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A study of Spanish Greenland halibut commercial effort and CPUE in 3LMNO using GIS with comparisons to the Spanish Div. 3NO survey and EU Flemish Cap survey catches

by

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#### Abstract

An analysis of commercial CPUEs of Spanish commercial Greenland halibut fishery at depths of more than 700 meters is presented in this paper. We use percentage of effort from NAFO observers and CPUEs from IEO (Instituto Español de Oceanografía) observers. A GIS analysis was used in order to see how the effort is distributed. From 2005 to 2006 the CPUEs experimented a high increase. In recent years the effort of the Spanish fleet has decreased substantially and remained mostly around the Northwest of Div. 3L and North of Flemish Pass. We compare these data with the 3NO Spanish survey and the EU Flemish Cap survey data. Results from surveys do not reflect this increase in the commercial values.

#### Introduction

Fisheries are usually distributed through large areas. Historically, trawl data have been analyzed ignoring the spatial aspects or by analysis on geographically small scales (Issak and Hubert, 1997). Since the advent of GIS and the widespread use of GPS on survey vessels, large scale investigations of patterns of fish distributions and abundances, and their variation over time, are possible. The ability of GIS to graphically display and analyse layers of data as well as combine several layers together, makes GIS a powerful tool for dealing with large and long-term data sets generated from trawl surveys which has great implications for habitat conservation and fisheries management.

A Geographic Information System (GIS) analysis of bottom trawl events was carried out for Greenland halibut with data from commercial catches in NAFO Regulatory Area of Divisions 3LMNO and 3MNO from research surveys in order to visualize and compare the spatial and temporal distribution of catch-per-unit-effort (CPUE) and effort between them. The distribution is highly variable in both space and time.

The Spanish fleet has three different fisheries in NAFO Subarea 3 characterized by different mesh size, target species, depth and fishing area. The Spanish fleet effort in NAFO area is mainly directed to Greenland halibut (mostly in Div. 3LM), alternating with the skate fishery in the second half of the year (Div. 3NO), shrimp fishery (Div. 3LM), and redfish (Div. 3O) (González *et al.*, 2007).

Research surveys data and commercial vessels results are often not in accordance. The discrepancies can be due mainly to the sampling design and to catchability. A research survey follows usually a stratified design all over the area studied, since commercial vessels goes where the fishing occurs. So, in general, the commercial index is higher than the research index.

The aim of the present work is to compare the values and distribution of the CPUE of the surveys made by Spain in the NAFO Regulatory Area with the commercial CPUE in the same area.

## Material and Methods

The data presented in this paper correspond to depths upper 700 meters, because at these depths the Spanish fleet is only targeting Greenland halibut, and there is no other fishery above 700 meters (González *et al.*, 2007). We only use data of Greenland halibut catches.

Data were checked for consistency, corrected and later converted into an ArcMap compatible format. A planar reference system was used in order to obtain data that could be used and analysed within the GIS. The analysis were performed per 0.2 x 0.2 degrees rectangles. All the geographical databases were referenced to the Mercator projection. Moreover, bathymetric curves were exported as shapefiles (ArcMap format) from GEBCO Digital Atlas.

### Research survey data

We use the catch per unit of effort (CPUE) per hour, calculated in each rectangle as the total Greenland halibut catch (sum of the catch in each haul in this rectangle) divided by the total number of fishing hours in the rectangle, of two different surveys, the Spanish Div. 3NO of NAFO Regulatory Area survey and the EU Flemish Cap survey in Div. 3M of NAFO Regulatory Area.

