Maritimes Region American Lobster: Fisheries Spatial Distribution

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Table of Contents

ABSTRACT

Cook, A. M., Denton, C., Zisserson, B. and Element, G. 2024. Maritimes Region American Lobster: Fisheries Spatial Distribution. Can. Tech. Rep. Fish. Aquat. Sci. 3602: iv + 121 p

Existing estimates of the spatial distribution of the American lobster fishery in the Maritimes Region do not adequately capture fine scale fishing activity within defined management areas. In some areas, this results in misrepresentation of the true density, spatial extent and productivity of the fishery. This document addresses this problem by using fisheries logbook data to draw grids within each Lobster Fishing Area to more accurately represent fishing activities. This is possible because mandatory logbook reporting by licence holders relies on a higher resolution grid system to record fishing activity within management areas. By combining logbook reports with at-sea sampling depth measurements and surveys, more meaningful spatial and temporal analyses of effort, landings and catch rate across the entire region could be performed. The results show complex, grid-level changes in fishery dynamics over time as well as a fisheries footprint that in some cases is considerably smaller than allowed by regulation.

RÉSUMÉ

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Les estimations existantes de la répartition spatiale de la pêche au homard américain dans la Région des Maritimes ne saisissent pas adéquatement l'activité de pêche à petite échelle dans les zones de gestion définies. Dans certaines zones, il en résulte une représentation erronée de la densité, de l'étendue spatiale et de la productivité de la pêche. Ce document aborde ce problème en utilisant les données des journaux de bord pour établir des grilles à l'intérieur de chaque zone de pêche au homard afin que les activités de pêche soient représentées de manière plus précise. Cela est possible parce que la déclaration obligatoire des carnets de pêche par les détenteurs de permis s'appuie sur un système de grille à plus haute résolution pour enregistrer l'activité de pêche dans les zones de gestion. En combinant les rapports des journaux de bord avec les mesures de profondeur d'échantillonnage en mer et les relevés, des analyses spatiales et temporelles plus significatives de l'effort, des débarquements et du taux de capture dans l'ensemble de la région pourraient être réalisées. Les résultats démontrent des changements complexes, au niveau de la grille, dans la dynamique de la pêche au fil du temps, ainsi qu'une empreinte de la pêche qui, dans certains cas, est considérablement plus petite que ce qui est autorisé par la réglementation.

1 Introduction

American lobster fisheries are among the most economically important fisheries in Canada. Within the Maritimes Region there are 13 (Figure 1) inshore lobster fishing areas (LFAs) that hold considerable cultural, social and economic importance.

Fisheries stock assessments occur annually for each of these LFAs based on the methodologies outlined in Cook et al. (2020) and Cook et al. (2023). These assessments use both fisheries independent survey data and fisheries dependent data from mandatory commercial logbooks. For each LFA, assessments typically report high (across an entire LFA) level outputs of trends and temporal patterns. Specific changes to fisheries distribution are not typically included in stock assessments but are becoming of increasing interest and importance due to ecosystem changes like climate change as well as increased interest in marine spatial planning and increased use in ocean development planning. Other publications have attempted to document distribution patterns of lobster fisheries (e.g. Serdynska et al. 2022), however they do not accurately reflect the true spatial extent of fishing for many LFAs (particularly LFAs 27-32). The assumptions and treatment of data in those reports do not accurately represent the fisheries data as inappropriate source data and calculations were used for catch and effort calculations.

In this document, we provide a methodology based on fisheries logbook and sales slip data for estimating measures of unbiased catch per unit effort (CPUE), fishery effort (trap hauls) and landings. Further, we discretize this information to a finer spatial resolution defined by various sources for the fisheries within each LFA by providing metrics of fisheries statistics on a density scale (variable / km^2). We analyze and produce maps for each LFA separately as each maintains different environmental and fisheries management characteristics (Table 1) that may alter the interpretation of fisheries footprints.

2 Materials and Methods

2.1 Data Sources and Analyses

2.1.1 Logbook Data

Mandatory commercial fishing logbooks (hereafter “logbooks”) provide the most detailed accounting of the spatial and temporal effort and landings for commercial lobster fishing currently available. These logbooks are filled out daily and are submitted on a monthly basis to Dockside Monitoring Companies (DMCs) for data entry and transmission to the Department of Fisheries and Oceans’ (DFO) Commercial Data Division (CDD). Logbooks contain fishing information including *Date Fished*, *Vessel Registration Number*, *Fishing Licence Number* and Reporting *Grid Number(s*) (Figure 1). For each day fished, *Grid Number, Effort (Number of Traps Hauled)* and *Estimated Landings* are provided. The measured weight of lobsters landed is reported in the *Weigh-Out Slip* portion of the logbook, which is completed upon sale of the lobsters. The slip-weight cannot always be linked directly to a fishing trip as harvesters may sell only a portion of a trip’s catch or aggregate catch from multiple trips in a single sales event. As such, slips are the most accurate accounting of annual (or seasonal) landings available, whereas daily logs are the most accurate information available on fishing effort and spatial distribution. Logbook data are stored in the Maritimes Fishery Information System (MARFIS), which is maintained by CDD.

As with most databases, errors or incomplete information can exist in the lobster logbook data in MARFIS. The process of filtering logbooks to ensure data quality produces an underestimate of total

number of traps hauls (effort) and total landings. To provide fishery-level estimates of total trap hauls (H_{ly}) we used CPUE (CE_{ly}) estimated from the filtered logbooks that meet data quality standards and the reported slip landings (S_{ly}) for each LFA (l) and year (y). For fishing seasons that span two calendar years, year refers to the end of season year.

$$H_{ly} = \frac{S_{ly}}{CE_{ly}} \quad \text{Eq. 1}$$

where

$$CE_{ly} = \frac{\sum_{i=1}^{n} c_{lyi}}{\sum_{i=1}^{n} e_{lyi}} \quad \text{Eq. 2}$$

for all filtered logbook entries (i = 1:n). As CE_{ly} is a ratio estimator, with both catch (c_{ly}) and effort (e_{ly}) being random variables, it is considered biased on the order of 1/n where n represents the sample size (Cochran 1977). Although n is large for these datasets an asymptotically correct estimator is (van Kempen and van Vliet 2000):

$$CE_{ly}{}' = CE_{ly} + \frac{\sigma_e^2}{\mu_e^2}\frac{\mu_c}{\mu_e} - \frac{\sigma_{ec}}{\mu_e^2} \quad \text{Eq. 3}$$

with variance estimated as:

$$var\left(CE_{ly}{}'\right) = \frac{1}{n}\left[\frac{\sigma_c^2}{\mu_e^2} + \frac{\mu_c^2\sigma_e^2}{\mu_e^4} - \frac{2\mu_c\sigma_{ec}}{\mu_e^3}\right] \quad \text{Eq. 4}$$

Where μ_c , μ_e , σ_c^2, σ_e^2 and σ_{ec} represent the mean of catch, mean of effort, variance of catch, variance of effort and the covariance of effort and catch respectively. Confidence intervals were approximated by Chebyshev's inequality. In this document, the bias corrected CE_{ly}' statistics is presented. Point estimates of H_{ly}, associated variances $var(H_{ly})$ and confidence intervals are based on those calculated with CE_{ly}'.

CE_{ly}, H_{ly} and S_{ly} were discretized to the smallest spatial scales using the reported proportion of total landings or total trap hauls within logbook grids. The discretization assumed that the filtered logbooks represent an unbiased sample of the spatial fishing patterns. To meet the Government of Canada privacy policy (Treasury Board Directive, 2010), data was screened so that grid fisheries statistics with less than five vessel IDs and licence IDs were not displayed. This "Rule of Five" was not met in all years and LFAs, so grids that did not meet this criteria were left blank for all maps in this document.

The fisheries statistics in LFA 28 did not meet the minimum threshold in any year and were therefore not included in this document. It is important to note fishing in LFA 28 does occur in all grids on an annual basis. The non-public, underlying data is still available and used by DFO for stock assessment and marine spatial planning exercises.

2.1.2 Adjustment of Spatial Grids

In LFAs 27-32, the LFA boundaries and the grids within them do not accurately represent the extent of fishing activities because the LFAs begin at a line 50 nautical miles (nm) from the coast. However, lobster fishing in these LFAs typically occurs closer to the coast. To provide a more realistic representation of the spatial extent of Lobster fishing within these LFAs than would be provided in the grid referenced data, we used three sources of information:

1. georeferenced at-sea sampling of commercial fishing coupled with a high-resolution digital elevation map to determine the depth at each trap location
2. results from a harvester survey (Parlee et al, in prep).
3. direct reports from harvesters.

In each LFA, the greater of the upper 99th quantile break (removing outliers) or the deepest depth reported by harvesters was used to define the commercial fishing area and provide a more realistic determination of fishing areas.

2.1.3 LFA 37

At the time of completion of this publication, LFA 37 is considered a shared resource between LFA 36 and 38. The LFA 37 grids overlaps those of LFA 36, therefore fisheries statistics for those grids in LFA 36 are for the entire grid area. LFA 38 harvesters fishery statistics in LFA 37 grids represent just the activity within the shared area (Figure 1).

2.1.4 Time series Trends

Temporal trends in CPUE in each grid are displayed as the percent change from mean CE_{ly}' between 2006 and 2010 commercial fishing seasons and the mean CE_{ly}' for each of 2011:2013, 2014:2016, 2017:2019 and 2020:2022.

3 Results

3.1 LFA Overview

Table 2 summarizes the licence numbers and types allocated to each LFA and the number of traps associated with the allocated licence, and the maximum number of trap hauls for each LFA. The majority of licences are Category A, with most in LFA 34 and the fewest in LFA 28. A comparison of LFAs at the largest scale shows that fishing effort is not evenly distributed across the Maritimes Region. This macro-

view, however, tells us less about the localized activity of nearly 3000 harvesters fishing in LFAs with unique dimensions, coastline and physical management structures (Tables 1 and 2; Figure1).

3.2 Depth and Area of Lobster Fishing

The depth distribution of fishing from observations and harvester surveys was less than or equal to 80 m for LFAs 27-32 (Figure 2). The resulting fishery footprint estimations for these LFAs calculated in this document are substantially smaller than those available for fishing as outlined in regulations (Table 3; Figure 3); estimations range from 3% to 44% (excluding landlocked LFA 28) of the available (regulated) LFA area.

3.3 Distribution of the Fishery

Figures 4 – 116 show reports of fishing activity by logbook grid area. Metrics of fishery footprint were highly variable within LFAs, with some reporting grids experiencing much greater fishing pressure, and/or yielding higher catch rates than others. Variation on a smaller spatial scale has also changed over time. For example, though catch rates in LFA 27 have increased since 2019, the increase is concentrated in the southern reporting grids, rather than being spread evenly throughout the LFA (Figure 4). Similarly, fishing pressure in LFA 31B is more concentrated since 2019, with a notable increase in density of trap hauls in a single grid, without corresponding increases in other areas of the LFA (Figure 50). Finally, of the many similarly sized reporting grids in LFA 34, a disproportionately high density and volume of fishing effort occurs in two adjacent near-shore grids (Figures 78 – 83). Notably, catch rates in LFA 34 have been highest in grids farther from shore, where there has historically been less effort (Figure 74).

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Cook, A.M., Hubley, P.B., Denton, C., and Howse, V. 2020. 2018 Framework Assessment of American Lobster (Homarus americanus) in LFA 27–33. DFO Can. Sci. Advis. Sec. Res. Doc. 2020/017. vi + 251 p.

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Serdynska, A., Rozalska, K. and Coffen-Smout, S. 2022. Mapping Inshore Lobster Landings and Fishing Effort on a Maritimes Region Statistical Grid (2015–2019). Can. Tech. Rep. Fish. Aquat. Sci. 3509: vii + 51 p.

Treasury Board Directive on Privacy Impact Assessment. 2010. Available online: http://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=18308&section=te

TABLES

Table 1: Maritimes Region Lobster Fishing Areas restrictions and seasons.

LFA	Season	Trap limit[1]	Minimum Legal Size (mm)	Other measures	V-notch retention
27	May 15 - July 15	275	82.5		No restrictions
28	April 30 - June 30	250	84	Max. entrance hoop 153mm	Restricted
29	April 30 - June 30	250	84	Max. entrance hoop 153mm	Restricted
30	May 19 - July 20	250	82.5	Max. CL-135mm (female)	Restricted
31A	April 29 - June 30	250	82.5	Closed window (female), 114-124 mm	No restrictions
31B	April 19 - June 20	250	82.5	V-notching[2]	Restricted if >=110 mm, must v-notch and release set quantity of females >= 110 mm each season (Class A = 50kg, Class B = 15kg, Partnerships, including stacked licences = 75kg).
32	April 19 - June 20	250	82.5	V-notching[2]	Restricted if >=110 mm, must v-notch and release set quantity of females >= 110 mm each season (Class A = 50kg, Class B = 15kg, Partnerships, including stacked licences = 75kg).
33	Last Mon. Nov - May 31	250	82.5		Restricted, unless setal hair has grown all the way across the mutilation
34	Last Mon. Nov - May 31	375/400	82.5		Restricted, unless setal hair has grown all the way across the mutilation
35	Oct 14 - Dec 31 and Last day Feb - July 31	300	82.5		Restricted, unless setal hair has grown all the way across the mutilation
36	2nd Tues Nov - Jan 14 and March 31 - June 29	300	82.5		Restricted, unless setal hair has grown all the way across the mutilation
37	2nd Tues Nov - Jan 14 and March 31 - June 29	N/A	N/A		N/A
38	2nd Tues Nov – Jun 29	375	82.5		Restricted, unless setal hair has grown all the way across the mutilation
38B	June 30 – Fri before 2nd Tues Nov	375	82.5		Restricted, unless setal hair has grown all the way across the mutilation

[1]The trap limit is for a Category A licence (full-time). A Category B licence (part-time) is allowed 30% of the limit of a Category A licence, and a licence fished under a partnership or stacking arrangement, 150%.

[2]V-notching means there is an active program to v-notch female lobsters. There is a possession restriction of v-notched lobsters in all LFAs except in LFA 27 and LFA 31A.

Table 2: Number of Licences and type for Maritimes Inshore Lobster Fishery as of April 21st 2022.

Number of Licences					Number of Traps		
LFA	**Category A**	**Category B**	**Communal Commercial**	**Length of Season (Days)**	**Category A / Commercial Communal**	**Category B**	**[1]Max Number of Potential Trap Hauls**
27	491	12	12	60	275	83	8,359,260
28	7	0	7	60	250	75	210,000
29	53	5	5	60	250	75	892,500
30	20	0	0	61	250	75	305,000
31A	68	3	0	61	250	75	1,050,725
31B	70	0	0	61	250	75	1,067,500
32	147	4	6	61	250	75	2,351,550
33	634	28	21	187	250	75	31,013,950
34	944	0	35	187	375/400[2]	113/120[2]	70,120,875
35	75	2	17	230	300	90	6,389,400
36	161	1	15	156	300	90	8,250,840
38	119	1	16	232	375	113	11,771,216

[1] This would be if the entire trap allotment for the LFA was fished every possible day of the season. This does not occur due to operational constraints such as weather, etc.

[2] Licence holders in LFA 34 are allowed one additional month of fishing at the end of season, starting April 1st, during which their trap limit is increased to the amount indicated.

Table 3: Area of LFA after adjustment for observed depth distribution of commercial fishing activities.

LFA	Max Fishing Depth (m)	Original LFA Area (km^2)	Depth Pruned Area (km^2)	Proportion of Original Area
27	60	33297	3549	0.11
28	73	660	660	1.00
29	73	1203	655	0.44
30	46	4838	125	0.03
31A	80	5255	776	0.15
31B	67	7327	997	0.14
32	73	8681	1874	0.22

FIGURES

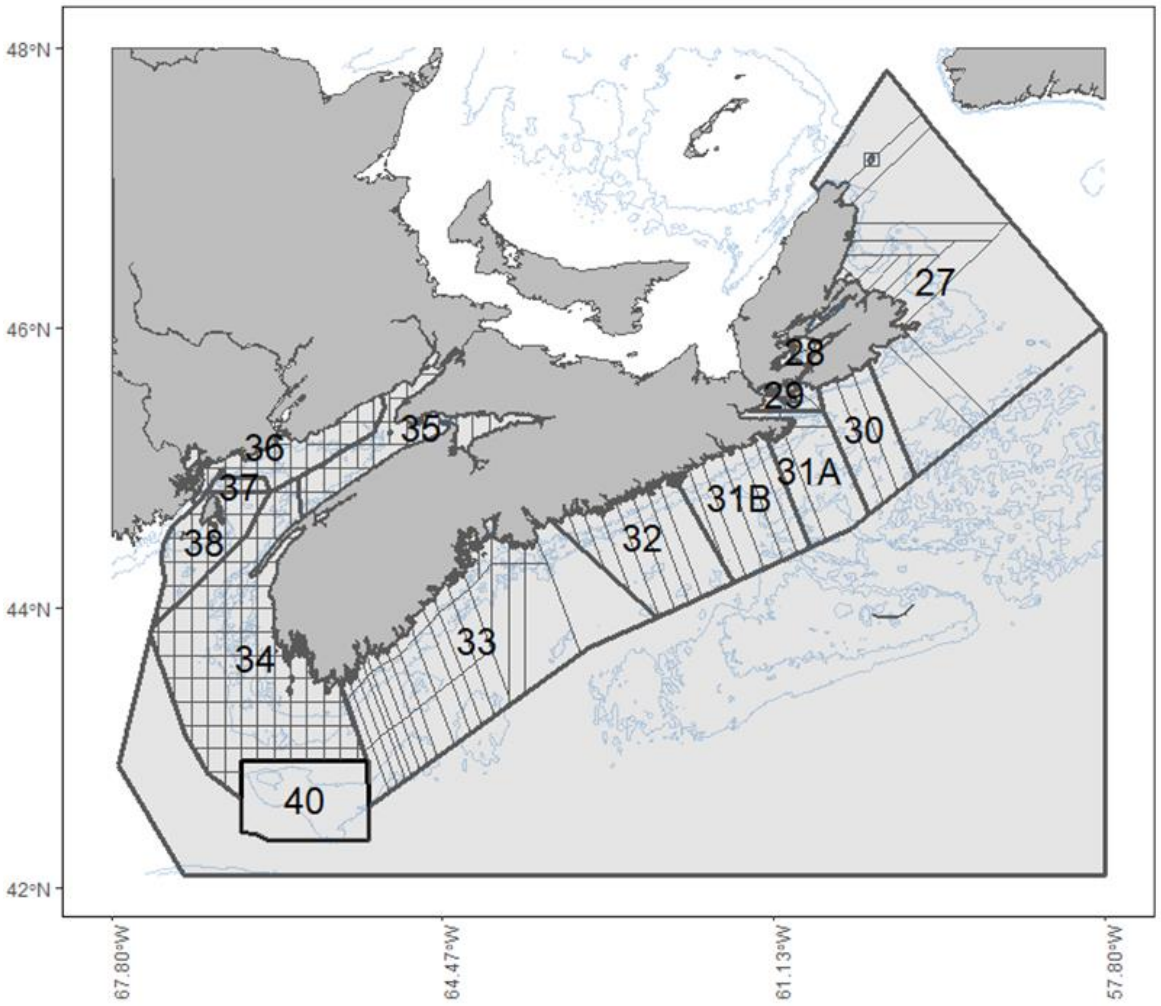

Figure 1: Inshore lobster fishing areas (LFA)s within the DFO Maritimes Region. Within LFAs, the thinner grey lines represent reporting grids.

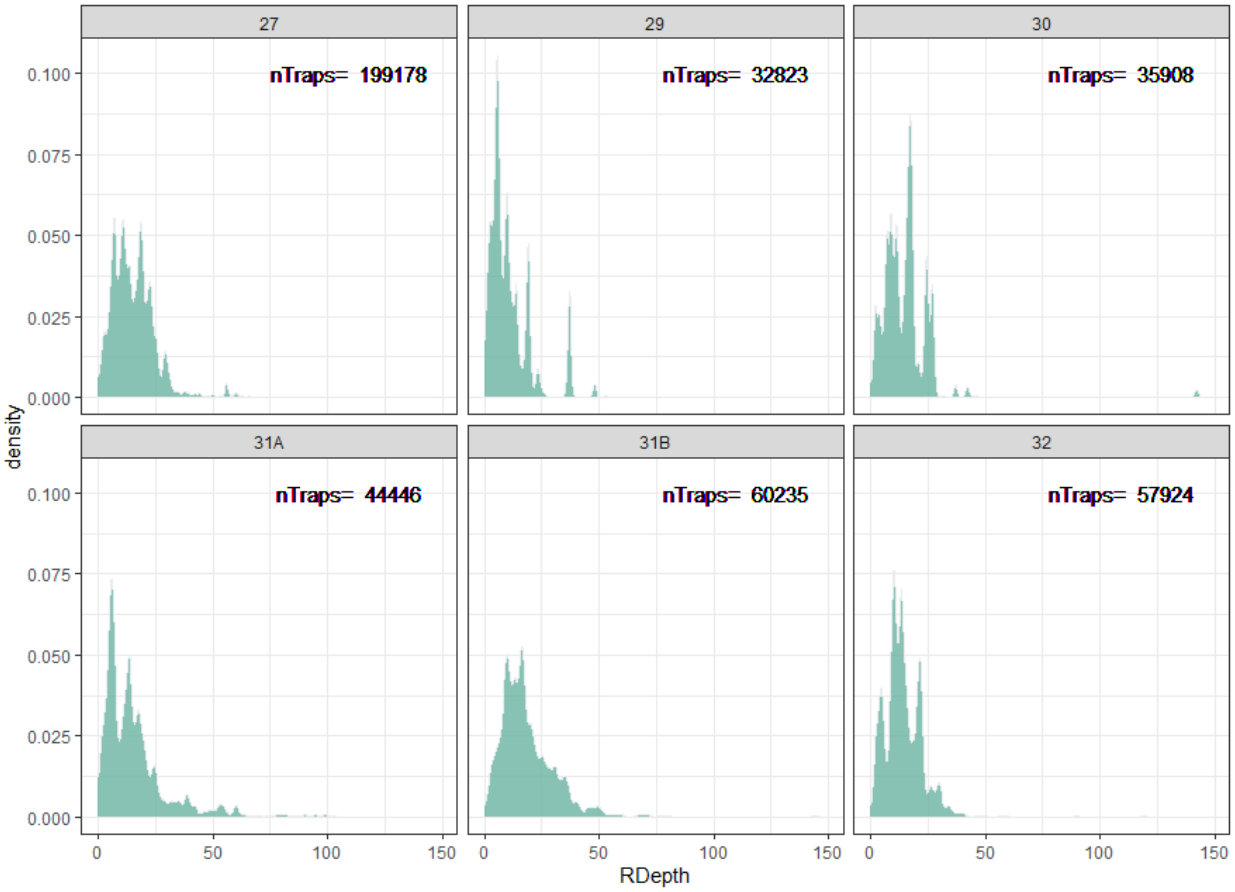

Figure 2: The distribution of depths of sampled traps during the commercial fisheries in LFAs 27 -32.

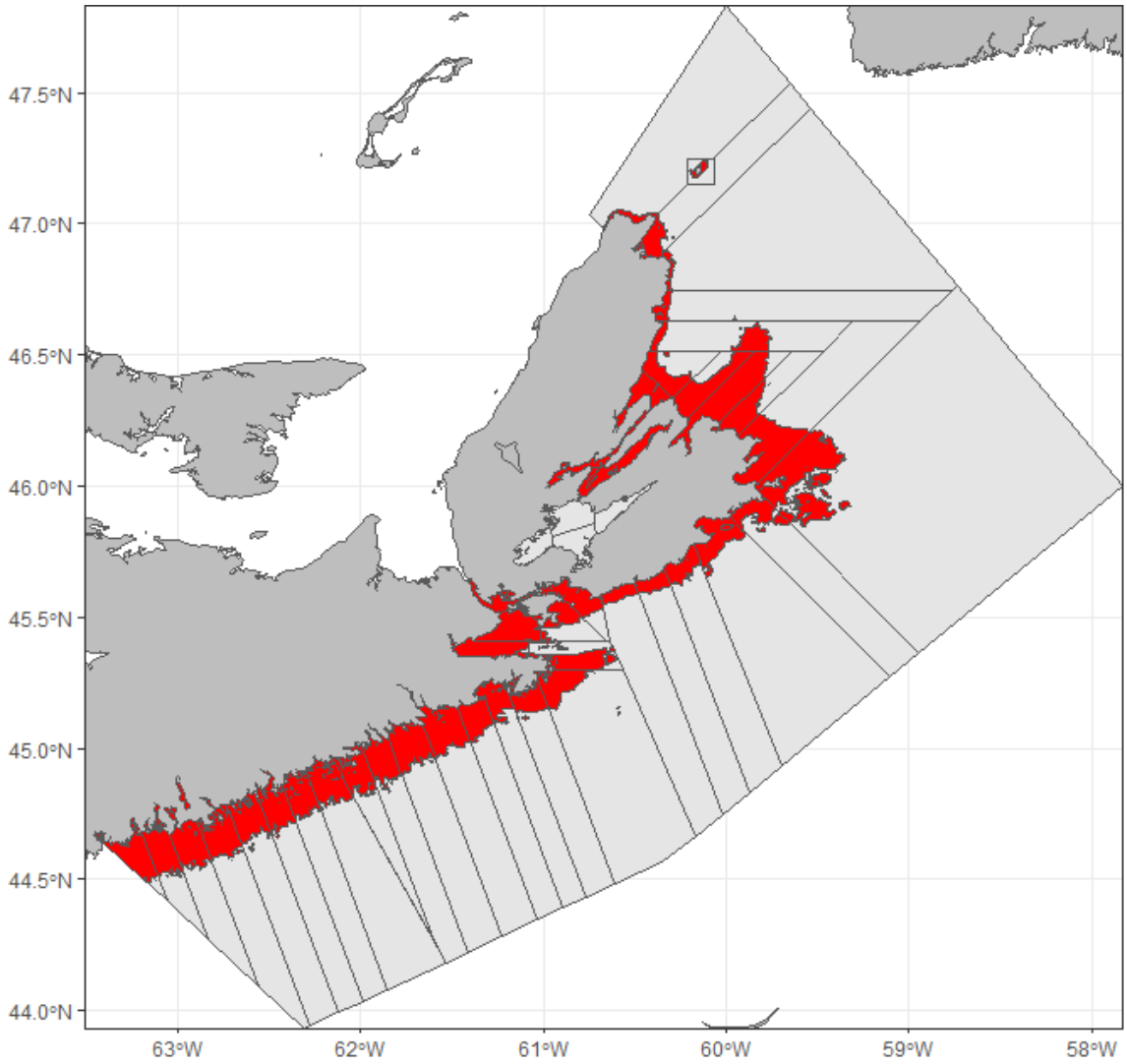

Figure 3: Depth truncated distribution of LFAs and grids after integrating depth contours with observed / reported commercial fishing depth as in Table 3 by LFA.

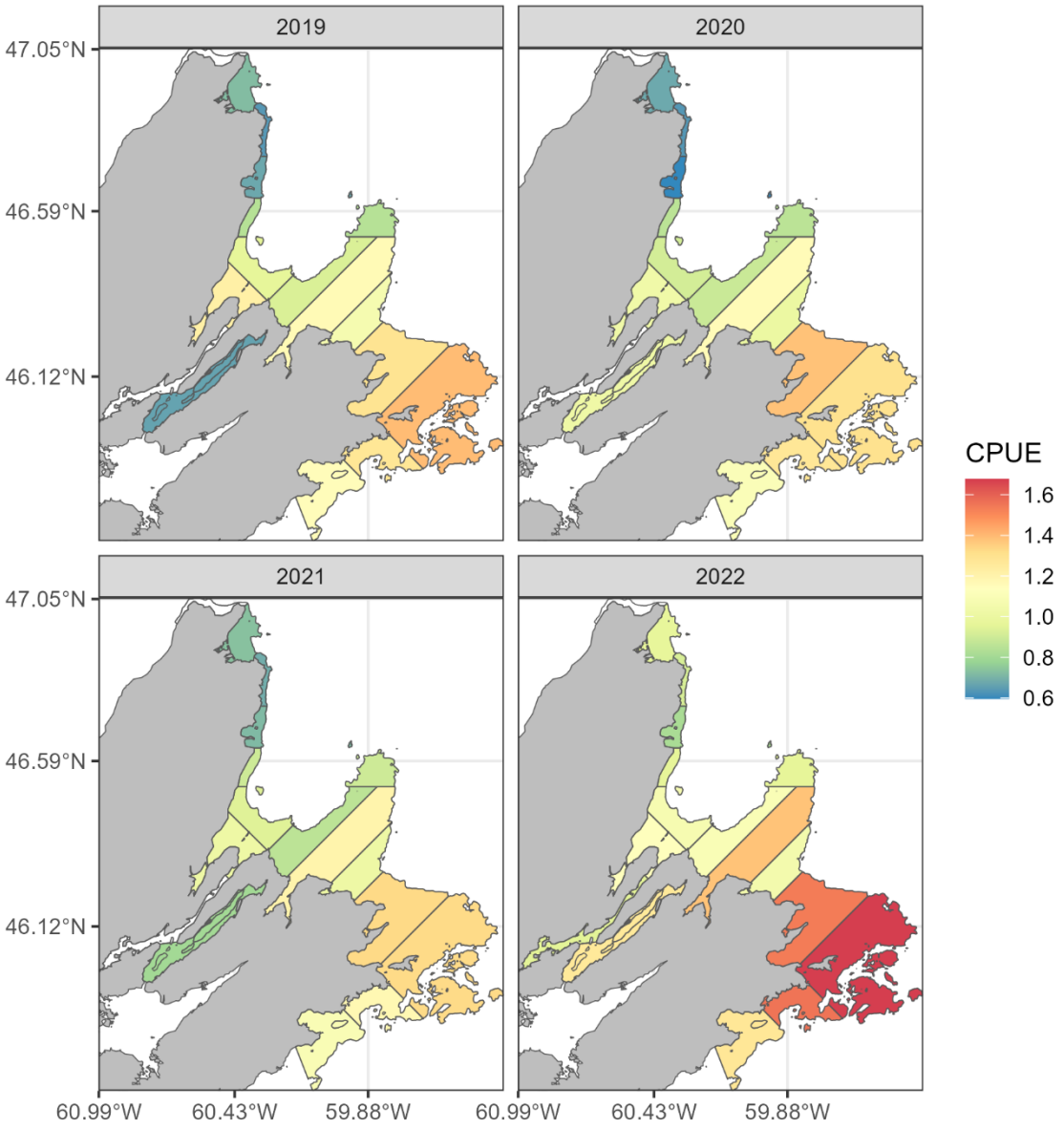

Figure 4: LFA27- Logbook reported catch (kg) per unit effort (trap haul) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

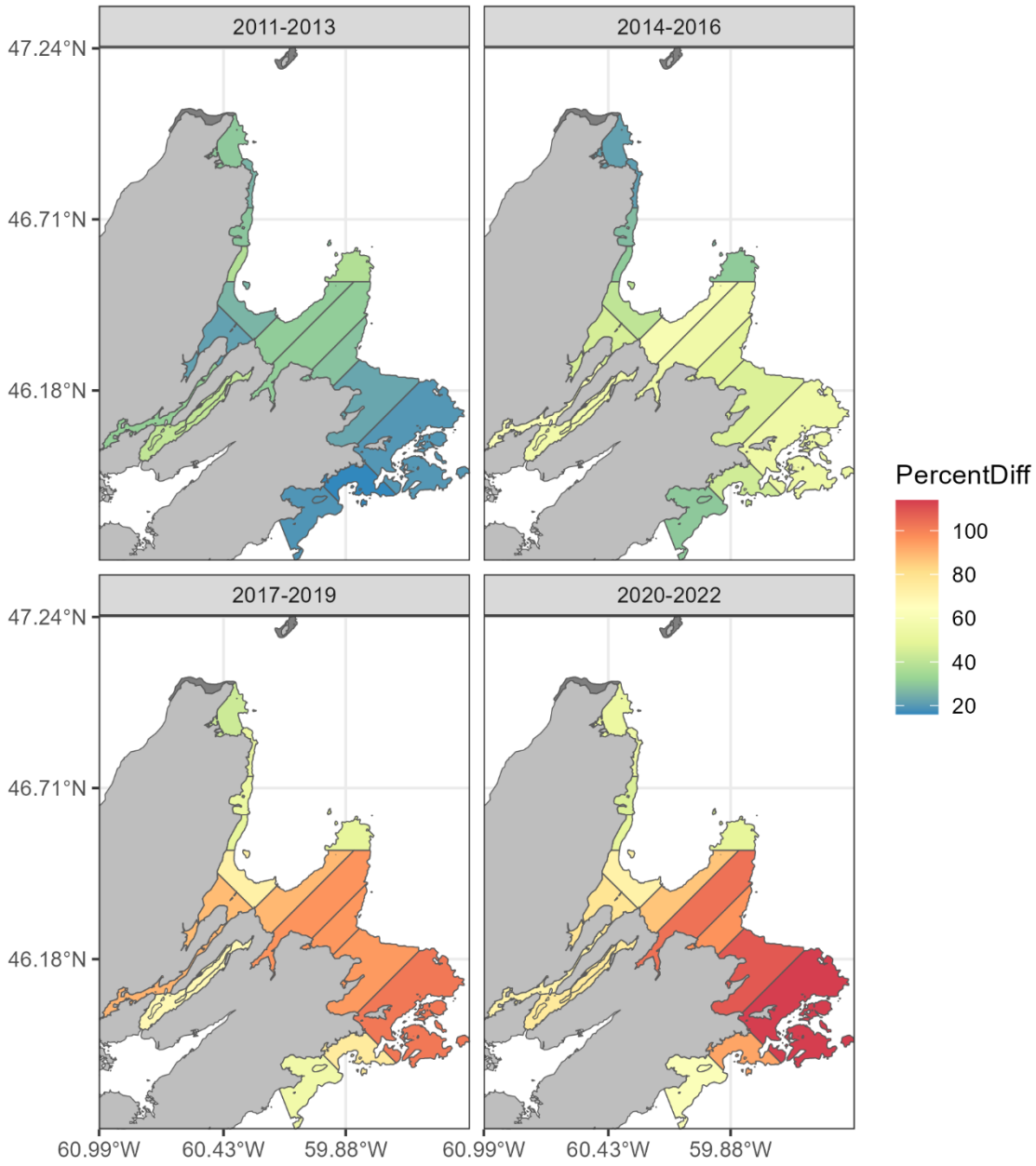

Figure 5: LFA27- Logbook reported grid estimates of percent difference in catch per unit effort (CPUE) relative to mean CPUE between 2006 and 2010. Grey grids indicate where a percent difference could not be estimated.

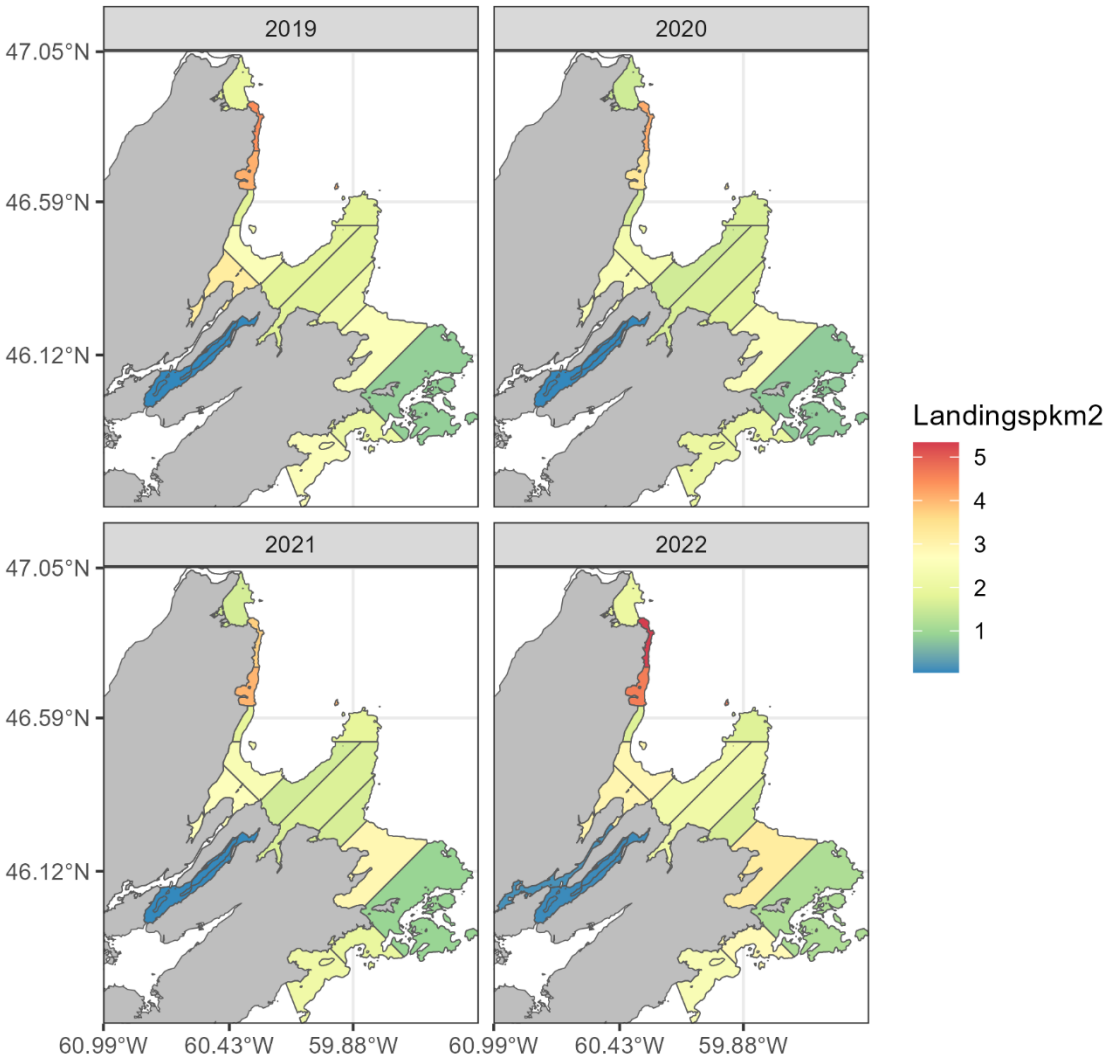

Figure 6: LFA27- Logbook reported Landings (t) by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

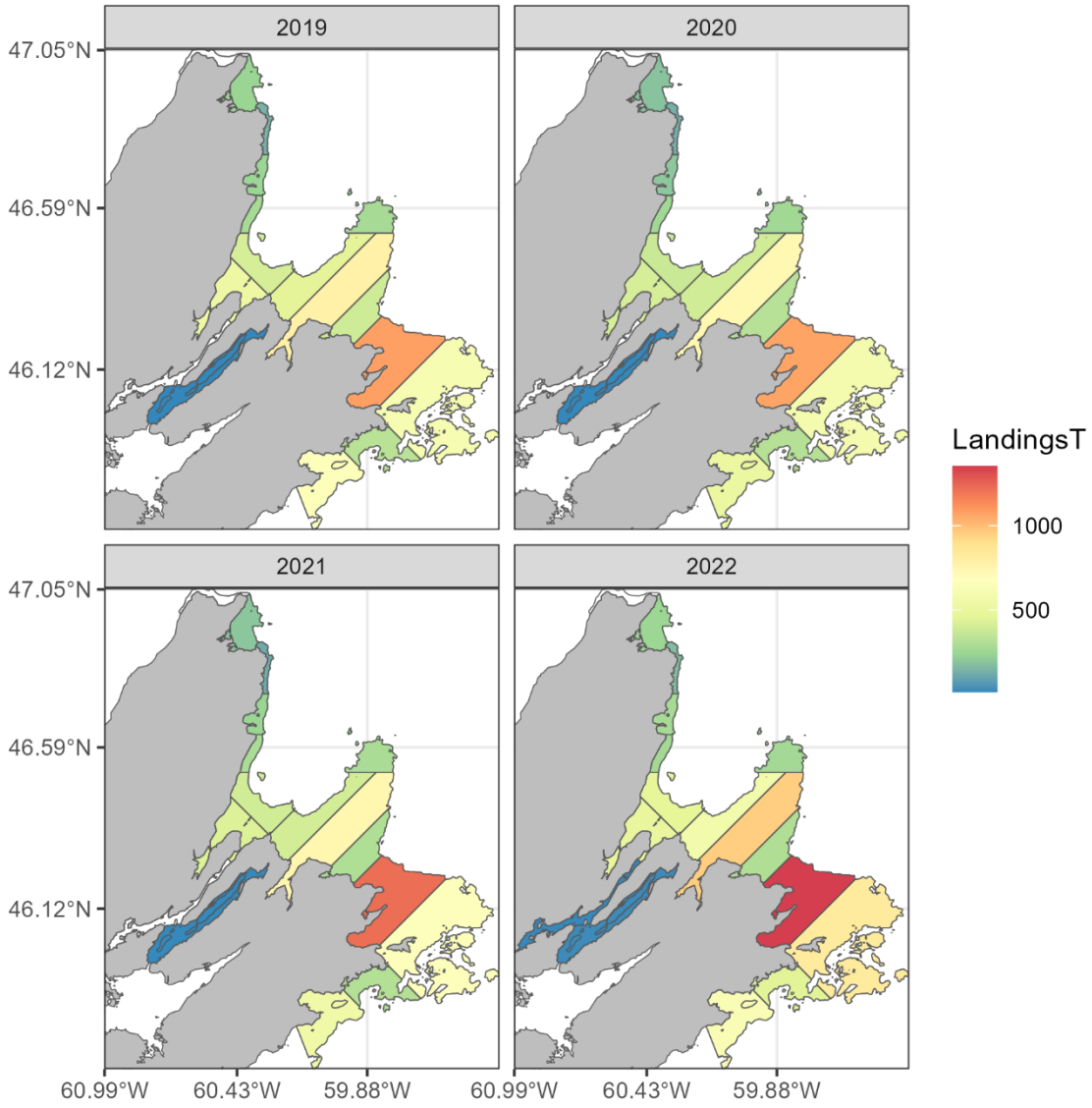

Figure 7: LFA27- Logbook reported Landings (t) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

