Mapping Inshore Lobster Landings and Fishing Effort on a Maritimes Region Modified Grid System

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by

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Mapping the distribution and intensity of inshore lobster fishing activity has management applications beyond classifying fishing intensity, harvest levels, and potential differences in lobster production. Mapping inshore lobster fishing is constrained by a lack of region-wide coordinate data reporting requirements for lobster effort and landings. This report describes an analysis of Maritimes Region lobster logbook data reported at a grid level, including Bay of Fundy Grey Zone data reported at the coordinate level. Annual and composite (2008–2011) grid maps were produced for landings, number of days fished, number of traps hauled, and the same series standardized by grid area, as well as maps of weight per number of traps hauled as an index of catch per unit effort (CPUE). Spatial differences in fishing pressure, landings and CPUE are indicated, potential mapping applications are outlined, and the limitations of and potential for improvements to the grid reporting system are discussed.

RÉSUMÉ

La cartographie de la répartition et de l'intensité des activités de pêche au homard côtière, a des applications de gestion au-delà des classifications de l'intensité de la pêche, des niveaux de prises et des différences possibles dans la production de homard. La cartographie de la pêche au homard côtière est limitée en raison du manque à l'échelle régionale d'exigences relatives à la déclaration de données de coordonnées pour l'effort de pêche et les débarquements de homard. Le présent rapport décrit une analyse des données provenant des journaux de bord des pêcheurs de la région des Maritimes et déclarées à l'échelle du quadrillage, y compris des données relatives à la zone grise de la baie de Fundy consignées sous forme de coordonnées. On a dressé des cartes annuelles et combinées (2008–2011) avec quadrillage pour consigner les débarquements, le nombre de jours de pêche, le nombre de casiers levés et la même série d'éléments normalisés par zone des grilles. En outre, on a dressé des cartes indiquant le poids par nombre de casiers levés comme indice des prises par unité d'effort. On décrit dans le rapport les différences spatiales relatives à la pression de la pêche, les débarquements et les prises par unité d'effort, les applications de cartographie potentielles, et on y aborde également les limites et les possibilités quant à l'amélioration du système de déclaration par quadrillage.

INTRODUCTION

Mapping the spatial distribution of inshore lobster fishing activity at effective planning scales provides the potential for multiple applications in the context of integrated oceans and coastal management and planning as mandated under Canada's *Oceans Act*. The spatial distribution of inshore lobster fishing in the Maritimes Region is constrained, however, by the lack of coordinate data reporting requirements for fisheries effort and landings. This report describes the analysis of Maritimes Region lobster logbook data reported at a grid level, including Bay of Fundy Grey Zone data reported at the coordinate level. Annual and composite (2008–2011) grid maps were produced for landings, number of days fished, number of traps hauled, and the same series standardized by grid area, as well as maps of weight per number of traps hauled as an index of catch per unit effort (CPUE). Spatial differences in fishing pressure, landings and CPUE are indicated, mapping applications are outlined, and the limitations of and potential for improvements to the grid reporting system are discussed.

American lobster (*Homarus americanus*) is widely distributed in coastal waters from the southern tip of Labrador to Maryland, with the major fisheries concentrated in the Gulf of St. Lawrence and the Gulf of Maine (Figure 1). Lobster distribution in the Maritimes Region is confirmed by summer research vessel surveys from 1999 to 2012 as shown in Figure 2. Lobsters are also found in deeper waters (< 750 m) in the Gulf of Maine and along the outer edge of the continental shelf from Sable Island to North Carolina. The deep water distribution is due to the presence of warm slope water that keeps the slope and deep basins in the Gulf of Maine warm year-round. Warm deep water is not found on the eastern Scotian Shelf, in the Gulf of St. Lawrence, or off Newfoundland. In the Maritimes Region there are 12 active Lobster Fishing Areas (LFAs) that comprise the inshore lobster fishery. They are found from the northern tip of Cape Breton, along the Atlantic Coast of Nova Scotia, and into the Bay of Fundy. An independent statistical grid overlaying the LFAs acts as the smallest reporting unit for fisher's logbook data (Figure 3). The statistical grid is not coincident with all LFA boundaries, particularly in the Bay of Fundy. For the purposes of this report, some of the statistical grids are reduced in the extent to which they extend offshore in order to reflect the known lobster distribution and the spatial patterns in the inshore fishery (Figures 4 and 5).

Historic lobster landings records (1892–1946) were reported by calendar year and summarized by county, while annual landings from 1947 to 1995 are summarized by statistical districts (Tremblay et al. 2011). In 1995, the mandatory catch reporting system changed for all LFAs in the Maritimes Region, with fishers reporting daily catch by port of landing and date. The spatial reporting of lobster fishing activity started in November 1998 when fishers in LFA 34, off southwest Nova Scotia, adopted a Lobster Catch and Settlement Report requiring them to submit spatial information on daily catch and effort by reference to a 10 x 10-minute statistical grid system that provided the first visual portrayal of landings and effort distribution in LFA 34 (Figure 3). This 10-minute statistical grid reporting system was later implemented in LFAs 35–38 in the Bay of Fundy in 2003 (DFO 2007; Robichaud and Pezzack 2007) and was in full use for LFAs 34–38 by 2005. Similar data were obtained in 2004 and 2005 during a pilot project in LFAs 27–32 (i.e., the Eastern Shore of Nova Scotia to northern Cape Breton), using a non-uniform statistical grid of inshore-offshore corridors along the Atlantic coast of Nova Scotia as shown in Figure 3. By 2006 (2005–2006 for LFA 33, i.e., Baccaro Point to Halifax), a mandatory Lobster Catch and Settlement Report was introduced to all fishers in LFAs 27–33 and participation rates increased thereafter. The percentages of licenses reporting at the statistical grid level did not consistently exceed 70% until 2008. Therefore, there is a greater risk of underestimating lobster landings and effort at the statistical grid level with the 2005–2007 data that were reviewed in this analysis. As the risk of underestimation is lower for 2008 onwards, where reporting of landings and effort at the statistical grid level exceeded 70%, only 2008–2011 data were analyzed on a region-wide grid in this analysis. For the remainder of this report the terms 'statistical grid' and 'grid' are considered interchangeable, and 'statistical grid cell' and 'grid cell' both refer to the individual reporting units within that grid. It should be noted that lobster landings and effort data from the offshore LFA 41 fishery were not incorporated in this grid analysis.

Potential Applications of Lobster Mapping to Oceans Management

Spatial analysis and mapping the distribution and intensity of inshore lobster fishing activity are important information sources in management applications beyond classifying fishing pressure, harvest levels, and potential differences in lobster production. In an oceans management and planning context, lobster mapping products fulfill coastal and marine spatial planning applications such as: mitigating human use conflicts with seabed cables and marine shipping terminals; informing environmental emergency response operations and protocols; monitoring compliance and threats in marine protected areas; assessing use intensity in the context of ecosystem approaches to management, e.g., cumulative impacts assessment; providing advice in Marine Stewardship Council sustainability eco-certification processes; assessing the risk and relative probability of interactions with Schedule 1-listed species under the *Species at Risk Act*, e.g., North Atlantic right whales; informing federal and provincial government-mandated environmental assessment processes; addressing marine conservation objectives and planning a bioregional marine protected areas network; and decision support in the sectoral management of aquaculture development and ocean renewable (tidal, wind and wave) energy projects.

METHODS

Lobster Logbook Data

October 2005–December 2011 logbook data from DFO Science were investigated for use in the analysis, but as mentioned above only data between 2008 and 2011 were retained. The data included total days fished per month and year per grid cell, total number of traps hauled per month and year per grid cell, and total catch weight (kg) per month and year per grid cell. Within the logbook data, a subset of records related to catch weight and trap hauls did not report in which statistical grid cell the fishing occurred. As a result, these data could not be included in the analysis and were removed. The removal meant that, over four years, approximately 8.1% of the total catch weight and approximately 6.4% of total trap hauls could not be attributed to the correct grid cells. This underestimation should be noted as it affects the analysis described later. For a detailed breakdown of the excluded data by LFA and by year, see Appendix 1.

Grey Zone Logbook Data

In addition to the grid level logbook data reported in the Bay of Fundy Grey Zone in LFA 38, some lobster fishing in the Grey Zone is also reported at the coordinate level and is stored in the Maritime Fisheries Information System database (MARFIS; see Figure 6). The Grey Zone landings and effort data in the MARFIS system for LFA 38 are complementary to the Grey Zone statistical grid record data and are considered in this analysis. The Grey Zone logbook data is reported by latitude and longitude rather than by statistical grid number. The coordinate information was used to isolate those records that fell within the statistical grid between 2008 and 2011, and to assign a statistical grid number to each record. The statistical grid cells that contained the Grey Zone records were: 49, 61–63, 74–76, and 98. For each grid cell, the total numbers of days fished, traps hauled, and catch weight (kg) were calculated for each year and the four-year interval and then combined with the grid level logbook data.

Preparation of the Grid

In order to effectively map effort and landings in relation to known lobster distributions based on active fishing areas and lobster research surveys, the non-uniform statistical grid of inshore-offshore corridors in LFAs 33–27 was, for the purposes of this analysis, revised for fishing areas east of Halifax. The grid to the west of Halifax was unmodified with the exception of the removal of islands as discussed below. Starting with the easternmost grid cell in LFA 33 off Halifax running eastwards to LFA 27, the outer grid cell boundaries in these LFAs were realigned with the 100-m depth contour (Figure 4). The revised grid better reflects the maximum extent of observed fishing activity, and mirrors the known distribution of lobster abundance along the Atlantic coastline as illustrated by Pezzack in Figure 1. However, it is important to note that in some of these grids fishing may stop well inside the 100-m depth contour, and in others there may be occasional exploratory effort outside the 100-m depth contour.

Additional grid editing was undertaken to ensure the statistical integrity of the grid through removal of extraneous lines and manual editing of the topology of some LFA grid files to reassign redundant or aberrant grid cells. Four larger islands off Nova Scotia (Scaterie, Cape Sable, Brier, and St. Paul) were removed from the grids that contained them to improve the accuracy of the subsequent standardized area calculations of effort and landings. The larger southwest New Brunswick islands of Grand Manan, Deer Island and Campobello have important fishing grounds, but these islands were not removed from the grid due to time constraints, impacting area calculations for grids 38, 49 and 50. The largest impact would be from Grand Manan where the area of the fishing grids would be overestimated. Smaller coastal islands and islets off Nova Scotia and New Brunswick, of which there are many, were not removed from the grid and essentially comprise ‘fishable area’, although on a region-wide scale their effect on standardized area analyses is considered minimal. Area calculations for all grid cells abutting the coastline were based on trimming to the coastline of the statistical grid.

Data Processing

Data discovery of the combined dataset revealed several cases of null values for individual grid cells in single years and across all four years, 2008–2011. For purposes of comparison, grid cells with no reported data (null values) in single years and in all four years were treated as zero values during the classification and are noted as such with black-lined highlighted grids in maps. Missing grid cell data could mean the following: 1) no fishing activity occurred in the grid cell during those years; 2) fishing activity occurred in the grid cell, but it was unreported; 3) fishing activity occurred in the grid cell, but it was reported in an adjacent grid cell(s); and 4) as observed, reporting for the grid cell was inconsistent, e.g., numbers of days fished and catch weight were reported, but the numbers of traps hauled were unreported.

Annual and composite maps were produced for catch weight, fishing effort expressed as numbers of trap hauls and days fished, and for catch per unit effort (CPUE) based on catch weight per number of trap hauls – a proxy indicator of spatial differences in lobster production. It is recognized that CPUE is imperfect in this regard, as it is affected by various factors. Its value as an indicator of differences in productivity is best when the areas compared have similar seasons and effort levels. In order to produce effort and landings map products standardized by area, annual values for the number of traps hauled, the number of days fished, and catch weight in kilograms were divided by the area (km^2) per corresponding grid cell to calculate traps hauled/km^2, days fished/km^2, and catch weight/km^2 respectively.

Fishers are allowed to report activity in up to three grids per day, with no obligation to report fishing time spent in each grid. For the purposes of calculating the number of days fished per grid cell, if any fishing occurred in a given grid cell on a given day that grid cell was assigned a value of 1 day fished. While this approach is appropriate to understand how many days fishing occurred in any given grid cell, it is worth cautioning that one day of fishing may not represent the same level of effort in each grid cell.

In order to calculate catch per unit effort, the relationship between trap hauls and the corresponding catch weight had to be considered where possible. The catch weight and trap haul attributes of the logbook data were reported as monthly totals, while the Grey Zone dockside monitoring data was reported as a daily total. In both datasets there were examples where total catch weight or total trap hauls were reported, but the corresponding attribute was null. These null records were removed from the analysis so as not to bias the overall ratio in favour of either catch weight or trap hauls. If a number of trap hauls were reported and the corresponding catch weight was reported as zero, the record was retained. In total, approximately 3% of the total catch weight and 16% of the total trap hauls were removed from the logbook data, and approximately 4% of the total catch weight was removed from the Grey Zone dockside monitoring data. The total catch weights and trap hauls were then summarized for each year, and all four years combined, and used to calculate the respective ratios of catch per unit effort. Ideally, the ratio would be calculated for each individual trap haul and then averaged, but the way the data is reported requires that the annual and composite totals be used instead.

Data were divided into five classification intervals using modified quantile breaks, and the same intervals were used for each year to allow for comparisons between years; however, only one set of yearly maps is included in this report, namely for 2011. The five quantile class breaks were calculated from a pool of all values from the four years of data to account for the full possible range of values. These class breaks were then manually applied to the data for individual years. Landings and effort values were totalled on an annual basis rather than on a fishing season basis, which extends over two calendar years in LFAs 33, 34, 35, 36, and 38. As noted above, grid cells with no reported data in individual years and for all four years in the composites are black-line highlighted in all map products.

Three sources of data deficiencies related to inshore lobster fishing activity are outlined below. Deficiencies relate to data not being available, or not being collected at a scale that allow comparisons between grid cells. Combined, these data deficiencies contribute to a potential underestimation of the true fishing effort and landings associated with the entire inshore lobster fishery.

