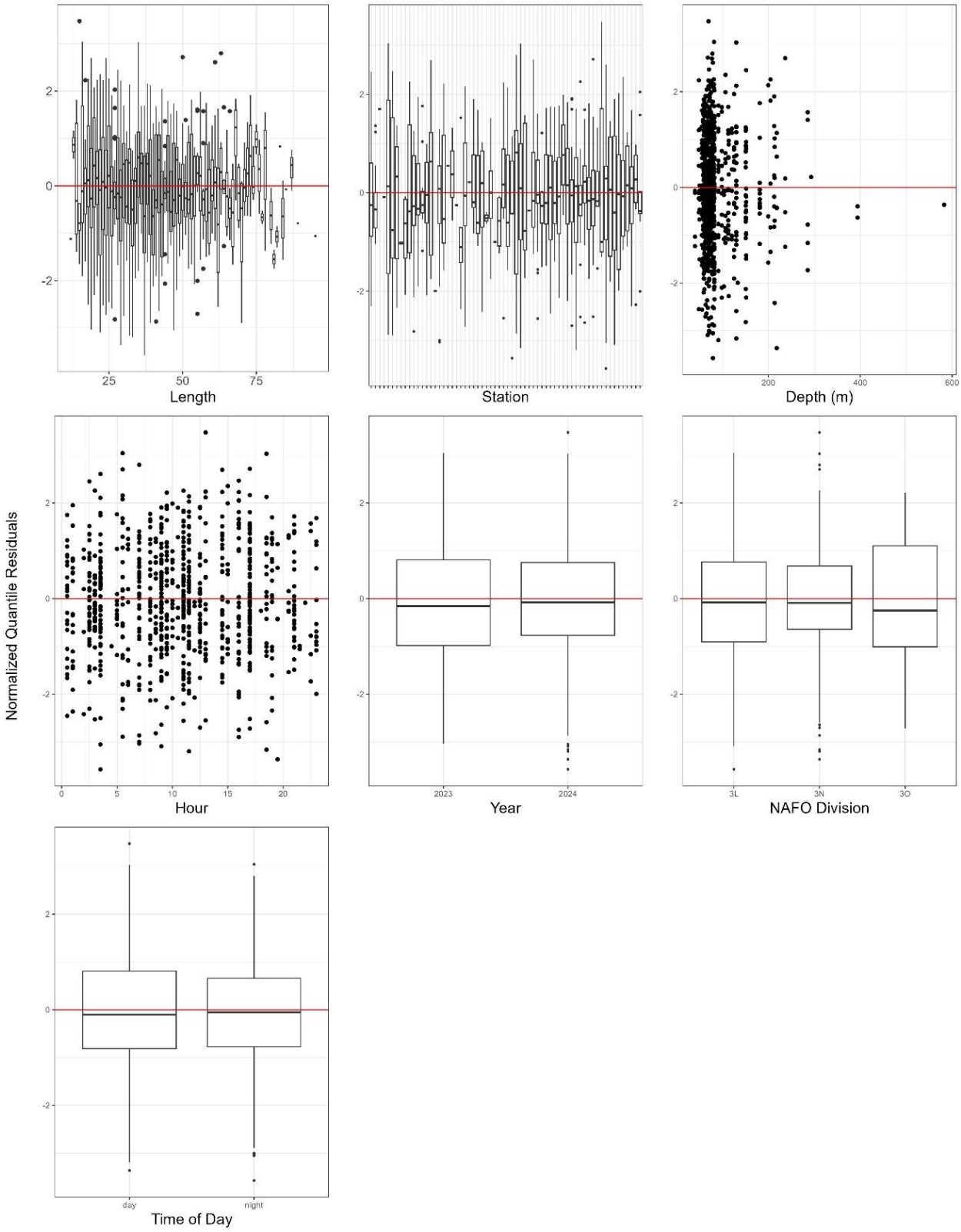

*Figure A1 - 38. Normalized quantile residuals as a function of length, station, depth, hour, year, NAFO division, and diel period for Toad Crab (*Hyas *sp.), best model selected for length disaggregated conversion factor analysis for the CCGS John Cabot, and MV Calvert for spring NAFO divisions 3LNO.*

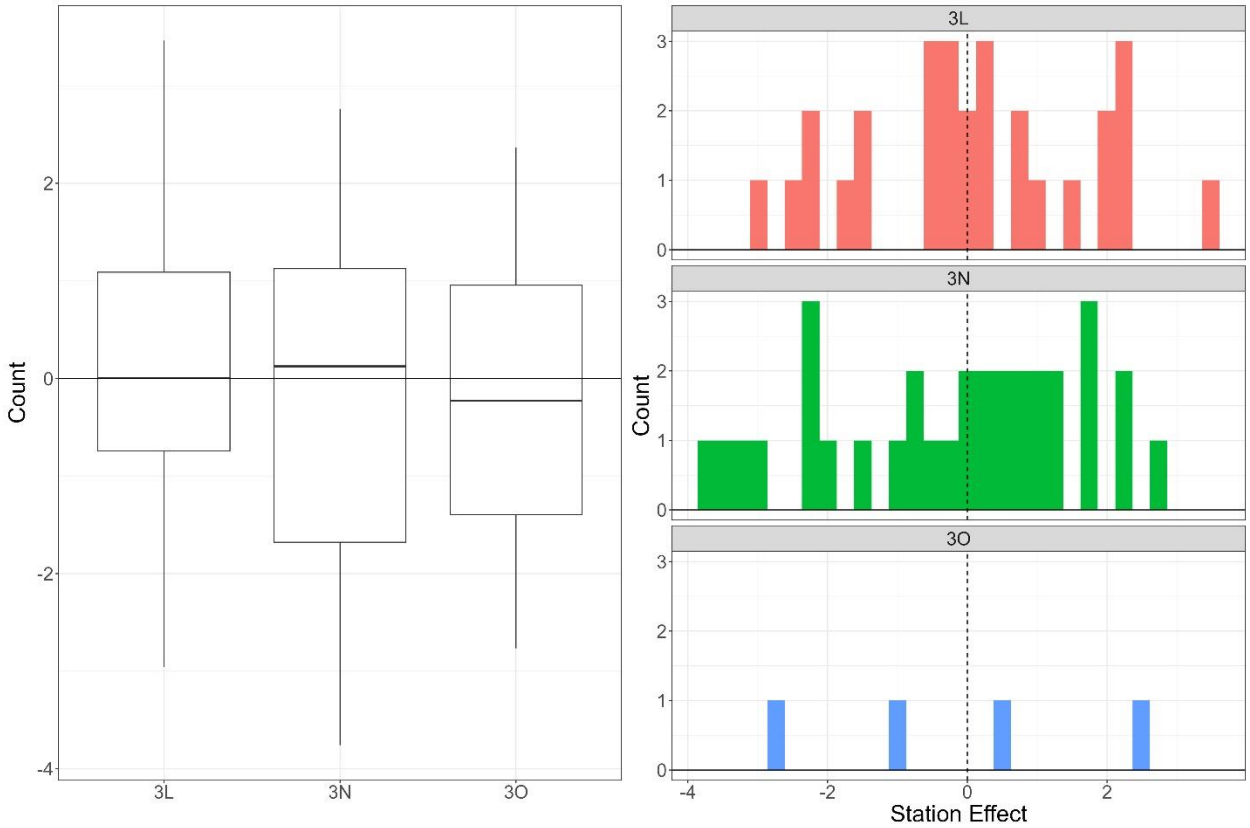

*Figure A1 - 39. Boxplot (left) and histogram (right) of station effect by NAFO division for best model selected for Toad Crab (*Hyas *sp.) conversion factor analysis between the CCGS John Cabot and MV Calvert in spring NAFO divisions 3LNO.*

9. APPENDIX 2: SIZE AGGREGATED CONVERSION FACTOR RESULTS

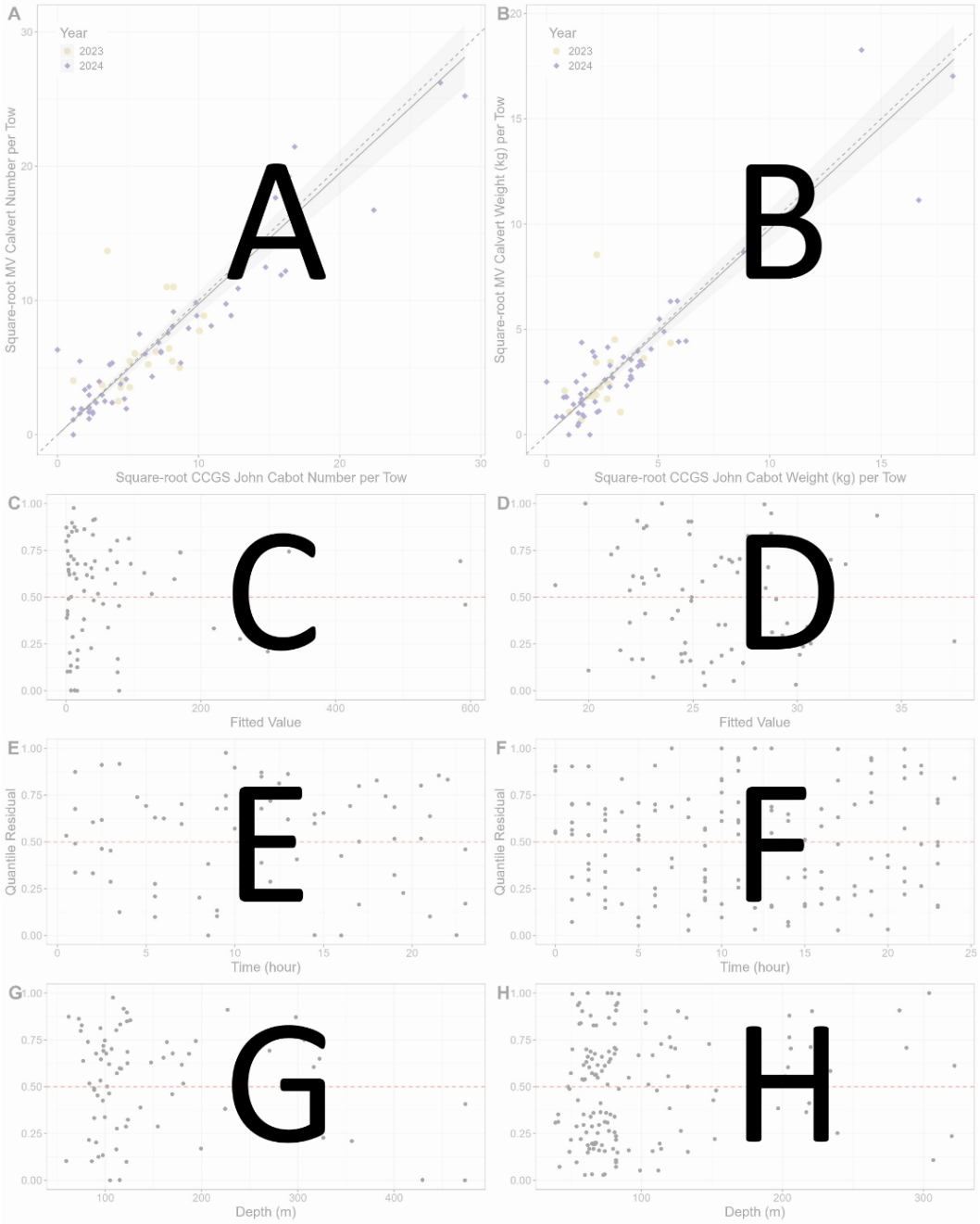

Figure A2- 1. An outline for the interpretation of the figures presenting the data and results for taxa where size aggregated analyses was completed. Panel A is the biplot of the square-root of the MV Calvert catch numbers against the square-root of CCGS John Cabot catch numbers, where the solid black line and shaded interval show the estimated conversion and approximate 95% CI from the best size-aggregated model. Panel B is the same as A except for catch weights. Below A and B are the quantile residuals from the analysis of catch numbers, and weights plotted as a function of the fitted values (panels C and D respectively), time (panels E and F respectively), and depth (panels G and H respectively). Captions for the individual taxa figures only state the species and vessel pairing visualized in the figure.

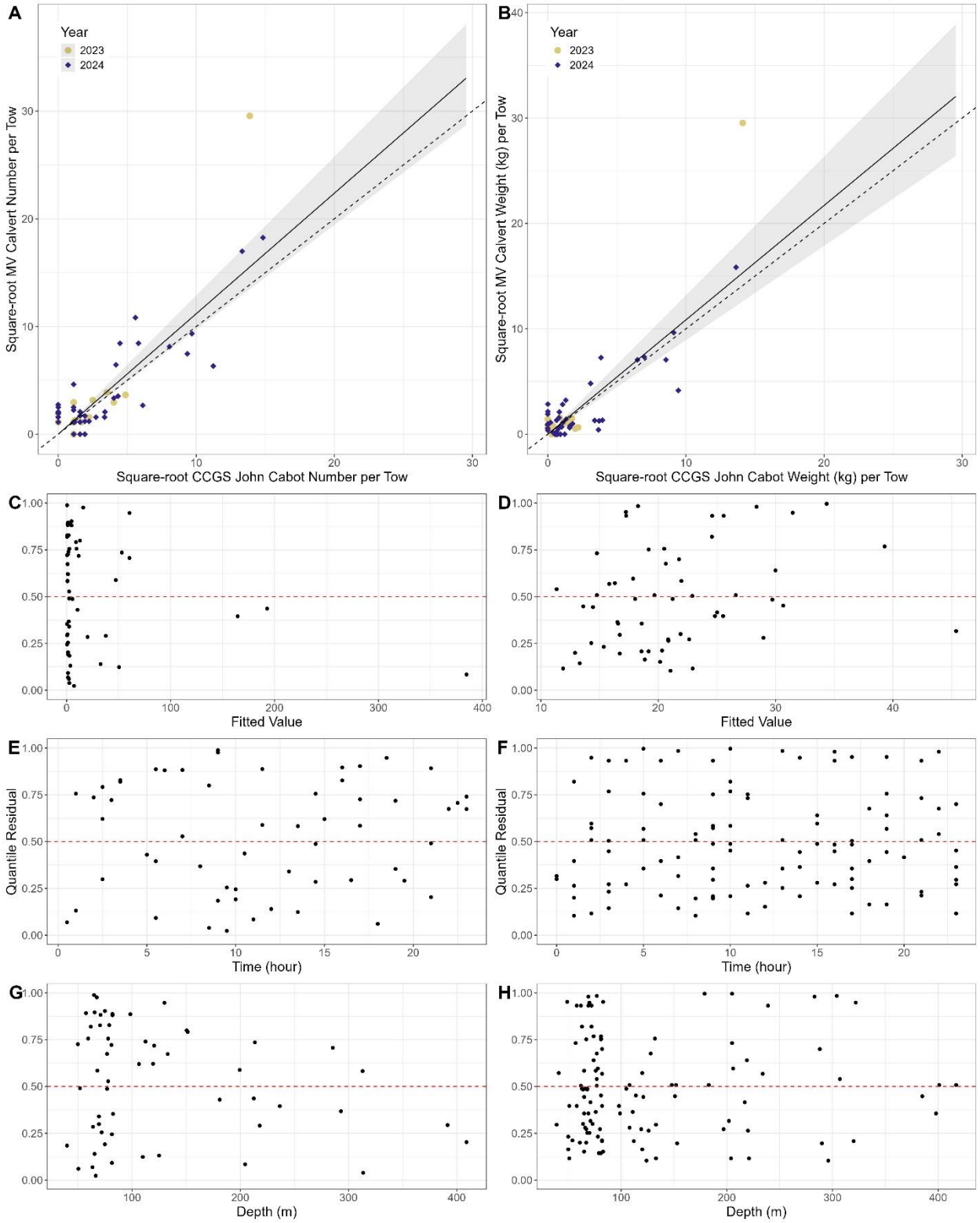

*Figure A2- 2. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Atlantic Cod (*Gadus morhua*), spring 3LNO.*

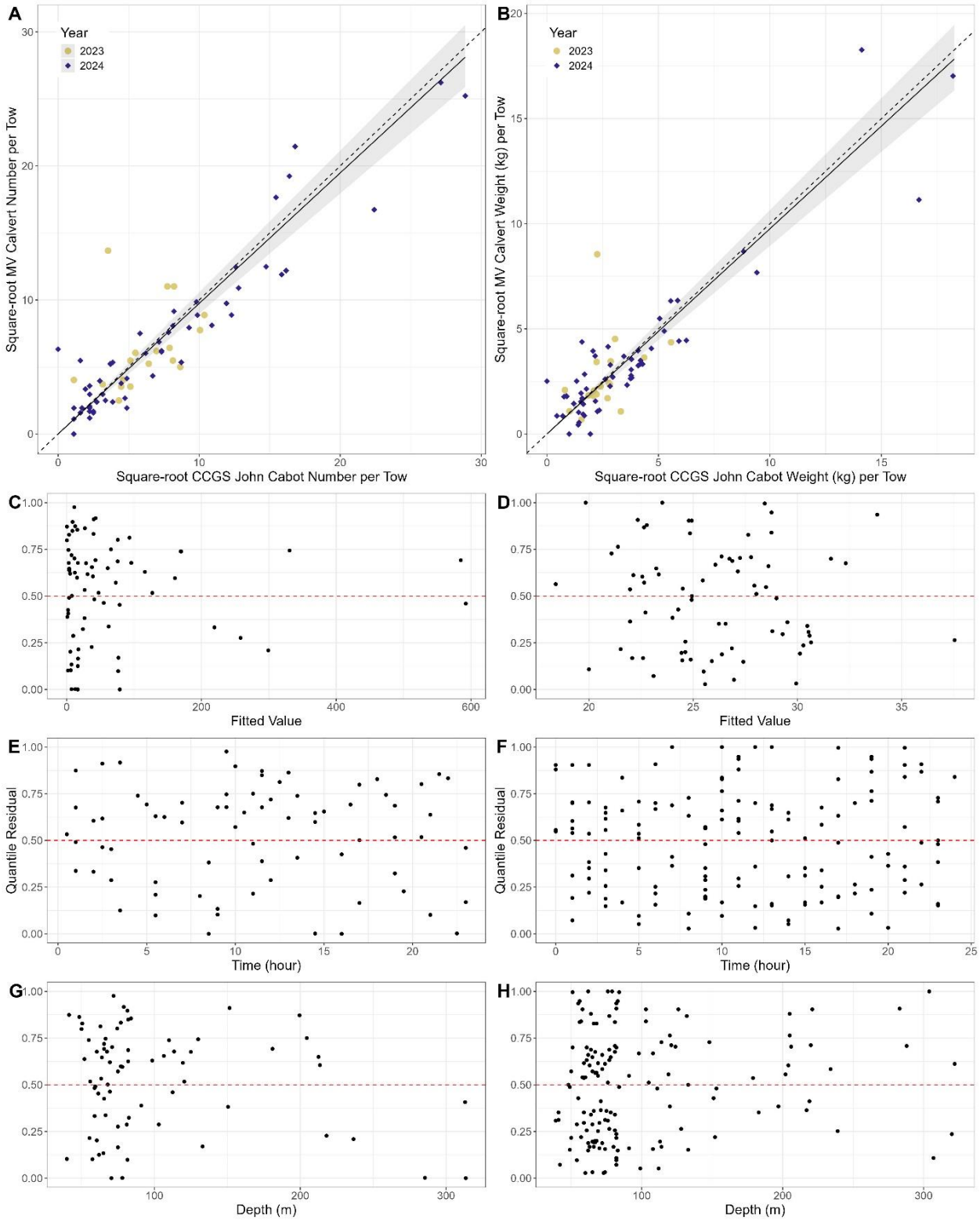

*Figure A2- 3. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of American Plaice (*Hippoglossoides platessoides*), spring 3LNO.*

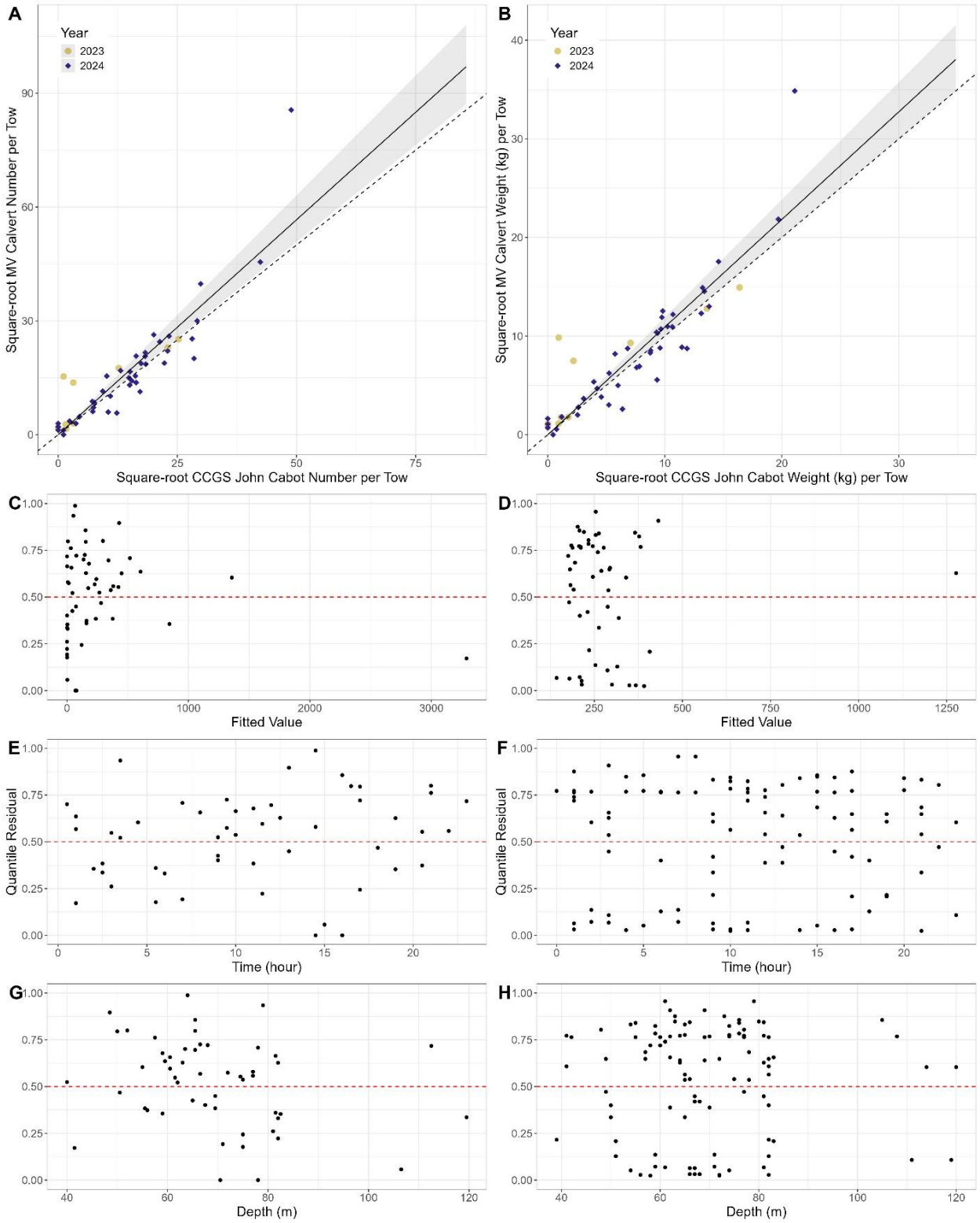

*Figure A2- 4. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Yellowtail Flounder (*Myzopsetta ferruginea*), spring 3LNO.*

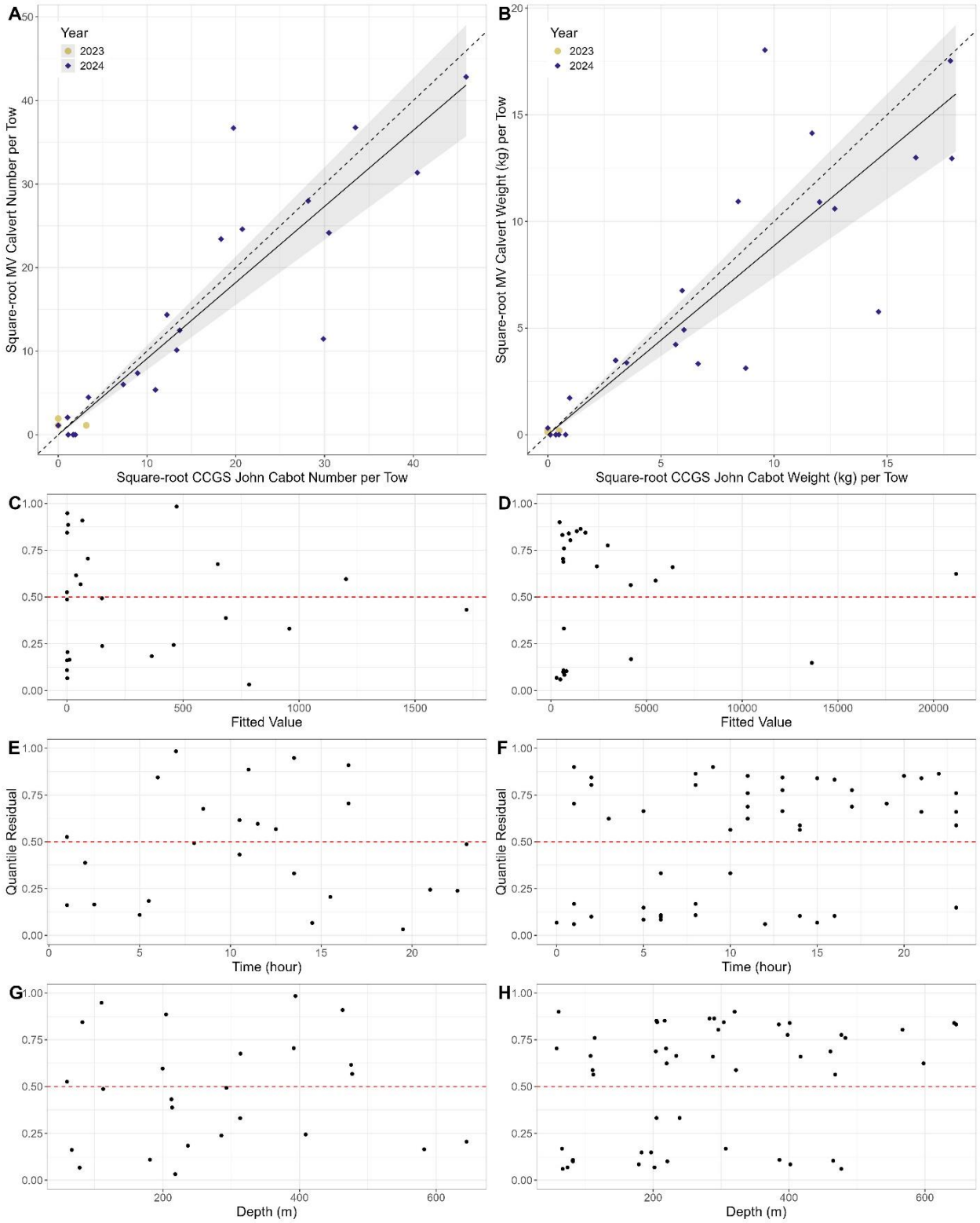

*Figure A2- 5. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Redfish (*Sebastes mentella *&* S. fasciatus*), spring 3LNO.*