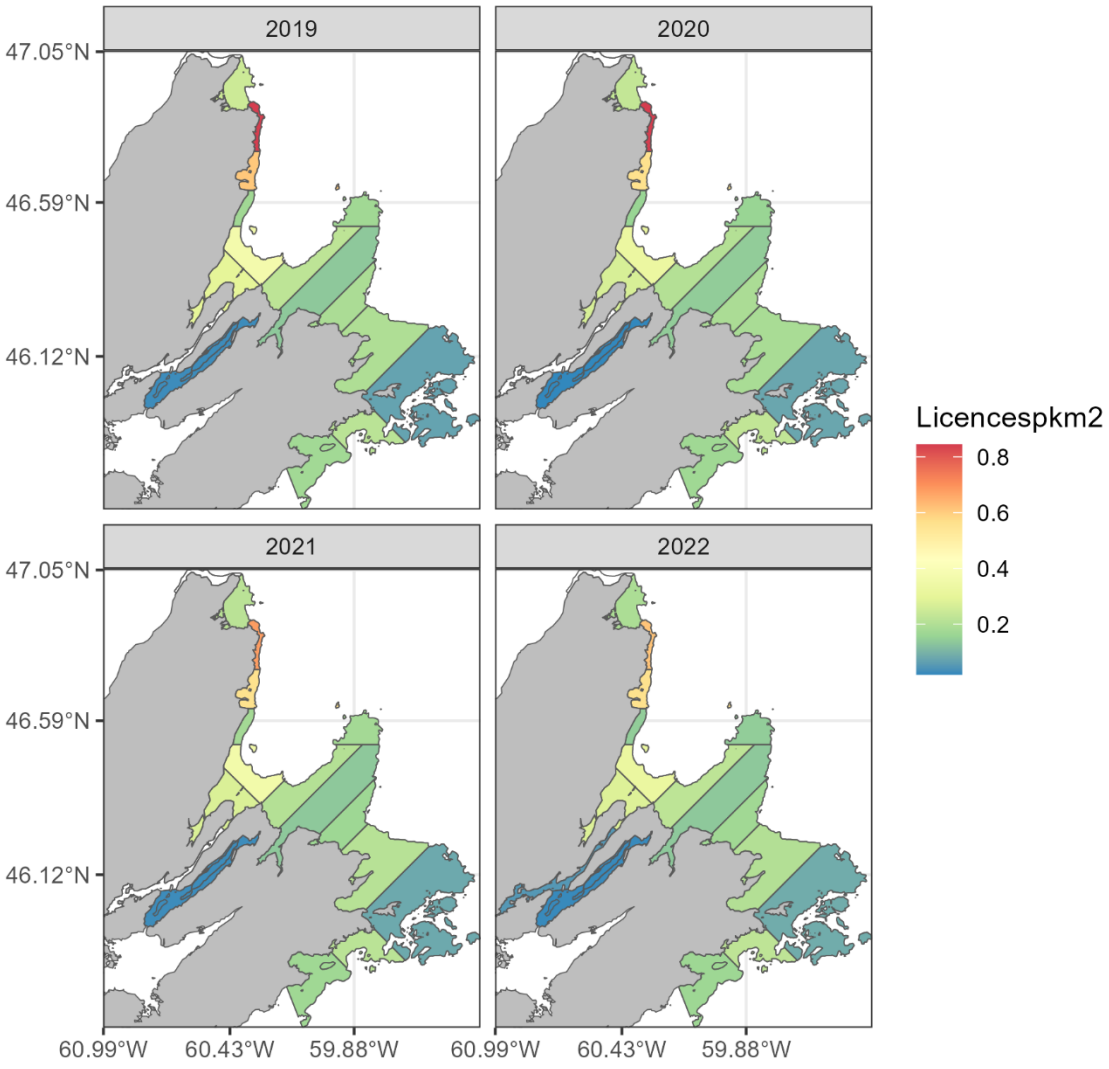

Figure 8: LFA27- Logbook reported number of licences fishing by grid corrected by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

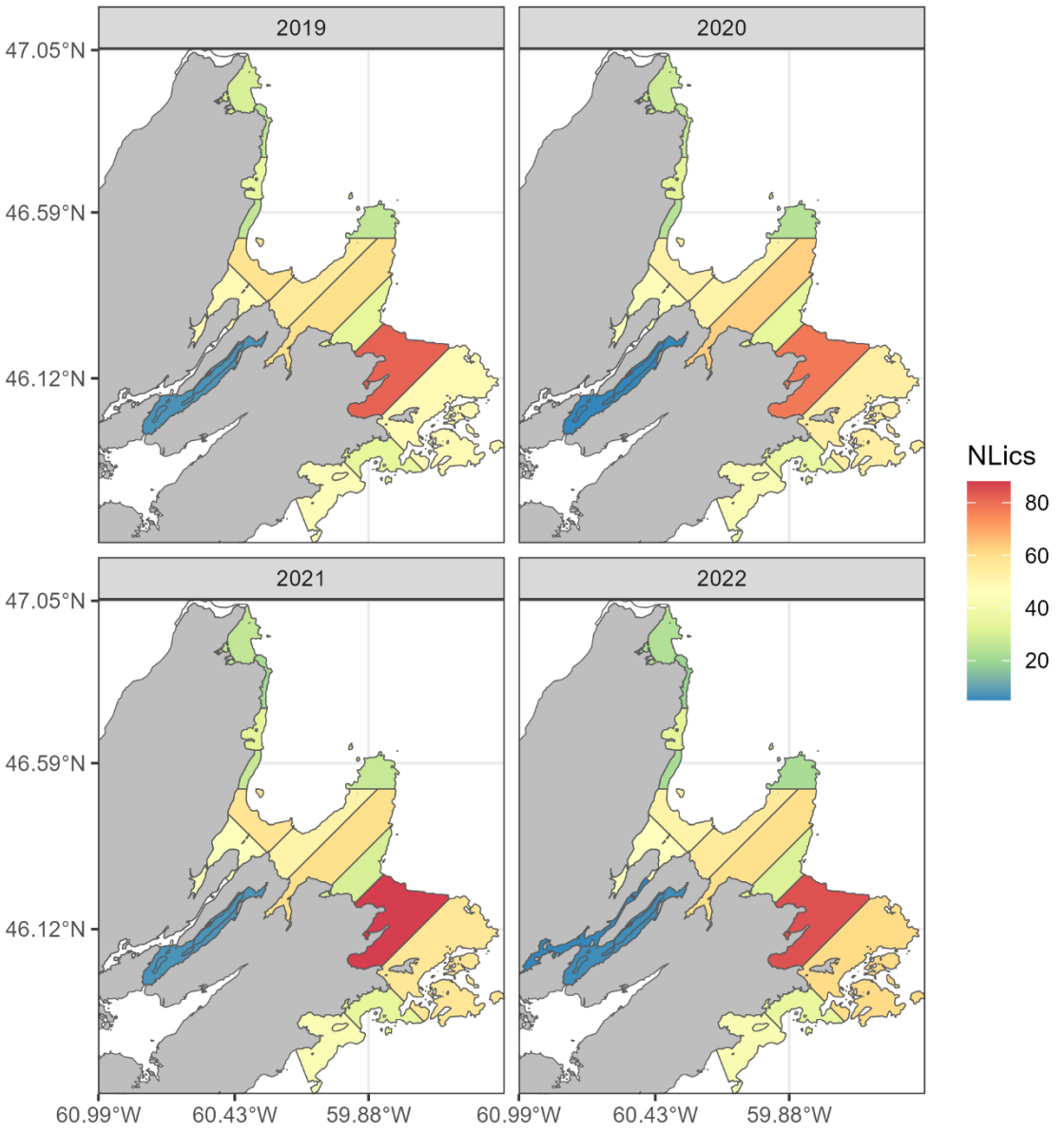

Figure 9: LFA27- Logbook reported number of licences fishing by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

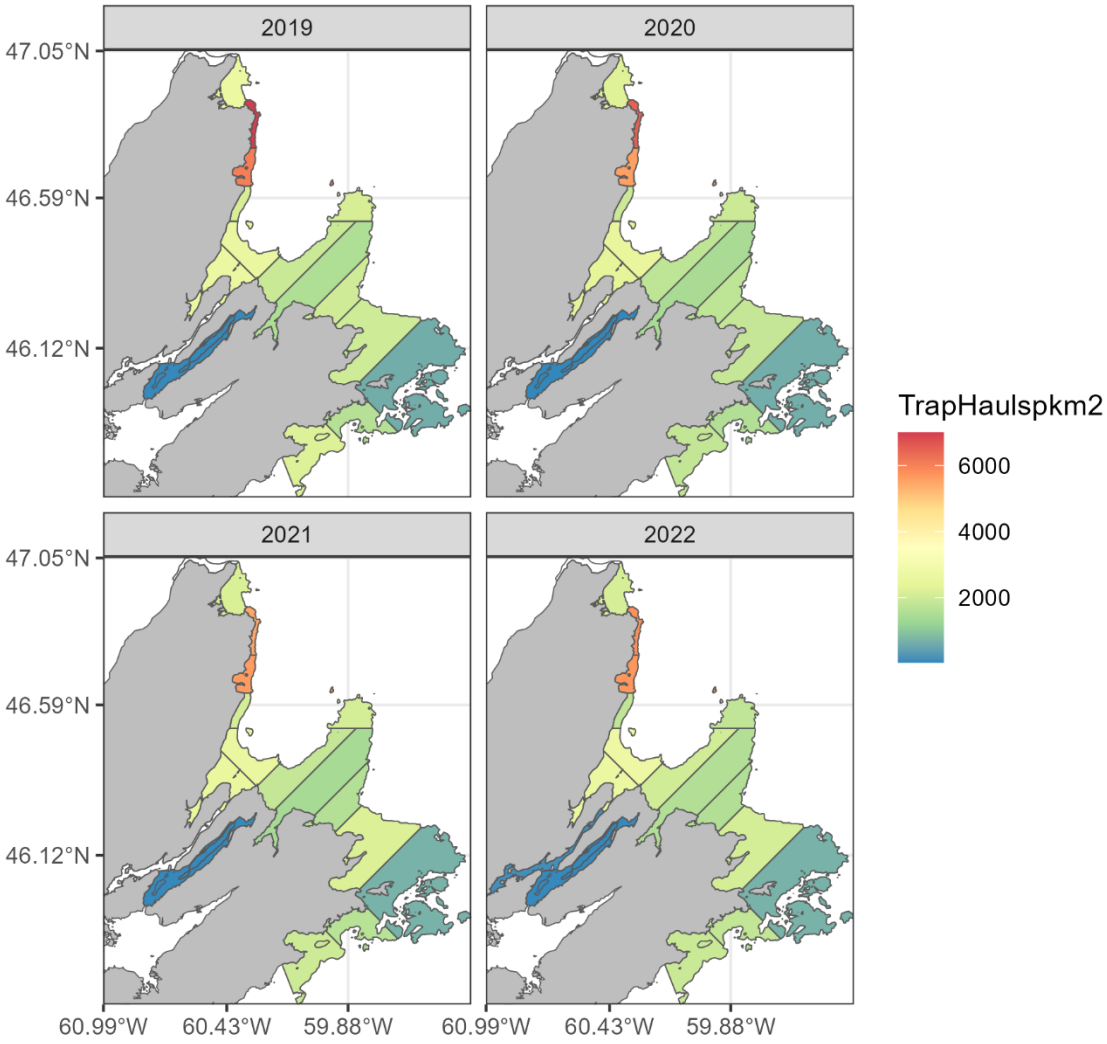

Figure 10: LFA27- Logbook reported number of trap hauls (TH) by grid corrected by the area of the grid (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

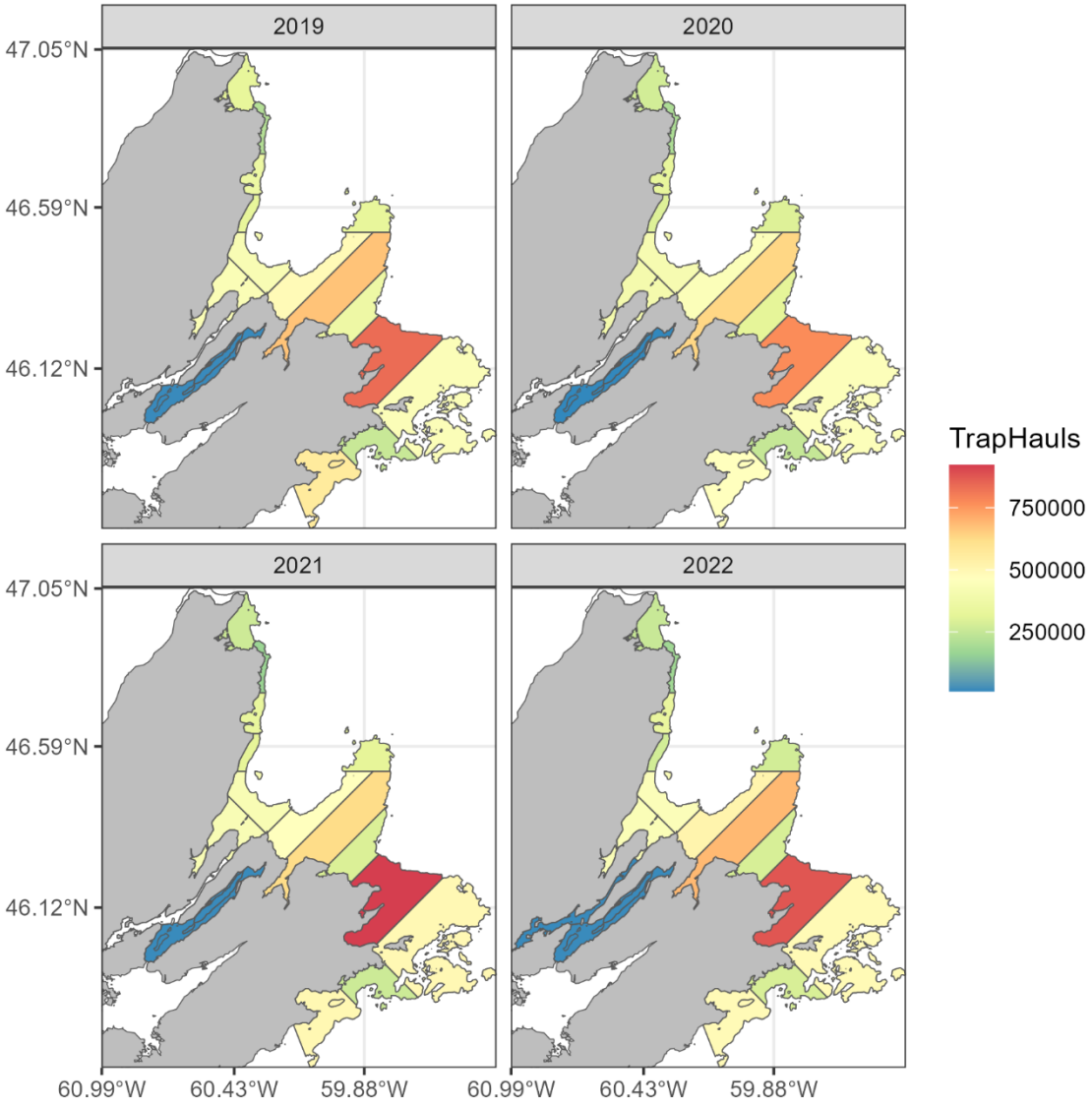

Figure 11: LFA27- Logbook reported number of trap hauls by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

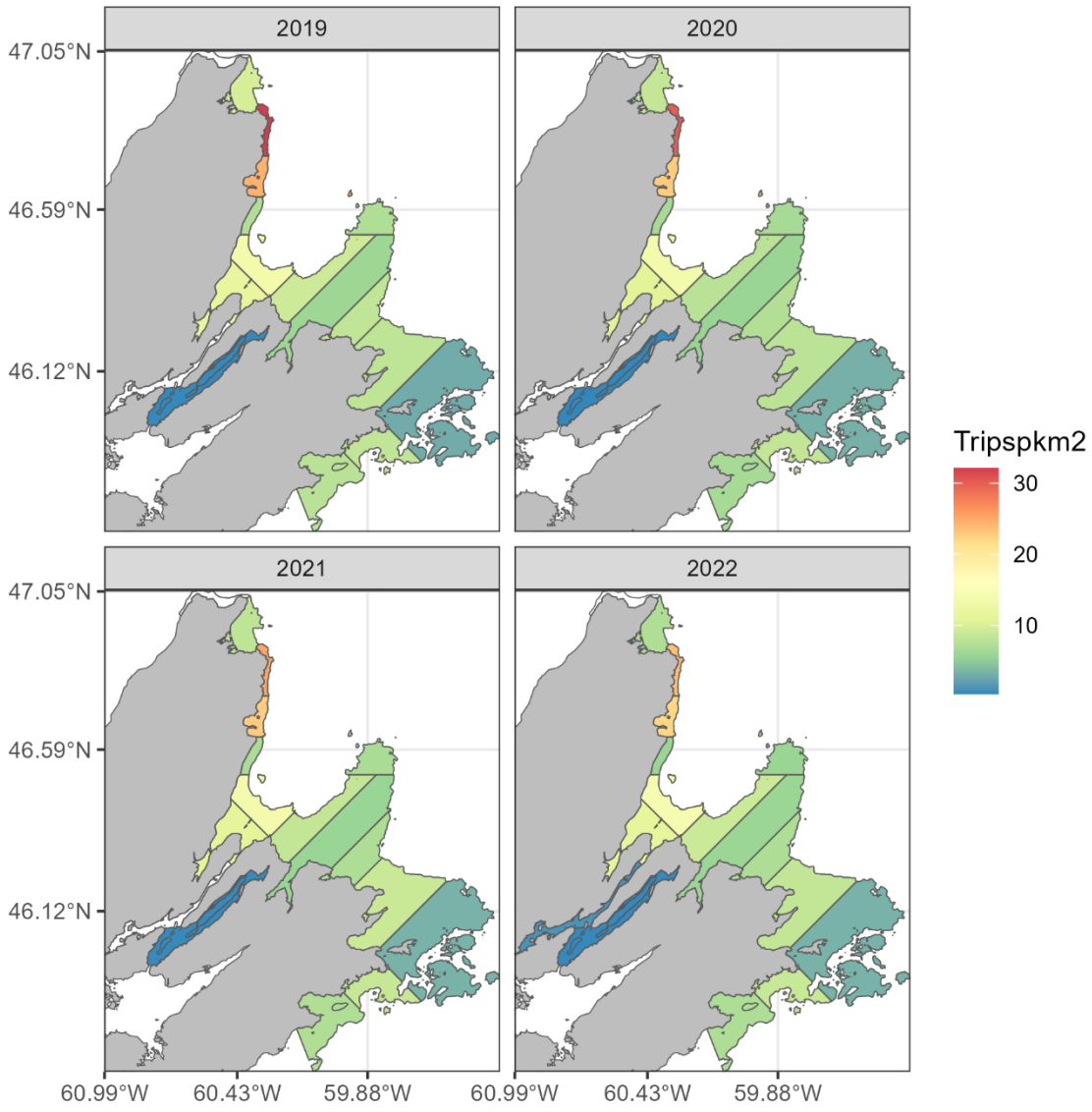

Figure 12: LFA27- Logbook reported number of trips by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

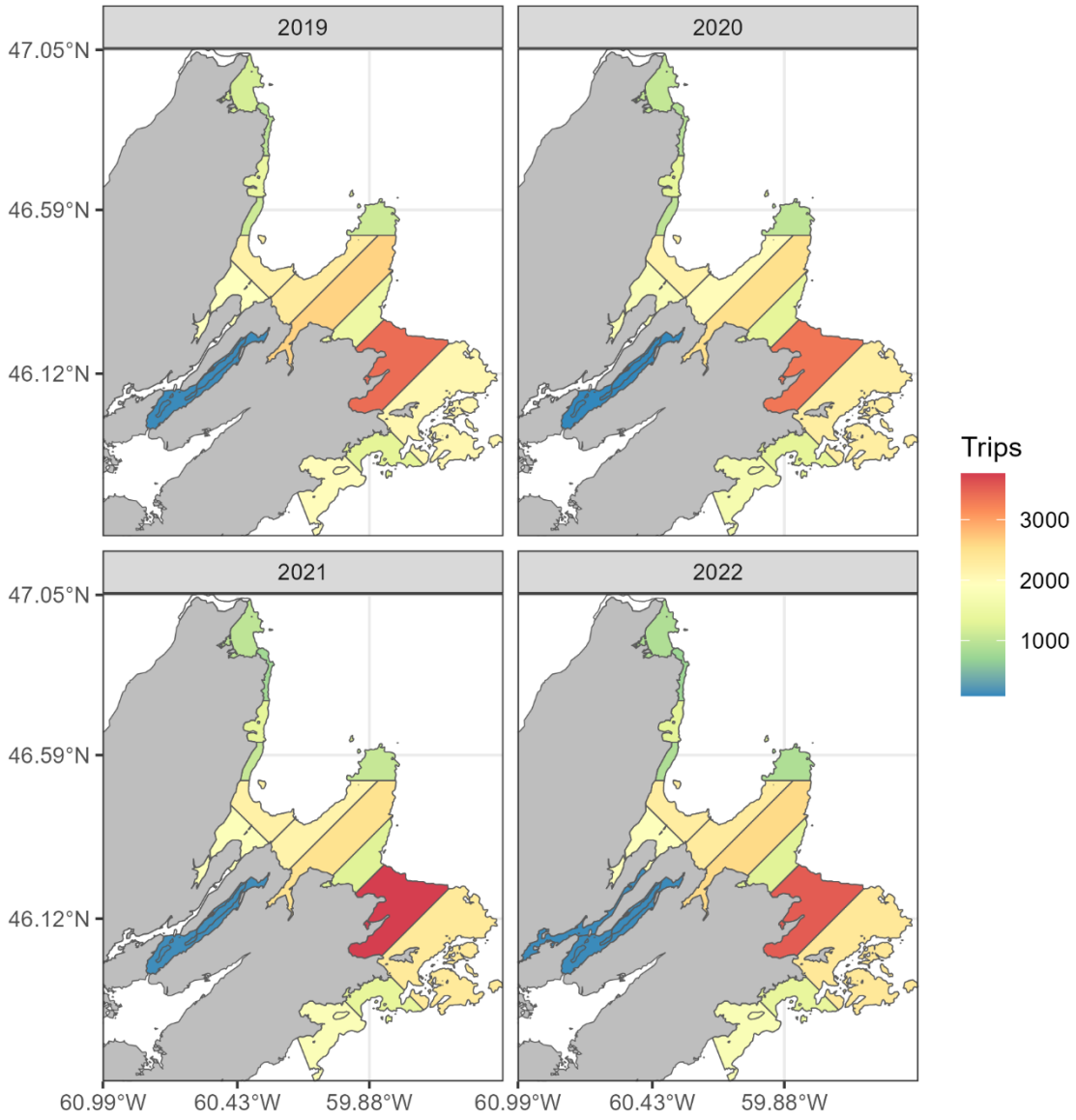

Figure 13: LFA27- Logbook reported number of trips by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

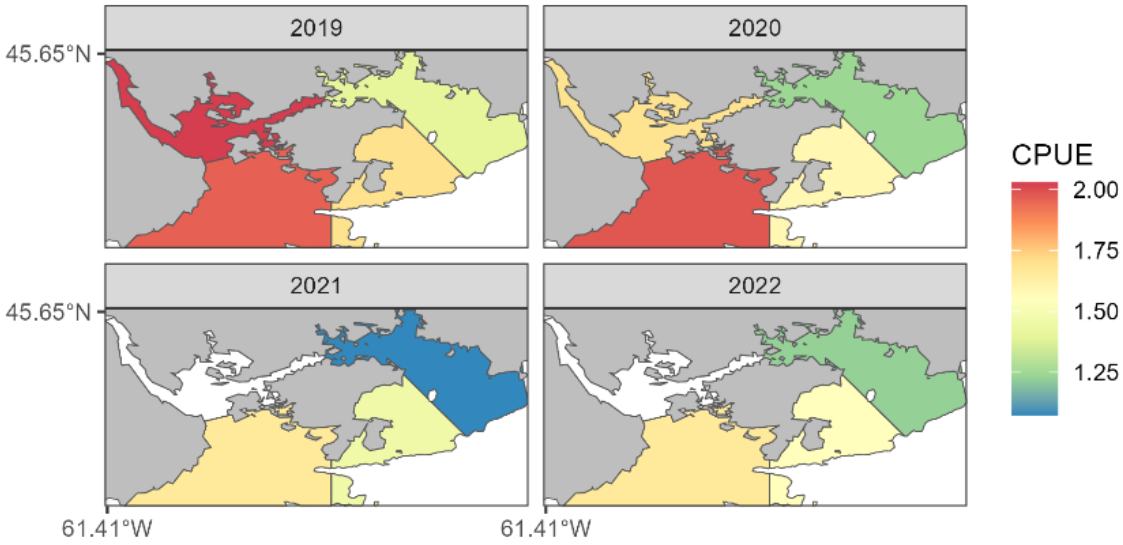

Figure 14: LFA29- Logbook reported catch (kg) per unit effort (trap haul) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

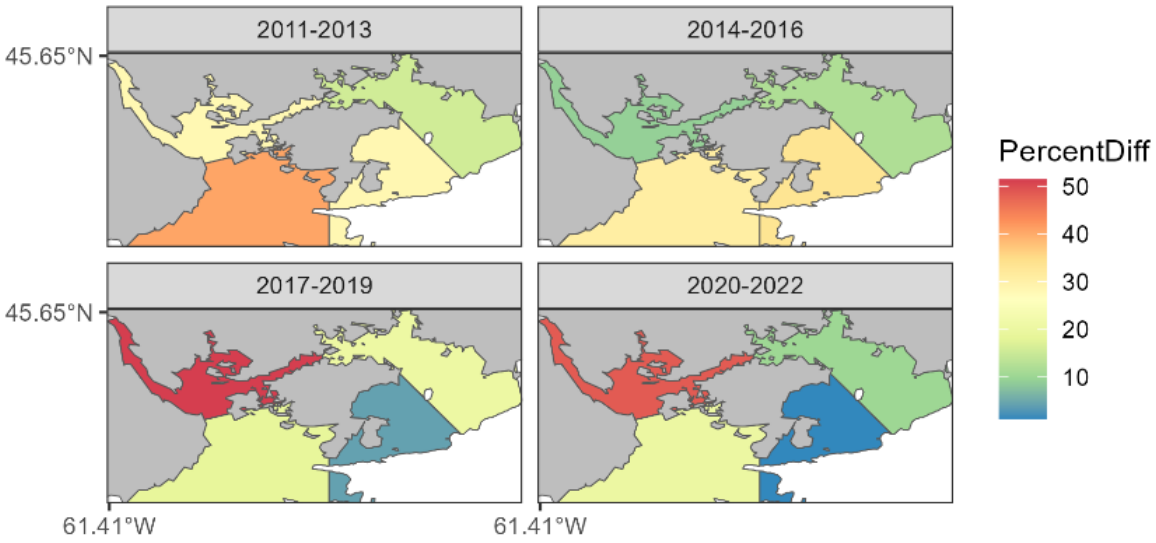

Figure 15: LFA29- Logbook reported grid estimates of percent difference in catch per unit effort (CPUE) relative to mean CPUE between 2006 and 2010. Grey grids indicate where a percent difference could not be estimated.

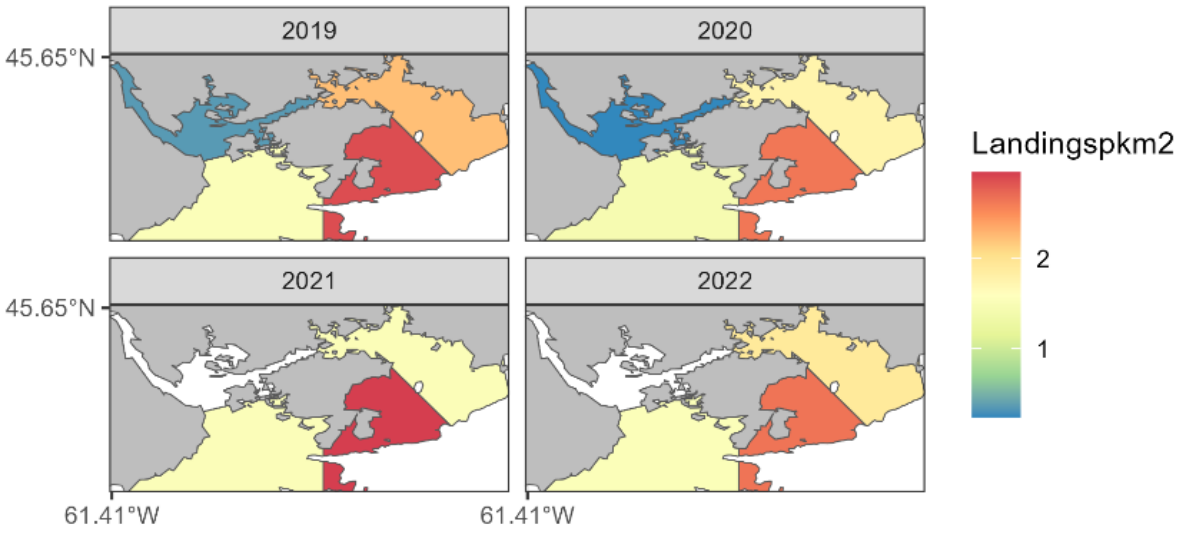

Figure 16: LFA29- Logbook reported Landings (t) by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

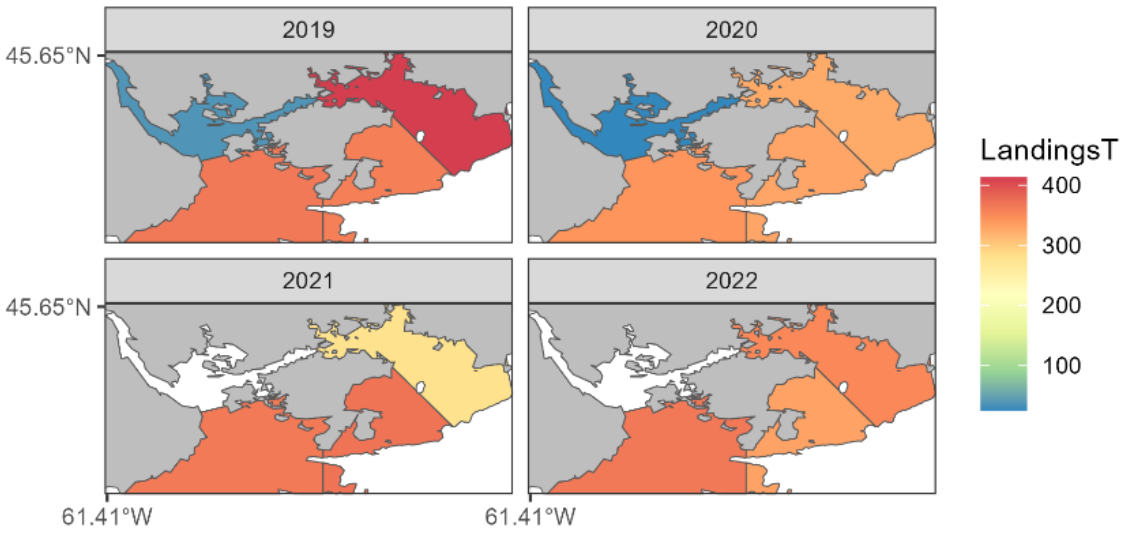

Figure 17: LFA29- Logbook reported Landings (t) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

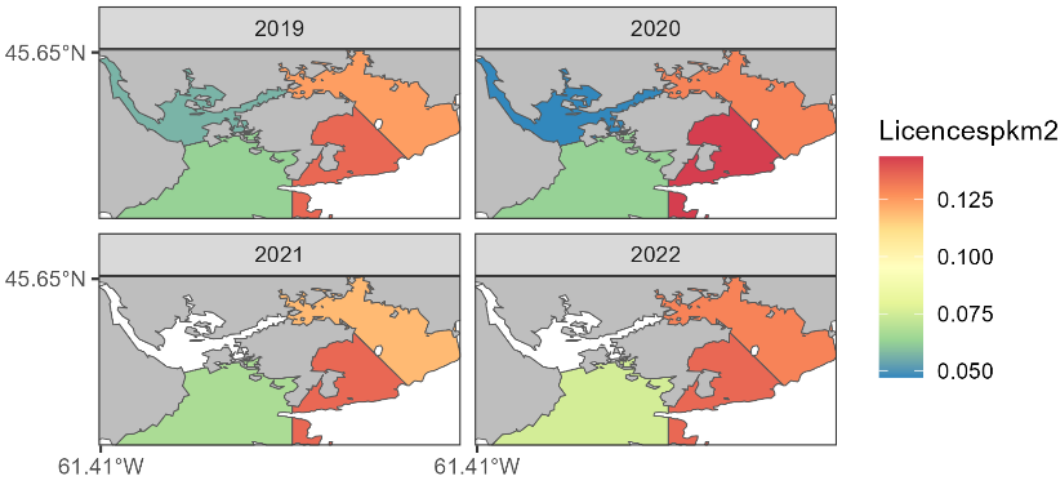

Figure 18: LFA29- Logbook reported number of licences fishing by grid corrected by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

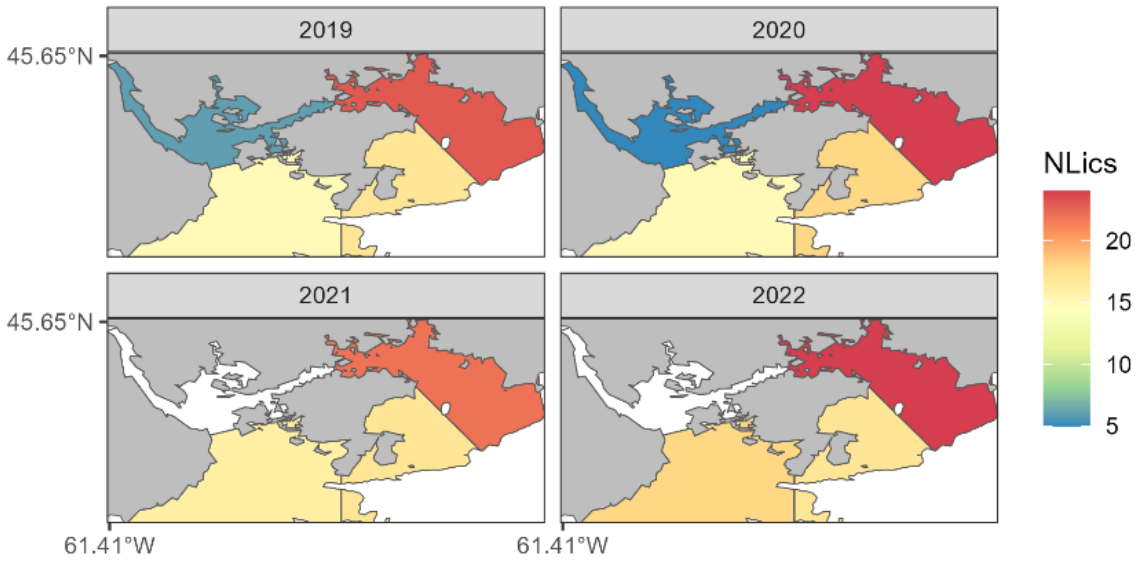

Figure 19: LFA29- Logbook reported number of licences fishing by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

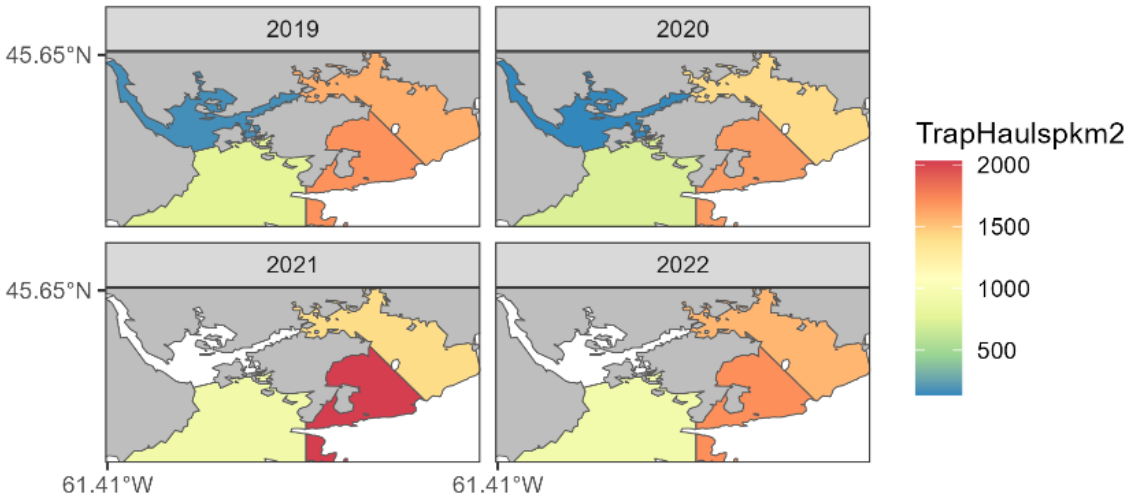

Figure 20: LFA29- Logbook reported number of trap hauls (TH) by grid corrected by the area of the grid (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

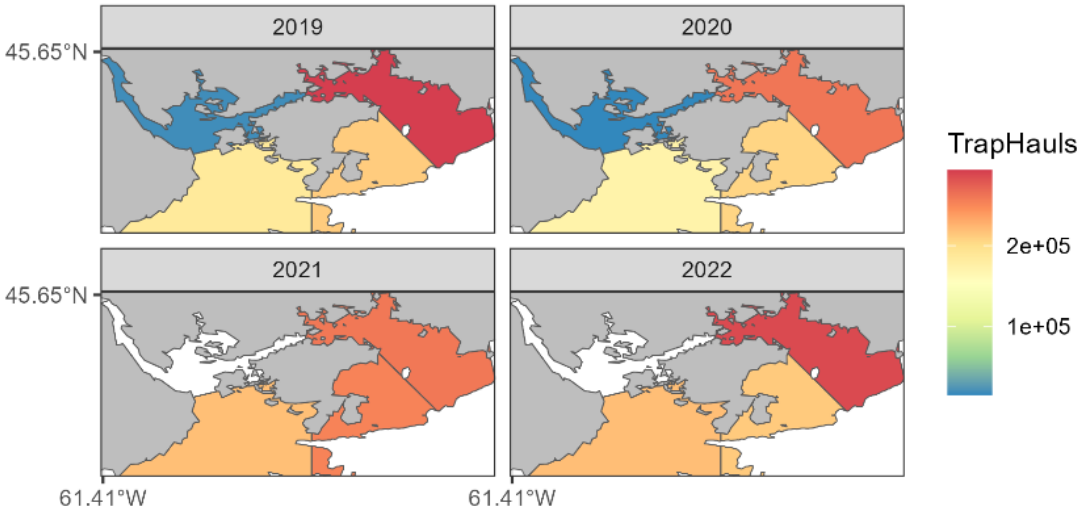

Figure 21: LFA29- Logbook reported number of trap hauls by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

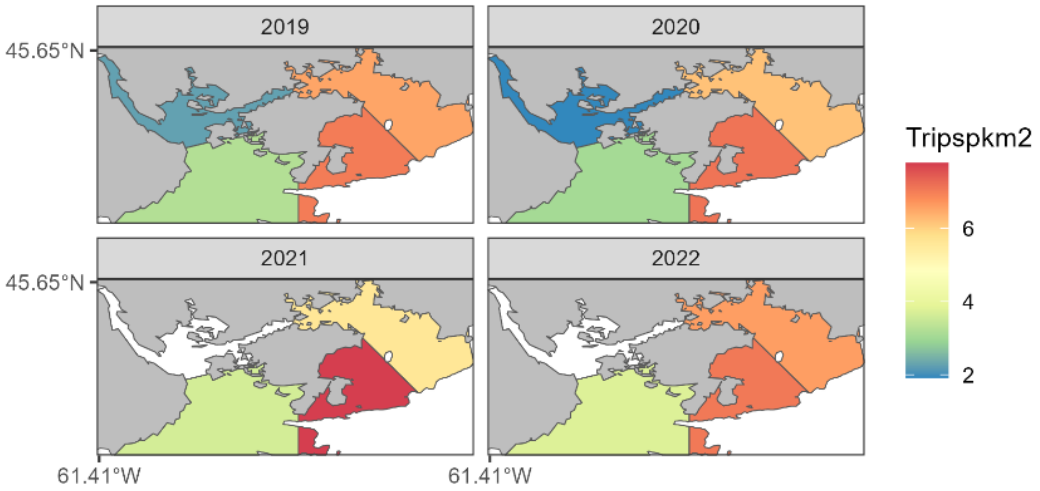

Figure 22: LFA29- Logbook reported number of trips by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