First, one data deficiency relates to the disputed lobster fishing area known as the Grey Zone in the Bay of Fundy, southwest of Grand Manan, New Brunswick, which is fished by both Canadian and Maine-based lobster fishers. Enquiries with US federal and state authorities indicated there were no data reporting requirements at a scale or frequency in the Grey Zone that would enable pooling US and Canadian lobster logbook data. Hence, only two Canadian datasets are used in the analysis and the grid data classifications of Grey Zone lobster effort and landings are likely underestimated due to unknown US fishing activity. Eight grid cells or portions thereof are potentially affected by missing US data, namely grids 49, 61–63, 74–75 and 86–87. Inconsistent data reporting in the Grey Zone may result in spurious data analysis.

As discussed earlier, a second data deficiency relates to the reported trap haul and catch weight logbook data that did not have associated grid cell information. In order to help quantify the resulting annual and composite underestimation, the total trap hauls and catch weight were summarized by LFA for 2008–2011 (Appendix 1).

A third data deficiency stems from the Aboriginal Food, Social and Ceremonial (FSC) fishery. The effort level in these fisheries is a small fraction (< 0.5%) of the commercial fishery. During the 2010–2011 fishing season, 6,273 kg (13,829 lbs.) of lobster were reported harvested in LFAs 25–38. In the 2011–2012 fishing season, 12,605 kg (27,790 lbs.) of lobster were reported harvested in the same LFAs. It is noted that LFAs 25 and 26 do not fall within the study area, but the data reporting method does not allow quantification of catch weight by LFA or grid cell. It is also not possible to limit those records from the 2011–2012 fishing season that occurred in 2012. While the Aboriginal FSC fishery constitutes a small portion of the overall lobster harvest, it is worth identifying as a source of underestimation for our analysis.

RESULTS AND DISCUSSION

Composite catch weight and catch weight standardized by area for 2008–2011 are shown in Figures 7 and 8 respectively. The highest composite catches (Class 5 in red) in Figure 7 include a large proportion of LFA 34 grids off southwest Nova Scotia, some grids in the Bay of Fundy, and grids in LFAs 27, 29 and 31 in eastern Nova Scotia. LFA 34 has the highest number of grids (32) with Class 5 catches. The standardization by area analysis for catch weight in Figure 8 reduced the number of Class 5 grids in eastern Nova Scotia from Figure 7. Coastal grids with the lowest catch (Class 1 in dark green) are off the northern tip of Cape Breton, the Bras d’Or Lakes (LFA 28), and the extreme upper Bay of Fundy (Minas Basin).

Catch per unit effort (CPUE) over four years as measured by composite weight per number of traps hauled in Figure 9 is highest in the Bay of Fundy (LFAs 35 and 36), in offshore southwest Nova Scotia (LFA 34), and in LFA 30 off the south coast of Cape Breton. Although the coastal grids in LFA 34 have the highest catch over four years, the CPUE in LFA 34 is lower, most likely due to the relatively high levels of effort in terms of both days fished (Figures 10 and 11) and the number of traps hauled (Figures 12 and 13), resulting in lower LFA 34 yields relative to unit of effort. Grids in LFA 33 (south shore of Nova Scotia) and LFA 27 (eastern Cape Breton) also have higher levels of effort in terms of days fished (Figures 10 and 11) and trap hauls (Figures 12 and 13). Coastal grids with the lowest numbers of days fished and trap hauls correlate with the lowest catch weight grids, namely in northern Cape Breton (LFA 27), the Bras d'Or Lakes (LFA 28), and the upper and mid-Bay of Fundy (LFAs 35 and 36). CPUE in Figure 9 compared with trap hauls in Figure 12 illustrates higher numbers (Class 5 in red) of trap hauls associated with low CPUE (Classes 1–3) in LFA 27 and inshore LFA 34 grids, indicating high levels of exploitation. Figures 9 and 12 also suggest that where trap haul effort is lower (Classes 2–3) such as in the Bay of Fundy, CPUE is higher (Class 5 in red). Figures 10 and 12 confirm the expected general correlation between the highest numbers of days fished and traps hauled respectively in LFAs 27, 33 and 34. The standardization by area analysis for days fished and traps hauled respectively in Figures 11 and 13 noticeably reduced the number of Class 5 grids in LFA 27. Spatial differences that emerge from the standardization analyses are sensitive to the interpretations made regarding the size of the area fished (i.e., the modifications to the grids east of Halifax). If the actual areas fished are different, then the pattern of spatial differences may change.

Yearly region-wide maps in the data series were produced for all four years (2008–2011), however, the only annual maps included here are for 2011, as shown in Figures 14 to 20. The spatial patterns observed in the 2008–2011 composite map series described above are also reflected in the 2011 annual maps. For example, the highest 2011 catch weights per grid in Figure 14 are from LFA 34 grids off southwest Nova Scotia, LFA 36 and 38 grids around Grand Manan, New Brunswick, and some grids in LFAs 27, 29 and 31 in eastern Nova Scotia. Multiple grids have no reported 2011 data, including all offshore grids in LFA 33. CPUE in 2011 (Figure 16) is highest in the Bay of Fundy (LFAs 35, 36 and 38), in offshore southwest Nova Scotia (LFA 34), and in LFA 30 off southern Cape Breton. LFAs 27, 33 and 34 have the highest numbers of days fished and traps hauled in 2011 as shown in Figures 17 and 19 respectively. Effort in 2011 in terms of days fished and number of traps hauled was also highest in LFA 31A grids off Canso, southwest Nova Scotia and in grids near Grand Manan, New Brunswick. It is important to note that the picture of catch and effort distribution is time sensitive, is not static, and year-to-year differences may result from future changes in the fishery and the distribution of lobsters. Accordingly, an update of these maps should be considered every 3 to 5 years.

One potential coastal management application of the inshore lobster mapping series is shown in Figures 21, 22 and 23. Here we show standardized catch weight, standardized fishing effort, and CPUE maps on a fine scale resolution along the Eastern Shore of Nova Scotia from Owl's Head to the St. Mary's River estuary, i.e., grids 326–333. Maps at this scale may be used in ocean management and planning to assess use intensity in the context of ecosystem approaches to management, to identify risks and interactions with other potential ocean uses, e.g., aquaculture development and renewable ocean energy, and to address marine conservation objectives and marine protected area network planning. The classification at this scale is driven by high landings and effort such as in LFA 34. Hence, sub-regional analyses conducted for management applications in coastal areas could be made more relevant by integrating finer spatial and temporal scales and by reclassifying the data with modified quantile classifications for specific scales.

In light of the comments made above on the removal of islands from the grid, an official version of the grid that is authoritative and cleaned of overlapping landmasses could have broader management applications within Fisheries and Oceans Canada and for external mapping consultants.

Limitations and potentially confounding factors in the analysis include region-wide variations among LFAs in terms of the timing of fishing seasons, the number of licenses, the number of traps per license, and the length of fishing season. No effort was made to standardize for these factors in this regional mapping analysis.

Overall, the spatial analysis was limited by the application of combining a 10-minute grid with a non-uniform statistical grid to produce a regional data classification on irregular-sized polygons. Effort reporting by coordinates would provide the best spatial information, but this would require more capacity in both government (to manage and analyze the large data volume) and industry (to provide high resolution effort data). An improvement over the current system would be more inshore-offshore demarcations in the grids east of Halifax, and a better alignment of grids in the Bay of Fundy with the depth contours. Presently, it is difficult to separate deep and shallow areas in the Bay of Fundy. In the absence of additional demarcations in the grids east of Halifax, the modifications made to truncate grids in this area at the 100-m depth contour provided a workable region-wide grid for effective comparisons of lobster catch and effort classifications.

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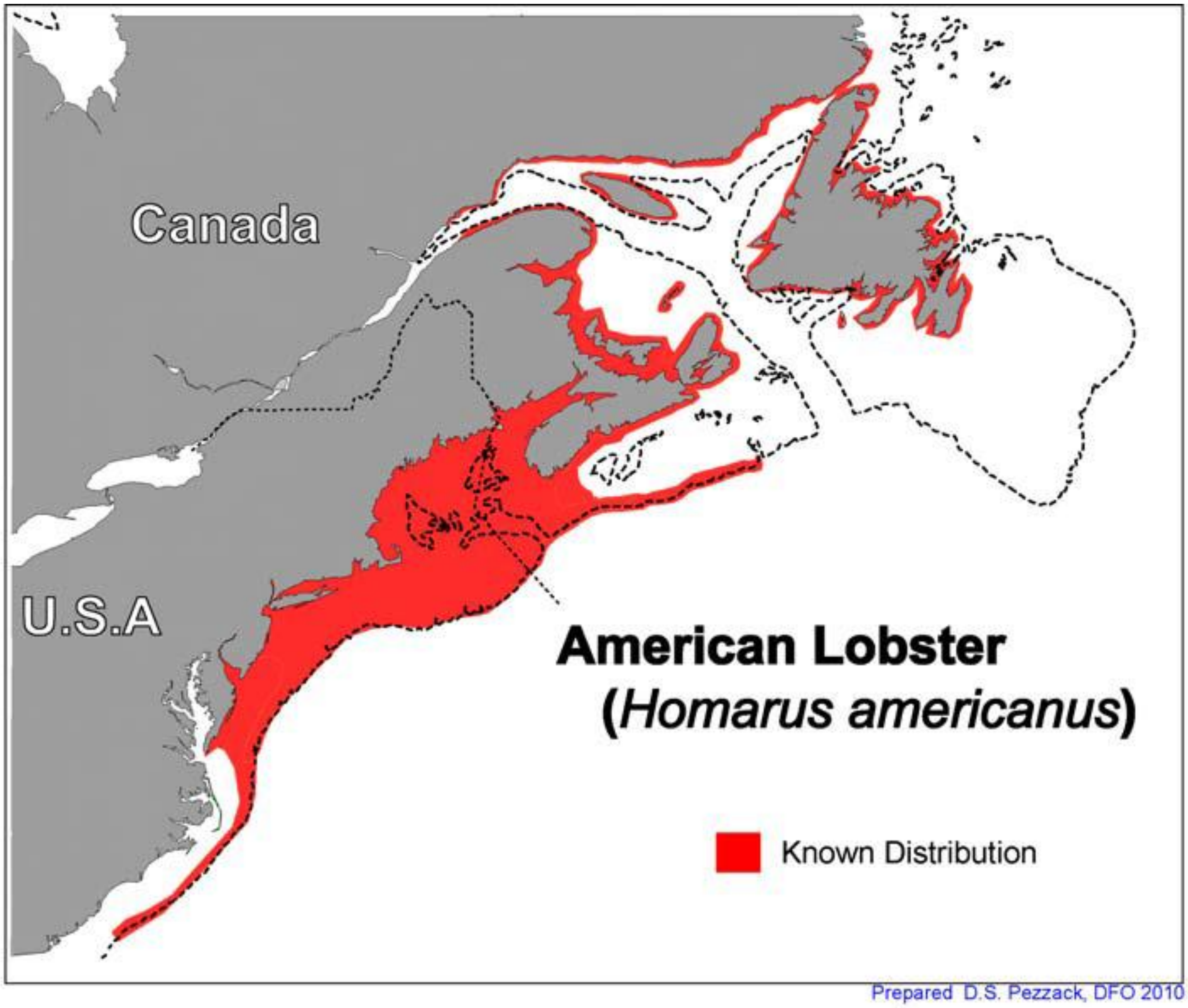

Figure 1.—Lobster distribution based on known fishing areas and DFO and NMFS bottom trawl surveys. Prepared by D. Pezzack, DFO Science, 2010. Source: Tremblay et al. 2011.

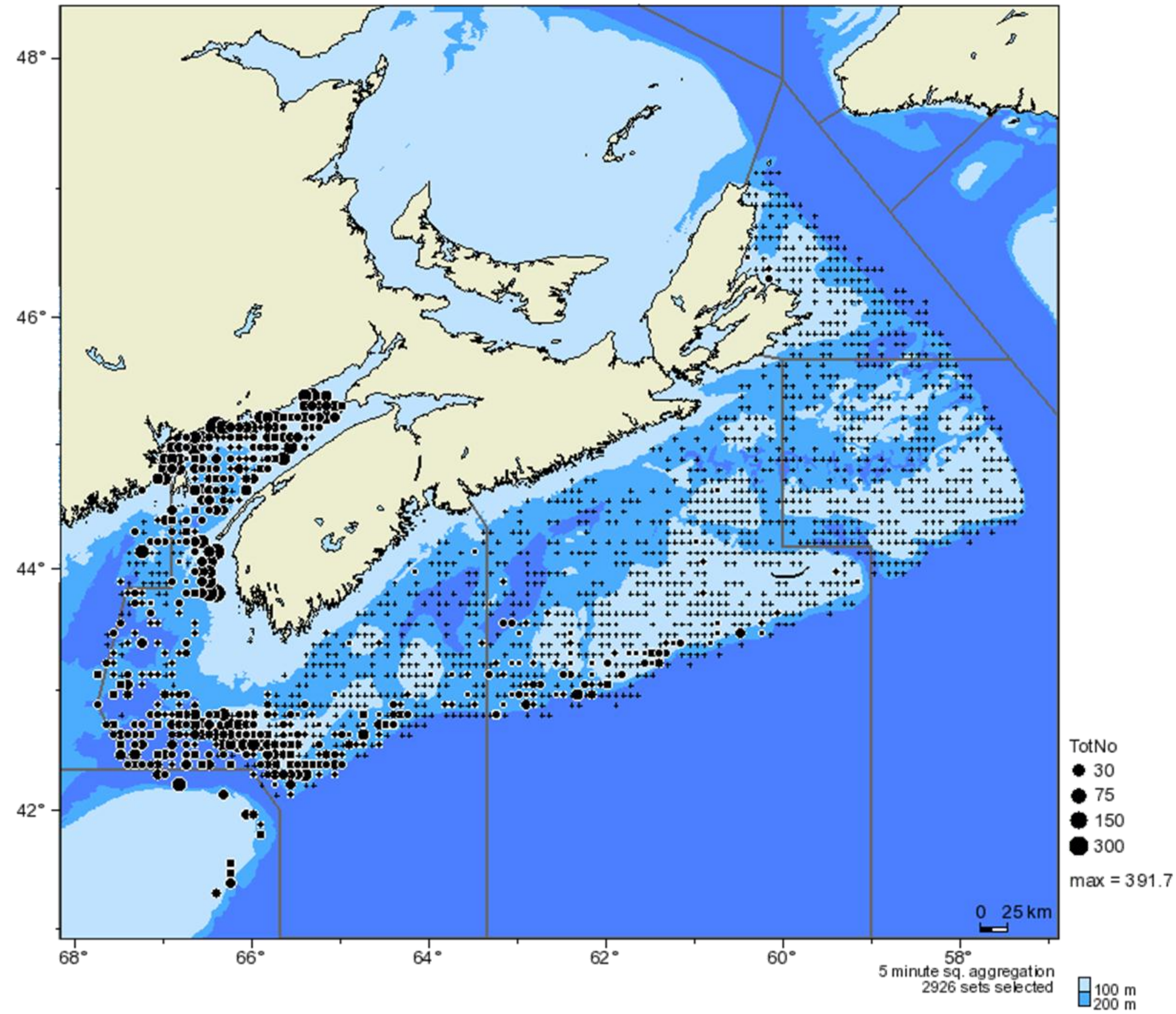

Figure 2.—Composite lobster catch in summer research vessel surveys, 1999–2012 (stratified random survey; average adjusted total number). Data are aggregated by 5-minute squares. Crosses indicate zero catches. Source: DFO Virtual Data Centre.