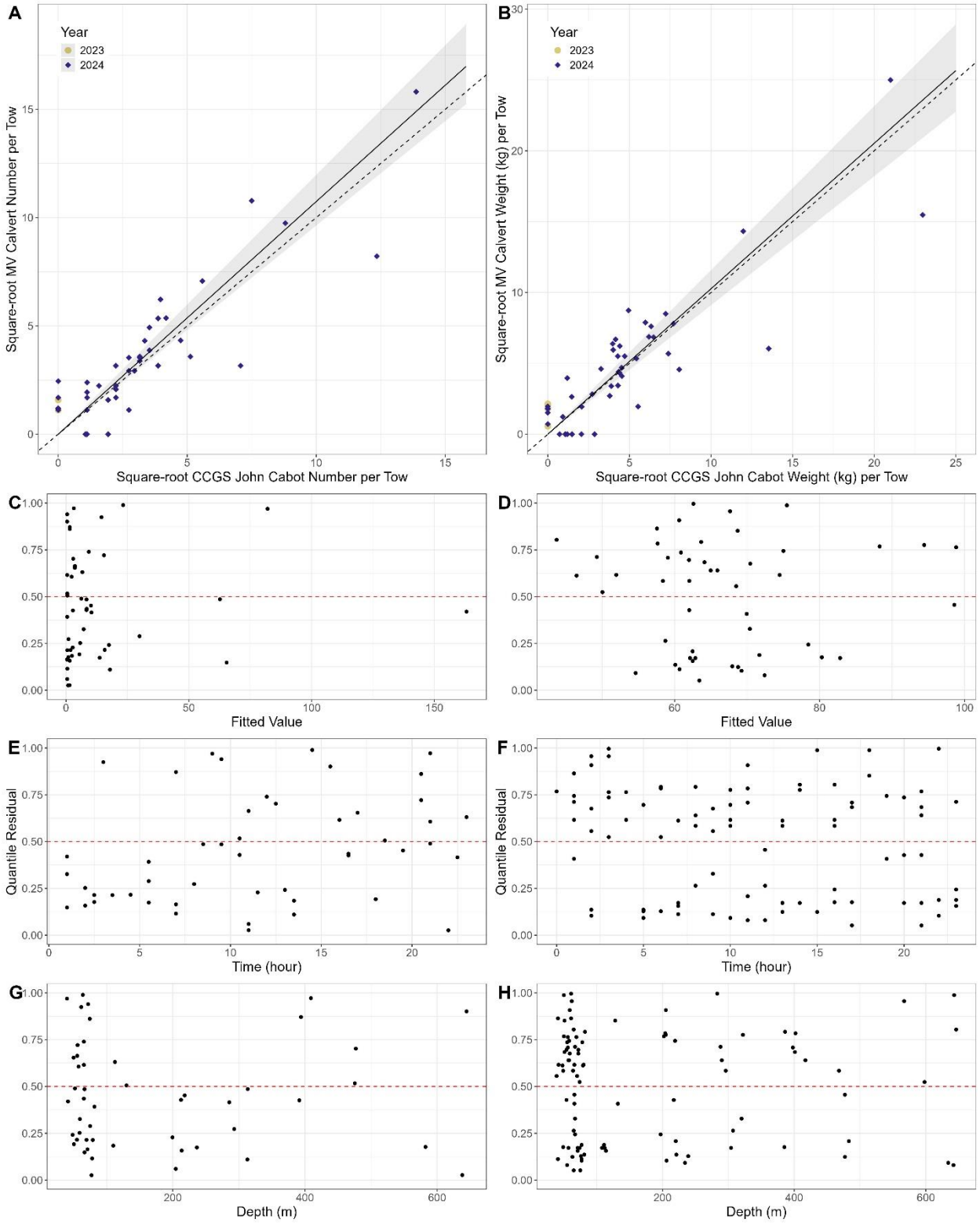

*Figure A2- 6. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Thorny Skate (*Amblyraja radiata*), spring 3LNO.*

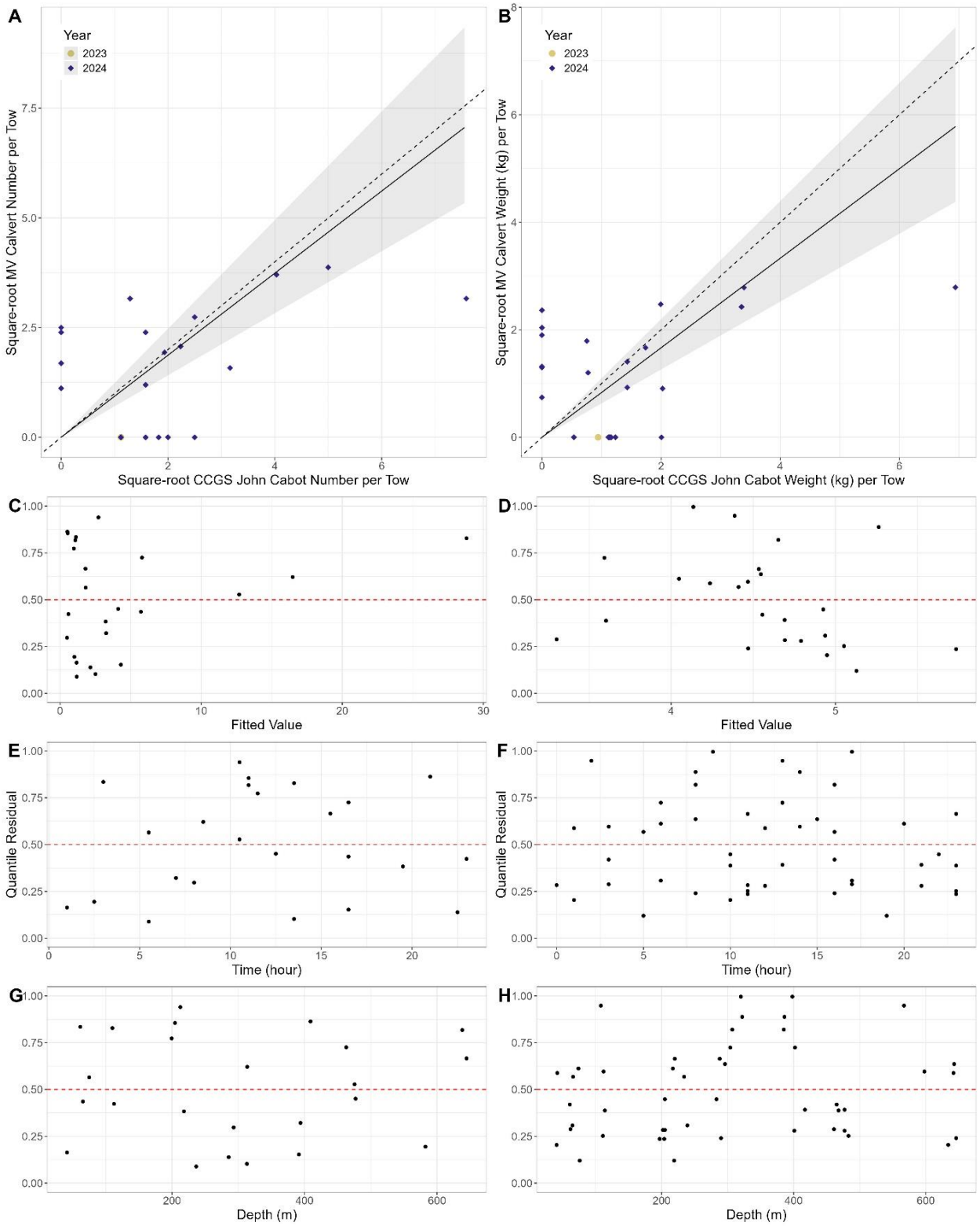

*Figure A2- 7. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Witch Flounder (*Glyptocephalus cynoglossus*), spring 3NO.*

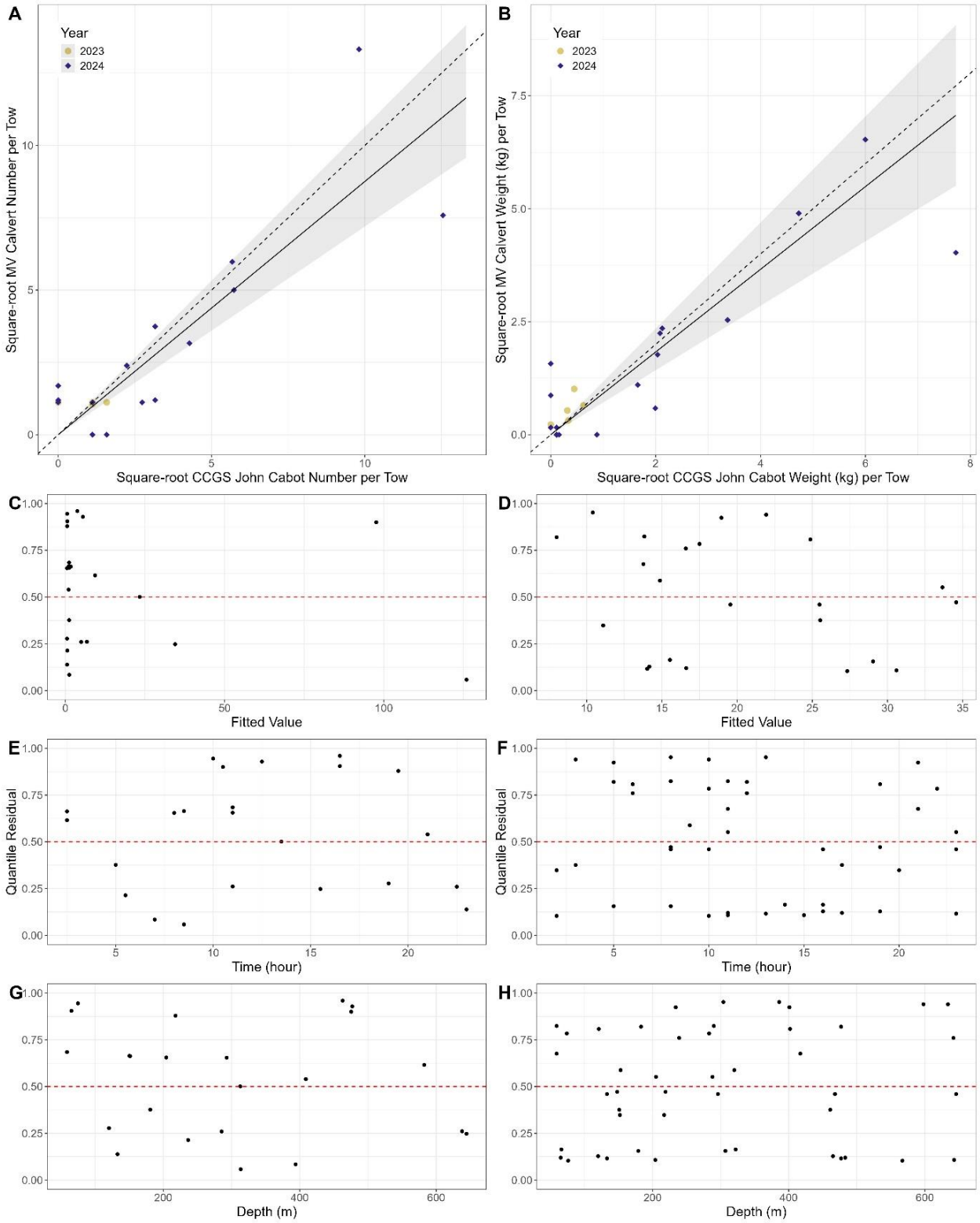

*Figure A2- 8. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Greenland Halibut (*Reinhardtius hippoglossoides*), spring 3LNO.*

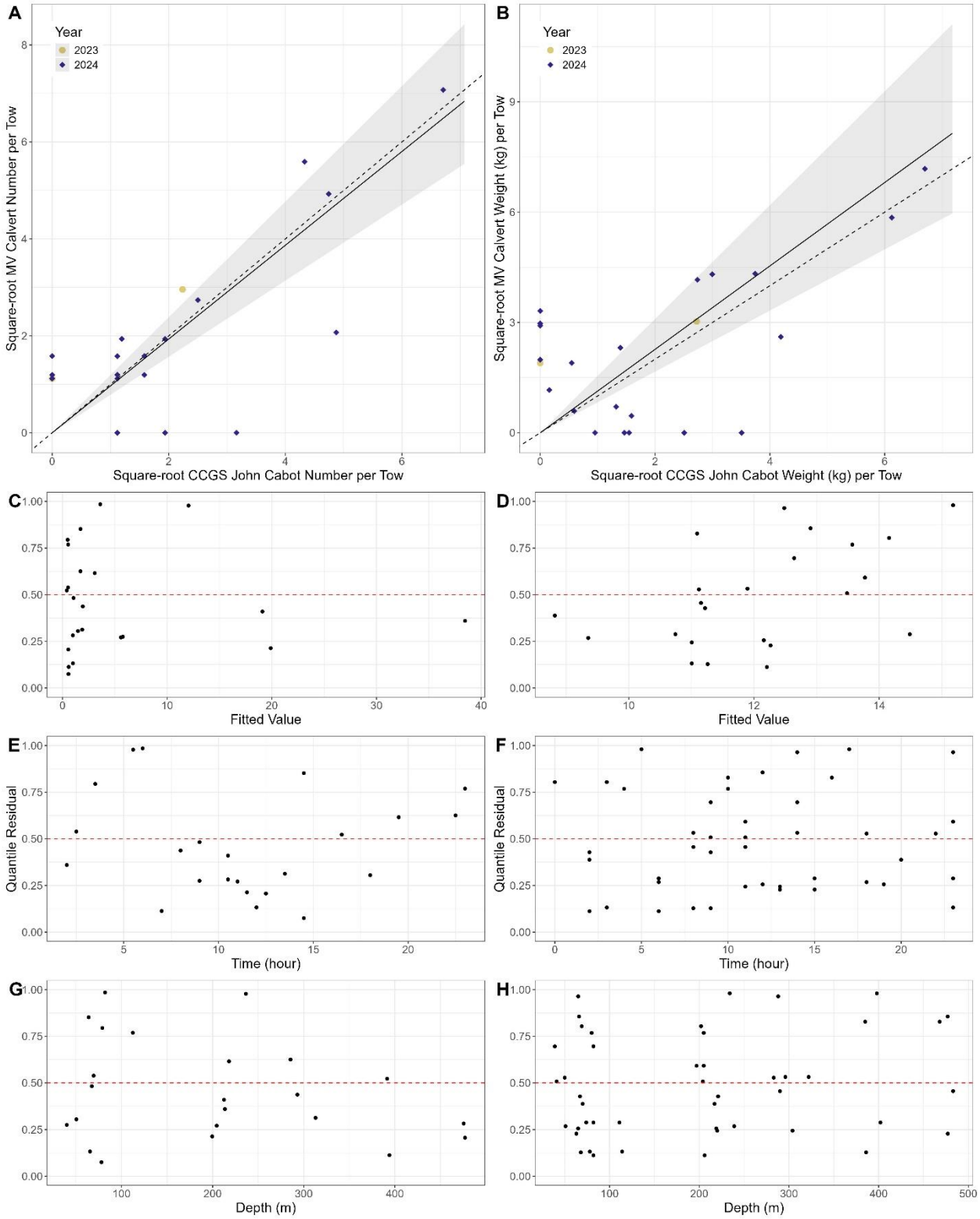

*Figure A2- 9. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Striped Wolffish (*Anarhichas lupus*), spring 3LNO.*

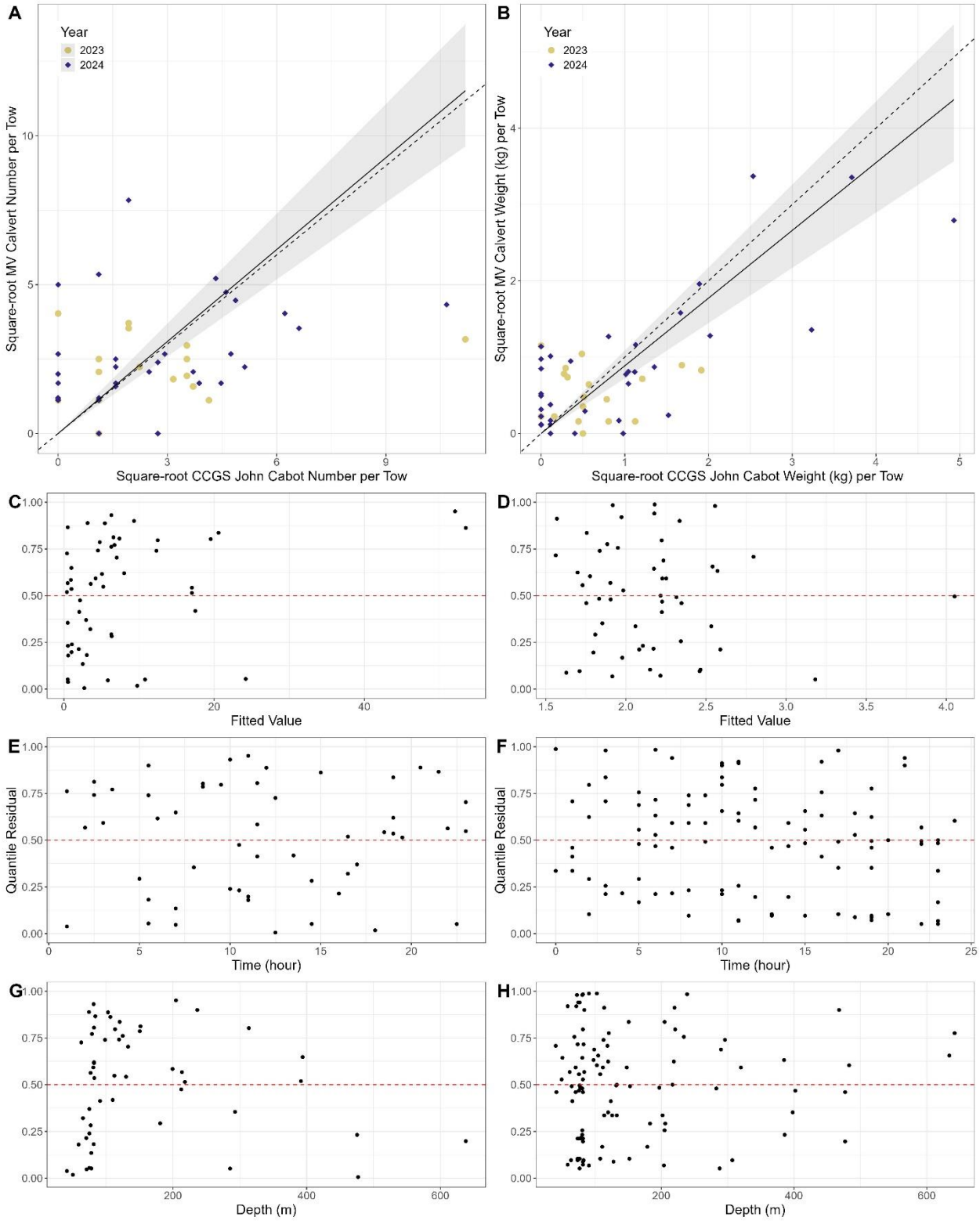

*Figure A2- 10. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Snow Crab (*Chionoecetes opilio*), spring 3LNO.*

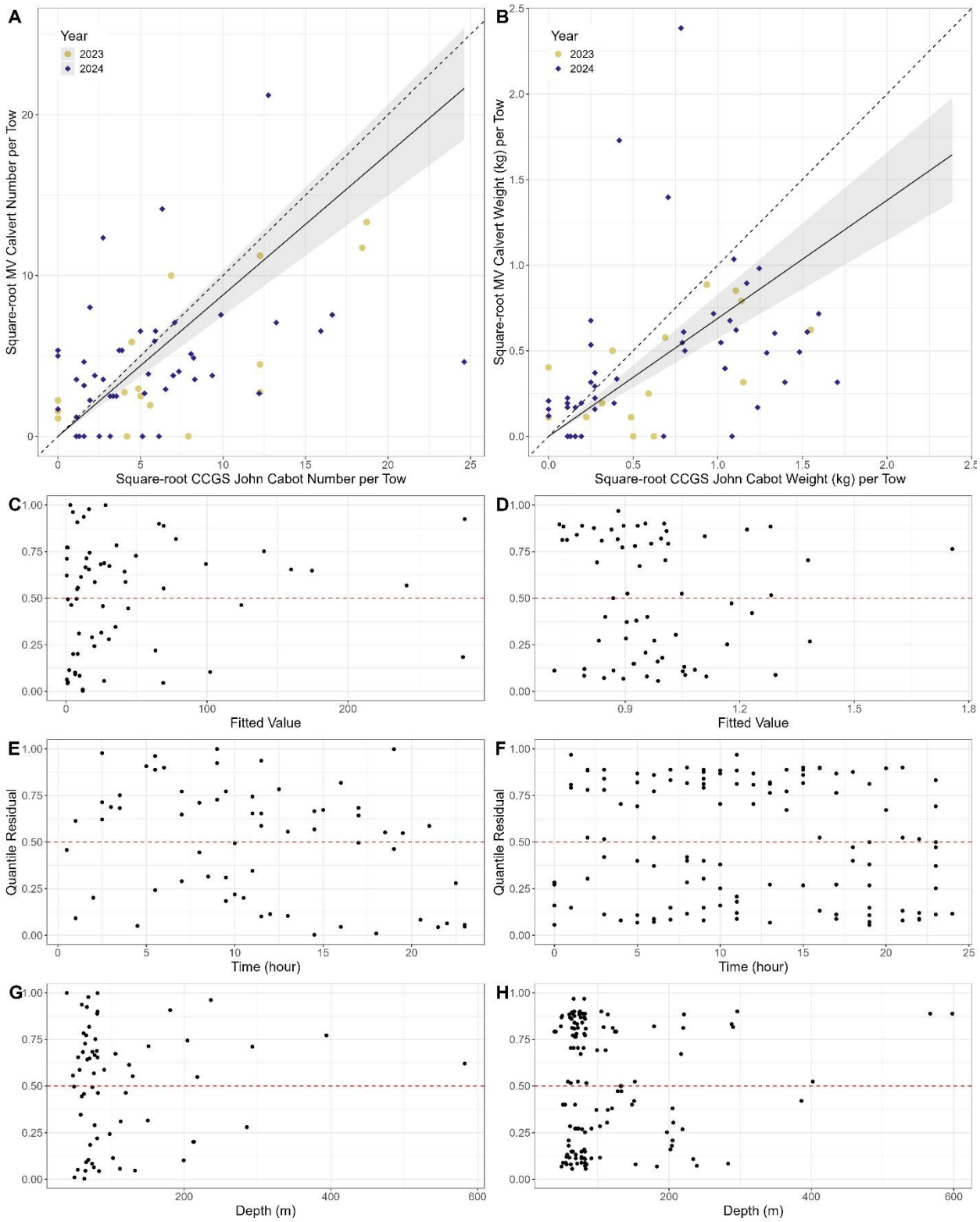

*Figure A2- 11. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Toad Crab (*Hyas *sp.), spring 3LNO.*

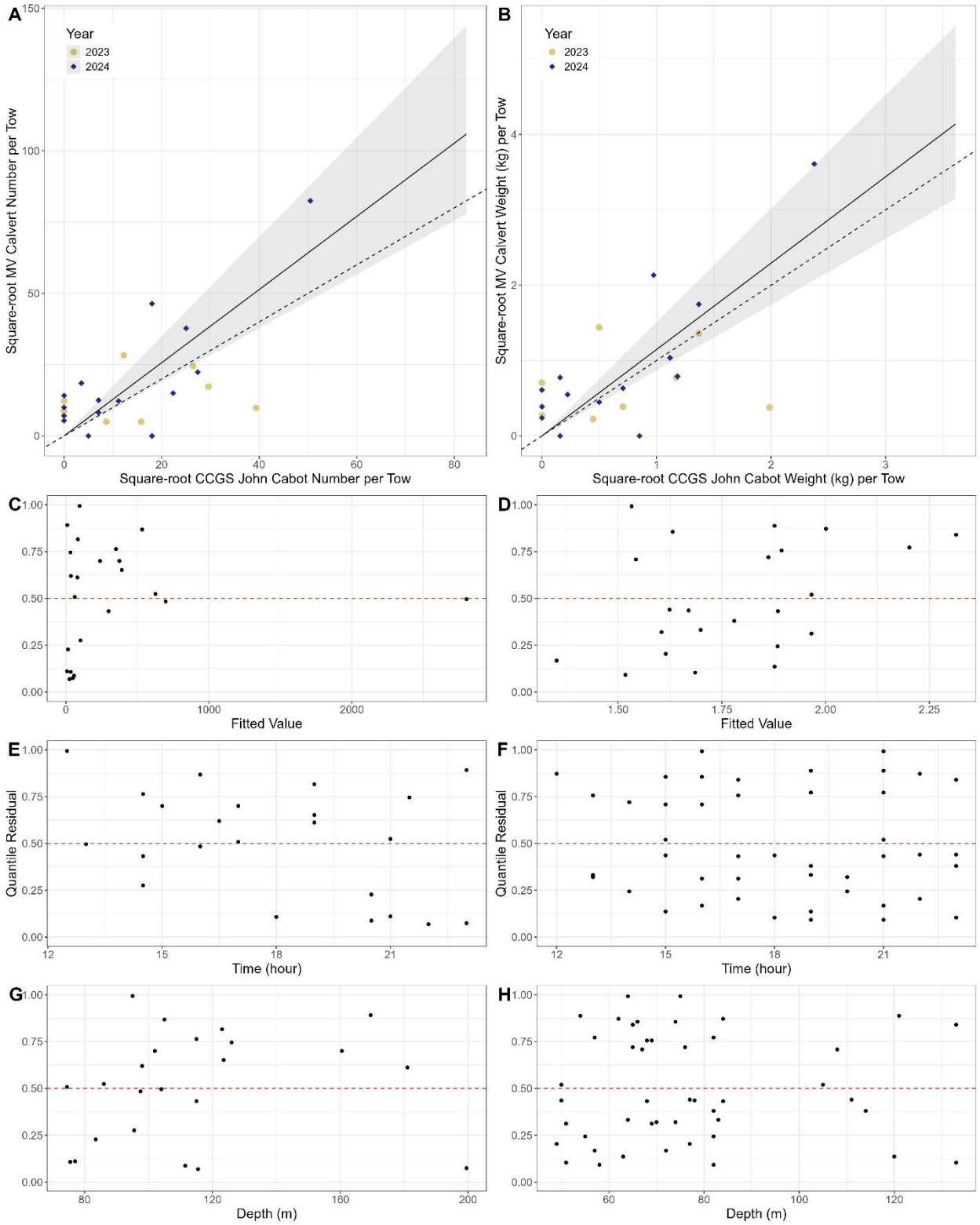

*Figure A2- 12. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Striped Shrimp (*Pandalus montagui*), spring 3LNO.*

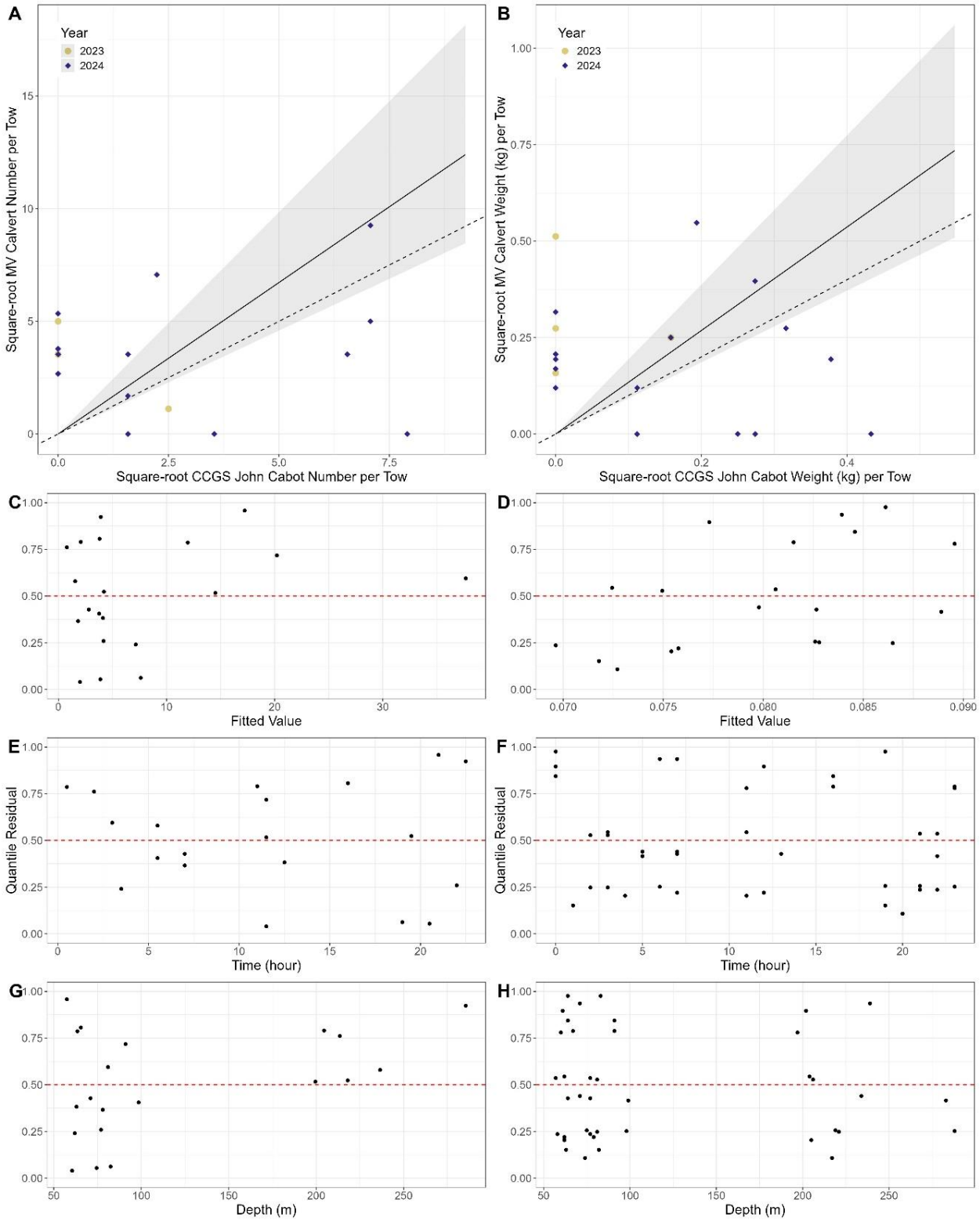

*Figure A2- 13. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of alligatorfishes & poachers (*Agonus *spp.), spring 3LNO.*