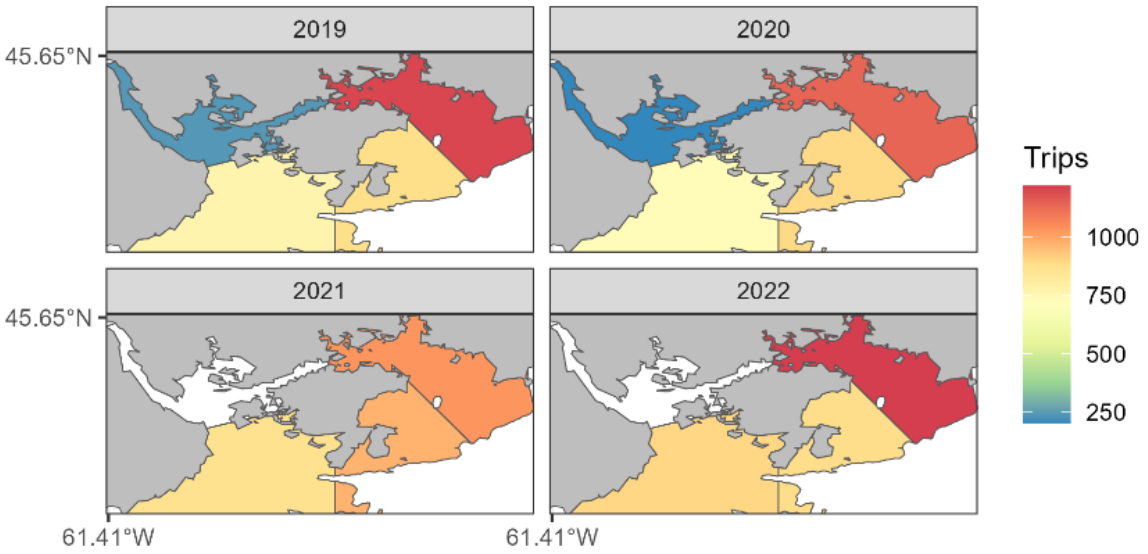

Figure 23: LFA29- Logbook reported number of trips by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

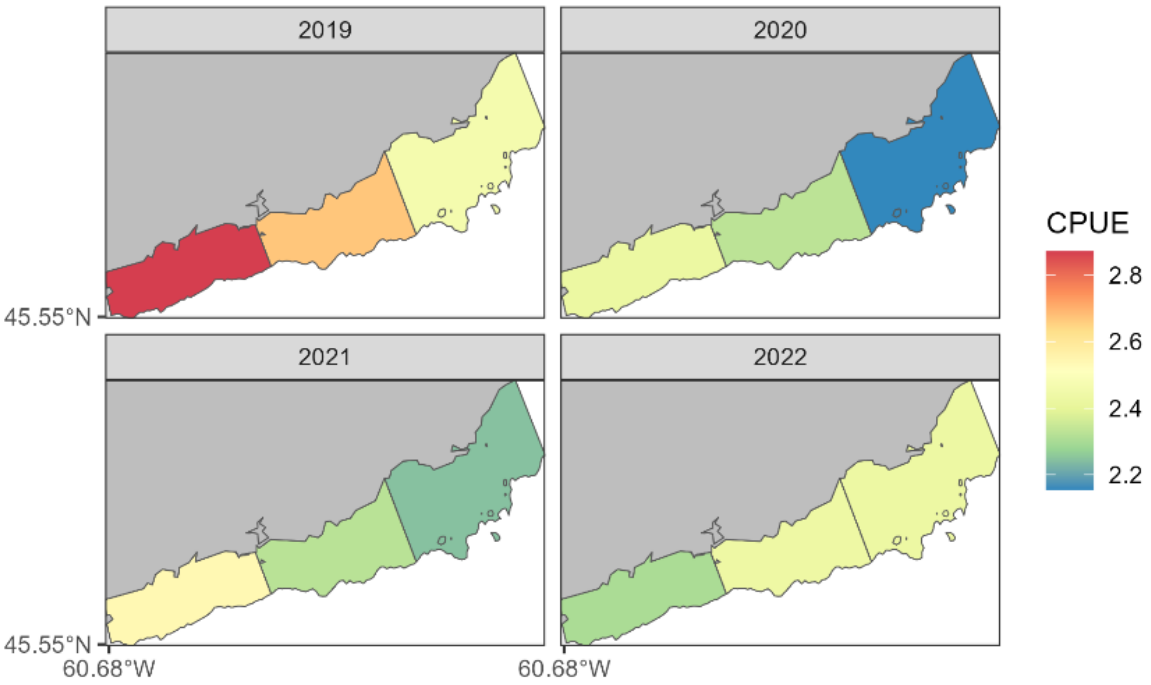

Figure 24: LFA30- Logbook reported catch (kg) per unit effort (trap haul) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

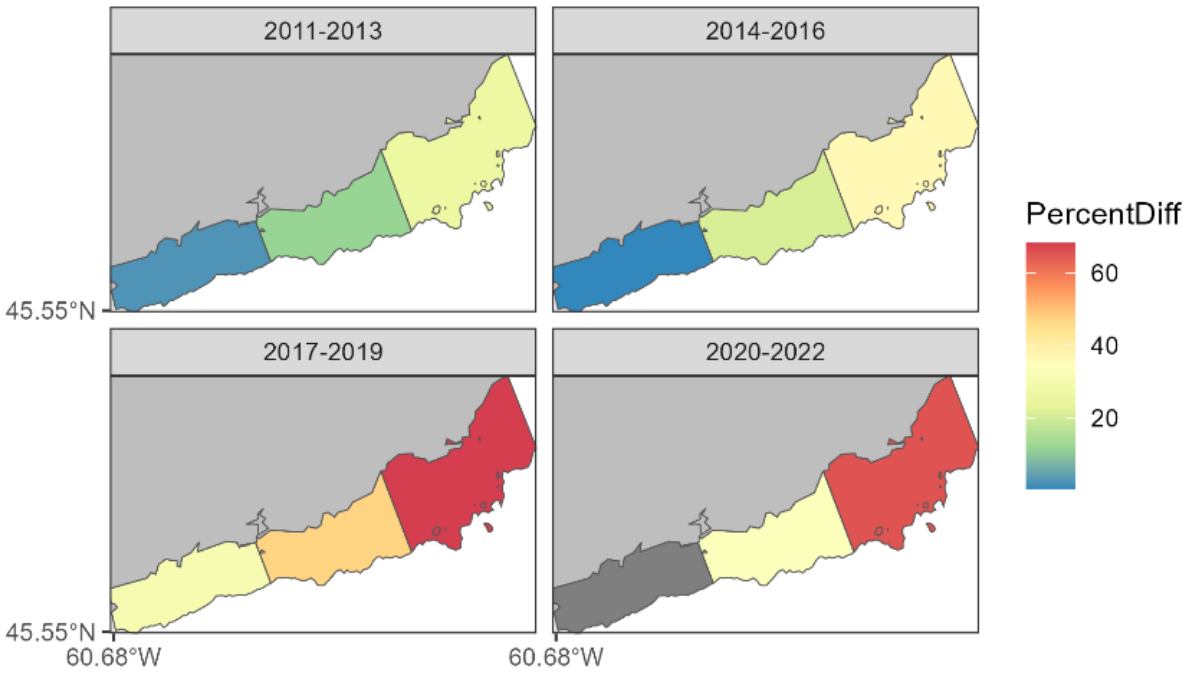

Figure 25: LFA30- Logbook reported grid estimates of percent difference in catch per unit effort (CPUE) relative to mean CPUE between 2006 and 2010. Grey grids indicate where a percent difference could not be estimated.

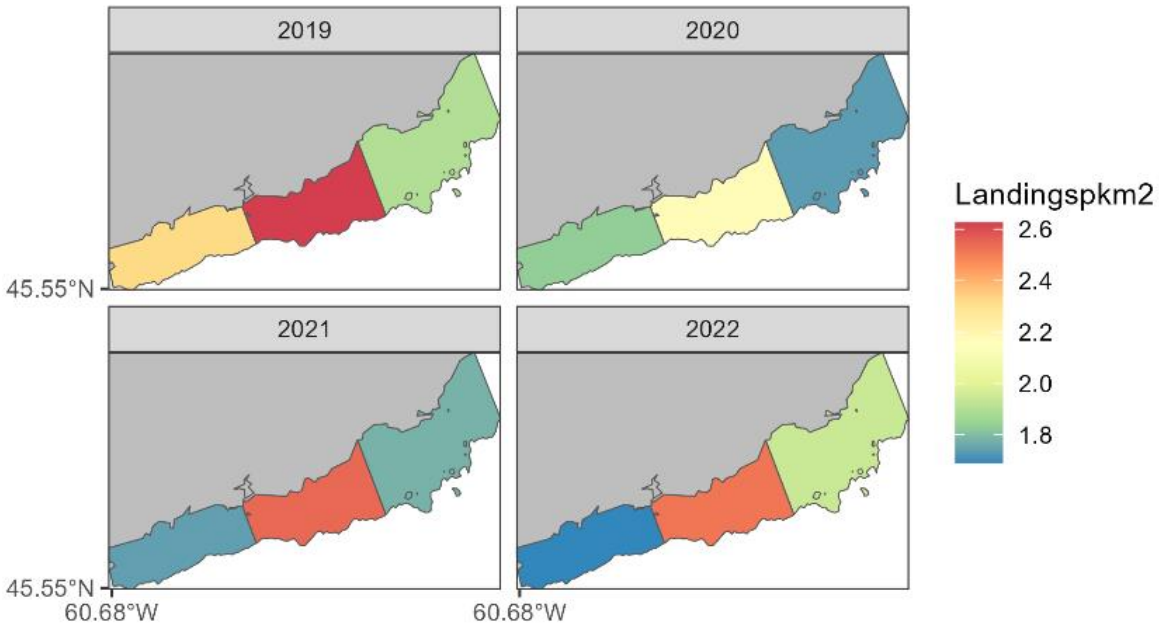

Figure 26: LFA30- Logbook reported Landings (t) by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

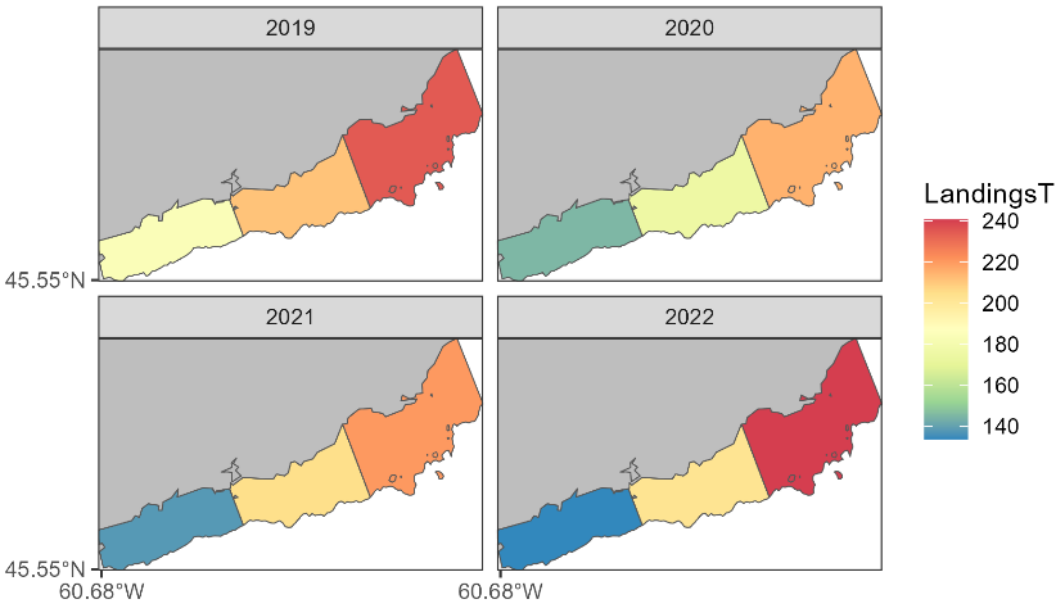

Figure 27: LFA30- Logbook reported Landings (t) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

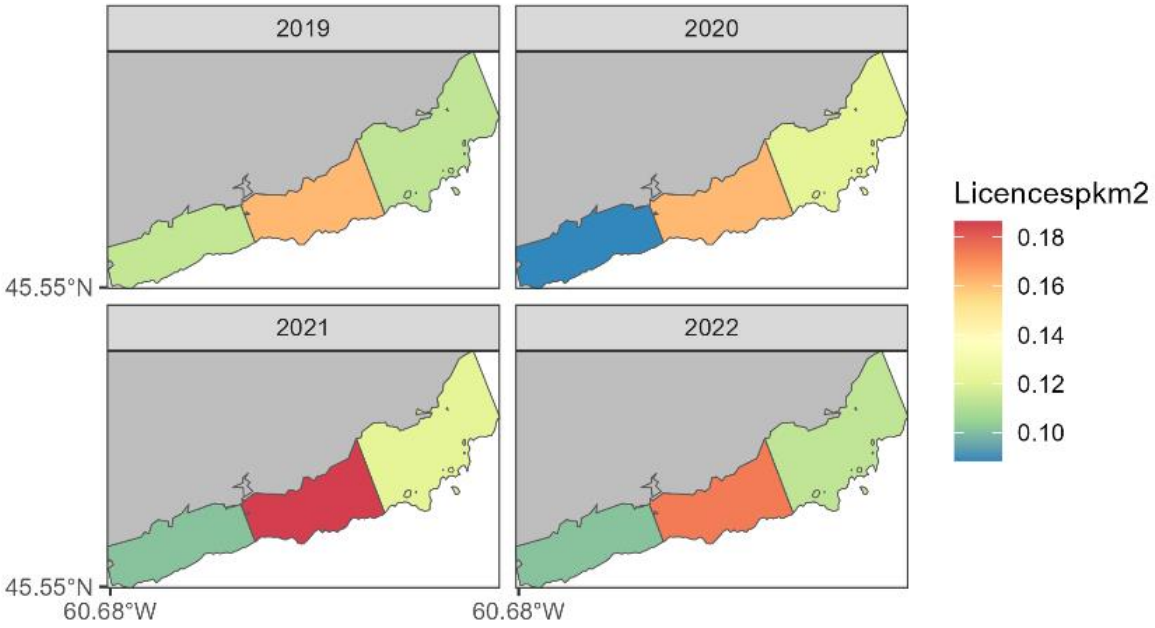

Figure 28: LFA30- Logbook reported number of licences fishing by grid corrected by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

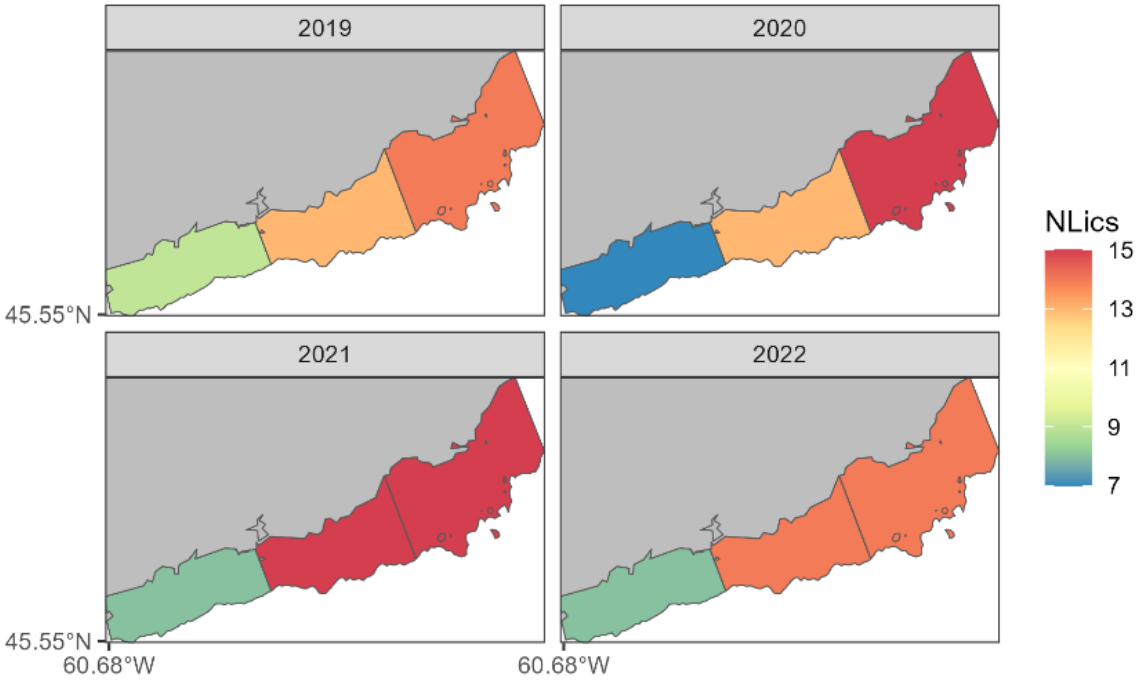

Figure 29: LFA30- Logbook reported number of licences fishing by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

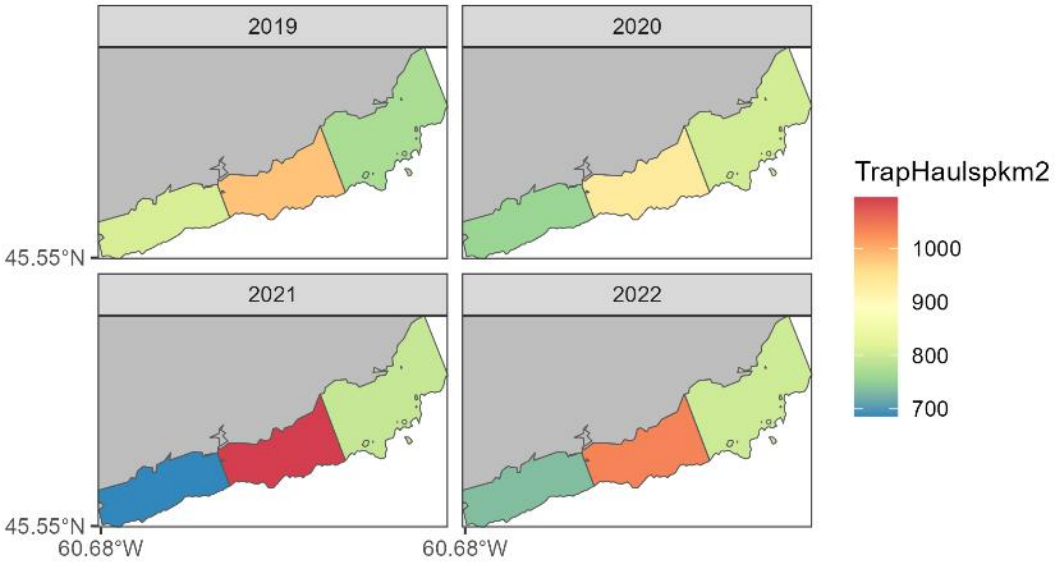

Figure 30: LFA30- Logbook reported number of trap hauls (TH) by grid corrected by the area of the grid (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

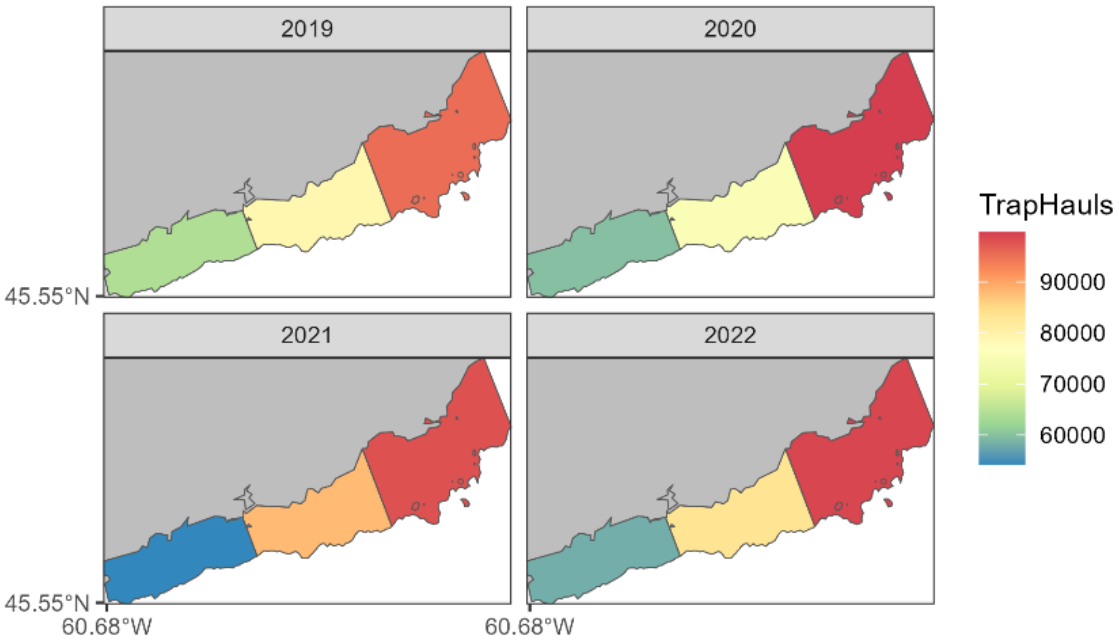

Figure 31: LFA30- Logbook reported number of trap hauls by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

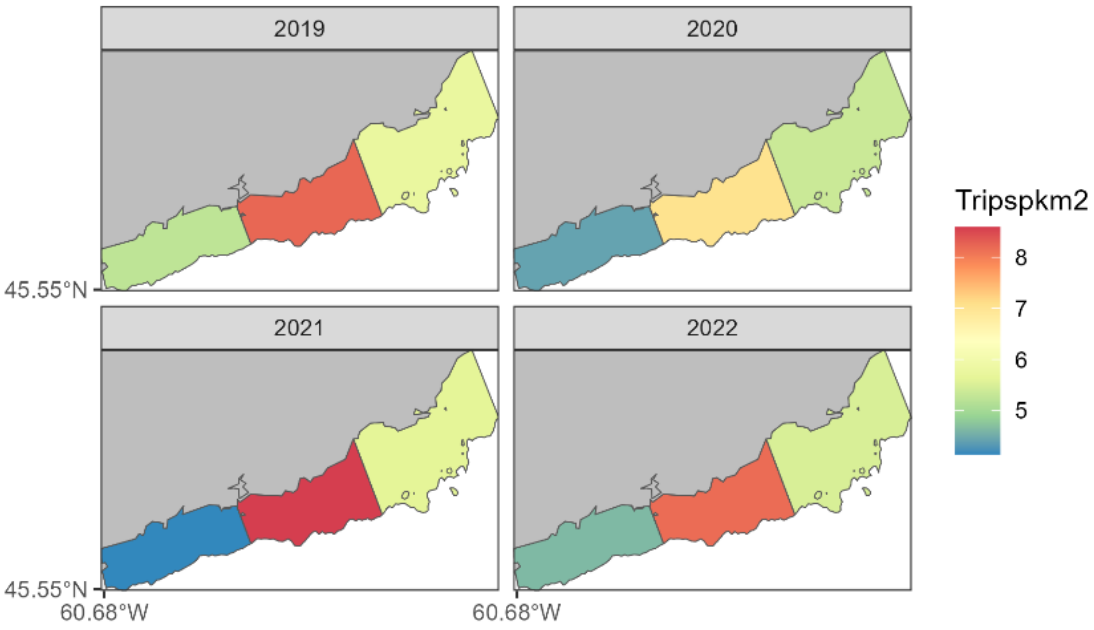

Figure 32: LFA30- Logbook reported number of trips by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

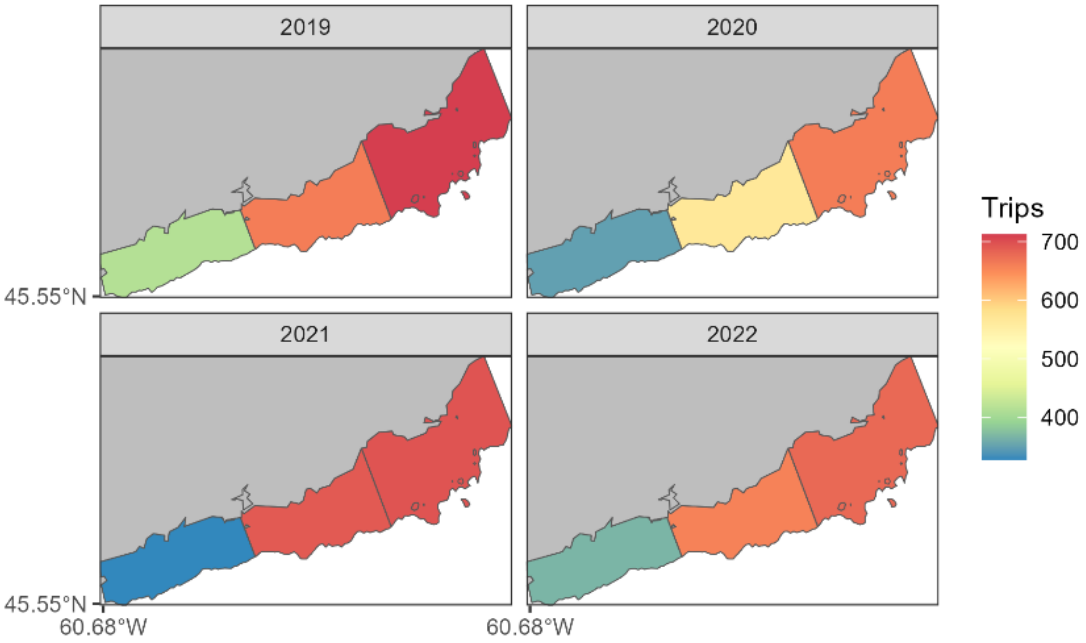

Figure 33: LFA30- Logbook reported number of trips by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

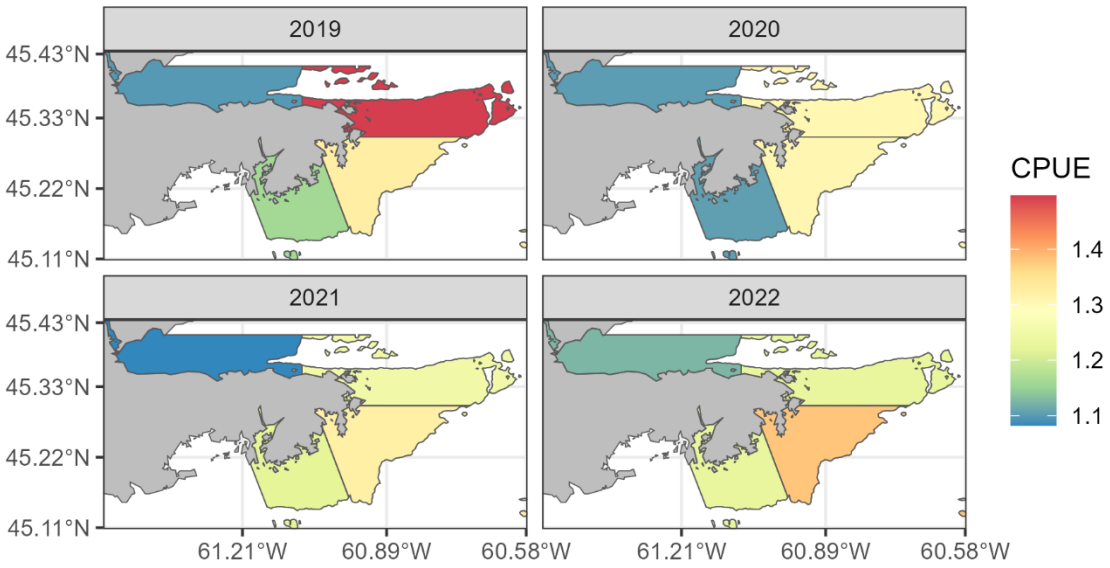

Figure 34: LFA31A- Logbook reported catch (kg) per unit effort (trap haul) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

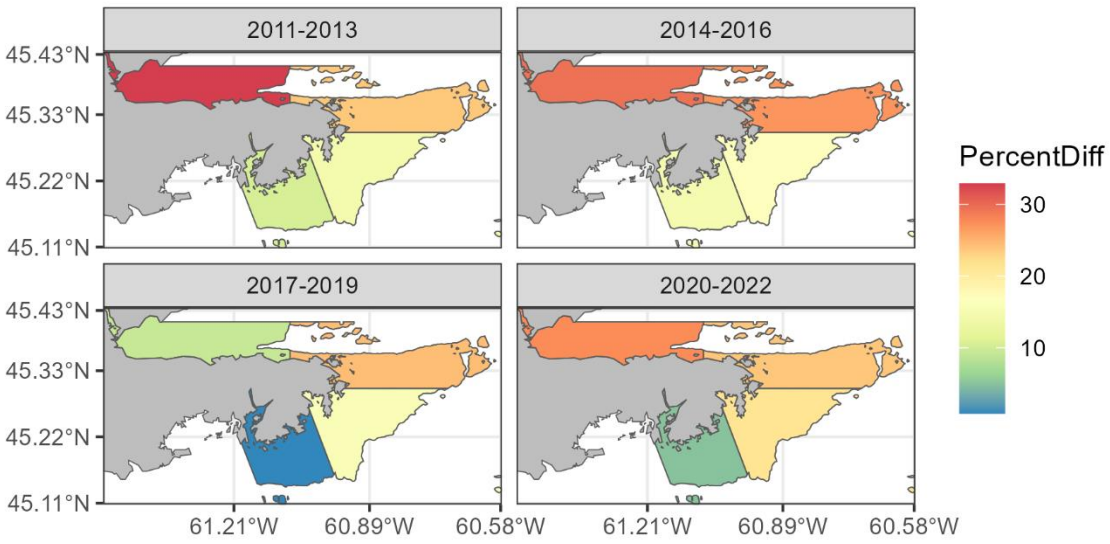

Figure 35: LFA31A- Logbook reported grid estimates of percent difference in catch per unit effort (CPUE) relative to mean CPUE between 2006 and 2010. Grey grids indicate where a percent difference could not be estimated.

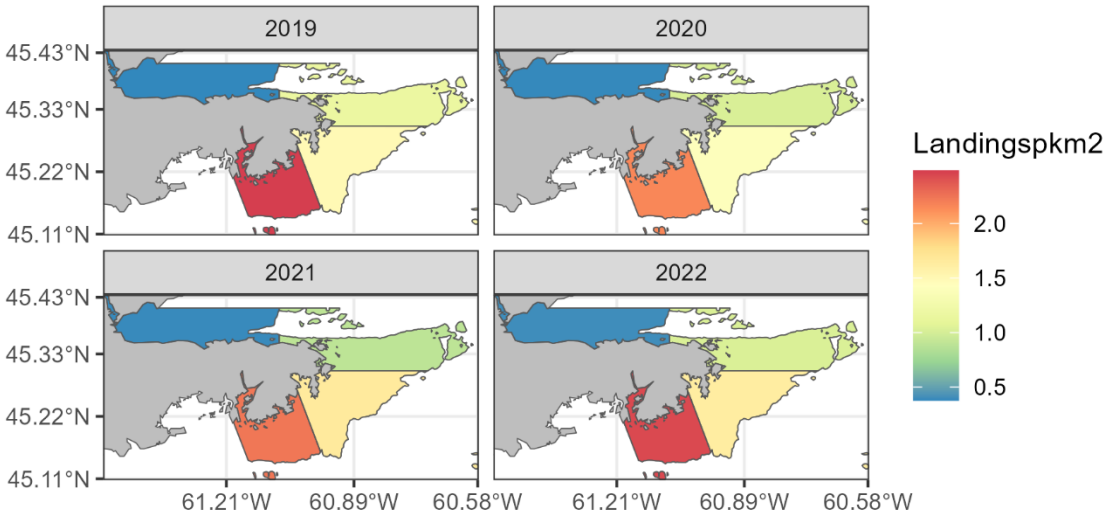

Figure 36: LFA31A- Logbook reported Landings (t) by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

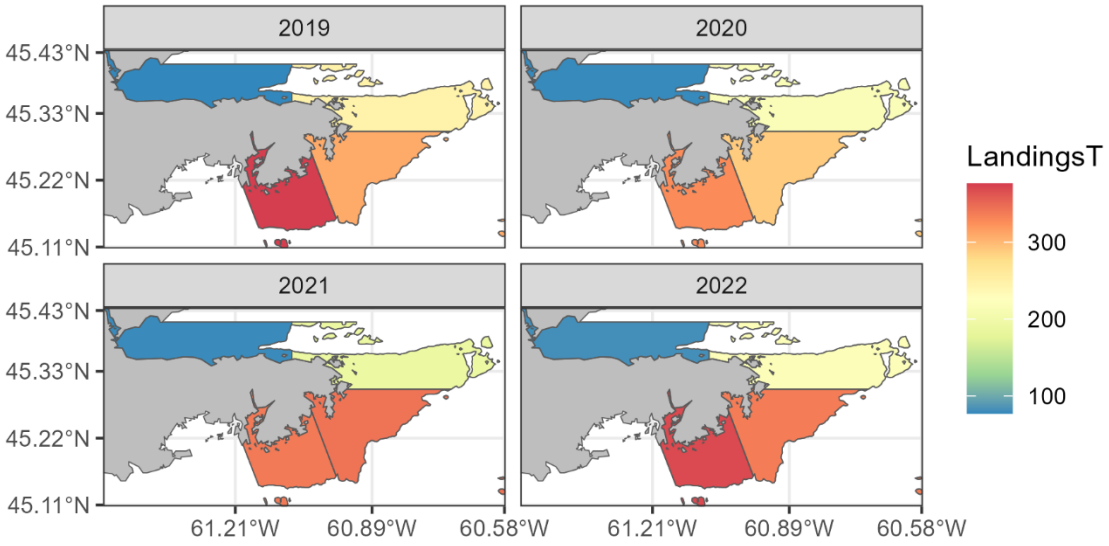

Figure 37: LFA31A- Logbook reported Landings (t) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

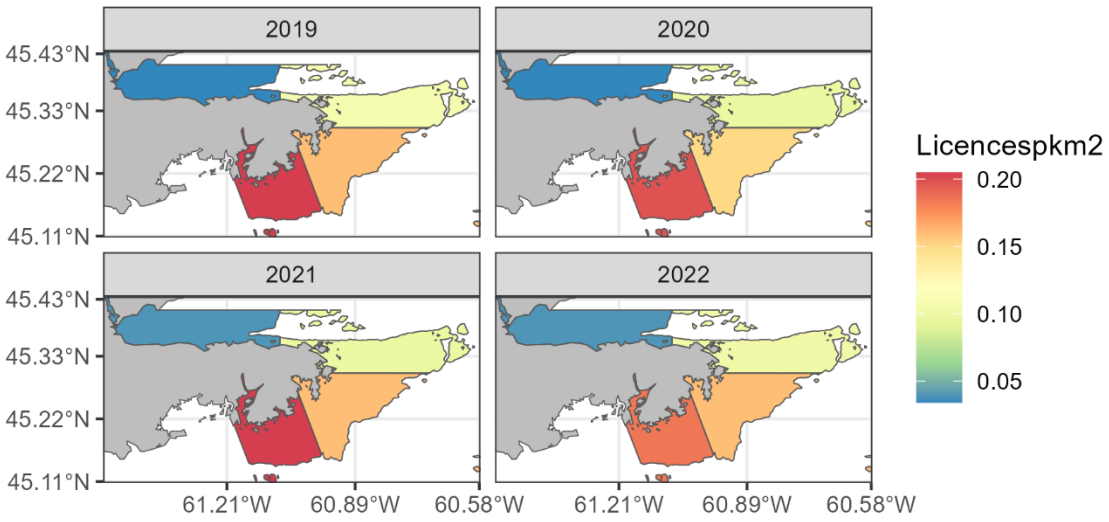

Figure 38: LFA31A- Logbook reported number of licences fishing by grid corrected by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

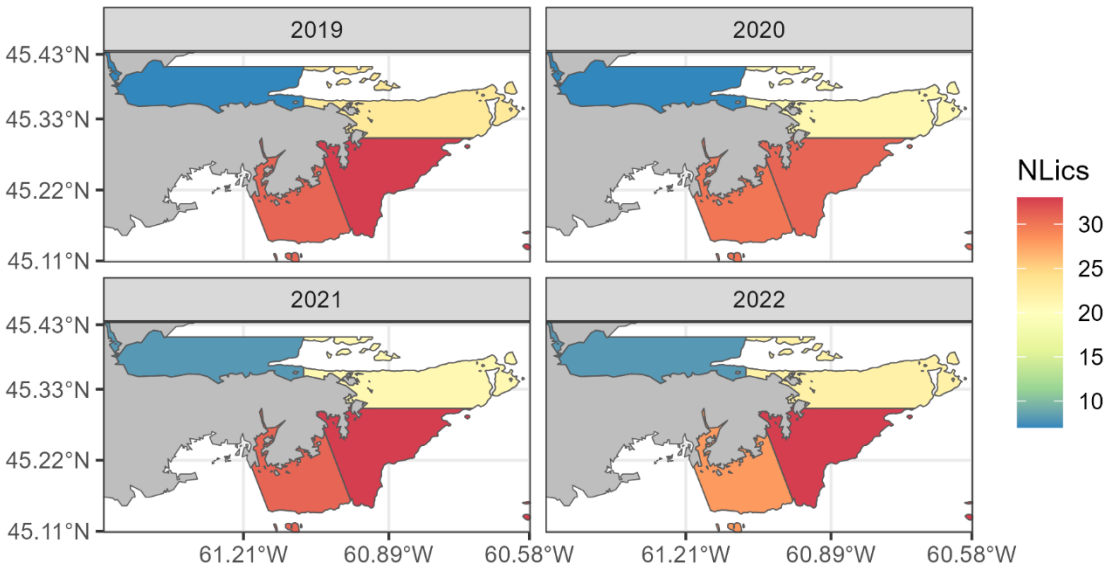

Figure 39: LFA31A- Logbook reported number of licences fishing by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

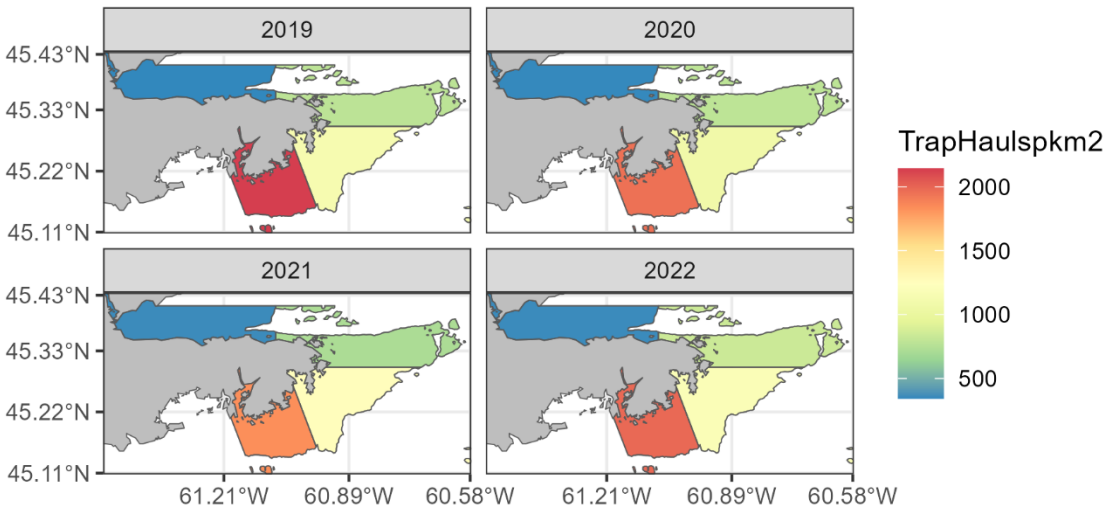

Figure 40: LFA31A- Logbook reported number of trap hauls (TH) by grid corrected by the area of the grid (km2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

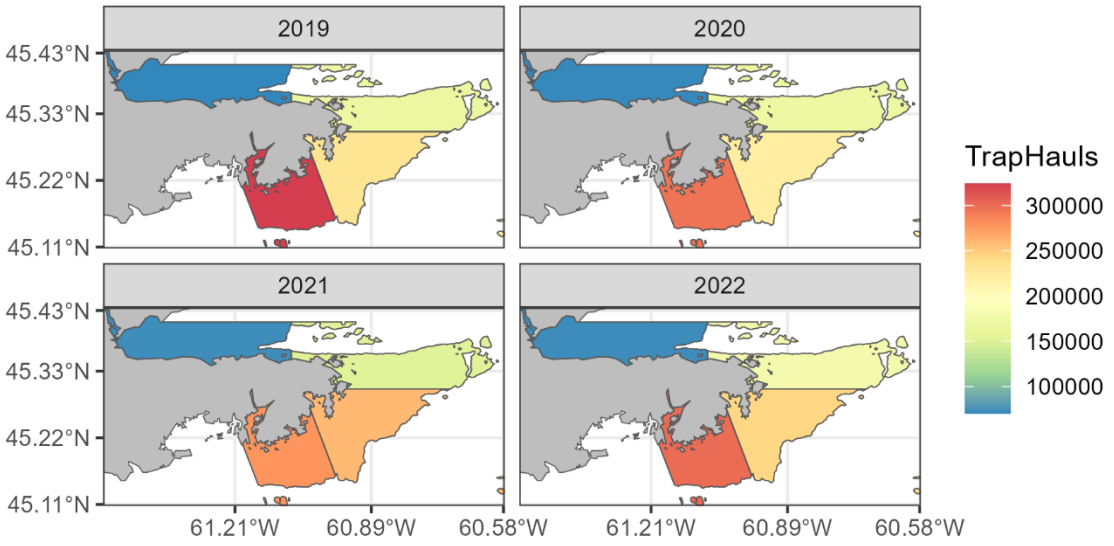

Figure 41: LFA31A- Logbook reported number of trap hauls by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