The Spanish 3NO survey on NAFO Regulatory Area was initiated in 1995. Until 2001, the surveys were carried out in spring (May), on board the Spanish vessel *C/V Playa de Menduña* using bottom trawl net type *Pedreira* and following a stratified design. Since that year, the *R/V Vizconde de Eza* replaced the *C/V Playa de Menduña* as the research vessel for the survey, using bottom trawl net type *Campelen*. Since 1998, the depth surveyed reached the 1450 meters. The main specifications and geometry of these gears, as the rigging profile and the net plan, and a sheet with the resume of the main technical data of the survey are described in previous paper (Walsh *et al.*, 2001). A calibration between the two vessels to transform the data of the former vessel in the new vessel was performed in 2001 (González Troncoso *et al.*, 2004). But, in order to avoid the errors committed in the transformation, we only use, in this study, the data corresponding to the *R/V Vizconde de Eza* since 2002, that was the first year in which the research vessel surveyed all the strata.

The EU (Spain and Portugal) 3M survey Flemish Cap has been performed since 1988. Since 1991, the *R/V Cornide de Saavedra* using a trawl net *Lofoten* was the vessel used in the survey until 2003, when was replaced by the *R/V Vizconde de Eza* in the performance of the survey. The design used in the surveys can be seen in Saborido-Rey and Vázquez, 2003. A calibration between the two vessels was performed in 2003 and 2004 (González-Troncoso and Casas, 2005). In that years the area surveyed was extended, reaching depths of 1400 meters. We present the data since 2004 because before that year there is no data above 700 meters, and this was the first year in which the *R/V Vizconde de Eza* surveyed all the strata.

### Commercial data

A first study with the effort information from NAFO observers between the years 2001 and 2006 on board was made. The coverage of these observers is almost the 100% for the Spanish fleet (more than a sample, it is a census). For example, in 2006, information from 2769 days was available while total effort of the Spanish fleet in NAFO Regulatory Area was 2826 days (98% coverage). For these data, we calculated the percentage of the effort per each rectangle as the percentage of the effort in this rectangle divided for the total effort in all the area each year. These data allow us to know the areas of the whole zone studied where the effort of the commercial vessels is higher.

In addition to NAFO observers, IEO scientific observers were on board since 1992. The coverage of the effort of these observers is very variable over the years, from the almost 100% in years 1992-1994 up to the approximately 10% of the total effort of recent years. Despite the coverage of the sample, we consider that it reflects the usual behaviour of the Spanish fleet. A complete sampling was carried out by IEO observers, including the position of the hauls, the depth, and other technical aspects haul by haul. For this work, CPUE for Greenland halibut was estimated per each rectangle of 0.2 x 0.2 in the same manner as in the survey data.

Table 1 summarizes the total number of bottom trawl events (> 700 m) used in the calculations.

## Results

NAFO observers data maps (effort percentage values per rectangle of 0.2 x 0.2 degrees) (Fig. 2) show that during year 2003 percentage of effort reaches a maximum, as we can see, too, in the number of rectangles covered, in Table 2. From 2003 to 2006 there is a marked decrease in the area where the effort is being done. 2006 effort was a 48% of the 2003 effort.

All the maps show an area, in the Northeast of 3L and North of Flemish Pass Area, which is clearly defined independently of the percentage effort value. In this area is where the most part of the percentage of the effort is concentrated year by year. The fishing area was quite extensive until 2003 and then has decreased and concentrated in the areas described before, probably due that is where traditionally the vessels obtained the highest levels of CPUE, and when the effort decreased they went to the safest areas. This concentration of the fleet can be seen in numbers in Table 2 and Figure 1. The number of rectangles covered dropped off in 2006.

Spanish Scientific Observers Program data (CPUE values per rectangle of 0.2 x 0.2 degrees) are shown in Figure 3 from year 1992 up to 2006. From year 1992 to 1994 there was a decreasing in the CPUE. In 1993 and 1994 it was an extension of the fishing area but with smaller CPUEs than in 1992. Year 1995 is not representative, because in this year it was no almost presence of Spanish commercial fleet in the zone. From 1996 to 1999 we can see an increase in the CPUE per rectangle and then remained stable until 2002. In year 2003 there was a decrease that was confirmed in years 2004 and 2005. Surprisingly, in 2006 most of the rectangles had a CPUE of more than 300 kg.

