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## INFORMATION ON FISHING EFFORT IN THE NRA FOR 2006

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### ABSTRACT

The NAFO Scientific Council requested that the NAFO Secretariat provide summary information, in accordance with Article 22.8 of the NAFO Conservation and Enforcement Measures, for the assessment of several stocks in the NAFO Regulatory Area (NRA), using NAFO Vessel Monitoring System (VMS).

The primary objective of this document is to assist the Scientific Council in determining the usefulness of the NAFO VMS for their work. Fishing effort was assessed for 2006 using the NAFO VMS position (POS), Catch-on-Entry (COE), and Catch-on-Exit (COX) reports. The data housed in the VMS database does not link vessel position to target species. This was achieved using fishery information from other reports submitted to the Secretariat, in combination with VMS data. Furthermore, gear information is only identified for a limited number of vessels, and therefore was excluded from this assessment. Average speed was used to determine if a vessel was fishing (average speed between 1-6 knots) or not. Fishing effort is shown as hours-on-ground, hours fishing, kW hours-on-ground and kW hours fishing. Quarterly effort is plotted for groundfish (GRO), shrimp (PRA/PAN) and redfish (*Sebastes mentella* REB) by NAFO Division.

### RECOMMENDATION FOR CONSIDERATION

The real-time nature of the NAFO VMS reporting system certainly presents an enticing prospect for fishery data analysis. Progression of the VMS data integrity and structure will ensure that it becomes an invaluable tool in assessing fishing effort in the NRA. The usefulness of the NAFO VMS data is dependent on the accurate determination of geographic location, date and time, gear type, target species and fishing/non-fishing.

#### 1. Geographic Location/Date and Time

Position reports (POS), and date and time are reported appropriately. The automatic nature of these reports reduces error and facilitates reporting consistency. It may be worth considering increasing the frequency of POS reports, currently two (2) hours, to more accurately determine vessel tasks i.e. trawling, hauling and steaming etc.

#### 2. Gear Type

Gear codes are currently assigned during vessel registration. The 'Vessel Gear' (CEM 2007, Annex IV) field is an optional element in the vessel notification report (NOT). Reporting of this element is relatively low (~23%), fishing effort assessment using this element is therefore ineffectual.

#### 3. Target Species

Vessels transmit COE and COX (CEM 2007, Annex X) reports six (6) hours prior to entering and exiting the NRA, respectively. Vessels are obligated to identify a 'Directed Species' during a COE message, and actual catch information is transmitted in a corresponding COX message. Unfortunately, COE and COX reports are not

transmitted consistently (~20% missing); solely relying on this data to derive a vessels target species is not currently viable.

A mandatory implementation of an electronic observer scheme would greatly improve the capacity to accurately determine fishing effort i.e. CAX (CEM 2007, Annex XXa) and OBR (CEM 2007, Annex XXb) reports.

#### 4. Fishing/non-Fishing

Average vessel speed was used to distinguish fishing from non-fishing. This is not the most accurate method to determine speed as it is calculated as an average over two-hour intervals. POS reports at a higher frequency would improve accuracy. Furthermore, two elements exist that would further improve reliability. ‘Speed’ and ‘Course’ are data elements (NAF standard) that should be included in POS report transmission. Course could be used to calculate mean length of the vector (MLV) statistic (ICES Advice 2006, Book 9, Appendix 1), which would further differentiate steaming from fishing, based on vessel movement.

## INTRODUCTION

Due to the perceived sensitivity of the NAFO VMS dataset, the NAFO Secretariat is obliged to present data in summary form in accordance with NAFO CEM 2007, Article 22.8. All invalid and incomplete records (~6.5%) were removed from the POS dataset. VMS data exists from 2003, however fishing effort was only presented for 2006 due to the exploratory nature of this assessment. The assessed data from 2006 constitutes about a quarter of all available data. Furthermore, the completeness of data from previous years, for stock assessments is yet to be determined. Fishing effort was identified for three categories: GRO - all fish not including shrimp and pelagic redfish; PRA/PAN – shrimp; REB - pelagic redfish (*Sebastes mentella*).