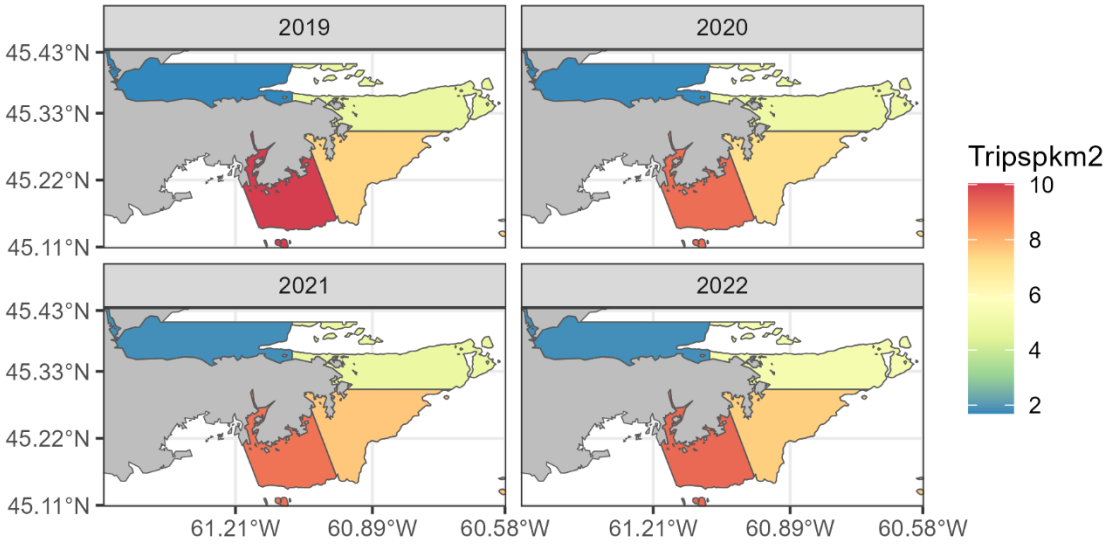

Figure 42: LFA31A- Logbook reported number of trips by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

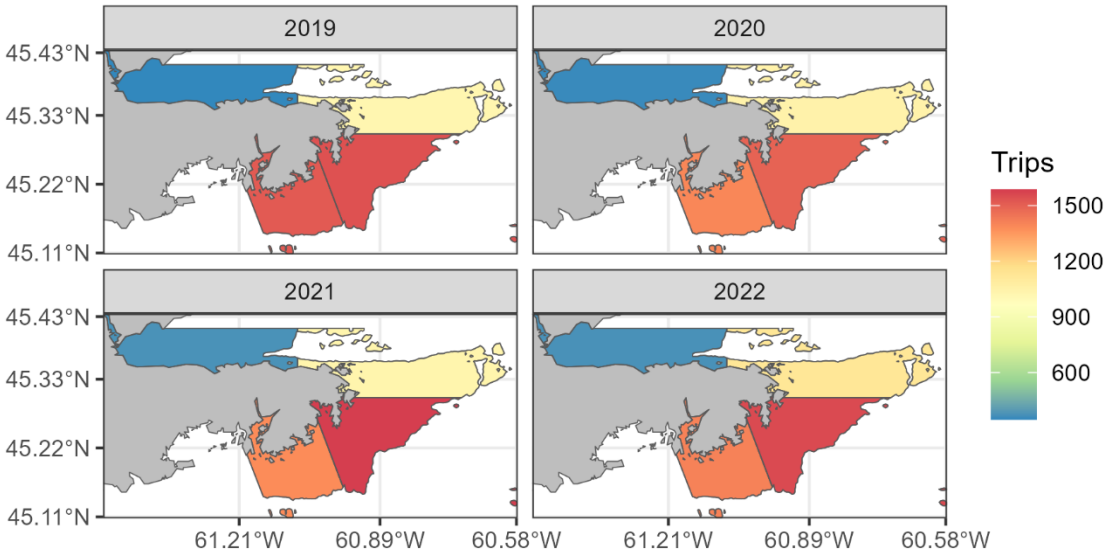

Figure 43: LFA31A- Logbook reported number of trips by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

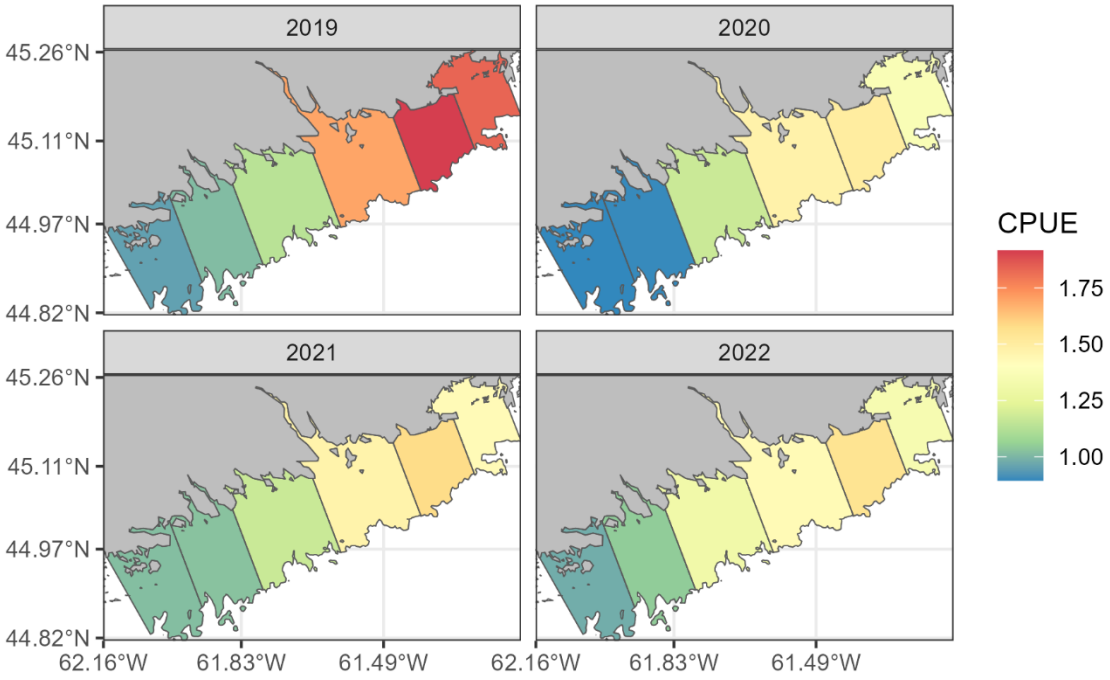

Figure 44: LFA31B- Logbook reported catch (kg) per unit effort (trap haul) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

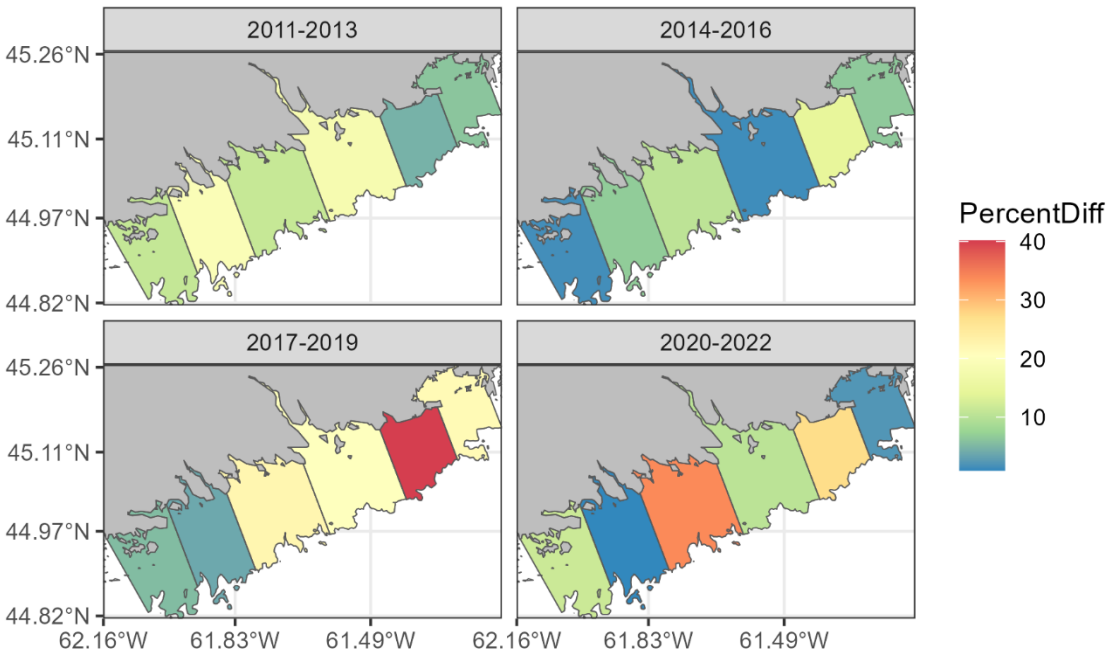

Figure 45: LFA31B- Logbook reported grid estimates of percent difference in catch per unit effort (CPUE) relative to mean CPUE between 2006 and 2010. Grey grids indicate where a percent difference could not be estimated.

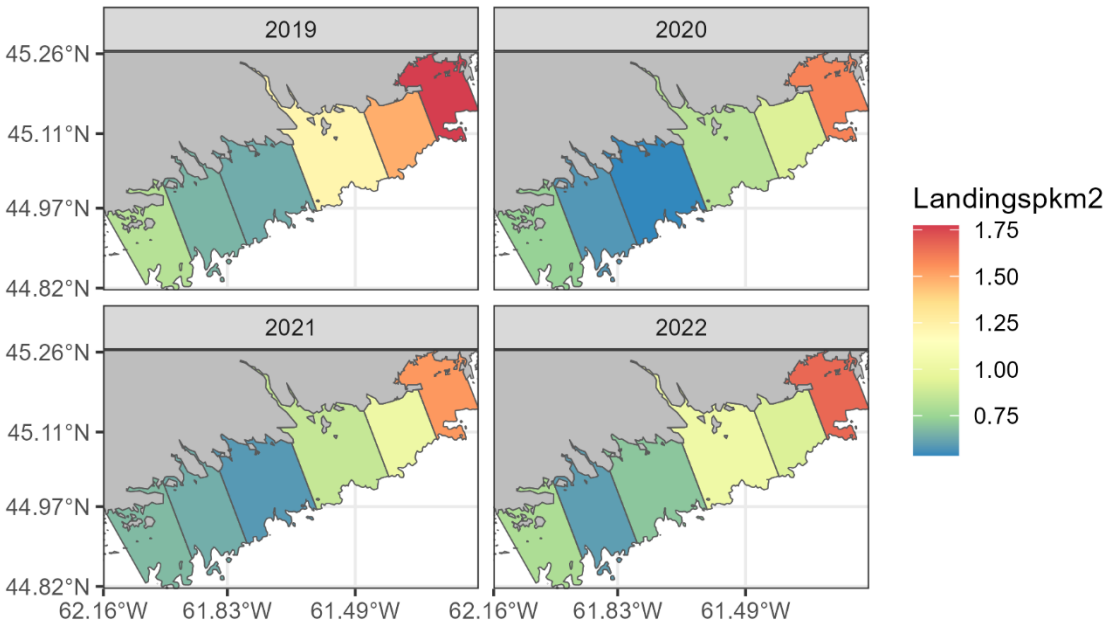

Figure 46: LFA31B- Logbook reported Landings (t) by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

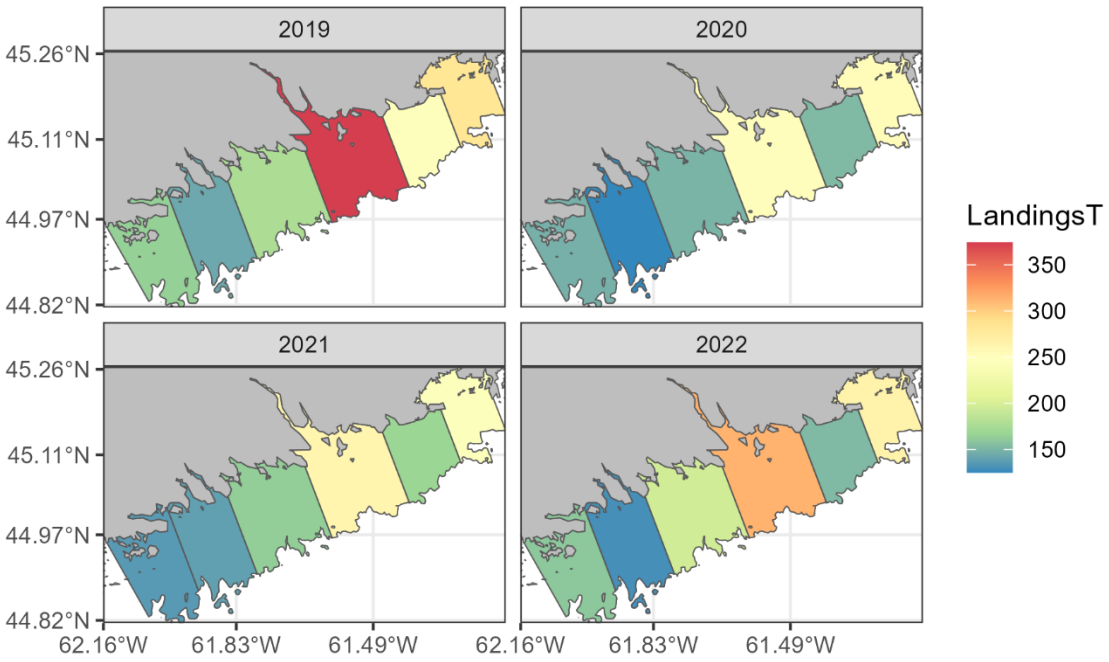

Figure 47: LFA31B- Logbook reported Landings (t) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

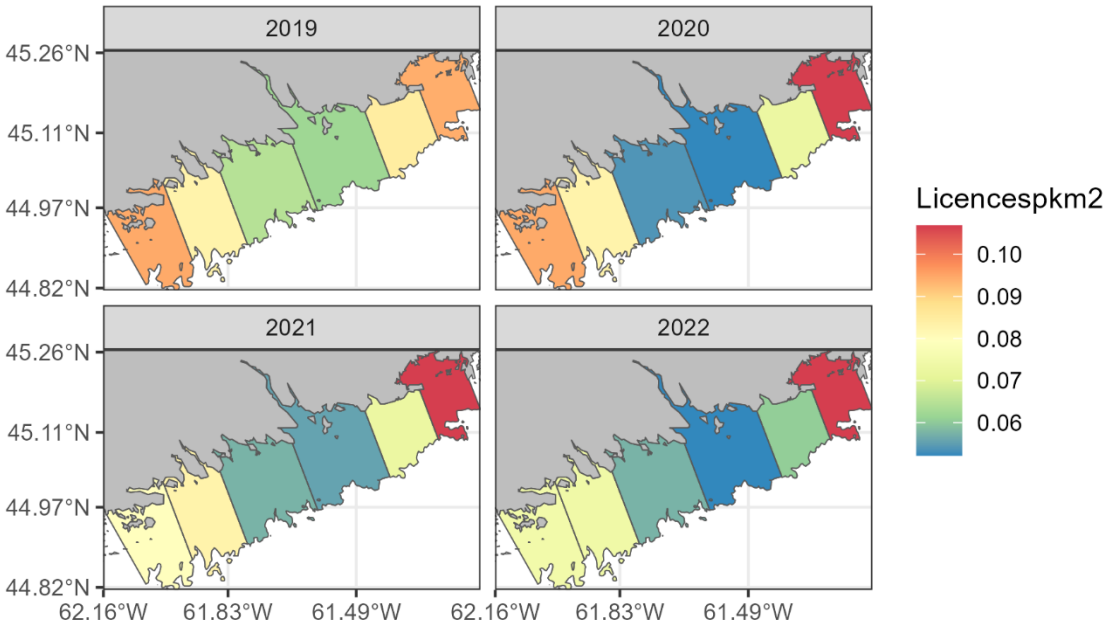

Figure 48: LFA31B- Logbook reported number of licences fishing by grid corrected by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

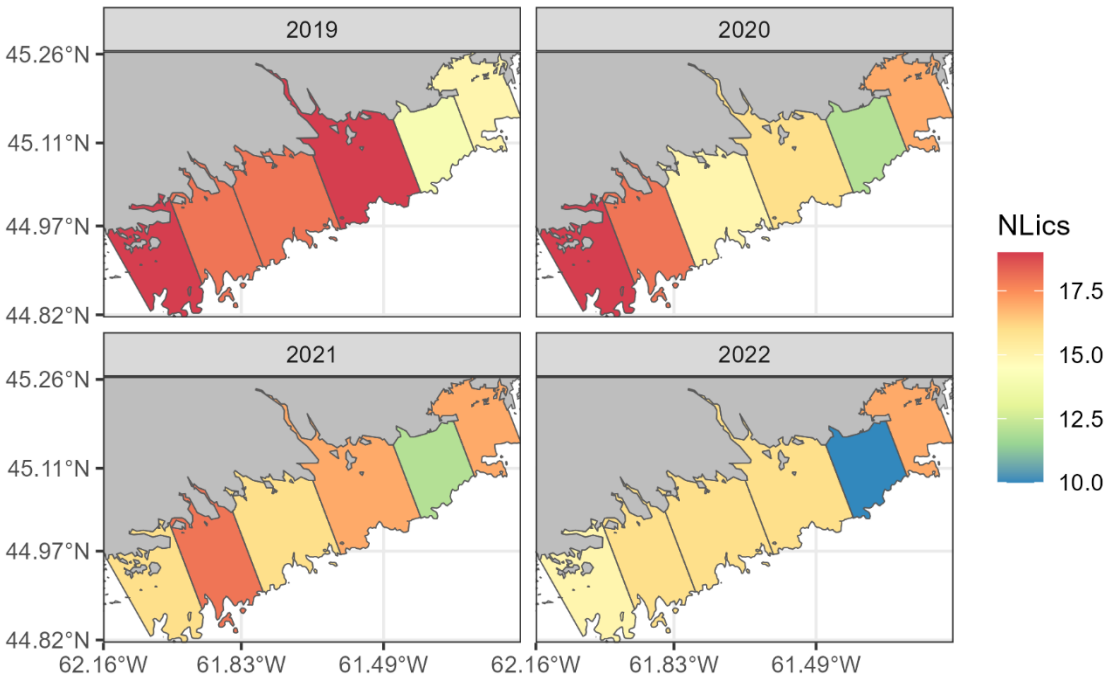

Figure 49: LFA31B- Logbook reported number of licences fishing by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

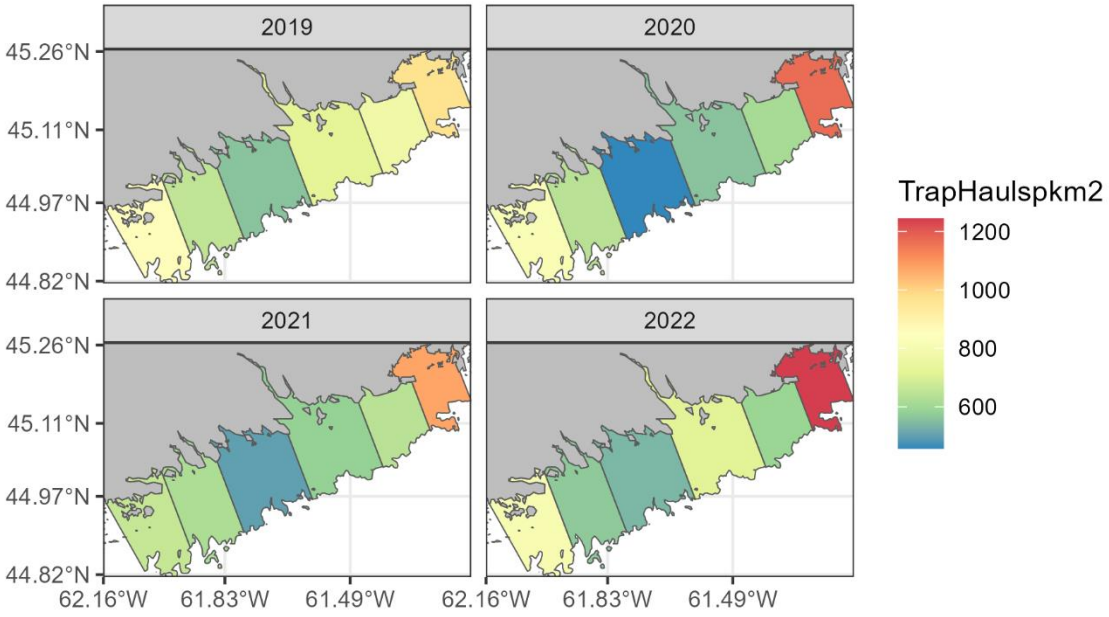

Figure 50: LFA31B- Logbook reported number of trap hauls (TH) by grid corrected by the area of the grid (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

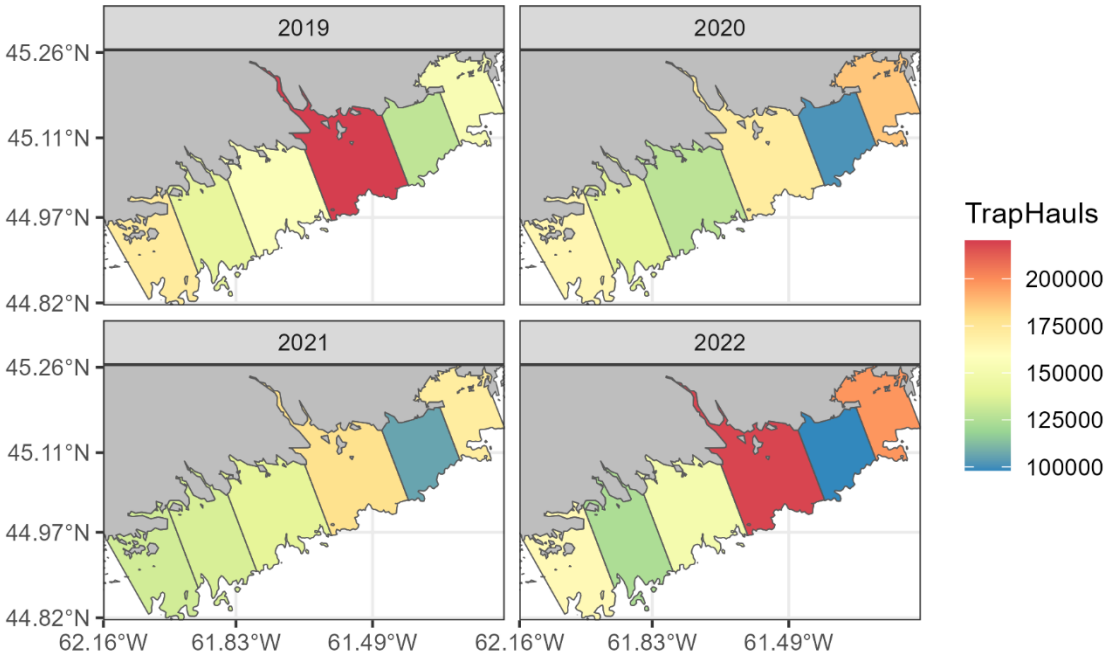

Figure 51: LFA31B- Logbook reported number of trap hauls by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

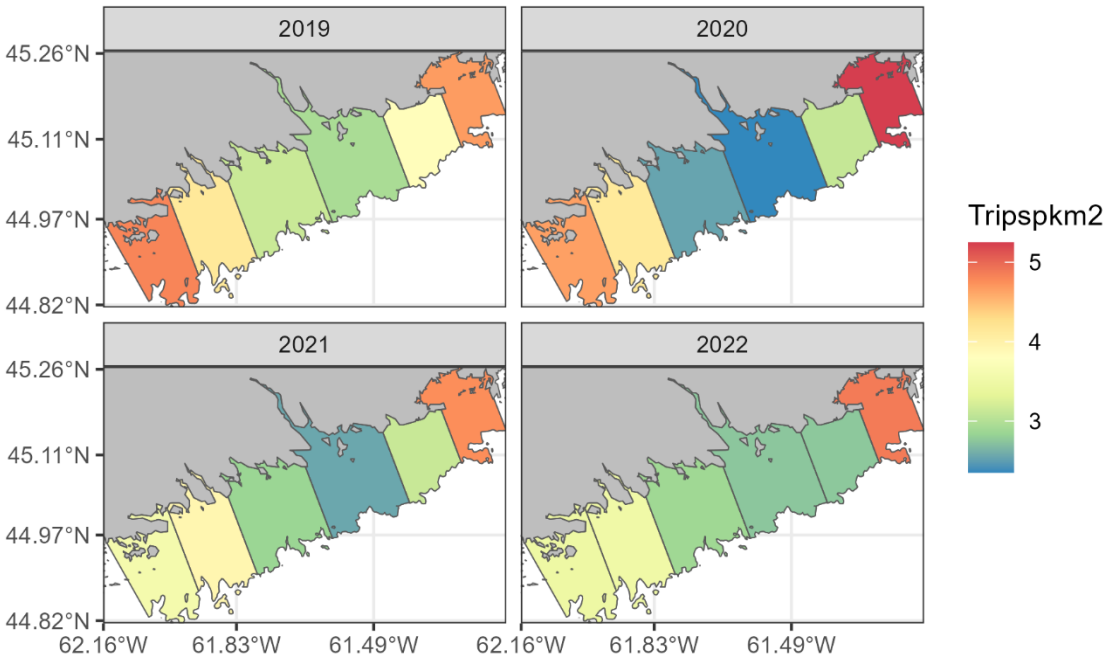

Figure 52: LFA31B- Logbook reported number of trips by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

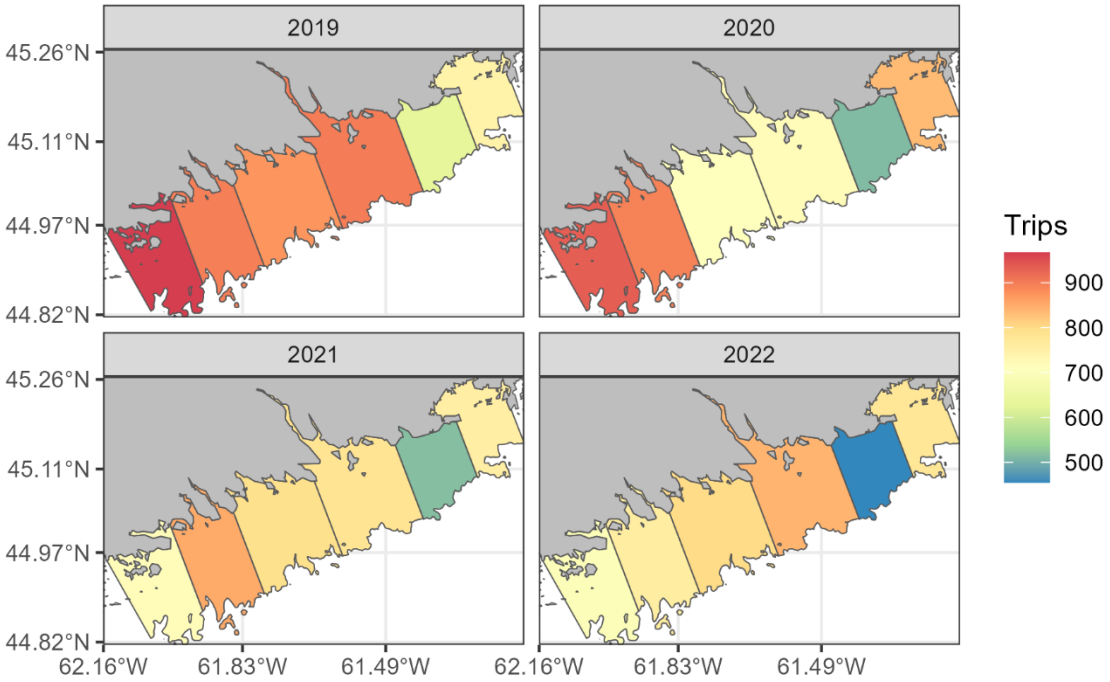

Figure 53: LFA31B- Logbook reported number of trips by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

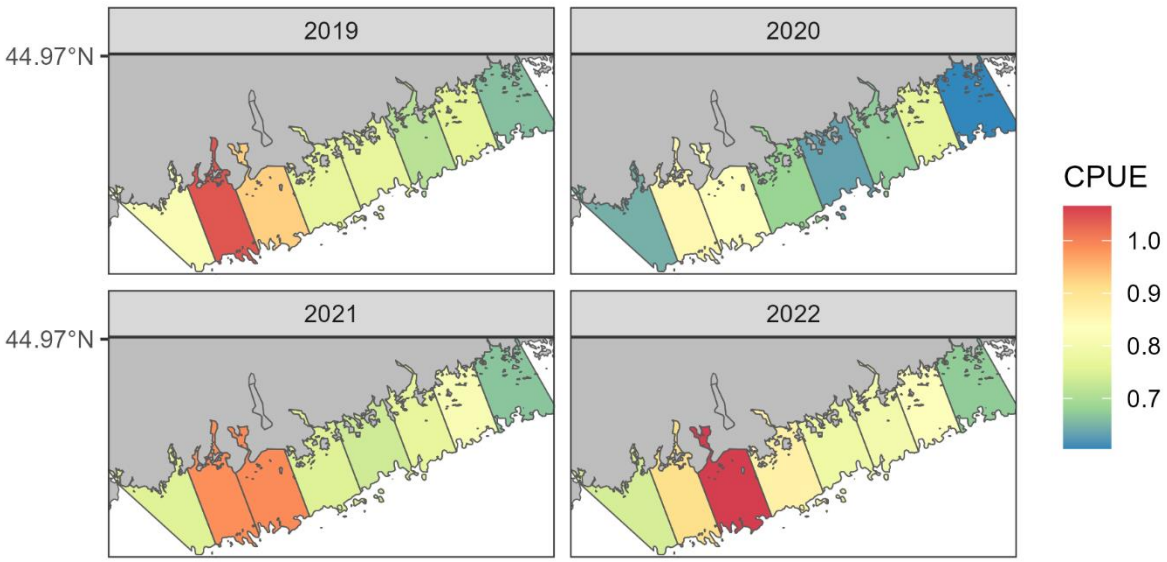

Figure 54: LFA32- Logbook reported catch (kg) per unit effort (trap haul) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

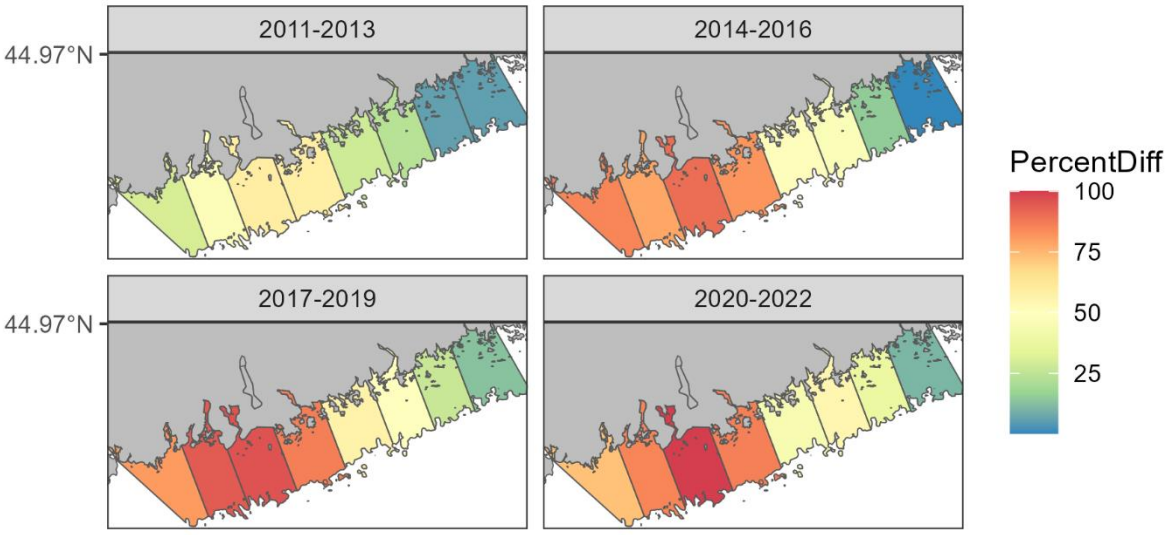

Figure 55: LFA32- Logbook reported grid estimates of percent difference in catch per unit effort (CPUE) relative to mean CPUE between 2006 and 2010. Grey grids indicate where a percent difference could not be estimated.

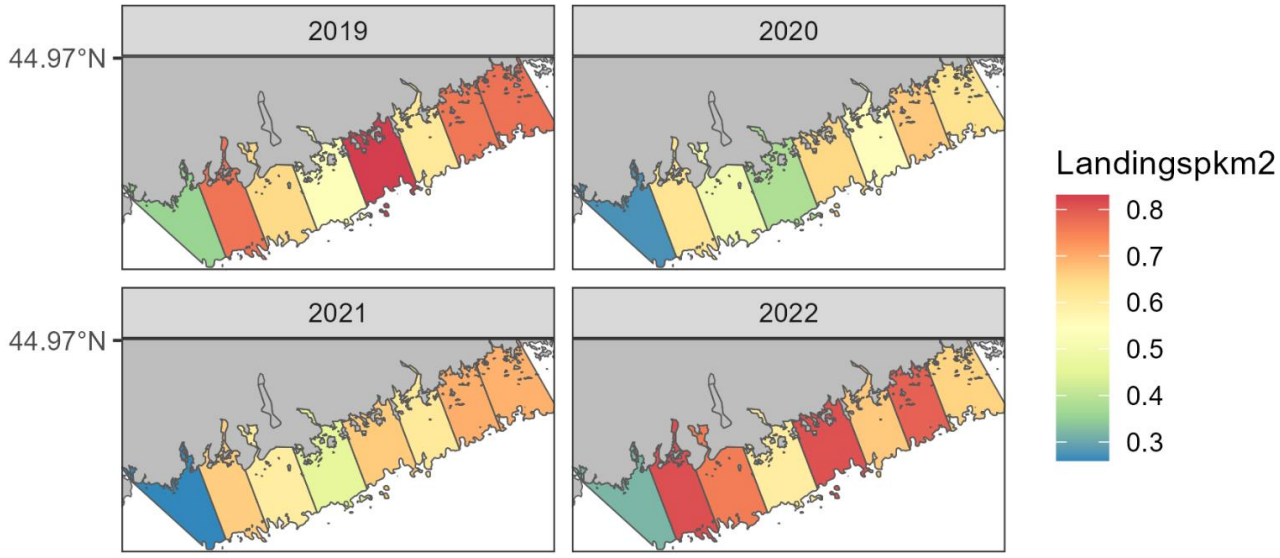

Figure 56: LFA32- Logbook reported Landings (t) by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

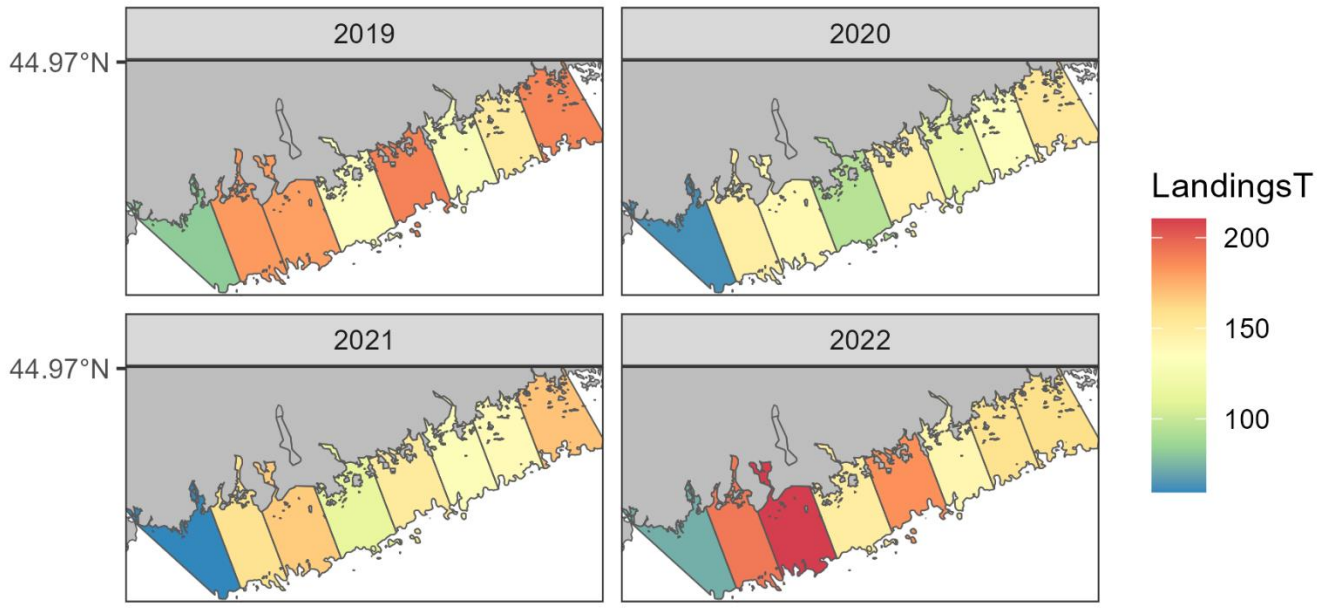

Figure 57: LFA32- Logbook reported Landings (t) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

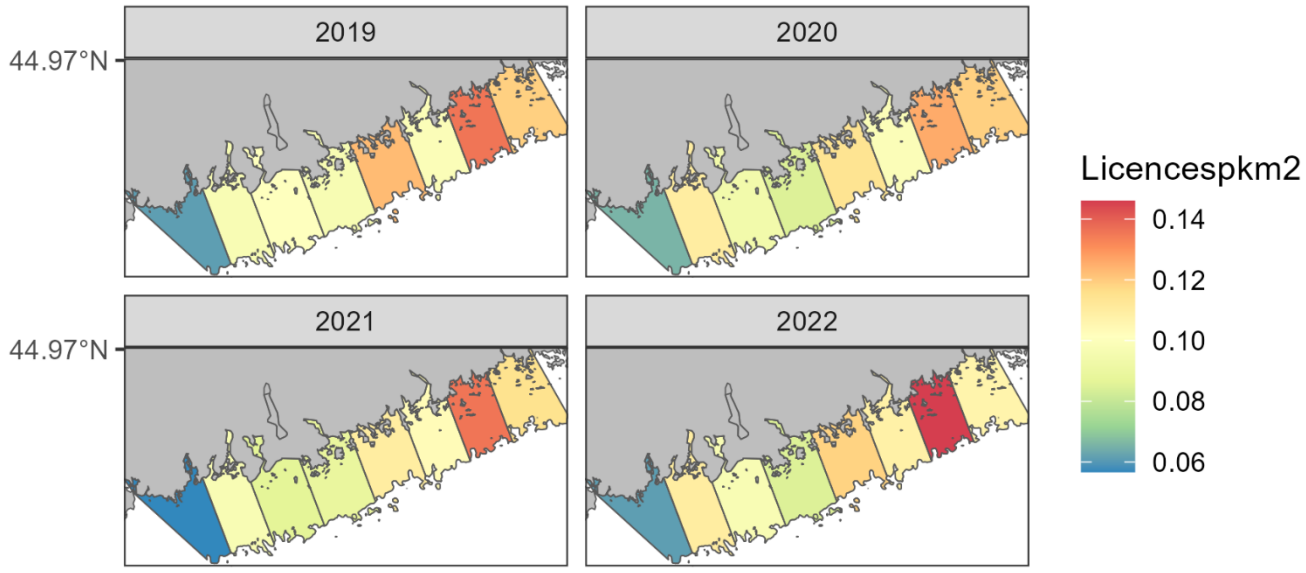

Figure 58: LFA32- Logbook reported number of licences fishing by grid corrected by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

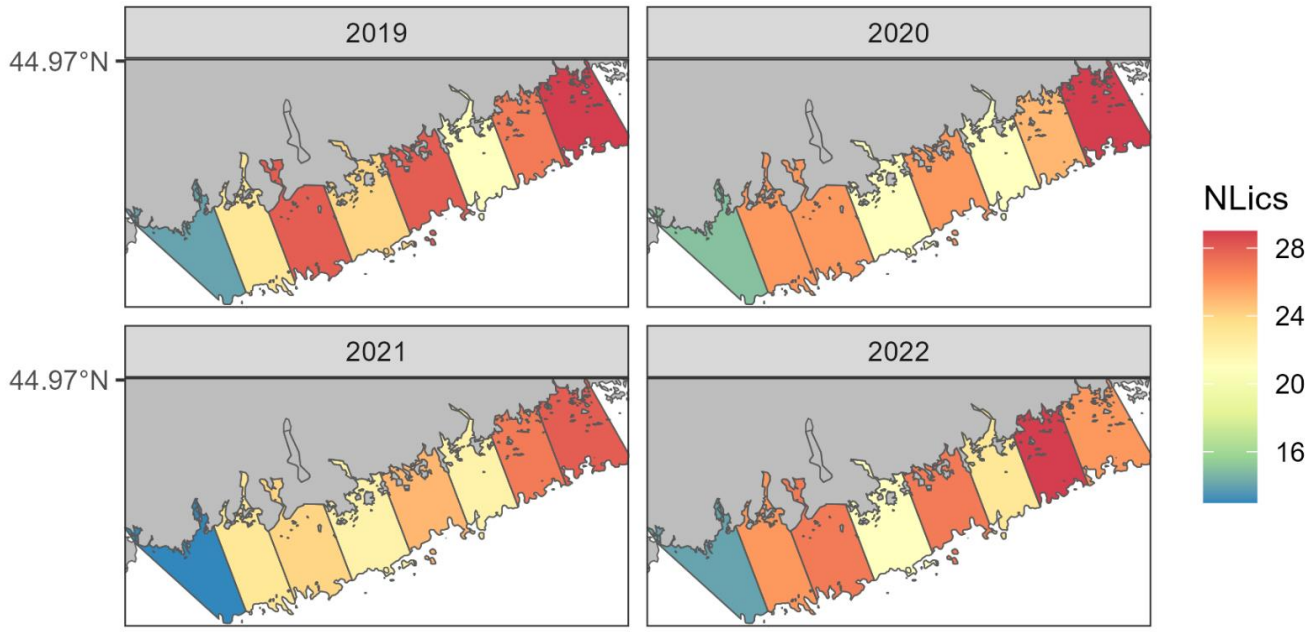

Figure 59: LFA32- Logbook reported number of licences fishing by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