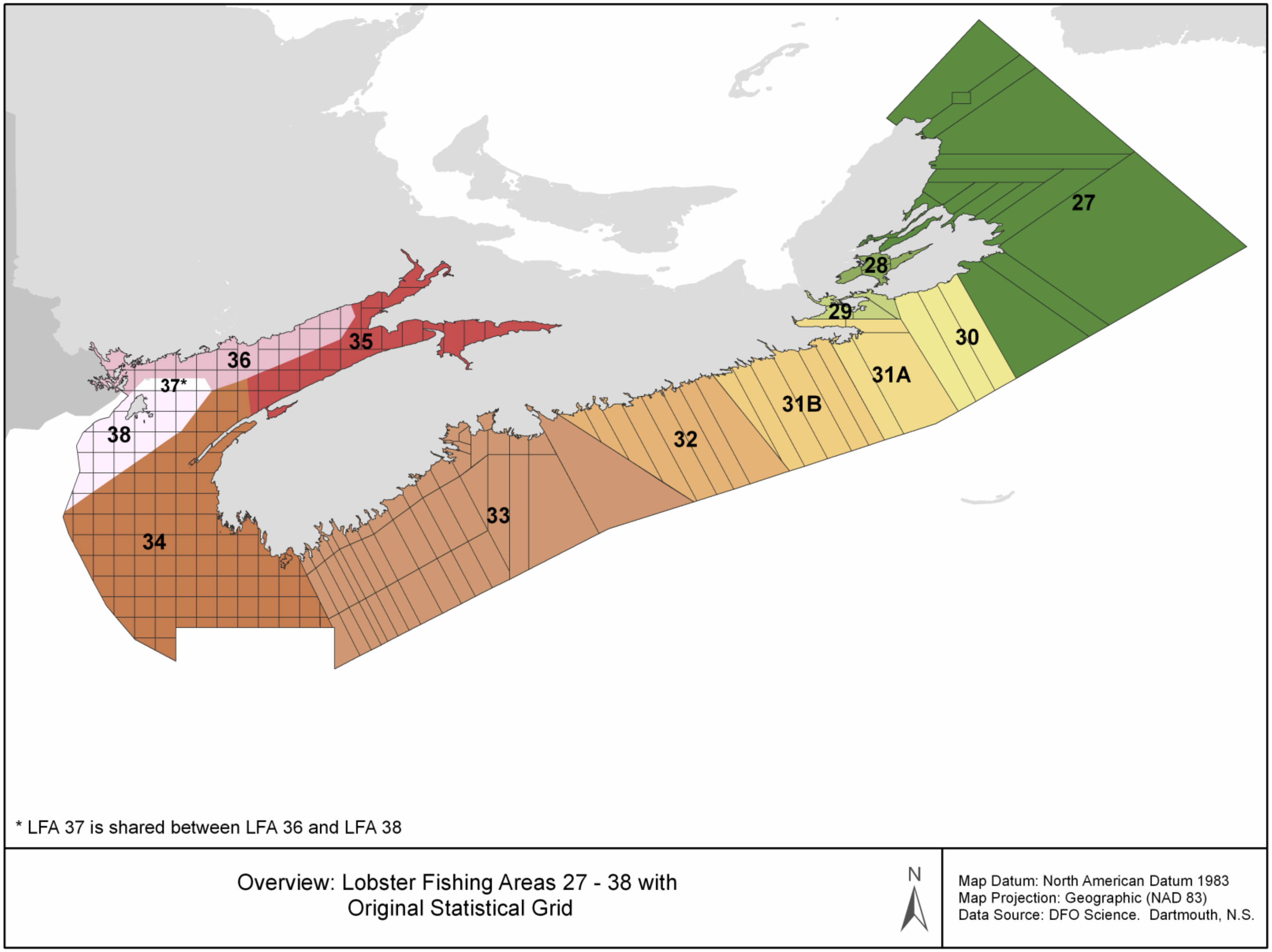

Figure 3.—Lobster Fishing Areas with statistical grids

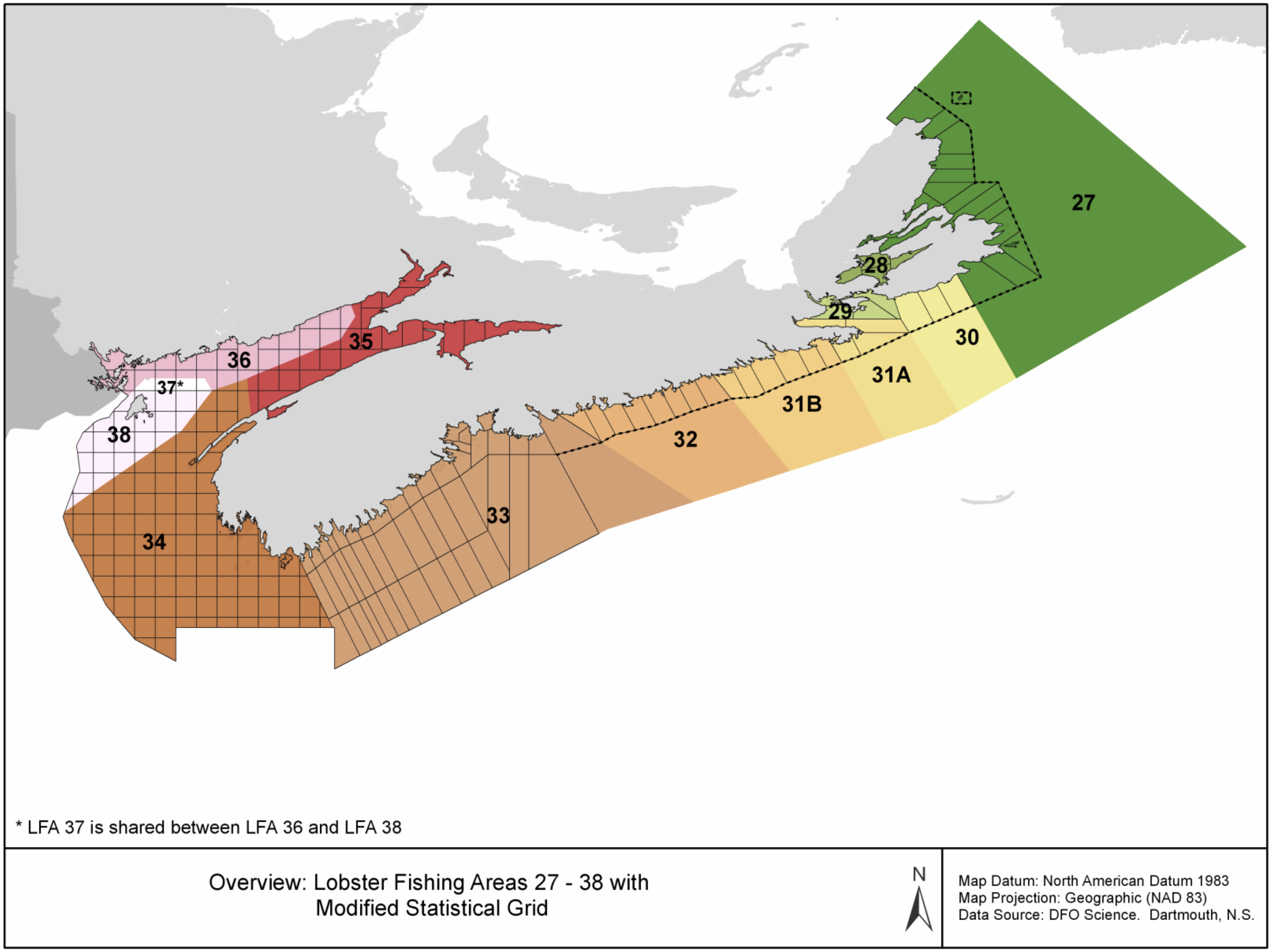

Figure 4.—Lobster Fishing Areas with statistical grids east of Halifax modified for the purposes of this report.

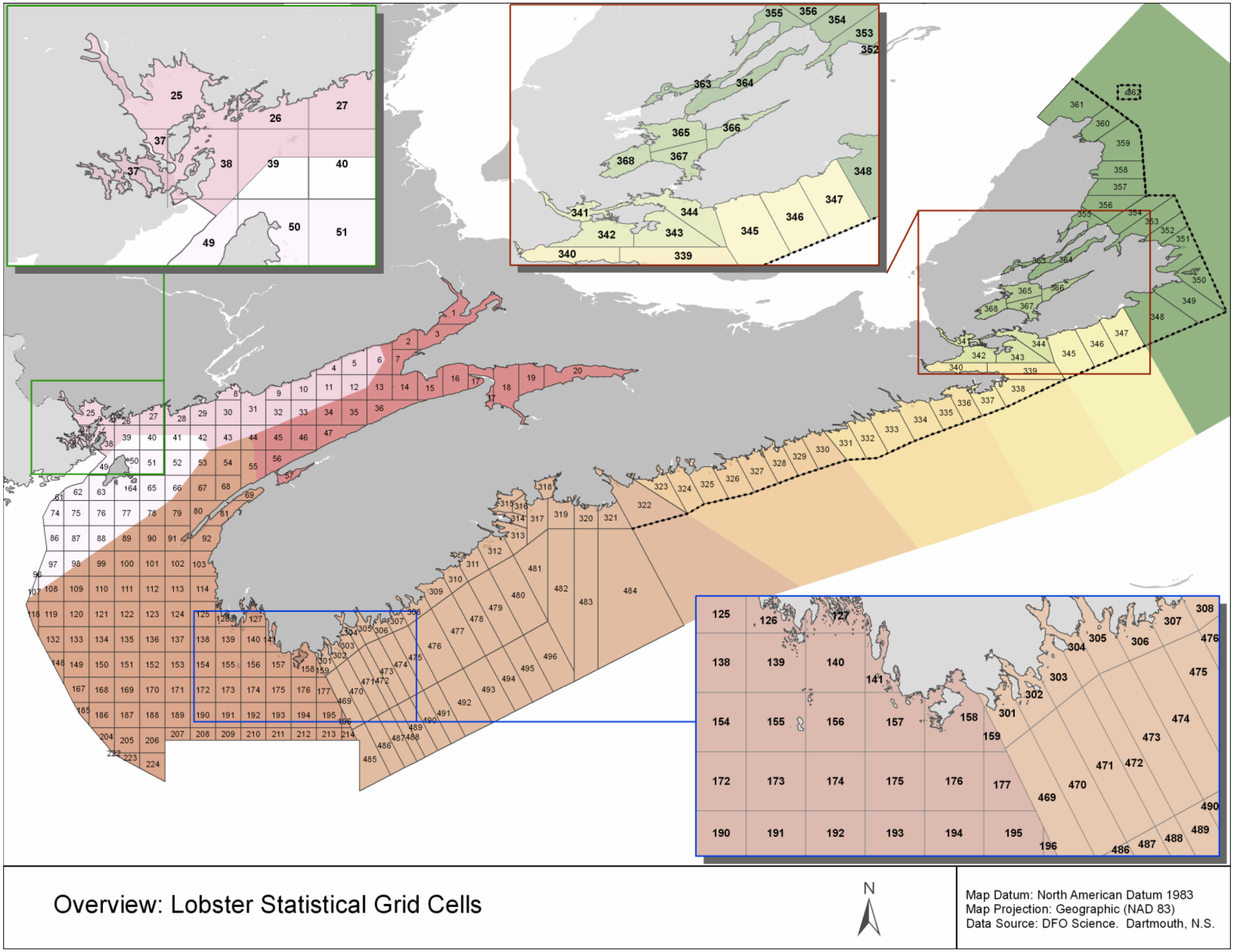

Figure 5.—Statistical Grid. Note that grids to the east of Halifax are modified for the purposes of this report.