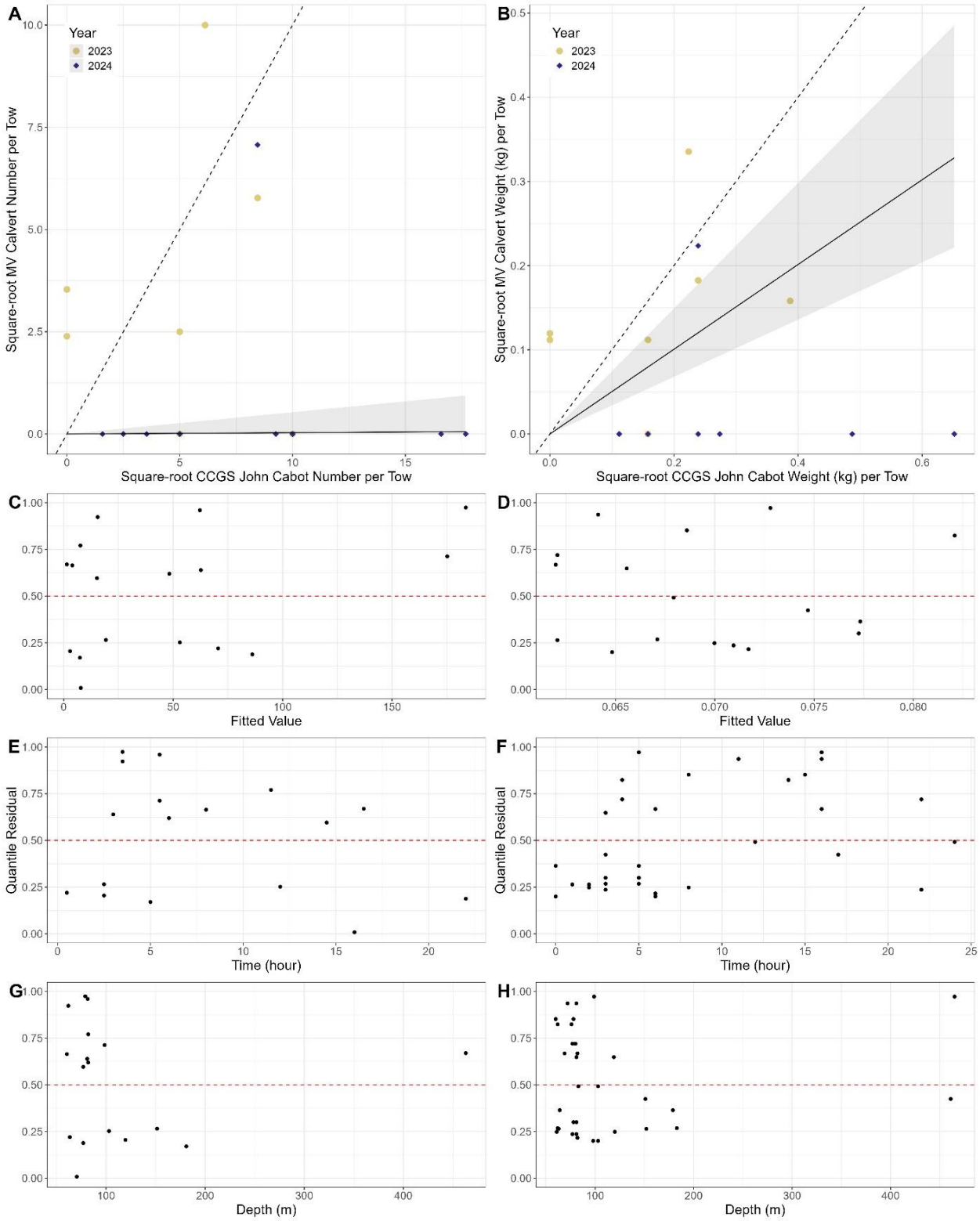

*Figure A2- 14. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of amphipods and gammarids (*Amphipoda*), spring 3LNO.*

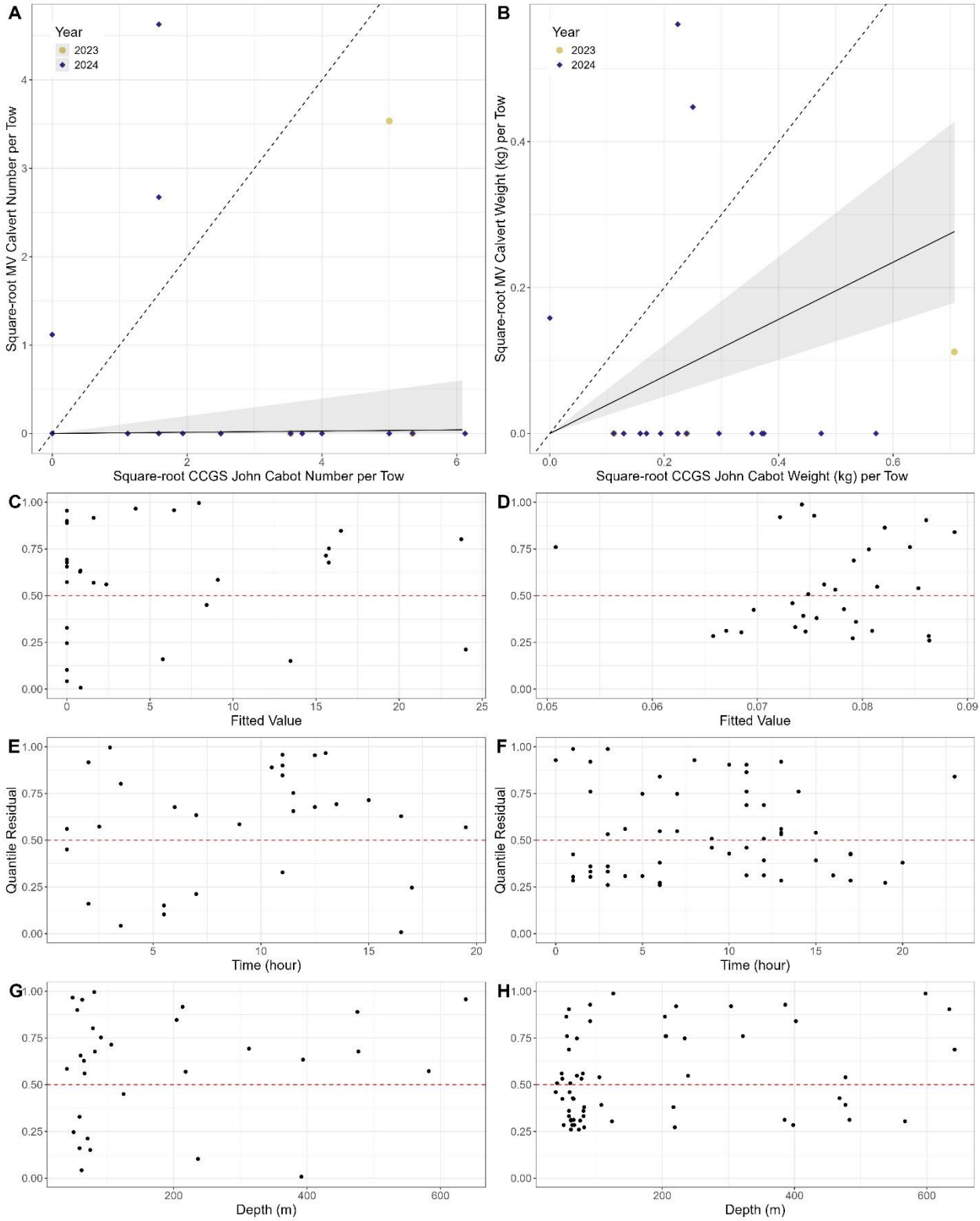

Figure A2- 15. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of annelids and polychaetes, spring 3LNO.

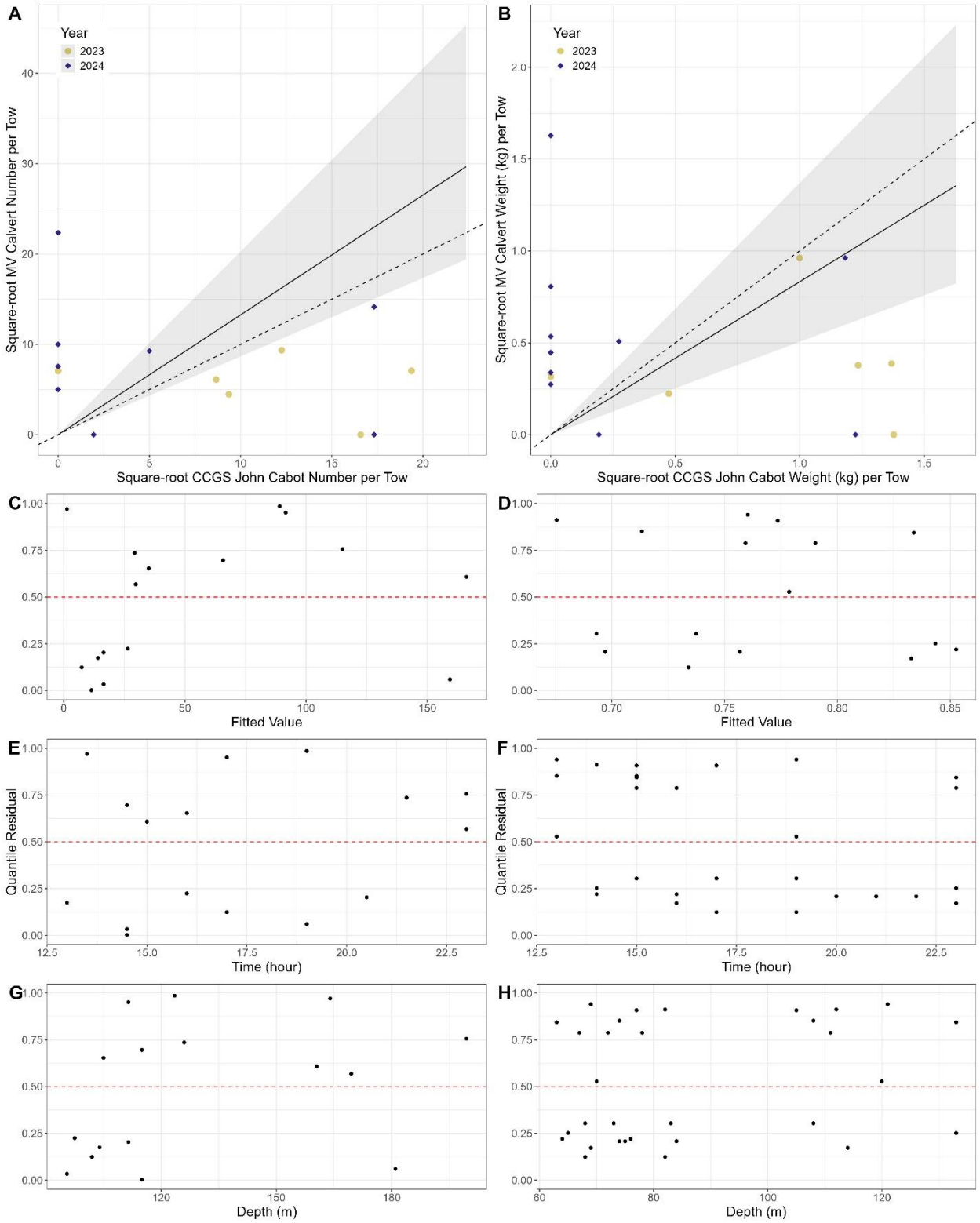

Figure A2- 16. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of benthic shrimp (Eualus belcheri, Sclerocrangon sp., Sabinea septemcarinata, Sabinea sarsi, & Argis sp.), spring 3LNO.

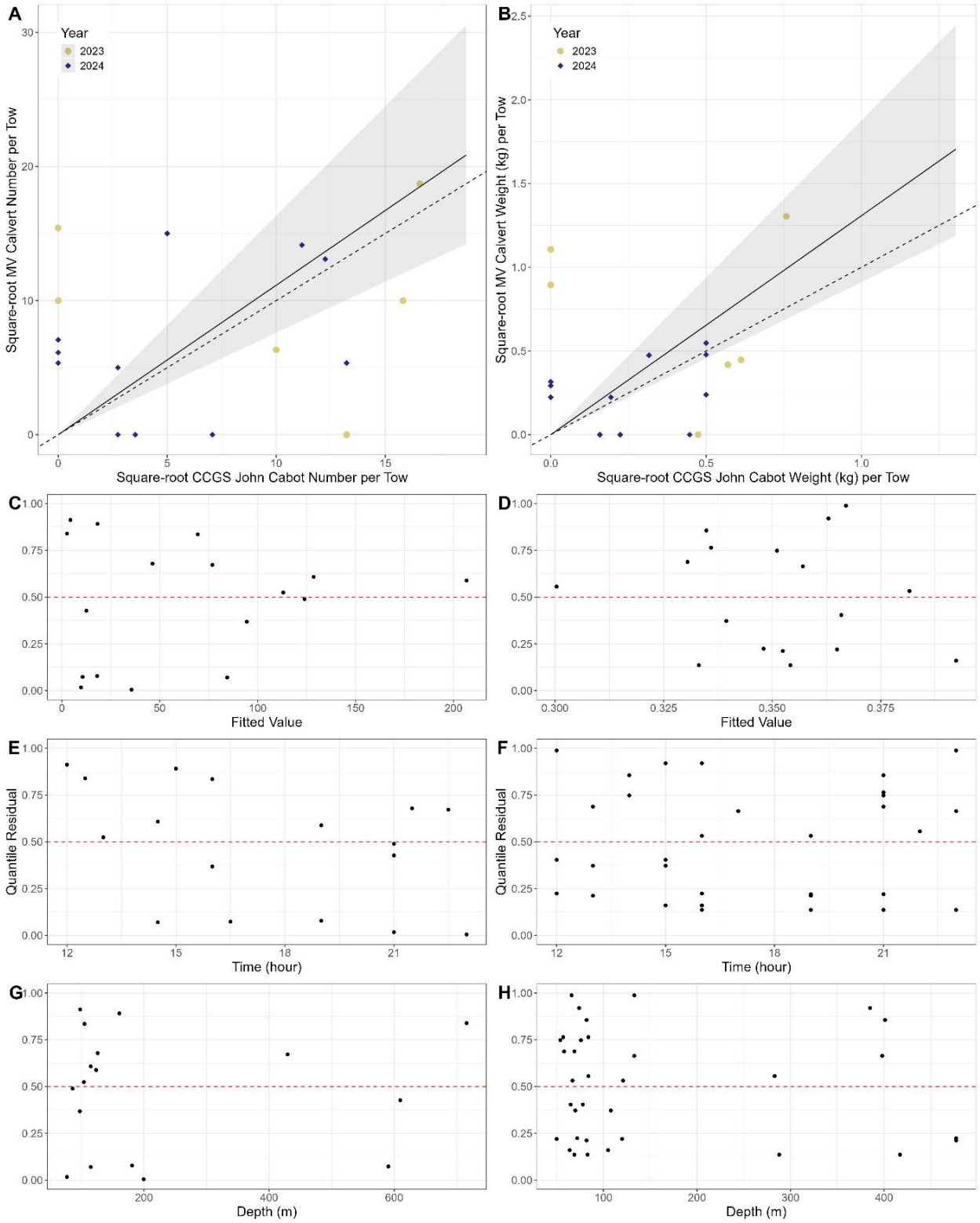

Figure A2- 17. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of benthopelagic shrimp (Benthesicymus sp., Aristeus sp., Eualus fabricii, Eualus macilentus, Eualus gaimardii, Spirontocaris sp., Lebbeus sp., Dichelopandalus sp., Atlantopandalus sp., Sabinea hystrix, & Pontophilus sp.), spring 3LNO.

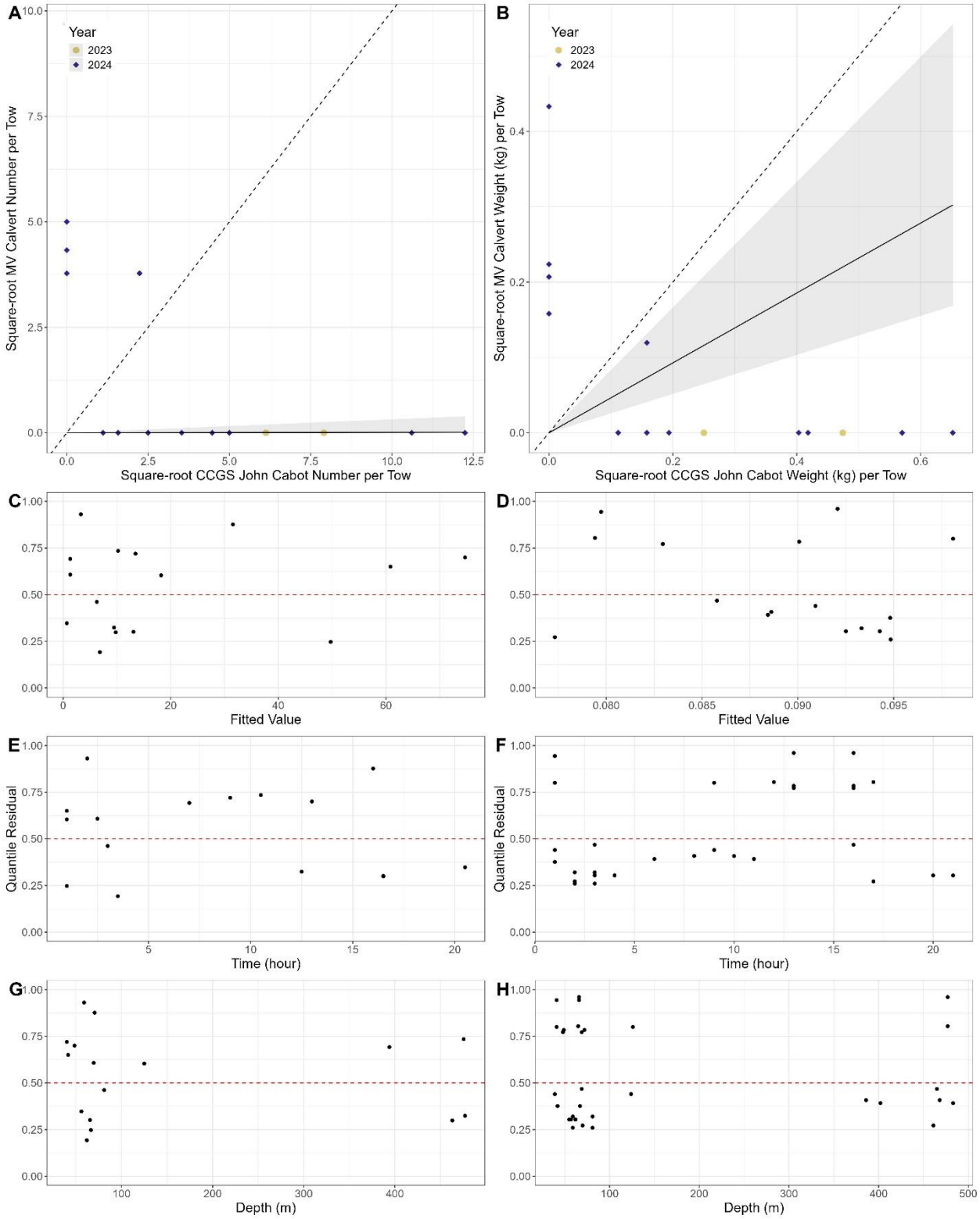

Figure A2- 18. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of bivalves, spring 3LNO.

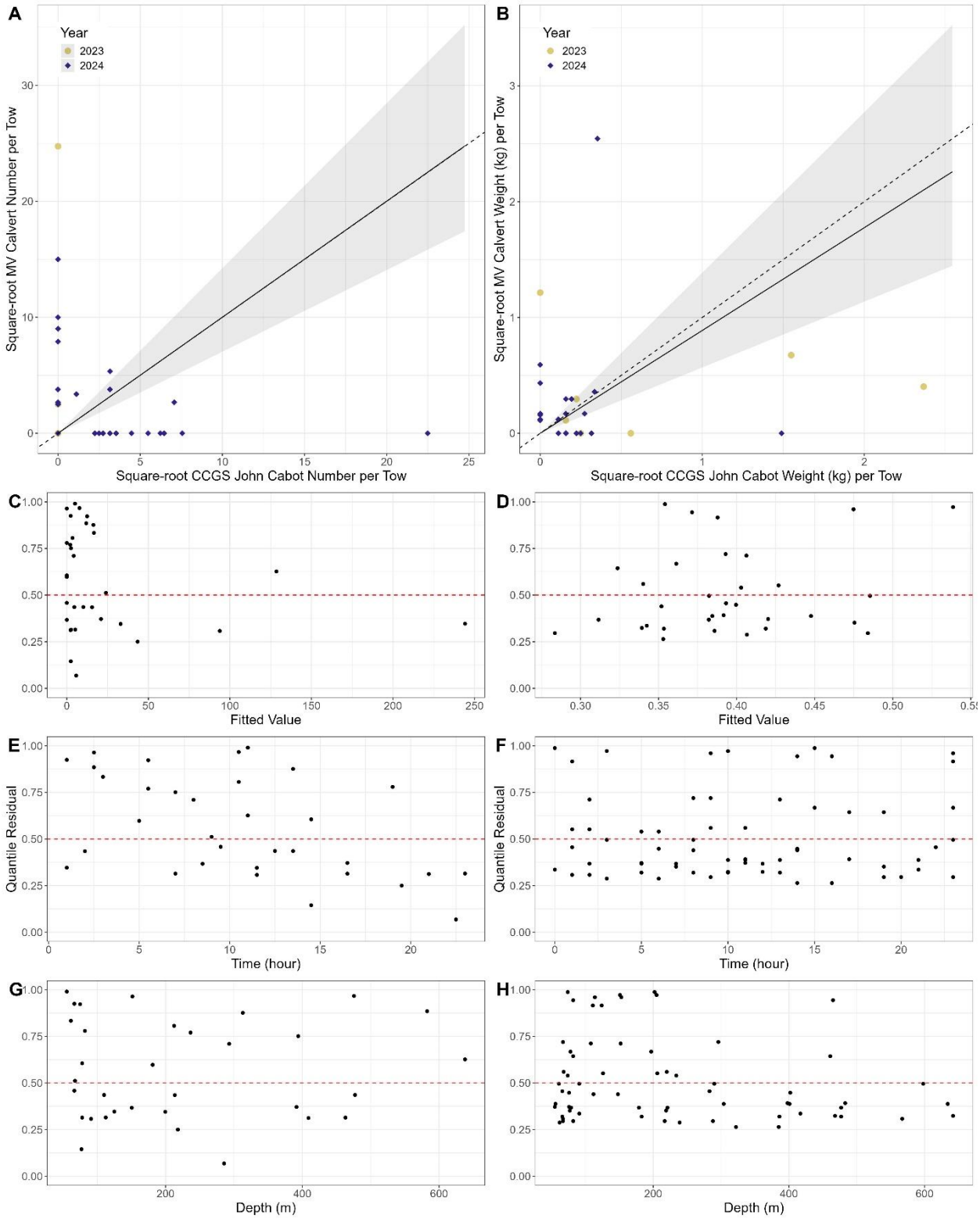

*Figure A2- 19. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of brittle stars (*Ophiuroidea *except* Gorgonocephalus*), spring 3LNO.*

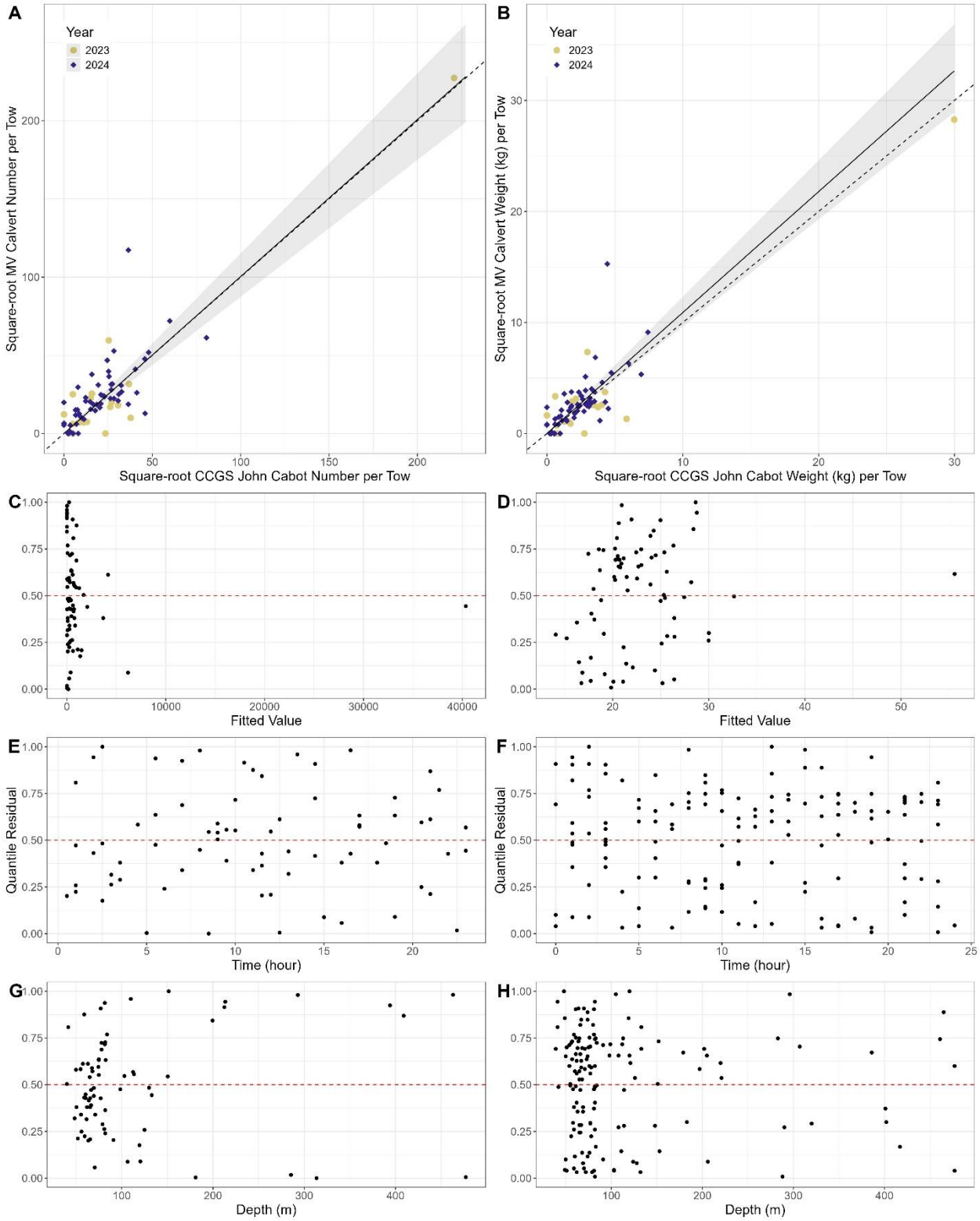

*Figure A2- 20. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Capelin (*Mallotus villosus*), spring 3LNO.*