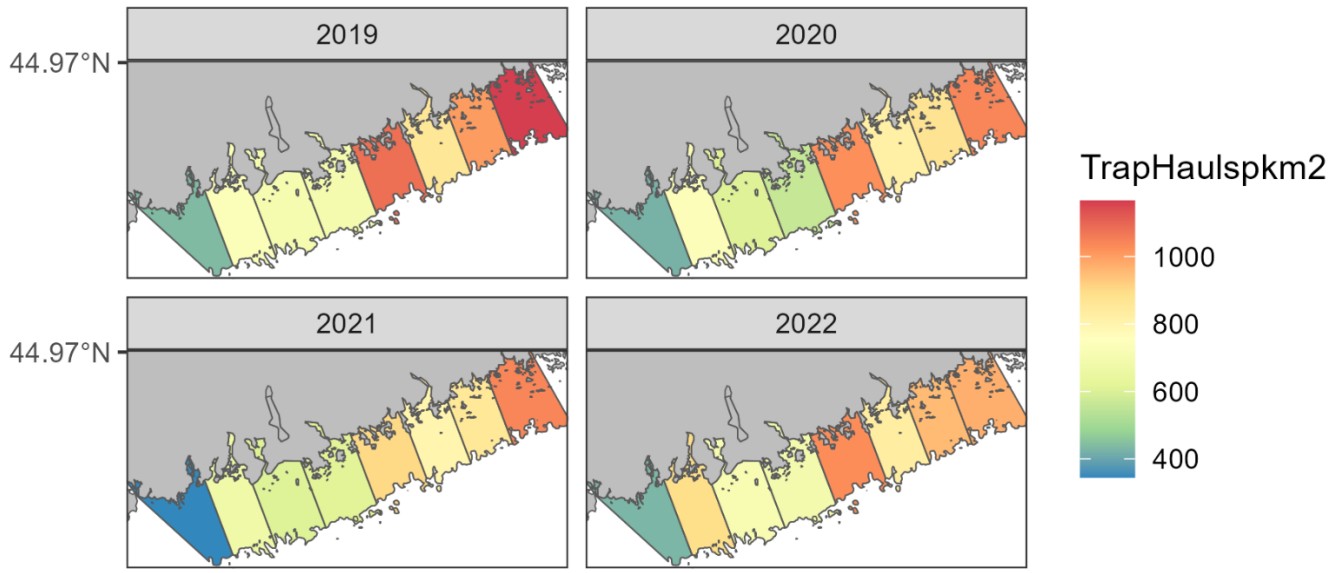

Figure 60: LFA32- Logbook reported number of trap hauls (TH) by grid corrected by the area of the grid (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

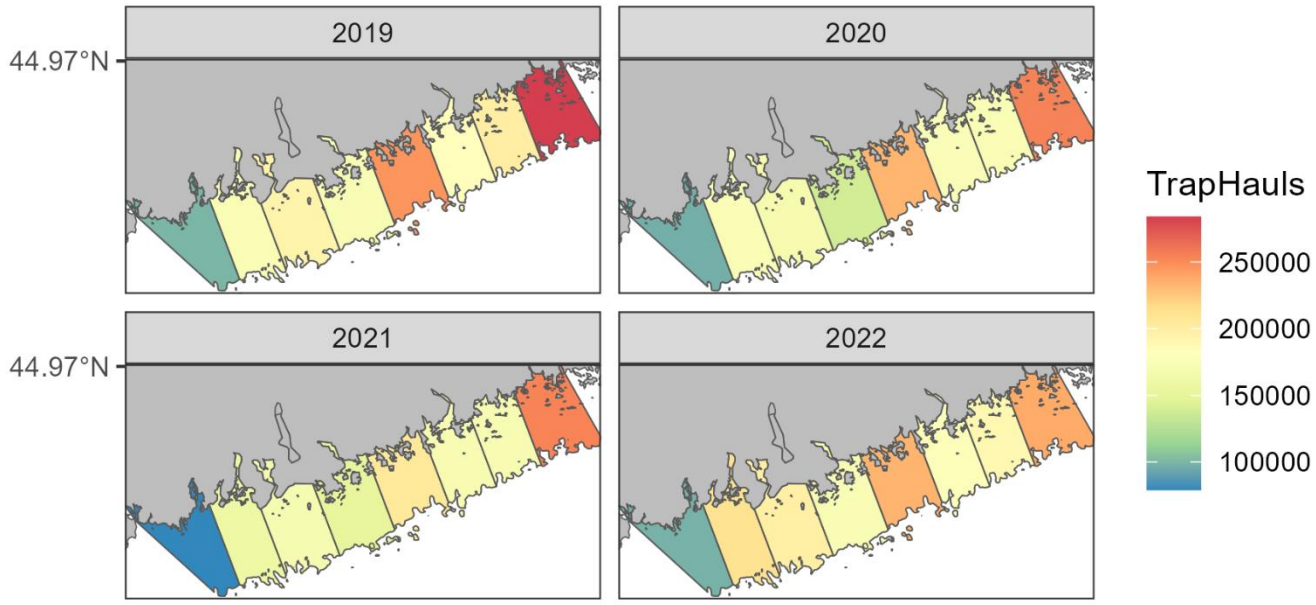

Figure 61: LFA32- Logbook reported number of trap hauls by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

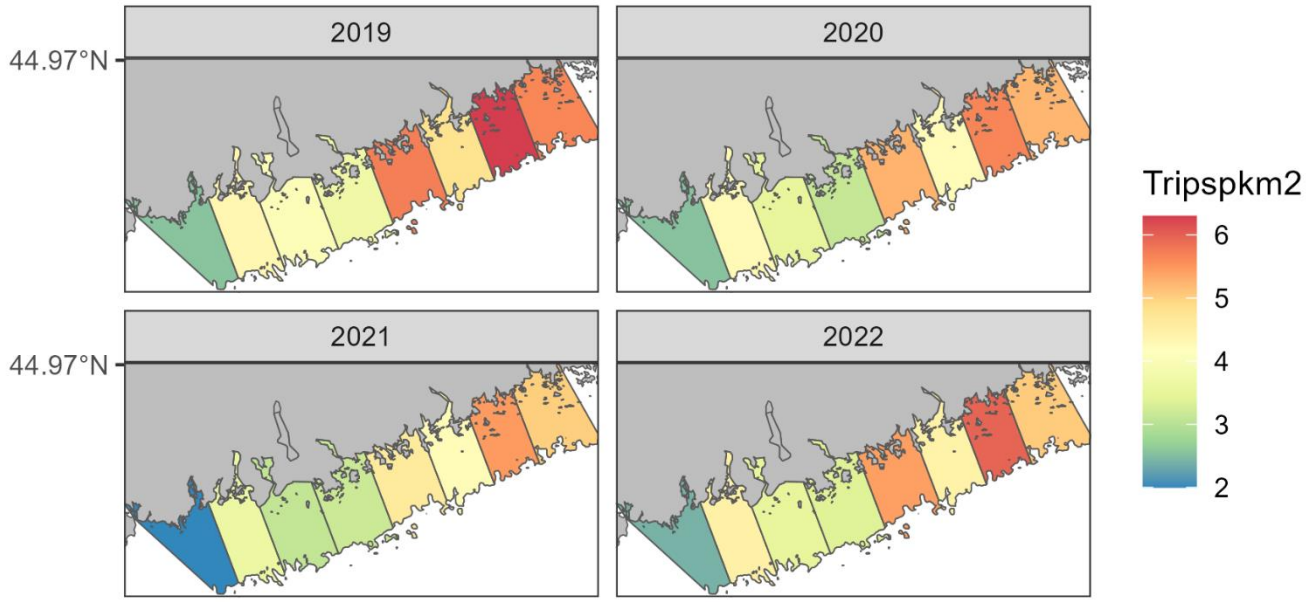

Figure 62: LFA32- Logbook reported number of trips by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

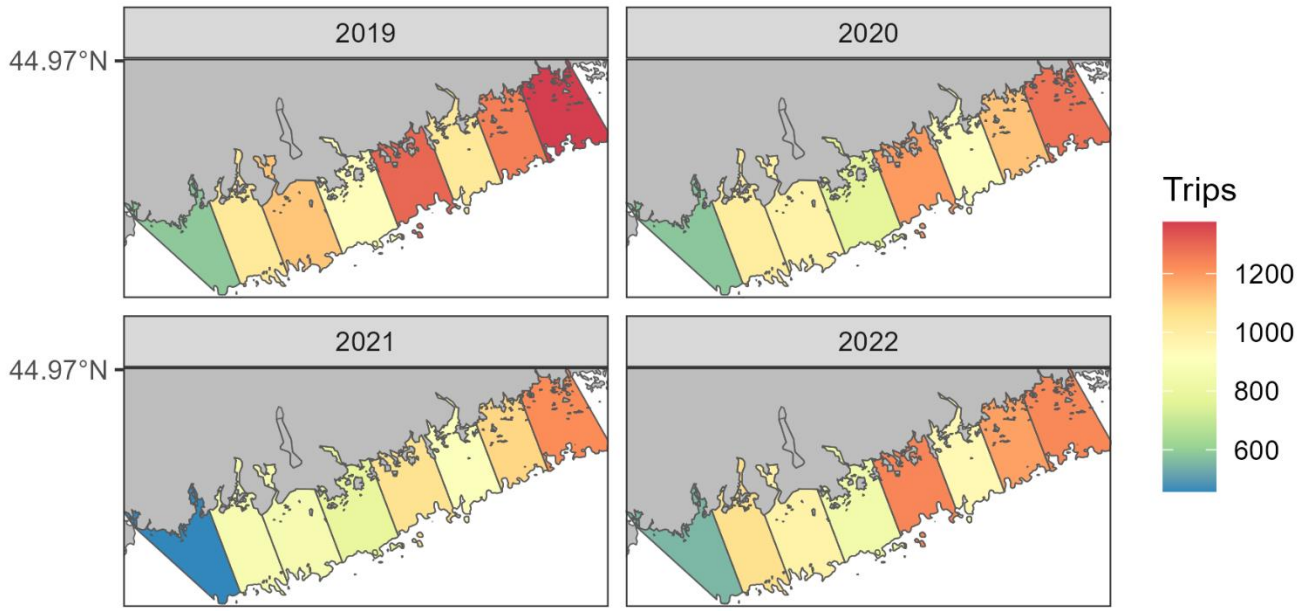

Figure 63: LFA32- Logbook reported number of trips by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

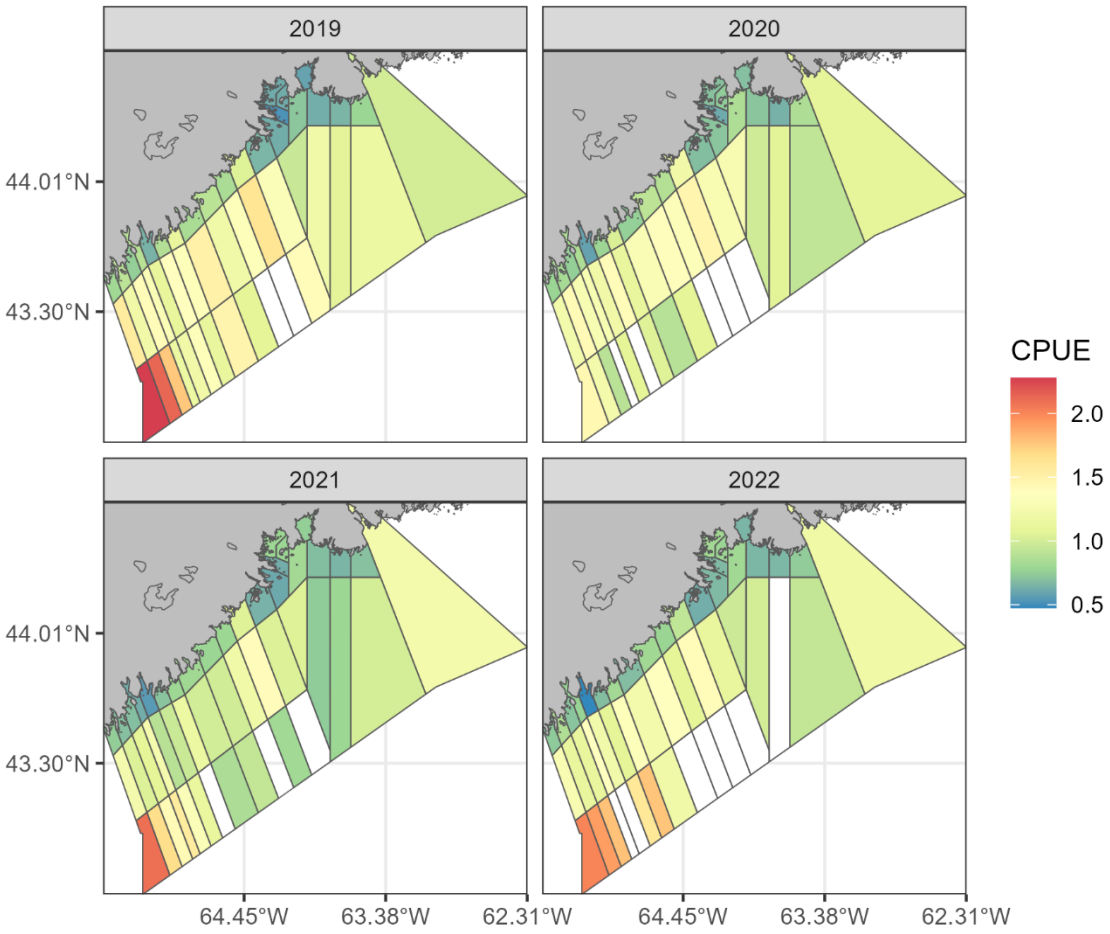

Figure 64: LFA33- Logbook reported catch (kg) per unit effort (trap haul) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

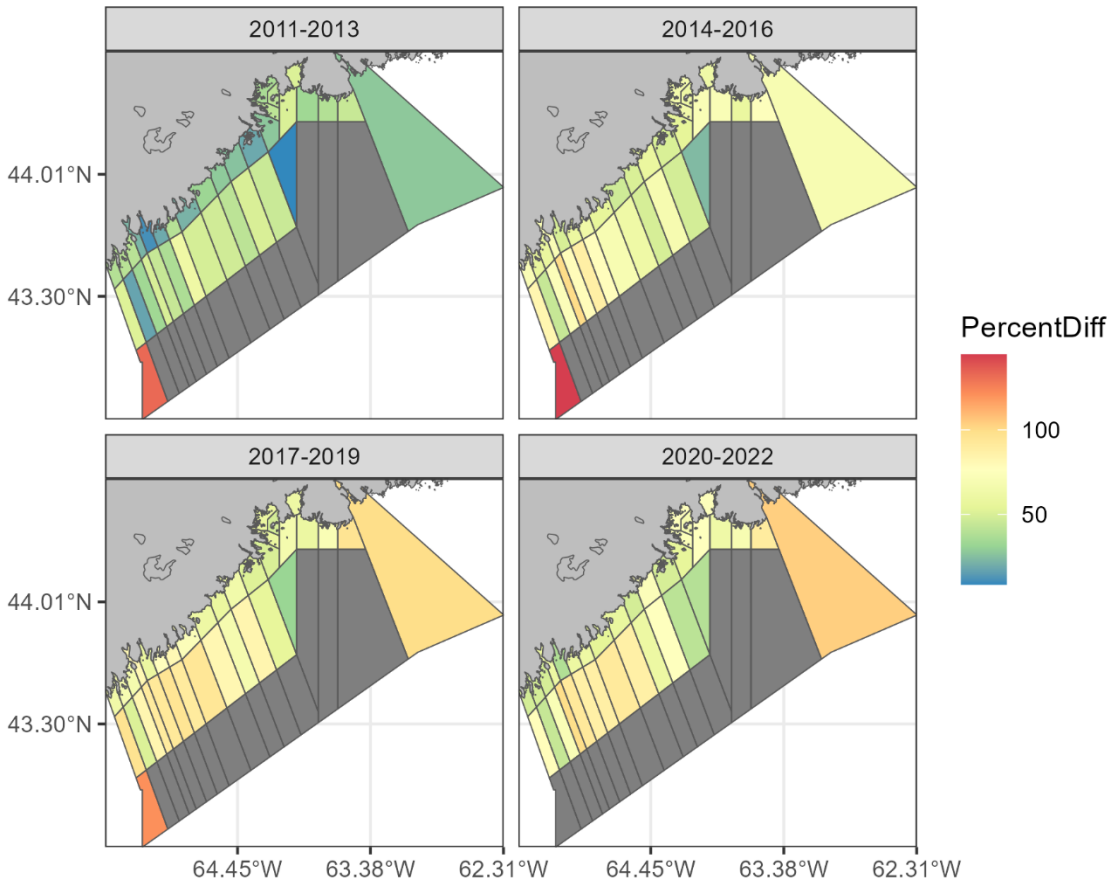

Figure 65: LFA33- Logbook reported grid estimates of percent difference in catch per unit effort (CPUE) relative to mean CPUE between 2006 and 2010. Grey grids indicate where a percent difference could not be estimated.

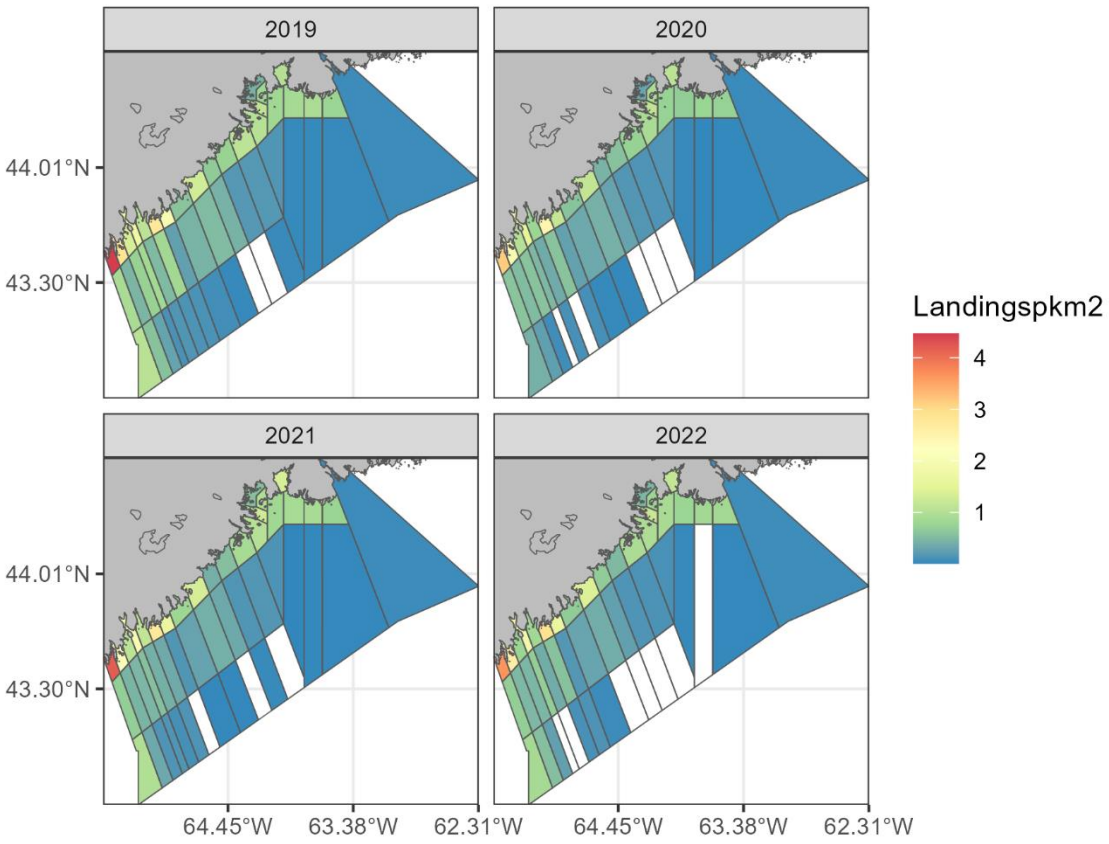

Figure 66: LFA33- Logbook reported Landings (t) by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

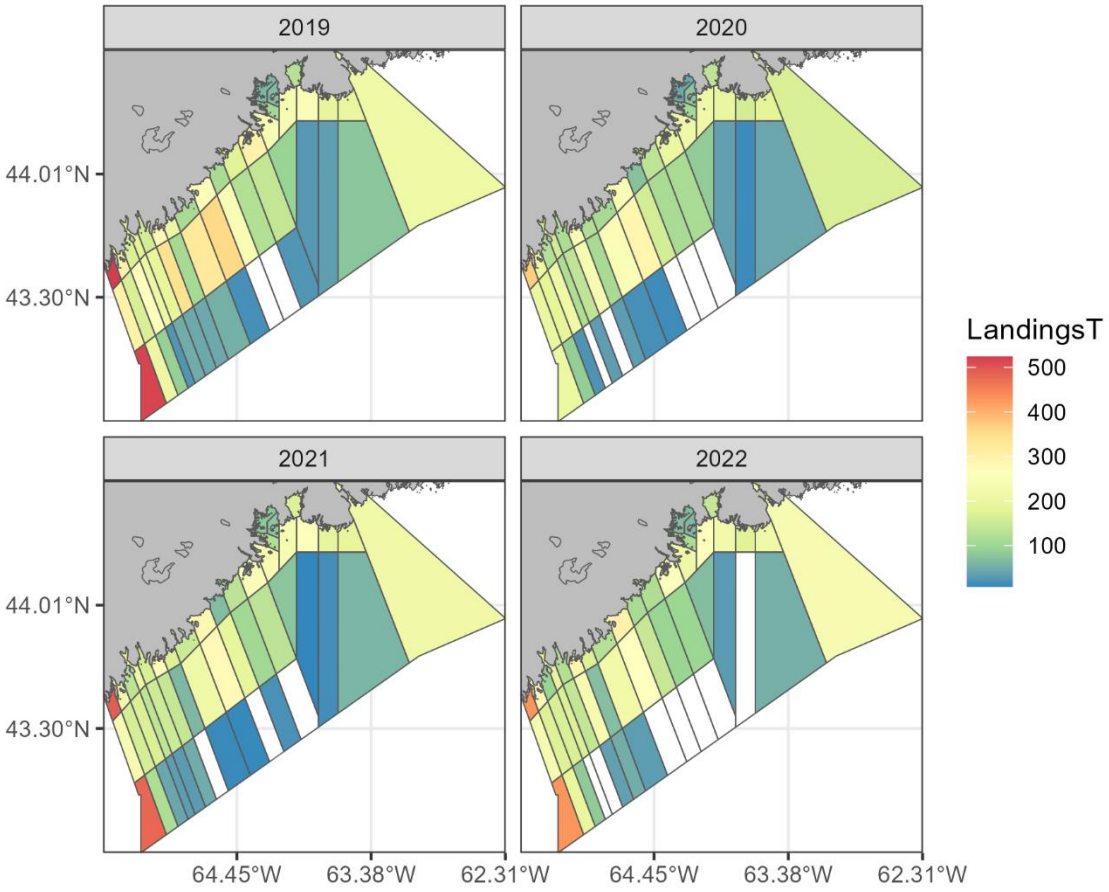

Figure 67: LFA33- Logbook reported Landings (t) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

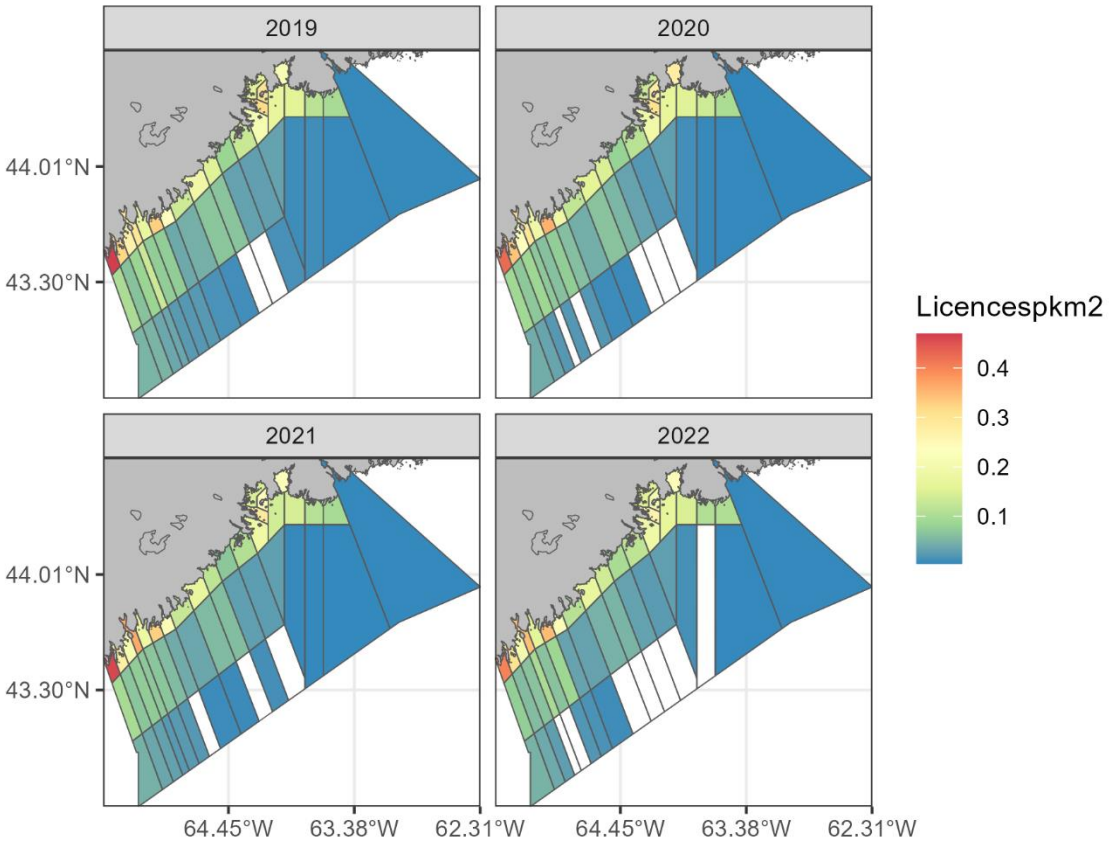

Figure 68: LFA33- Logbook reported number of licences fishing by grid corrected by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

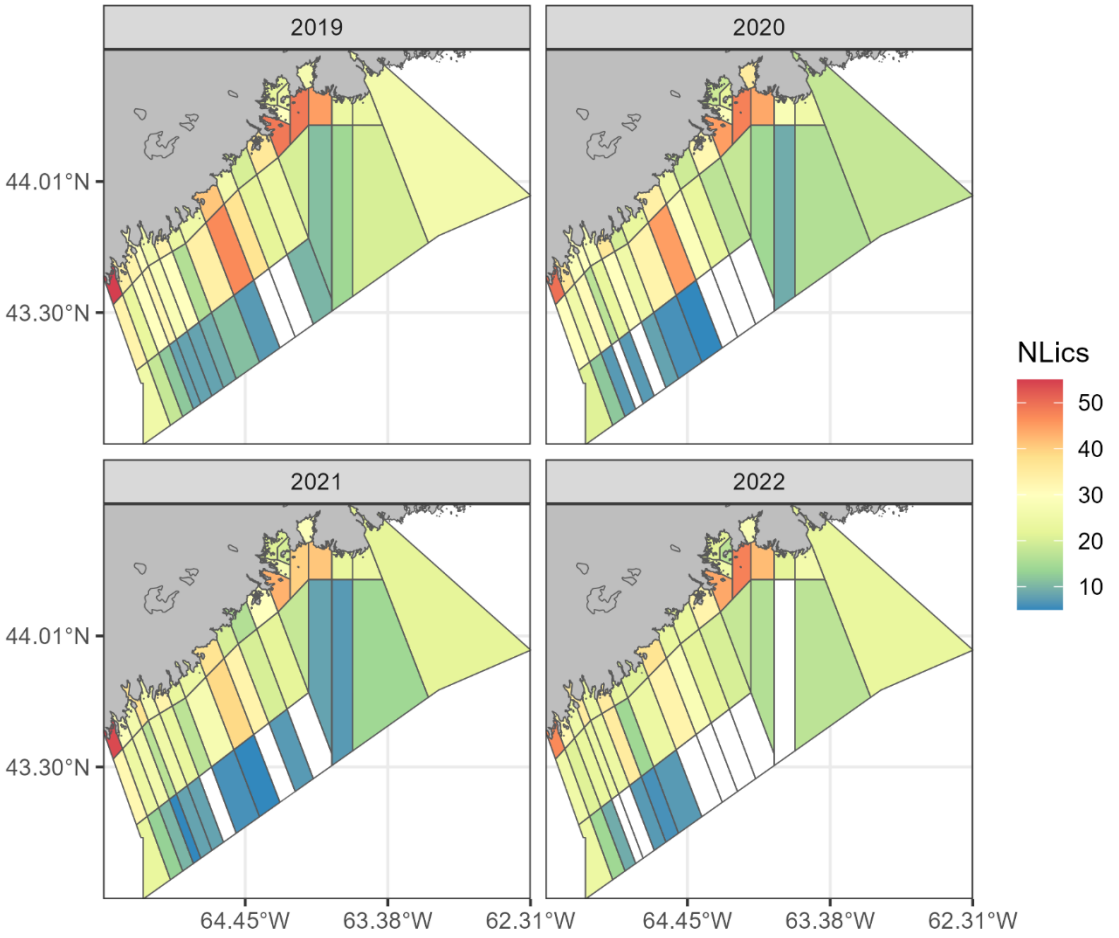

Figure 69: LFA33- Logbook reported number of licences fishing by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

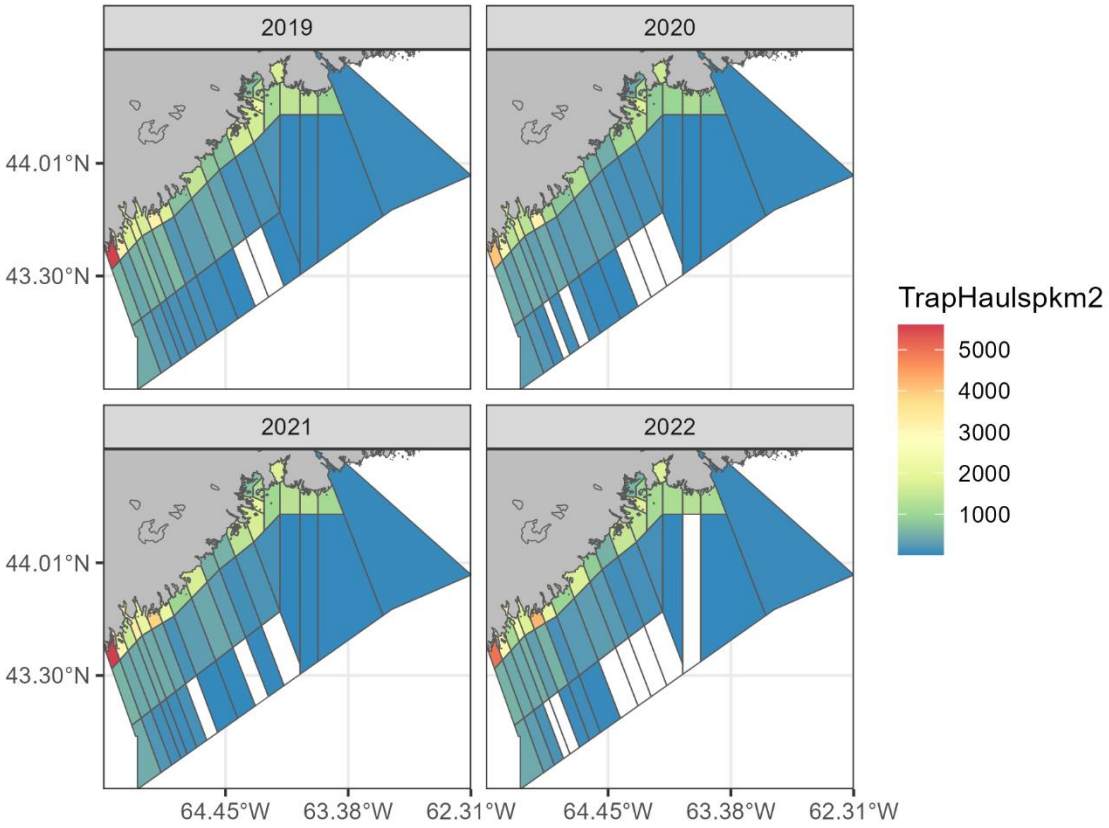

Figure 70: LFA33- Logbook reported number of trap hauls (TH) by grid corrected by the area of the grid (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

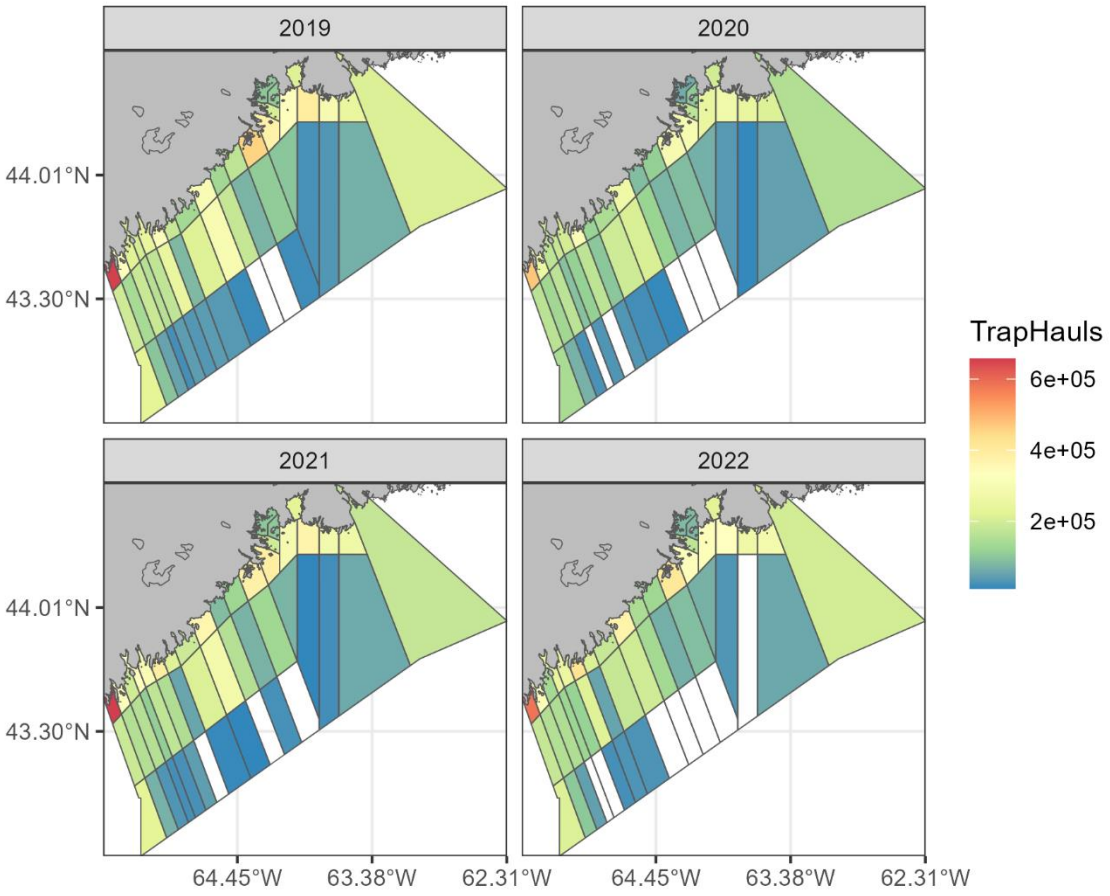

Figure 71: LFA33- Logbook reported number of trap hauls by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

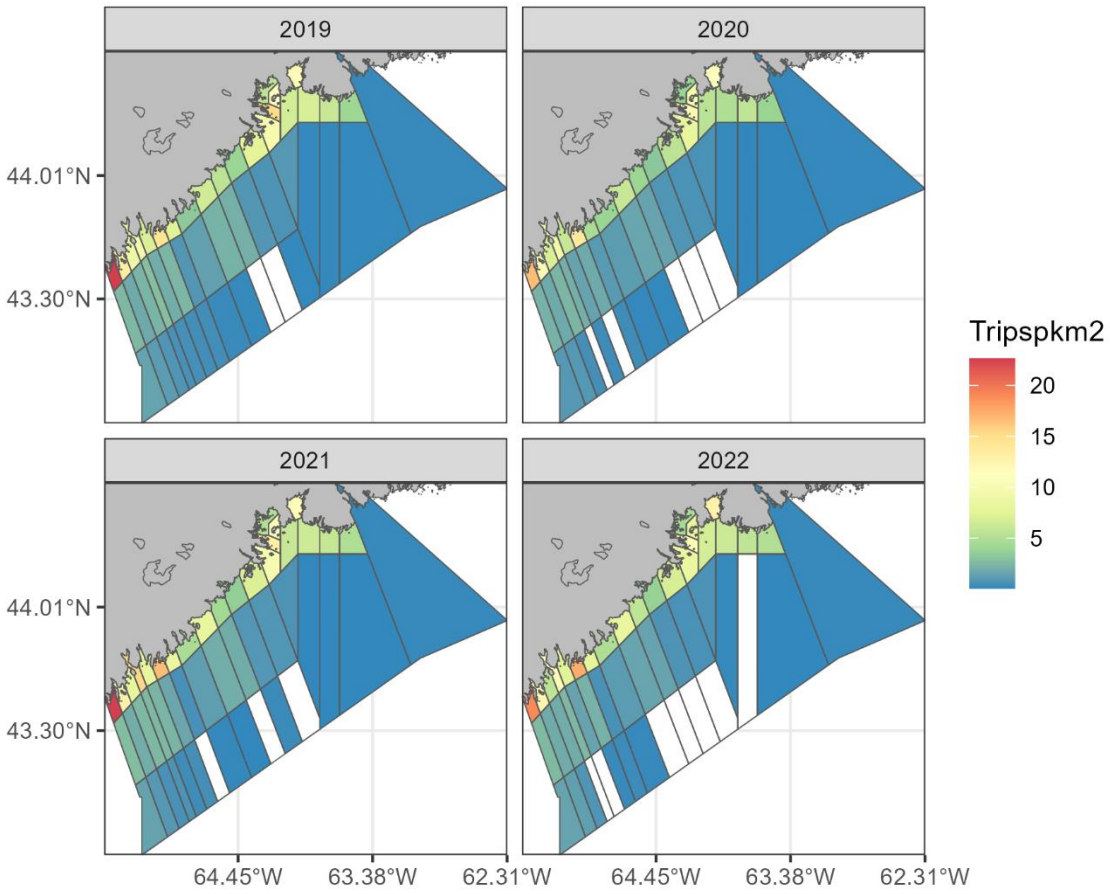

Figure 72: LFA33- Logbook reported number of trips by grid adjusted by area (km ^{2}). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

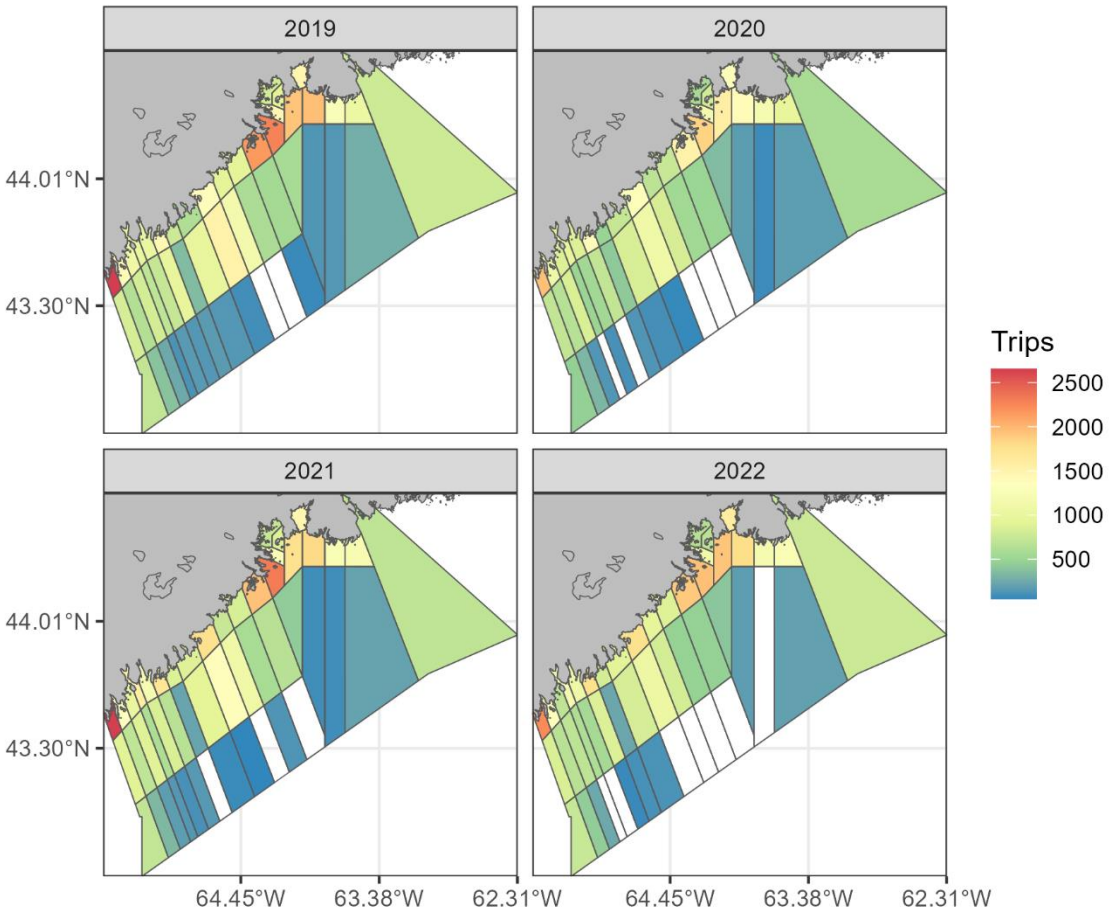

Figure 73: LFA33- Logbook reported number of trips by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