## METHODS

### Data Source

The primary data source is the NAFO VMS, with POS reports being matched to target species using COE/COX reports. Other trip and target species information submitted to the Secretariat was also used as a secondary data source.

### Average Vessel Speed

POS reports within the VMS provide the necessary variables to calculate average vessel speed. The variables used in this analysis were vessel position (lat1 lon1, lat2 lon2) and data and time of transmission (t1, t2) with angles being transformed to radians. The distance between successive transmissions (d) was calculated from

$$d = 2 \sin^{-1} \sqrt{\left(\frac{\sin(\text{lat1} - \text{lat2})}{2}\right)^2 + \cos(\text{lat1}) \cos(\text{lat2}) \left(\frac{\sin(\text{lon1} - \text{lon2})}{2}\right)^2},$$

and the mid-latitude between transmission from

$$\text{lat} = \tan^{-1} \left( \frac{\sin(\text{lat1}) \cos(\text{lat2}) \sin(\text{lon} - \text{lon2}) - \sin(\text{lat2}) \cos(\text{lat1}) \sin(\text{lon} - \text{lon1})}{\cos(\text{lat1}) \cos(\text{lat2}) \sin(\text{lon1} - \text{lon2})} \right) \quad \text{for } \sin(\text{lon1} - \text{lon2}) \neq 0$$

Where  $\text{lon} = (\text{lon1} + \text{lon2}) / 2$

as described by Williams (2007: <http://williams.best.vwh.net/avform.htm>).

Average vessel speed was then calculated from  $s = d / (t2 - t1)$ .

## Fishing Effort

Fishing effort is presented in-terms of hours-on-ground, fishing hours, and kW hours. When comparing average vessel frequency for NAFO VMS data and NEAFC VMS data, it is observed that a similar bimodal frequency distribution exists (Figure 1A and Figure 1B). Based on this similarity and fishing speeds data presented by ICES (ICES Advice 2006, Book 9, Appendix 1), vessels were deemed to be fishing when speeds were between 1 and 6 knots. Ocean Data View (ODV:<http://odv.awi-bremerhaven.de/home.html>) was used to plot latitude and longitude mid-points for each position pair. Quarterly plots and NAFO Divisional information is shown for GRO, PRA/PAN and REB.

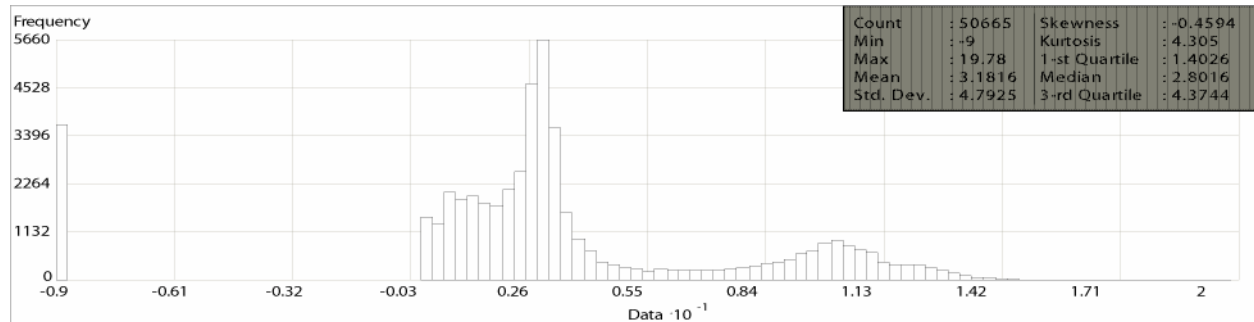


Figure 1A – Frequency distribution of calculated vessel speed for NEAFC VMS data (2004). Speeds are represented as  $10^{-1}$  (ICES Advice 2006, Book 9, Appendix 1, Figure 9.3.2.1.3).