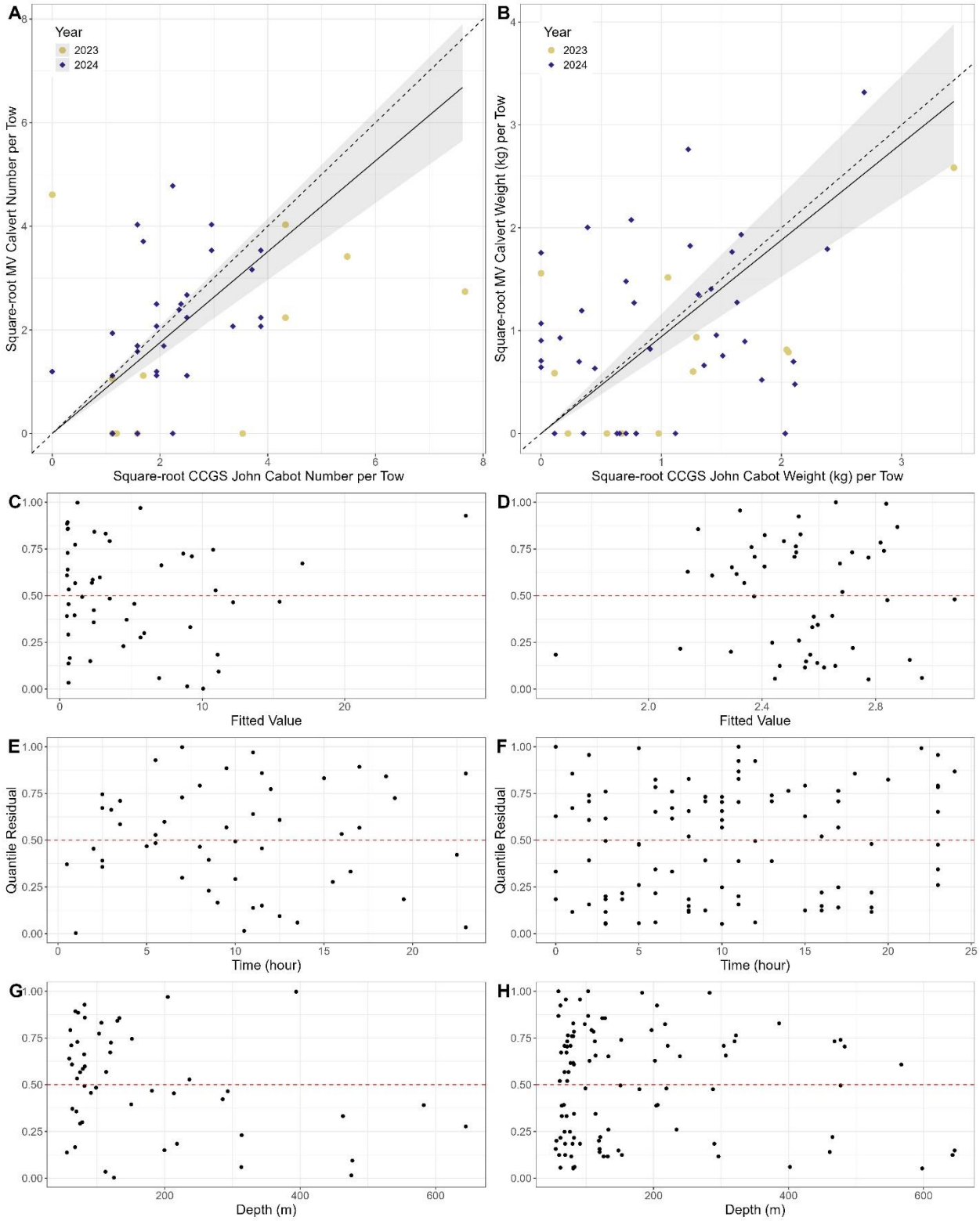

*Figure A2- 21. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Eelpouts (*Lycodes *sp.), spring 3LNO.*

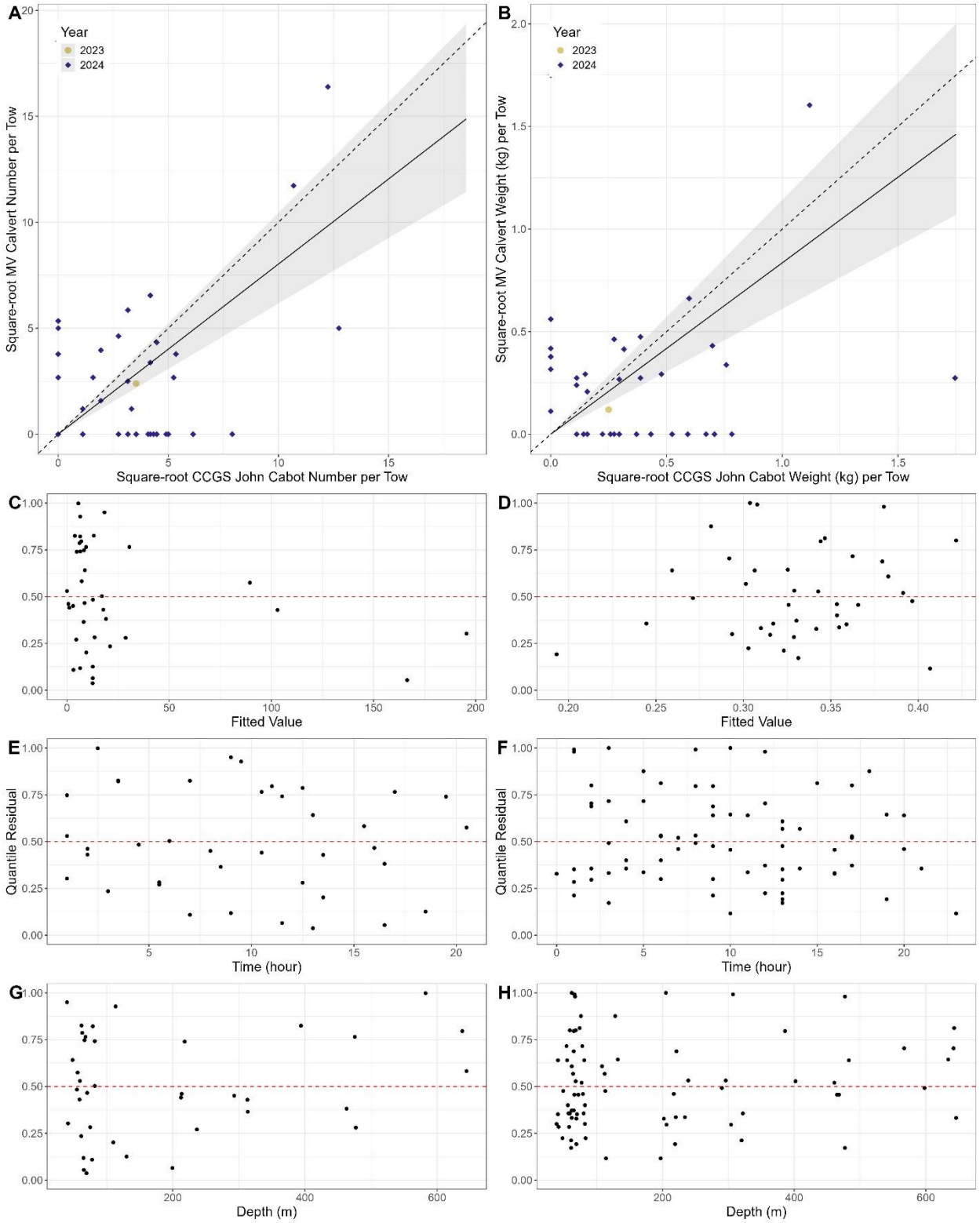

Figure A2- 22. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of gastropods, spring 3LNO.

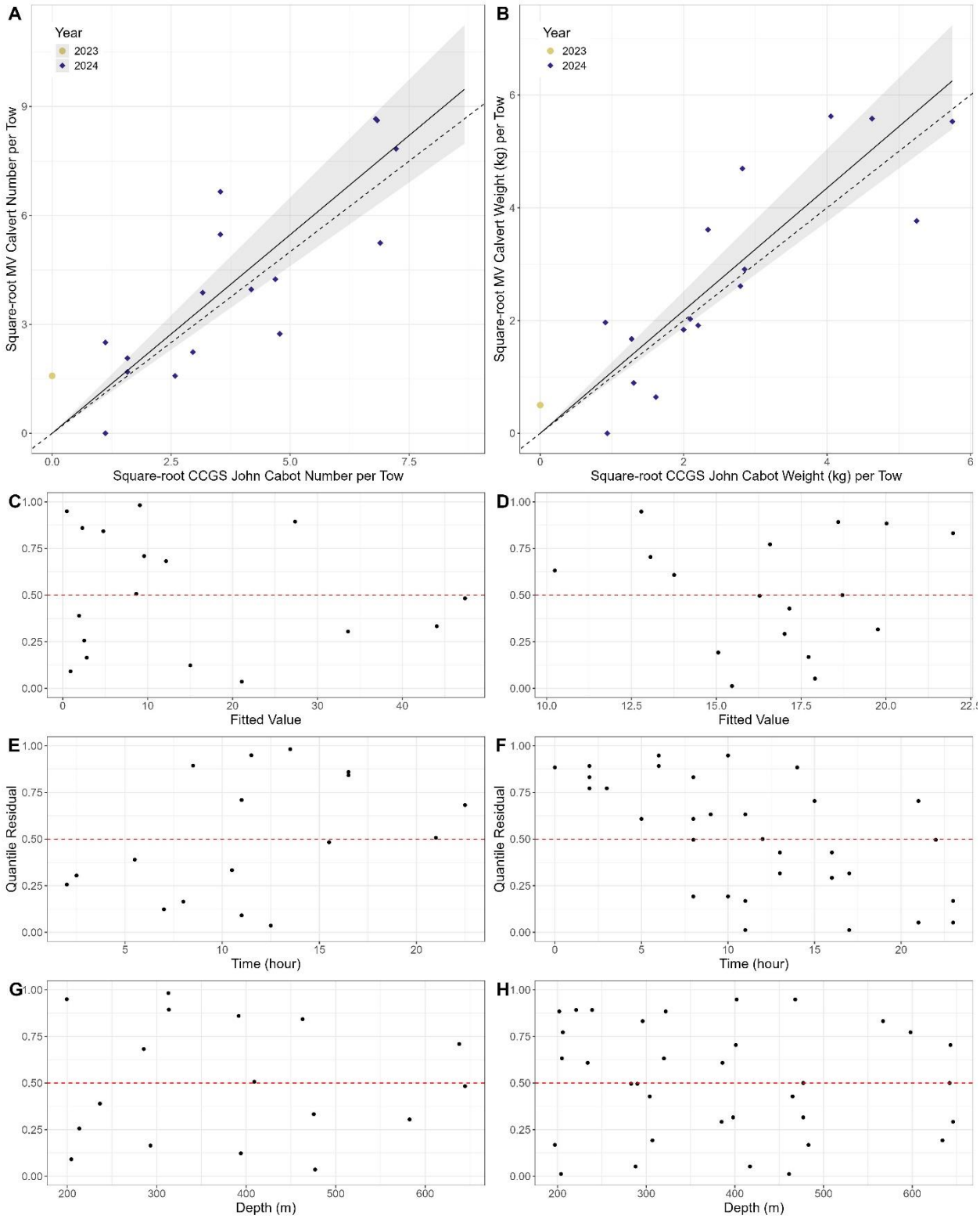

*Figure A2- 23. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Roughhead Grenadier (*Macrourus berglax*), spring 3LNO.*

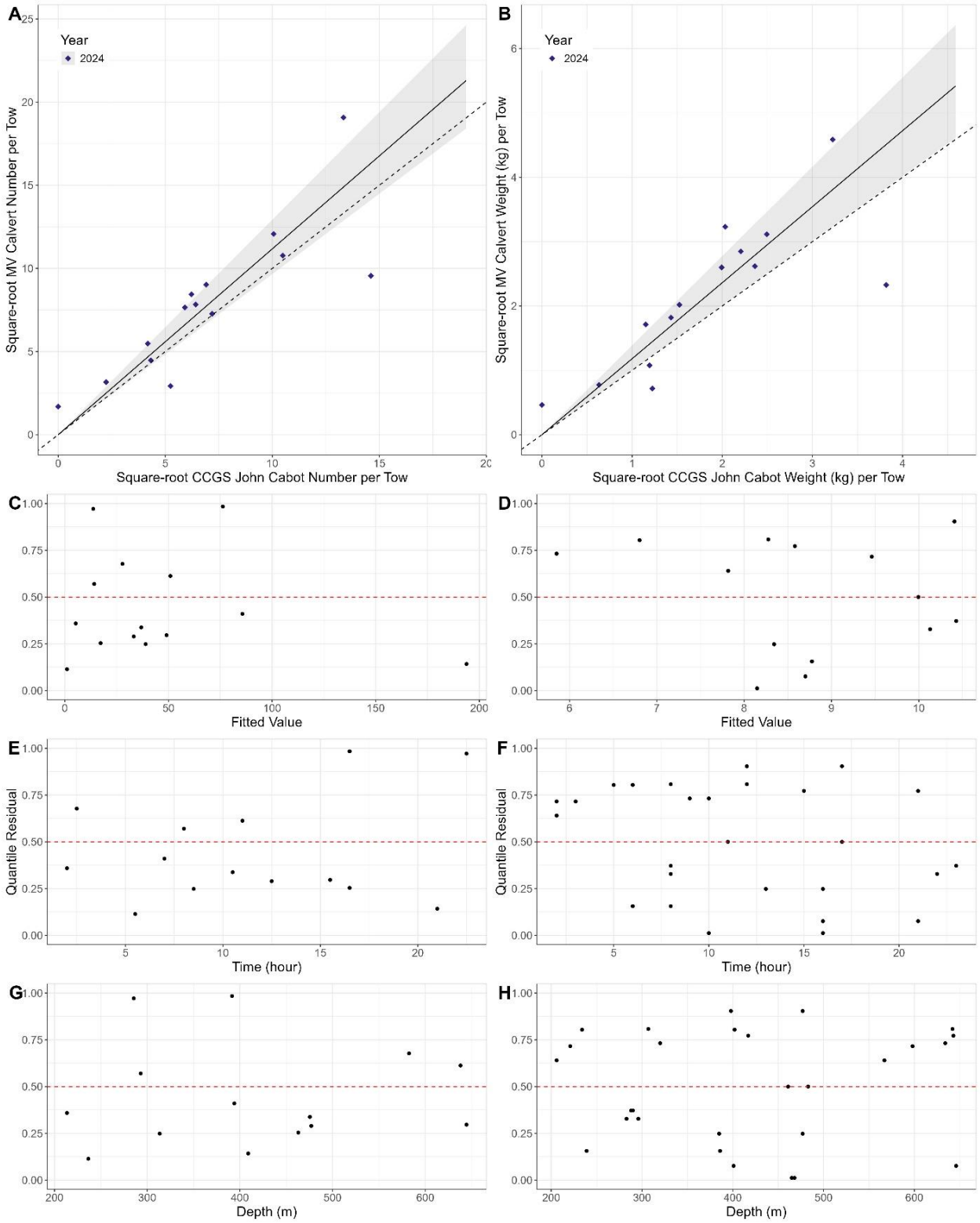

*Figure A2- 24. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of other Grenadiers (*Nezumia *sp.,* Trachyrhynchus *sp.,* Coryphaenoides *sp.,* Coelorhynchus *sp.), spring 3LNO.*

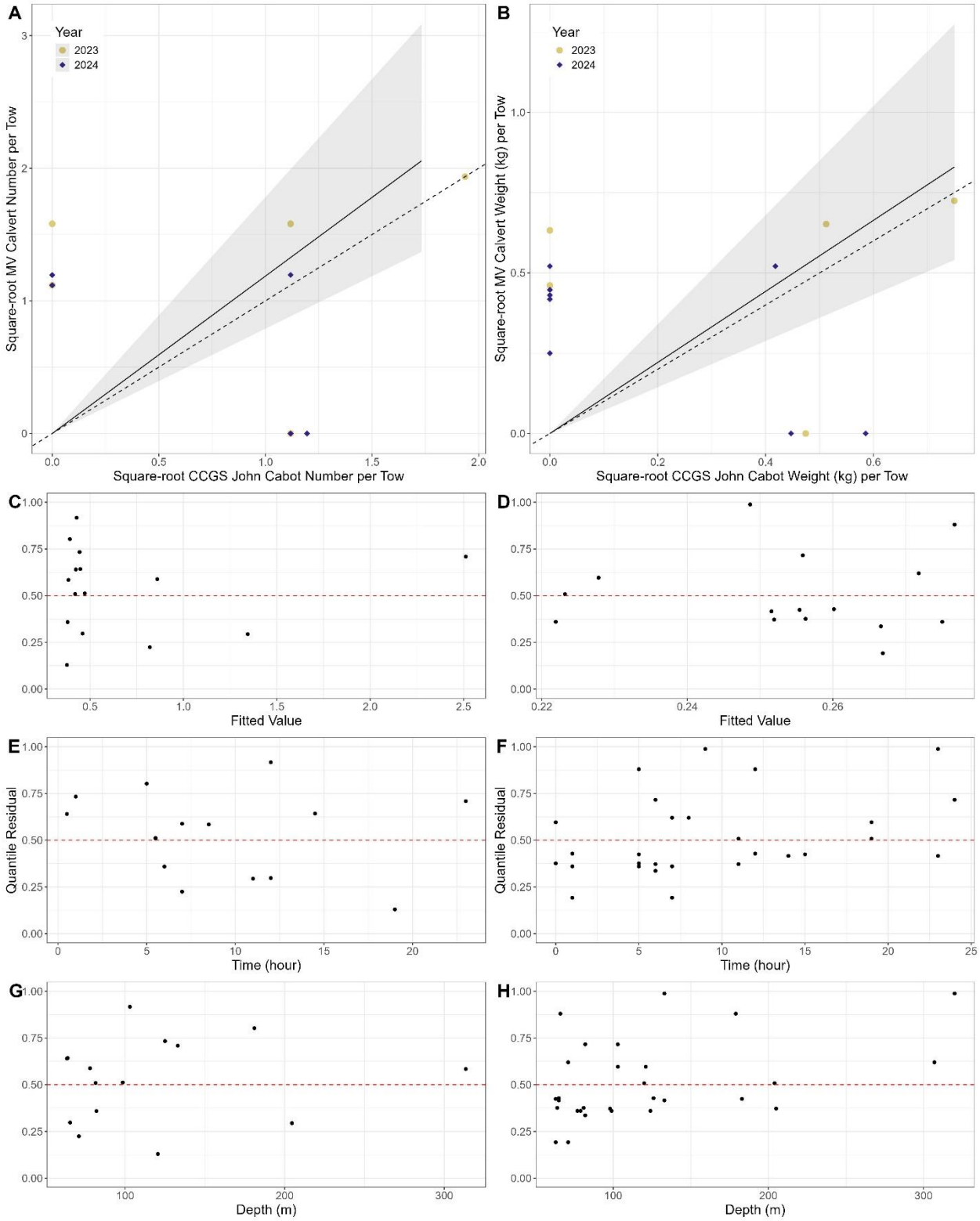

*Figure A2- 25. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Atlantic Herring (*Clupea harengus*), spring 3LNO.*

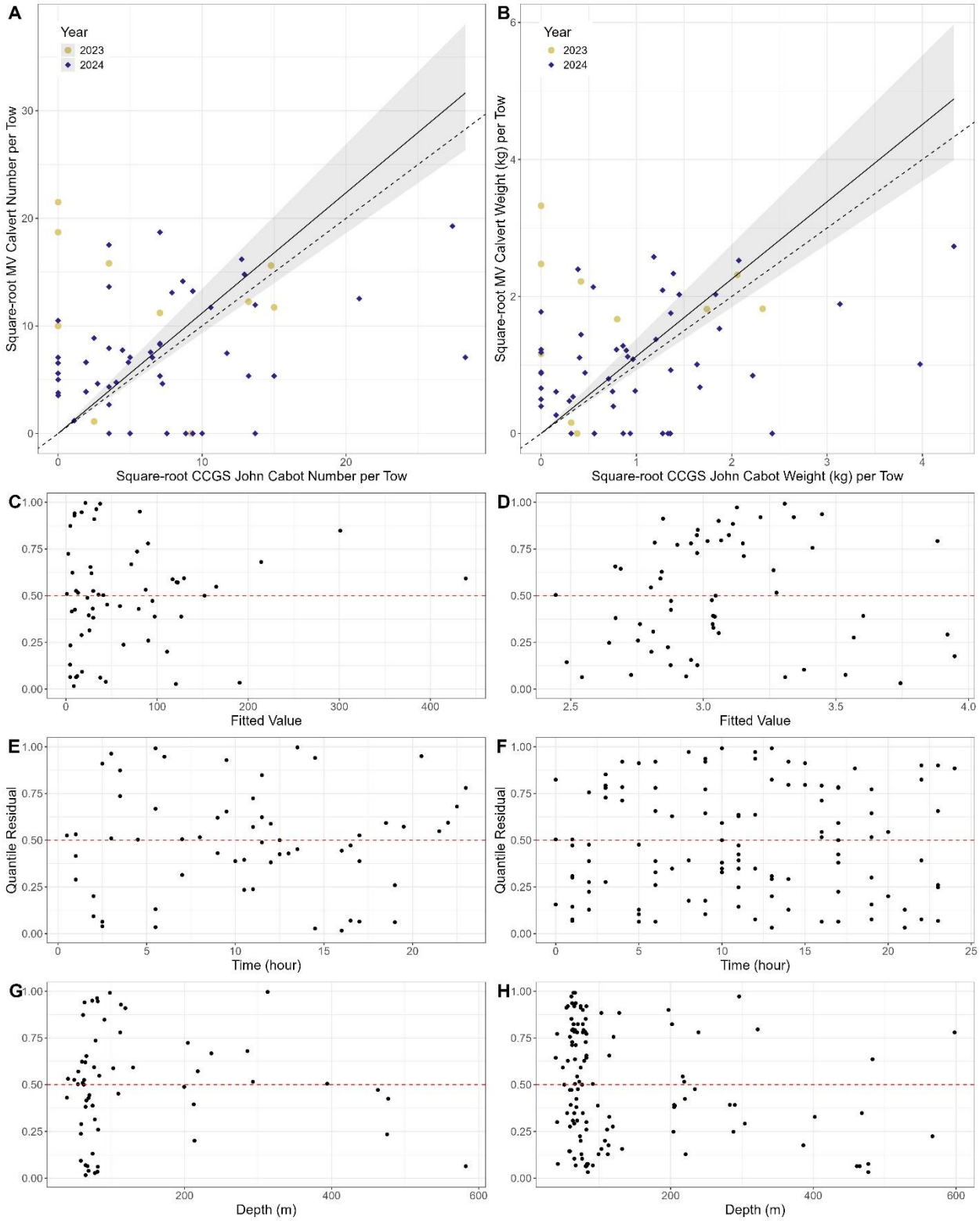

*Figure A2- 26. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of sand dollars (*Clypeasteroida*), spring 3LNO.*

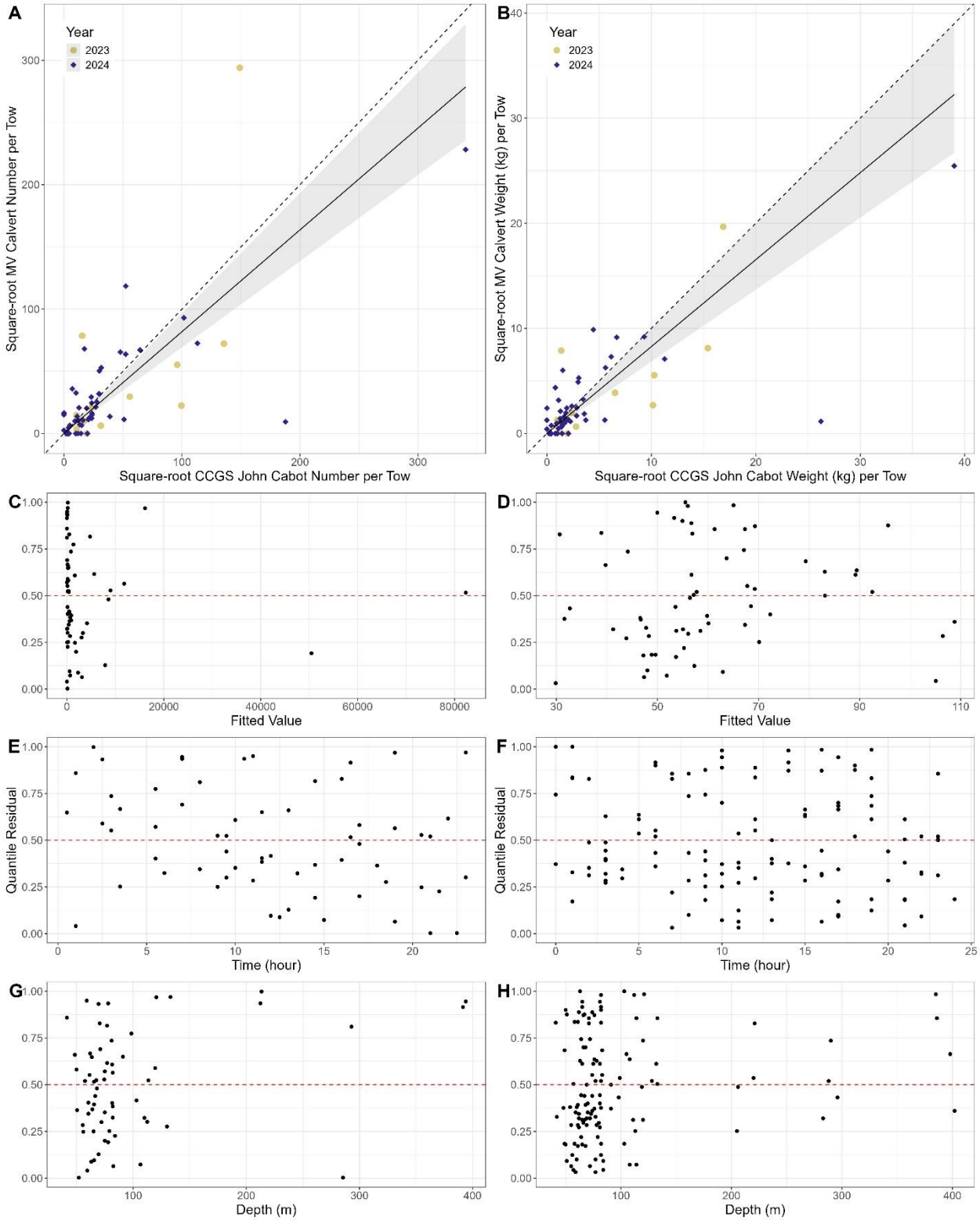

*Figure A2- 27. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Sand Lance (*Ammodytes *sp.), spring 3LNO.*

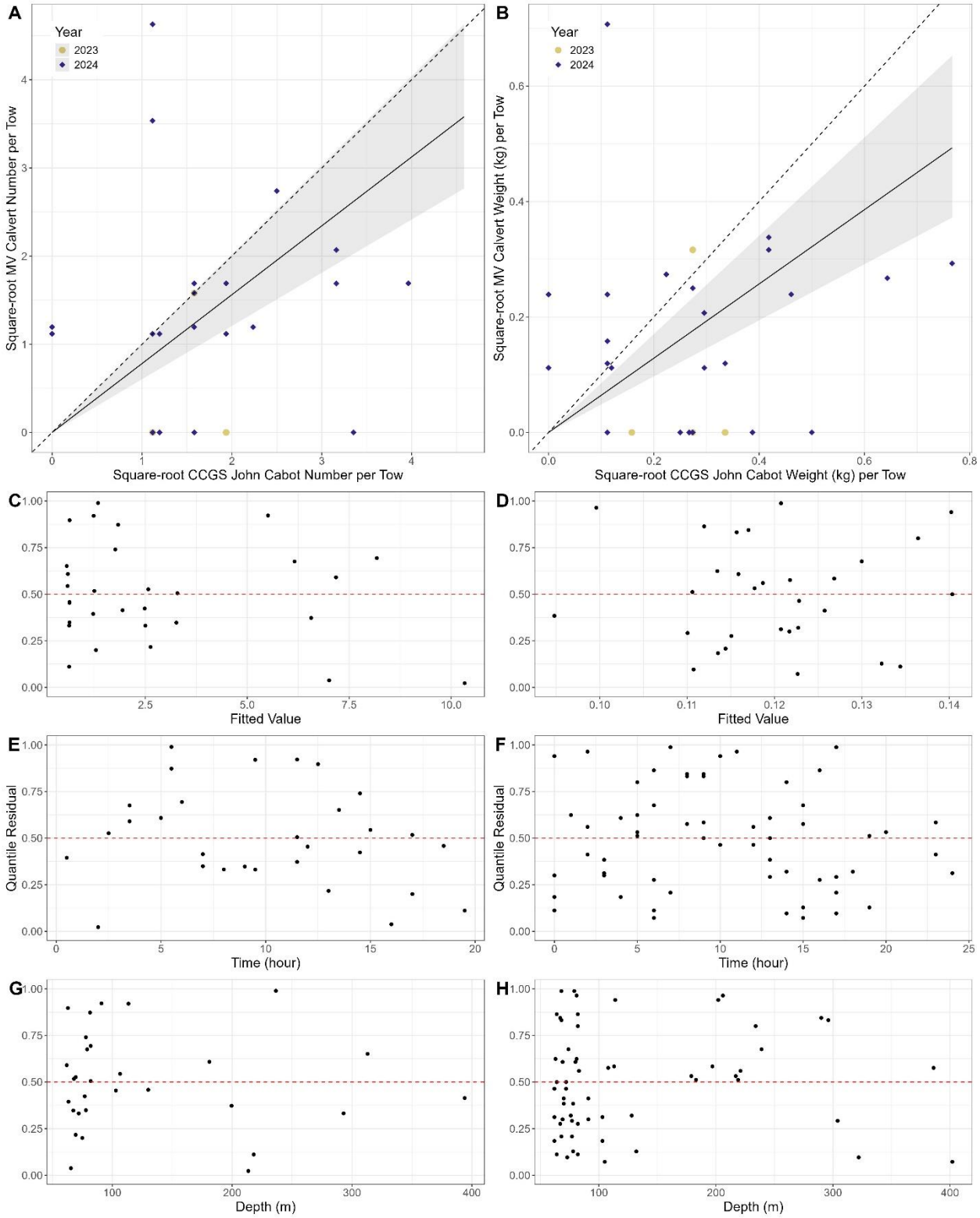

*Figure A2- 28. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Icelandic Scallop (*Chlamys islandica*), spring 3LNO.*