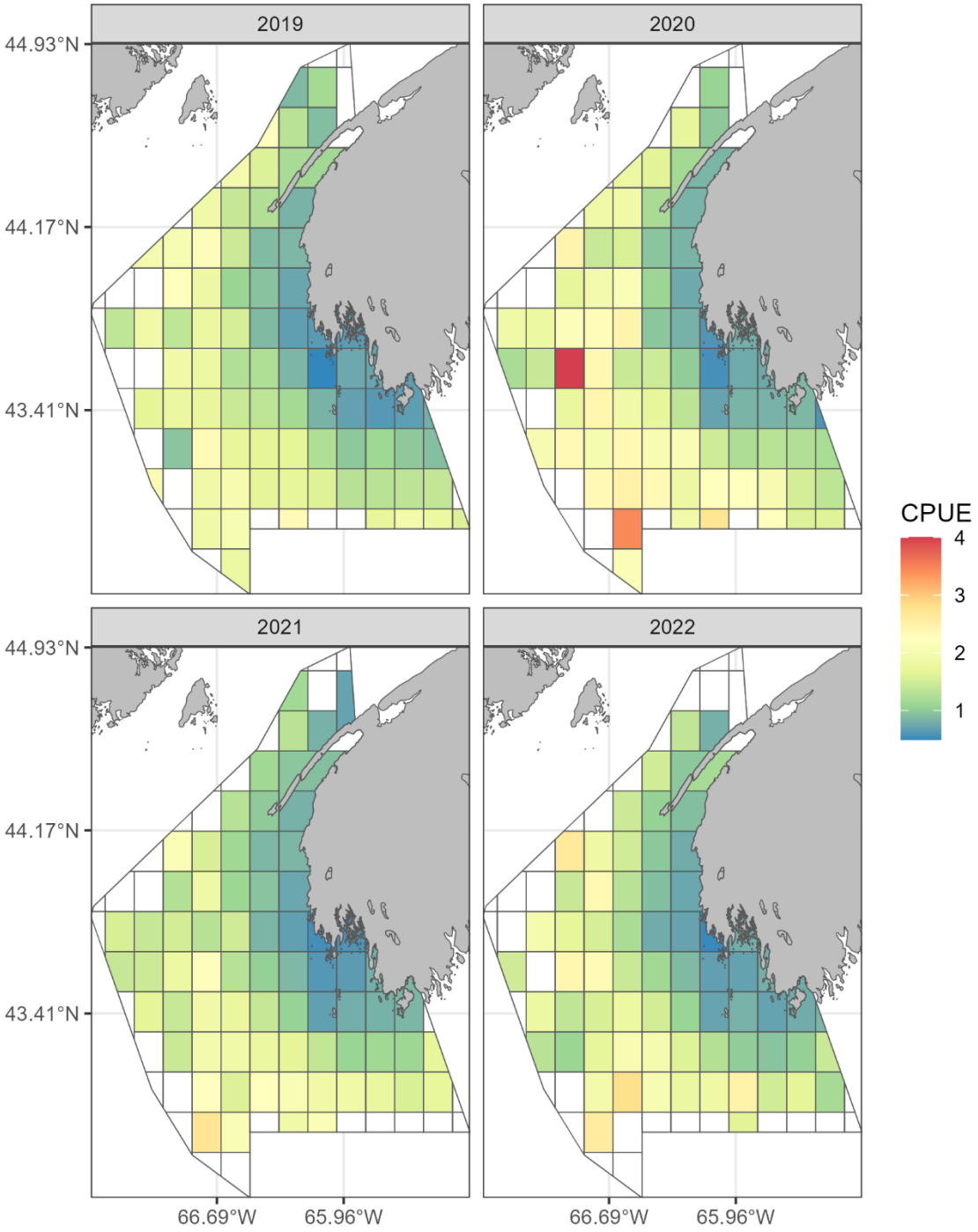

Figure 74: LFA34- Logbook reported catch (kg) per unit effort (trap haul) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

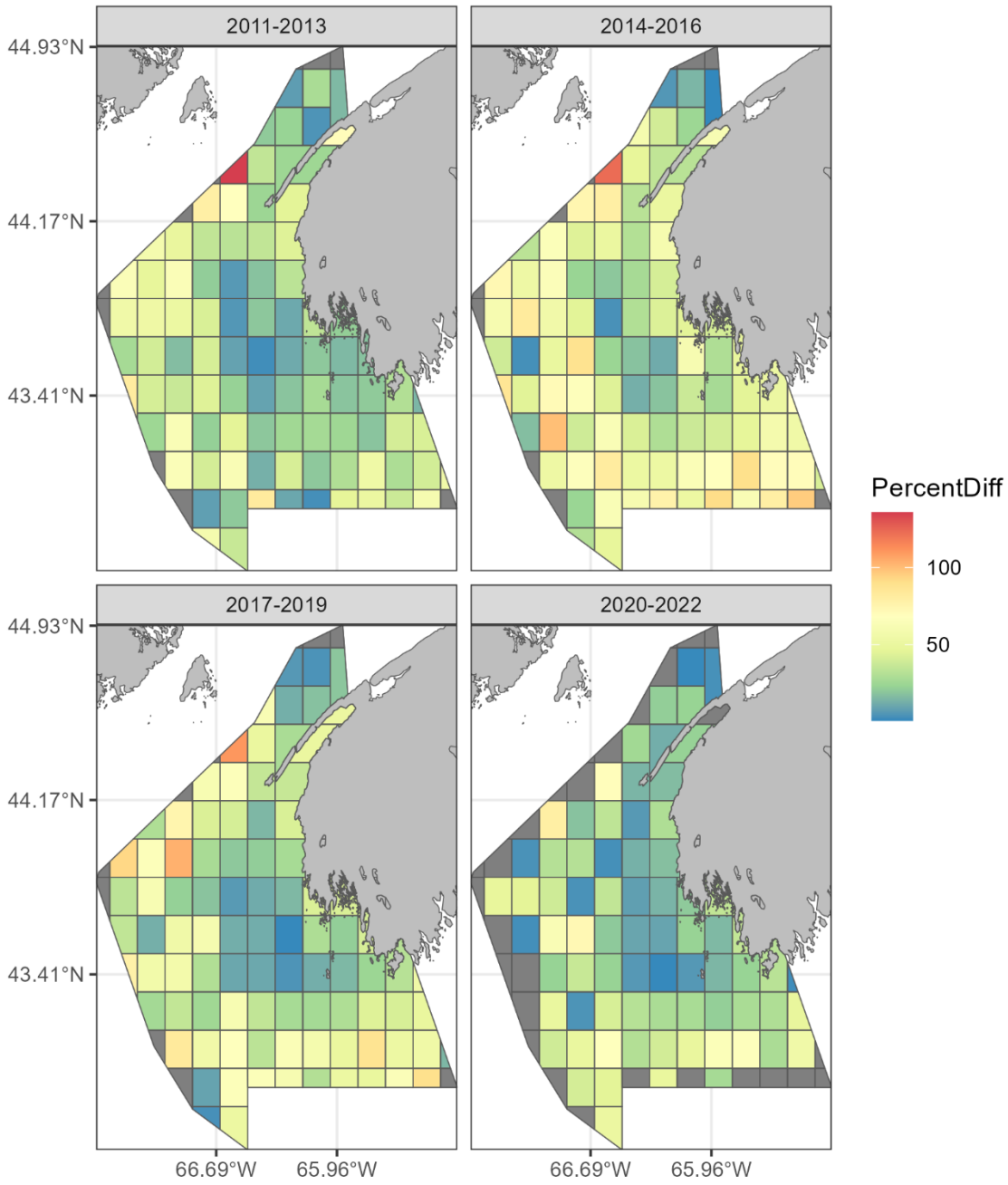

Figure 75: LFA34- Logbook reported grid estimates of percent difference in catch per unit effort (CPUE) relative to mean CPUE between 2006 and 2010. Grey grids indicate where a percent difference could not be estimated.

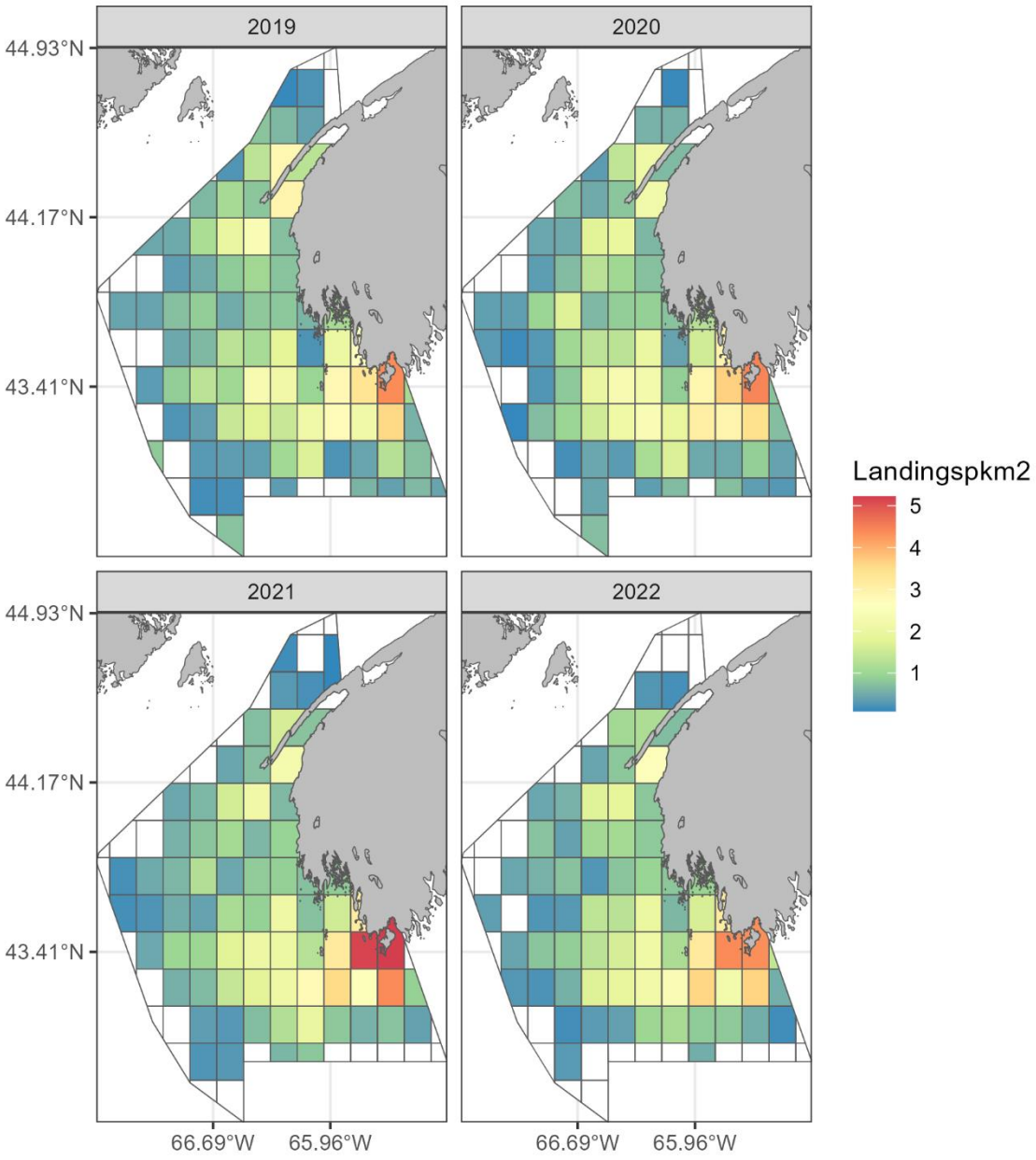

Figure 76: LFA34- Logbook reported Landings (t) by grid adjusted by area (km2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

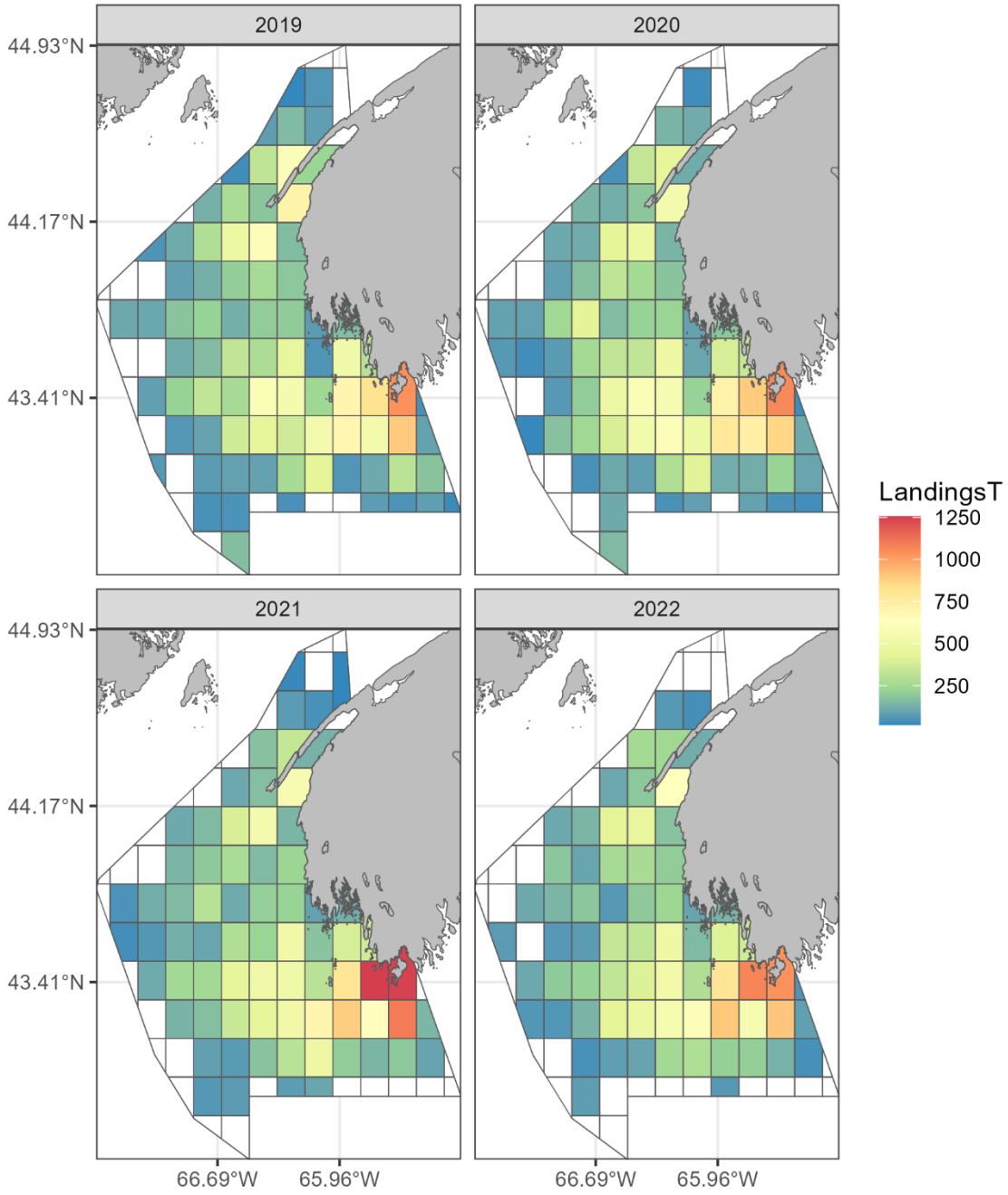

Figure 77: LFA34- Logbook reported Landings (t) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

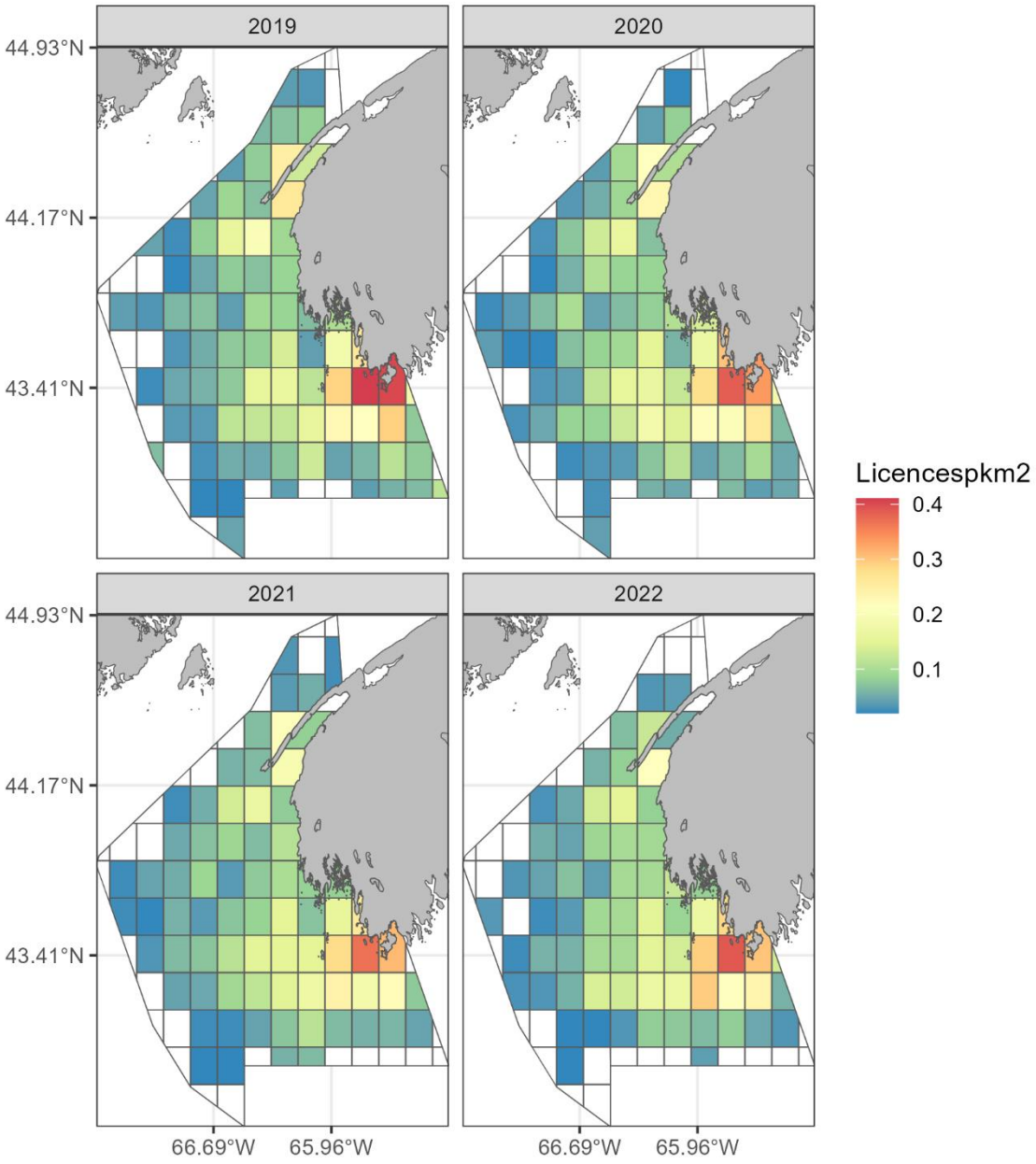

Figure 78: LFA34- Logbook reported number of licences fishing by grid corrected by area (km ^{2}). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

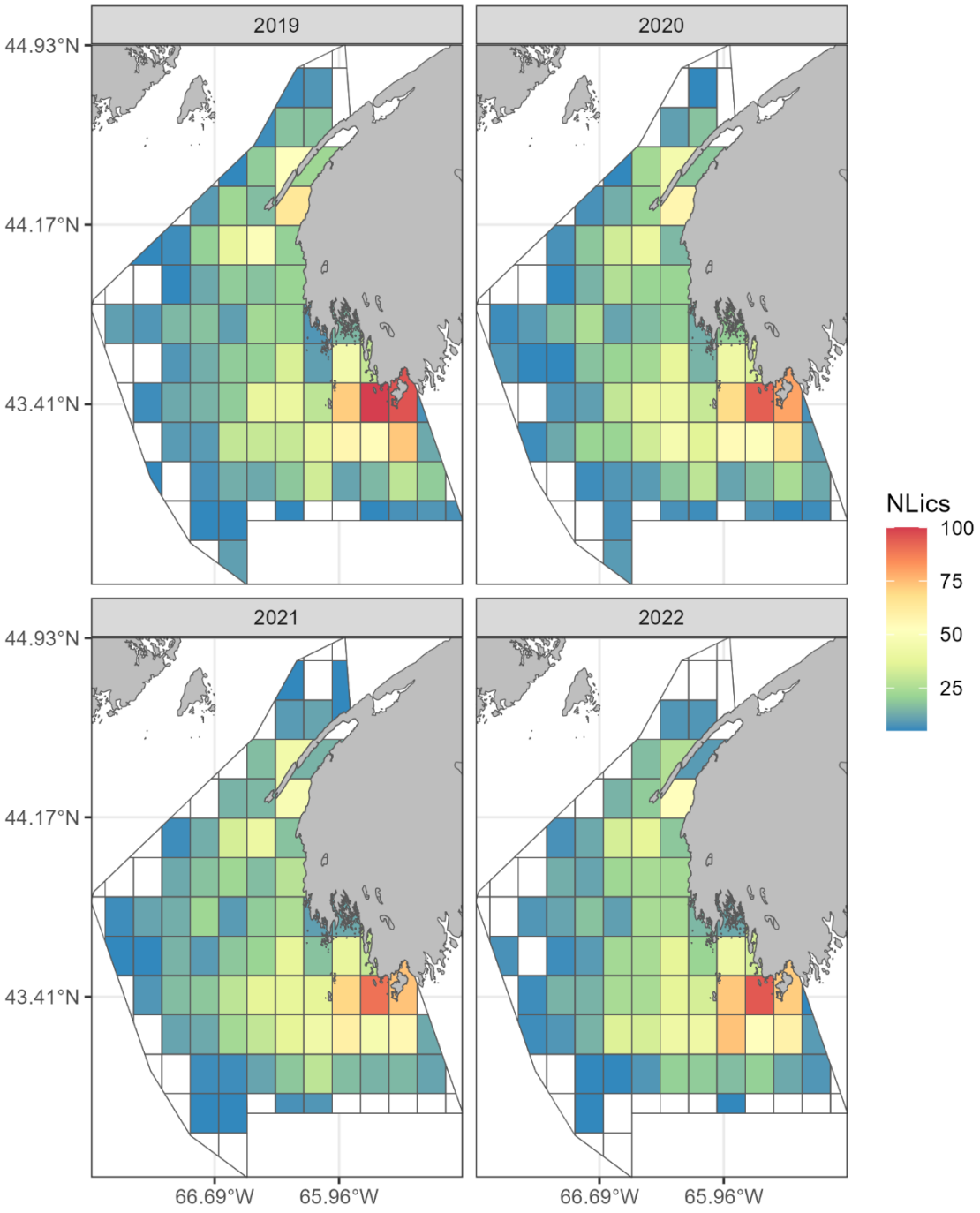

Figure 79: LFA34- Logbook reported number of licences fishing by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

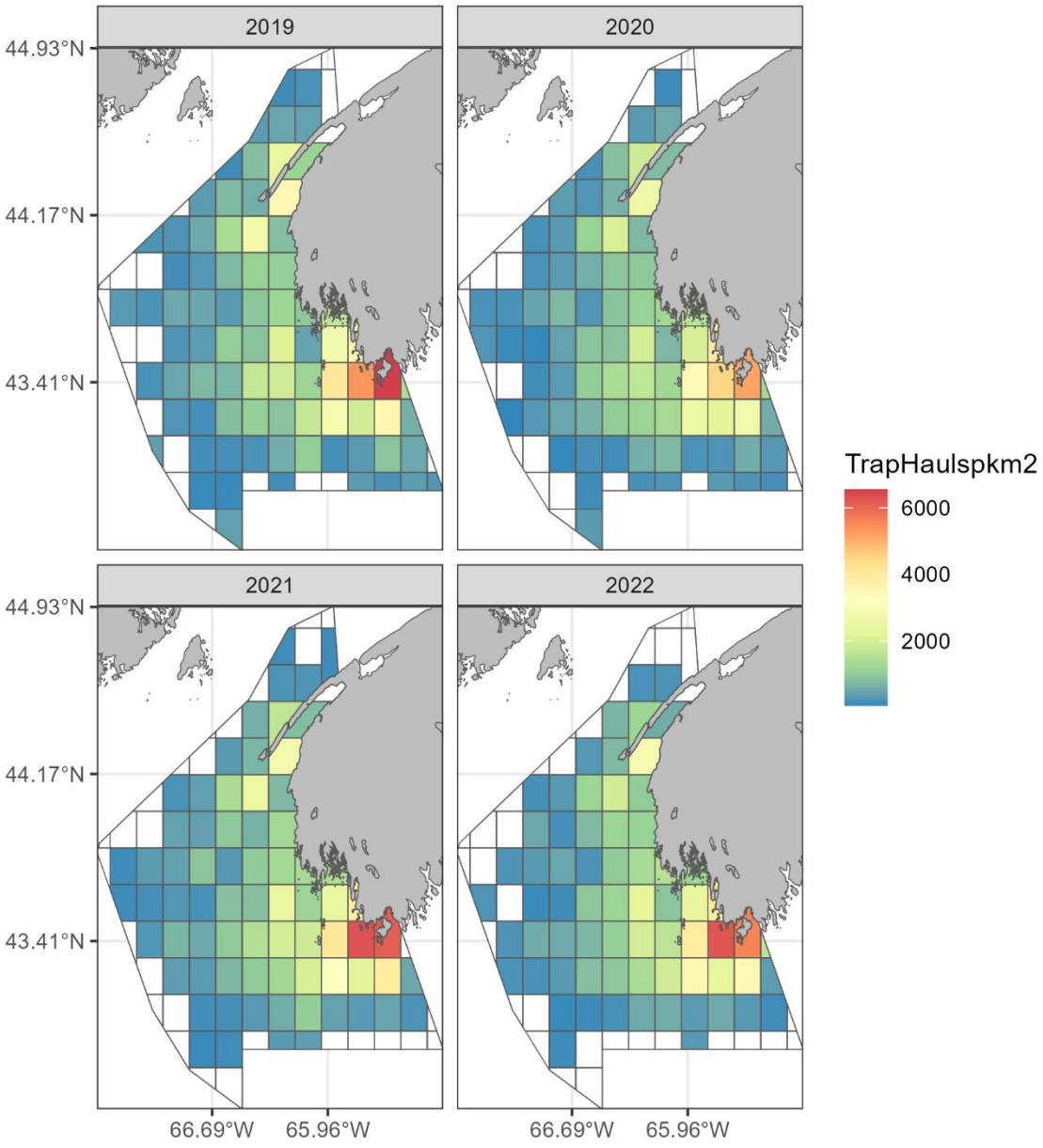

Figure 80: LFA34- Logbook reported number of trap hauls (TH) by grid corrected by the area of the grid (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

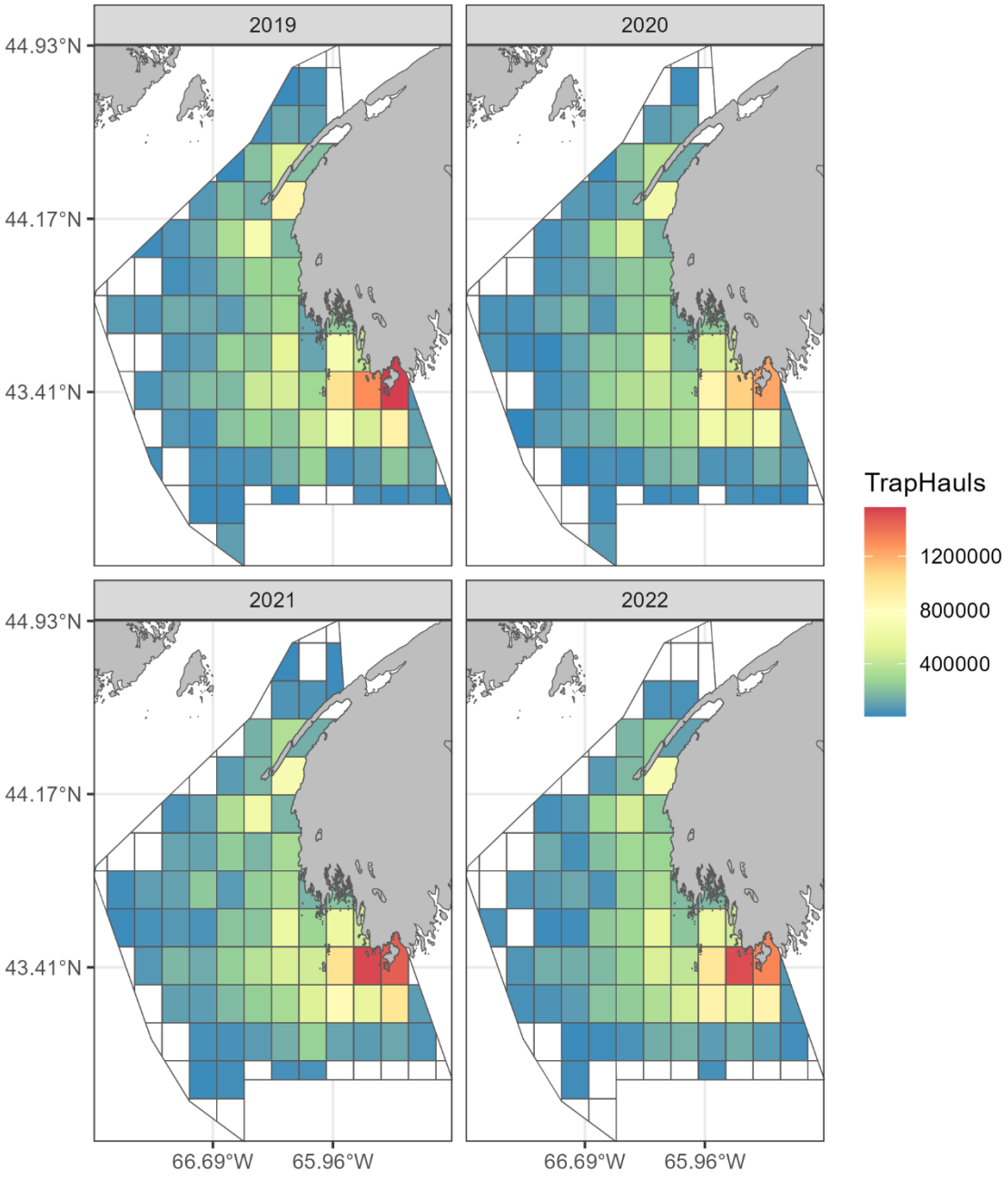

Figure 81: LFA34- Logbook reported number of trap hauls by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

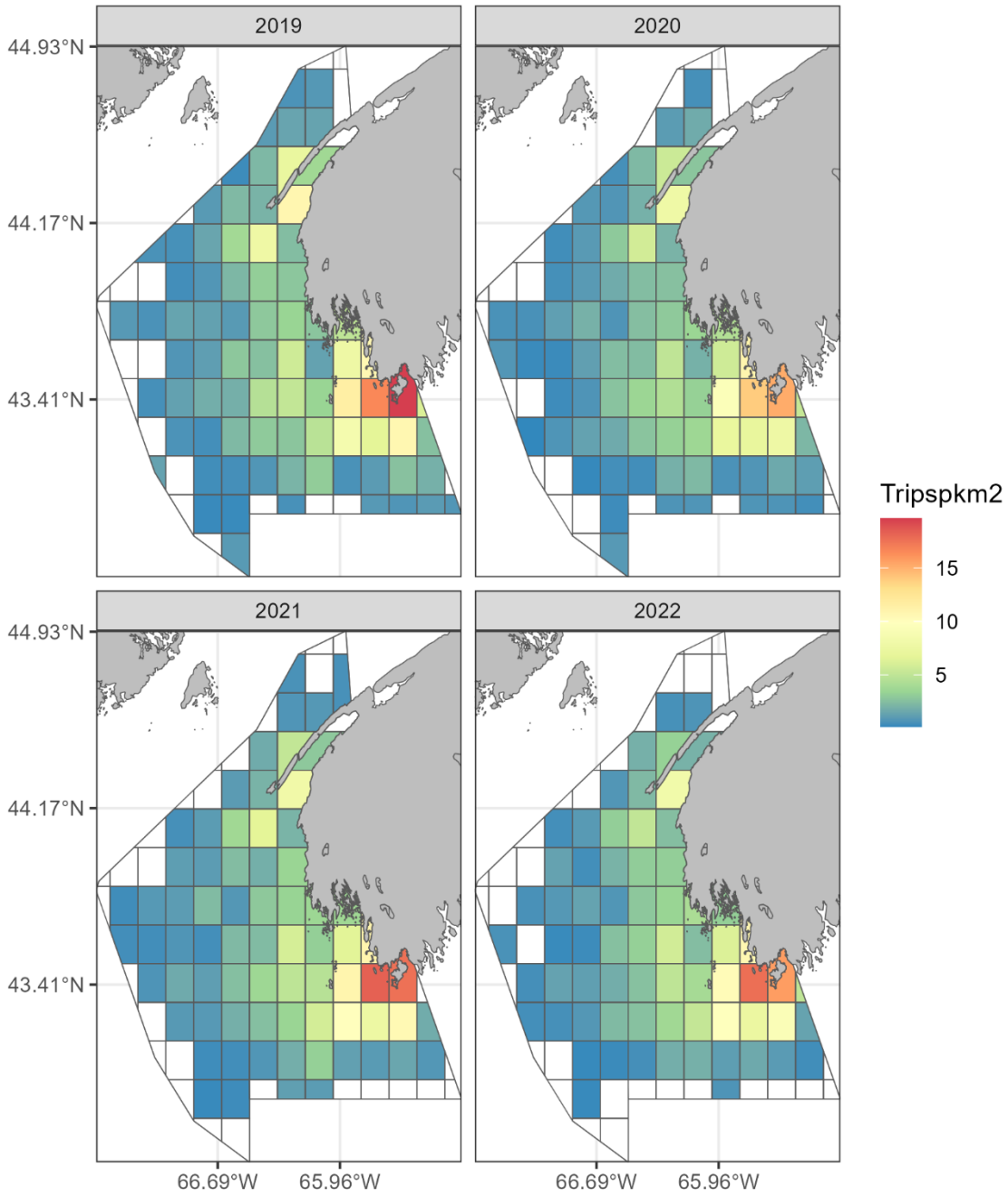

Figure 82: LFA34- Logbook reported number of trips by grid adjusted by area (km ^{2}). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

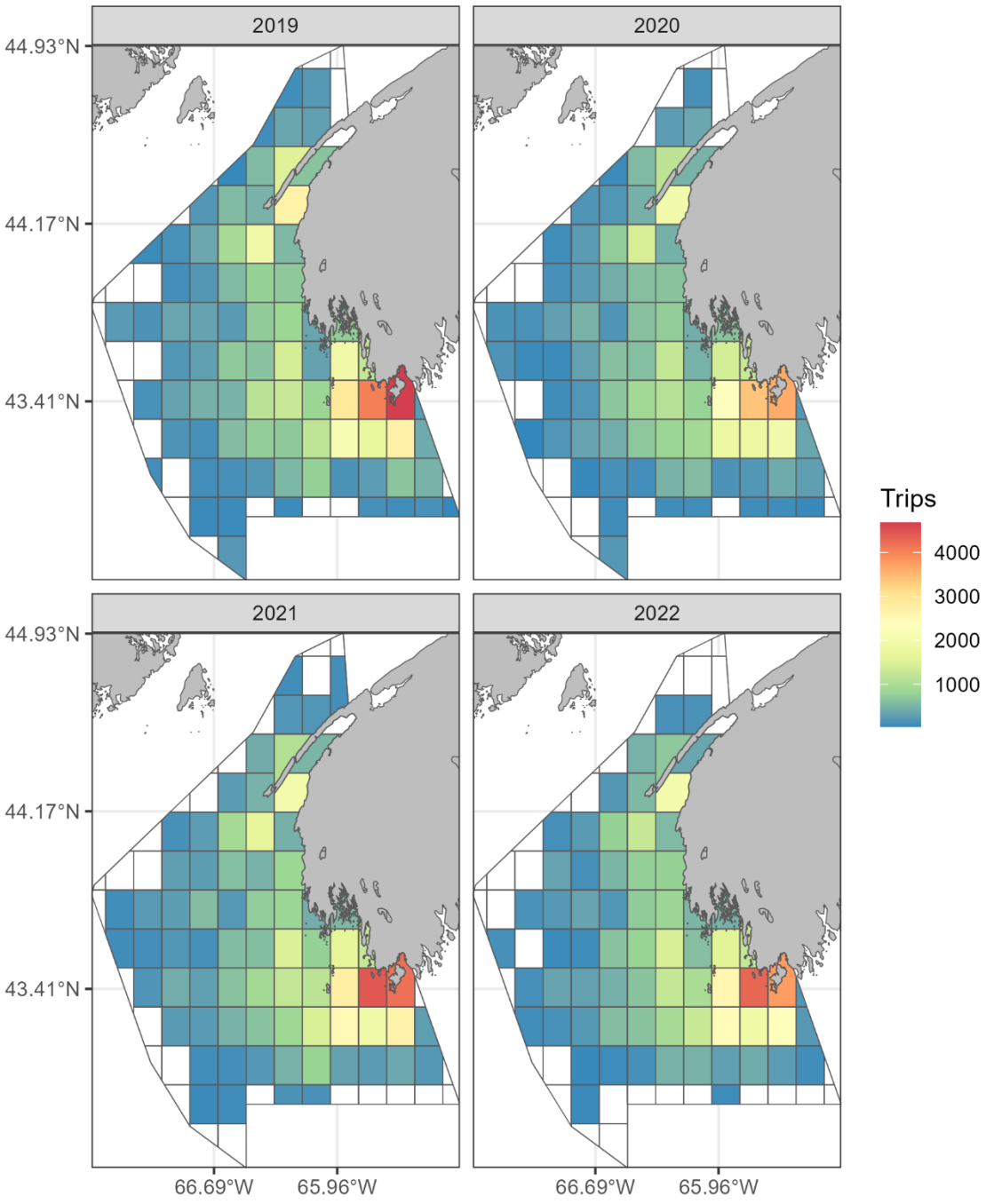

Figure 83: LFA34- Logbook reported number of trips by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

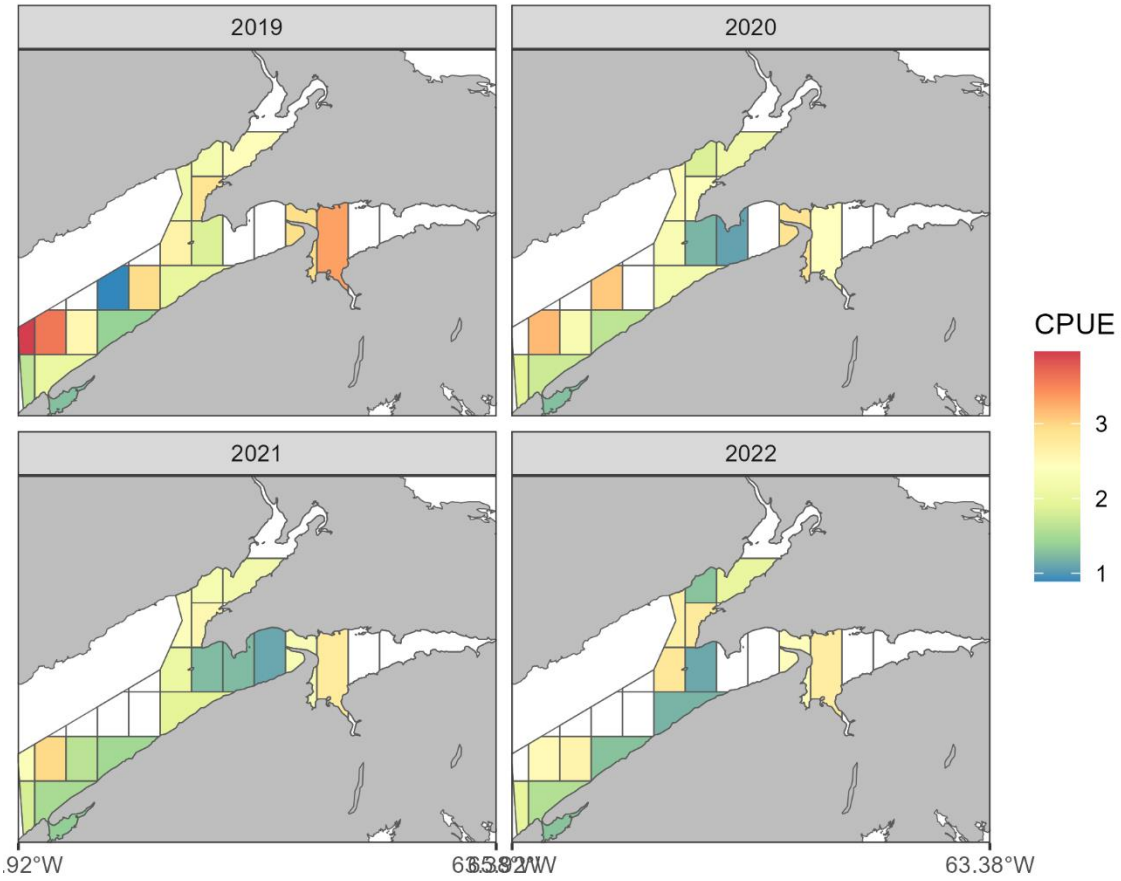

Figure 84: LFA35- Logbook reported catch (kg) per unit effort (trap haul) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

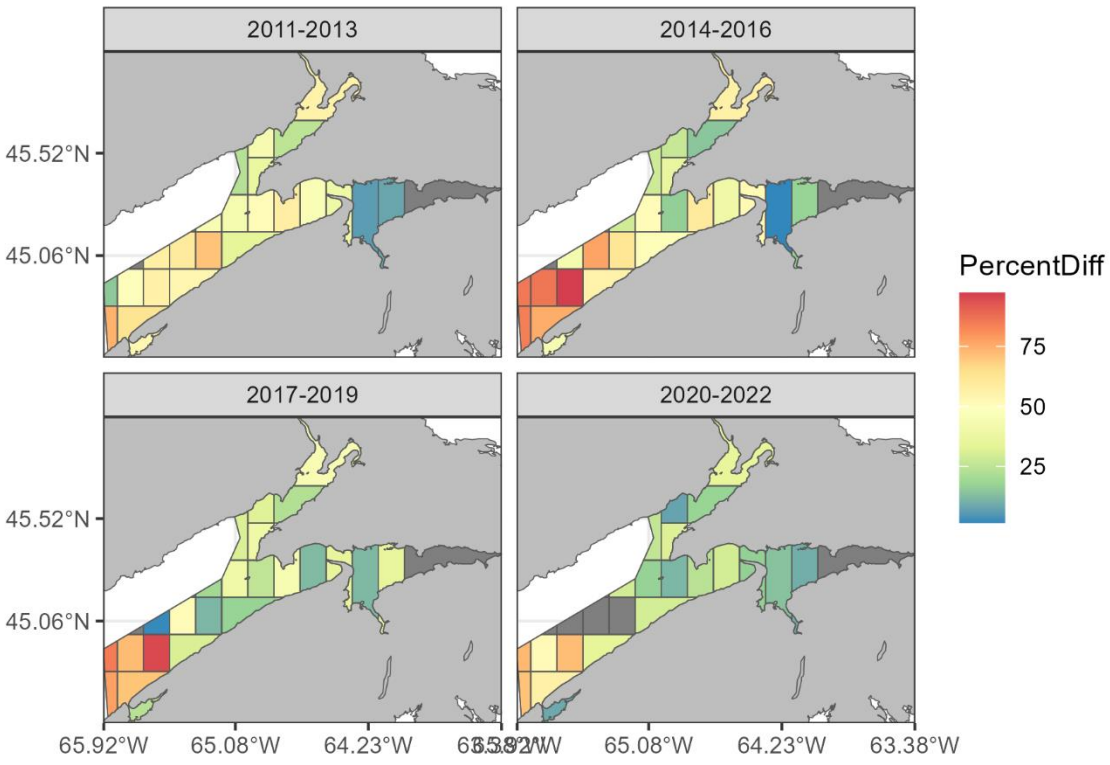

Figure 85: LFA35- Logbook reported grid estimates of percent difference in catch per unit effort (CPUE) relative to mean CPUE between 2006 and 2010. Grey grids indicate where a percent difference could not be estimated.