Survey data maps (CPUE values per rectangle of 0.2 x 0.2 degrees) (Fig. 4) do not show the increase in CPUE values for the 2005 to 2006 period. The rectangles observed in the Figure 3 with a high increase of CPUE between 2005 and 2006 are not observed in the surveys.

Note that the scale is different in Figures 3 and 4. This is due the CPUE of the surveys is much smaller than the commercial one, so, in order to see something in the survey figure, we put in it a lesser scale.

## Discussion

In last years the effort of the Spanish fleet in the NAFO Regulatory Area has deeply decreased. Between 2003 and 2006 the effort has decreased a 59% (González *et al.*, 2007), due to a Recovery Plan for Greenland halibut in the area, which has caused a reduction of the fishing days. In response to this reduction, the fleet is seem to be concentrated their effort in the areas that traditionally the Greenland halibut yields appears to be highest.

The increase in the CPUE of the commercial catches during 2006 is not easily explained with the data we have and it is no confirm by the survey data (3NO and 3M). This high increase in commercial data seems difficult to explain by the population dynamic since in last years surveys and fisheries data we never observed a high new recruitment. One possible explanation could be a change in the commercial catchability in the fishing areas or a migration phenomenon.

This increase in the commercial CPUEs is confirmed by the standardized CPUEs of the Spanish commercial vessels (Fernández *et al.*, 2007).

## References

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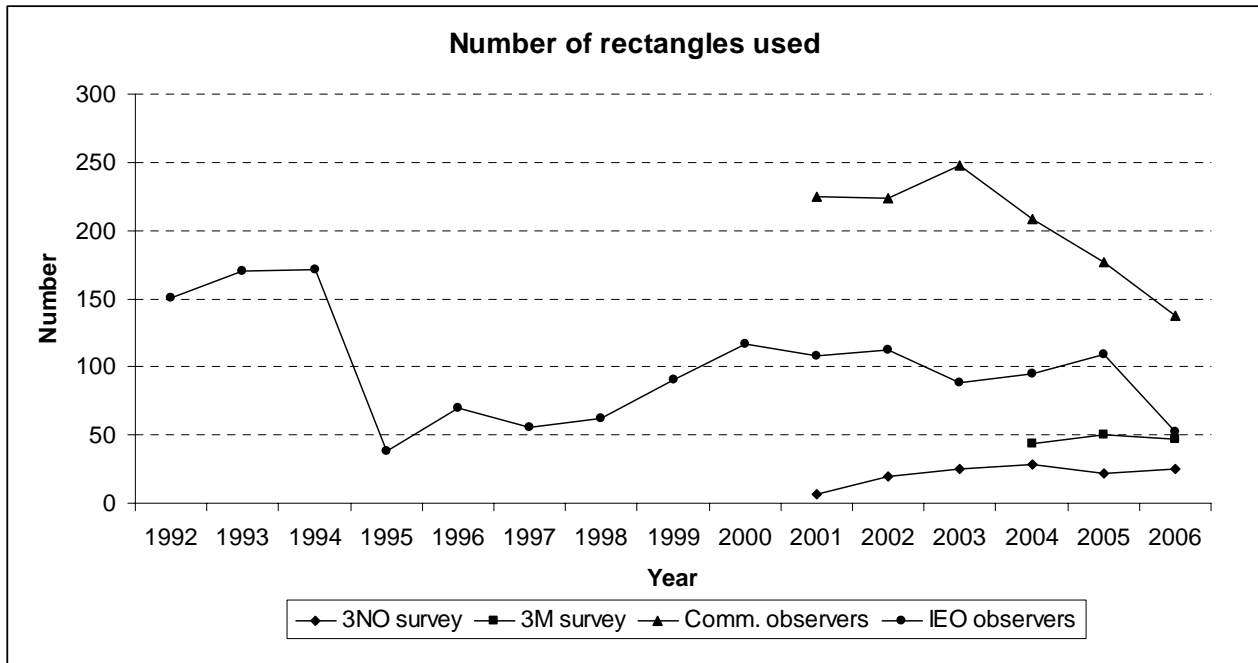
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**Table 1.** Towns of all the period with data only above 700 metros

