22 Annex 12 - Irish Sea (Region 5)

Name and map (geographical location: longitude, latitude)

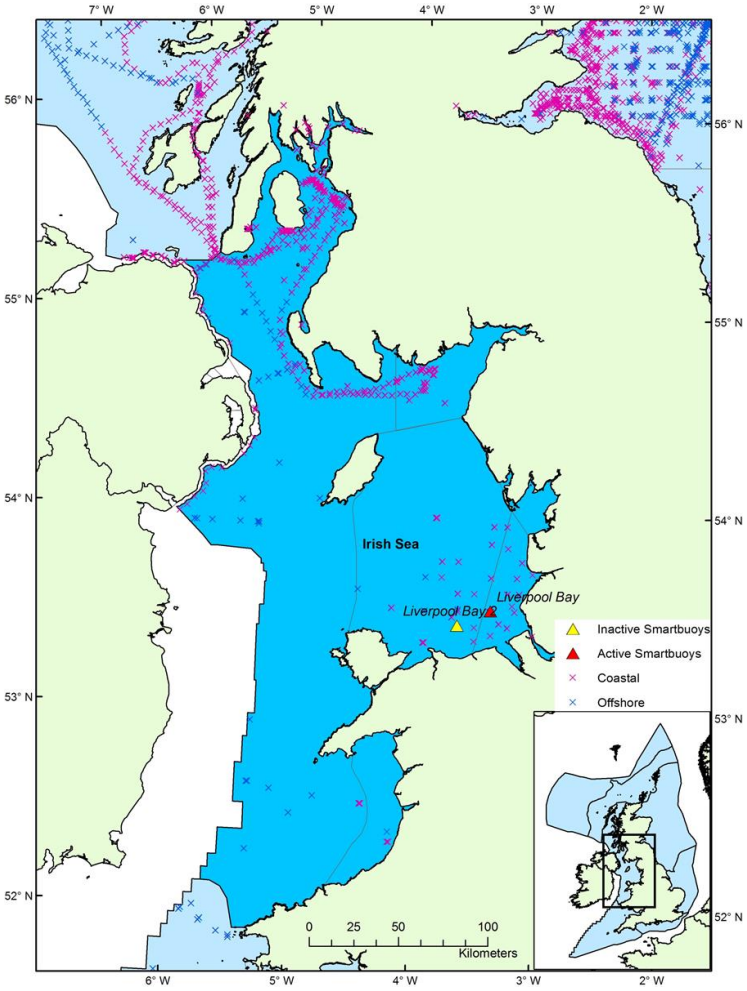


Figure A12.1: Map showing the location of the Irish Sea (Region 5, dark blue). Grey lines indicate UK marine areas from the second application of the COMP which fall into this region (Solway, North East Irish Sea, Liverpool Bay, Cardigan Bay). The locations of sites (X) where data were available from 2006 onwards are shown: red = coastal (salinity 30-34.0), blue = offshore sites (salinity >34.0). The location of monitoring sites with moorings (SmartBuoys) is also shown.

22.1 Description of the area

Including environmental information

The hydrography of the Irish Sea is more complex than that of the other English and Welsh regional seas. Multi-year runs of the ERSEM physical model have identified four different hydrodynamic types (Annex 3). The eastern Irish Sea between the Solway, the Isle of Man and north Wales is generally shallow and permanently mixed, especially towards the coasts. Coastal salinity of the eastern Irish Sea is less than 33 (multi-annual mean of 32.2 at the Liverpool Bay SmartBuoy site). Small areas of summer stratification occur in deeper water to the east of the Isle of Man. Density gradients which cause stratification can be caused by differences in salinity and temperature with salinity more important here than in other regions (Horsburgh et al 2000). The western Irish Sea between Northern Ireland and the Isle of Man is deep and occasionally stratified. The sea area south of the Isle of Man shows predictable seasonal stratification and a well-established gyre-type circulation.

The Irish Sea region contains sub-regions which were assessed during previous applications of the Comprehensive Procedure (Figure A12.1). Cardigan Bay was screened out during intital procedures, and the North East Irish Sea and Liverpool Bay were both assessed as Non Problem Areas. In the third application of the Common Procedure, all marine waters (salinity >30) in Region 5 were considered, with separate assessments for coastal and offshore waters. The inshore coastal regions are assessed under the Water Framework Directive (WFD).

WFD assessments of the status of transitional and coastal waters in this region have identified six Problem Areas (Northern Ireland): Belfast Harbour, Belfast Lough Inner, Dundrum Bay Inner, the Lagan estuary, Quoile Pondage, and the Newry River/Estuary.

Risks

Human pressures: Shifts in human population, changes in nutrient management practices within the catchment resulting from economic pressures.

Environmental pressures: Changes in storminess affecting nutrient run-off from land and also turbidity.

Assessment of risk – Human populations in the catchment of the Irish Sea are relatively low compared to the southern North Sea, but the much deeper Irish Sea has a longer residence time for seawater of around one year (Knight and Howarth 1999). Terrestrial nutrient management measures have resulted in inputs to the sea either showing no change or decreasing over the past decade (Charting Progress 2, OSPAR QSR 2010). **There is a moderate probability** that inputs of anthropogenic nutrients to the Irish Sea will increase in the next 10 years.

22.2 Description of monitoring design in relation to spatial and temporal variability of assessment parameters in the area

This section should include information on how the monitoring design addresses the particular typology and main hydrographical dynamics in the area, so as to provide evidence of representativeness of monitoring.

As a Non-Problem Area the Irish Sea is subject to the relevant requirements of the OSPAR Eutrophication Monitoring Programme to measure DIN, DIP, salinity and temperature about every three years in winter.

Nutrients: AFBI have a comprehensive nutrient monitoring programme, with many of their sites visited by ship at least once during the winter season and monthly during the algal growing season. Site 38A has an automated nutrient analysis system and is a candidate sentinel site for tracking the status of a large part of the stratified central Irish Sea, but lies just outside of the regional sea boundary. In Liverpool Bay, the Cefas SmartBuoy site monitors water quality in a key transitional region with elevated nutrients. High frequency data have been used together with ship measurements from the wider area to understand seasonality of nutrient concentrations, and the relationship between riverine inflow, mixing and observed nutrients at the buoy site (Greenwood et al 2011b). The overall coverage of nutrients in the region is good.

Light attenuation: There is a reasonable body of literature describing the optical properties of the Irish Sea (Cunningham et al 2003; Kratzer et al 2003; Tilstone et al 2005; Bowers and Binding 2006; Hulatt et al 2009). These observations have been funded by R&D projects, and there is no systematic set of optical measurements in the Irish Sea. Kratzer et al (2003) reported a downward trend in Secchi depth measurements in the Menai Straights over the period 1962-1988, with some evidence of a return to less turbid conditions in 1996 (Defra 2010). The overall coverage for light attenuation is poor.

Chlorophyll: The frequency of chlorophyll sampling in the eastern Irish Sea has decreased since the reduction in activity of the Irish Sea Coastal Observatory. A Cefas SmartBuoy remains on site to provide high frequency data but is no longer calibrated. A description of the seasonal cycle of phytoplankton based on the first six years of data is available in Greenwood et al (2011a). Chlorophyll concentrations in the western and central Irish Sea are monitored by AFBI. The overall coverage for chlorophyll is moderate.

Oxygen: Gowen et al (2008) listed the available data for benthic oxygen concentration in the stratified Irish Sea. Although measurements are sparse, there are no records showing oxygen depletion. Glider deployments in the central Irish Sea in spring 2010 (http://cobs.noc.ac.uk/cobs/gliders/spring2010.php) showed high oxygen concentrations throughout the water column. Glider deployments in late summer would be necessary to detect any low oxygen regions, if present. The overall coverage for oxygen is poor.

Phytoplankton composition: Phytoplankton communities have been intensively studied during research cruises (Montagnes et al 1999; Gowen and Stewart 2005; Moore et al 2006; Hickman et al 2009, Scherer 2012) but regular monitoring is limited.. At the Liverpool Bay mooring, a time series of phytoplankton cell counts was obtained from an automated water sampler for the period 2003-2008. The cellular abundance at Liverpool Bay was dominated by diatoms (Greenwood et al 2011a). The overall coverage for phytoplankton composition is poor.

Seagrasses and seaweeds: An analysis of light availability at the seabed using MODIS satellite data showed the greater part of the Cardigan Bay seafloor lies within the photic zone, as does the inshore Anglesey and North Wales coast, and inshore areas of Morecambe Bay. A further area of photic seafloor is found to the east of the Isle of Man. Further consultation with agencies implementing the WFD is required to understand the current ranges of seagrass species in the Irish Sea, and whether effects of eutrophication are evident.

22.3 Assessment

Nutrients

Normalised and non-normalised mean winter concentrations of DIN (µM) per year were calculated for the period from 2006 to 2014. Data used were from all depths sampled.

In coastal waters, sufficient data for assessment were available for all years (Figure A12.2). In three years (2006, 2010, 2011), normalised mean winter DIN values were above the threshold (18 µM, Table A12.1). Confidence levels for concluding Non Problem Area status were low (0%) in these years and 100% in other years (Table A12.1). The overall confidence level for concluding Non Problem Area over the assessment period was high (100%). Non-normalised mean winter DIN values were lower, and below the threshold in all years (Figure A12.2).

In offshore waters, normalised mean winter DIN concentrations were below the assessment threshold (15 µM) in all years (Table A12.2) but in three years there were insufficient data for an assessment (see Figure A12.2). Confidence levels for concluding Non Problem Area status per year were high (100%, Table A12.2). The overall confidence level for concluding Non Problem Area over the assessment period was high (100%). Non-normalised means were all below the assessment treshold (Figure A12.2).

For TOxN (Figure A12.3, Tables A12.3 and A12.4), normalised means were lower than for DIN, and the assessment threshold was exceeded in coastal waters in 2006 and 2011. In all other years, confidence levels in coastal waters were high (71-100%, Tables A12.3 and A12.4). They were also

high overall (100%). In offshore waters, normalised mean winter TOxN concentrations were below the assessment threshold (15 µM) in all years (Table A12.4) and confidence levels were 100% (Table A12.4).

Normalised mean winter DIN concentrations were used in the assessment.

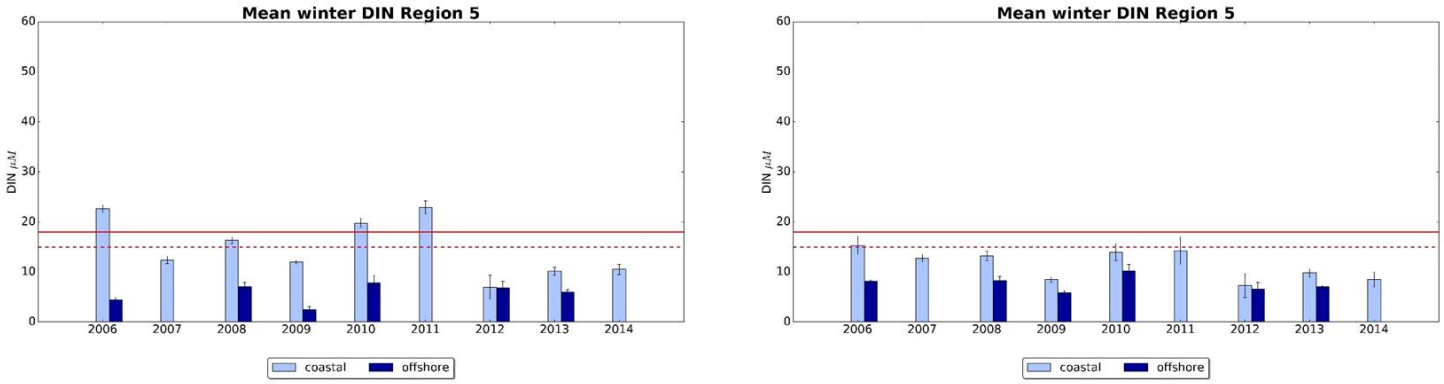


Figure A12.2: Mean winter concentrations of DIN (µM) per year in the Irish Sea during the assessment period, 2006 to 2014. Results are shown separately for coastal waters and offshore waters, using data from all depths sampled. Data are shown as normalised means (left) and non-normalised means (right). Coastal data were normalised to salinity 32, offshore data were normalised to 34. Assessment thresholds for coastal (18 µM, solid red line) and offshore waters (15 µM, dashed red line) are shown.