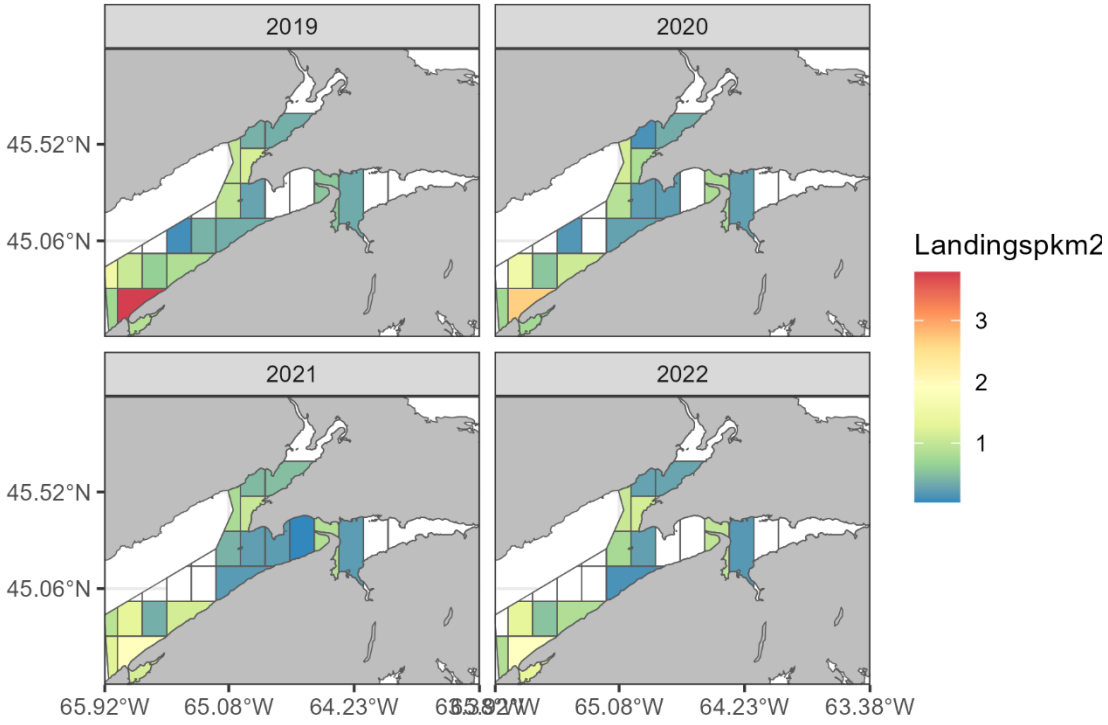

Figure 86: LFA35- Logbook reported Landings (t) by grid adjusted by area (km2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

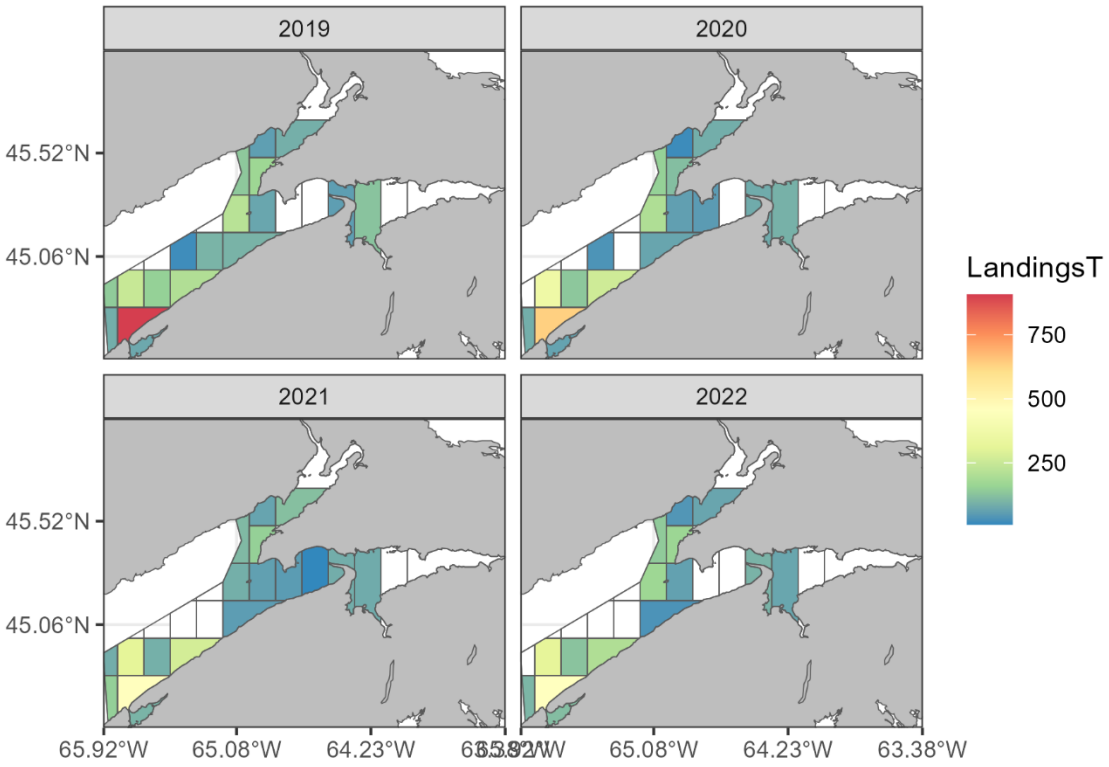

Figure 87: LFA35- Logbook reported Landings (t) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

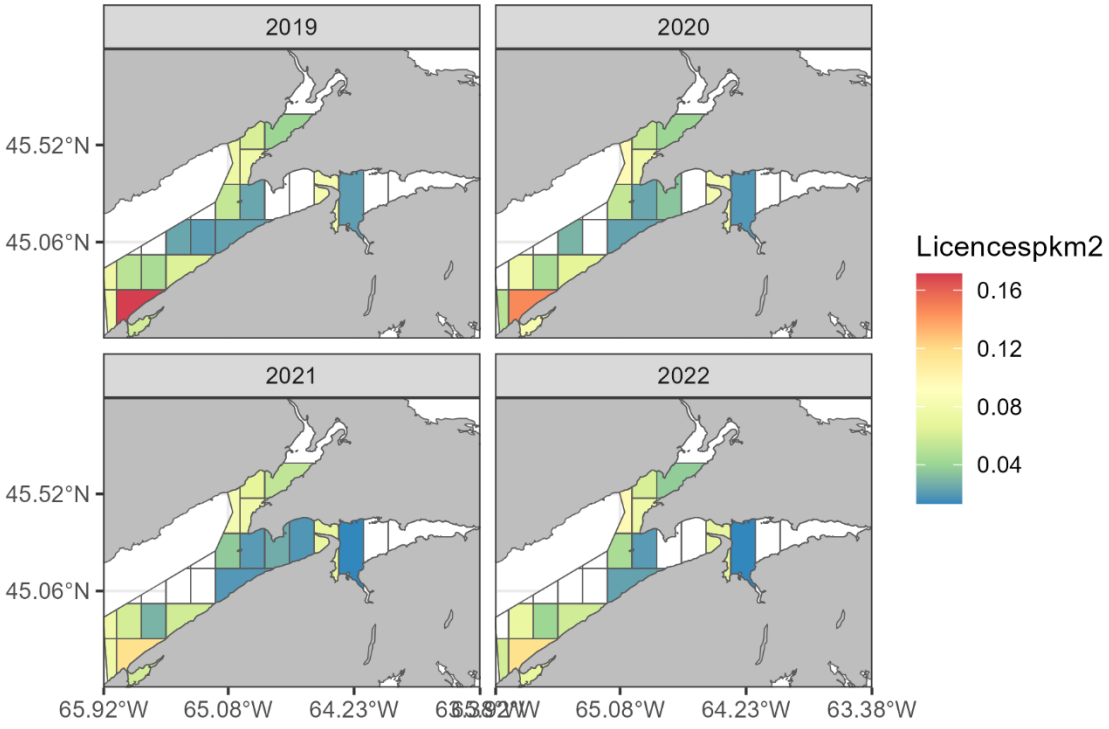

Figure 88: LFA35- Logbook reported number of licences fishing by grid corrected by area (km ^{2}). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

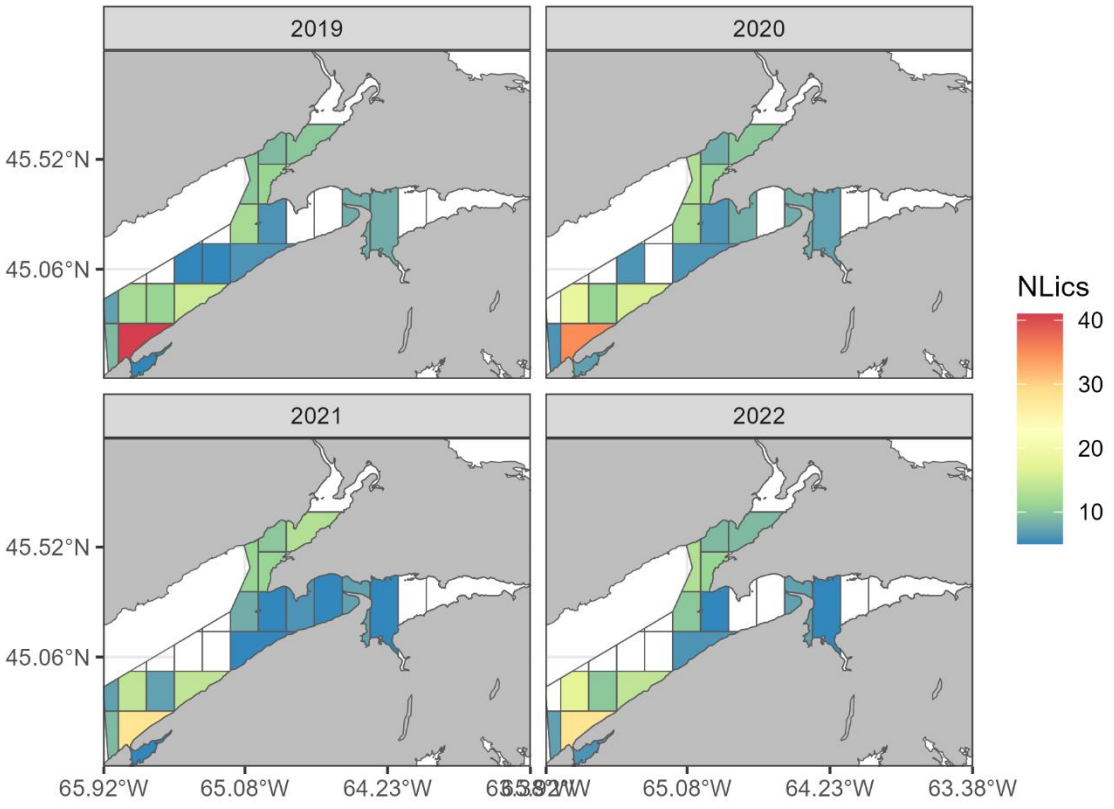

Figure 89: LFA35- Logbook reported number of licences fishing by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

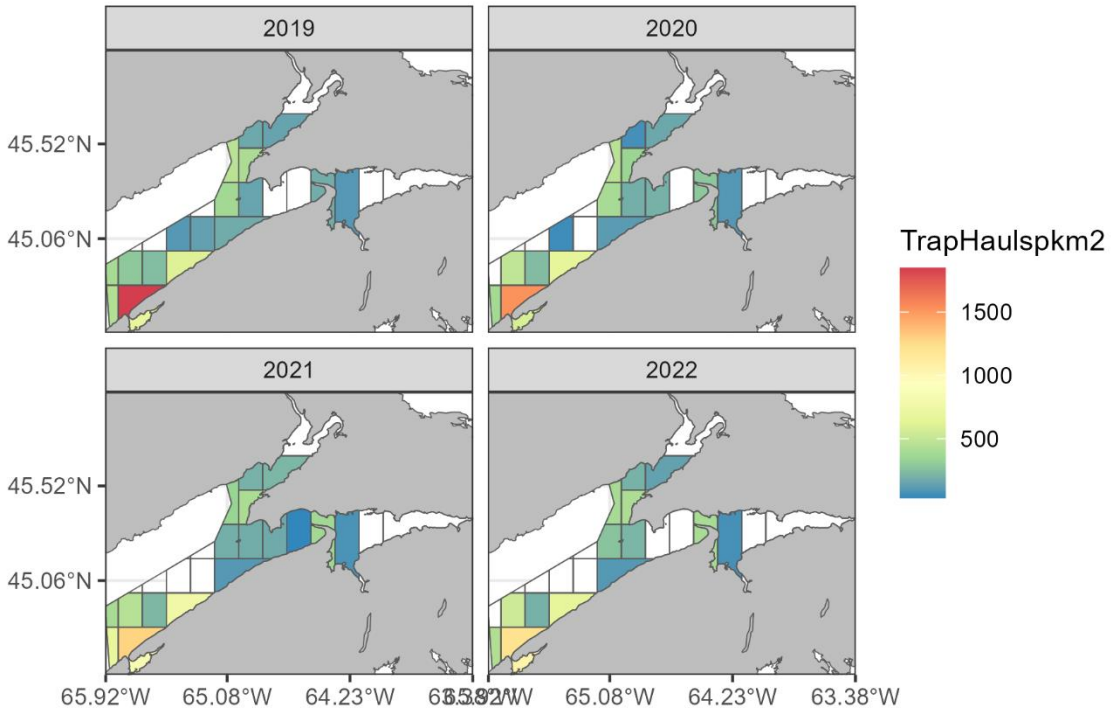

Figure 90: LFA35- Logbook reported number of trap hauls (TH) by grid corrected by the area of the grid (km2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

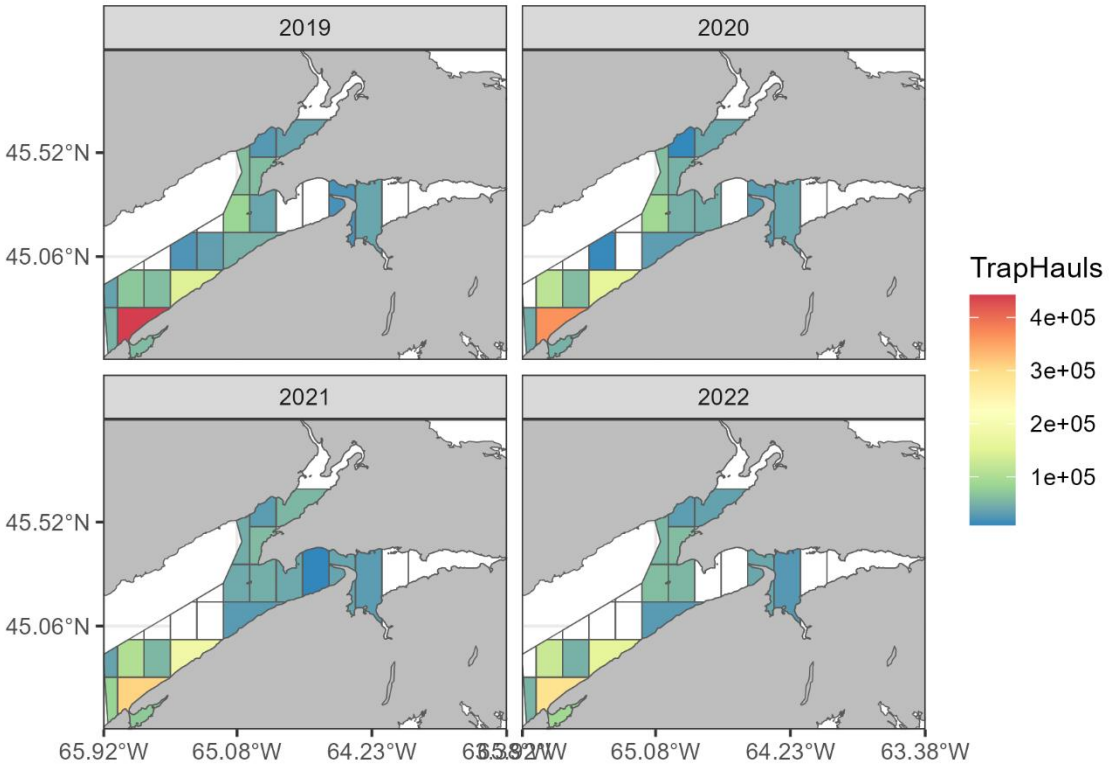

Figure 91: LFA35- Logbook reported number of trap hauls by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

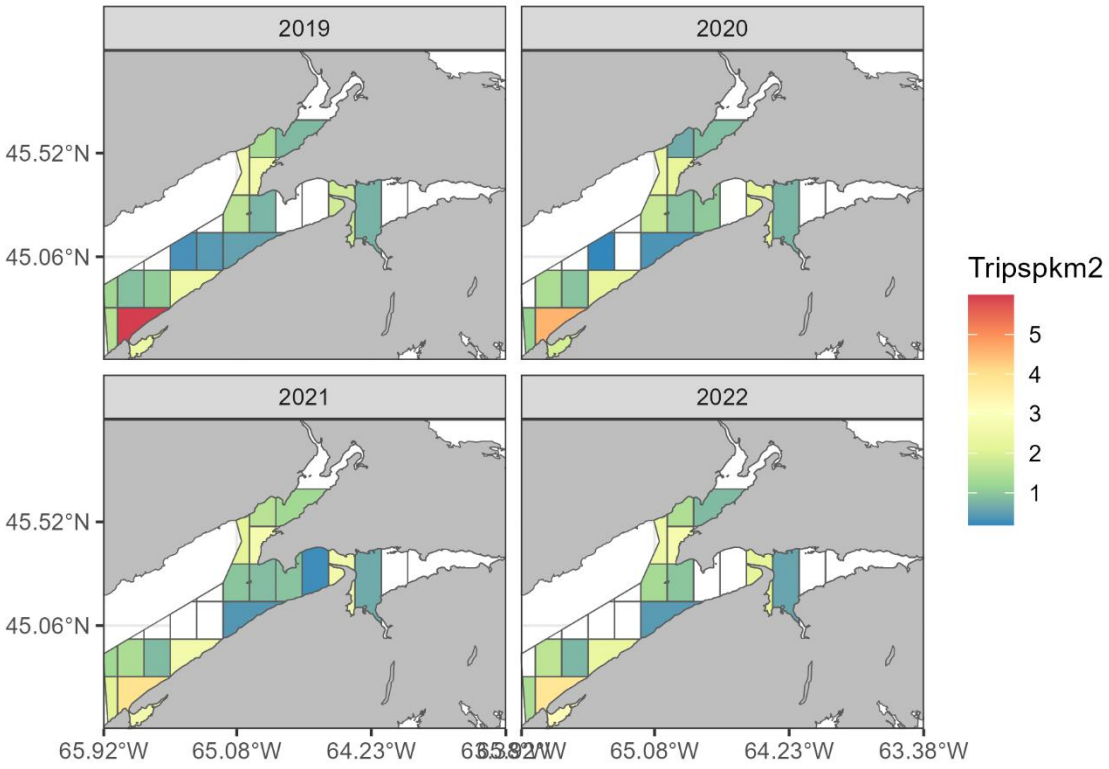

Figure 92: LFA35- Logbook reported number of trips by grid adjusted by area (km ^{2}). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

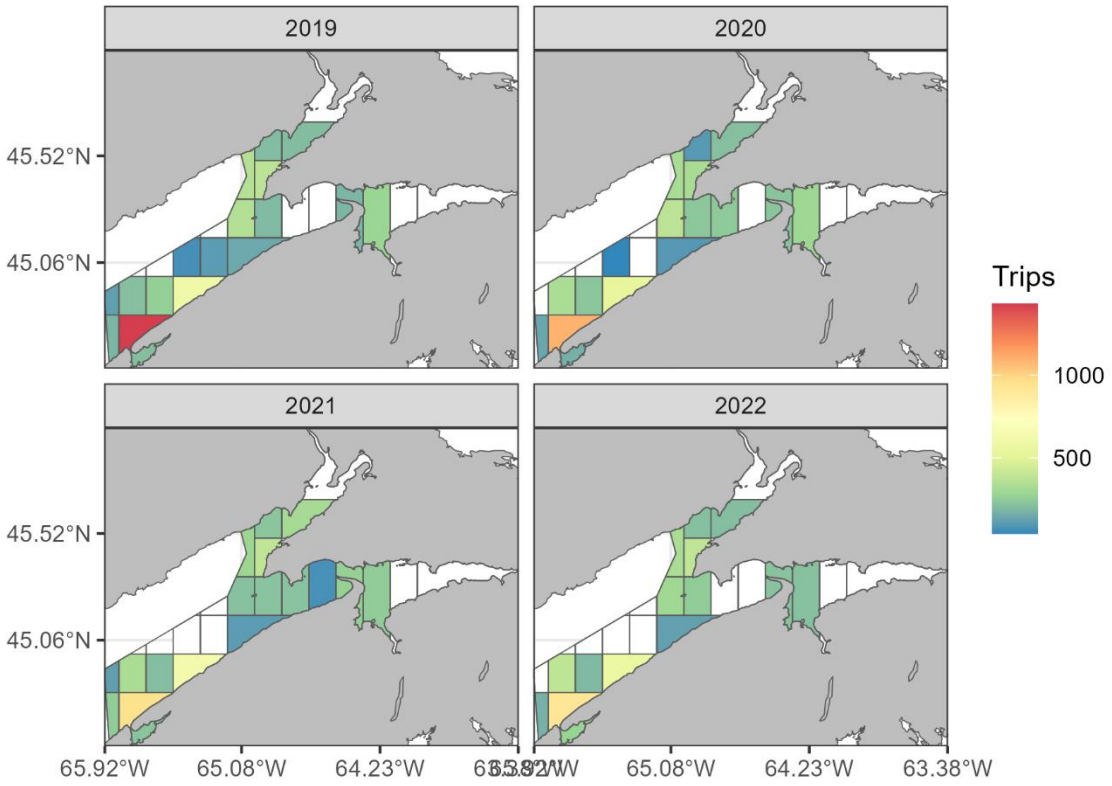

Figure 93: LFA35- Logbook reported number of trips by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

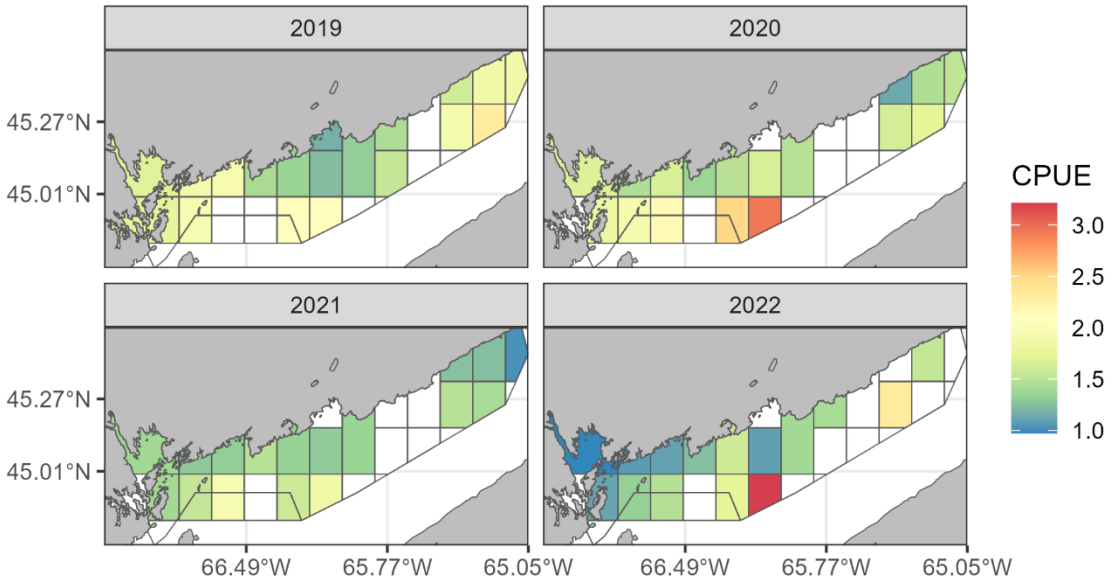

Figure 94: LFA36- Logbook reported catch (kg) per unit effort (trap haul) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

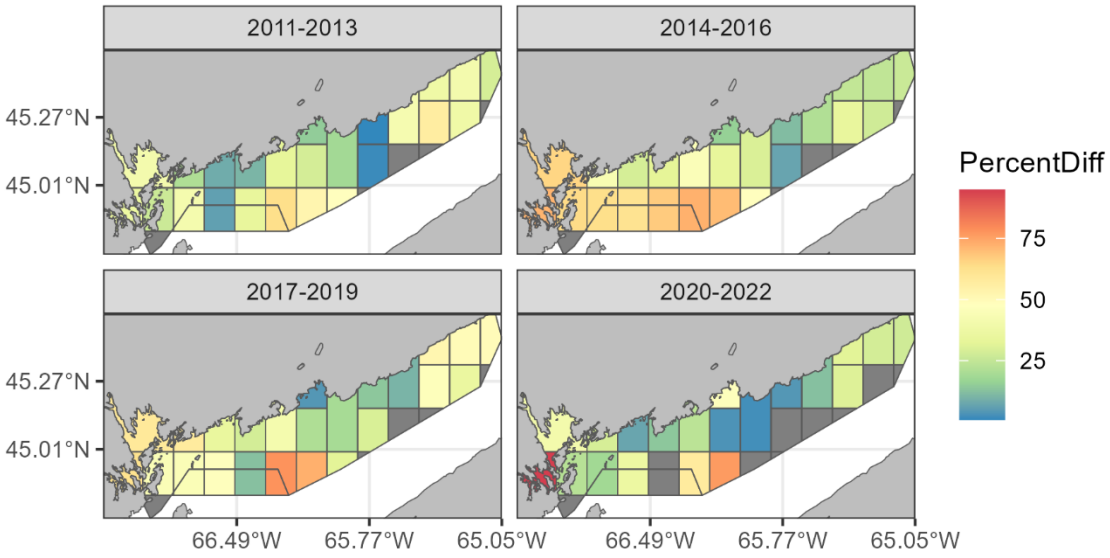

Figure 95: LFA36- Logbook reported grid estimates of percent difference in catch per unit effort (CPUE) relative to mean CPUE between 2006 and 2010. Grey grids indicate where a percent difference could not be estimated.

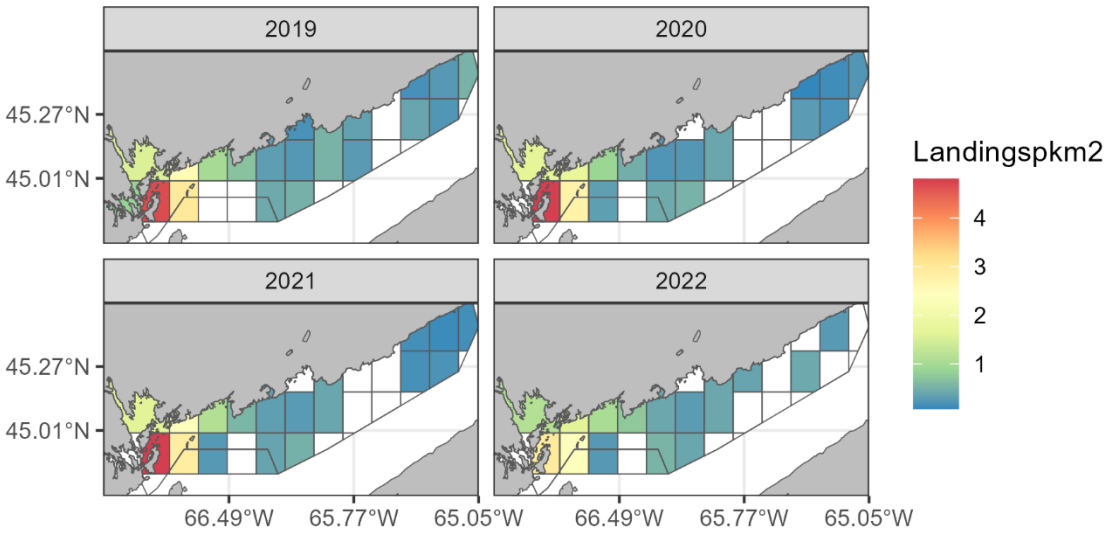

Figure 96: LFA36- Logbook reported Landings (t) by grid adjusted by area (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

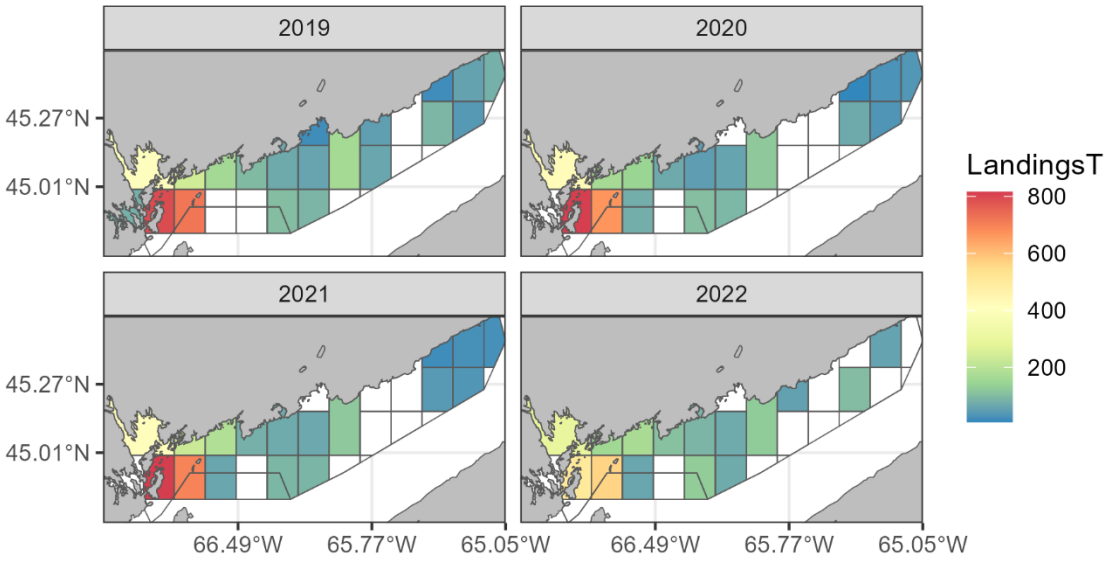

Figure 97: LFA36- Logbook reported Landings (t) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

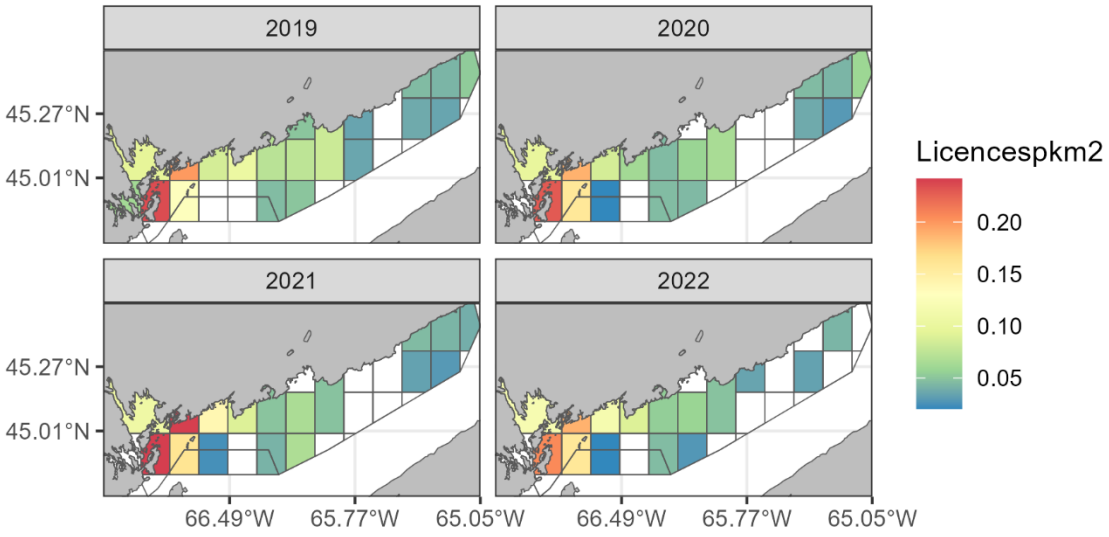

Figure 98: LFA36- Logbook reported number of licences fishing by grid corrected by area (km ^{2}). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

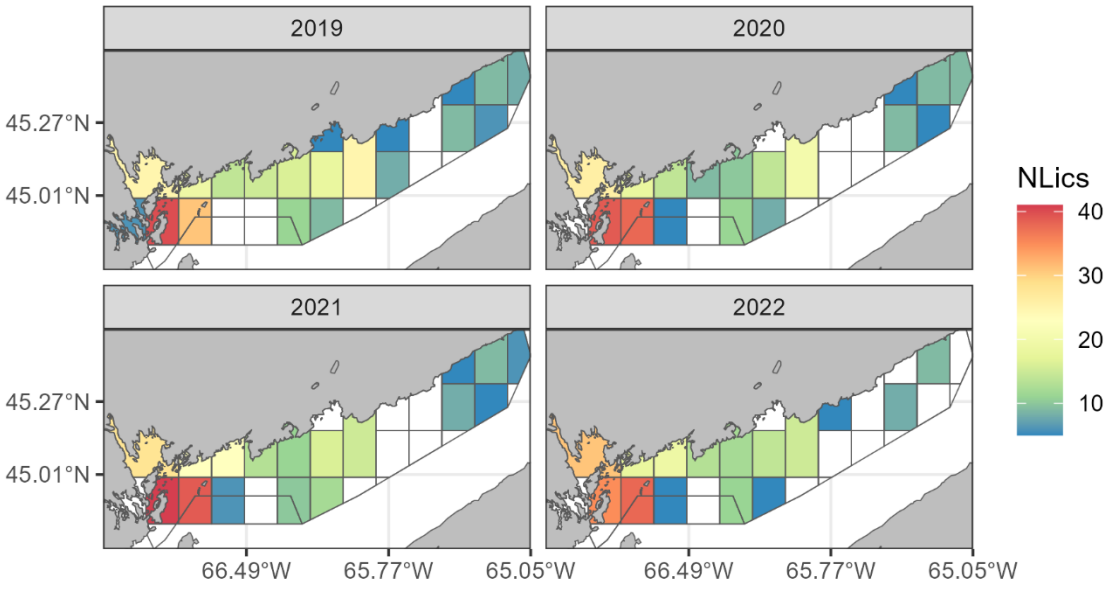

Figure 99: LFA36- Logbook reported number of licences fishing by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

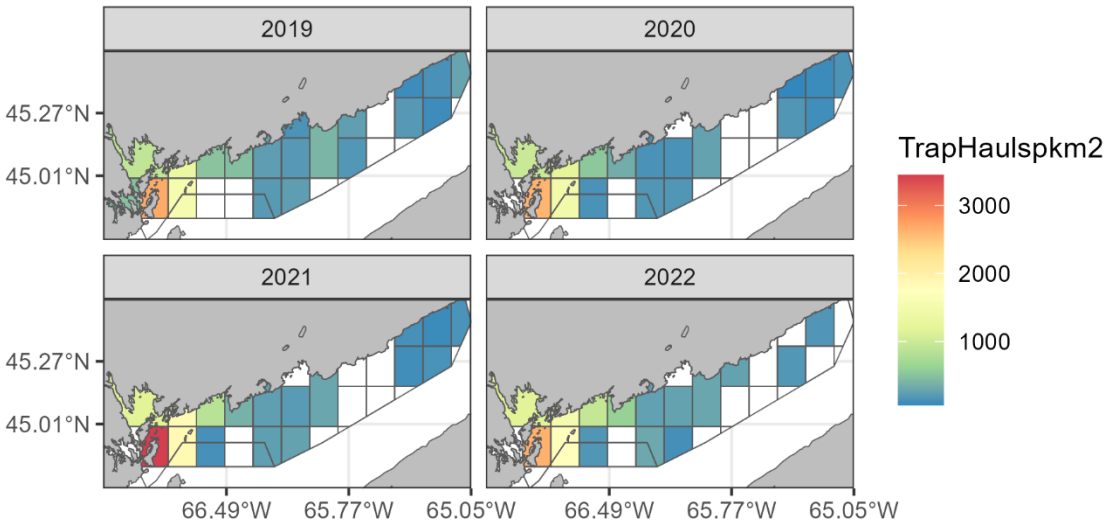

Figure 100: LFA36- Logbook reported number of trap hauls (TH) by grid corrected by the area of the grid (km^2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

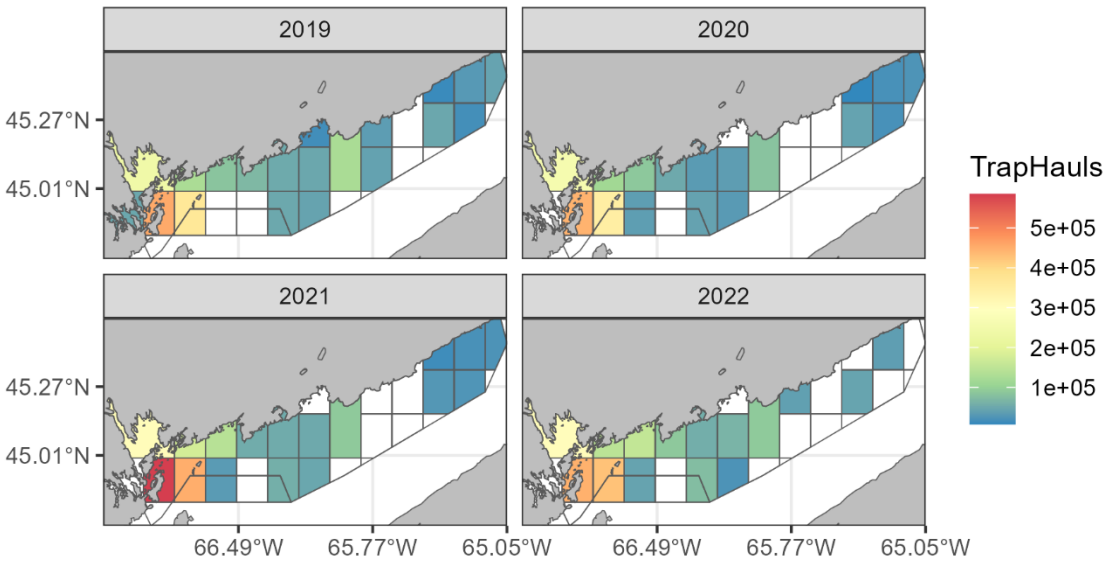

Figure 101: LFA36- Logbook reported number of trap hauls by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