<b>DATA</b>	<b>Period</b>	<b>Data Type</b>	<b>Bottom trawl hauls</b>	<b>Months surveyed</b>
<i>NAFO observers data</i>	2001-2006	Effort	48183	All the year
<i>IEO Observers data</i>	1992-2006	Catch and effort	39487	All the year
<i>Research survey data 3NO</i>	2002-2006	Catch and effort	156	May-June
<i>Research survey data 3M</i>	2004-2006	Catch and effort	182	July

**Table 2.** Number of rectangles by year used in the GIS analysis.

<b>Data</b>	<b>3NO Survey</b>	<b>3M Survey</b>	<b>NAFO obs. data</b>	<b>IEO obs. data</b>
1992				151
1993				170
1994				171
1995				38
1996				70
1997				56
1998				62
1999				91
2000				117
2001	7		225	108
2002	20		224	112
2003	25		248	88
2004	28	44	208	95
2005	22	50	177	109
2006	25	47	138	52
<b>Total</b>	<b>127</b>	<b>141</b>	<b>1220</b>	<b>1490</b>



**Figure 1.** Number of rectangles by year used in the GIS analysis.

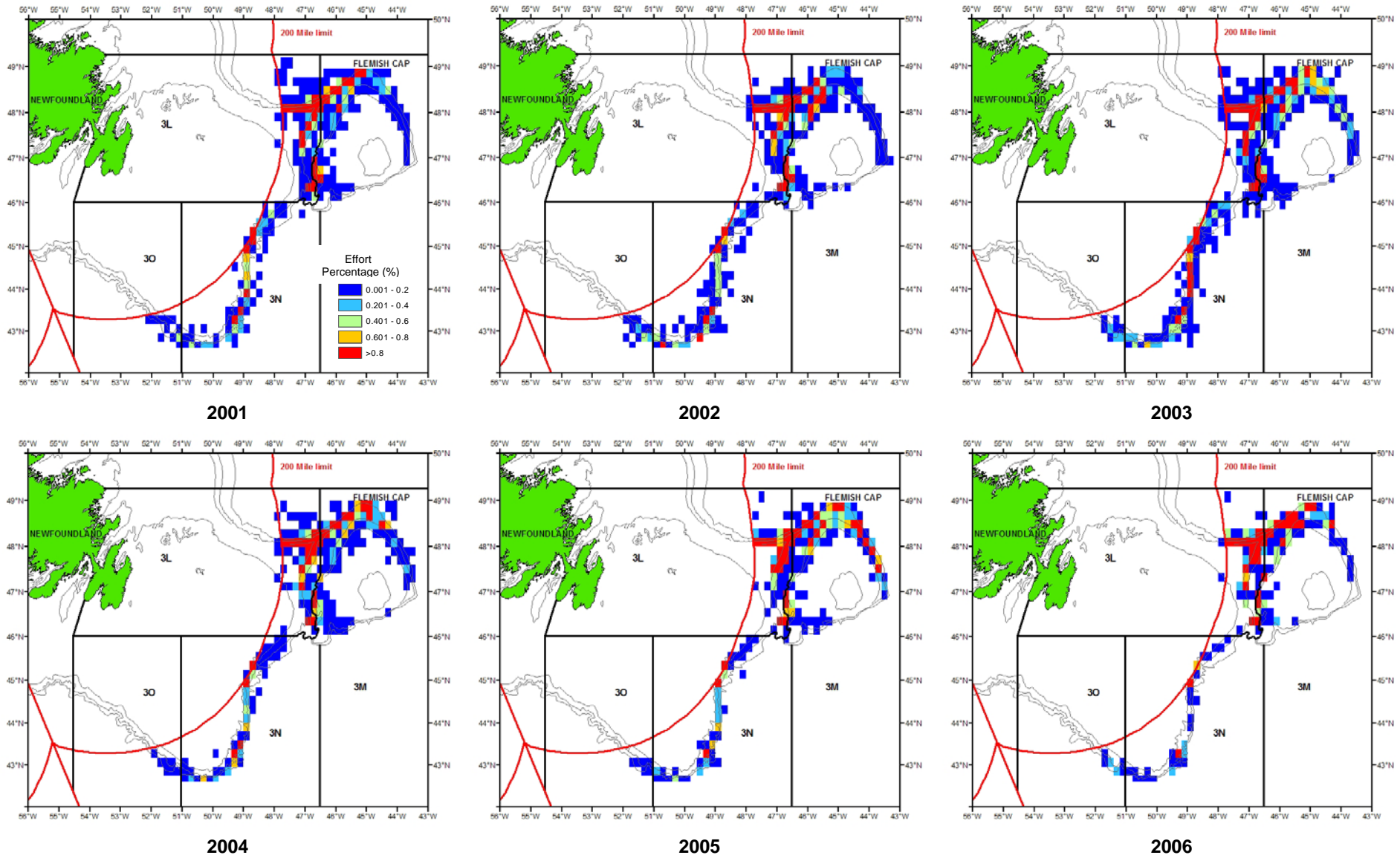


Figure 2. NAFO observers data maps (Effort percentage values per rectangle of 0.2 x 0.2 degrees)