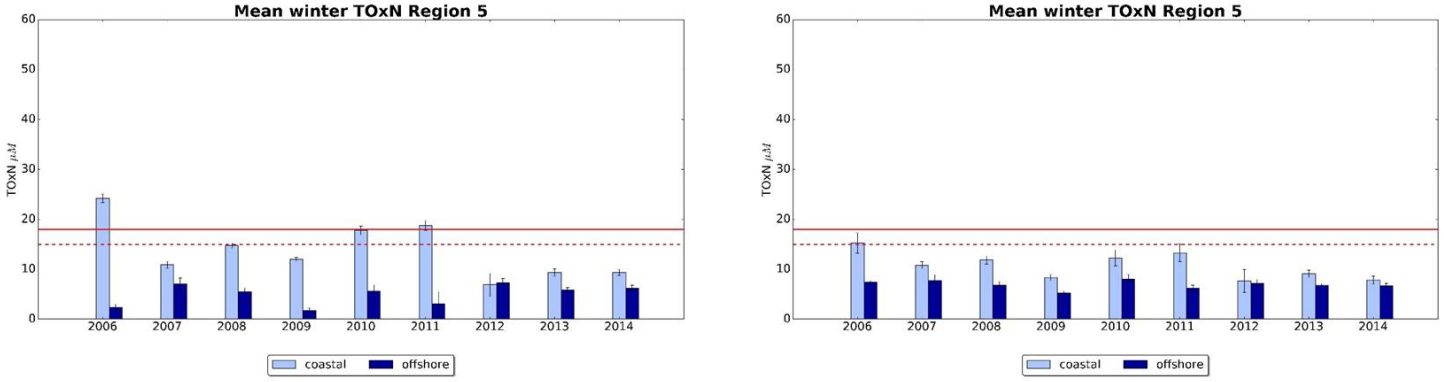


Figure A12.3: Mean winter concentrations of TOxN (µM) per year in the Irish Sea during the assessment period, 2006 to 2014. Results are shown separately for coastal waters and offshore waters, using data from all depths sampled. Data are shown as normalised means (left) and non-normalised means (right). Coastal data were normalised to salinity 32, offshore data were normalised to 34. Assessment thresholds for coastal (18 µM, solid red line) and offshore waters (15 µM, dashed red line) are shown

Table A12.1. Normalised means and yearly confidence levels for winter DIN in Region 5 coastal. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold (µM)	Year	Min Value	Max Value	Normalised Mean	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
5	Coastal	18	2006	8.7	33.8	22.64	0.39	43	0
5	Coastal	18	2007	6.3	27.1	12.39	0.37	69	100
5	Coastal	18	2008	7.5	27.78	16.33	0.34	112	100
5	Coastal	18	2009	2	31.7	12.04	0.19	184	100
5	Coastal	18	2010	6.36	31.6	19.79	0.44	48	0.01
5	Coastal	18	2011	6.2	37	22.92	0.64	36	0
5	Coastal	18	2012	5.2	11.8	6.96	0.92	6	100
5	Coastal	18	2013	6.23	29.6	10.13	0.38	97	100
5	Coastal	18	2014	5.23	15.97	10.5	0.47	16	100
			All	2	37	13.31	0.19	611	100

Table A12.2. Normalised means and yearly confidence levels for winter DIN in Region 5 offshore. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 6 in main report).

Region	Location	Assessm Threshold (µM)	Year	Min Value	Max Value	Normalised Mean	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
5	Offshore	15	2006	7.61	8.8	4.45	0.22	11	100
5	Offshore	15	2007	8.07	8.82	8.11	0.16	4	100
5	Offshore	15	2008	0.2	11.6	7.06	0.41	26	100
5	Offshore	15	2009	4.03	7.09	2.51	0.25	16	100
5	Offshore	15	2010	6.19	19.3	7.84	0.74	20	100
5	Offshore	15	2011	5.8	6	0.31	0.09	4	100
5	Offshore	15	2012	3.5	11	6.82	0.57	10	100
5	Offshore	15	2013	6.17	7.9	6	0.2	12	100
5	Offshore	15	2014	6.27	6.92	4.98	0.07	3	100
			All	0.2	19.3	6.23	0.24	106	100

Table A12.3. Normalised means and yearly confidence levels for winter TOxN in Region 5 coastal. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold (µM)	Year	Min Value	Max Value	Normalised Mean	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
5	Coastal	18	2006	7.75	52.14	24.18	0.42	61	0
5	Coastal	18	2007	4.4	24.7	10.88	0.34	112	100
5	Coastal	18	2008	4.25	26.35	14.79	0.27	134	100
5	Coastal	18	2009	1.5	27.7	11.98	0.2	191	100
5	Coastal	18	2010	5.8	34.4	17.75	0.44	55	71.18
5	Coastal	18	2011	6	32.3	18.81	0.5	54	5.52
5	Coastal	18	2012	5.1	11.4	6.88	0.93	7	100
5	Coastal	18	2013	5.45	26.4	9.37	0.36	97	100
5	Coastal	18	2014	4.88	14.2	9.35	0.31	23	100
			All	1.5	52.14	12.7	0.17	734	100

Table A12.4. Normalised means and yearly confidence levels for winter TOxN in Region 5 offshore. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. nan = no data. All = overall values and confidence levels (see Table 6 in main report).

Region	Location	Assessm Threshold (µM)	Year	Min Value	Max Value	Normalised Mean	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
5	Offshore	15	2006	6.3	8.7	2.32	0.33	15	100
5	Offshore	15	2007	5.65	10.26	7.06	0.51	8	100
5	Offshore	15	2008	0.1	9.1	5.54	0.35	26	100
5	Offshore	15	2009	3.53	6.74	1.69	0.27	16	100
5	Offshore	15	2010	5.59	15.9	5.65	0.58	20	100
5	Offshore	15	2011	5.7	7.4	3.03	1.03	7	100
5	Offshore	15	2012	3.2	10.6	7.34	0.38	21	100
5	Offshore	15	2013	5.88	7.7	5.89	0.2	12	100
5	Offshore	15	2014	6.03	7.84	6.22	0.25	8	100
			All	0.1	15.9	5.45	0.16	133	100

High frequency data

High frequency data obtained from a SmartBuoy in Liverpool Bay (Figure A12.4) were analysed to calculate mean winter TOxN values at the mooring. Mean winter TOxN concentrations exceeded the assessment threshold in 2006, as was observed from normalised means in Figure 12.3. In 2009, the mean winter TOxN value (18.4 µM) was just above the assessment threshold, possibly reflecting freshwater input. These high frequency data were included in the final dataset used in the assessment (see Annex 2), contributing towards temporal and spatial representivity of the data in this region. Salinities were used to assign each derived data point to either coastal water (salinity <34) or offshore water (salinity ≥34).

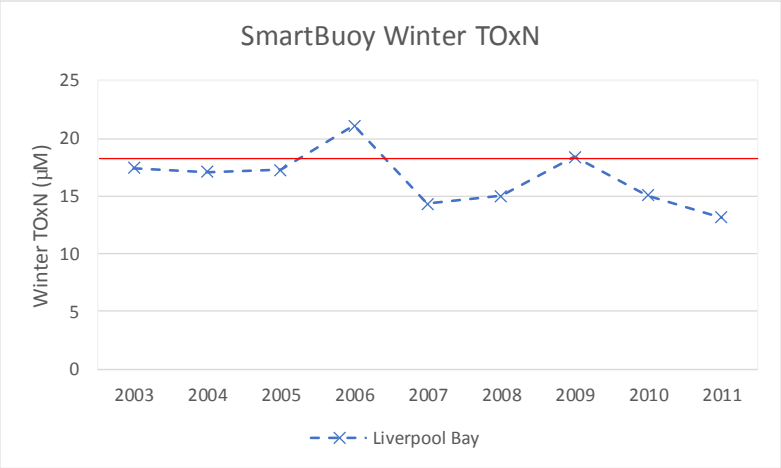


Figure A12.4: Mean winter concentrations of total oxidised nitrogen (TOxN, µM) per year from the SmartBuoy in Liverpool Bay (See Figure 2), 2002 to 2014. The assessment threshold for coastal waters (18 µM, red line) is shown.

DIN:DIP ratios

Mean winter DIN:DIP ratios (Figure A12.5) were below the assessment threshold (24) in coastal and offshore waters.Confidence levels in the mean values were high (100%, Tables A12.5, A12.6). The overall confidence level for concluding Non Problem Area over the assessment period was high (100%) in both coastal and offshore waters.

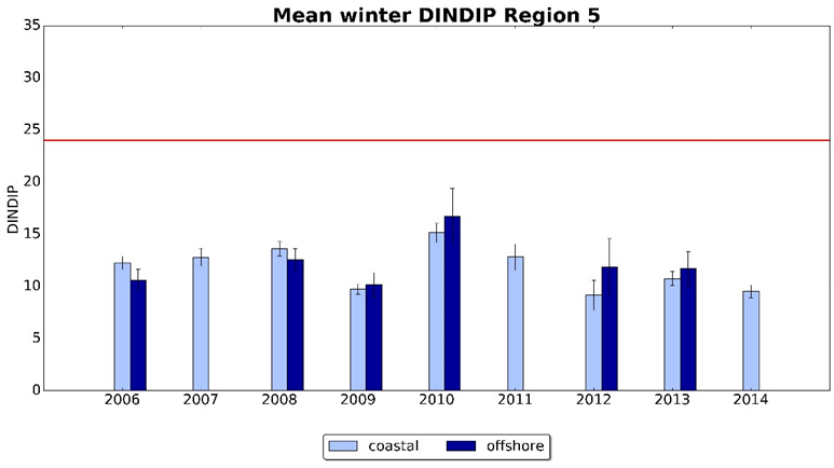


Figure A12.5: Mean winter ratios of DIN:DIP per year in the Irish Sea during the assessment period, 2006 to 2014. Results are shown separately for coastal waters and offshore waters, using data from all depths sampled. The assessment threshold of 24 is shown by the red line.

Table A12.5. Means and yearly confidence levels for winter DIN:DIP in Region 5 coastal. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 5 in main report). All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold	Year	Min Value	Max Value	Mean Value	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
5	Coastal	24	2006	7.12	17.51	12.25	0.31	43	100
5	Coastal	24	2007	5.08	18.74	12.81	0.42	69	100
5	Coastal	24	2008	7.06	21.23	13.61	0.35	73	100
5	Coastal	24	2009	1.38	33.05	9.73	0.24	146	100
5	Coastal	24	2010	9.5	23.24	15.15	0.46	48	100
5	Coastal	24	2011	8.66	21.76	12.82	0.62	35	100
5	Coastal	24	2012	6.75	10.46	9.16	0.56	6	100
5	Coastal	24	2013	7.27	23.12	10.76	0.34	97	100
5	Coastal	24	2014	8.17	12.98	9.53	0.29	16	100
			All	1.38	33.05	11.73	0.15	533	100

Table A12.6. Means and yearly confidence levels for winter DIN:DIP in Region 5 offshore. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 6 in main report).

Region	Location	Assessm Threshold	Year	Min Value	Max Value	Mean Value	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
5	Offshore	24	2006	8.11	13.69	10.61	0.46	11	100
5	Offshore	24	2007	11.59	12.5	11.89	0.18	4	100
5	Offshore	24	2008	2.86	16.77	12.58	0.51	26	100
5	Offshore	24	2009	8.73	14.32	10.16	0.54	13	100
5	Offshore	24	2010	6.5	33.28	16.71	1.28	19	100
5	Offshore	24	2011	9.06	9.68	9.37	0.15	4	100
5	Offshore	24	2012	5.93	21.57	11.84	1.22	10	100
5	Offshore	24	2013	7.54	14.91	11.72	0.73	12	100
5	Offshore	24	2014	9.02	9.48	9.23	0.11	3	100
			All	2.86	33.28	12.4	0.39	102	100

Chlorophyll:

For coastal waters, sufficient data were available for an assessment from 2006 to 2012. In one year (2007), the 90th percentiles exceeded the threshold (15 µg l^{-1}, Figure A12.6). In all other years, the 90th percentiles were below the assessment threshold and confidence in these values was high (75-100%, Table A12.7). Confidence overall was also high (100%).

In offshore waters, sufficient data were available in 2007, 2010 and 2011. In these three years, the 90th percentiles were low (<4.5 µg l^{-1}) and below the assessment threshold (10 µg l^{-1}). Confidence levels in the mean values were 75 to 99% (Table A12.8). Overall confidence levels were high (99.9%).

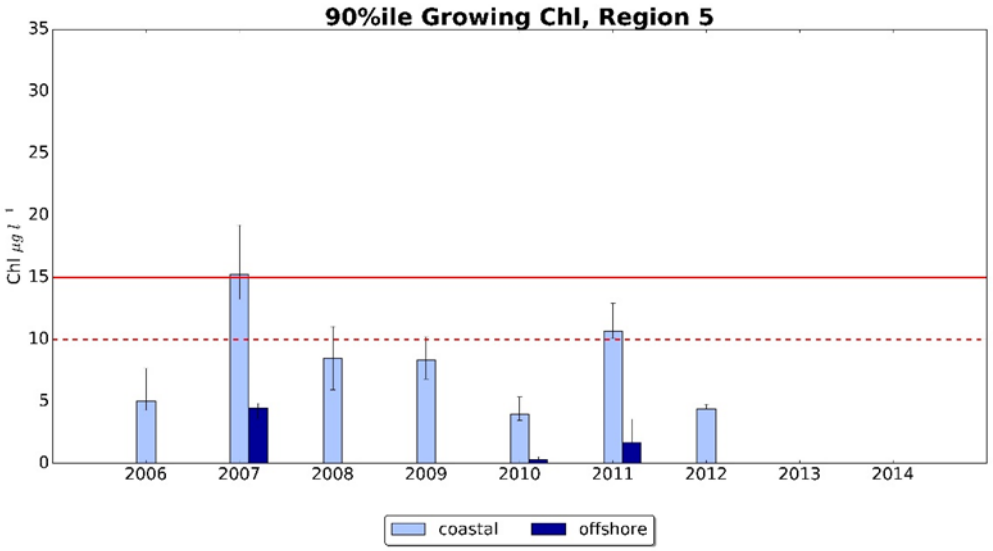


Figure A12.6: Growing season chlorophyll per year in the Irish Sea during the assessment period, 2006 to 2014, shown as 90th percentiles. Results are shown separately for coastal waters and offshore waters, using data from all depths sampled. Assessment thresholds are shown for offshore waters (10 µg l^{-1}) and coastal waters (15 µg l^{-1}).