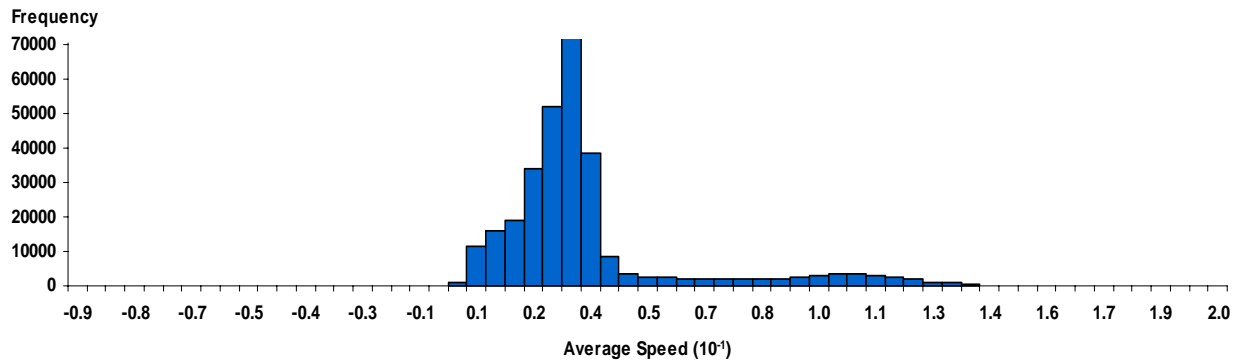


Figure 1B - Frequency distribution of calculated vessel speed for all NAFO VMS data. Speeds are represented as  $10^{-1}$

## RESULTS

### Location

Vessels spend approximately 80% of their time fishing in the NRA. Positions exist primarily in NAFO Divisions 1F and 3LMNO. Due to the long linear nature of the positions; and based upon a comparison between all positions (Figure 2A) and fishing positions (Figure 2B), it is apparent that no or minimal fishing occurs between  $50^{\circ}\text{N}$  and  $55^{\circ}\text{N}$  and the south eastern area of the NRA. For the most part, positions follow the NRA as expected; however some steaming positions occur between Newfoundland and the NRA. Most fishing and steaming vessels appear to avoid the top of the Flemish Cap.

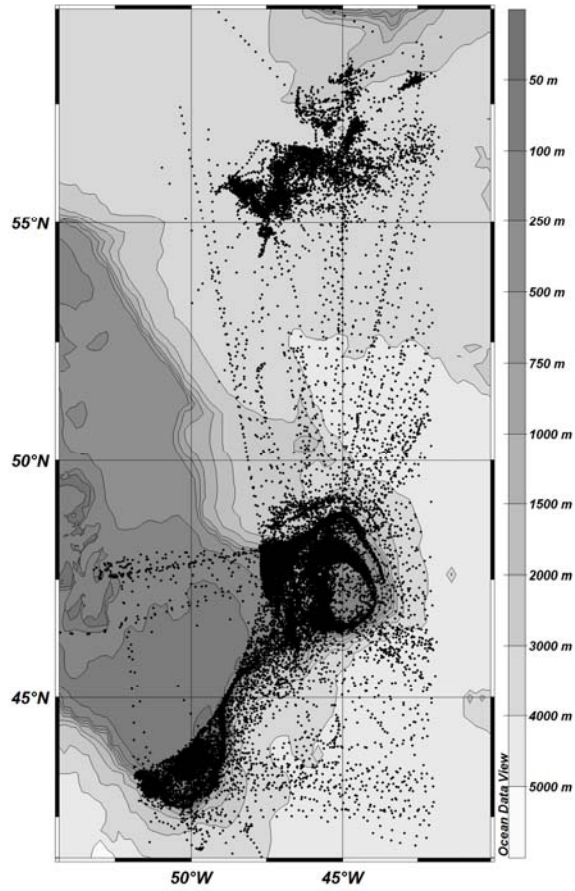


Figure 2A – ODV plot of all VMS mid-positions in 2006.