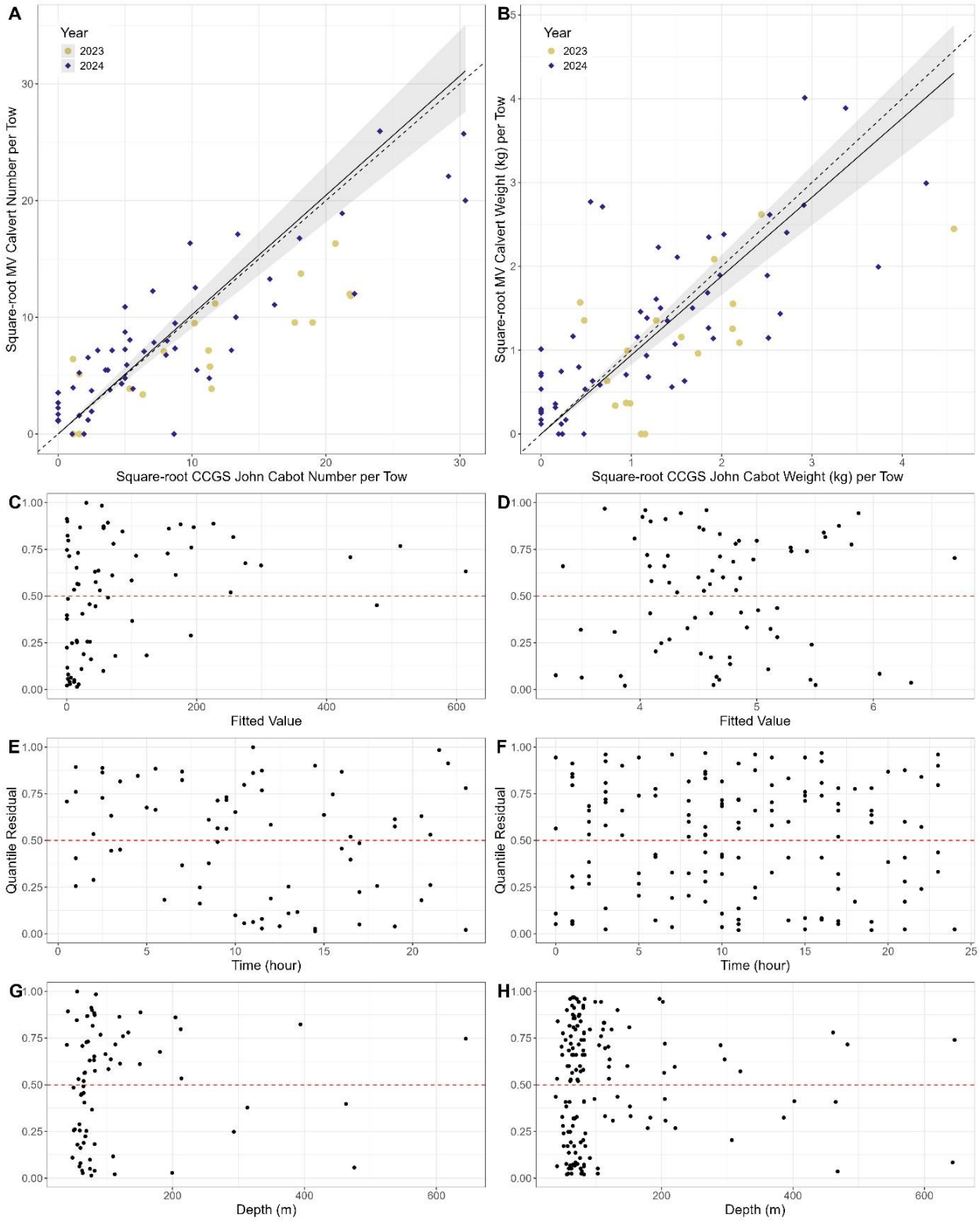

*Figure A2- 29. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of sculpins (*Artediellus *sp.,* Triglops *sp.,* Myoxocephalus *sp.,* Gymnocanthu *sp.,* Cottunculus *sp.,* Icelus *sp.,* Myoxocephalus *sp.,* Hemitripterus Americanus*), spring 3LNO.*

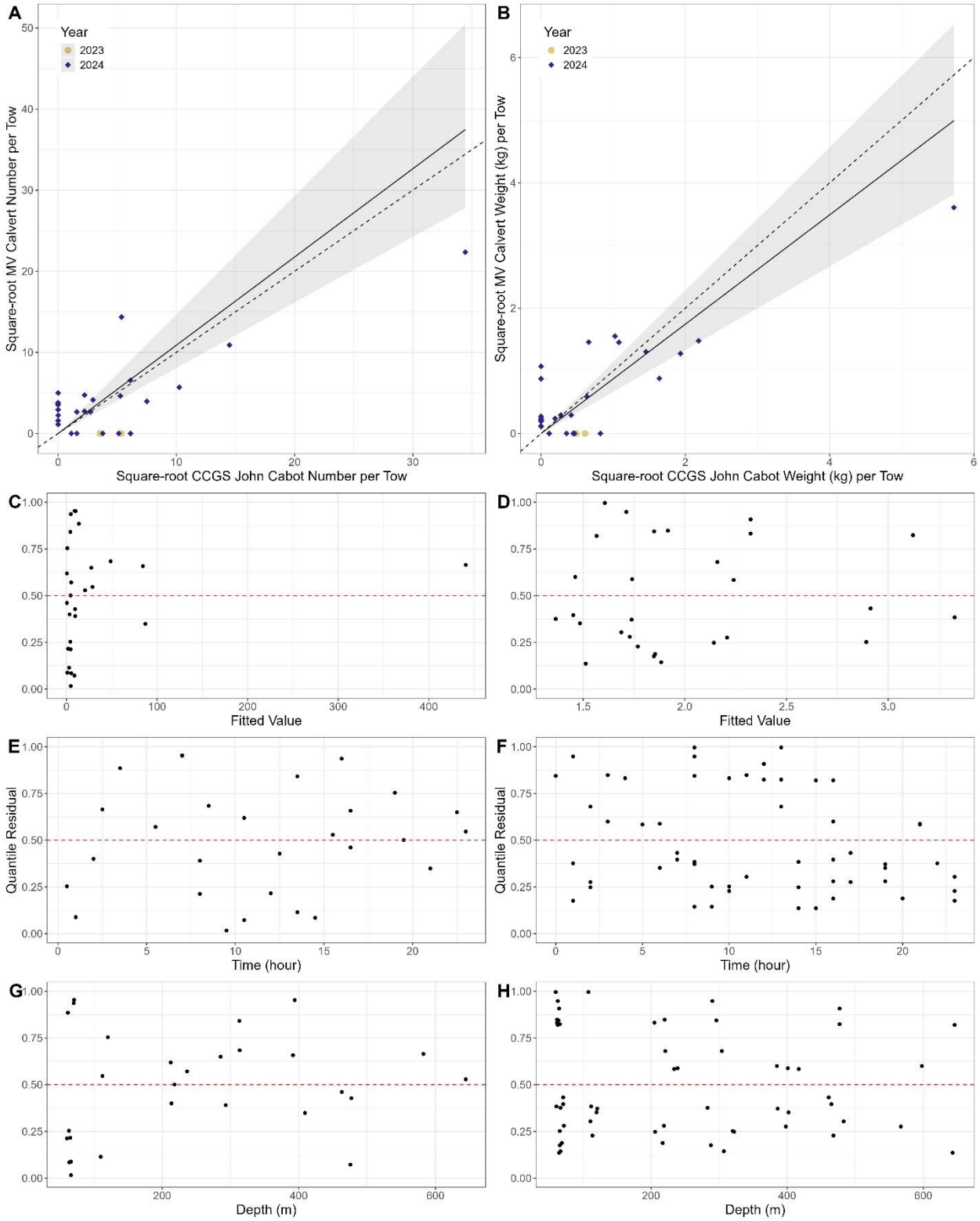

*Figure A2- 30. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of sea anemones (*Actinaria*), spring 3LNO.*

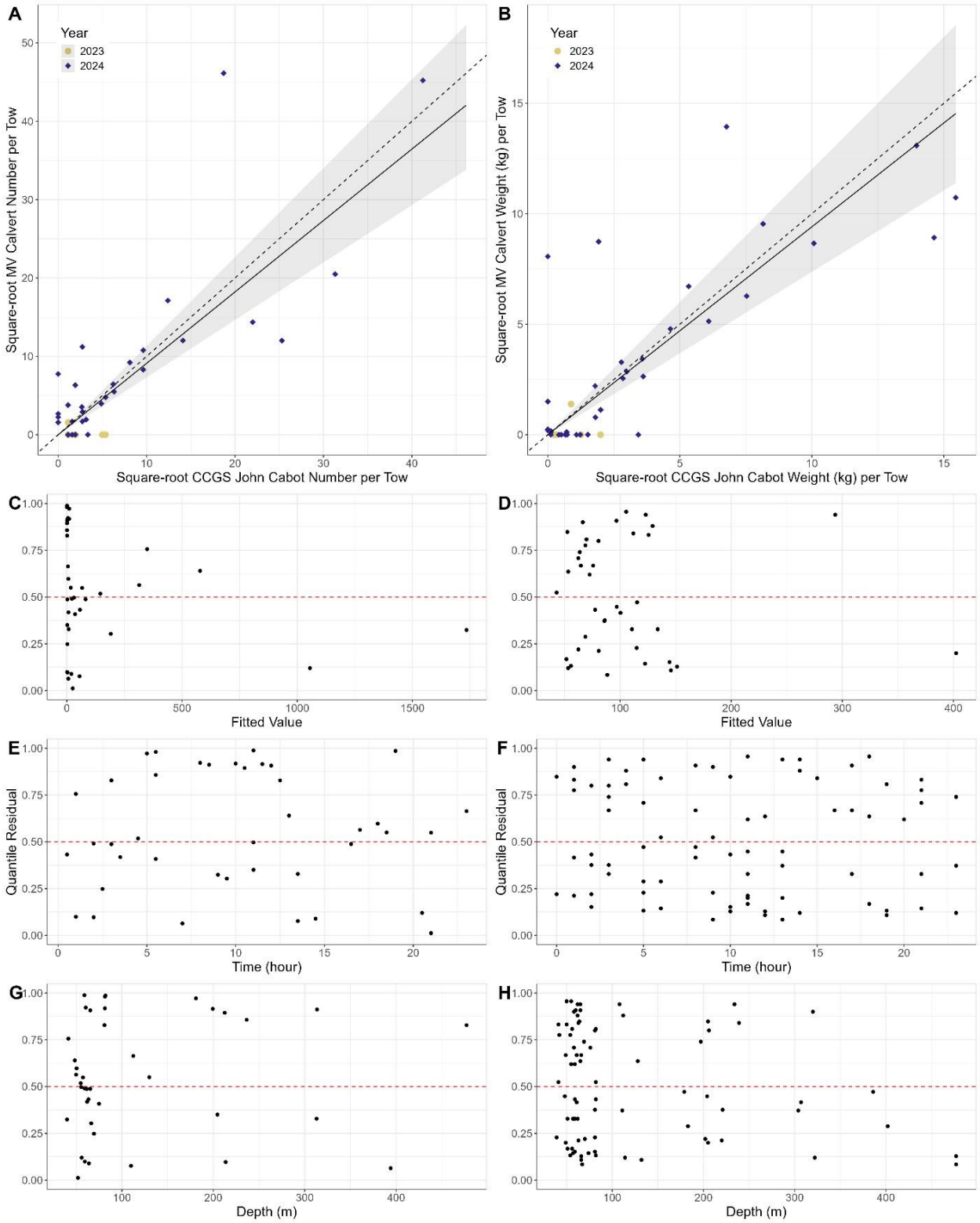

*Figure A2- 31. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of sea cucumbers (*Molpadia *sp.,* Stereoderma *sp.,* Phyllophoridae*,* Psolus *sp.,* Cucumaria *sp., and* Pentamera *sp.), spring 3LNO.*

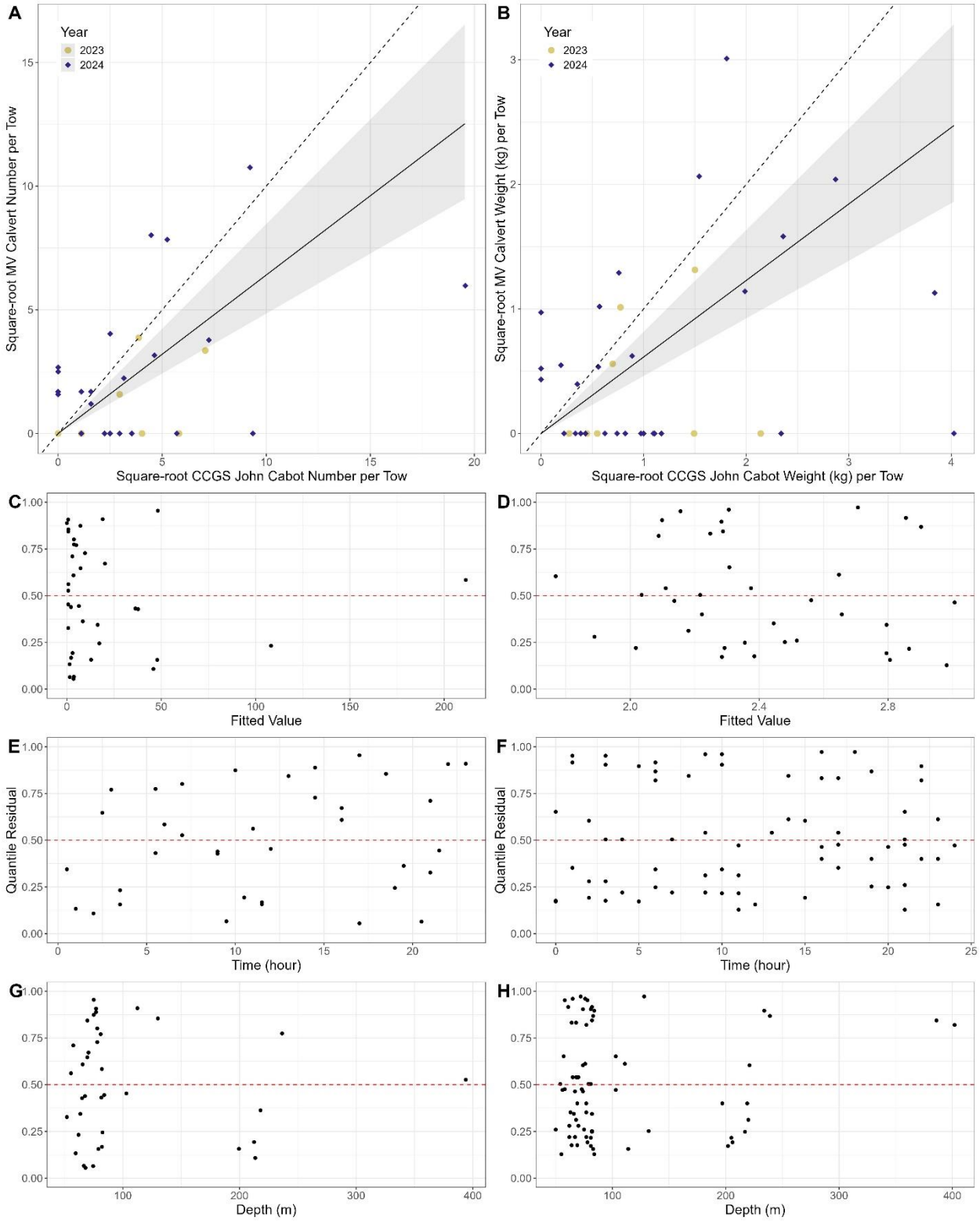

*Figure A2- 32. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of sea potatoes (*Boltenia *sp.), spring 3LNO.*

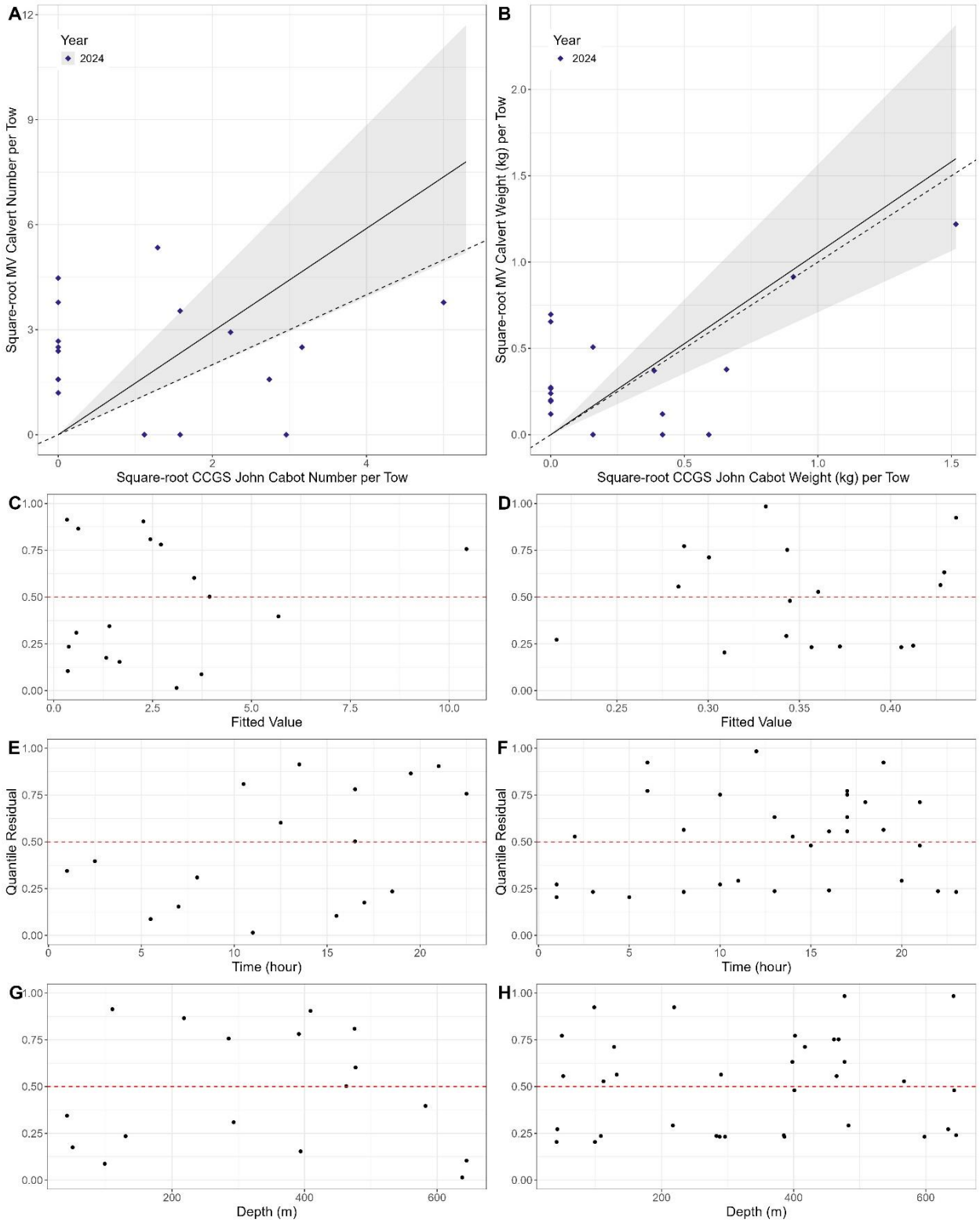

*Figure A2- 33. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Cushion Sea Star (*Ceramaster granularis*, and* Hippasteria phrygiana*), spring 3LNO.*

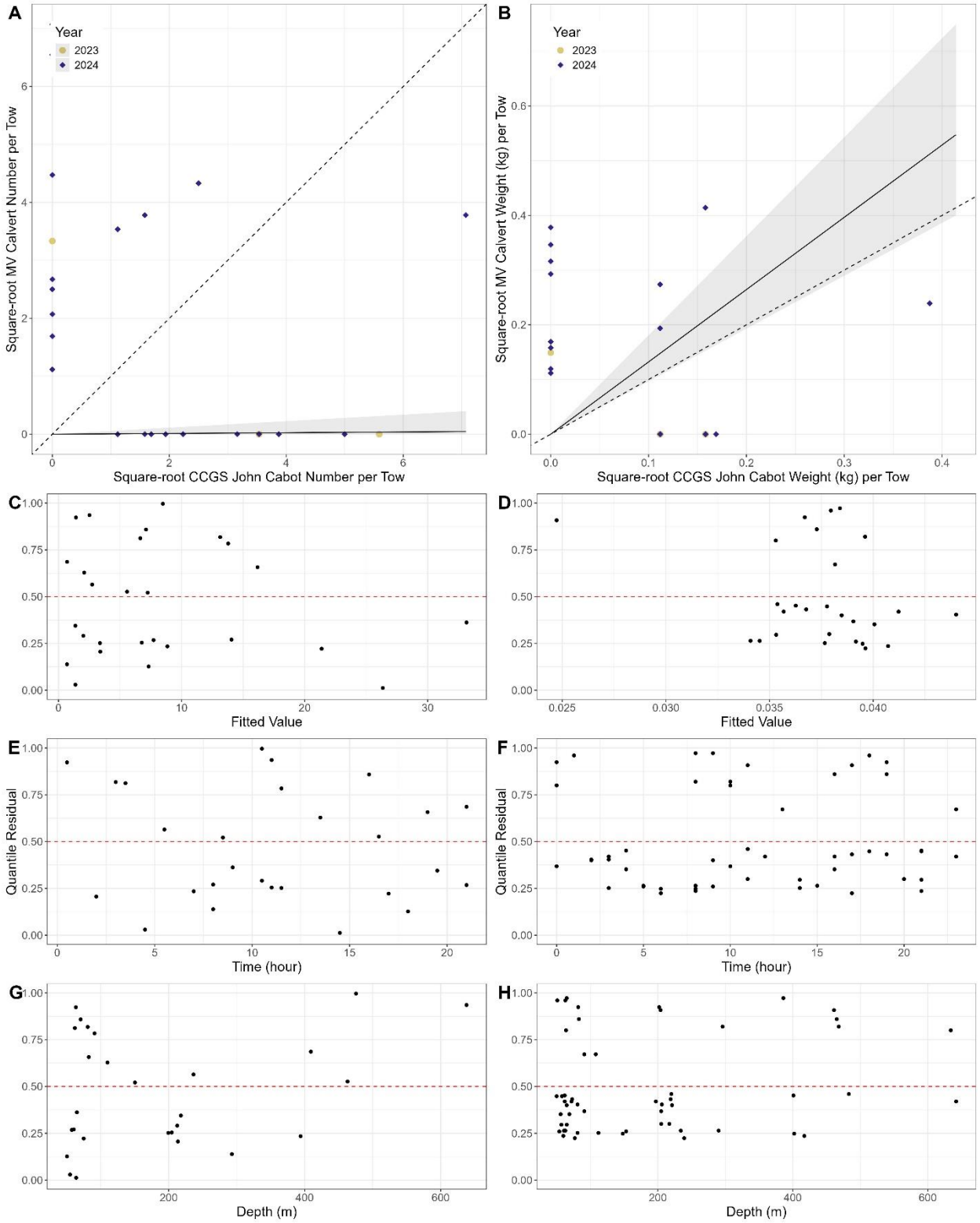

*Figure A2- 34. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of Henricia Sea Star (*Henricia *sp.), spring 3LNO.*

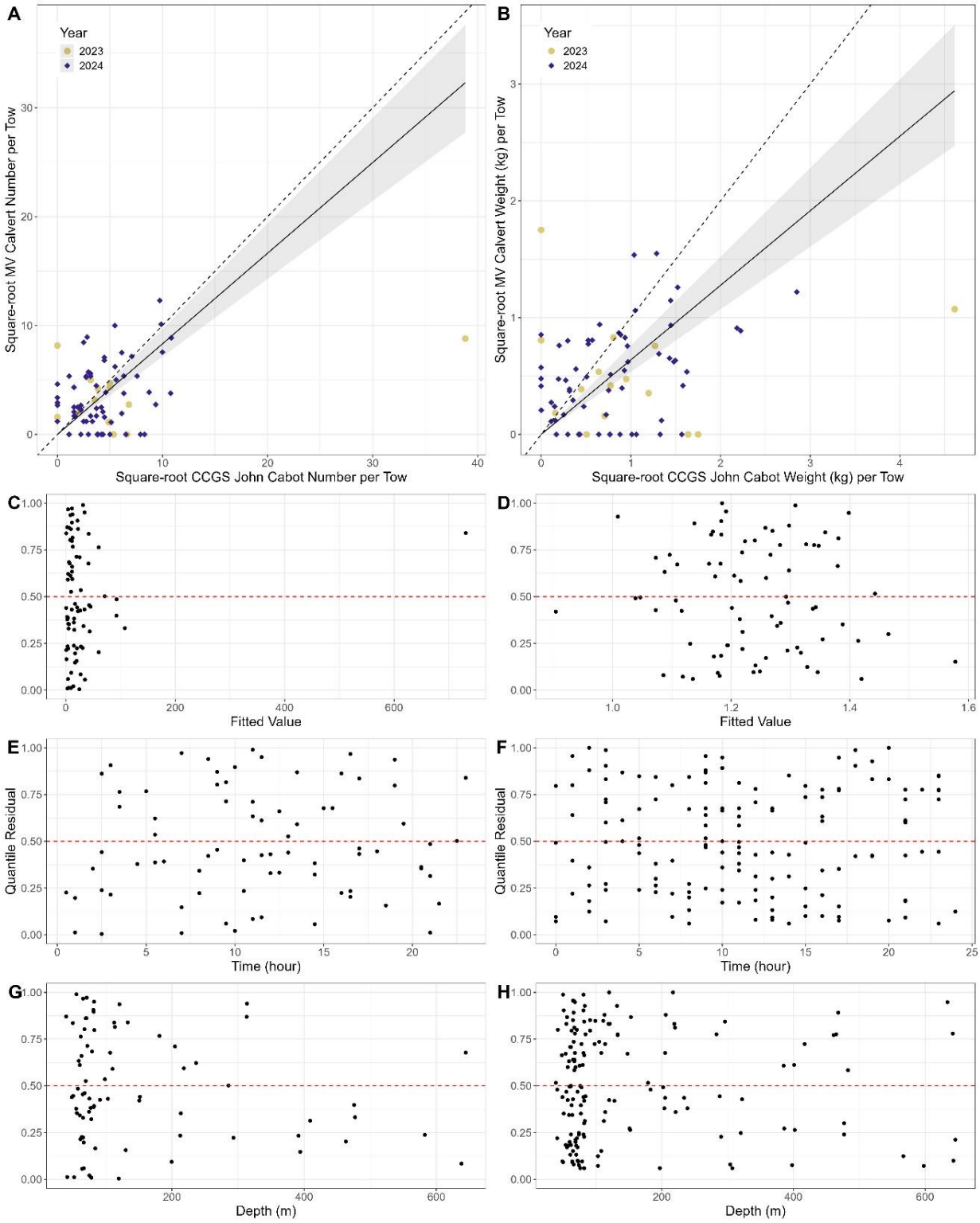

Figure A2- 35. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of sea stars (all grouped, including: Asteroidea, Pteraster *sp.,* Pseudoarchaster *sp.,* Solaster *sp.,* Crossaster papposus, Astropecten americanus, Porania pulvillus, Asterias rubens, Leptasterias *sp.,* Urasterias lincki, Tremaster mirabilis, Diplopteraster multipes, Psilaster andromeda, Poraniomorpha *sp.,* Ceramaster granularis, Hippasteria phrygiana, Henricia *sp.), spring 3LNO.*