High frequency data

High frequency data obtained from a SmartBuoy in the Irish Sea (Figure A12.7) were analysed to calculate 90th percentiles in chlorophyll concentrations during the growing season each year. During the assessment period, all values were well below the assessment threshold. These high frequency data were included in the final dataset used in the assessment (see Annex 2), contributing towards temporal and spatial representivity of the data in this region.

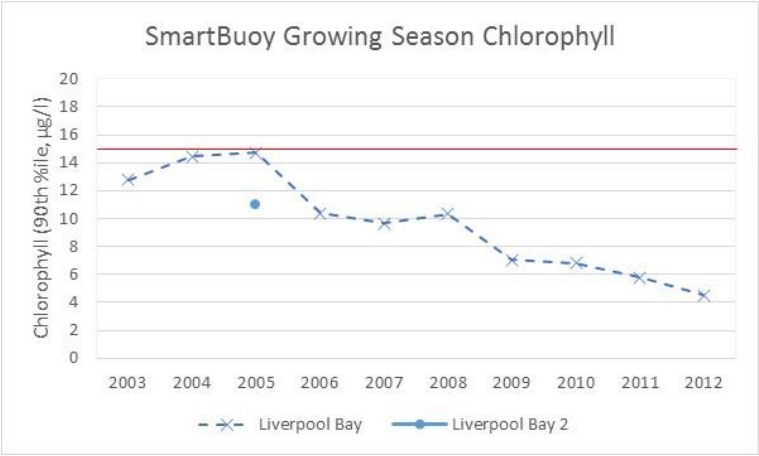


Figure A12.7: Growing season chlorophyll concentrations (90th %ile, µg l^{-1}) per year in the Irish Sea from a SmartBuoy in Liverpool Bay (see Figure 2), 2002 to 2011. The assessment threshold (15 µg l^{-1}, solid red line) for coastal waters is shown. Few data were available from the Liverpool Bay 2 mooring.

Table A12.7. Chlorophyll growing season 90th percentiles in Region 5 coastal, and confidence levels per year. The table shows the assessment threshold, the number of available data points (n), the number of data points below the threshold, and the % of samples below the threshold. nan = no data. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold (µg l^{-1})	Year	90th percentile	Mean	Std Dev	Number of Samples (n)	95% Conf Limit lower	95% Conf Limit upper	Number (n) below the assessment threshold	Confidence level (%)
5	Coastal	15	2006	5.01	2.87	2.52	98	4.3	7.68	97	99.96
5	Coastal	15	2007	15.22	6.63	5.83	109	13.24	19.21	96	19.92
5	Coastal	15	2008	8.51	4.15	4.47	186	5.95	11.03	181	99.99
5	Coastal	15	2009	8.34	3.31	3.12	180	6.8	10.22	180	100
5	Coastal	15	2010	3.98	1.89	1.89	123	3.48	5.37	123	100
5	Coastal	15	2011	10.67	5.42	4.73	243	10.08	12.93	234	99.98
5	Coastal	15	2012	4.41	3.2	1.05	13	4.35	4.76	13	74.58
5	Coastal	15	2013	nan	nan	nan	nan	nan	nan	nan	nan
5	Coastal	15	2014	nan	nan	nan	nan	nan	nan	nan	nan
			All	9.81	4.16	4.31	952	8.86	10.64	924	100

Table A12.8. Chlorophyll growing season 90th percentiles in Region 5 offshore, and confidence levels per year. The table shows the assessment threshold, the number of available data points (n), the number of data points below the threshold, and the % of samples below the threshold. nan = no data. All = overall values and confidence levels (see Table 6 in main report).

Region	Location	Assessm Threshold (µg l^{-1})	Year	90th percentile	Mean	Std Dev	Number of Samples (n)	95% Conf Limit lower	95% Conf Limit upper	Number (n) below the assessment threshold	Confidence level (%)
5	Offshore	10	2006	nan	nan	nan	nan	nan	nan	nan	nan
5	Offshore	10	2007	4.48	2.36	1.53	17	3.65	4.84	17	83.32
5	Offshore	10	2008	nan	nan	nan	nan	nan	nan	nan	nan
5	Offshore	10	2009	nan	nan	nan	nan	nan	nan	nan	nan
5	Offshore	10	2010	0.31	0.25	0.1	40	0.3	0.54	40	98.52
5	Offshore	10	2011	1.68	1.13	0.87	13	1.68	3.58	13	74.58
5	Offshore	10	2012	nan	nan	nan	nan	nan	nan	nan	nan
5	Offshore	10	2013	nan	nan	nan	nan	nan	nan	nan	nan
5	Offshore	10	2014	nan	nan	nan	nan	nan	nan	nan	nan
			All	2.95	0.92	1.22	70	1.74	4.32	70	99.94

Phytoplankton indicator species:

The WFD tool was applied to data from the SmartBuoy site in Liverpool Bay. The overall outcome was high (Figure A12.8), but the tool could not be applied fully due to insufficient data for 'seasonal succession'.

	Normalised EQR			SE(EQR)				Final EQR			Confidence of class (%)						
WaterBody Name	90%ile	ElevatedCounts	SeasSuccess	90%ile	ElevatedCounts	SeasSuccess	No. of tools with EQR	Final EQR	SE	Face Value Class	High	Good	Moderate	Poor	Bad	GoodOrBetter	ModerateOrWorse
							0										
Liverpool_Bay	0.812	0.895		0.038	0.021		2	0.853	0.022	High	0.98	0.02	0.00	0.00	0.00	1.00	0.00

Figure A12.8: Results of the WFD phytoplankton index applied to SmartBuoy data from the site in Liverpool Bay during the assessment period.

Oxygen:

Sufficient data were available for assessments in two years in coastal water (2008 and 2009, Figure A12.7, Table A12.10). Concentrations were above the assessment threshold (6 mg l^{-1}), indicating no problem with oxygen deficiency in the region. Confidence levels in the mean values in the lowest quartile were in these years were 96.5% and 99.9%, and 99.7% overall. Percentage saturation in 2008 and 2009 was higher than 60%.

In offshore waters, insufficient data were available for an assessment (Table A12.11).

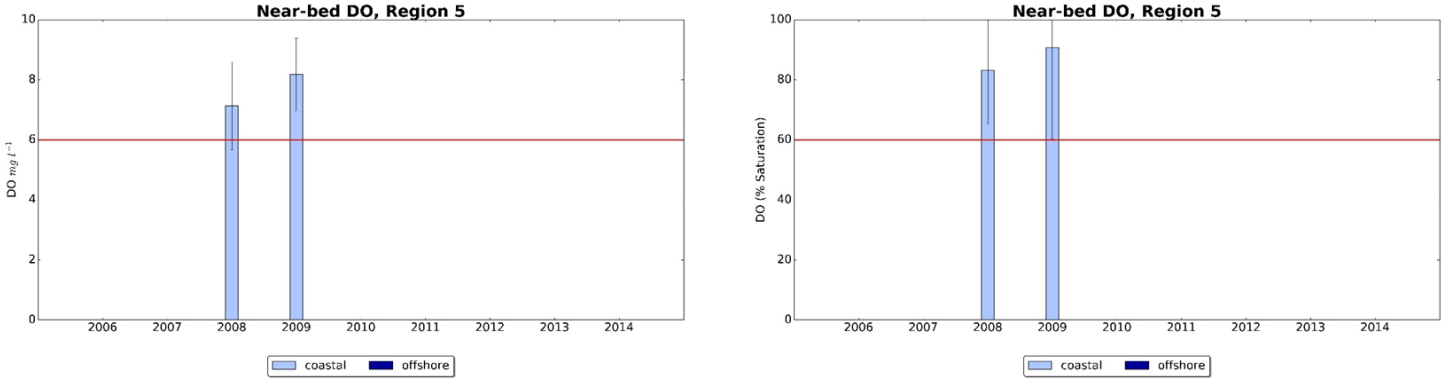


Figure A12.7: Near-bed dissolved oxygen (DO) concentrations (mg l^{-1}) per year in the Irish Sea during the assessment period, 2006 to 2014, shown as concentrations (mg l^{-1}, left) and percentage saturation (right). Results are given as mean values in the lowest quartile of the data, for coastal data (none) and offshore data. Thresholds of 6 mg l^{-1} and 60% saturation are shown by the red lines.

Table A12.10: Near-bed dissolved oxygen (mg l^{-1}) in Region 5 coastal, and confidence levels per year. The table shows the threshold used, the mean and standard error in the lowest quartile of the data (Q25), the number of available data points in the lowest quartile and in the available dataset (total), and confidence levels in assessment outcomes. Minimum (Min) and maximum (Max) values in the total dataset are also shown. nan = no data. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold (mg l^{-1})	Year	Min Value	Max Value	Mean (Q25)	Std Error (Q25)	Number of Samples (Q25)	Number of Samples (total)	Confidence Level (%) for concluding Non Problem
5	Coastal	6	2006	nan	nan	nan	nan	nan	0	nan
5	Coastal	6	2007	nan	nan	nan	nan	nan	0	nan
5	Coastal	6	2008	5.79	8.85	7.13	0.461	4	15	96.46
5	Coastal	6	2009	8.09	9.74	8.18	0.095	2	8	99.91
5	Coastal	6	2010	nan	nan	nan	nan	nan	0	nan
5	Coastal	6	2011	nan	nan	nan	nan	nan	0	nan
5	Coastal	6	2012	nan	nan	nan	nan	nan	0	nan
5	Coastal	6	2013	6.32	8.16	6.32	nan	1	4	nan
5	Coastal	6	2014	nan	nan	nan	nan	nan	0	nan
			All	5.79	9.74	7.11	0.287	7	27	99.69

Table A12.11: Near-bed dissolved oxygen (mg l^{-1}) in Region 5 offshore, and confidence levels per year. The table shows thresholds (classification limit) used, the mean and standard in the lowest quartile of the The table shows the threshold used, the mean and standard error in the lowest quartile of the data (Q25), the number of available data points in the lowest quartile and in the available dataset (total), and confidence levels in assessment outcomes. Minimum (Min) and maximum (Max) values in the total dataset are also shown. nan = no data. All = overall values and confidence levels (see Table 6 in main report).

Region	Location	Assessm Threshold (mg l^{-1})	Year	Min Value	Max Value	Mean (Q25)	Std Error (Q25)	Number of Samples (Q25)	Number of Samples (total)	Confidence Level (%) for concluding Non Problem
5	Offshore	6	2006	nan	nan	nan	nan	nan	0	nan
5	Offshore	6	2007	nan	nan	nan	nan	nan	0	nan
5	Offshore	6	2008	nan	nan	nan	nan	nan	0	nan
5	Offshore	6	2009	nan	nan	nan	nan	nan	0	nan
5	Offshore	6	2010	nan	nan	nan	nan	nan	0	nan
5	Offshore	6	2011	nan	nan	nan	nan	nan	0	nan
5	Offshore	6	2012	nan	nan	nan	nan	nan	0	nan
5	Offshore	6	2013	7.76	7.76	7.76	nan	1	1	nan
5	Offshore	6	2014	nan	nan	nan	nan	nan	0	nan
			All	7.76	7.76	7.76	nan	1	1	nan

Assessment outcomes for the Irish Sea

2003 - In OSPAR integrated report, 1995-2001: Non Problem Area.

2008 - Period 2001-2005: Non Problem Area.

2014 - Third application of the Common Procedure (2006-2014):

Initial and final classification for the Irish Sea: Non Problem Area (2006-2014).

Table A12.12: Assessment table (Irish Sea, 2006-2014). Aggregated confidence ratings (Tables 5 and 6 in the main report) were calculated over the nine-year assessment period.

Category	Assessment Parameters	Description of Results	Score (+ - ?)	Aggregated confidence rating
Degree of Nutrient Enrichment (I)	Riverine inputs and direct discharges of total N and total P	N - P -	N - P -	
	Winter DIN concentrations	Coastal: + - - - + + - - -	Coastal: -	100
		Offshore: - ? - - - ? - - ?	Offshore: -	100
	Winter DIN:DIP ratio	Coastal: - - - - - - - - -	Coastal: -	100
		Offshore: - ? - - - ? - - ?	Offshore: -	100
Direct Effects (II)	90th percentile chlorophyll concentration	Coastal: - + - - - - - ? ?	Coastal: -	100
		Offshore: ? - ? ? - - ? ? ?	Offshore: -	99.94
	Area-specific phytoplankton indicator species	Coastal: -	Coastal: -	
		Offshore:	Offshore:	
	Macrophytes including macroalgae	Not assessed		
Indirect Effects (III)	Oxygen deficiency	Coastal: ? ? - - ? ? ? ? ?	Coastal: ?	99.69
		Offshore: ? ? ? ? ? ? ? ? ?	Offshore: ?	-
	Changes/kills in zoobenthos and fish kills	Not assessed		
	Organic carbon/organic matter	Not assessed		
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)	Not assessed		

Key to the Score

+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters
- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters
? = Not enough data to perform an assessment or the data available are not fit for the purpose

Table A12.13: Results of the OSPAR Comprehensive Assessment 2016 for the Irish Sea, 2006-2014. PA = Problem Area, NPA = Non Problem Area.