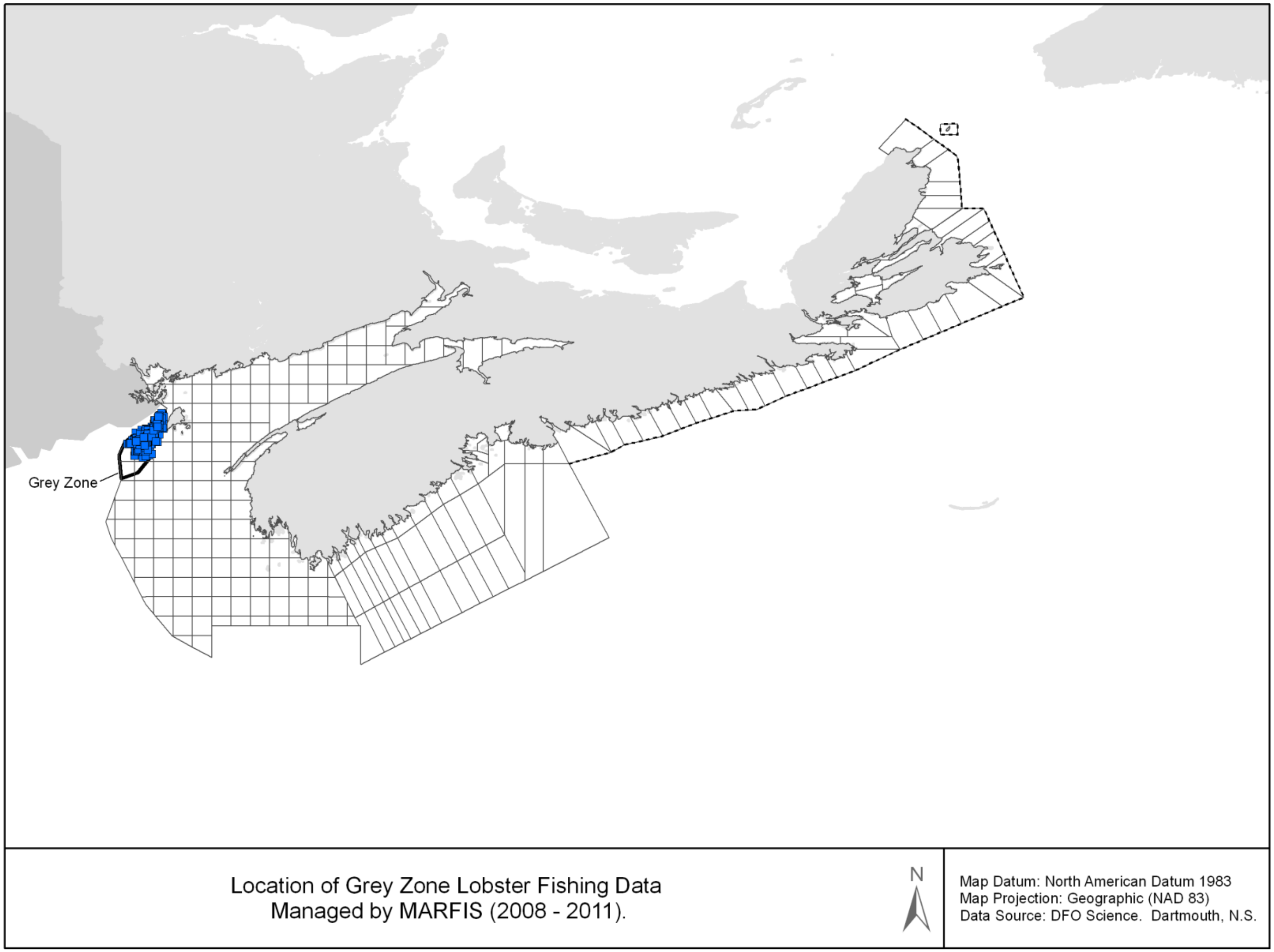

Figure 6.—Location of Maritime Fishery Information System (MARFIS) Data (dark blue) in relation to inshore modified statistical grid (modifications made for the purposes of this report).