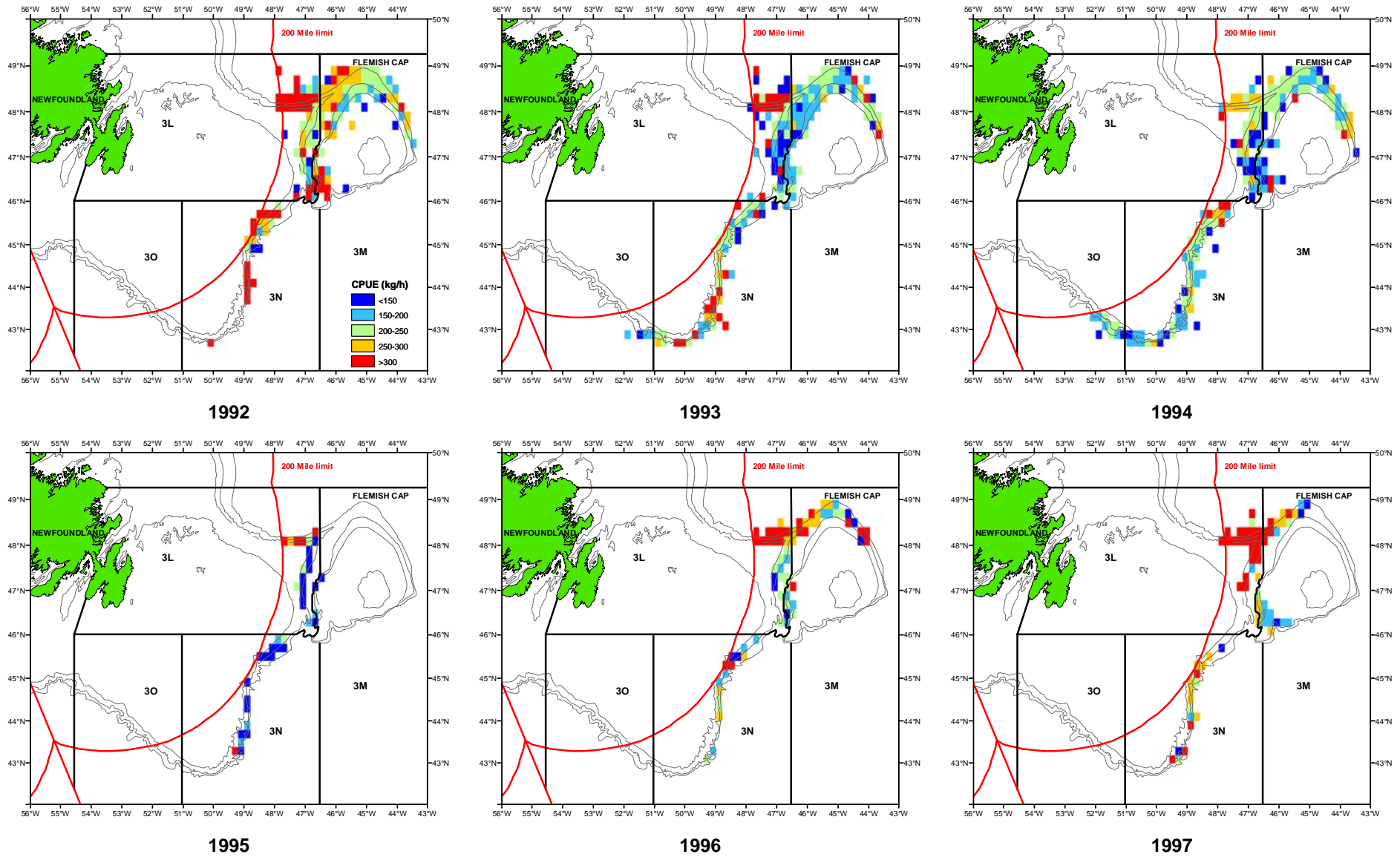


Figure 3. Spanish Scientific Observers Program data (CPUE values per rectangle of 0.2 x 0.2 degrees)