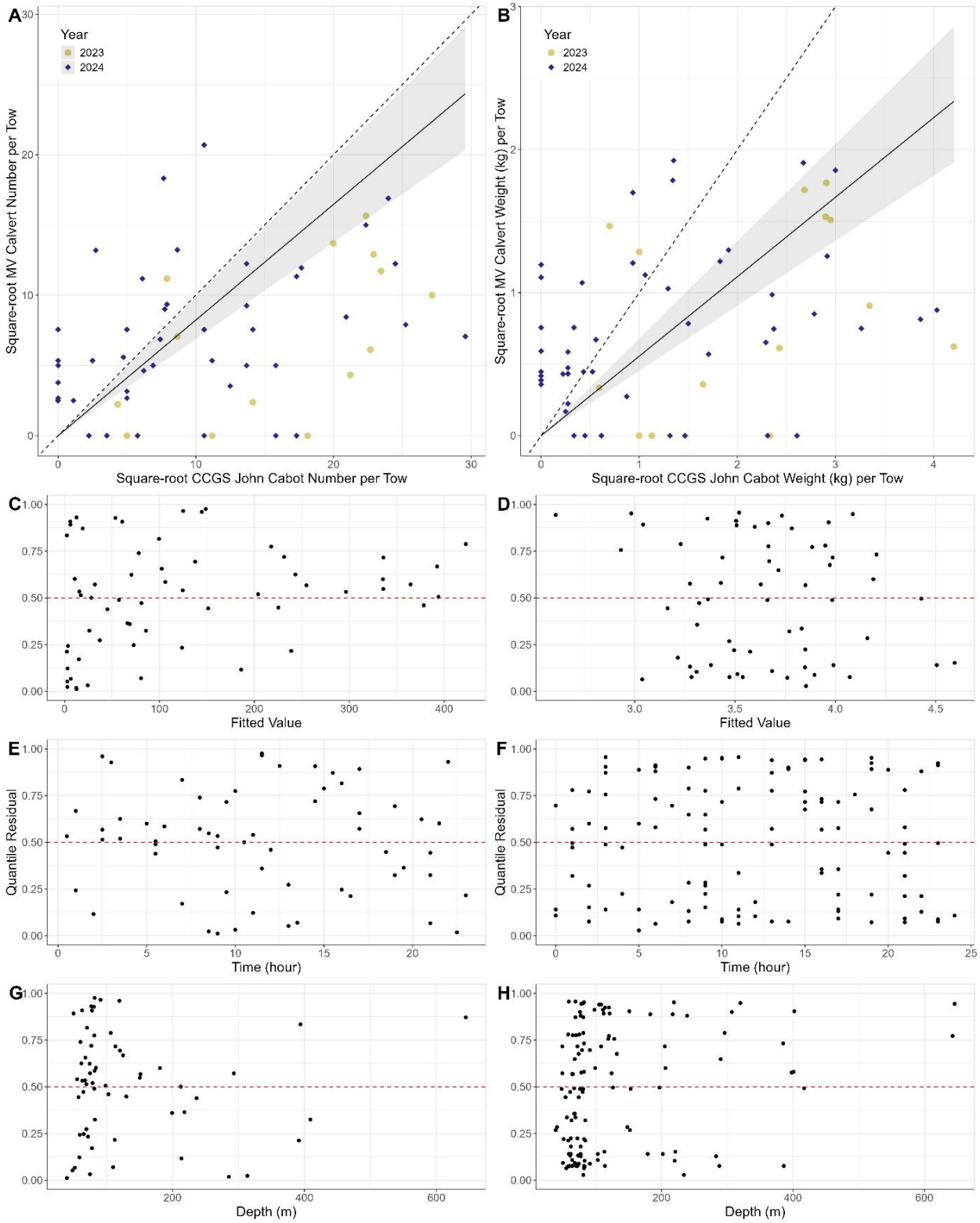

*Figure A2- 36. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of sea urchins (*Strongylocentrotus *sp.,* Brisaster *sp., and* Phormosoma *sp.), spring 3LNO.*

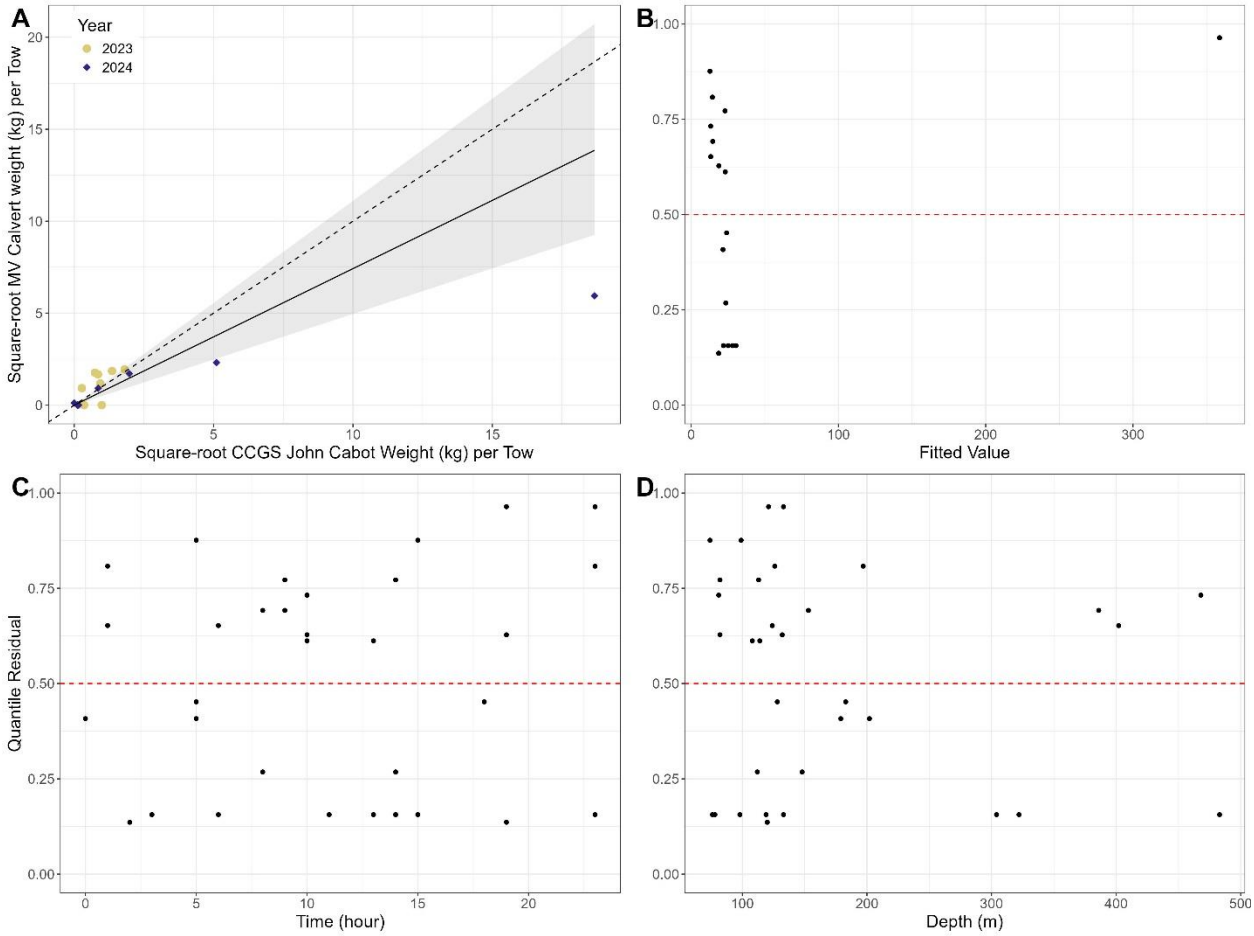

*Figure A2- 37. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of basket stars (*Gorgonocephalus *spp.), spring 3LNO.*

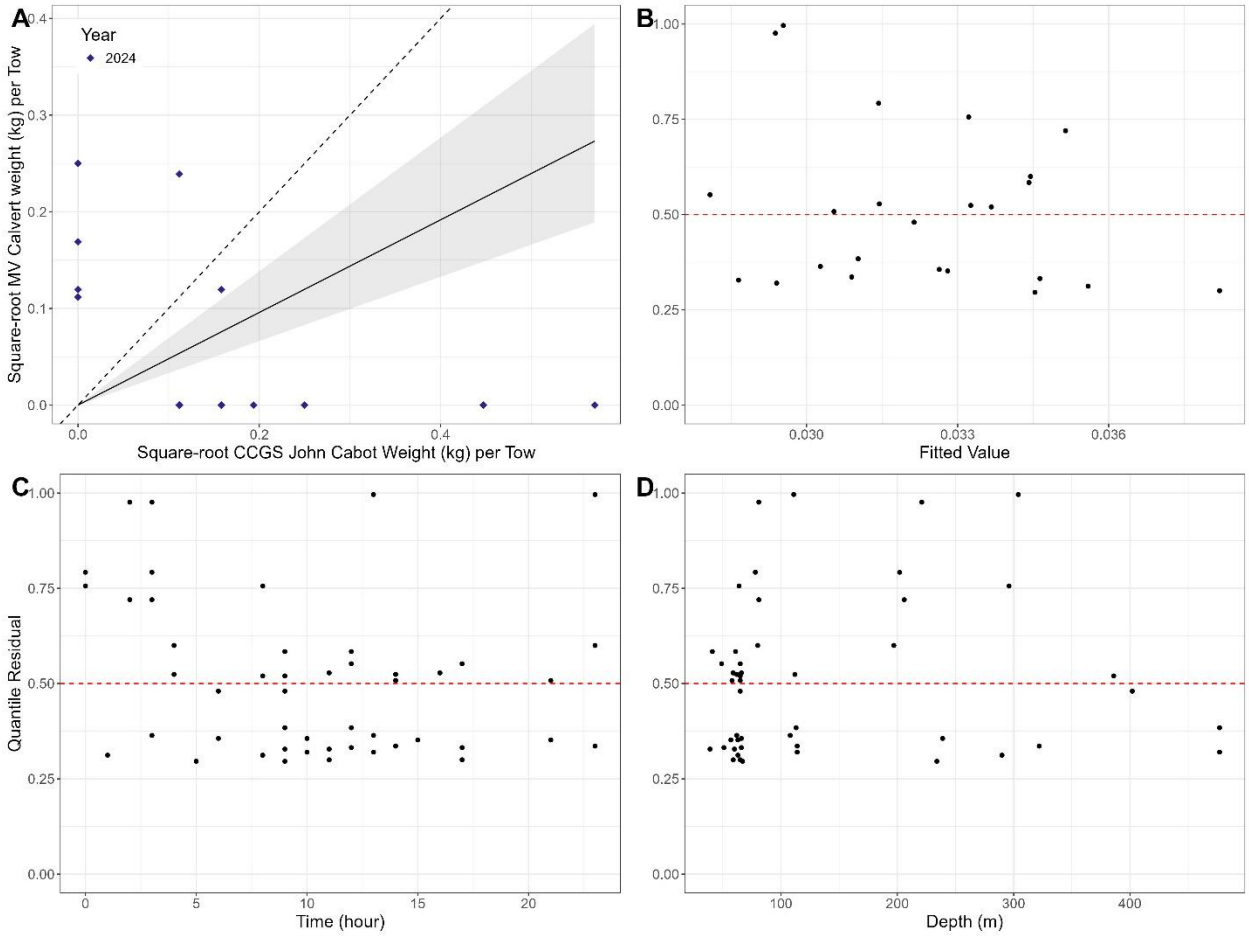

Figure A2- 38. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of bryozoans, spring 3LNO.

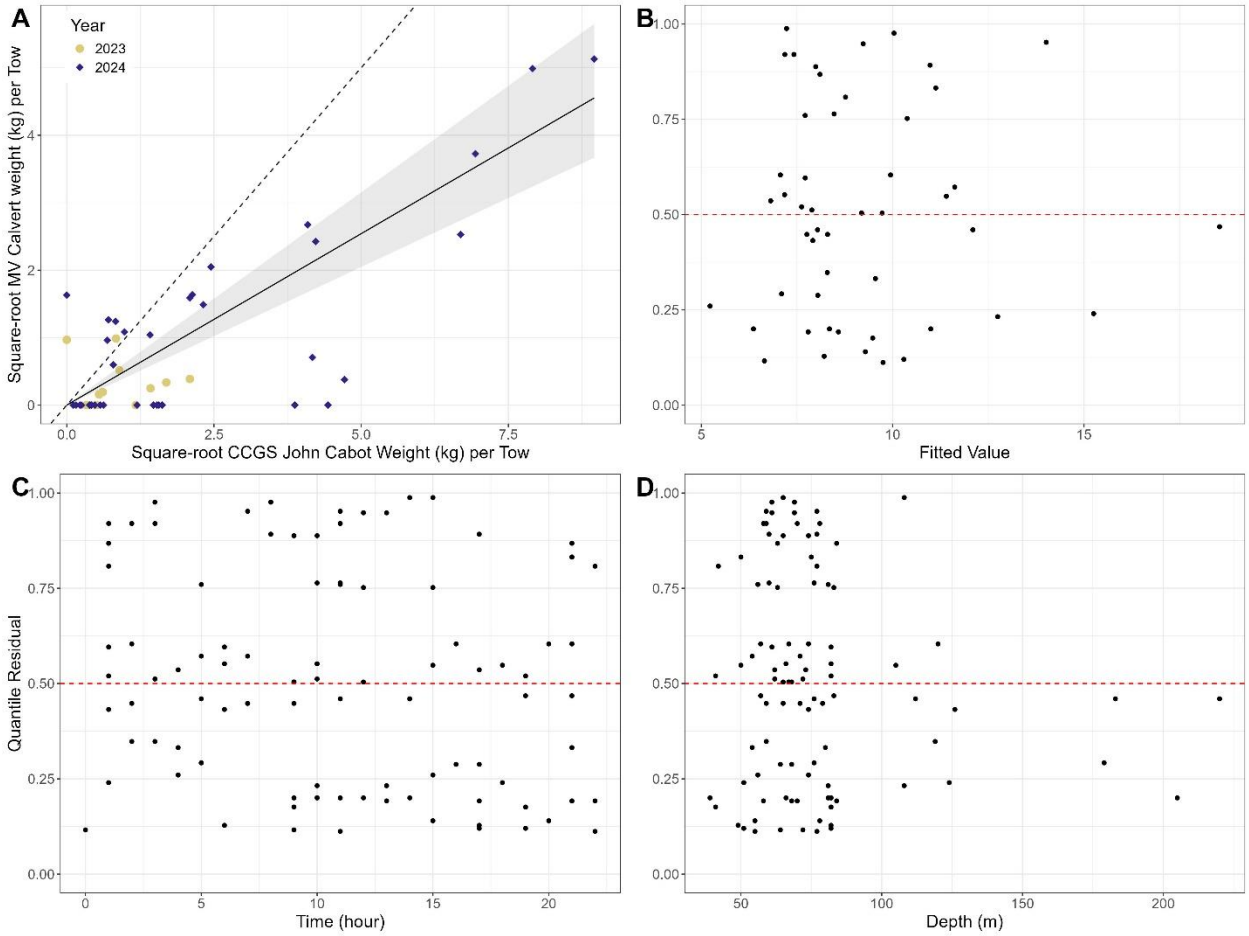

*Figure A2- 39. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of comb jellies (*Ctenophora*), spring 3LNO.*

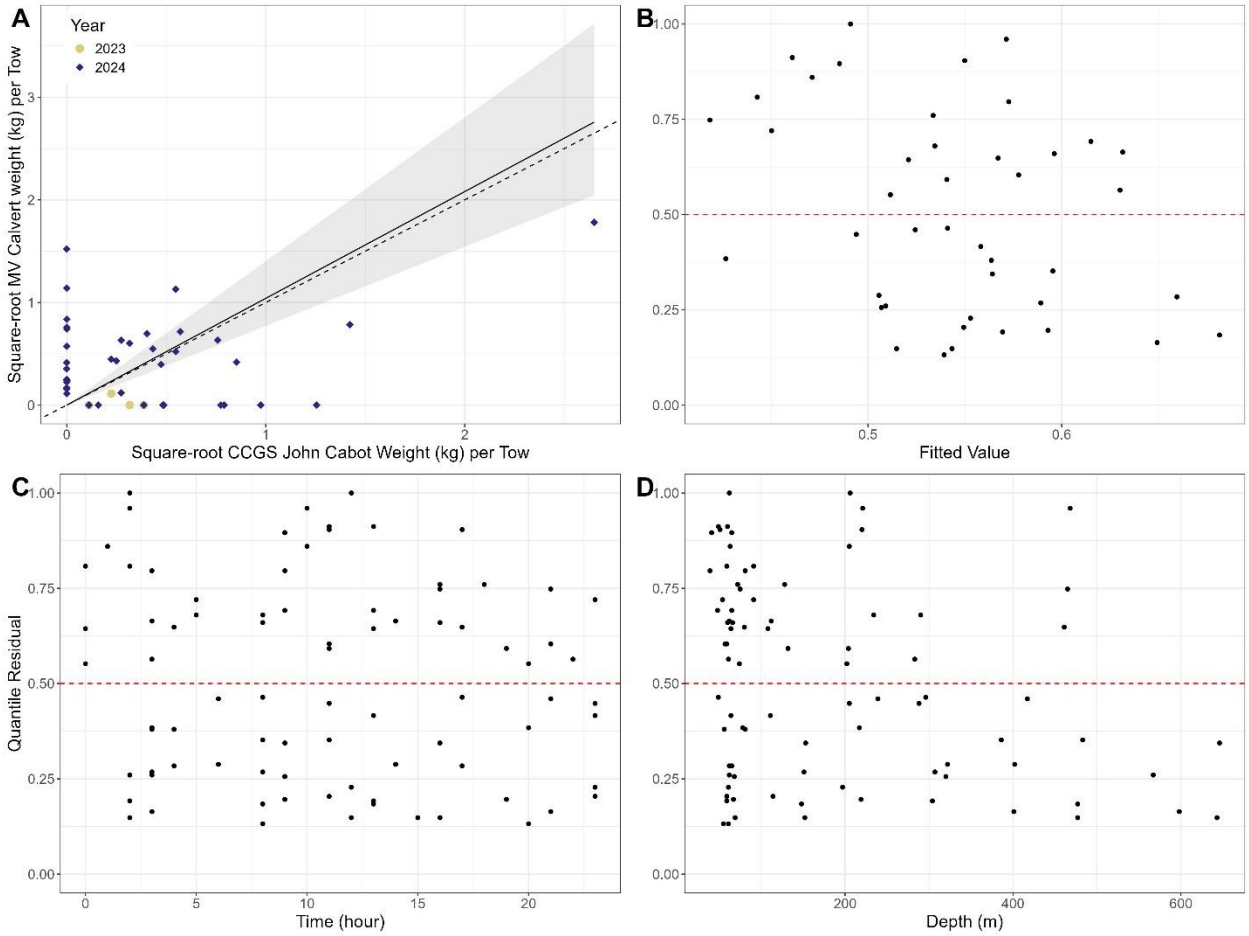

*Figure A2- 40. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of soft corals (*Duva florida*,* Gersemia rubiformis*,* Gersemia *spp.,* Nephtheidae *spp.), spring 3LNO.*

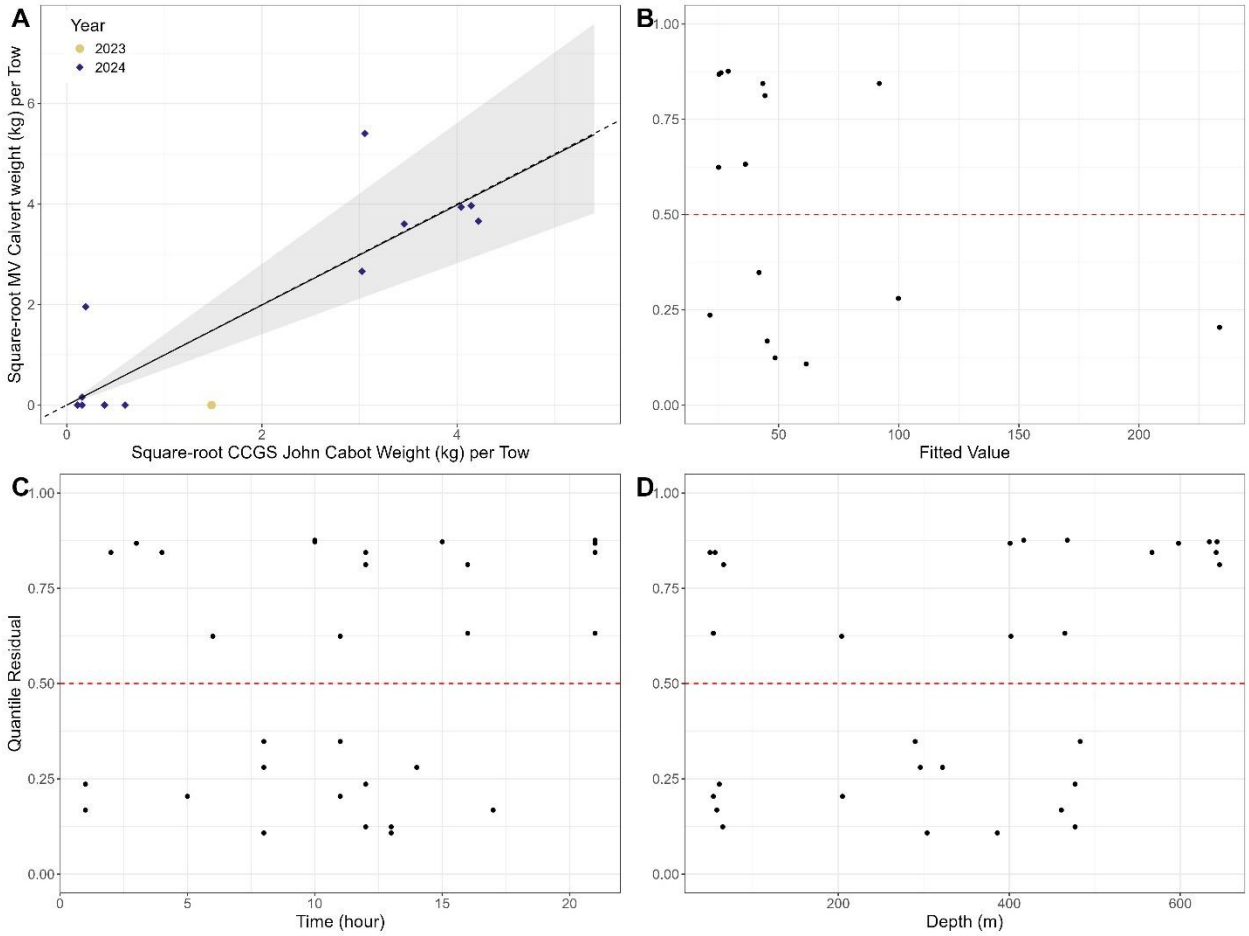

*Figure A2- 41. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of jellyfish (*Scyphozoa*), spring 3LNO.*

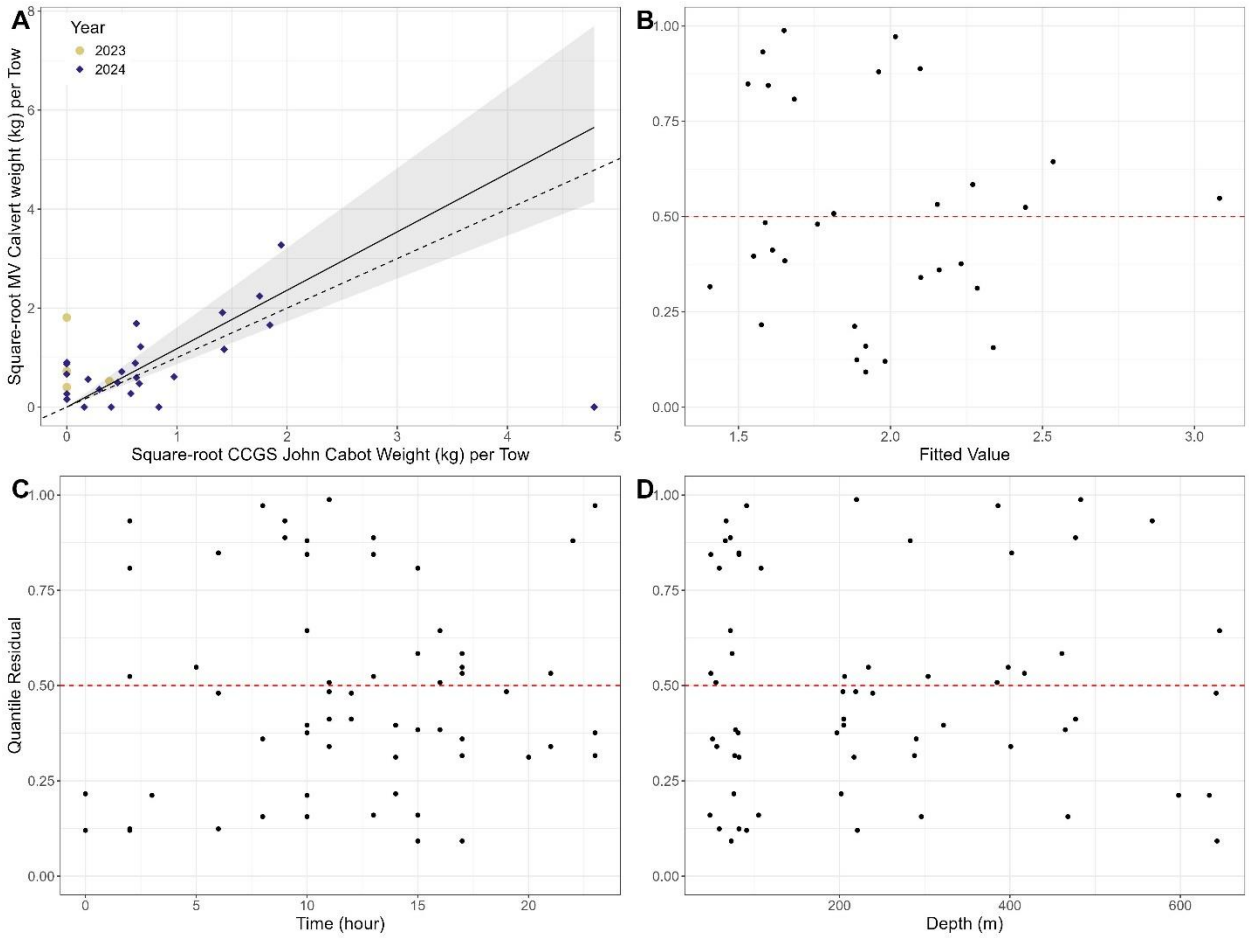

*Figure A2- 42. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of sponges (*Porifera*), spring 3LNO.*

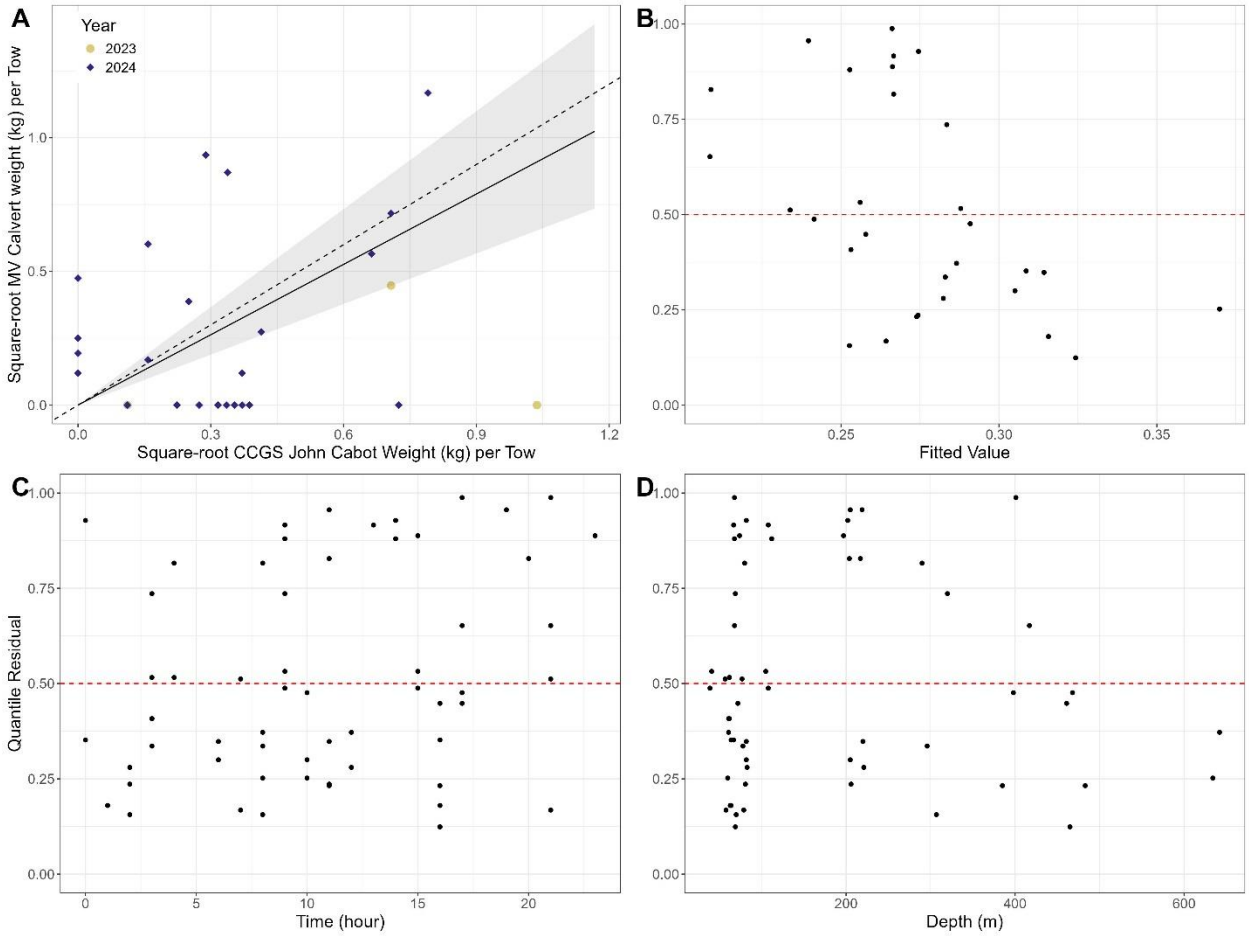

*Figure A2- 43. Results of size aggregated analysis for the MV Calvert and CCGS John Cabot for catch of tunicates (*Ascidiacea*,* Ascidiidae*,* Ascidia *sp.,* Pelonaia *sp.,* Pyuridae*,* Thaliacea*), spring 3LNO.*