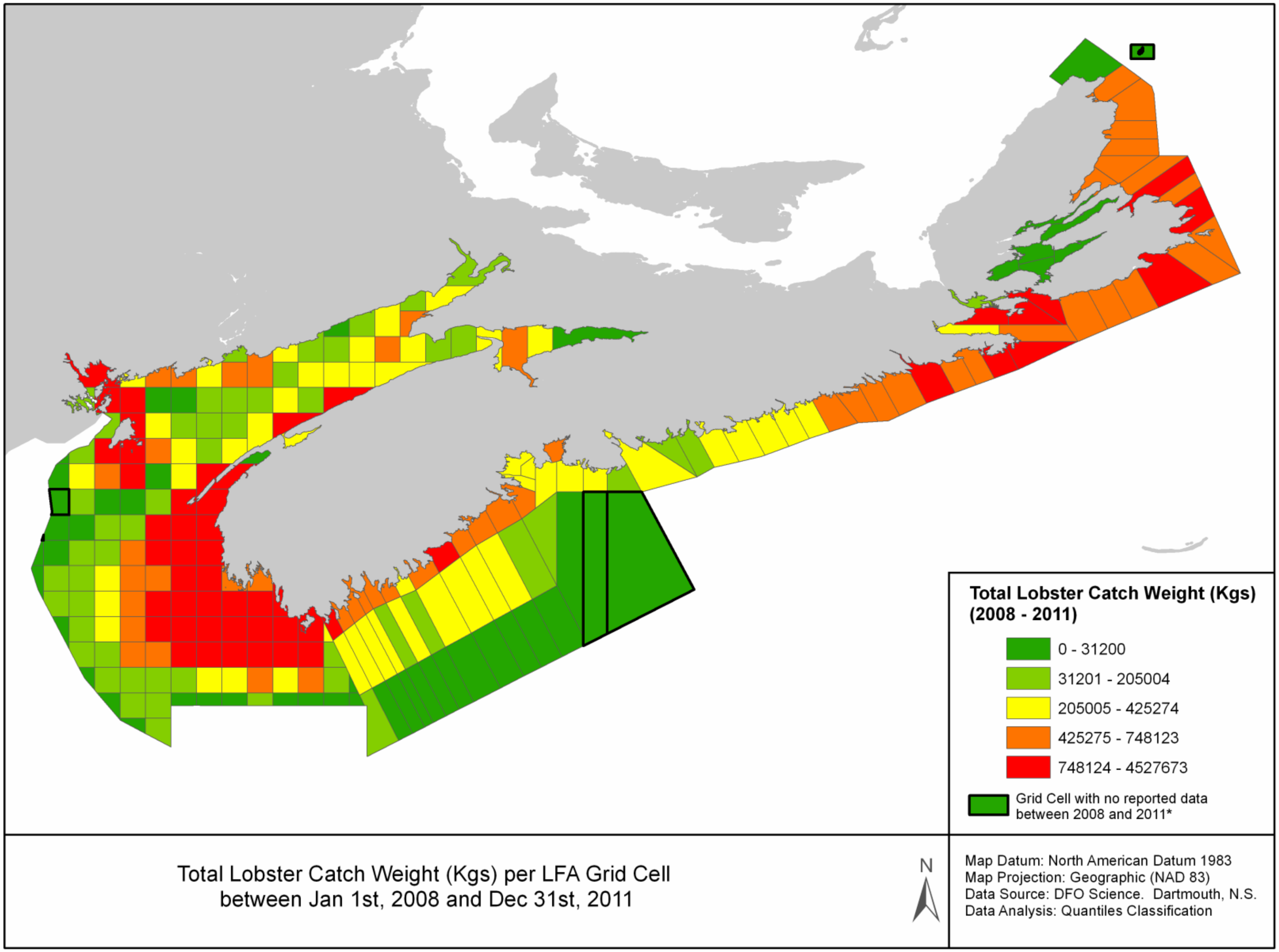

Figure 7.—Composite catch weight, 2008–2011

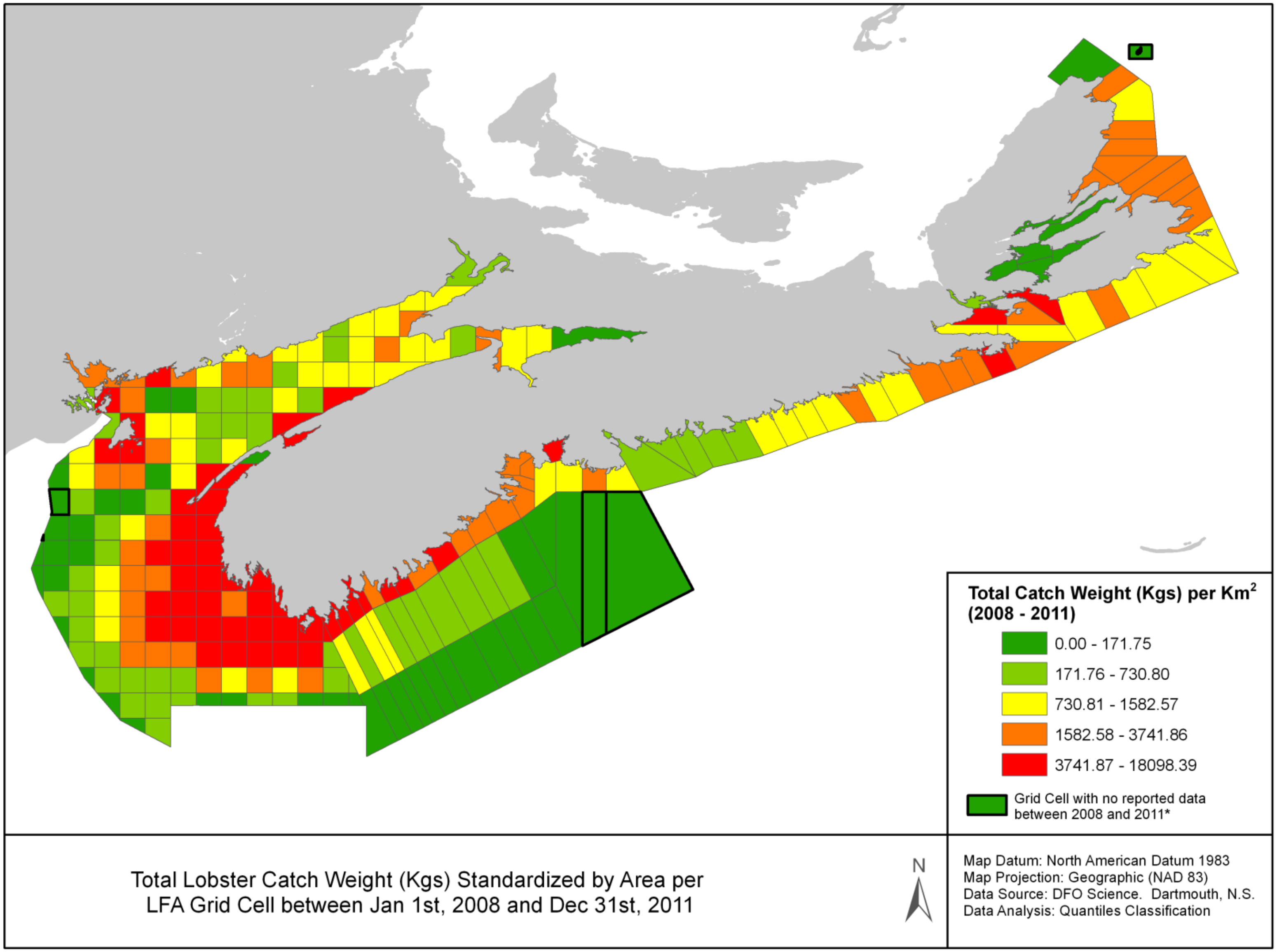

Figure 8.—Composite catch weight standardized by area, 2008–2011

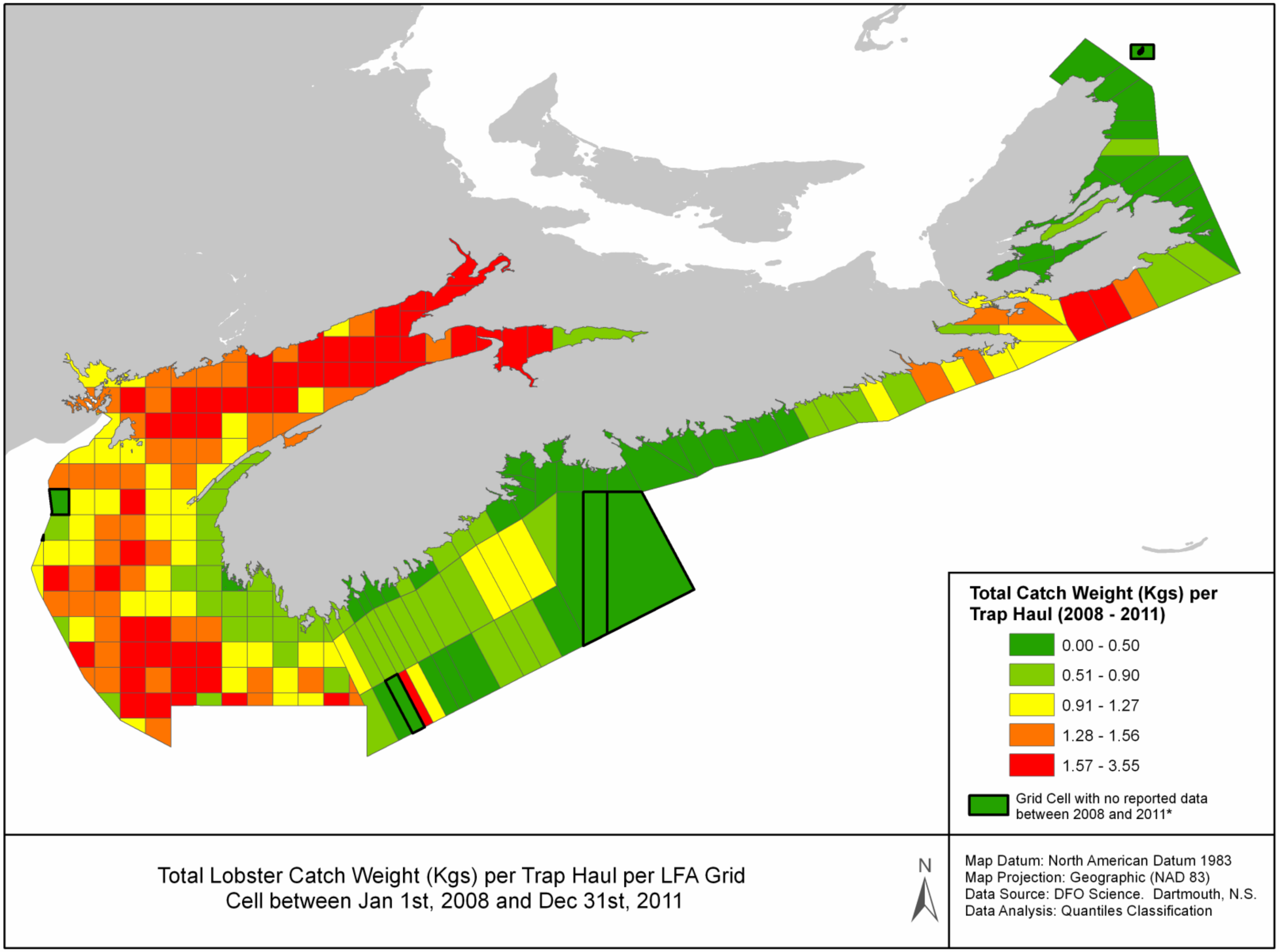

Figure 9.—Composite catch weight per trap haul (CPUE), 2008–2011

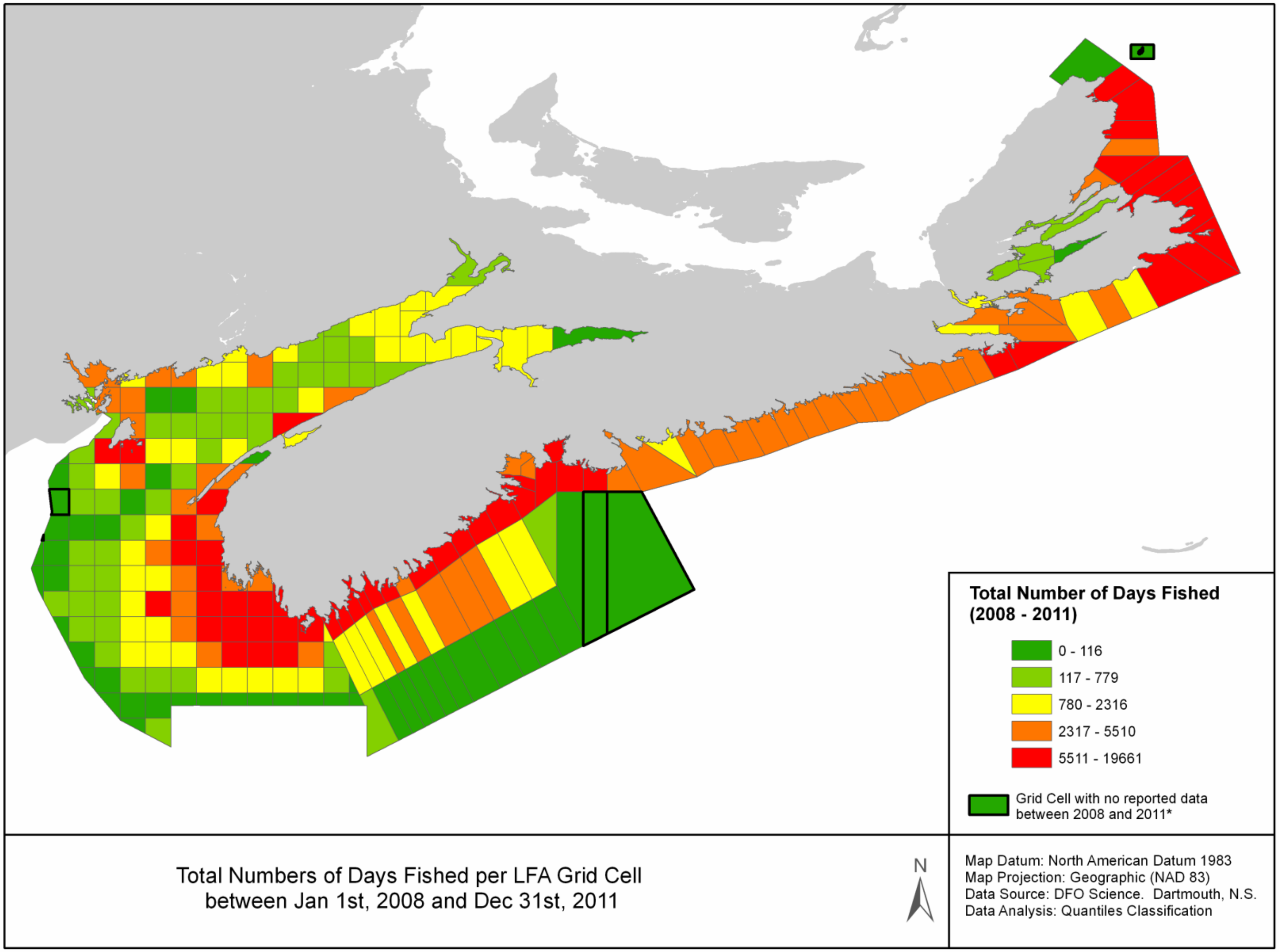

Figure 10.—Composite number of days fished, 2008–2011

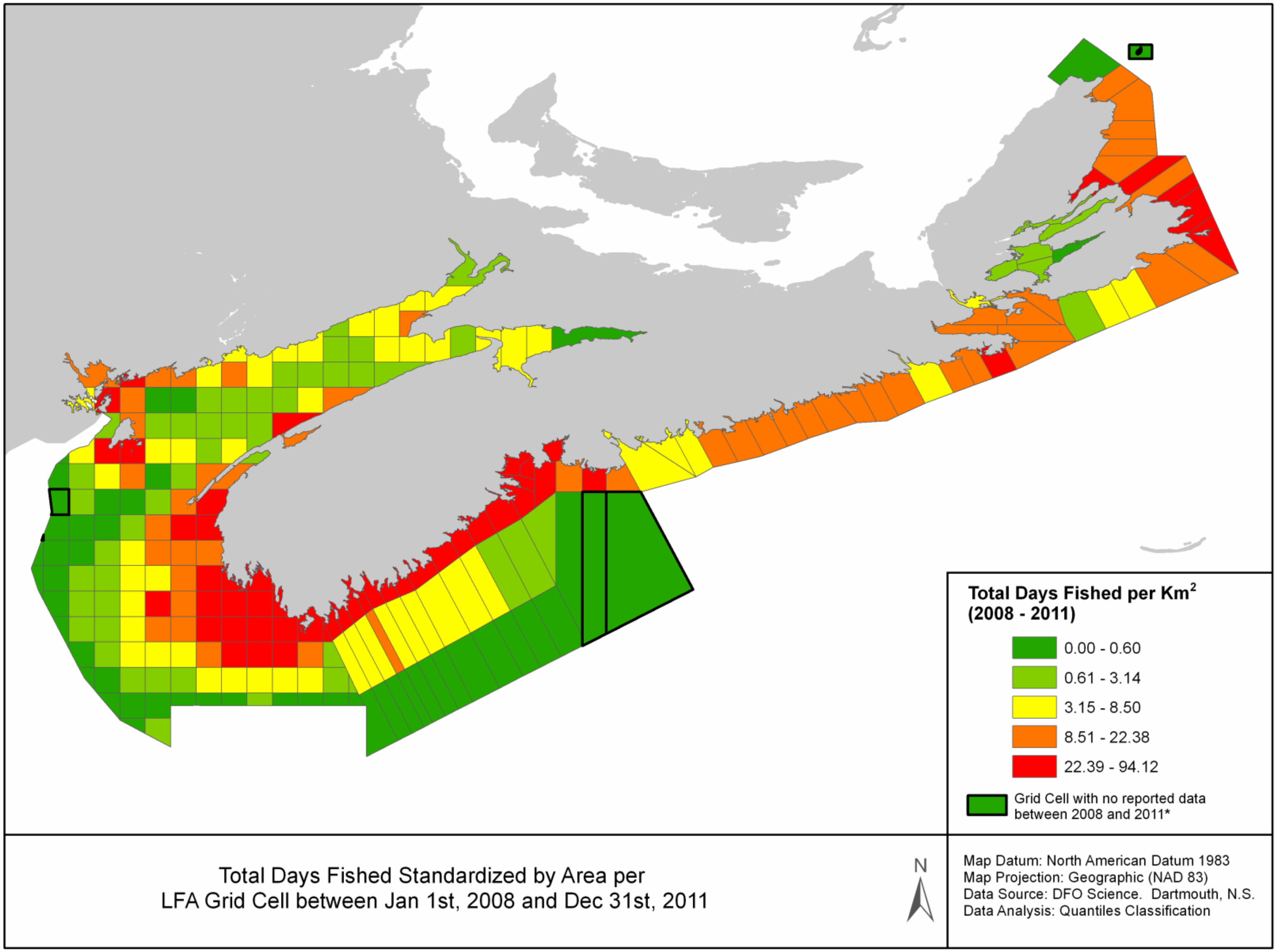

Figure 11.—Composite number of days fished standardized by area, 2008–2011

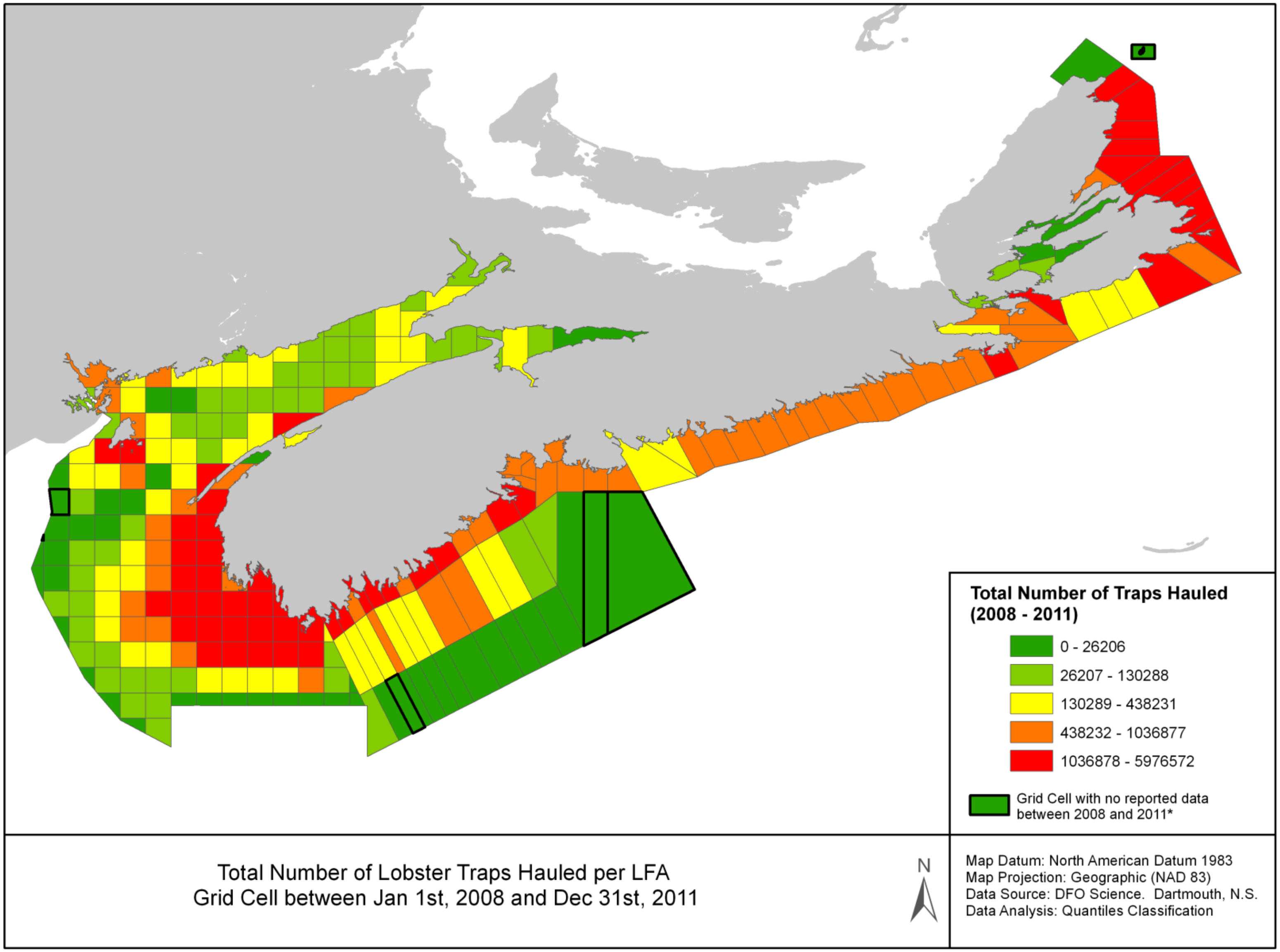

Figure 12.—Composite number of traps hauled, 2008–2011

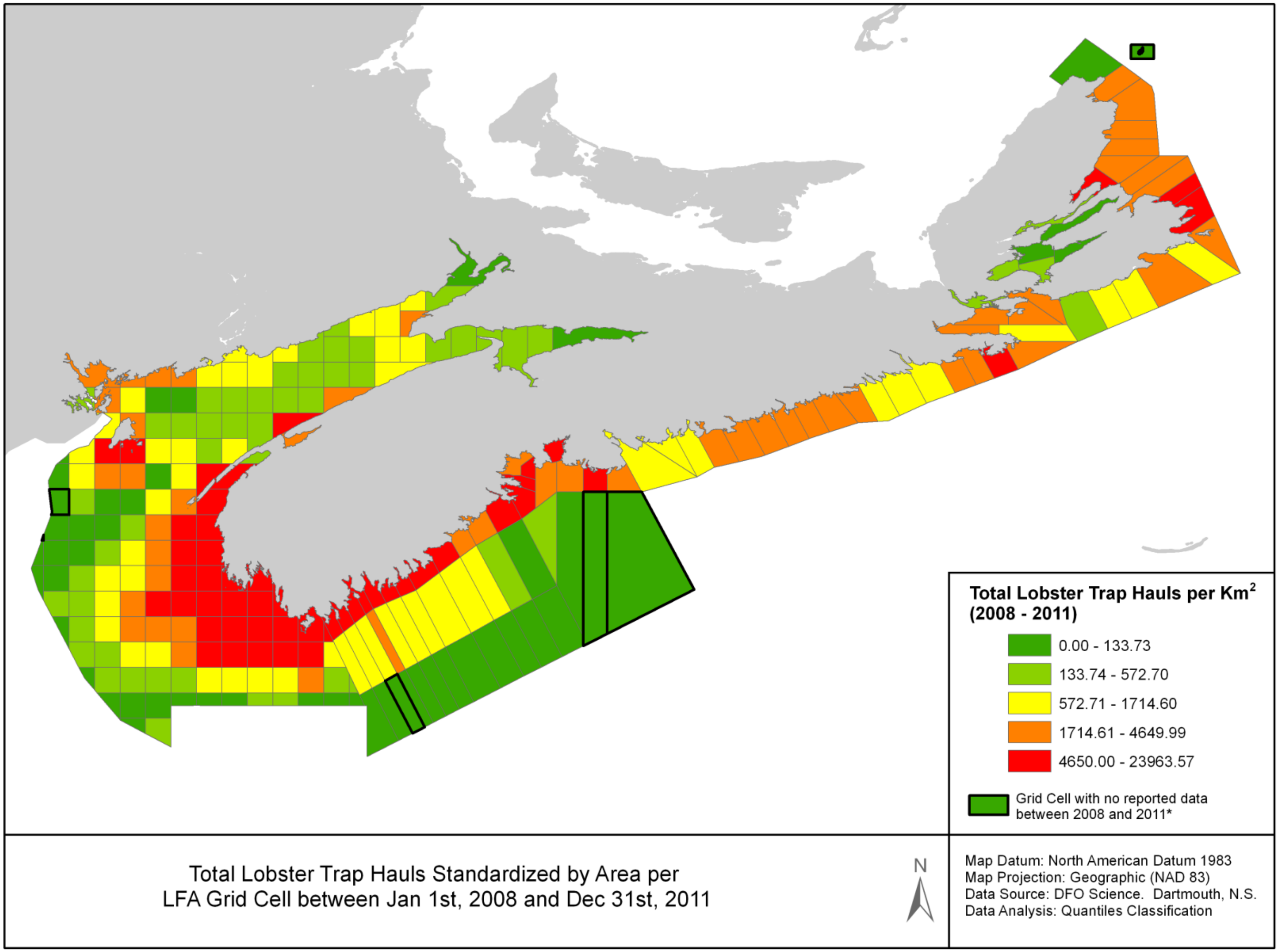

Figure 13.—Composite number of traps hauled standardized by area, 2008–2011

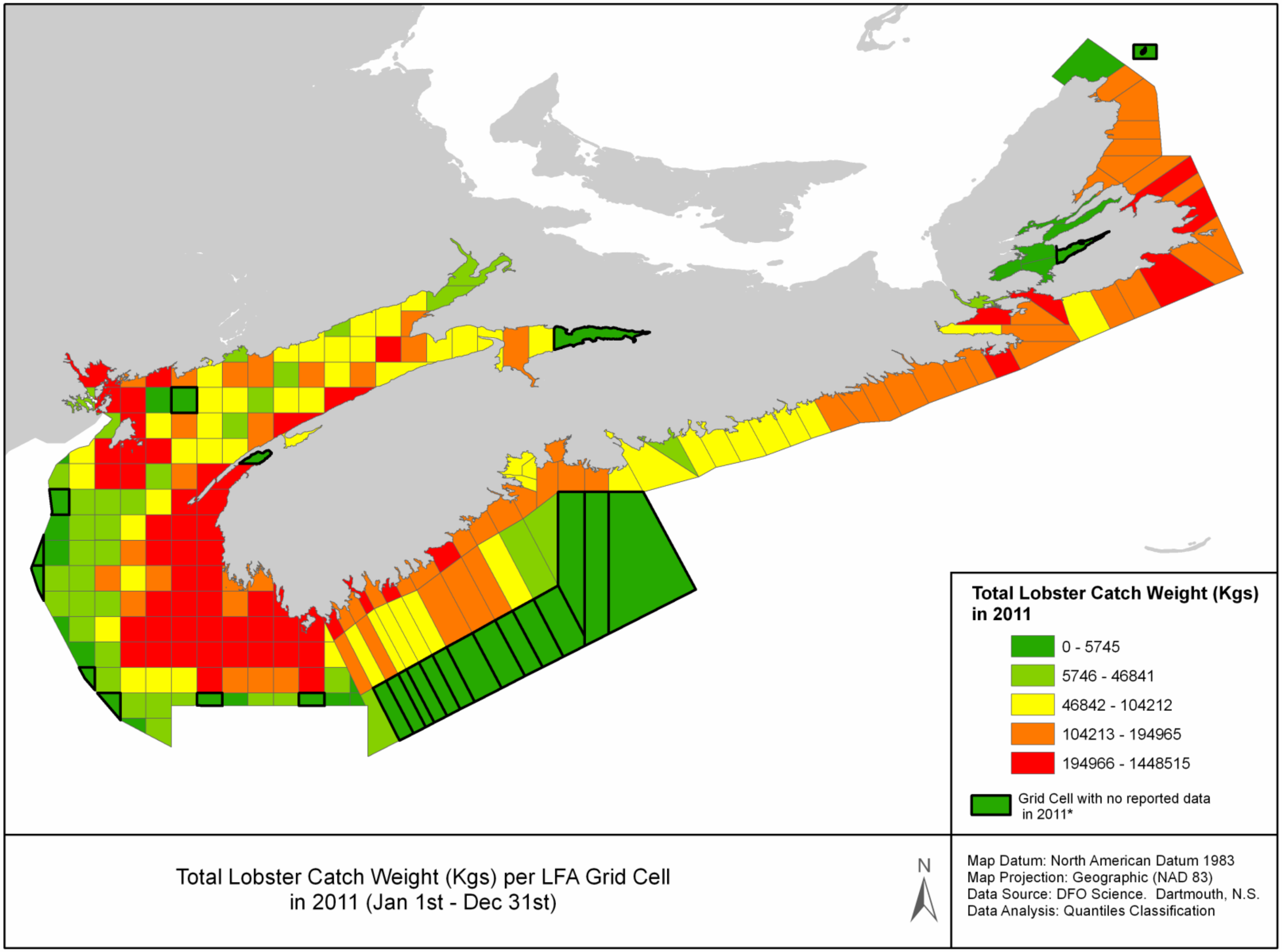

Figure 14.—Annual catch weight, 2011

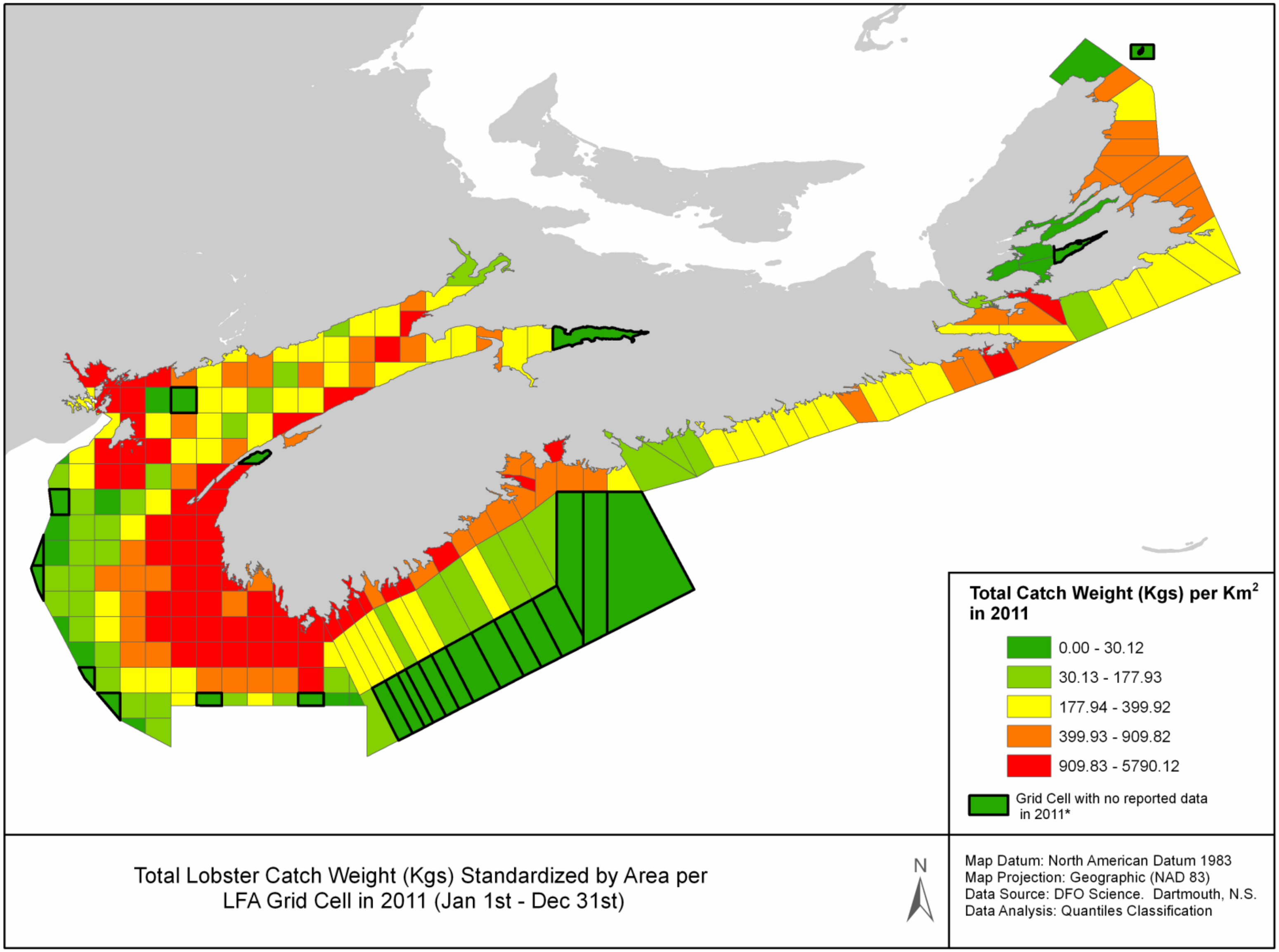

Figure 15.—Annual catch weight standardized by area, 2011

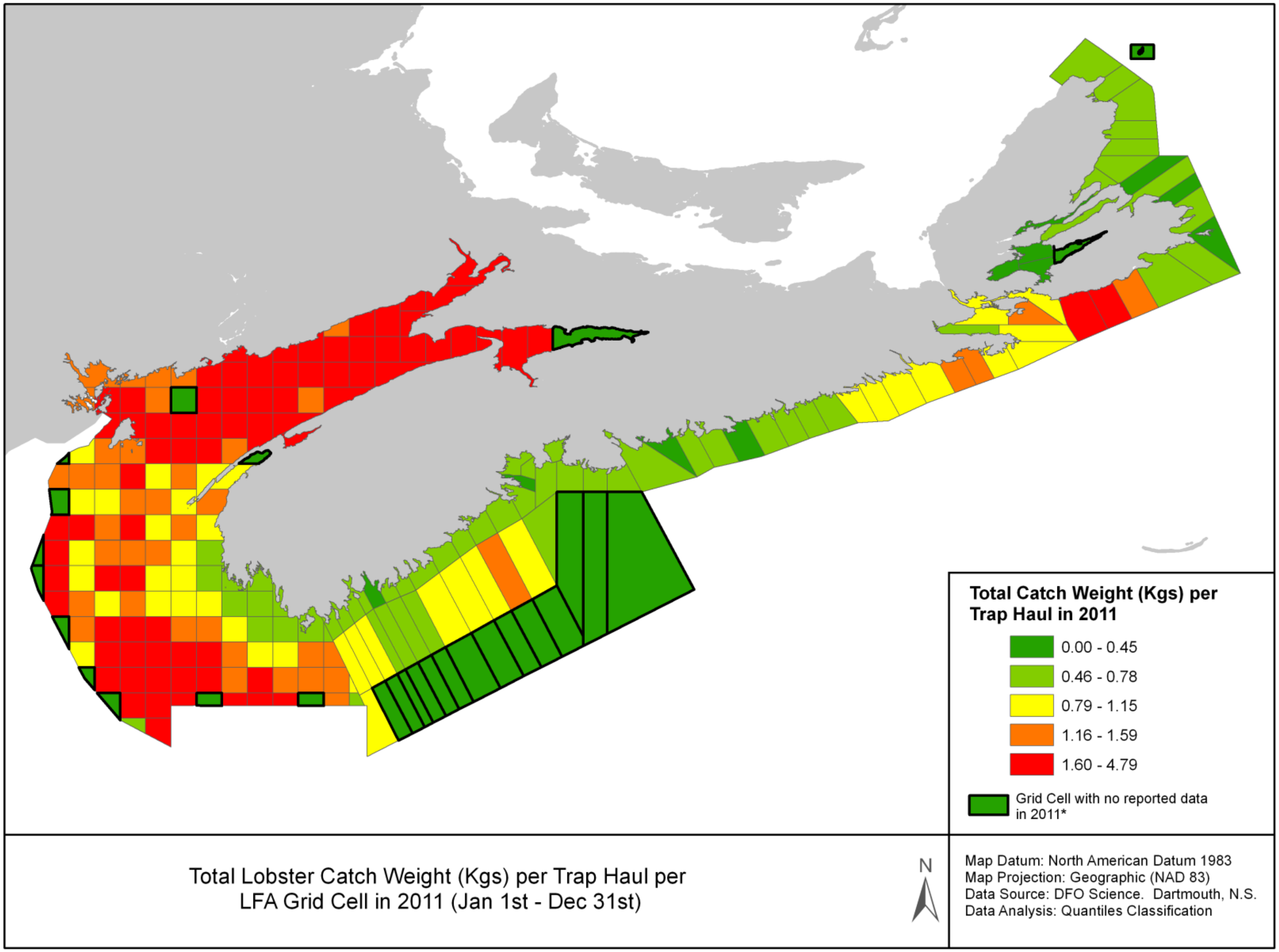

Figure 16.—Annual catch weight per trap haul (CPUE), 2011

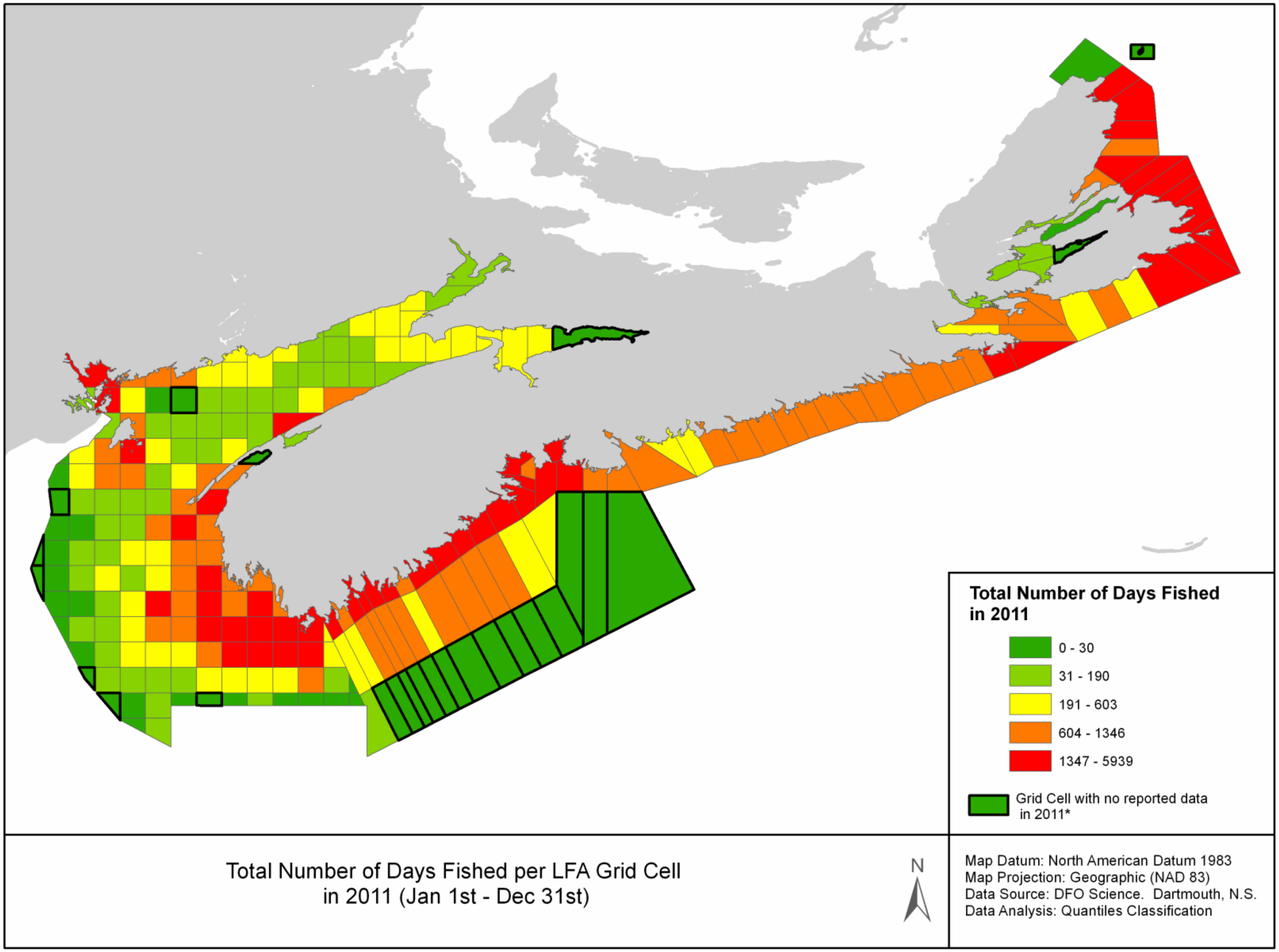

Figure 17.—Annual number of days fished, 2011

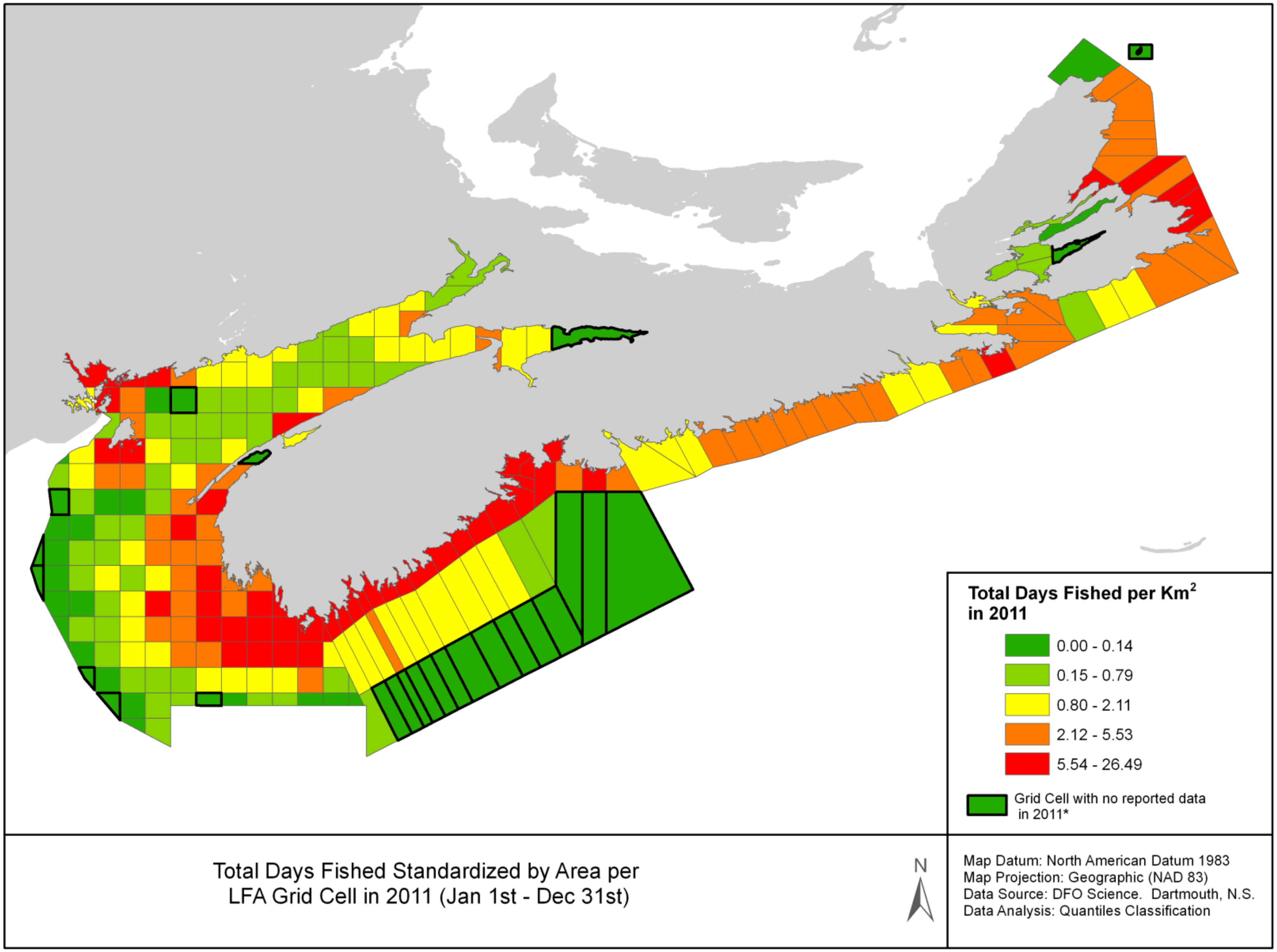

Figure 18.—Annual number of days fished standardized by area, 2011