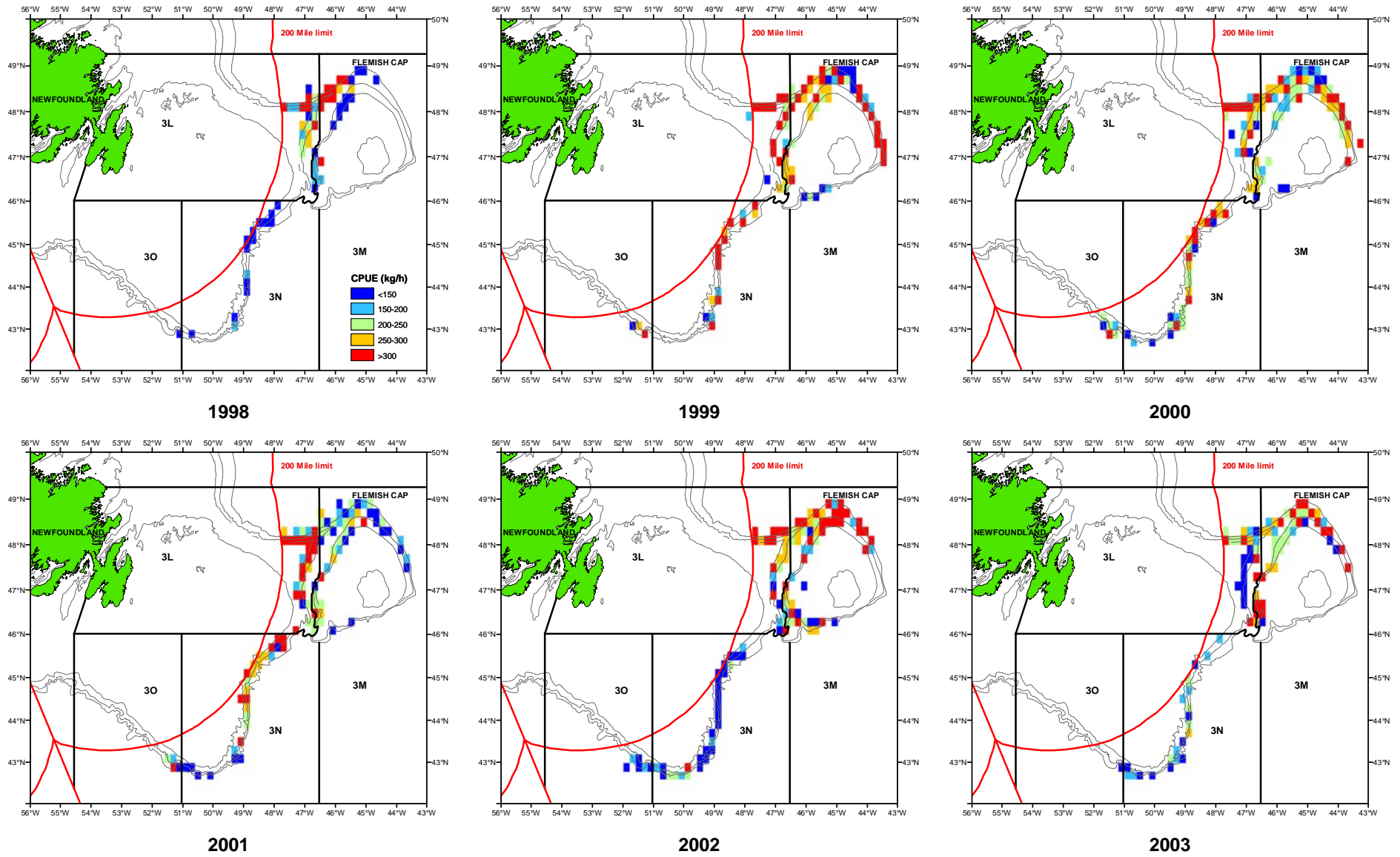


Figure 3 (cont.). Spanish Scientific Observers Program data (CPUE values per rectangle of 0.2 x 0.2 degrees)