Key to the table

NI Riverine inputs and direct discharges of total N and total P
DI Winter DIN and/or DIP concentrations
NP Increased winter N/P ratio
Ca 90th percentile, maximum and mean chlorophyll *a* concentration
Ps Area-specific phytoplankton indicator species
Mp Macrophytes including macroalgae
O_2 Oxygen deficiency
Ck Changes/kills in zoobenthos and fish kills
Oc Organic carbon/organic matter
At Algal toxins (DSP/PSP mussel infection events)

\+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters
\- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters
? = Not enough data were available for assessments. These data were not required or used to confirm Non Problem Status
Note: Categories I, II and/or III/IV are scored '+' in cases where one or more of its respective assessment parameters is showing an increased trend, elevated levels, shifts or changes.

Area	**Category I** Degree of nutrient enrichment		**Category II** Direct effects		**Category III and IV** Indirect effects/ other possible effects				Initial classification	Overall appraisal of all relevant information (concerning the harmonised assessment parameters, their respective assessment levels and the supporting environmental factors)	Final classification	Assessment period
Irish Sea – coastal water	NI	-	Ca	-	O_2	?	At		NPA	• There is evidence that the area is not nutrient enriched (high confidence) based on nutrient data of good representivity. DIN concentrations are decreasing. • There is evidence that there is no accelerated growth (high confidence) based on chlorophyll data of good representivity. • The available evidence does not suggest any undesirable disturbance (high confidence) based on dissolved oxygen data of low representivity. It is confirmed that this area remains a Non Problem Area (high confidence) based on the available evidence. Nutrient inputs are decreasing.	NPA	2006-2014
	DI	-	Ps	-	Ck							
	NP	-	Mp		Oc							
Irish Sea – offshore water	NI	-	Ca	-	O_2	?	At		NPA	• There is evidence that this area is not nutrient enriched (high confidence) based on nutrient data of good representivity. DIN concentration is decreasing. • There is good evidence that there is no	NPA	2006-2014
	DI	-	Ps		Ck							
	NP	-	Mp		Oc							

								accelerated growth (high confidence) based on chlorophyll data of good representivity. • There is no evidence to assess undesirable disturbance. It is confirmed that this area remains a Non Problem Area (high confidence) based on the available evidence. Nutrient inputs to the area are decreasing.		

23 Annex 13 - Minches and Western Scotland (Region 6)

23.1 Description of the area

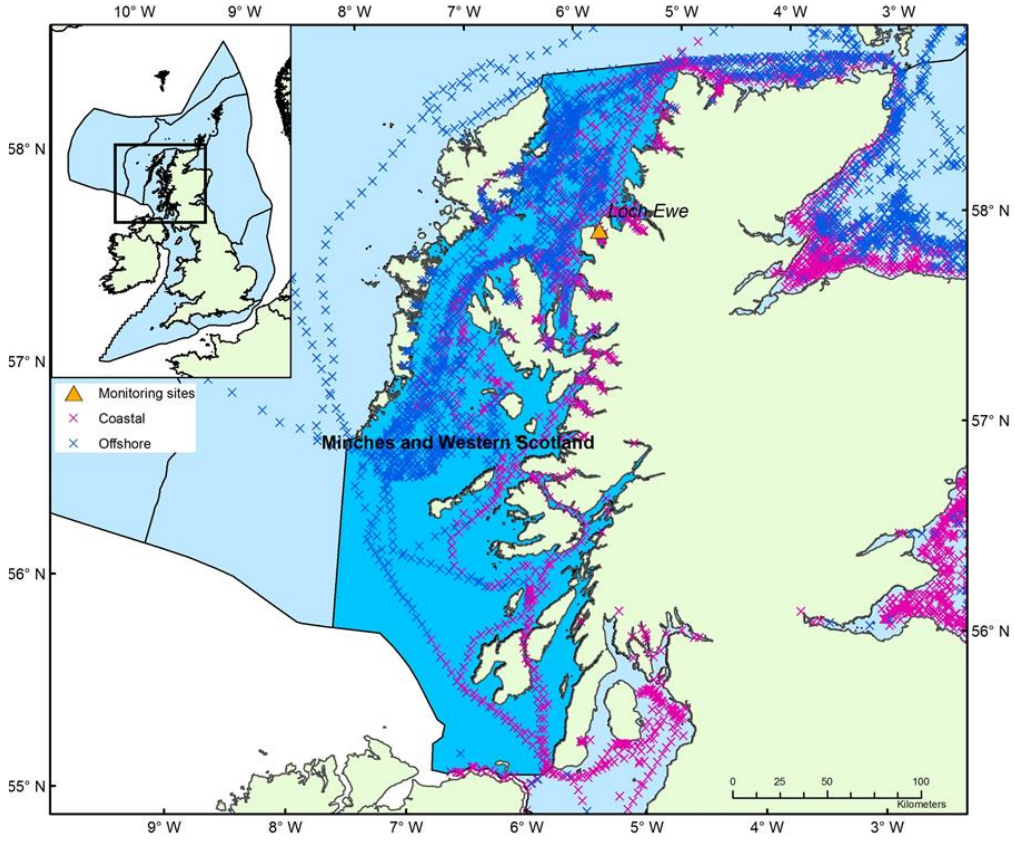


Figure A13.1: Map showing the location of the Minches and Western Scotland (Region 6, dark blue). The locations of sites (X) where data were available from 2006 onwards are shown: red = coastal (salinity 30-34.5), blue = offshore sites (salinity >34.5).

23.2 Description of monitoring design in relation to spatial and temporal variability of assessment parameters in the area

This section should include information on how the monitoring design addresses the particular typology and main hydrographical dynamics in the area, so as to provide evidence of representativeness of monitoring.

All marine waters off Scotland have previously been screened out as Non Problem Areas, and there is no requirement to assess parameters other than nutrients and chlorophyll over time scales sufficient to confirm status or detect any changes in status. Transitional and coastal waters are all Non Problem Areas, and continue to be monitored and assessed under EU directives by the Scottish Environment Protection Agency (SEPA, see Annex 2), and Marine Scotland Science (MSS).

23.3 Assessment

Available data on nutrients and chlorophyll indicate that all assessment parameters were well below the respective assessment thresholds (Figures A13.2 to A13.6), confirming the previous classifications as Non Problem Area.

Nutrients

Normalised and non-normalised mean winter concentrations of DIN (µM) per year were calculated for the period from 2006 to 2014. Data used were from all depths sampled.

In coastal waters, sufficient DIN data were available for assessment in all years during the assessment period (Figure A13.1). All normalised mean winter DIN values were below the threshold (18 µM, Table A13.1). Confidence levels per year were high (100%, Table A13.1). The overall confidence level for concluding Non Problem Area over the assessment period was 100%. Non-normalised mean winter DIN values showed the same outcome (Figure A13.2).

In offshore waters, sufficient data were available in all years (Figure A13.2). All normalised mean winter DIN values were below the assessment threshold (15 µM) and confidence levels for concluding Non Problem Area were high (100%, Table A13.2). Non-normalised means showed the same outcome.

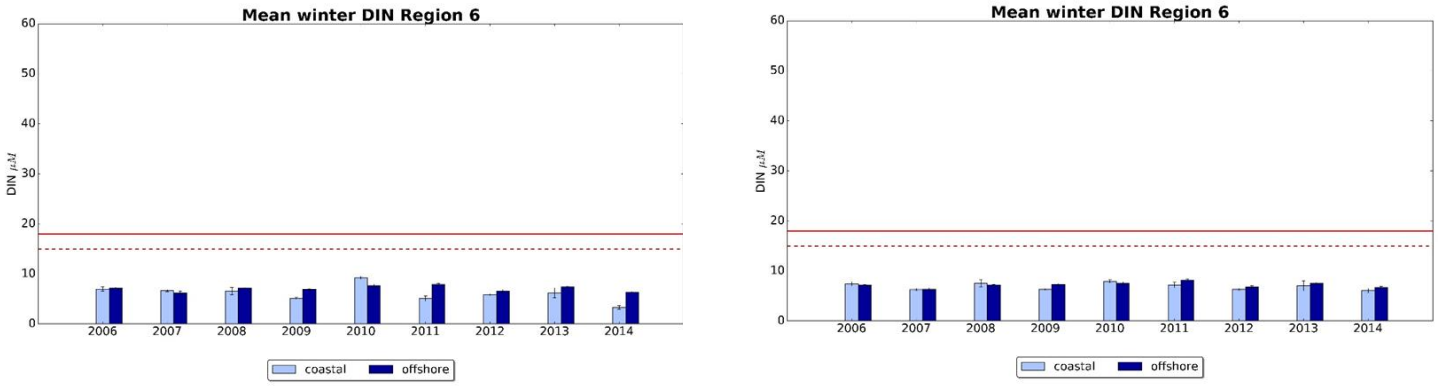


Figure A13.2: Mean winter concentrations of DIN (µM) per year in the Minches and Western Scotland during the assessment period, 2006 to 2014. Results are shown separately for coastal waters and offshore waters, using data from all depths sampled. Data are shown as normalised means (left) and non-normalised means (right). Coastal data were normalised to salinity 32, offshore data were normalised to 34.5. Assessment thresholds for coastal (18 µM, solid red line) and offshore waters (15 µM, dashed red line) are shown.

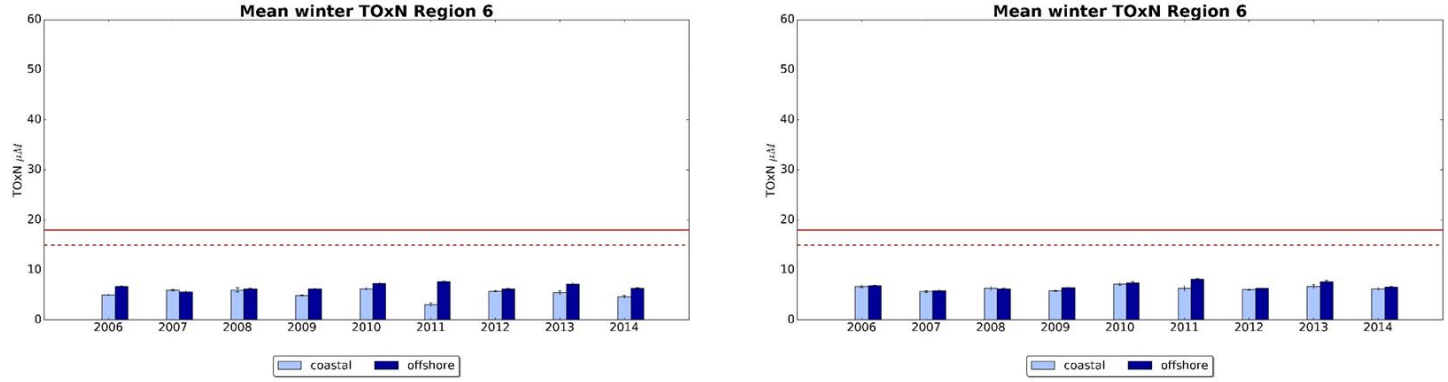


Figure A13.3: Mean winter concentrations of TOxN (µM) per year in the Minches and Western Scotland during the assessment period, 2006 to 2014. Results are shown separately for coastal waters and offshore waters, using data from all depths sampled. Data are shown as normalised means (left) and non-normalised means (right). Coastal data were normalised to salinity 32, offshore data were normalised to 34.5. Assessment thresholds for coastal (18 µM, solid red line) and offshore waters (15 µM, dashed red line) are shown

A lot more data were collected as TOxN than as DIN (see Tables A13.1 to A13.4). Nonetheless, assessment outcomes were the same (Figure A13.3). Confidence levels in mean values were high using both DIN and TOxN data (99-100%, Tables A13.1 to A13.4). Similarly, overall confidence levels for concluding Non Problem Area over the assessment period were high (100%).