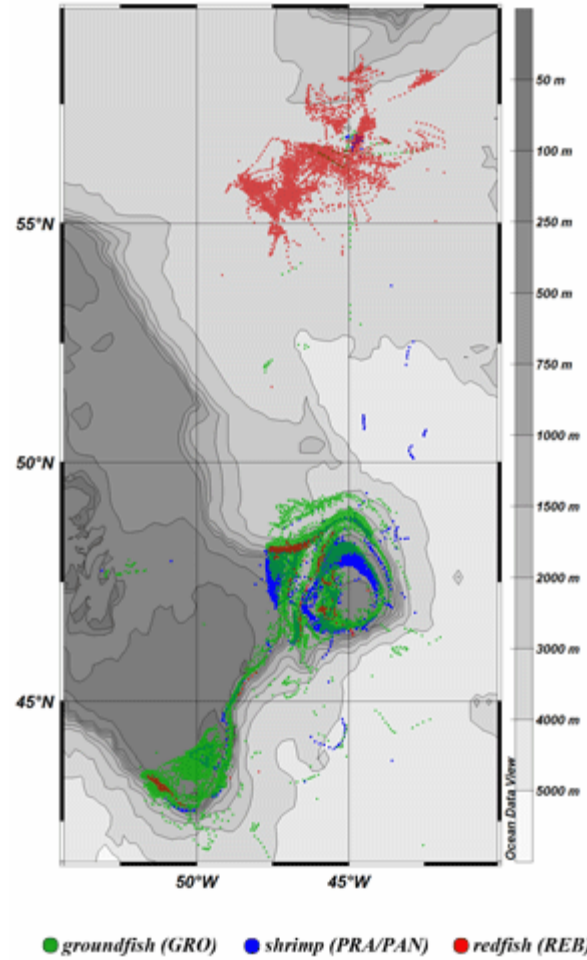


Figure 2B – ODV plot of VMS mid-positions for vessels fishing for groundfish, shrimp and redfish (*Sebastes mentella*) in 2006.

### Fishing Effort

Most fishing effort (~66%) can be attributed to vessels fishing for groundfish in Divisions 3LMNO (Figure 3). Redfish (*Sebastes mentella*) is fished almost exclusively in 1F (Figure 3). The identification of redfish in 3LO is likely a misreporting of other redfish species. Shrimp appear to be fished predominantly in 3LM (~98% of all shrimp fishing).

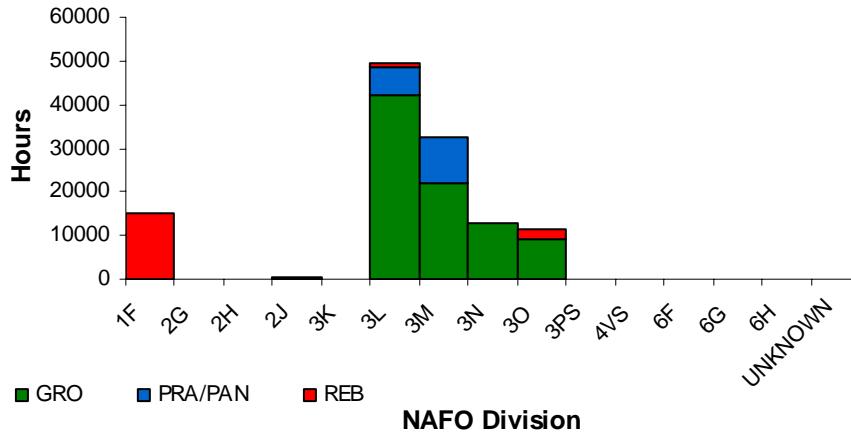


Figure 3 – Total fishing hours for each target species, as shown by NAFO Division (2006).

Division 3L is the most frequently fished (~87% of time spent fishing) and visited (~40% of all positions) Division in the NRA (TABLE 1A). When comparing number of vessel in a division, it appeared that Divisions 3LM and 1F had the greatest vessel concentration (TABLE 1B) i.e. approximately 60% of all vessels fish in 3LM and 1F. Vessels targeting redfish and shrimp had the greatest average kW capacity to fish (~40% greater capacity than vessels fishing for GRO in 3L).

TABLE 1A – NAFO VMS comparison of hours on ground and hours fishing, by NAFO Division (2006).