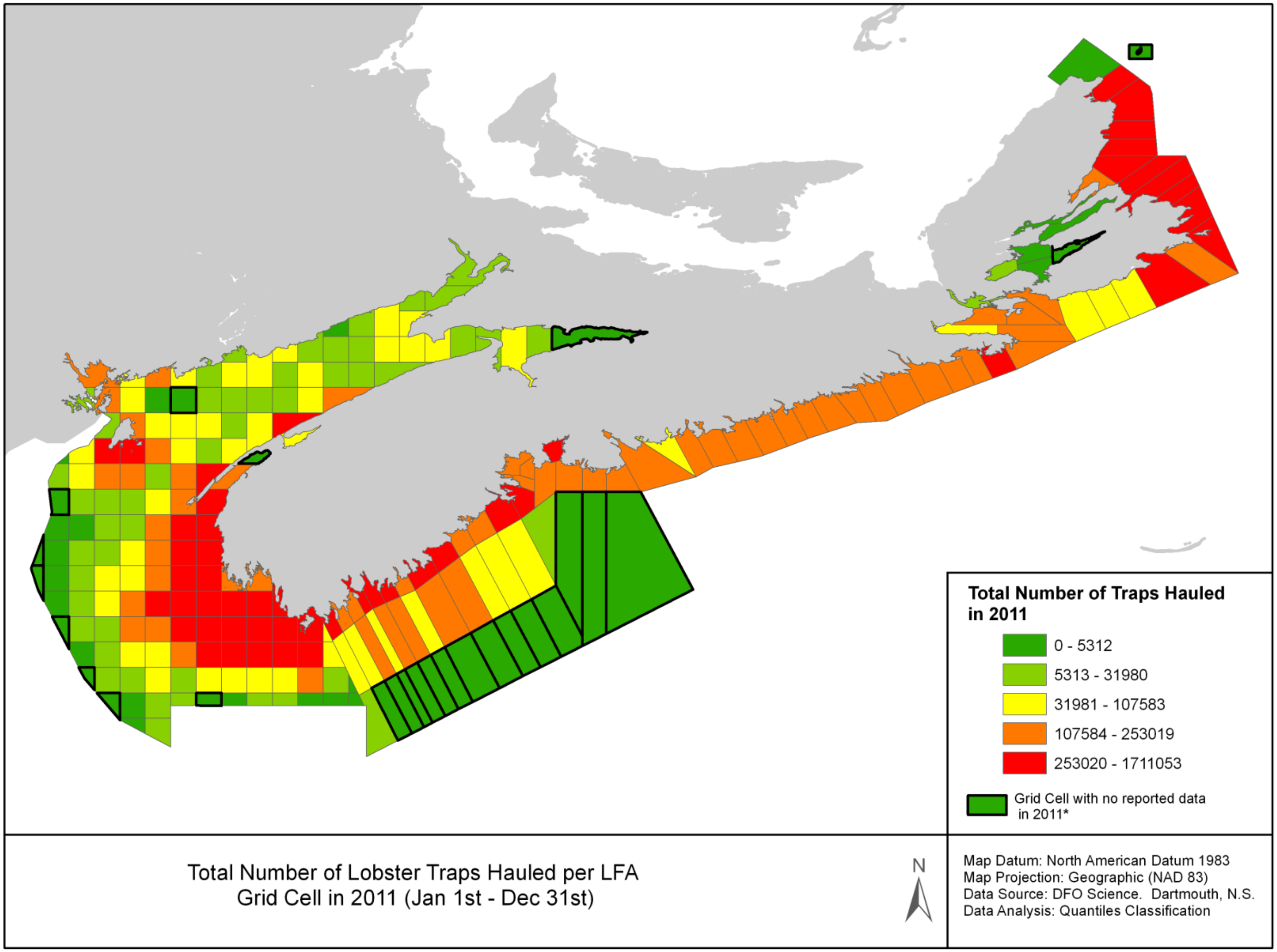

Figure 19.—Annual number of traps hauled, 2011

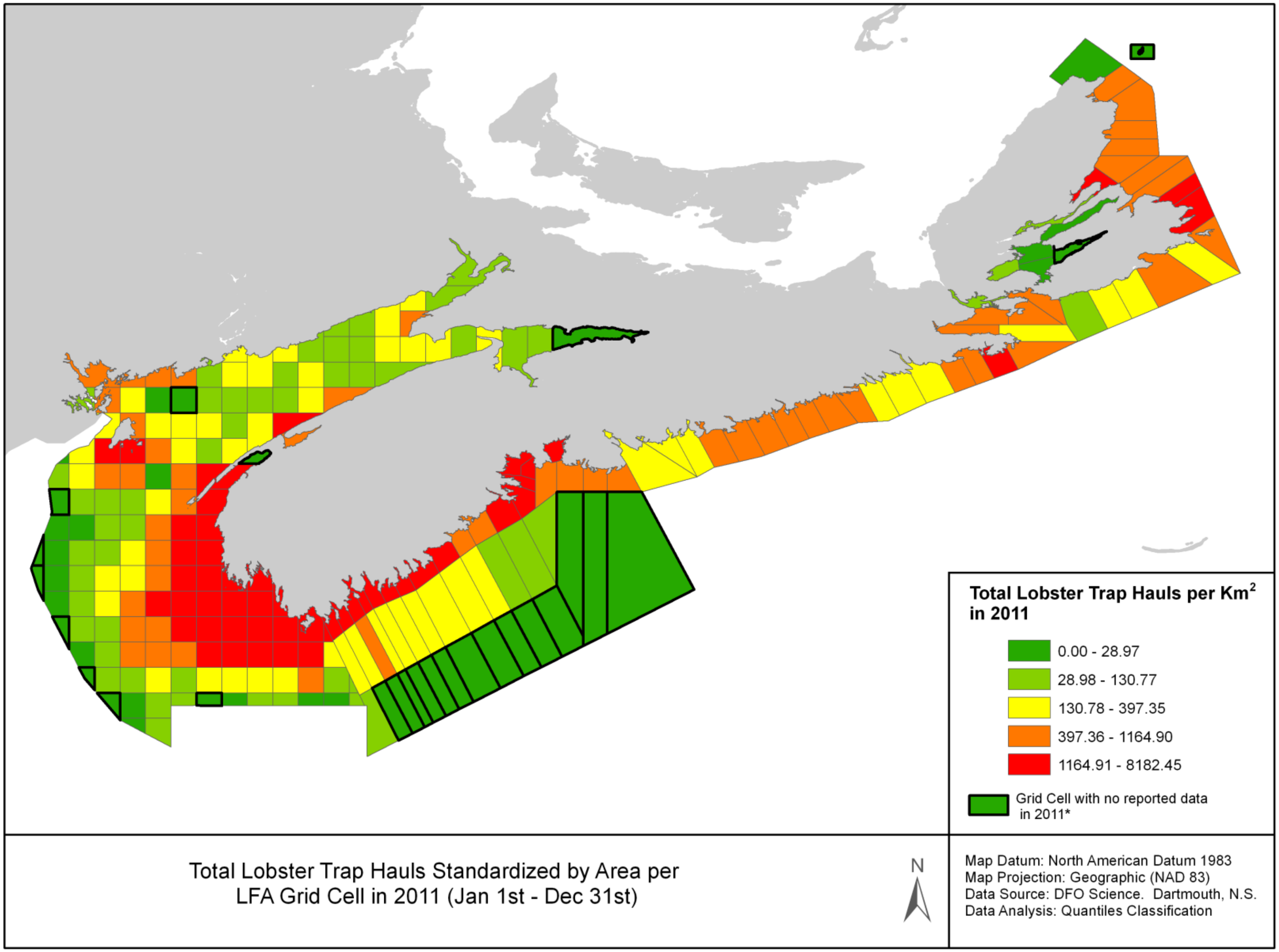

Figure 20.—Annual number of traps hauled standardized by area, 2011

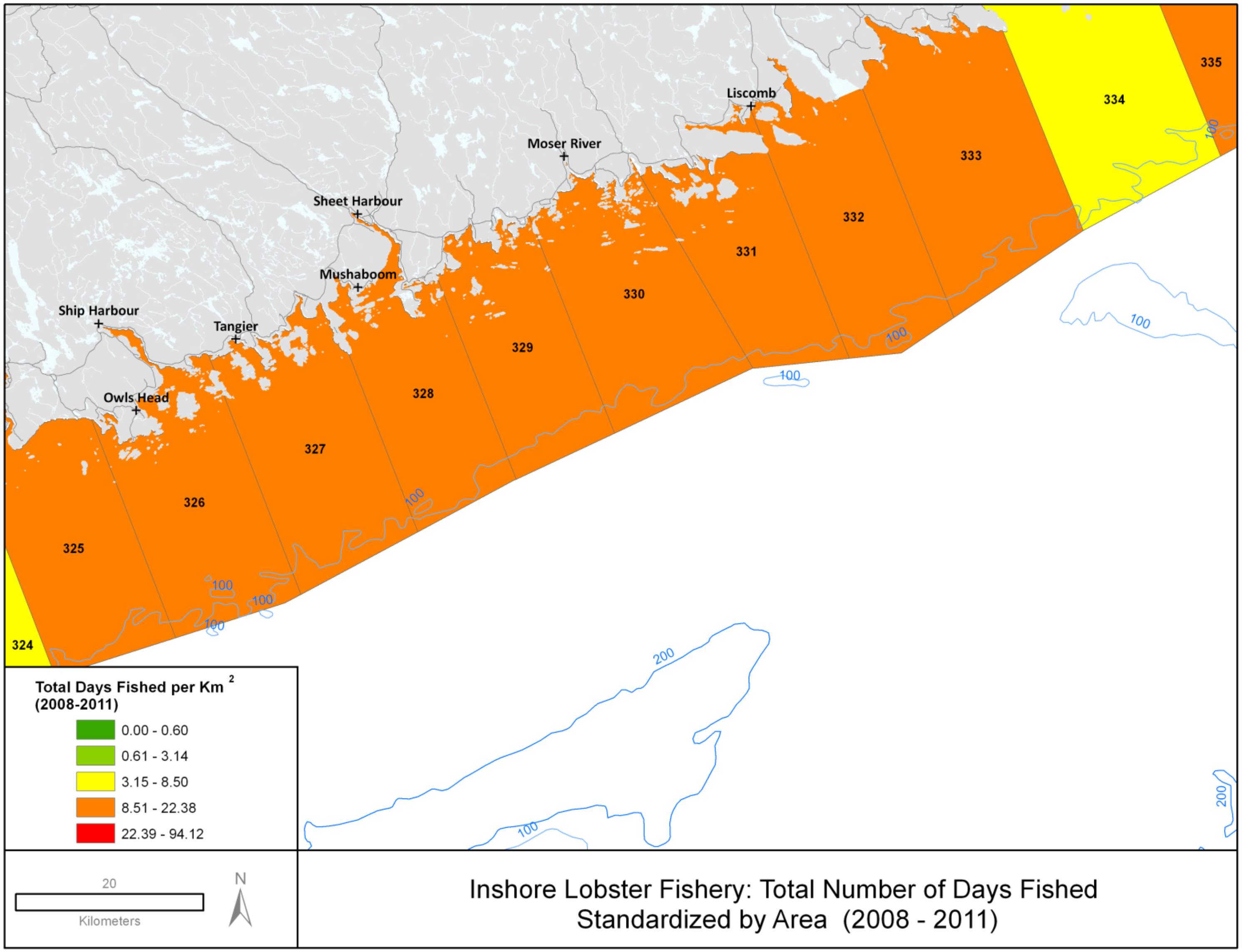

Figure 21.—Composite number of days fished along the Eastern Shore standardized by area, 2008–2011

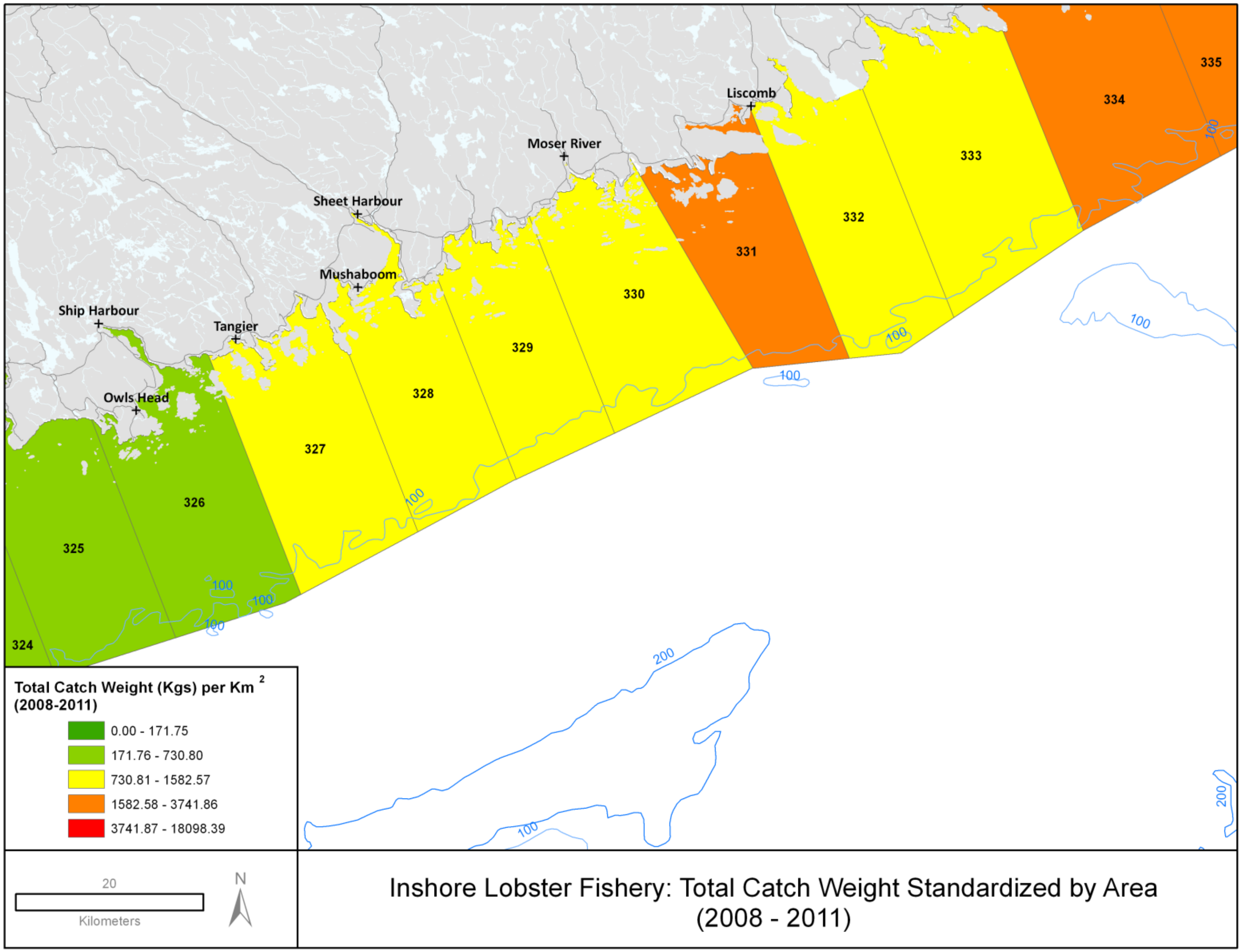

Figure 22.—Composite of total catch weight along the Eastern Shore standardized by area, 2008–2011

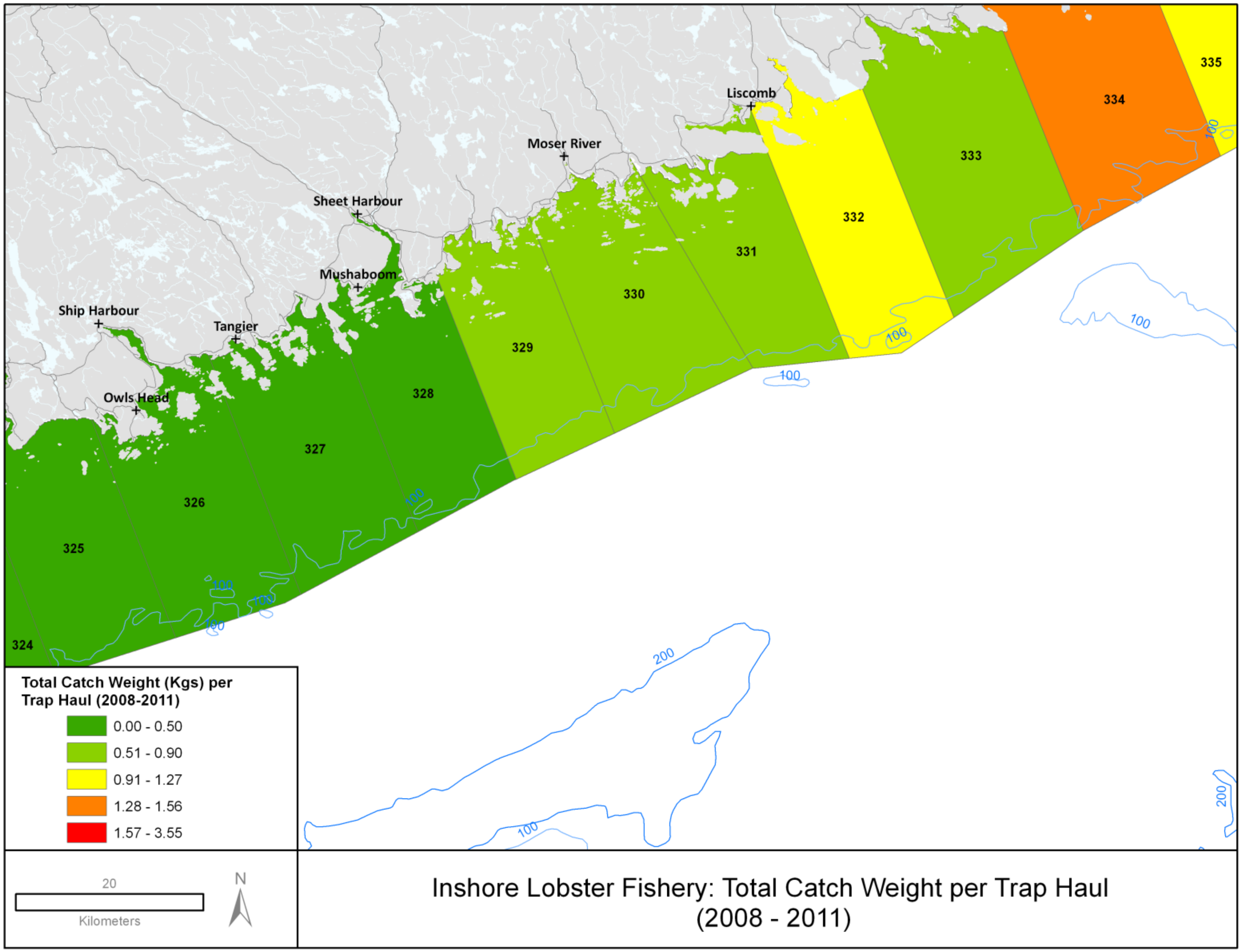

Figure 23.—Composite of catch weight per trap haul along the Eastern Shore, 2008–2011

APPENDIX 1: Summary of Lobster Logbook Data between 2008 and 2011.

Table 1.—Summary of reported logbook catch weight data with reported grid cells

	Total Catch Weight (Kg) with Reported Grid Cells				
LFA	**2008**	**2009**	**2010**	**2011**	**Total**
27	2409463.4	1842070.2	2164274.2	2247944.0	8663751.8
28	8545.7	10729.8	6688.7	5402.7	31366.9
29	959038.6	876315.6	812783.2	650623.4	3298760.8
30	398558.5	461704.9	382859.6	363225.7	1606348.6
31A	906485.1	862490.7	765008.3	688850.7	3222834.8
31B	992887.1	1143893.8	894509.8	806760.6	3838051.4