10. APPENDIX 3: FUNCTIONAL GROUP RESULTS

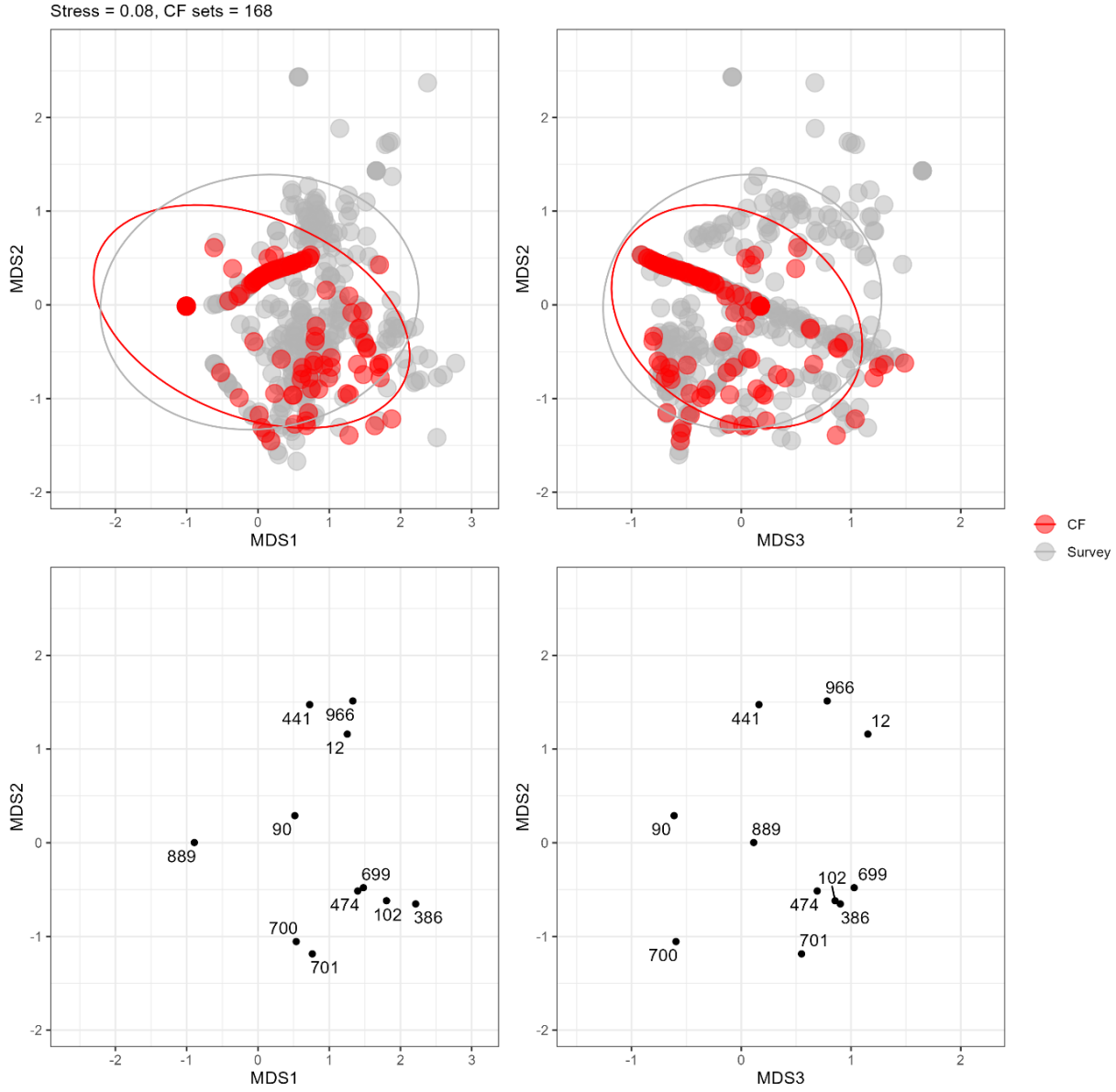

Figure A3- 1. Species composition of the large benthivore functional group in NAFO divisions 3LNO in spring comparative fishing (CF) sets. Plots on the top represent the composition of CF sets conducted with both MV Calvert and the CCGS John Cabot (red) and the survey sets from 2017 – 20 (grey) for CCGS Teleost and CCGS Alfred Needler. Colored ellipse represent 95% confidence intervals. Plots on the bottom represent the individual species scores with the species codes. Left hand plots are the first the second dimensions, while the right hand plots are the second and third dimensions. The stress for the nMDS analyses and number of CF sets are listed on the top.

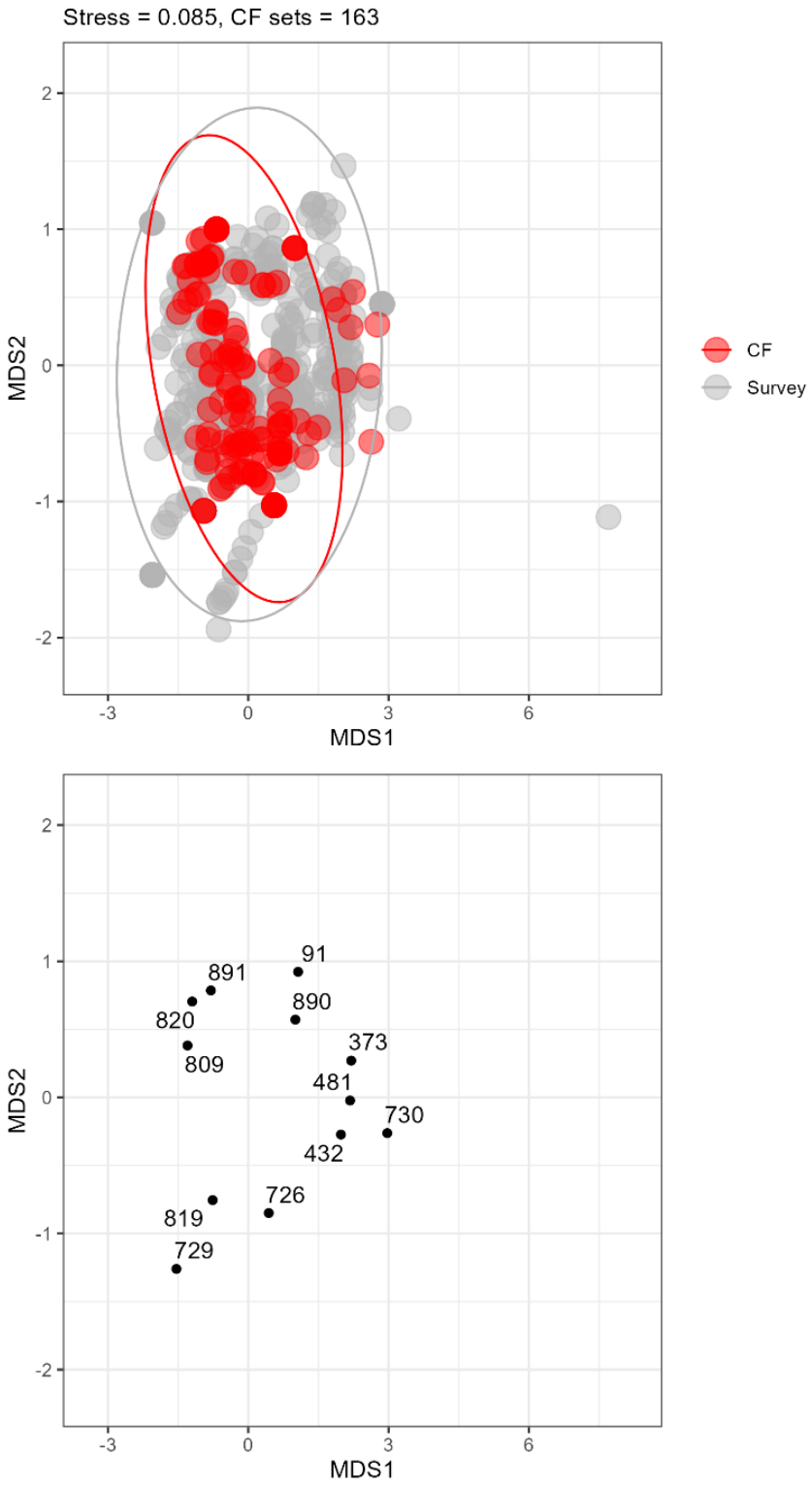

Figure A3- 2. Species composition of the medium benthivore functional group in NAFO divisions 3LNO in spring comparative fishing (CF) sets. Plot on the top represents the composition of CF sets conducted with both MV Calvert and the CCGS John Cabot (red) and the survey sets from 2017 – 20 (grey) for CCGS Teleost and CCGS Alfred Needler. Colored ellipse represent 95% confidence intervals. Plot on the bottom represents the individual species scores with the species codes. The stress for the nMDS analyses and number of CF sets are listed on the top.

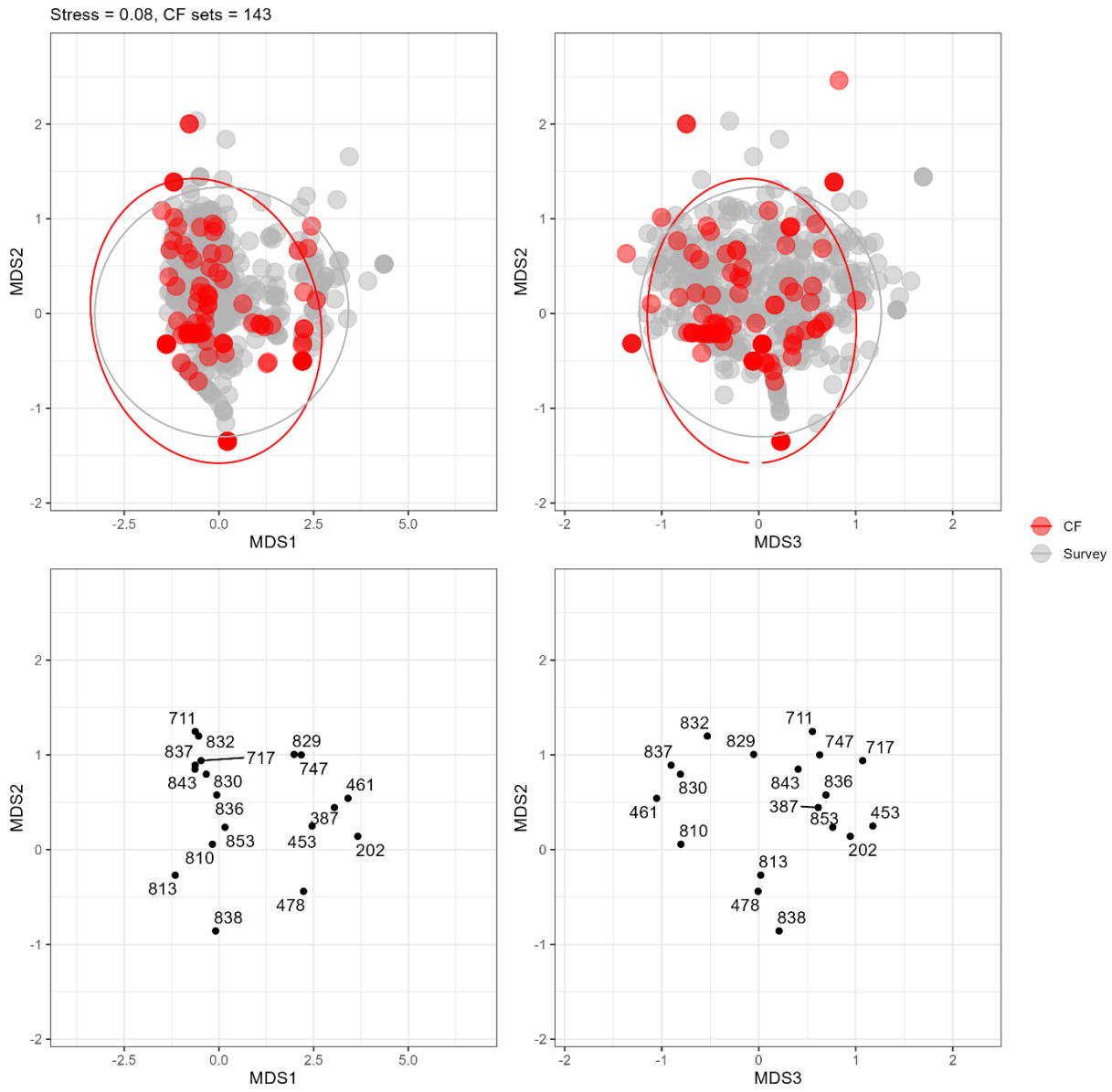

Figure A3- 3. Species composition of the small benthivore functional group in NAFO divisions 3LNO in spring comparative fishing (CF) sets. Plots on the top represent the composition of CF sets conducted with both MV Calvert and the CCGS John Cabot (red) and the survey sets from 2017 – 20 (grey) for CCGS Teleost and CCGS Alfred Needler. Colored ellipse represent 95% confidence intervals. Plots on the bottom represent the individual species scores with the species codes. Left hand plots are the first the second dimensions, while the right hand plots are the second and third dimensions. The stress for the nMDS analyses and number of CF sets are listed on the top.

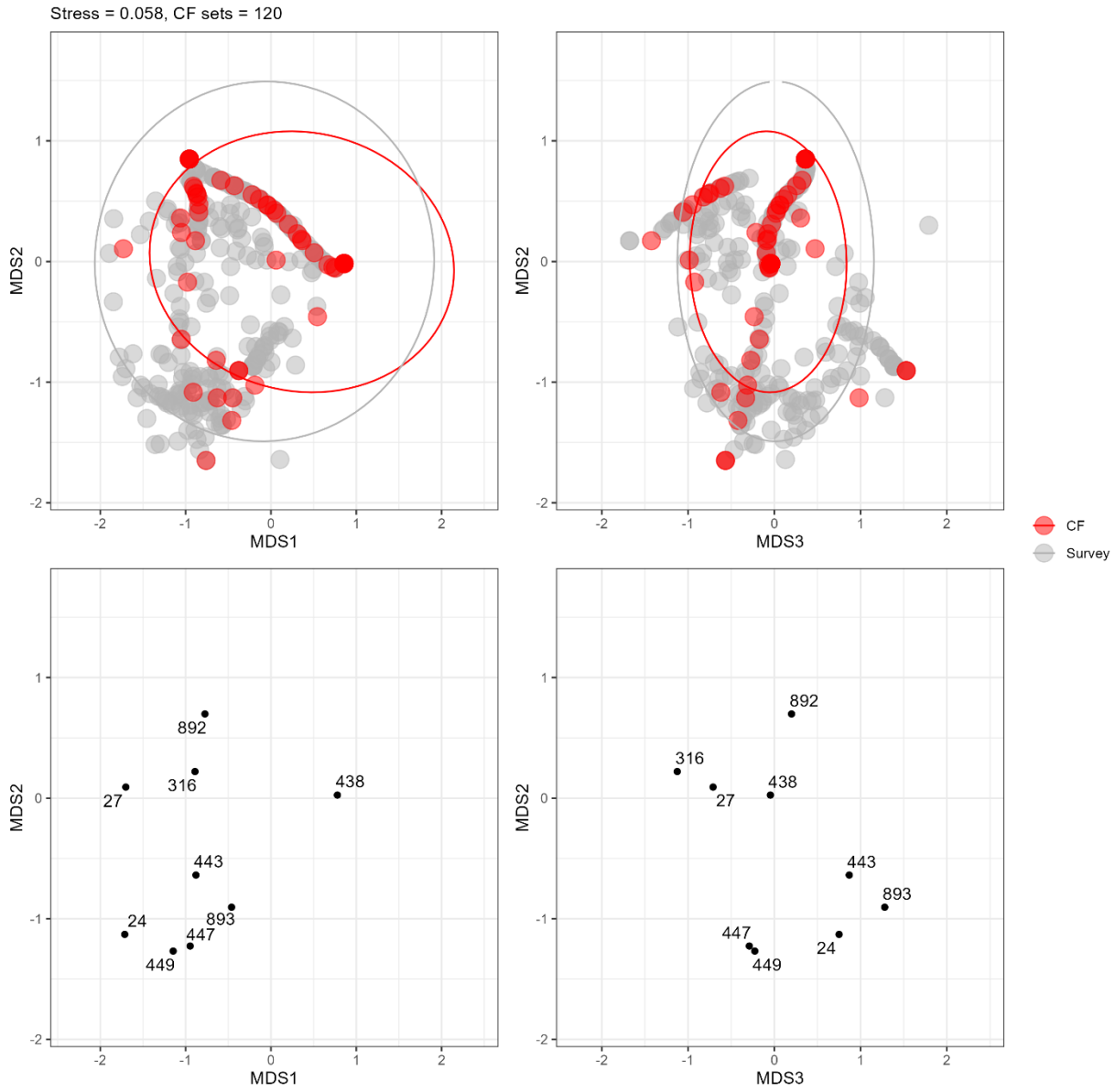

Figure A3- 4. Species composition of the piscivore functional group in NAFO divisions 3LNO in spring comparative fishing (CF) sets. Plots on the top represent the composition of CF sets conducted with both MV Calvert and the CCGS John Cabot (red) and the survey sets from 2017 – 20 (grey) for CCGS Teleost and CCGS Alfred Needler. Colored ellipse represent 95% confidence intervals. Plots on the bottom represent the individual species scores with the species codes. Left hand plots are the first the second dimensions, while the right hand plots are the second and third dimensions. The stress for the nMDS analyses and number of CF sets are listed on the top.

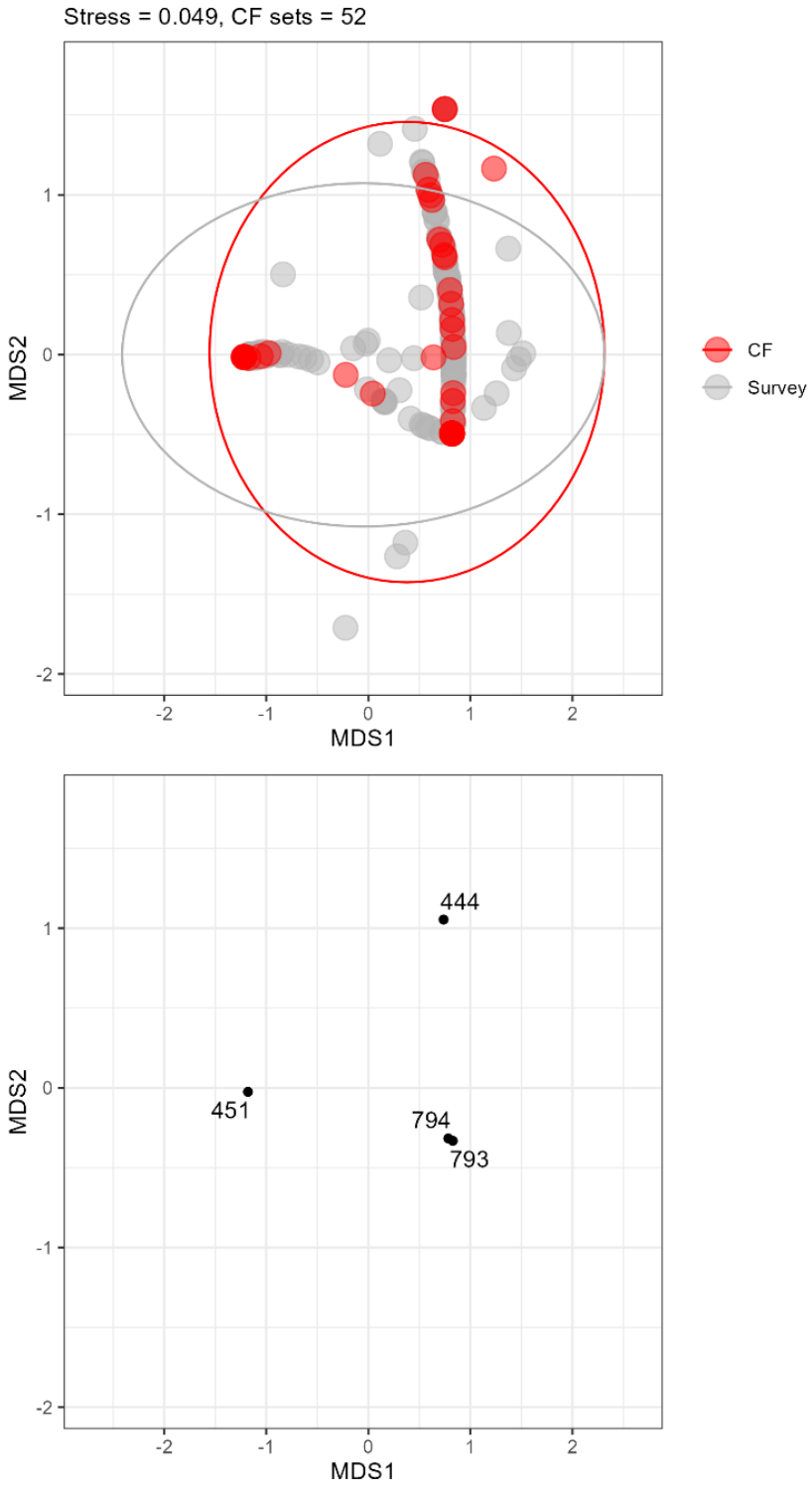

Figure A3- 5. Species composition of the plank-piscivore functional group in NAFO divisions 3LNO in spring comparative fishing (CF) sets. Plot on the top represents the composition of CF sets conducted with both MV Calvert and the CCGS John Cabot (red) and the survey sets from 2017 – 20 (grey) for CCGS Teleost and CCGS Alfred Needler. Colored ellipse represent 95% confidence intervals. Plot on the bottom represents the individual species scores with the species codes. The stress for the nMDS analyses and number of CF sets are listed on the top.

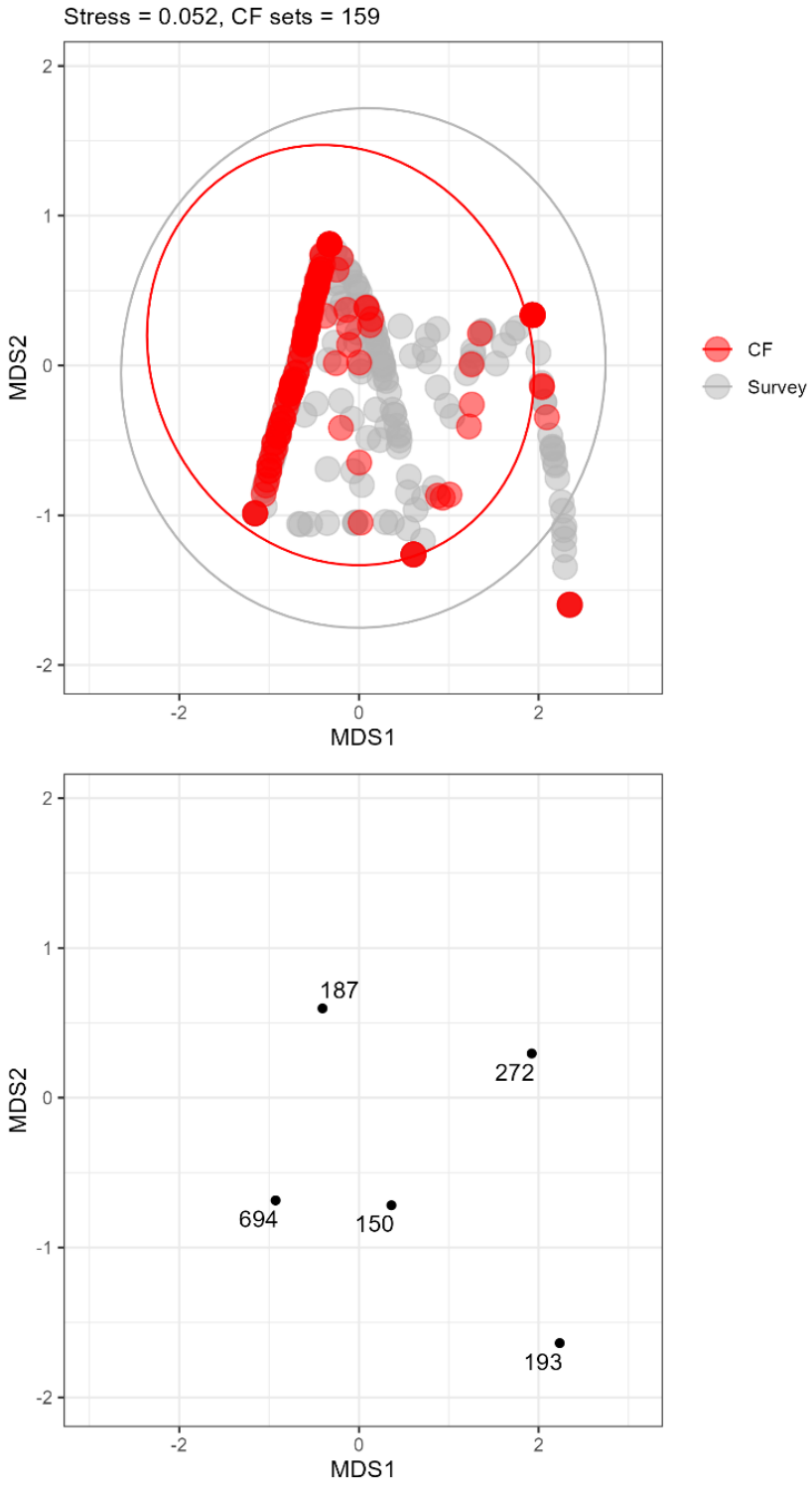

Figure A3- 6. Species composition of the planktivore functional group in NAFO divisions 3LNO in spring comparative fishing (CF) sets. Plot on the top represents the composition of CF sets conducted with both MV Calvert and the CCGS John Cabot (red) and the survey sets from 2017 – 20 (grey) for CCGS Teleost and CCGS Alfred Needler. Colored ellipse represent 95% confidence intervals. Plot on the bottom represents the individual species scores with the species codes. The stress for the nMDS analyses and number of CF sets are listed on the top.

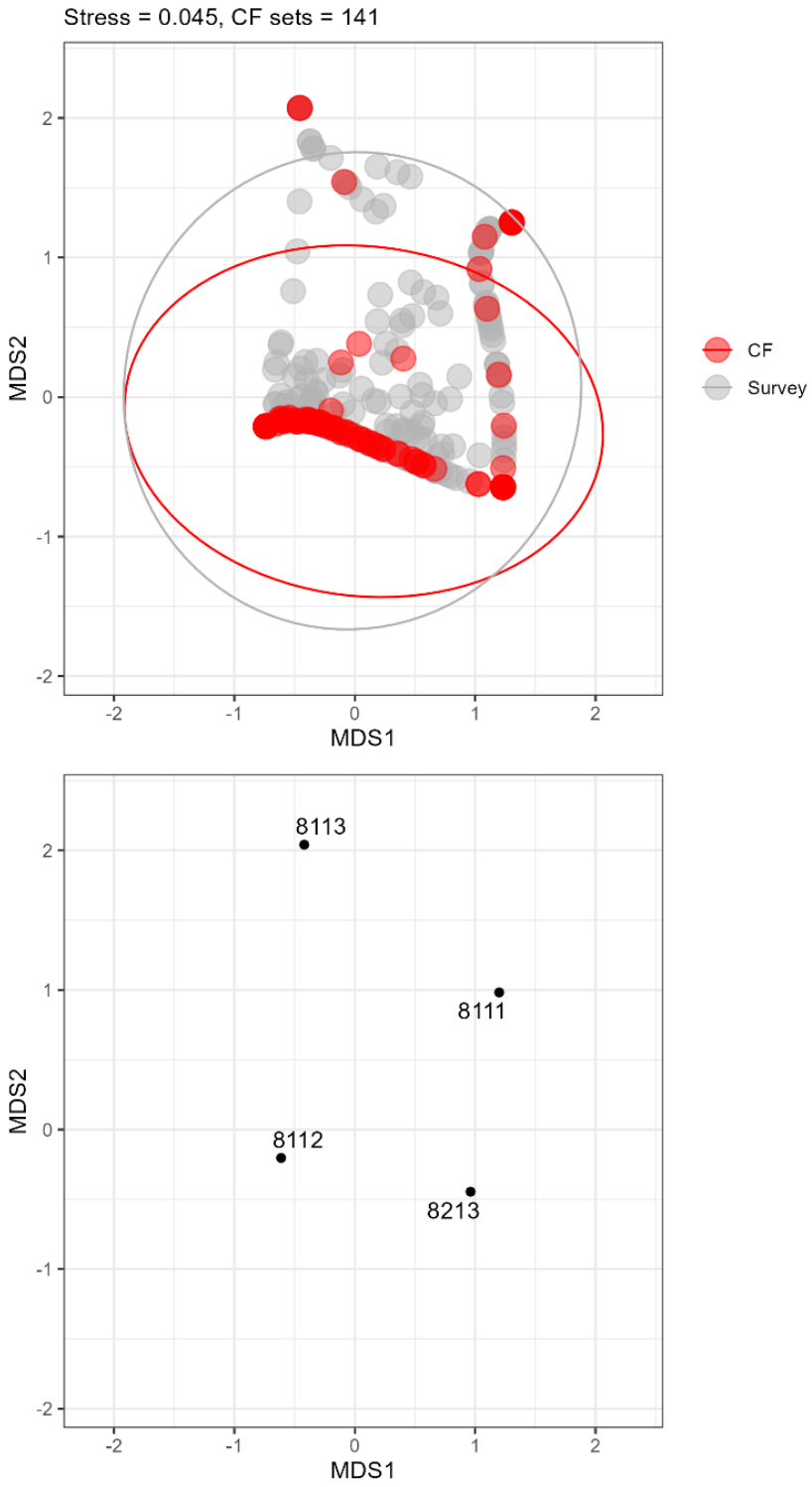

Figure A3- 7. Species composition of the shellfish functional group in NAFO divisions 3LNO in spring comparative fishing (CF) sets. Plot on the top represents the composition of CF sets conducted with both MV Calvert and the CCGS John Cabot (red) and the survey sets from 2017 – 20 (grey) for CCGS Teleost and CCGS Alfred Needler. Colored ellipse represent 95% confidence intervals. Plot on the bottom represents the individual species scores with the species codes. The stress for the nMDS analyses and number of CF sets are listed on the top.