Table A13.1. Normalised means and yearly confidence levels for winter DIN in Region 6 coastal. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold (µM)	Year	Min Value	Max Value	Normalised Mean	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
6	Coastal	18	2006	6.48	8.28	6.98	0.18	9	100
6	Coastal	18	2007	3.74	14.17	6.67	0.11	220	100
6	Coastal	18	2008	4.36	10.8	6.56	0.34	18	100
6	Coastal	18	2009	4.92	8.92	5.13	0.1	128	100
6	Coastal	18	2010	5.1	9.99	9.21	0.14	40	100
6	Coastal	18	2011	5.48	11.32	5.08	0.25	20	100
6	Coastal	18	2012	5.15	8.18	5.84	0.09	40	100
6	Coastal	18	2013	2.64	32.91	6.23	0.5	55	100
6	Coastal	18	2014	1.86	6.95	3.31	0.18	28	100
			All	1.86	32.91	5.78	0.08	558	100

Table A13.2. Normalised means and yearly confidence levels for winter DIN in Region 6 offshore. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold (µM)	Year	Min Value	Max Value	Normalised Mean	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
6	Offshore	15	2006	6.1	8.32	7.18	0.08	46	100
6	Offshore	15	2007	4.94	12.18	6.19	0.18	55	100
6	Offshore	15	2008	5.84	9.53	7.17	0.04	218	100
6	Offshore	15	2009	5.3	9.05	6.95	0.07	215	100
6	Offshore	15	2010	4.96	9.74	7.62	0.16	45	100
6	Offshore	15	2011	5.78	10.01	7.92	0.11	62	100
6	Offshore	15	2012	5.34	8.42	6.6	0.14	27	100
6	Offshore	15	2013	7.27	8.25	7.44	0.06	12	100
6	Offshore	15	2014	5.35	8.29	6.34	0.09	40	100
			All	4.94	12.18	6.98	0.04	720	100

Table A13.3. Normalised means and yearly confidence levels for winter TOxN in Region 6 coastal. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold (µM)	Year	Min Value	Max Value	Normalised Mean	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
6	Coastal	18	2006	5.64	7.78	4.99	0.09	23	100
6	Coastal	18	2007	3.65	13.45	5.92	0.09	257	100
6	Coastal	18	2008	3.73	9.89	6.02	0.21	34	100
6	Coastal	18	2009	4.42	8.03	4.86	0.08	145	100
6	Coastal	18	2010	4.83	9.4	6.24	0.12	67	100
6	Coastal	18	2011	4.82	9.25	3.05	0.19	21	100
6	Coastal	18	2012	3.96	9.67	5.69	0.07	82	100
6	Coastal	18	2013	2.46	18.4	5.46	0.19	82	100
6	Coastal	18	2014	1.71	8.5	4.59	0.14	50	100
			All	1.71	18.4	5.18	0.05	761	100

Table A13.4. Normalised means and yearly confidence levels for winter TOxN in Region 6 offshore. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 6 in main report).

Region	Location	Assessm Threshold (µM)	Year	Min Value	Max Value	Normalised Mean	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
6	Offshore	15	2006	5.25	8.44	6.72	0.03	218	100
6	Offshore	15	2007	4.58	11.4	5.66	0.12	84	100
6	Offshore	15	2008	5.34	8.7	6.25	0.04	218	100
6	Offshore	15	2009	5.1	8.26	6.25	0.06	215	100
6	Offshore	15	2010	2.93	9.65	7.34	0.13	86	100
6	Offshore	15	2011	5.23	9.94	7.63	0.08	124	100
6	Offshore	15	2012	4.15	7.35	6.24	0.06	79	100
6	Offshore	15	2013	7.18	10.55	7.18	0.15	25	100
6	Offshore	15	2014	4.97	8.29	6.32	0.06	86	100
			All	2.93	11.4	6.51	0.03	1135	100

DIN:DIP ratios

Mean winter DIN:DIP ratios (Figure A13.4) were below the threshold of 24 in coastal and offshore waters. Confidence levels for concluding Non Problem Area were high (96-100%, Tables A10.6 and A10.7). The overall confidence level in mean values for concluding Non Problem Area over the assessment period was high in coastal and offshore waters (100%).

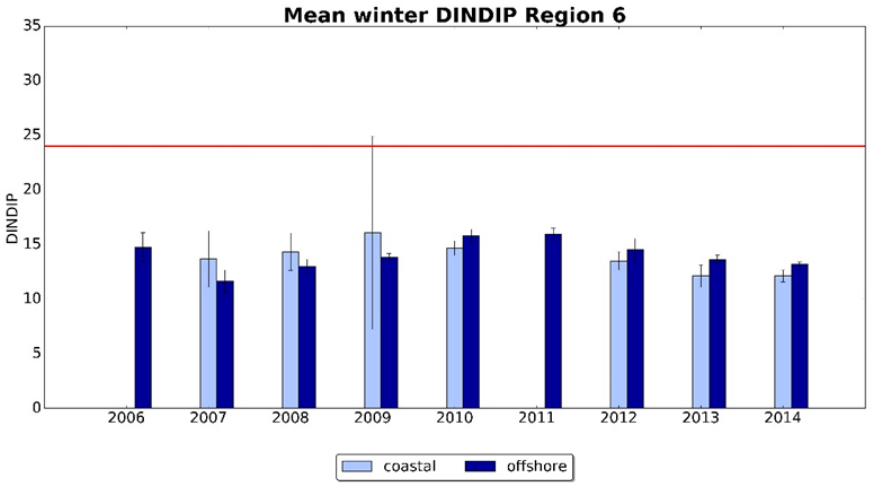


Figure A13.4: Mean winter ratios of DIN:DIP per year in the Minches and Western Scotland during the assessment period, 2006 to 2014. Results are shown separately for coastal waters and offshore waters, using data from all depths sampled. The assessment threshold of 24 is shown by the red line.

Table A13.5. Means and yearly confidence levels for winter DIN:DIP in Region 6 coastal. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold	Year	Min Value	Max Value	Mean Value	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
6	Coastal	24	2006	14.08	14.08	14.08	0	1	100
6	Coastal	24	2007	5.17	194.3	13.69	1.31	220	100
6	Coastal	24	2008	12.1	20.67	14.35	0.76	11	100
6	Coastal	24	2009	6.32	526	16.08	4.46	115	96.08
6	Coastal	24	2010	11.52	18.07	14.68	0.33	32	100
6	Coastal	24	2011	15.17	20.58	17.88	1.91	2	95.73
6	Coastal	24	2012	10.45	17.08	13.51	0.39	15	100
6	Coastal	24	2013	7.34	29.38	12.13	0.5	42	100
6	Coastal	24	2014	6.73	13.14	12.14	0.27	26	100
			All	5.17	526	14.15	1.27	464	100

Table A13.6. Means and yearly confidence levels for winter DIN:DIP in Region 6 offshore. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 6 in main report).

Region	Location	Assessm Threshold	Year	Min Value	Max Value	Mean Value	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
6	Offshore	24	2006	8.12	37.86	14.75	0.67	46	100
6	Offshore	24	2007	3.99	28.33	11.63	0.52	55	100
6	Offshore	24	2008	6.11	59.92	13.02	0.32	218	100
6	Offshore	24	2009	8.46	28.6	13.85	0.18	212	100
6	Offshore	24	2010	11.7	20.62	15.82	0.29	45	100
6	Offshore	24	2011	10.83	21.3	15.97	0.27	62	100
6	Offshore	24	2012	9.87	17.92	14.51	0.5	18	100
6	Offshore	24	2013	12.66	15	13.62	0.2	12	100
6	Offshore	24	2014	11.88	14.56	13.23	0.08	40	100
			All	3.99	59.92	13.77	0.14	708	100

Chlorophyll:

For coastal waters, the 90th percentile values were low (<7 µg l^{-1}) and below the assessment threshold value (15 µg l^{-1}). Yearly confidence levels were high (97-100%, Table A13.7), with an overall confidence level of 100%.

In offshore waters, data were available for five years; the 90th percentiles showed a higher maximum value (7.8 µg l^{-1}) than in coastal water, but were below the assessment threshold value (10 µg l^{-1}). Yearly confidence levels were 81.5 to 99.3% (Table A13.8). The overall confidence level was 100%.

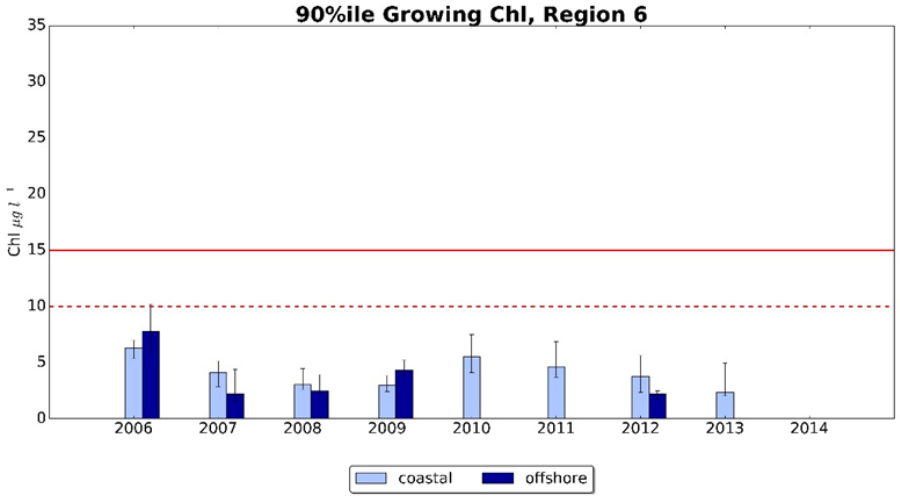


Figure A13.5: Growing season chlorophyll per year in the Minches and Western Scotland during the assessment period, 2006 to 2014, shown as 90th percentiles. Results are shown separately for coastal waters and offshore waters, using data from all depths sampled. Assessment thresholds are shown for offshore waters (10 µg l^{-1}) and coastal waters (15 µg l^{-1}).

Table A13.7. Chlorophyll growing season 90th percentiles in Region 6 coastal, and confidence levels per year. The table shows the assessment threshold, the number of available data points (n), the number of data points below the threshold, and the % of samples below the threshold. nan = no data. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold (µg l^{-1})	Year	90th percentile	Mean	Std Dev	Number of Samples (n)	95% Conf Limit lower	95% Conf Limit upper	Number (n) below the assessment threshold	Confidence level (%)
6	Coastal	15	2006	6.28	2.92	2.26	130	5.36	6.98	130	100
6	Coastal	15	2007	4.1	1.97	1.45	103	2.86	5.14	103	100
6	Coastal	15	2008	3.02	1.68	1.15	81	2.59	4.46	81	99.98
6	Coastal	15	2009	2.98	1.22	1.32	134	2.43	3.86	134	100
6	Coastal	15	2010	5.53	2.61	1.87	35	4.1	7.5	35	97.5
6	Coastal	15	2011	4.63	2.95	1.49	16	3.7	6.87	16	81.47
6	Coastal	15	2012	3.75	1.73	1.25	46	2.35	5.64	46	99.21
6	Coastal	15	2013	2.35	1.35	0.92	35	2.05	4.95	35	97.5
6	Coastal	15	2014	nan	nan	nan	nan	nan	nan	nan	nan
			All	4.18	1.98	1.72	580	3.76	4.95	580	100

Table A13.8. Chlorophyll growing season 90th percentiles in Region 6 offshore, and confidence levels per year. The table shows the assessment threshold, the number of available data points (n), the number of data points below the threshold, and the % of samples below the threshold. nan = no data. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold (µg l^{-1})	Year	90th percentile	Mean	Std Dev	Number of Samples (n)	95% Conf Limit lower	95% Conf Limit upper	Number (n) below the assessment threshold	Confidence level (%)
6	Offshore	10	2006	7.76	3.05	2.97	109	5.83	10.19	104	96.71
6	Offshore	10	2007	2.2	1.34	0.93	47	1.64	4.4	47	99.29
6	Offshore	10	2008	2.46	1.54	0.73	47	2.02	3.92	47	99.29
6	Offshore	10	2009	4.34	2.34	1.88	17	3.82	5.22	17	83.32
6	Offshore	10	2010	nan	nan	nan	nan	nan	nan	nan	nan
6	Offshore	10	2011	nan	nan	nan	nan	nan	nan	nan	nan
6	Offshore	10	2012	2.2	1.13	0.68	16	1.79	2.5	16	81.47
6	Offshore	10	2013	nan	nan	nan	nan	nan	nan	nan	nan
6	Offshore	10	2014	nan	nan	nan	nan	nan	nan	nan	nan
			All	4.68	2.23	2.3	236	3.97	7.05	231	100

Phytoplankton Indicator Species:

The WFD tool was applied to phytoplankton data collected in Loch Ewe, which is typically assessed under the WFD by SEPA. The outcome from the application of the phytoplankton tool to these data was high (Final EQR 0.87).

Oxygen:

Sufficient data on near-bed dissolved oxygen were available for assessments (2006-2014) in two years in coastal waters and two years in offshore waters (Figure A13.6). Additional data were available in other years, but were insufficient to be included in the assessments by year (Tables A13.9 and A13.10). Mean values in the lowest quartile of the data were above the thresholds in three of the four years. In 2008, the mean values were below the thresholds; possibly as a result of data from lochs and inner estuaries which were included in that year. Where there were sufficient data (n ≥5) in other years, confidence levels in the mean oxygen concentrations were high in both the coastal and offshore regions (96.8-99.96%, Tables A13.9 and A13.10). Overall confidence levels were also high (52.9-100%).