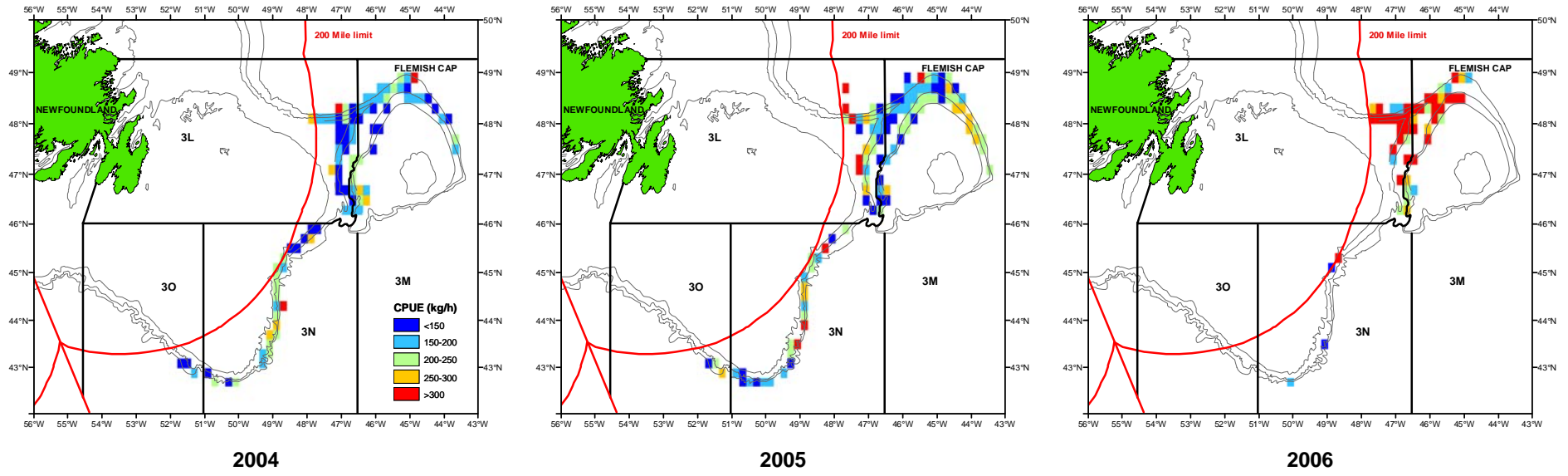


Figure 3 (cont.). Spanish Scientific Observers Program data (CPUE values per rectangle of 0.2 x 0.2 degrees)