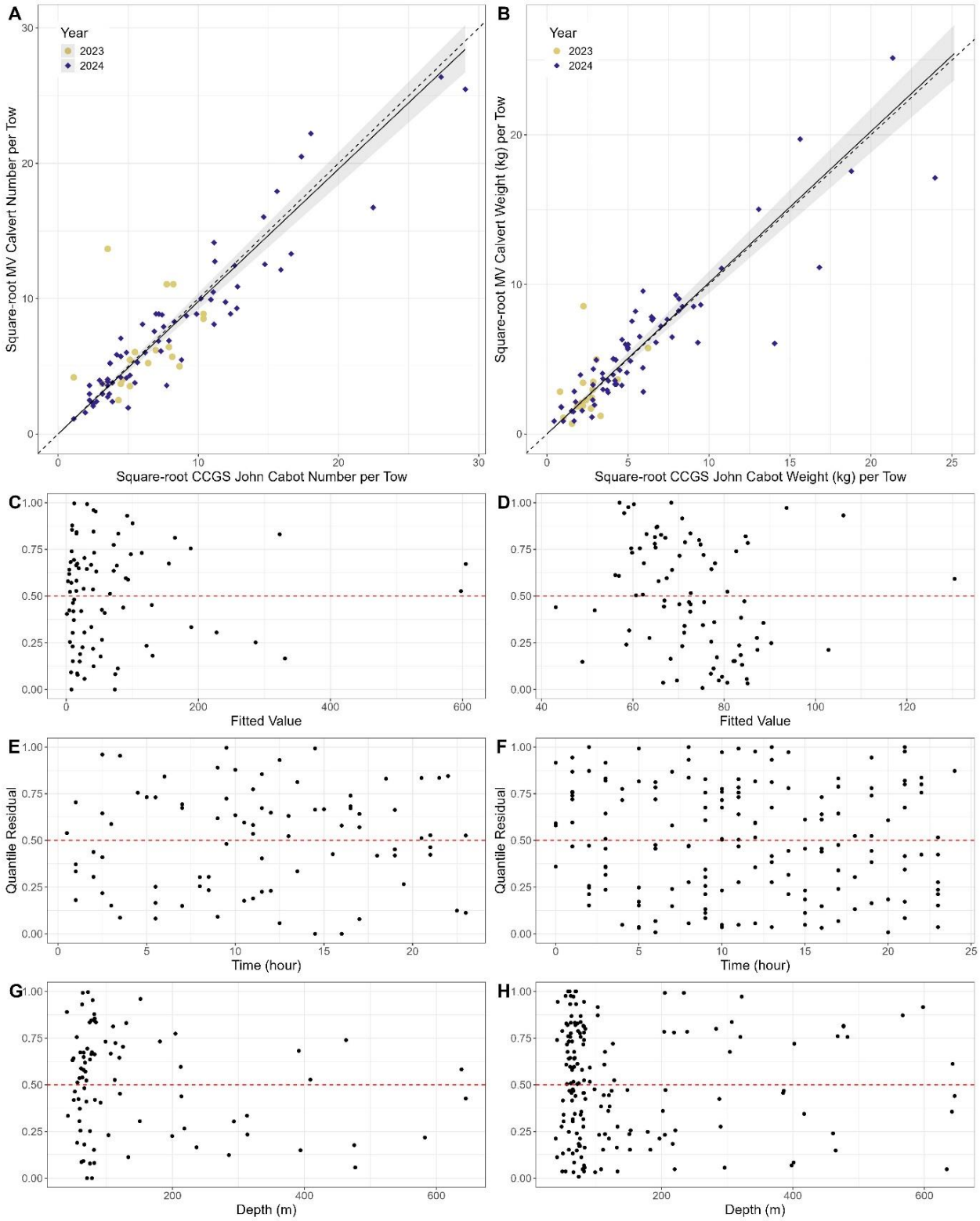

Figure A3- 8. Results of size aggregated analysis for the MV Calvert and the CCGS John Cabot for large benthivores in NAFO divisions 3LNO in spring.

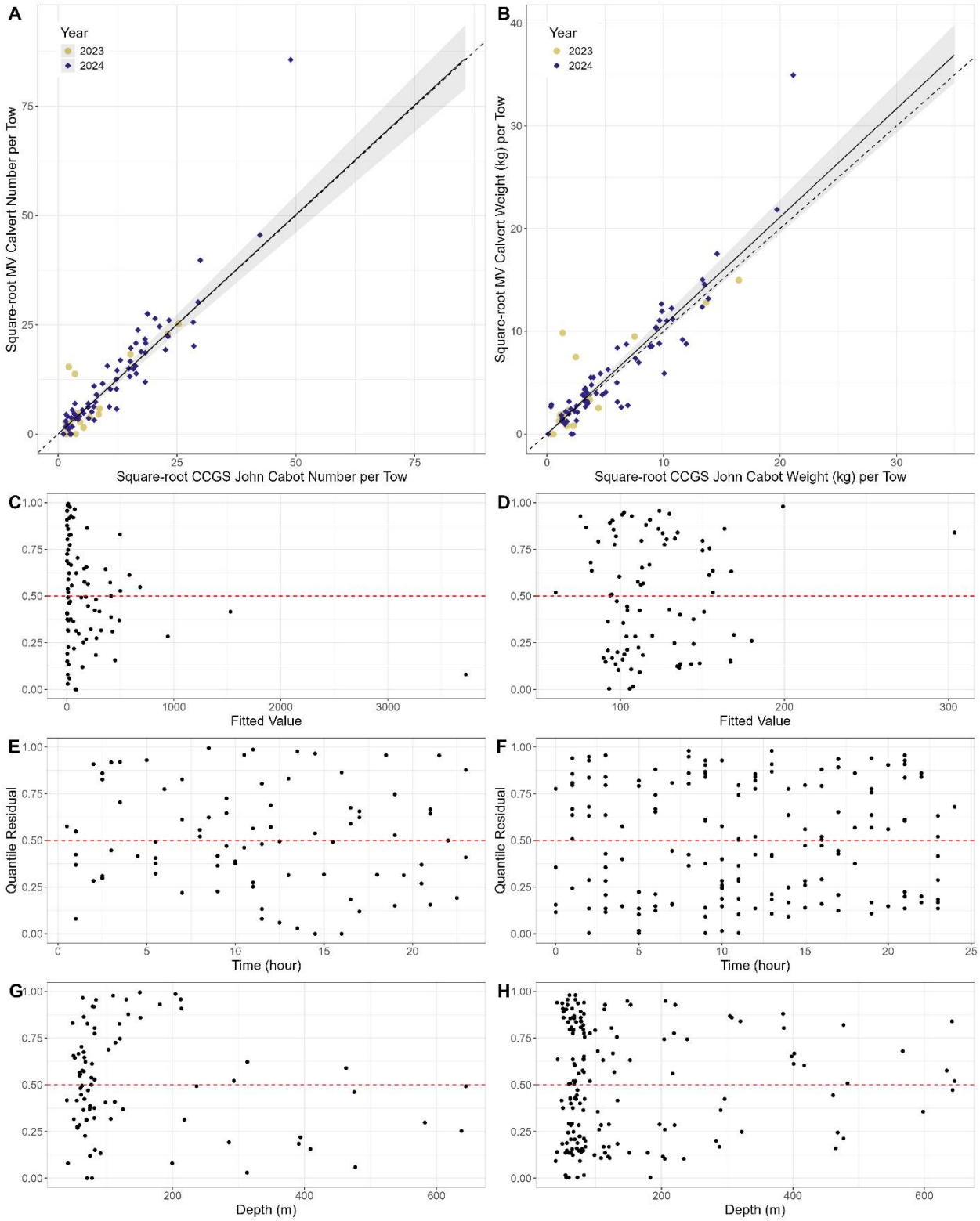

Figure A3- 9. Results of size aggregated analysis for the MV Calvert and the CCGS John Cabot for medium benthivores in NAFO divisions 3LNO in spring.

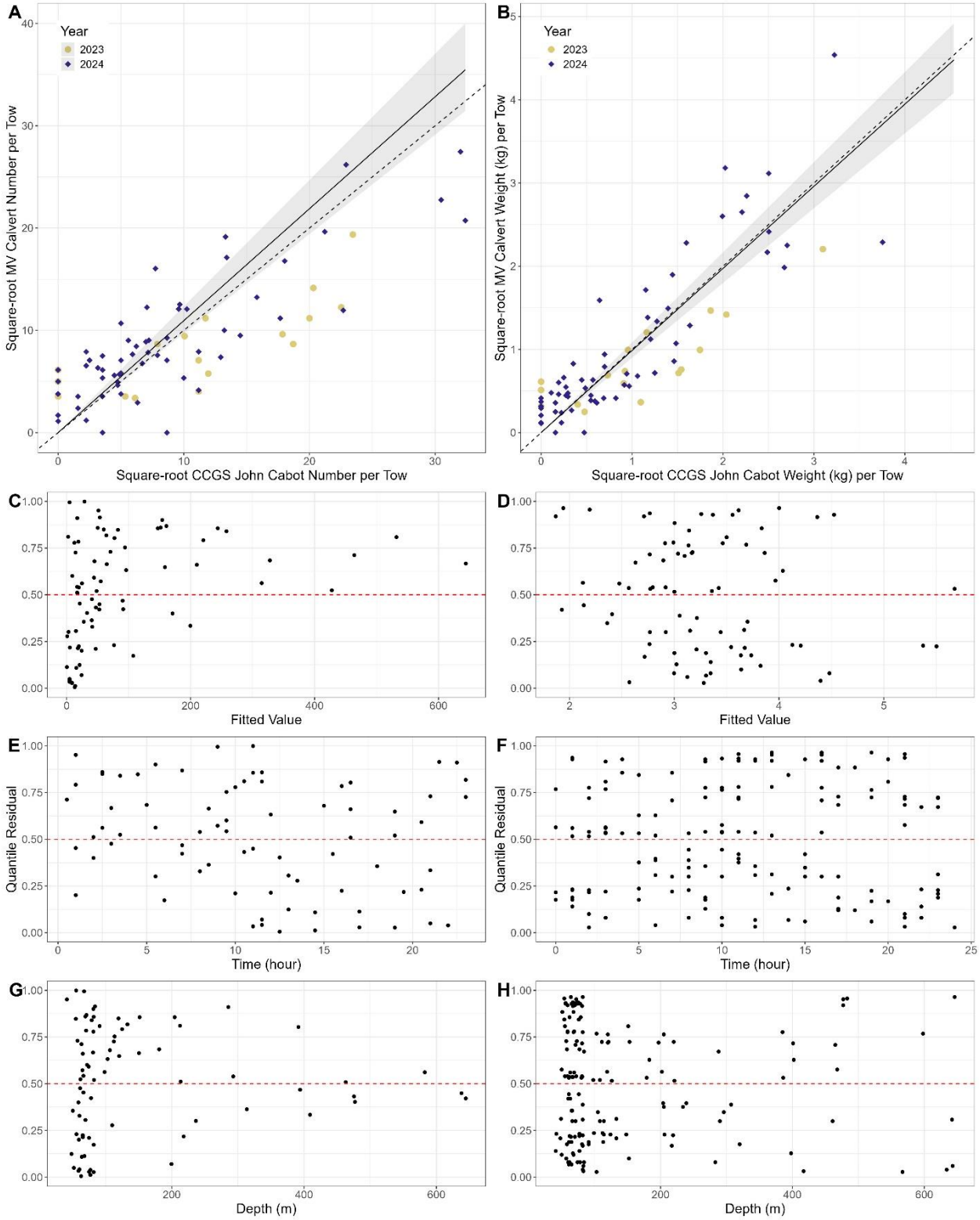

Figure A3- 10. Results of size aggregated analysis for the MV Calvert and the CCGS John Cabot for small benthivores in NAFO divisions 3LNO in spring.

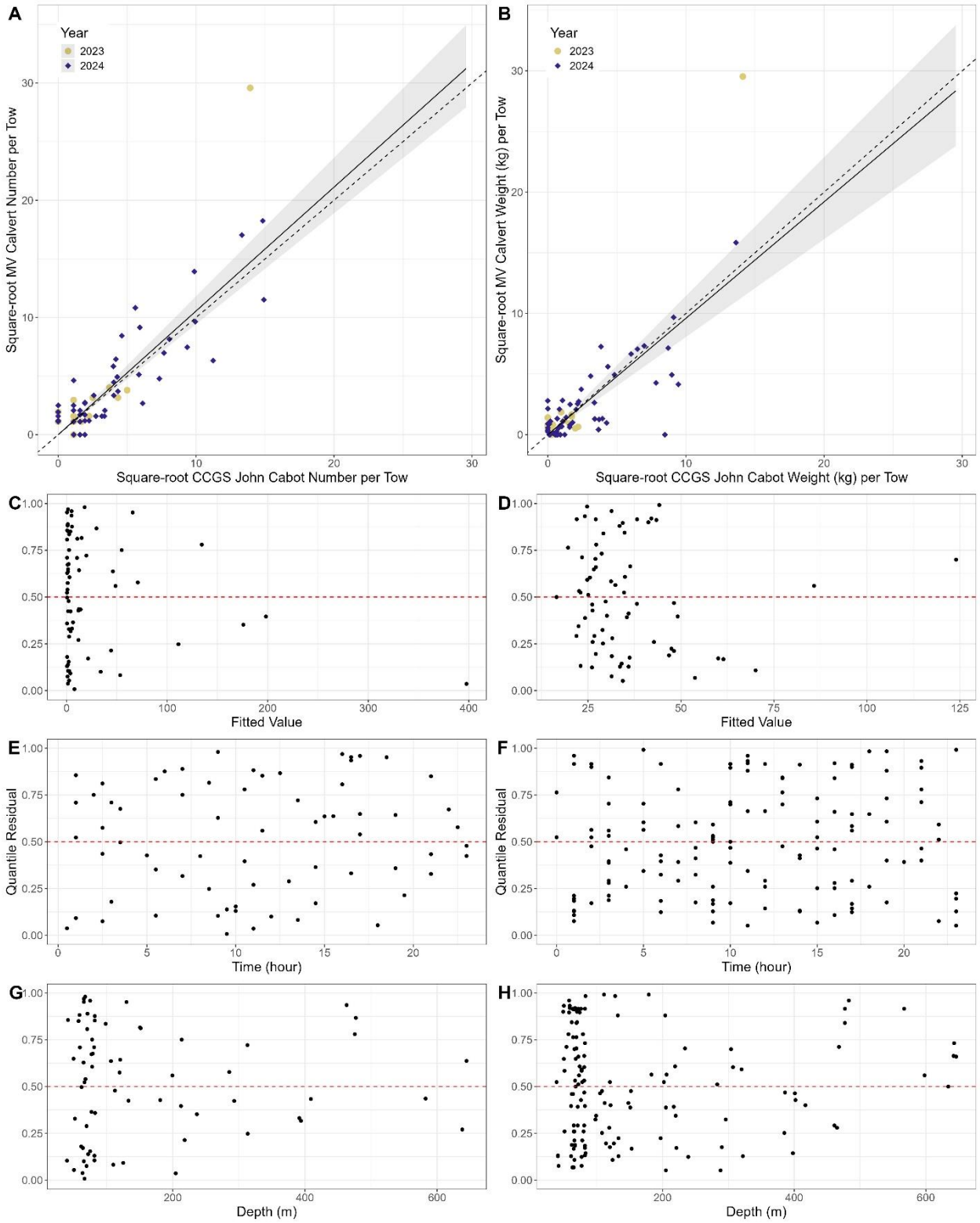

Figure A3- 11. Results of size aggregated analysis for the MV Calvert and the CCGS John Cabot for piscivores in NAFO divisions 3LNO in spring.

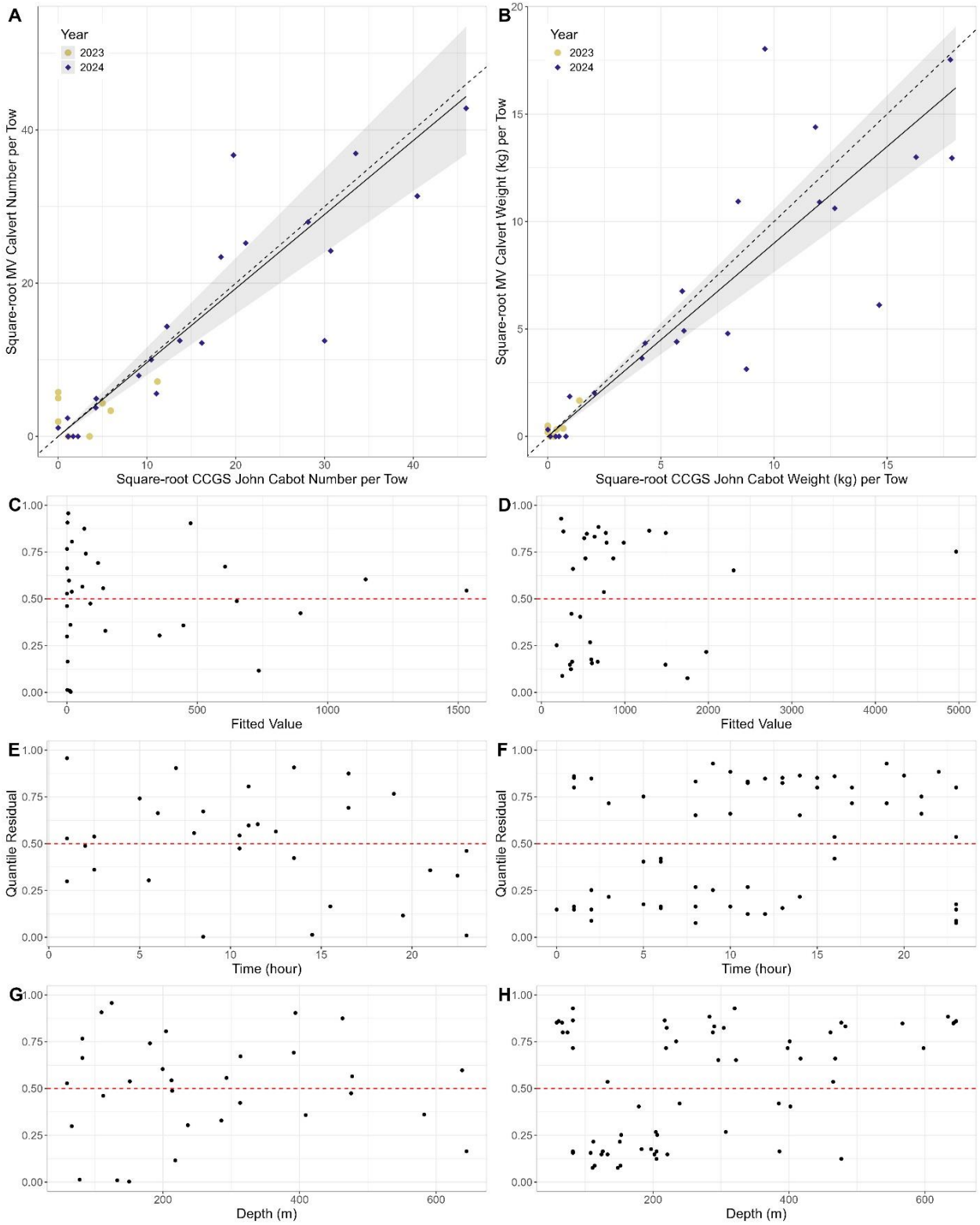

Figure A3- 12. Results of size aggregated analysis for the MV Calvert and the CCGS John Cabot for plank-piscivores in NAFO divisions 3LNO in spring.

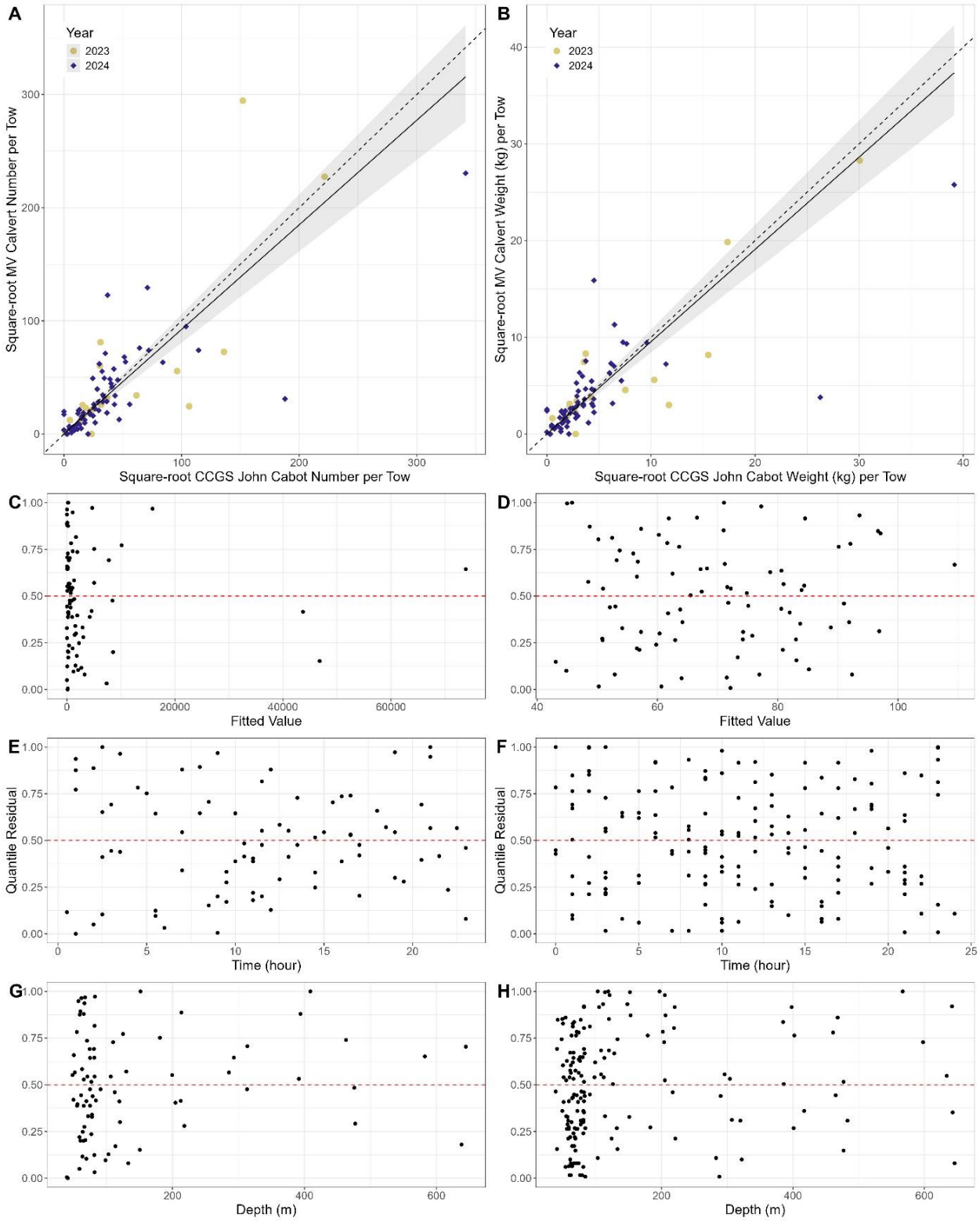

Figure A3- 13. Results of size aggregated analysis for the MV Calvert and the CCGS John Cabot for planktivores in NAFO divisions 3LNO in spring.

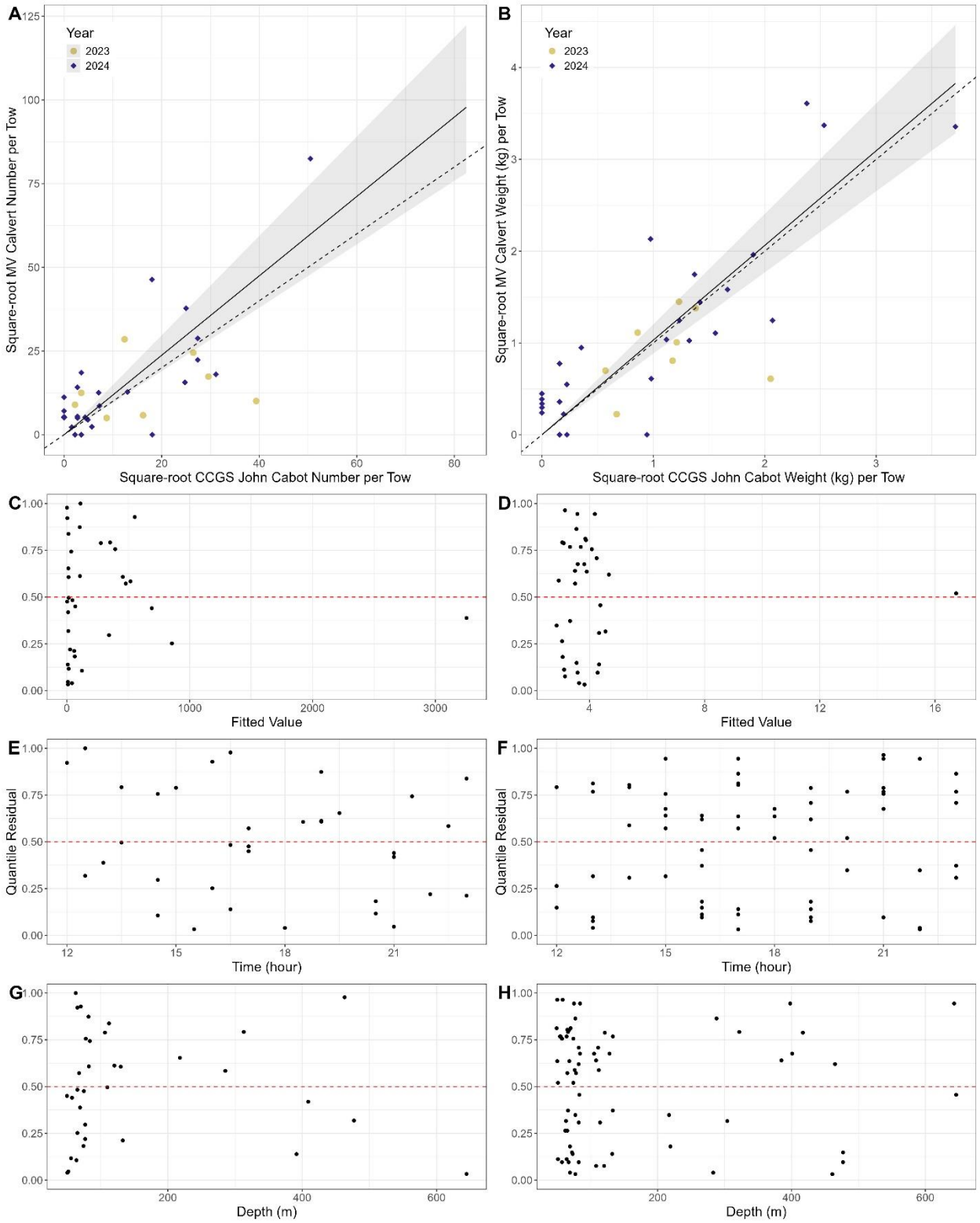

Figure A3- 14. Results of size aggregated analysis for the MV Calvert and the CCGS John Cabot for shellfish in NAFO divisions 3LNO in spring.