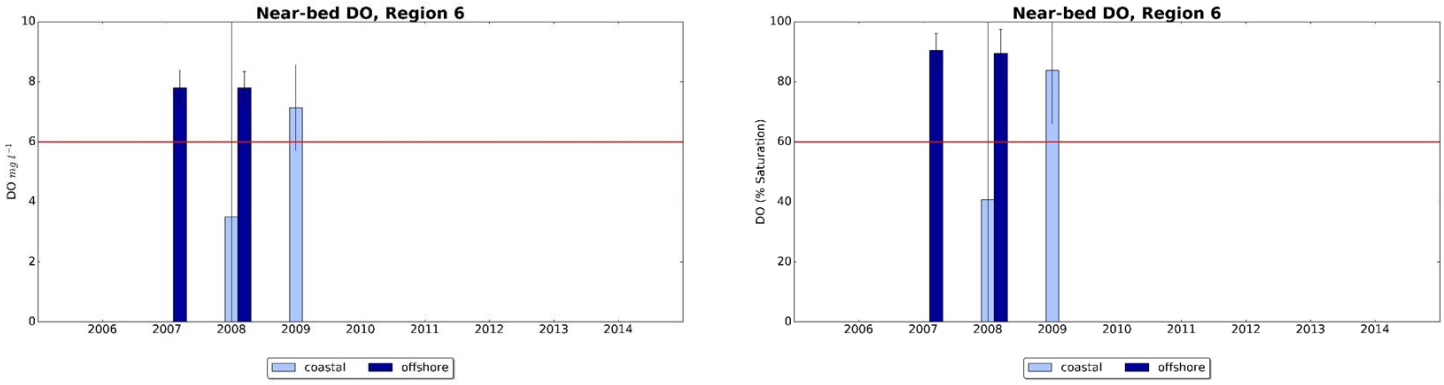


Figure A13.6: Near-bed dissolved oxygen(DO) concentrations (mg l^{-1}) per year in the Minches and Western Scotland during the assessment period, 2006 to 2014, shown as concentrations (mg l^{-1}, left) and percentage saturation (right). Results are given as mean values in the lowest quartile of the data during the stratified

season, and are shown separately for coastal waters and offshore waters. Thresholds of 6 mg l^{-1} and 60% saturation are shown by the red lines.

Table A13.9: Near-bed dissolved oxygen (mg l^{-1}) in Region 6 coastal, and confidence levels per year. The table shows the threshold used, the mean and standard error in the lowest quartile of the data (Q25), the number of available data points in the lowest quartile and in the available dataset (total), and confidence levels in assessment outcomes. Minimum (Min) and maximum (Max) values in the total dataset are also shown. nan = no data.

Region	Location	Assessm Threshold (mg l^{-1})	Year	Min Value	Max Value	Mean (Q25)	Std Error (Q25)	Number of Samples (Q25)	Number of Samples (total)	Confidence Level (%) for concluding Non Problem
6	Coastal	6	2006	nan	nan	nan	nan	nan	0	nan
6	Coastal	6	2007	7.23	8.79	7.23	nan	1	4	nan
6	Coastal	6	2008	2.79	10.16	3.5	0.715	2	8	3.65
6	Coastal	6	2009	5.82	8.81	7.14	0.45	4	15	96.79
6	Coastal	6	2010	nan	nan	nan	nan	nan	0	nan
6	Coastal	6	2011	nan	nan	nan	nan	nan	0	nan
6	Coastal	6	2012	7.4	7.4	7.4	nan	1	1	nan
6	Coastal	6	2013	7.88	7.88	7.88	nan	1	1	nan
6	Coastal	6	2014	nan	nan	nan	nan	nan	0	nan
			All	2.79	10.16	6.05	0.712	7	29	52.89

Table A13.10: Near-bed dissolved oxygen (mg l^{-1}) in Region 6 offshore, and confidence levels per year. The table shows the threshold used, the mean and standard error in the lowest quartile of the data (Q25), the number of available data points in the lowest quartile and in the available dataset (total), and confidence levels in assessment outcomes. Minimum (Min) and maximum (Max) values in the total dataset are also shown. nan = no data.

Region	Location	Assessm Threshold (mg l^{-1})	Year	Min Value	Max Value	Mean (Q25)	Std Error (Q25)	Number of Samples (Q25)	Number of Samples (total)	Confidence Level (%) for concluding Non Problem
6	Offshore	6	2006	nan	nan	nan	nan	nan	0	nan
6	Offshore	6	2007	7.53	10.27	7.79	0.141	3	11	99.95
6	Offshore	6	2008	7.57	10.56	7.79	0.128	3	13	99.96
6	Offshore	6	2009	7.9	8.47	7.9	nan	1	4	nan
6	Offshore	6	2010	nan	nan	nan	nan	nan	0	nan
6	Offshore	6	2011	nan	nan	nan	nan	nan	0	nan
6	Offshore	6	2012	7.26	7.62	7.26	nan	1	3	nan
6	Offshore	6	2013	7.67	7.67	7.67	nan	1	1	nan
6	Offshore	6	2014	nan	nan	nan	nan	nan	0	nan
			All	7.26	10.56	7.59	0.063	8	32	100

Assessment Outcomes for the Minches and Western Scotland

2003 - In OSPAR integrated report, 1995-2001: Non Problem Area.

2008 - Period 2001-2005: Non Problem Area.

2014 - Third application of the Common Procedure (2006-2014):

Initial and final classification for northern North Sea: Non Problem Area (2006-2014).

Table A13.11: Assessment table (Minches and Western Scotland, 2006-2014). Aggregated confidence ratings (Tables 5 and 6 in the main report) were calculated over the nine-year assessment period.

Category	Assessment Parameters	Description of Results	Score (+ - ?)	Aggregated confidence rating (%)
Degree of Nutrient Enrichment (I)	Riverine inputs and direct discharges of total N and total P	N - P -	- .-	
	Winter DIN concentrations (normalised)	Coastal: - - - - - - - - -	Coastal –	100
		Offshore: - - - - - - - - -	Offshore –	100
	Winter DIN:DIP ratio	Coastal: ? - - - - ? - - -	Coastal: –	100
		Offshore: - - - - - - - - -	Offshore: –	100
Direct Effects (II)	90th percentile chlorophyll concentration	Coastal: - - - - - - - - ?	Coastal: –	100
		Offshore:- - - - ? ? - ? ?	Offshore: –	100
	Area-specific phytoplankton indicator species	Not assessed		
	Macrophytes including macroalgae	Not assessed		
Indirect Effects (III)	Oxygen deficiency (mg l^{-1})	Coastal: ? ? + - ? ? ? ? ?	Coastal: ?	52.89
		Offshore:? - - ? ? ? ? ? ?	Offshore: ?	100
	Changes/kills in zoobenthos and fish kills	Not assessed		
	Organic carbon/organic matter	Not assessed		
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)	Not assessed		

Key to the Score

+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters
- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters
? = Not enough data to perform an assessment or the data available are not fit for the purpose

Table A13.12: Results of the OSPAR Comprehensive Assessment 2016 for Minches and Western Scotland, 2006-2014. PA = Problem Area, NPA = Non Problem Area.

Key to the table

NI Riverine inputs and direct discharges of total N and total P
DI Winter DIN and/or DIP concentrations
NP Increased winter N/P ratio
Ca 90th percentile, maximum and mean chlorophyll *a* concentration
Ps Area-specific phytoplankton indicator species
Mp Macrophytes including macroalgae
O_2 Oxygen deficiency
Ck Changes/kills in zoobenthos and fish kills
Oc Organic carbon/organic matter
At Algal toxins (DSP/PSP mussel infection events)

\+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters
\- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters
? = Not enough data were available for assessments. These data were not required or used to confirm Non Problem Status
Note: Categories I, II and/or III/IV are scored '+' in cases where one or more of its respective assessment parameters is showing an increased trend, elevated levels, shifts or changes.

Area	**Category I** Degree of nutrient enrichment		**Category II** Direct effects		**Category III and IV** Indirect effects/ other possible effects				Initial classification	Overall appraisal of all relevant information (concerning the harmonised assessment parameters, their respective assessment levels and the supporting environmental factors)	Final classification	Assessment period
Minches and W Scotland – coastal water	NI	-	Ca	-	O_2	?	At		NPA	• There is evidence that this area is not nutrient enriched (high confidence) based on nutrient data of good representivity. • There is good evidence that there is no accelerated growth (high confidence) based on chlorophyll data of good representivity. • There is good evidence that there is no undesirable disturbance based on oxygen concentrations with moderate representivity. It is confirmed that this area remains a Non Problem Area (high confidence) based on the available evidence. Nutrient inputs to the area are decreasing.	NPA	2006-2014
	DI	-	Ps		Ck							
	NP	-	Mp		Oc							
Minches and W Scotland – offshore water	NI	-	Ca	-	O_2	-	At		NPA	• There is evidence that this area is not nutrient enriched (high confidence) based on nutrient data of good representivity. • There is good evidence that there is no	NPA	2006-2014
	DI	-	Ps		Ck							
	NP	-	Mp		Oc							

								accelerated growth (high confidence) based on chlorophyll data of good representivity. • There is good evidence that there is no undesirable disturbance based on oxygen concentrations with moderate representivity. It is confirmed that this area remains a Non Problem Area (high confidence) based on the available evidence. Nutrient inputs to the area are decreasing.		

24 Annex 14 - Scottish Continental Shelf (Region 7)

24.1 Description of the area

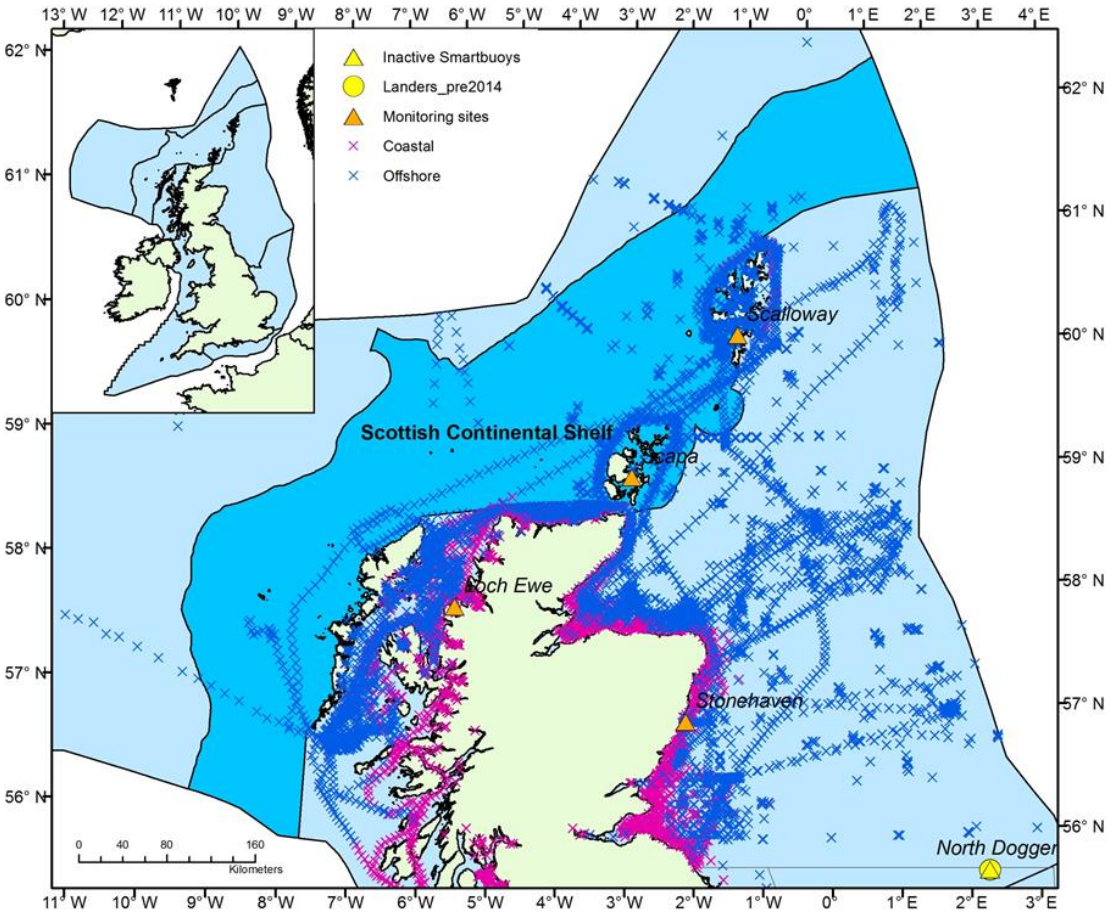


Figure A14.1: Map showing the location of the Scottish Continental Shelf (Region 7, dark blue). Grey lines indicate UK marine areas from the second application of the COMP which fall into this region. The locations of sites (X) where data were available from 2006 onwards are shown: red = coastal (salinity 30-34.5), blue = offshore sites (salinity >34.5). The location os Scotland monitoring sites are indicated by red triangles.

24.2 Description of monitoring design in relation to spatial and temporal variability of assessment parameters in the area

This section should include information on how the monitoring design addresses the particular typology and main hydrographical dynamics in the area, so as to provide evidence of representativeness of monitoring.

All marine waters off Scotland have previously been screened out as Non Problem Areas, and there is no requirement to assess parameters other than nutrients and chlorophyll over time scales sufficient to confirm status or detect any changes in status. Transitional and coastal waters are all Non Problem Areas, and continue to be monitored and assessed under EU directives by the Scottish Environment Protection Agency (SEPA, see Annex 2), and Marine Scotland Science (MSS).