Division	Hours on Ground			Hours Fishing (1-6 knots)		
	GRO	PRA/PAN	REB	GRO	PRA/PAN	REB
1F	301 <sup>§</sup>	238	18671	162	55	14683
2G	2	-	-	-	-	-
2H	4	13	119	-	-	89
2J	124	104	675	24	8	464
3K	542	546	88	30	28	2
3L	47048	7499	1330	42227	6111	1241*
3M	27343	12573	336	21913	10547	175*
3N	17500	454	93	12658	314	24*
3O	10588	6	2727	9061	2	2208*
3PS	-	40	-	-	2	-
4VS	40	-	-	12	-	-
6F	31	-	-	8	-	-
6G	122	-	-	80	-	-
6H	26	-	-	-	-	-
unknown	1	55	11	-	43	2

\*REB (*Sebastes mentella*) erroneously reported by vessels as RED (*Sebastes* sp.)

§RED (*Sebastes* sp.) erroneously reported by vessels as REB (*Sebastes mentella*)

TABLE 1B – Comparison of kW hours on ground and kW hours fishing, by NAFO Division (2006).

Division	kW hours ( $10^3$ ) - On Ground				kW hours ( $10^3$ ) – Fishing (1-6 knots)			
	Vessel Count	GRO	PRA/PAN	RED	Vessel Count	GRO	PRA/PAN	RED
1F	60	351.3	571.3	41612.7	46	208.1	44.6	32905.9
2G	1	2.5	-	-	-	-	-	-
2H	13	5.1	71.7	291.2	11	-	-	226.6
2J	39	154.3	381.6	1487.7	20	29.2	17.6	1052.0
3K	39	740.2	1581.0	174.1	8	24.1	66.0	4.1
3L	56	64484.3	18184.9	2575.8	55	57231.9	14653.3	2400.8
3M	62	40162.2	30717.1	749.8	58	31513.8	26213.6	390.5
3N	36	20673.6	320.3	203.2	32	13987.7	221.5	53.4
3O	31	19737.7	4.2	5626.0	30	16933.8	1.4	4558.7
3PS	1	-	106.2	-	1	-	5.3	-
4VS	2	39.7	-	-	1	10.7	-	-
6F	1	27.5	-	-	1	7.1	-	-
6G	1	171.9	-	-	1	112.7	-	-
6H	1	26.8	-	-	-	-	-	-
unknown	14	1.9	125.6	27.1	6	-	98.1	4.3

### Groundfish

Vessels appear to target groundfish in Division 3L most frequently, however Division 3M is fished more than 3L between July and September (TABLE 2A). The area around 48°N 47°W appears to be fished only between January and March (Figure 4A). From July to September the tail of the Grand Banks is targeted considerably more than between January and June, particularly the area at 44°N 50°W.

### Shrimp

Division 3L is not fished between April and June (Figure 4B). The greatest concentration of shrimp fishing occurs in 3M from October to December (TABLE 2B). The area around 46°30'N 47°30'W is only fished from July to September. Shrimp does not appear to be fished on the Flemish Cap itself.

### Pelagic Redfish

Pelagic redfish are almost exclusively fished from July to September (Figure 4C) in Division 1F (~94%). Fishing positions in 3LMNO are most likely fishing effort for demersal redfish, incorrectly reported through the COE/COX reports (TABLE 2C).

## DISCUSSION

The NAFO VMS does allow for vessel positions and average speed to be determined. Several enhancements will augment the usefulness of the NAFO VMS i.e. improved gear reporting, inclusion of course and speed in the POS reports and more complete COX/COE reports. The potential of the daily catch reports (CAX/OBR) should be considered in terms of the relevance to fishing effort and catch assessment.