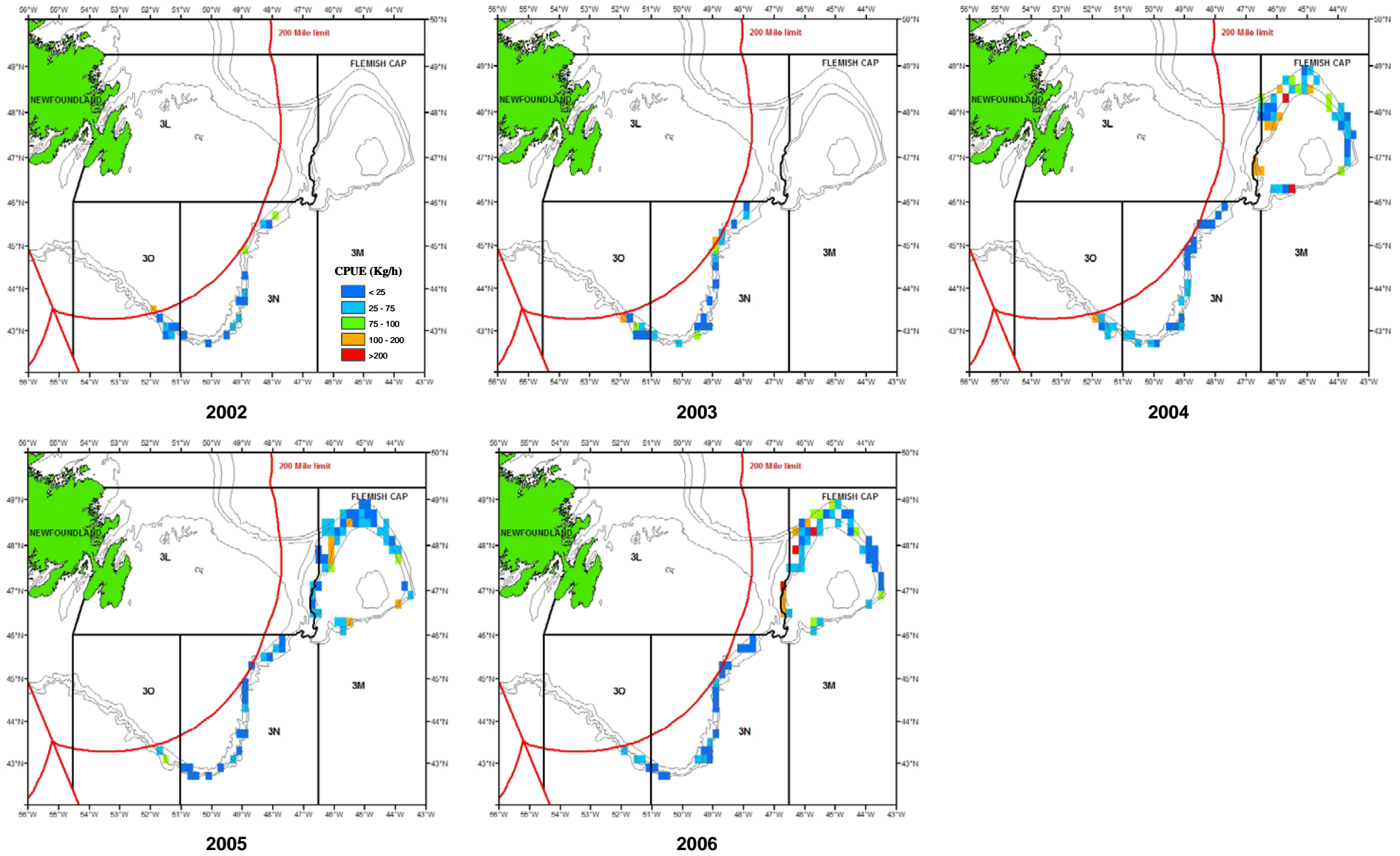


Figure 4. Survey data maps (CPUE values per rectangle of 0.2 x 0.2 degrees)