32	623849.8	670604.7	484673.1	584527.9	2363655.4
33	3170171.1	3122756.0	3731244.1	4397815.8	14421987.0
34	17325775.1	17298855.5	19994806.9	20352819.6	74972257.2
35	1532528.2	1731217.7	2256388.4	3087585.4	8607719.7
36	1476819.7	1533180.6	1653396.7	2198446.7	6861843.8
38	1692633.7	1642673.0	1964977.6	2190325.4	7490609.7
					135,379,187.1 Kg

Table 2.—Summary of reported logbook catch weight data without reported grid cells

	Total Catch Weight (Kg) with No Reported Grid Cells				
LFA	**2008**	**2009**	**2010**	**2011**	**Total**
27	137656.5	155383.7	206552.8	191219.5	690812.5
28	3944.0	2202.6	5279.8	0.0	11426.5
29	72086.3	150754.1	56057.7	94059.6	372957.7
30	240.4	0.0	2270.2	24218.7	26729.3
31A	19994.8	89054.7	108215.3	90694.4	307959.3
31B	12892.9	75407.1	65407.2	87063.0	240770.2
32	63197.1	105681.2	158767.1	158007.9	485653.2
33	106155.6	196159.0	248100.2	252982.4	803397.2
34	887249.6	1501978.6	2146313.1	2060520.9	6596062.2
35	139370.3	121620.8	305757.5	418998.2	985746.9
36	84120.9	100201.3	162812.1	234965.4	582099.7
38	137374.5	226396.6	169048.0	325819.0	858638.1
					11,962,252.8 Kg

Table 3.—Summary of reported logbook trap haul data with reported grid cells

	Total Trap Hauls with Reported Grid Cells				