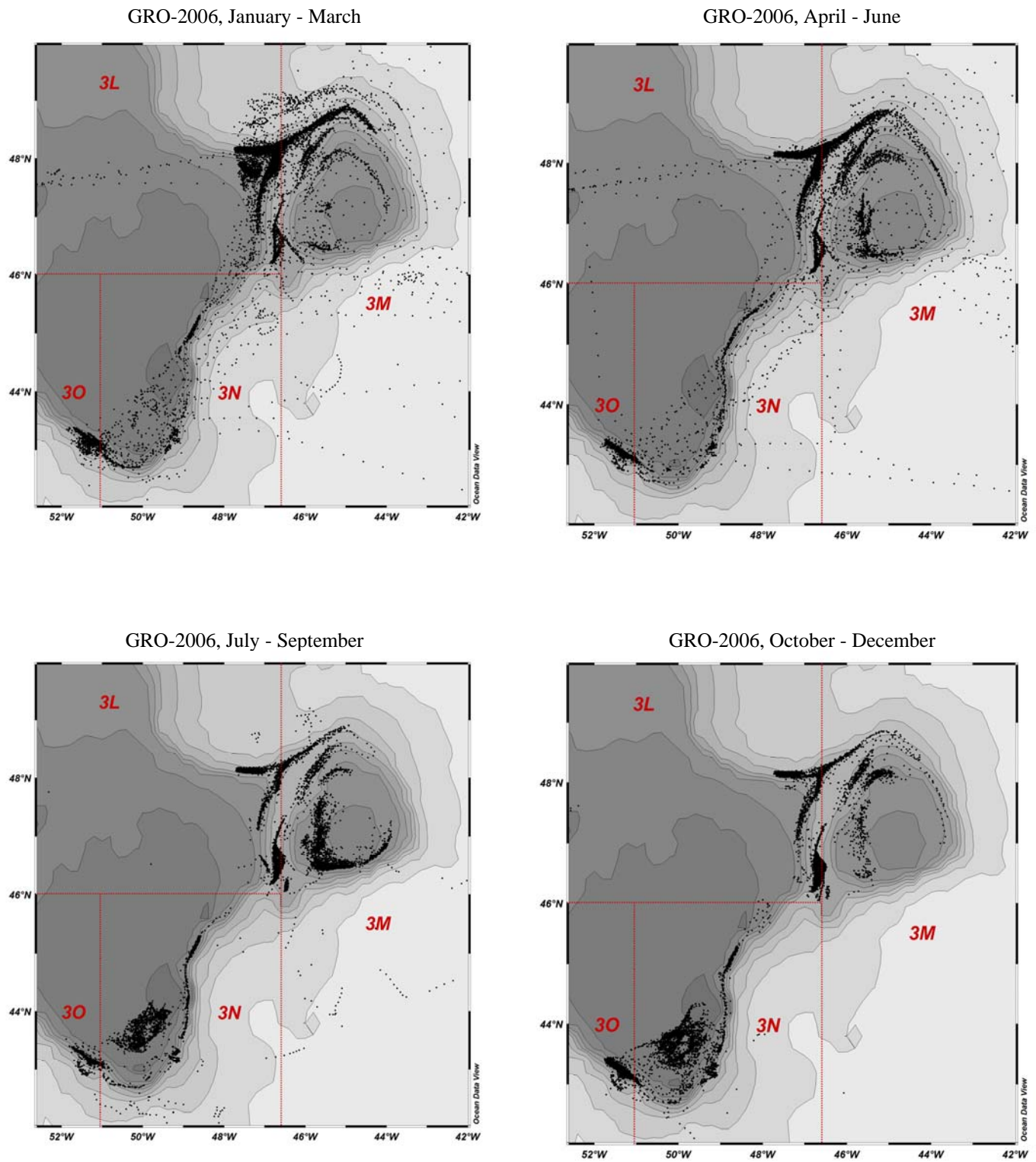


Figure 4A – ODV plot of VMS positions for vessels fishing for groundfish in 2006, shown by quarter.