24.3 Assessment

Available data on nutrients and chlorophyll indicate that all assessment parameters were well below the respective assessment thresholds (Figures A14.2 to A14.6), confirming the previous classifications as Non Problem Area.

Nutrients

Normalised and non-normalised mean winter concentrations of DIN (µM) per year were calculated for the period from 2006 to 2014. Data used were from all depths sampled.

In coastal waters, sufficient winter DIN data were available for assessment in seven years during the assessment period (Figure A14.2). In 2007, the normalised mean was negative (Table A12.1) due to a negative slope in the nutrient-salinity gradient (data not shown); the normalised mean value is not shown in the bar plot, but the non-normalised mean is shown (graph on right hand side, Figure A14.2).

All normalised and non-normalised mean winter DIN values in coastal waters were below the threshold (18 µM, e.g. Table A14.1). Confidence levels per year were high (99.1-100%, see Table A14.1). The overall confidence level for concluding Non Problem Area over the assessment period was 100%).

In offshore waters, sufficient data were available in eight years (Figure A14.2). All normalised mean winter DIN values were below the assessment threshold (15 µM). Non-normalised means showed the same outcome. Confidence levels were high (100%, Table A14.2) per year, and overall.

More data were collected as TOxN than as DIN (see Tables A14.1 to A14.4). Nonetheless, mean winter TOxN values (Figure A14.3) were comparable with those of mean winter DIN. Confidence levels in mean values were also high using TOxN data (100%, Tables A14.3 and A14.4). Similarly, overall confidence levels for concluding Non Problem Area over the assessment period were high (100%).

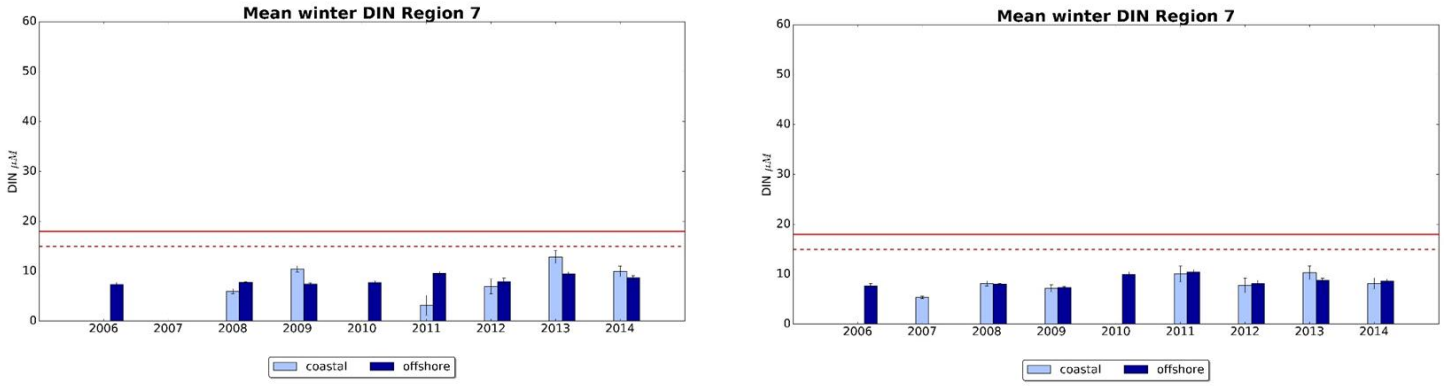


Figure A14.2: Mean winter concentrations of DIN (µM) per year in Region 7 during the assessment period, 2006 to 2014. Results are shown separately for coastal waters and offshore waters, using data from all depths sampled. Data are shown as normalised means (left) and non-normalised means (right). Coastal data were normalised to salinity 32, offshore data were normalised to 34.5. Assessment thresholds for coastal (18 µM, solid red line) and offshore waters (15 µM, dashed red line) are shown.

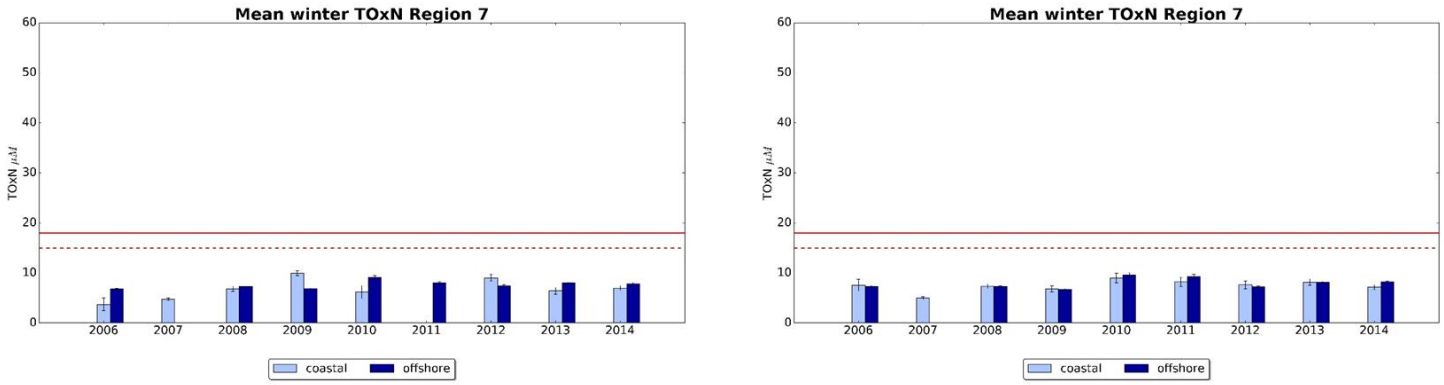


Figure A14.3: Mean winter concentrations of TOxN (µM) per year in Region 7 during the assessment period, 2006 to 2014. Results are shown separately for coastal waters and offshore waters, using data from all depths sampled. Data are shown as normalised means (left) and non-normalised means (right). Coastal data were normalised to salinity 32, offshore data were normalised to 34.5. Assessment thresholds for coastal (18 µM, solid red line) and offshore waters (15 µM, dashed red line) are shown.

Table A14.1. Normalised means and yearly confidence levels for winter DIN in Region 7 coastal. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold (µM)	Year	Min Value	Max Value	Normalised Mean	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
7	Coastal	18	2006	8.43	8.78	4.89	0.12	2	100
7	Coastal	18	2007	3.99	7.11	-0.3	0.11	56	100
7	Coastal	18	2008	5.71	10.54	6	0.24	19	100
7	Coastal	18	2009	5.57	12.35	10.48	0.31	30	100
7	Coastal	18	2010	6.91	8.67	-3.33	0.43	4	100
7	Coastal	18	2011	8.07	11.4	3.17	0.72	5	100
7	Coastal	18	2012	5.47	11.9	6.97	0.65	9	100
7	Coastal	18	2013	6.34	15.42	12.86	0.61	17	100
7	Coastal	18	2014	5.73	15.87	9.97	0.5	24	100
			All	3.99	15.87	5.46	0.2	166	100

Table A14.2. Normalised means and yearly confidence levels for winter DIN in Region 7 offshore. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 6 in main report).

Region	Location	Assessm Threshold (µM)	Year	Min Value	Max Value	Normalised Mean	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
7	Offshore	15	2006	6.1	9.32	7.35	0.18	22	100
7	Offshore	15	2007	5.41	6.77	5.93	0.28	3	100
7	Offshore	15	2008	6.8	9.72	7.8	0.06	156	100
7	Offshore	15	2009	5.86	9.06	7.46	0.09	85	100
7	Offshore	15	2010	6.35	12.41	7.72	0.19	41	100
7	Offshore	15	2011	6.44	13.9	9.55	0.23	52	100
7	Offshore	15	2012	5.58	12.8	7.95	0.32	32	100
7	Offshore	15	2013	7.56	16.49	9.46	0.22	63	100
7	Offshore	15	2014	5.84	15.6	8.69	0.2	76	100
			All	5.41	16.49	7.94	0.07	530	100

Table A14.3. Normalised means and yearly confidence levels for winter TOxN in Region 7 coastal. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold (µM)	Year	Min Value	Max Value	Normalised Mean	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
7	Coastal	18	2006	3.68	8.89	3.72	0.57	12	100
7	Coastal	18	2007	2.73	8.32	4.74	0.13	63	100
7	Coastal	18	2008	4.93	10.19	6.85	0.25	28	100
7	Coastal	18	2009	5.17	11.25	9.95	0.25	38	100
7	Coastal	18	2010	6.82	11.3	6.2	0.58	12	100
7	Coastal	18	2011	4.9	10.1	-1.65	0.5	11	100
7	Coastal	18	2012	5.2	13.99	9.02	0.33	30	100
7	Coastal	18	2013	5.4	11.09	6.41	0.33	20	100
7	Coastal	18	2014	5.14	12.59	6.99	0.24	38	100
			All	2.73	13.99	5.1	0.14	252	100

Table A14.4. Normalised means and yearly confidence levels for winter TOxN in Region 7 offshore. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 6 in main report).

Region	Location	Assessm Threshold (µM)	Year	Min Value	Max Value	Normalised Mean	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
7	Offshore	15	2006	4.57	9.13	6.81	0.07	131	100
7	Offshore	15	2007	5.14	5.98	5.03	0.21	3	100
7	Offshore	15	2008	5.34	8.75	7.26	0.05	165	100
7	Offshore	15	2009	5.4	8.1	6.87	0.07	97	100
7	Offshore	15	2010	5.81	12.43	9.11	0.18	91	100
7	Offshore	15	2011	4.5	13.57	7.98	0.15	101	100
7	Offshore	15	2012	4.6	10.03	7.46	0.11	98	100
7	Offshore	15	2013	4.26	11.34	7.97	0.07	126	100
7	Offshore	15	2014	5.05	15.4	7.84	0.1	135	100
			All	4.26	15.4	7.44	0.05	947	100

DIN:DIP ratios

Mean winter DIN:DIP ratios (Figure A14.4) were below the threshold of 24 in coastal and offshore waters. Confidence levels for concluding Non Problem Area were high (99.9-100%, Tables A14.5 and A14.6). The overall confidence level in mean values for concluding Non Problem Area over the assessment period was high in coastal and offshore waters (100%).

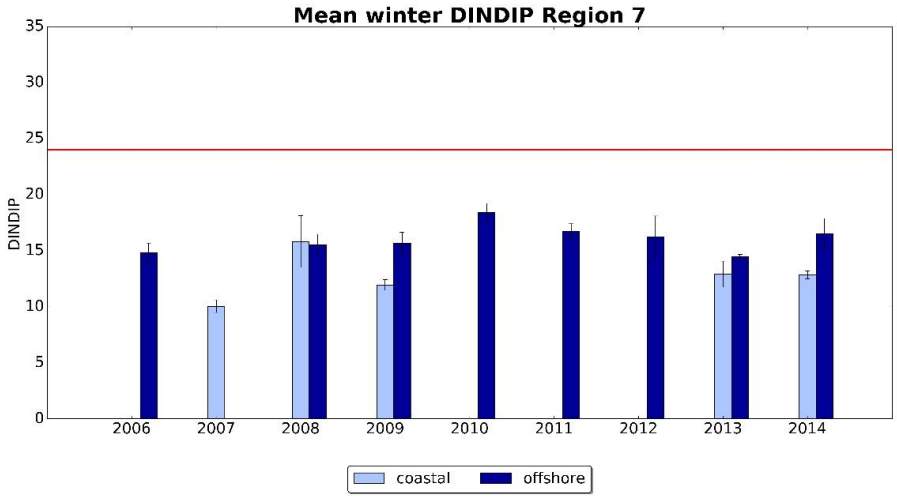


Figure A14.4: Mean winter ratios of DIN:DIP per year in Region 7 during the assessment period, 2006 to 2014. Results are shown separately for coastal waters and offshore waters, using data from all depths sampled. The assessment threshold of 24 is shown by the red line.

Table A14.5. Means and yearly confidence levels for winter DIN:DIP in Region 7 coastal. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold	Year	Min Value	Max Value	Mean Value	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
7	Coastal	24	2006	15.73	16.56	16.14	0.29	2	99.93
7	Coastal	24	2007	5.96	13.1	10.06	0.28	56	100
7	Coastal	24	2008	13.26	28.57	15.82	1.05	13	100
7	Coastal	24	2009	10.54	14.98	11.95	0.23	19	100
7	Coastal	24	2010	14.4	18.11	16.35	0.87	4	99.95
7	Coastal	24	2011	15.05	15.52	15.28	0.17	2	99.98
7	Coastal	24	2012	10.31	14.39	11.89	1.03	3	99.93
7	Coastal	24	2013	11.06	13.56	12.91	0.42	5	100
7	Coastal	24	2014	11.8	14.32	12.85	0.16	17	100
			All	5.96	28.57	11.93	0.27	121	100

Table A14.6. Means and yearly confidence levels for winter DIN:DIP in Region 7 offshore. The assessment threshold, minimum value, maximum value, standard error and number of samples are shown. All = overall values and confidence levels (see Table 6 in main report).