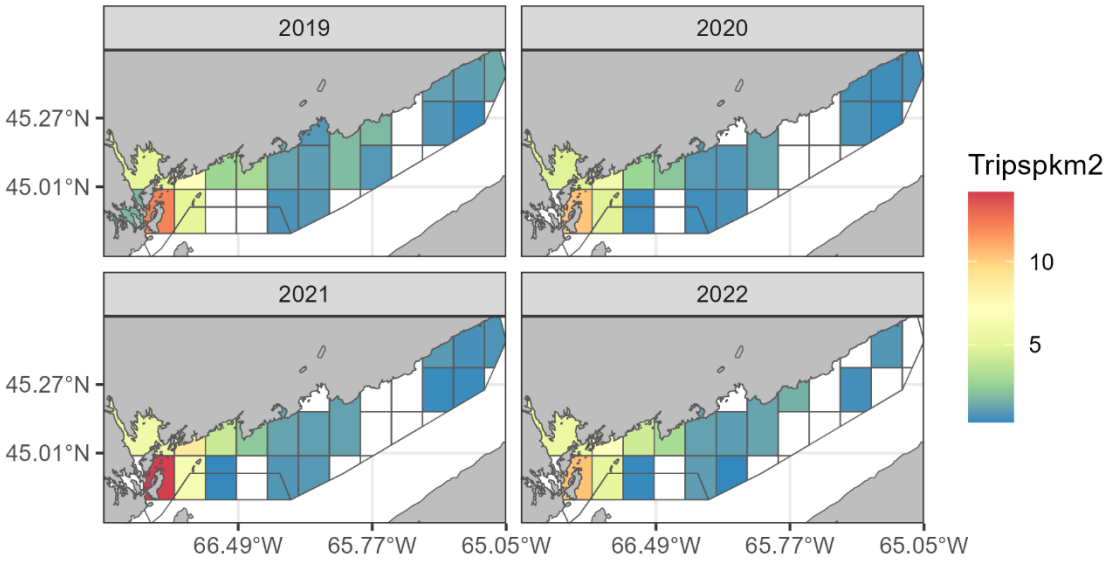

Figure 102: LFA36- Logbook reported number of trips by grid adjusted by area (km ^{2}). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

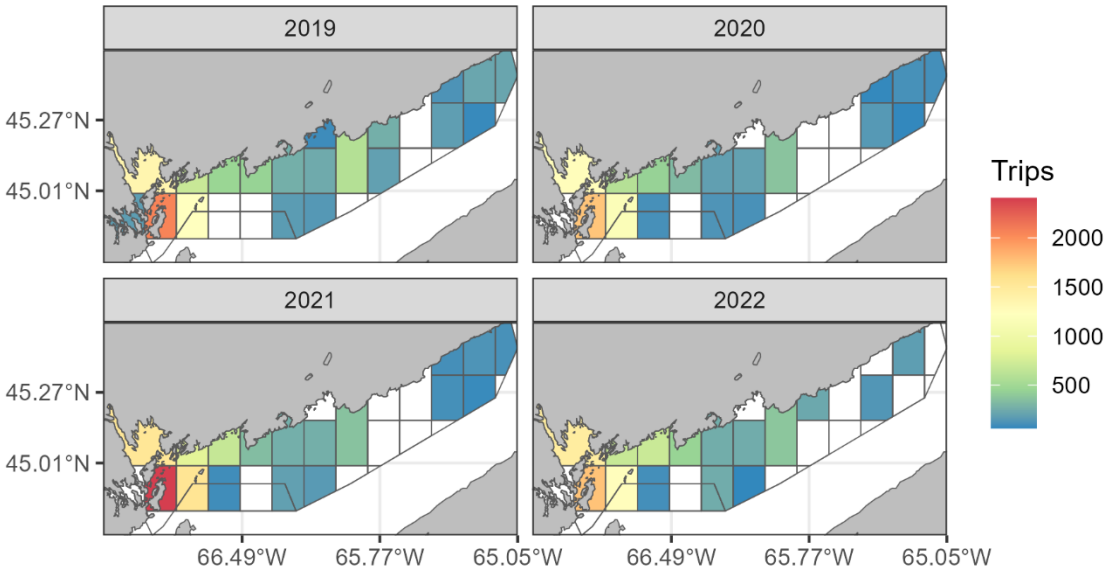

Figure 103: LFA36- Logbook reported number of trips by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

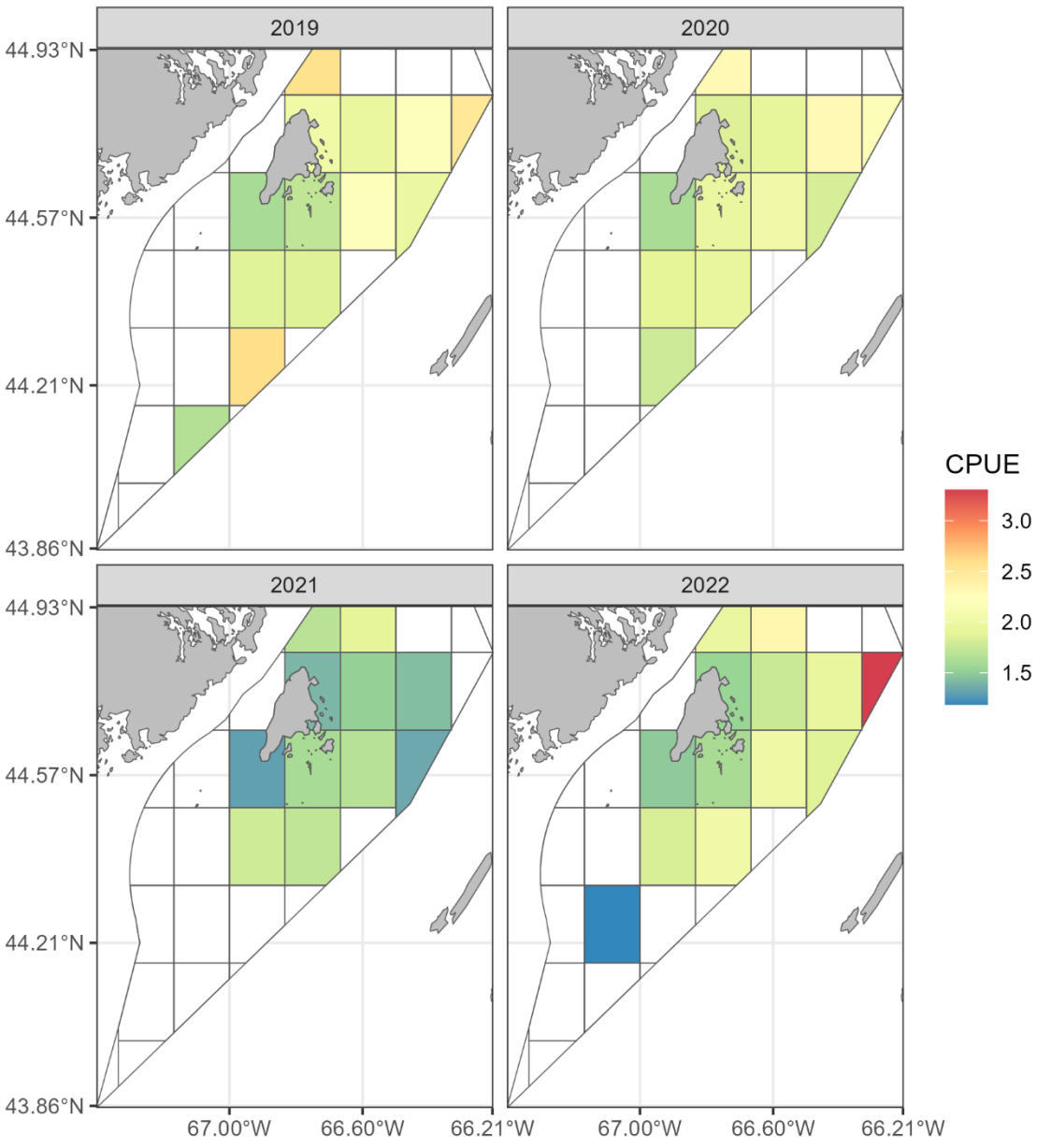

Figure 104: LFA38- Logbook reported catch (kg) per unit effort (trap haul) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

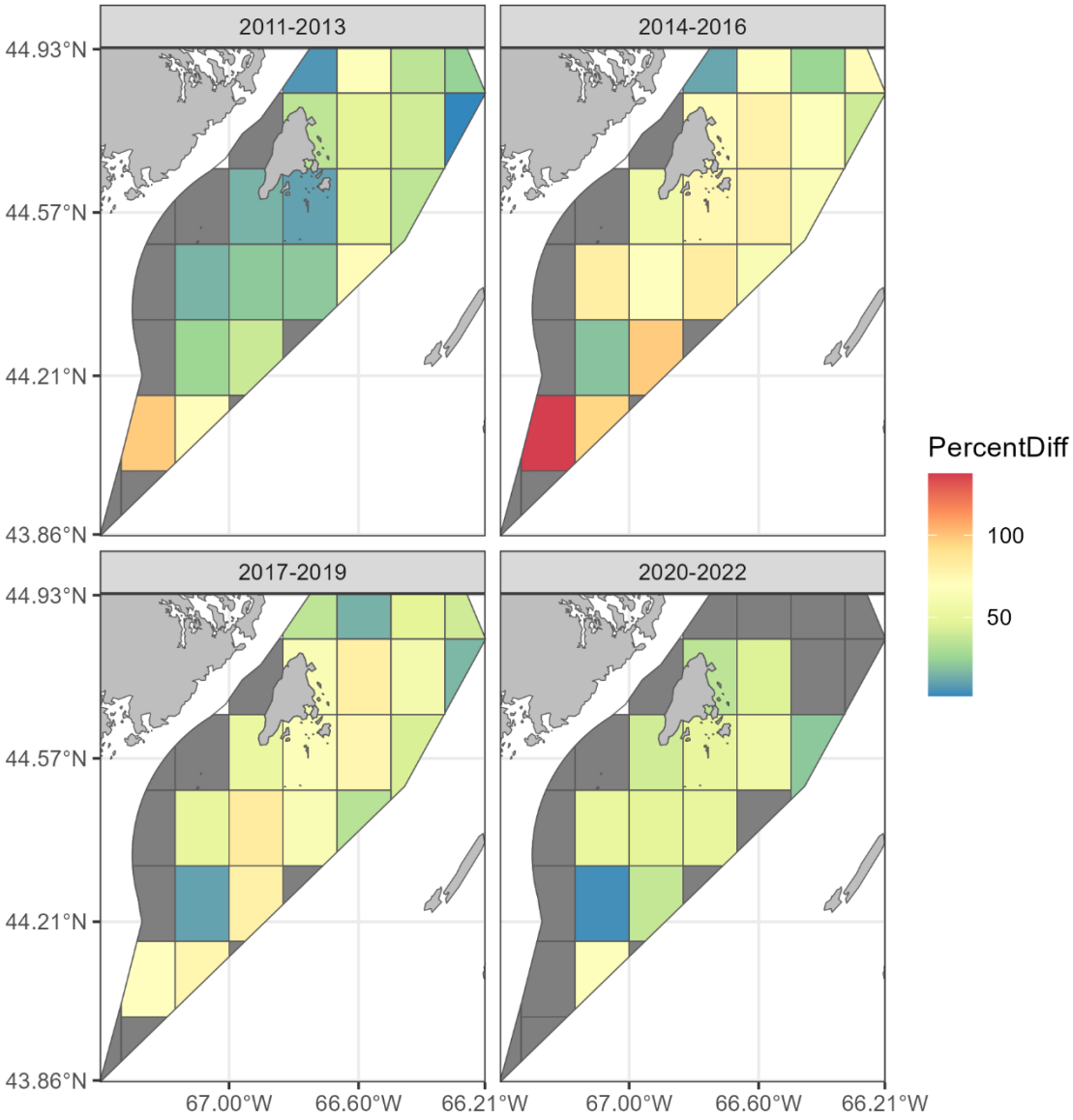

Figure 105: LFA38- Logbook reported grid estimates of percent difference in catch per unit effort (CPUE) relative to mean CPUE between 2006 and 2010. Grey grids indicate where a percent difference could not be estimated.

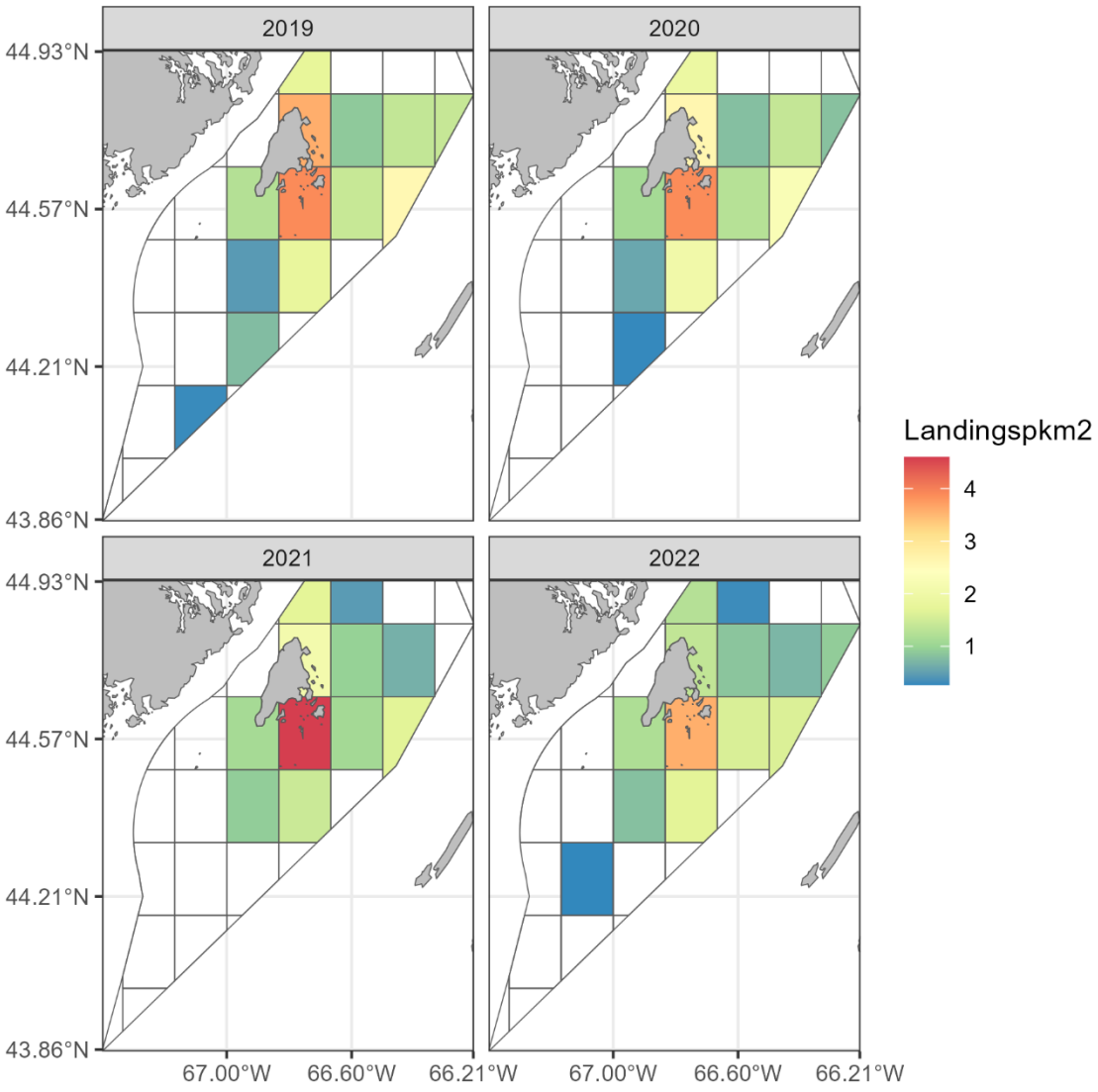

Figure 106: LFA38- Logbook reported Landings (t) by grid adjusted by area (km2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

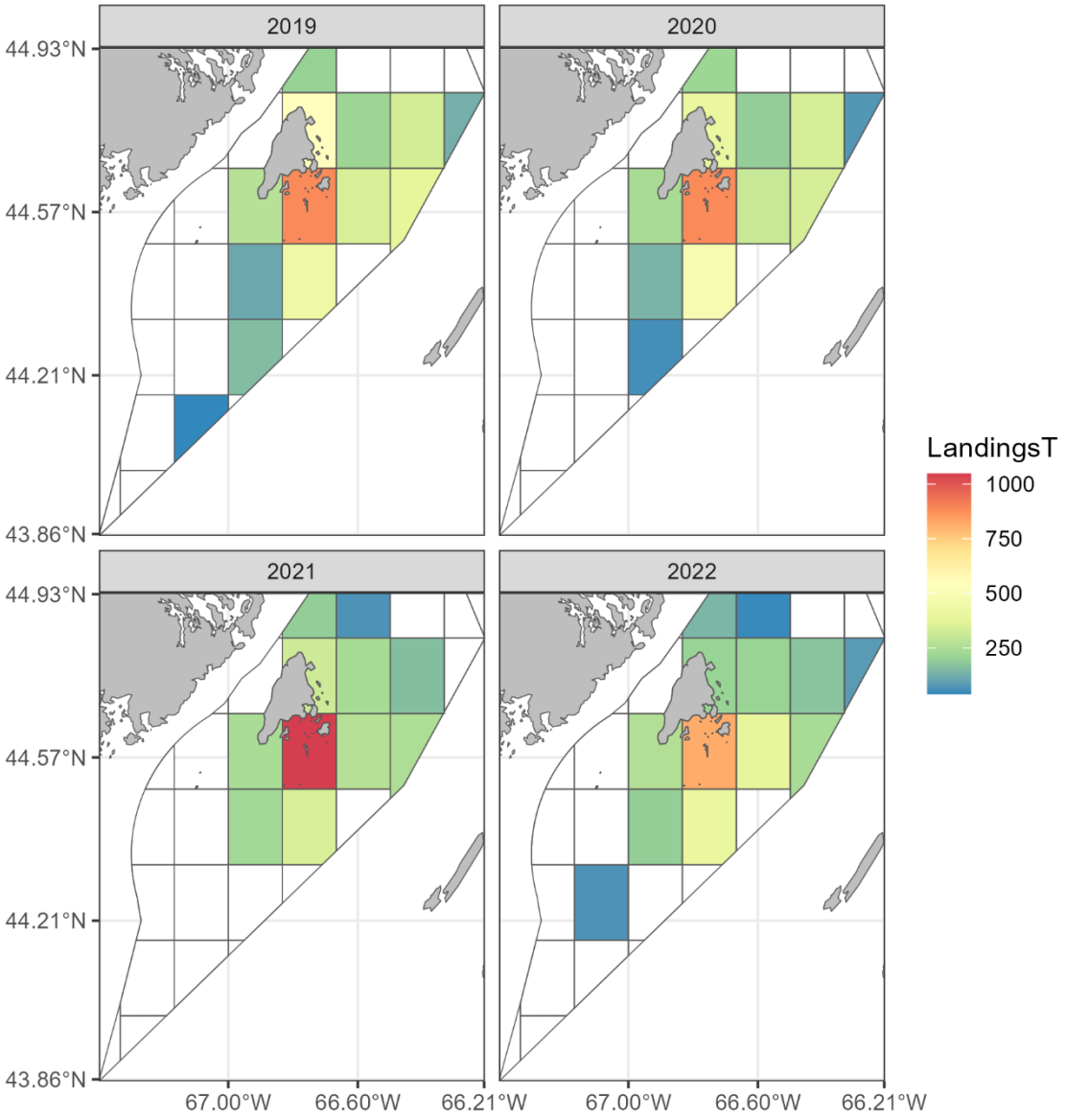

Figure 107: LFA38- Logbook reported Landings (t) by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

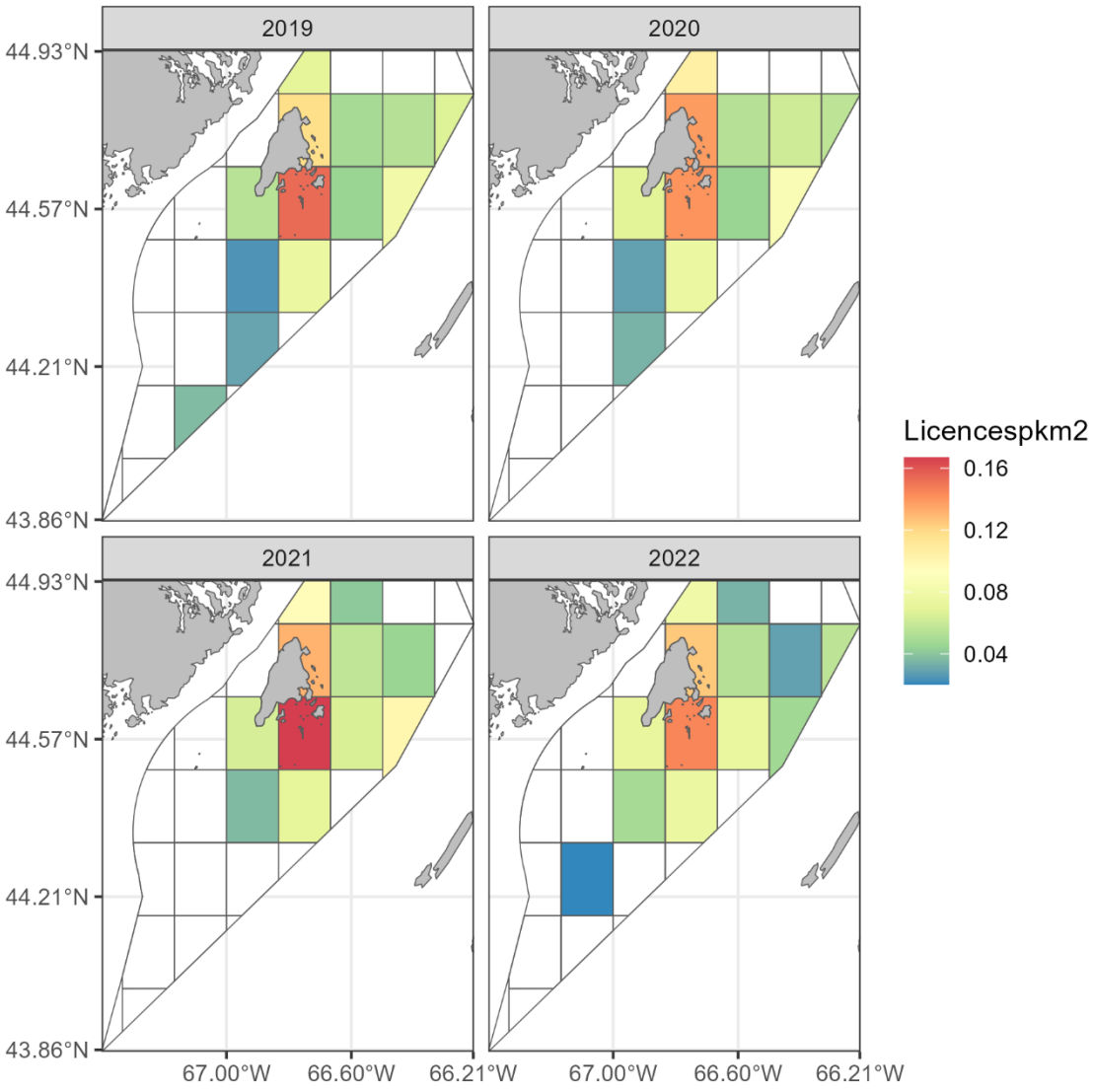

Figure 108: LFA38- Logbook reported number of licences fishing by grid corrected by area (km ^{2}). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

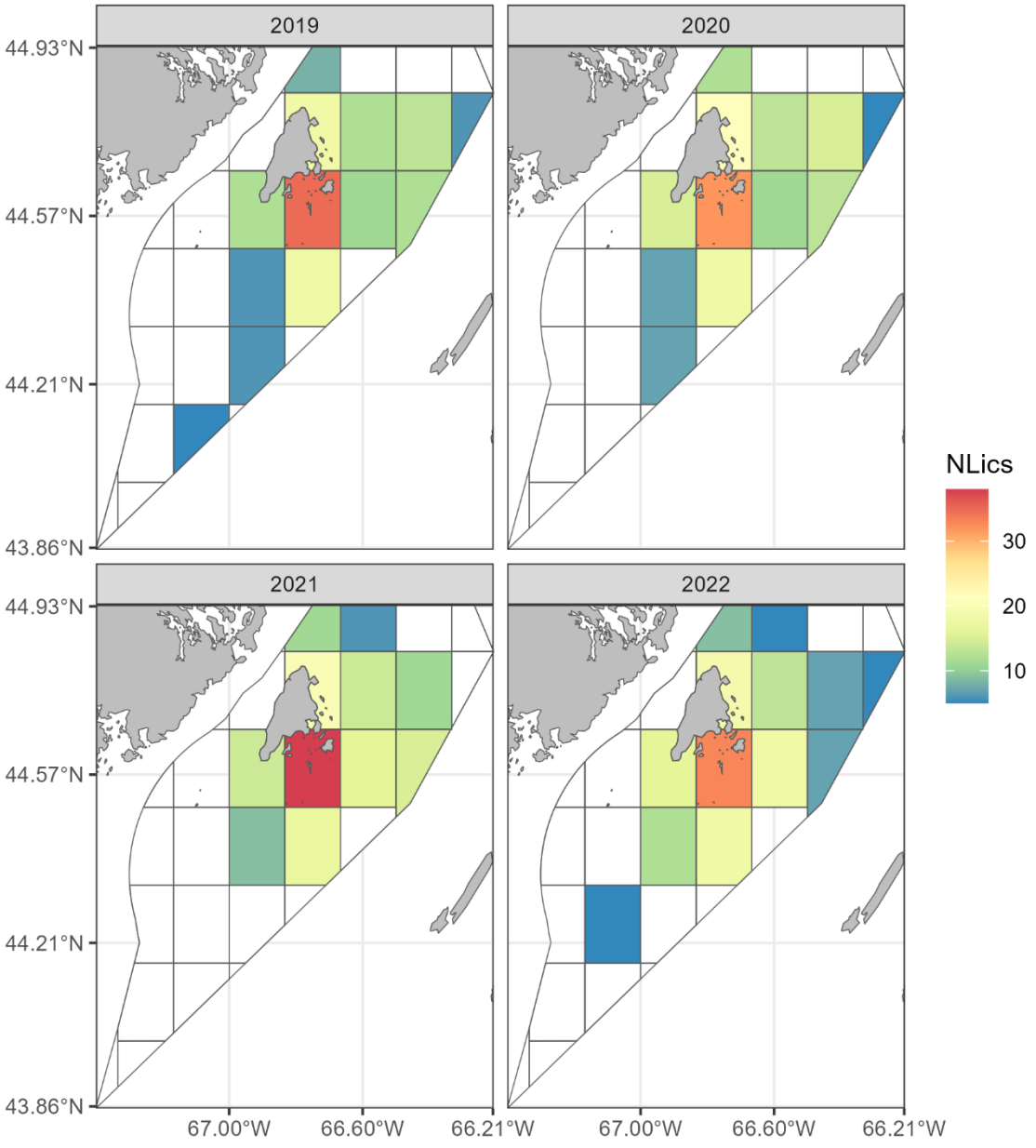

Figure 109: LFA38- Logbook reported number of licences fishing by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

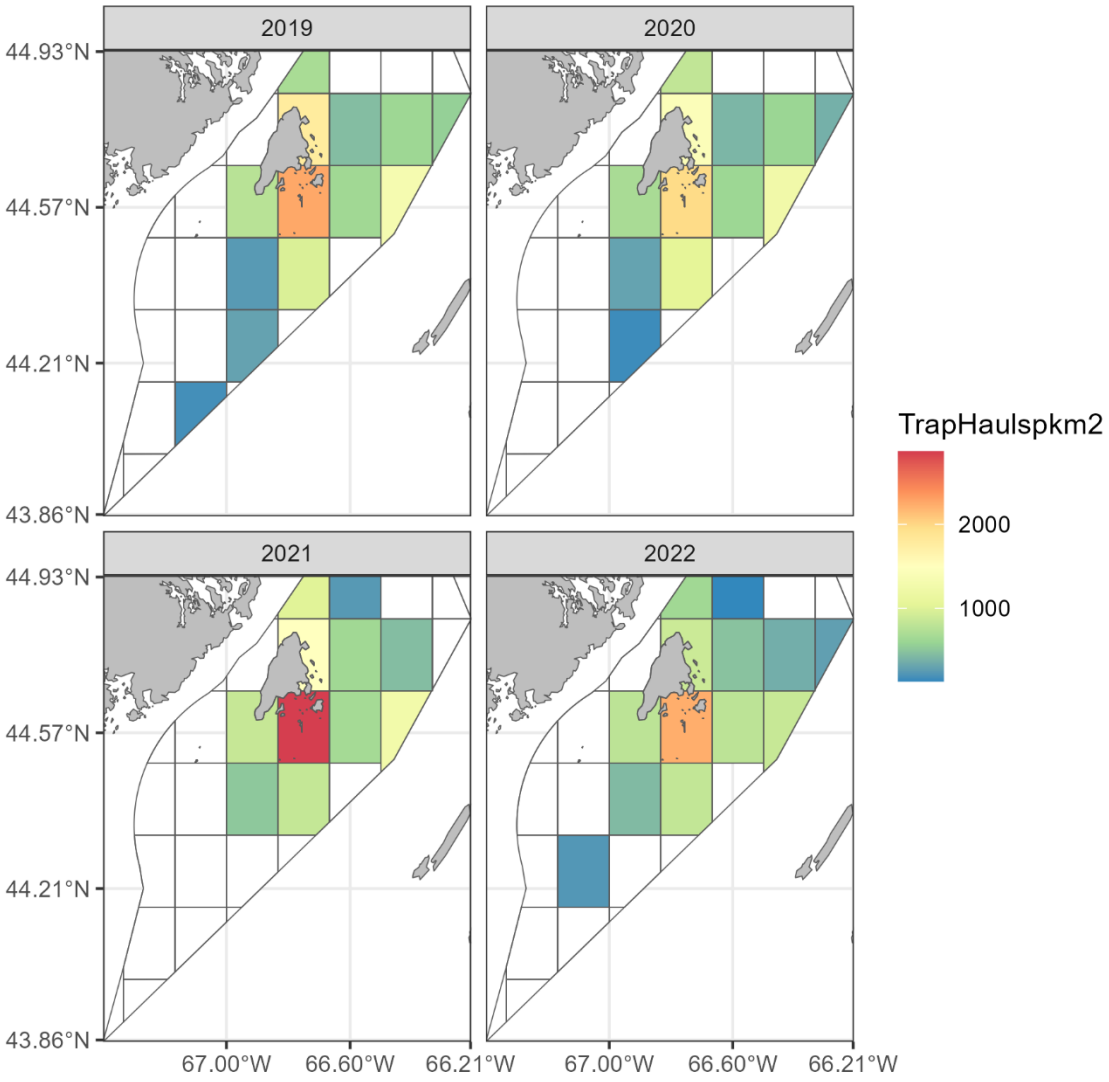

Figure 110: LFA38- Logbook reported number of trap hauls (TH) by grid corrected by the area of the grid (km2). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

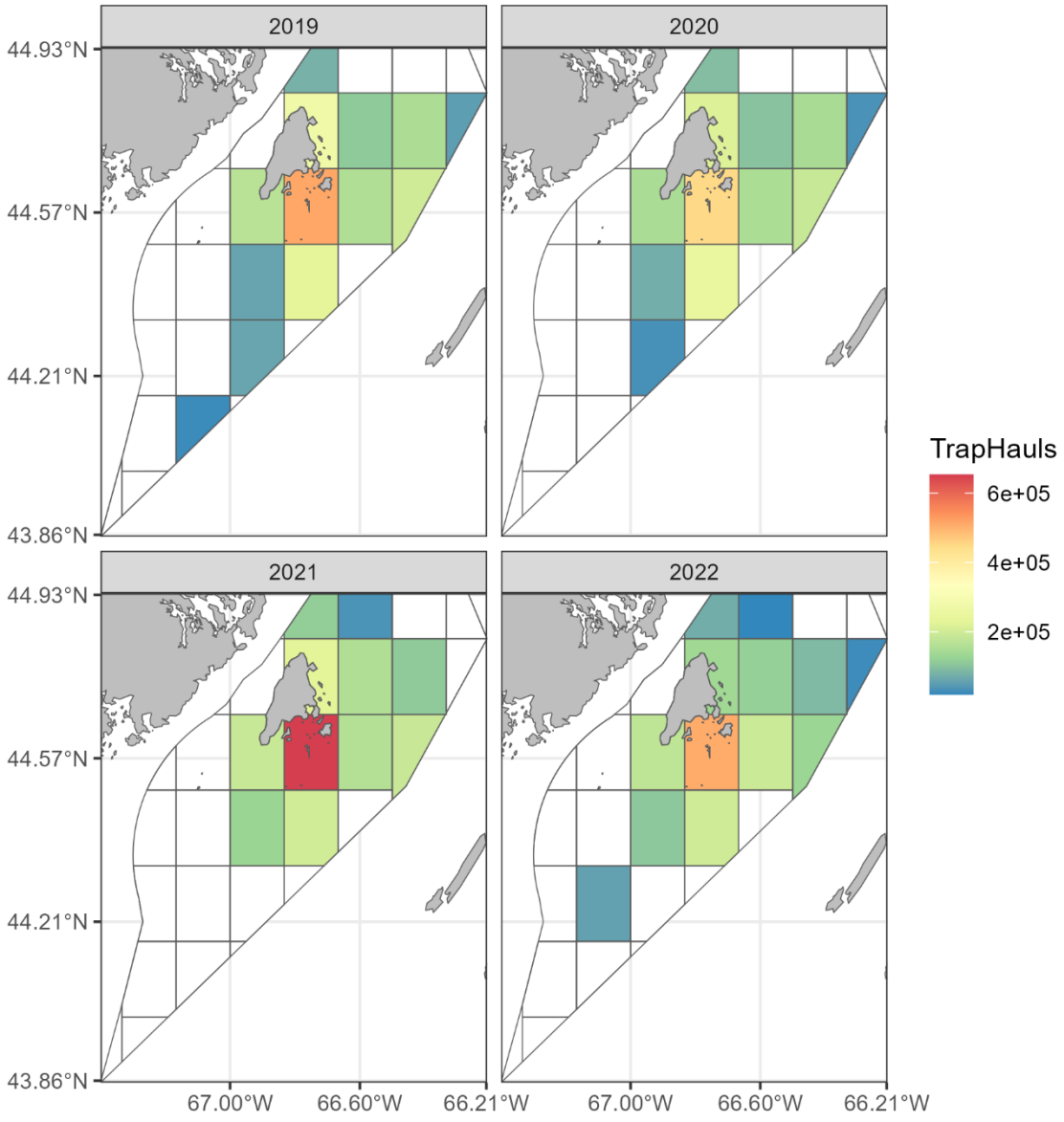

Figure 111: LFA38- Logbook reported number of trap hauls by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

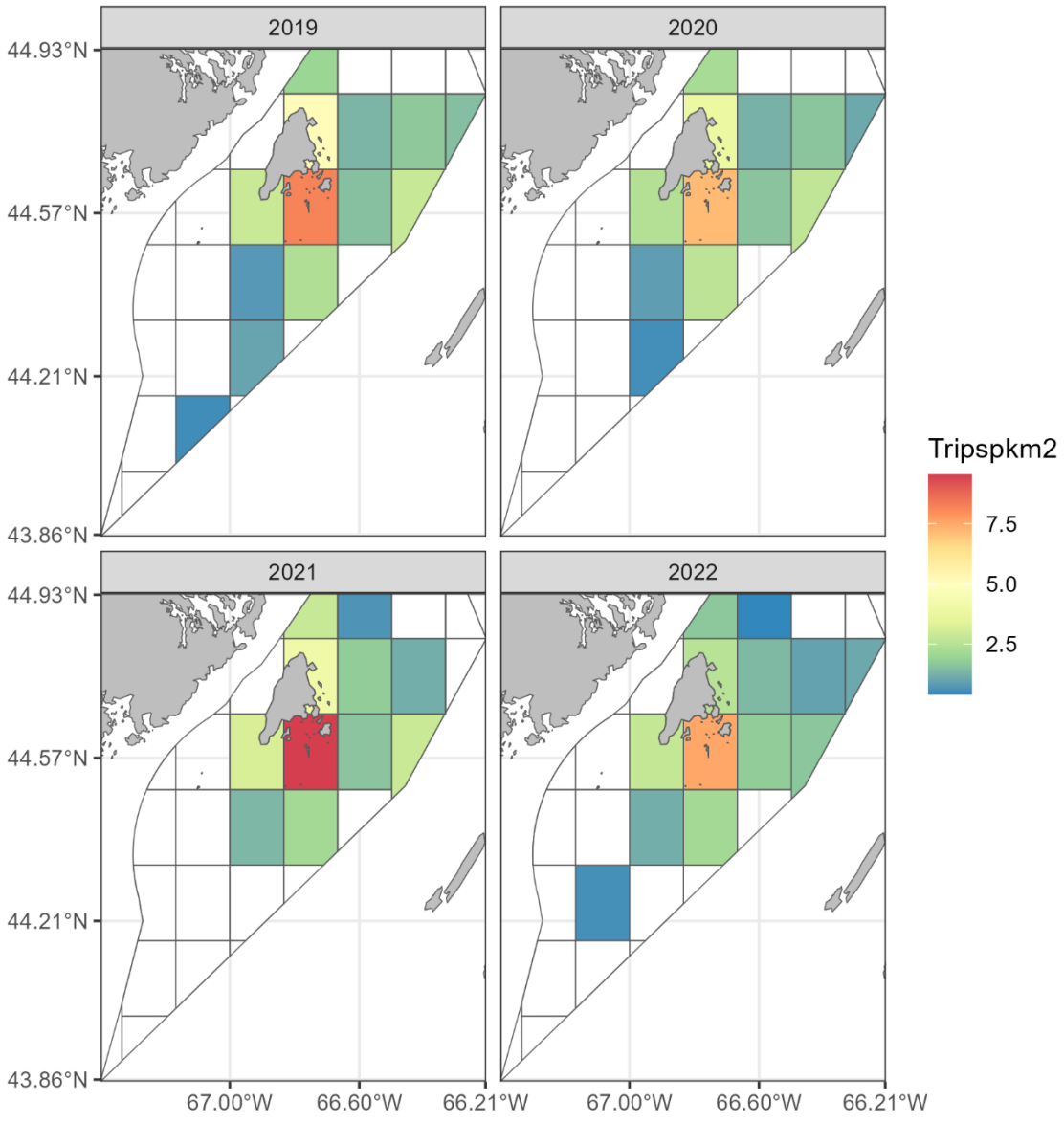

Figure 112: LFA38- Logbook reported number of trips by grid adjusted by area (km ^{2}). White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).

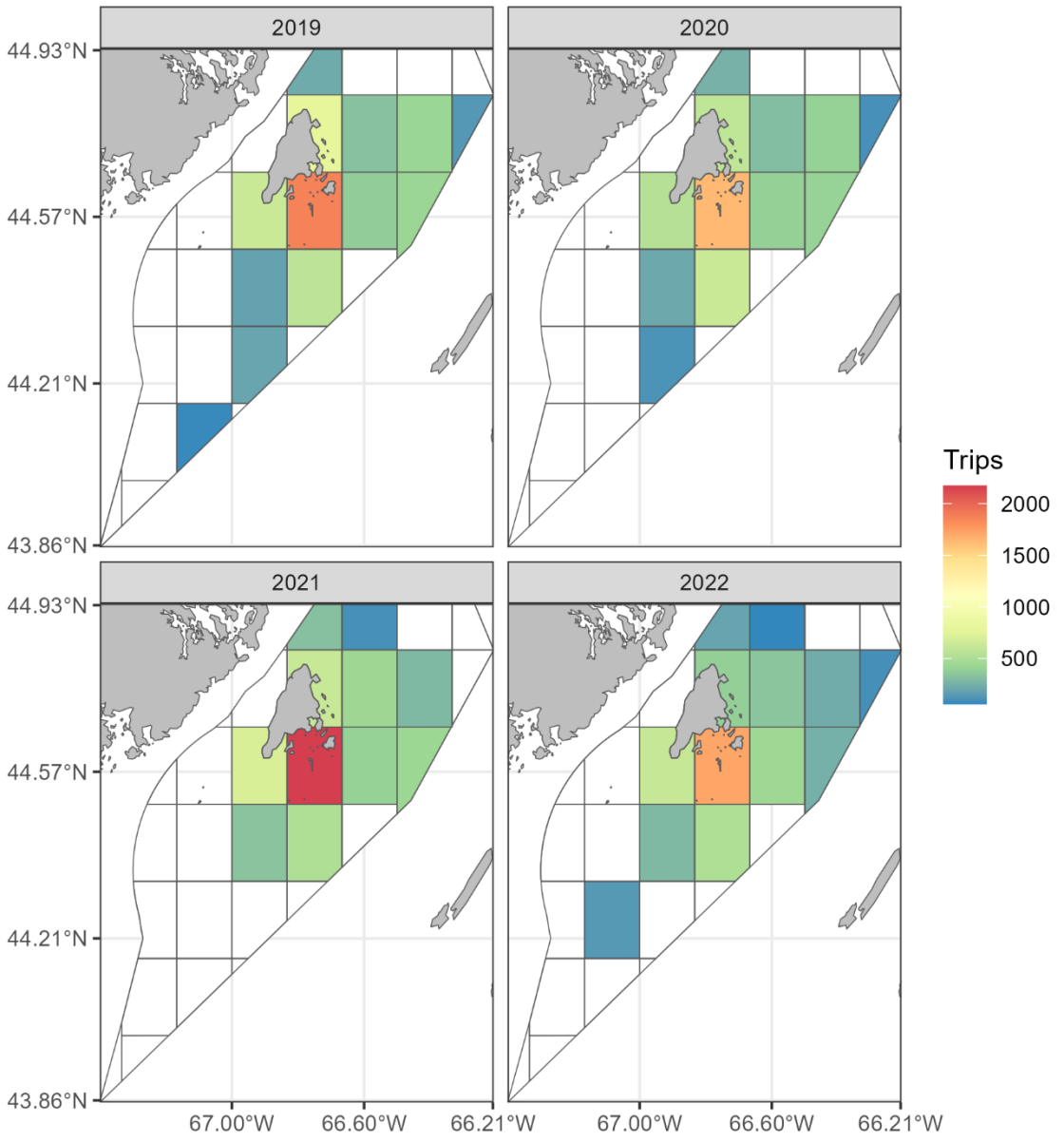

Figure 113: LFA38- Logbook reported number of trips by grid. White grids indicate areas where fishing information is privacy protected (i.e. <5 Licences reporting).