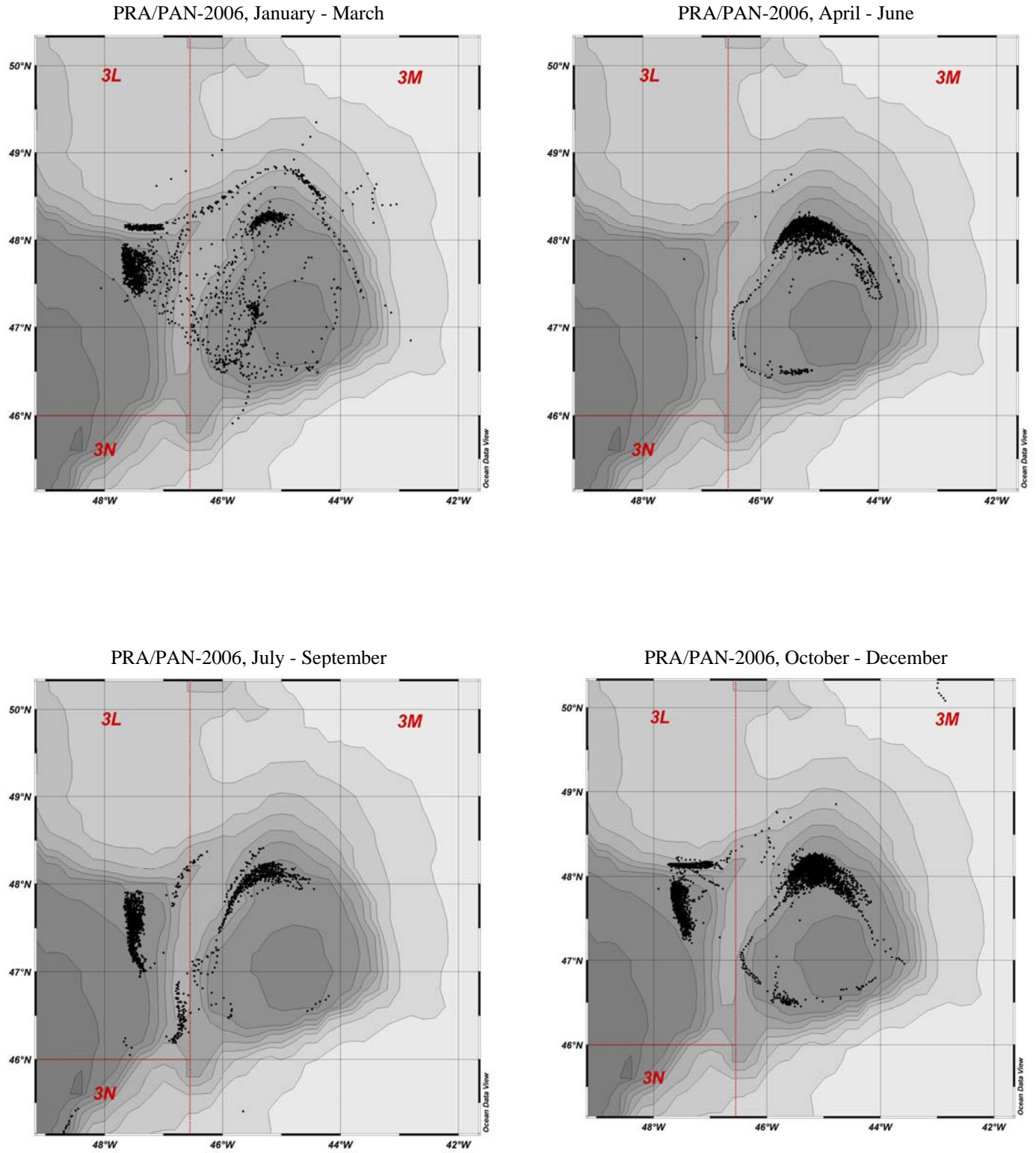


Figure 4B – ODV plot of VMS positions for vessels fishing for shrimp in 2006, shown by quarter.