LFA	**2008**	**2009**	**2010**	**2011**	**Total**
27	4970634	4370180	4428451	4368255	18137520
28	27440	36963	21284	18120	103807
29	731141	629978	647034	576968	2585121
30	231850	241361	232704	208526	914441
31A	786797	747793	734751	707492	2976833
31B	888799	892000	856092	778747	3415638
32	1429026	1374432	1155569	1158530	5117557
33	7060885	6629066	6830463	6950140	27470554
34	20525035	19368370	20057839	18534990	78486234
35	1118581	1182034	1187967	1258418	4747000
36	1036495	1121768	1175288	1234893	4568444
38	1526439	1440083	1483916	1450318	5900756
					154,423,905

Table 4.—Summary of reported logbook trap haul data without reported grid cells

	Total Trap Hauls with No Grid Cell Reported				
LFA	**2008**	**2009**	**2010**	**2011**	**Total**
27	248165	336287	388385	354954	1327791
28	0	6925	7040	0	13965
29	45008	80856	41496	64708	232068
30	200	0	1875	11748	13823
31A	17258	73728	95049	74714	260749
31B	13040	49729	58752	61312	182833
32	100424	199572	330964	299421	930381
33	99233	249366	372467	359199	1080265
34	721960	1281713	1876625	1553702	5434000
35	78431	77062	113671	158869	428033
36	33014	56787	80522	105790	276113
38	70549	138026	92209	106700	407484
					10,587,505