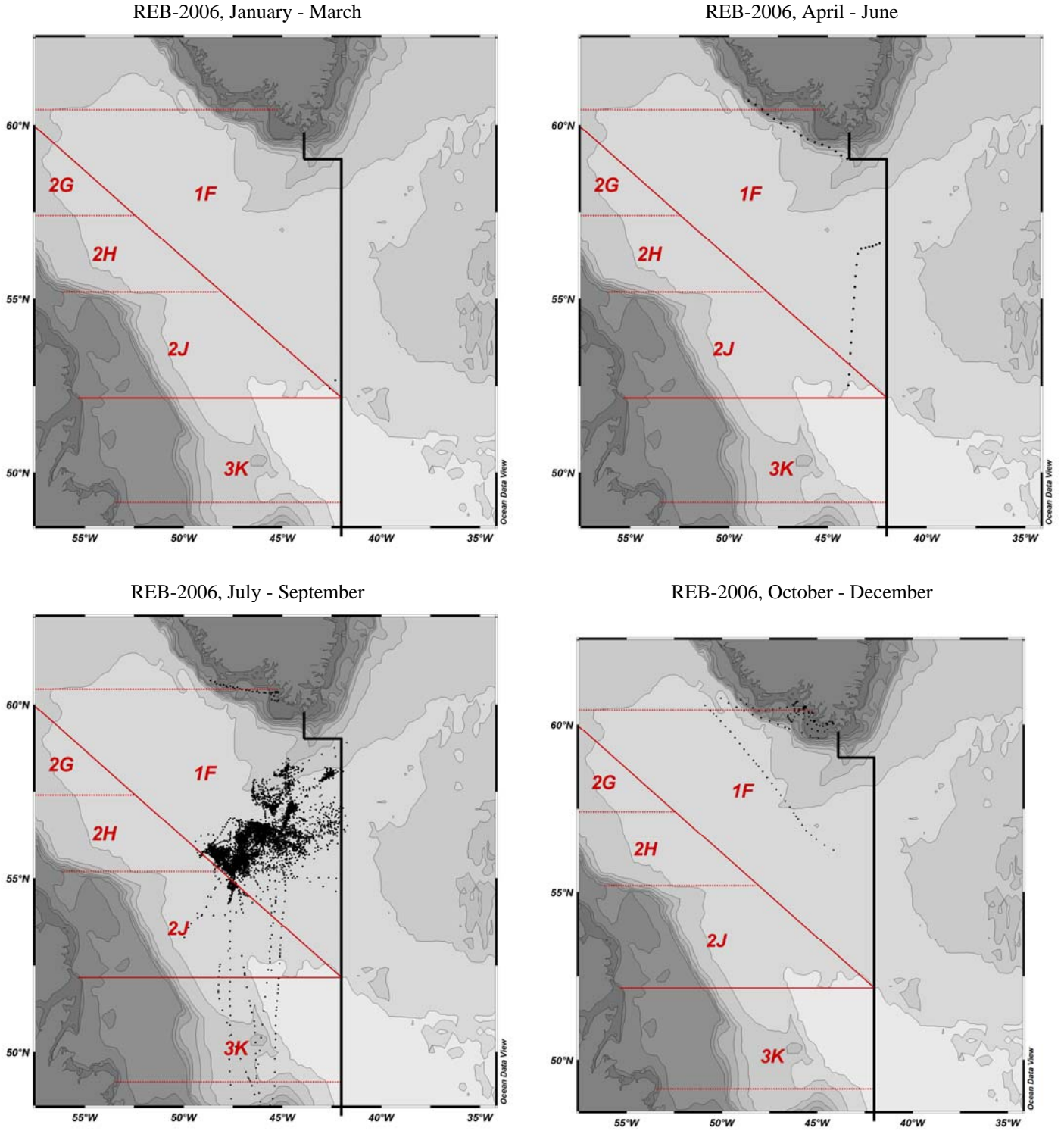


Figure 4C – ODV plot of VMS positions for vessels fishing for REB (*Sebastes mentella*) in 2006, shown by quarter.

TABLE 2A – Quarterly comparison of fishing hours for groundfish in 2006, shown by NAFO Division.

Quarter	1F	2J	3K	3L	3M	3N	3O	4VS	6F	6G
1	-	-	8	15936	4687	1159	1547	-	-	80
2	-	-	-	10174	5776	874	1611	-	-	-
3	162	24	22	6989	8872	4402	2268	-	-	-
4	-	-	-	9128	2578	6223	3635	12	8	-

TABLE 2B – Quarterly comparison of fishing hours for shrimp in 2006, shown by NAFO Division.

Quarter	1F	2J	3K	3L	3M	3N	3O	3PS	unknown
1	-	-	2	2391	1962	-	-	2	-
2	2	-	-	7	2571	-	-	-	-
3	53	-	-	1499	1000	298	2	-	-
4	-	8	26	2214	5014	16	-	-	43

TABLE 2C – Quarterly comparison of fishing hours for REB (*Sebastes mentella*) in 2006, shown by NAFO Division.

Quarter	1F	2J	3K	3L	3M	3N	3O	2H	unknown
1	-	-	-	-	-	-	-	-	-
2	12	-	-	-	-	-	-	-	-
3	14608	464	2	585	147	-	1885	89	2
4	63	-	-	656	28	24	323	-	-