Region	Location	Assessm Threshold	Year	Min Value	Max Value	Mean Value	Std Error	Number of Samples	Confidence Level (%) for concluding Non Problem
7	Offshore	24	2006	11.2	17.99	14.8	0.43	22	100
7	Offshore	24	2007	11.27	13.27	12.18	0.48	3	99.99
7	Offshore	24	2008	9.32	56.57	15.53	0.48	155	100
7	Offshore	24	2009	8.46	27.3	15.64	0.51	81	100
7	Offshore	24	2010	13.62	23.31	18.42	0.39	41	100
7	Offshore	24	2011	11.5	24.77	16.75	0.33	38	100
7	Offshore	24	2012	10.26	25.31	16.25	0.89	20	100
7	Offshore	24	2013	13.36	16	14.5	0.09	57	100
7	Offshore	24	2014	11.45	40.46	16.5	0.69	71	100
			All	8.46	56.57	15.88	0.21	488	100

Chlorophyll:

For coastal waters, sufficient data were available for an assessment in three years (2007-2009). The 90th percentile values were low (3-3.2 µg l^{-1}) and well below the assessment threshold (15 µg l^{-1}). Confidence levels in these years ranged from 40.95% to 88% (Table A14.7). Overall confidence levels were 97.8%.

In offshore waters, data were available for all years during the assessment priod. The 90th percentiles were higher than in coastal water in 2007 and 2008, but all 90th percentiles in offshore water well below the assessment threshold value (10 µg l^{-1}). Confidence levels in the mean values were 72 to 100%, Table A14.8. Overall confidence levels were 100%.

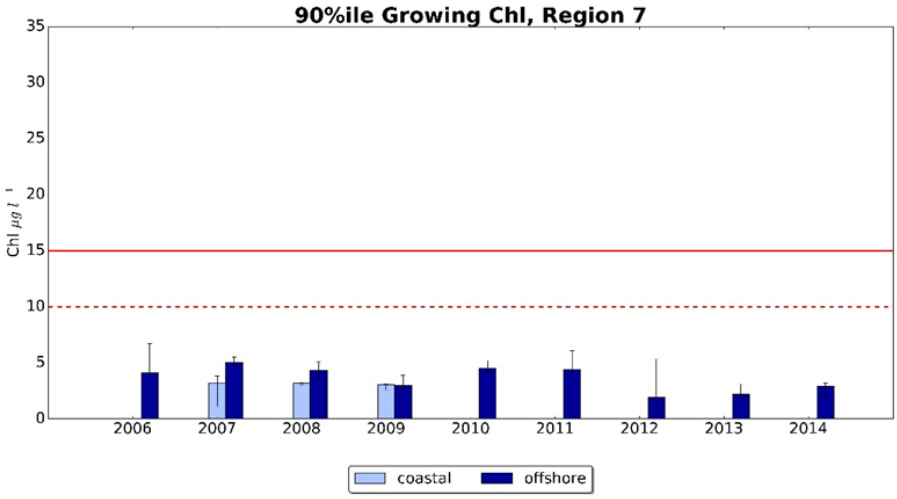


Figure A14.5: Growing season chlorophyll per year during the assessment period, 2006 to 2014, shown as 90th percentiles. Results are shown separately for coastal waters and offshore waters, using data from all depths sampled. Assessment thresholds are shown for offshore (10 µg l^{-1}) and coastal waters (15 µg l^{-1}).

Table A14.7. Chlorophyll growing season 90th percentiles in Region 7 coastal, and confidence levels per year. The table shows the assessment threshold, the number of available data points (n), the number of data points below the threshold, and the % of samples below the threshold. nan = no data. All = overall values and confidence levels (see Table 5 in main report).

Region	Location	Assessm Threshold (µg l^{-1})	Year	90th percentile	Mean	Std Dev	Number of Samples (n)	95% Conf Limit lower	95% Conf Limit upper	Number (n) below the assessment threshold	Confidence level (%)
7	Coastal	15	2006	nan	nan	nan	nan	nan	nan	nan	nan
7	Coastal	15	2007	3.22	1.72	1.12	6	1.11	3.82	6	46.86
7	Coastal	15	2008	3.18	2.62	0.77	5	3.07	3.25	5	40.95
7	Coastal	15	2009	3.05	1.61	1	20	2.59	3.11	20	87.84
7	Coastal	15	2010	nan	nan	nan	nan	nan	nan	nan	nan
7	Coastal	15	2011	4.15	3.1	1.29	3	3.77	4.24	3	27.1
7	Coastal	15	2012	1.72	1.72	0	2	nan	nan	2	19
7	Coastal	15	2013	nan	nan	nan	nan	nan	nan	nan	nan
7	Coastal	15	2014	nan	nan	nan	nan	nan	nan	nan	nan
			All	3.18	1.9	1.11	36	3.05	4.24	36	97.75

Table A14.8. Chlorophyll growing season 90th percentiles in Region 7 offshore, and confidence levels per year. The table shows the assessment threshold, the number of available data points (n), the number of data points below the threshold, and the % of samples below the threshold. nan = no data.

Region	Location	Assessm Threshold (µg l^{-1})	Year	90th percentile	Mean	Std Dev	Number of Samples (n)	95% Conf Limit lower	95% Conf Limit upper	Number (n) below the assessment threshold	Confidence level (%)
7	Offshore	10	2006	4.13	2.46	3.56	104	3.8	6.71	102	99.86
7	Offshore	10	2007	5.05	2.57	1.78	88	4.67	5.52	88	99.99
7	Offshore	10	2008	4.33	2.14	1.42	73	3.68	5.08	73	99.95
7	Offshore	10	2009	2.98	1.51	1.07	70	2.57	3.9	70	99.94
7	Offshore	10	2010	4.5	2.53	1.37	77	4.1	5.2	77	99.97
7	Offshore	10	2011	4.4	2.45	1.79	102	4.15	6.1	102	100
7	Offshore	10	2012	1.91	1	1.1	42	1.02	5.36	42	98.8
7	Offshore	10	2013	2.23	1.34	0.7	17	1.55	3.1	17	83.32
7	Offshore	10	2014	2.9	1.78	0.73	12	1.8	3.2	12	71.76
			All	4.4	2.18	2.07	585	4.1	4.68	583	100

Phytoplankton Indicator Species:

No phytoplankton data were available to apply the WFD tool.

Oxygen:

Sufficient data for assessments were only available in offshore waters in four years (2008-2011, Figure A14.6). In each year, concentrations of dissolved oxygen and percentage saturation were above the threshold (6 mg l^{-1} and 60%, respectively), providing evidence of no indirect effects of nutrient enrichment in offshore waters in this region. Confidence levels in concluding Non Problem Area were high by year (>80%, Table A14.10) and overall (100%).

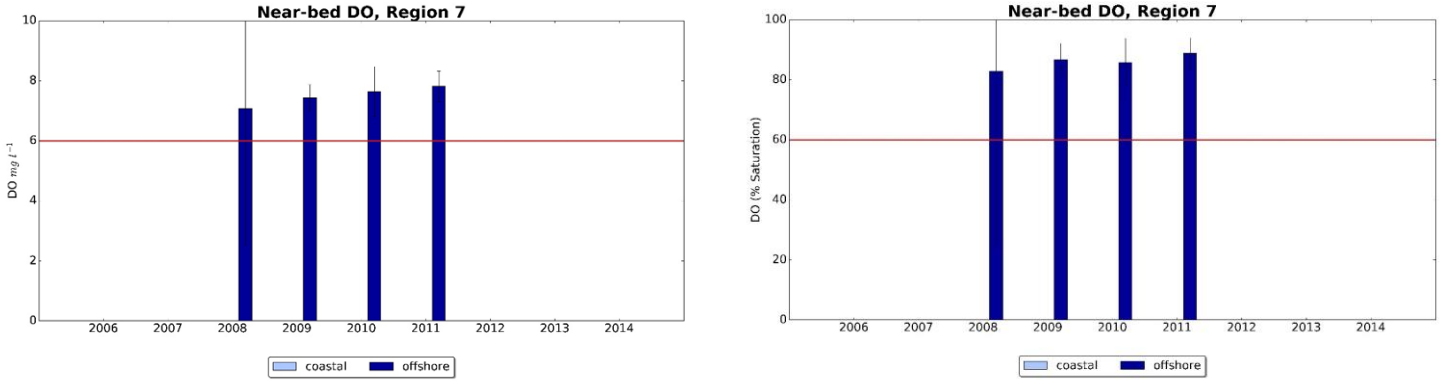


Figure A14.6: Near-bed dissolved oxygen(DO) on the Scottish Continental Shelf during the assessment period, 2006 to 2014, shown as concentrations (mg l^{-1}, left) and percentage saturation (right). Results are given as mean values in the lowest quartile of the data during the stratified season, and are shown separately for coastal data (none) and offshore data. Thresholds of 6 mg l^{-1} and 60% saturation are shown by the red lines.

Table A14.9: Near-bed dissolved oxygen (mg l^{-1}) in Region 7 coastal, and confidence levels per year. The table shows the threshold used, the mean and standard error in the lowest quartile of the data (Q25), the number of available data points in the lowest quartile and in the available dataset (total), and confidence levels in assessment outcomes. Minimum (Min) and maximum (Max) values in the total dataset are also shown. nan = no data.

Region	Location	Assessm Threshold (mg l^{-1})	Year	Min Value	Max Value	Mean (Q25)	Std Error (Q25)	Number of Samples (Q25)	Number of Samples (total)	Confidence Level (%) for concluding Non Problem
7	Coastal	6	2006	nan	nan	nan	nan	nan	0	nan
7	Coastal	6	2007	nan	nan	nan	nan	nan	0	nan
7	Coastal	6	2008	nan	nan	nan	nan	nan	0	nan
7	Coastal	6	2009	nan	nan	nan	nan	nan	0	nan
7	Coastal	6	2010	nan	nan	nan	nan	nan	0	nan
7	Coastal	6	2011	nan	nan	nan	nan	nan	0	nan
7	Coastal	6	2012	nan	nan	nan	nan	nan	0	nan
7	Coastal	6	2013	nan	nan	nan	nan	nan	0	nan
7	Coastal	6	2014	nan	nan	nan	nan	nan	0	nan
			All	nan	nan	nan	nan	nan	nan	nan

Table A14.10: Near-bed dissolved oxygen (mg l^{-1}) in Region 7 offshore, and confidence levels per year. The table shows the threshold used, the mean and standard error in the lowest quartile of the data (Q25), the number of available data points in the lowest quartile and in the available dataset (total), and confidence levels in assessment outcomes. Minimum (Min) and maximum (Max) values in the total dataset are also shown. nan = no data. All = overall values and confidence levels (see Table 6 in main report).

Region	Location	Assessm Threshold (mg l^{-1})	Year	Min Value	Max Value	Mean (Q25)	Std Error (Q25)	Number of Samples (Q25)	Number of Samples (total)	Confidence Level (%) for concluding Non Problem
7	Offshore	6	2006	nan	nan	nan	nan	nan	0	nan
7	Offshore	6	2007	8.53	8.87	8.53	nan	1	4	nan
7	Offshore	6	2008	4.96	11.08	7.07	1.06	3	12	80.62
7	Offshore	6	2009	7.10	10.49	7.43	0.14	4	14	99.97
7	Offshore	6	2010	7.25	11.98	7.64	0.19	3	11	99.83
7	Offshore	6	2011	7.30	10.75	7.82	0.18	5	19	99.99
7	Offshore	6	2012	7.30	8.59	7.30	nan	1	2	nan
7	Offshore	6	2013	7.33	7.33	7.33	nan	1	1	nan
7	Offshore	6	2014	7.35	8.83	7.35	nan	1	2	nan
			All	4.96	11.98	7.39	0.18	16	65	100

Assessment Outcomes for the Scottish Continental Shelf

2003 - In OSPAR integrated report, 1995-2001: Non Problem Area.

2008 - Period 2001-2005: Non Problem Area.

2014 - Third application of the Common Procedure (2006-2014):

Initial and final classification for northern North Sea: Non Problem Area (2006-2014).

Table A14.11: Assessment table (Scottish Continental Shelf, 2006-2014). Aggregated confidence ratings (Tables 5 and 6 in the main report) were calculated over the nine-year assessment period.

Category	Assessment Parameters	Description of Results	Score (+ - ?)	Aggregated confidence rating (%)
Degree of Nutrient Enrichment (I)	Riverine inputs and direct discharges of total N and total P	N - P -	- .-	
	Winter DIN concentrations (normalised)	Coastal: ? ? - - ? - - - -	Coastal –	100
		Offshore: - - - - - - - - -	Offshore –	100
	Winter DIN:DIP ratio	Coastal: ? - - - ? ? ? - -	Coastal: –	100
		Offshore: - ? - - - - - - -	Offshore: –	100
Direct Effects (II)	90th percentile chlorophyll concentration	Coastal: ? - - - ? ? ? ? ?	Coastal: –	97.75
		Offshore:- - - - - - - - -	Offshore: –	100
	Area-specific phytoplankton indicator species	Not assessed		
	Macrophytes including macroalgae	Not assessed		
Indirect Effects (III)	Oxygen deficiency (mg l^{-1})	Coastal: ? ? ? ? ? ? ? ? ?	Coastal: ?	-
		Offshore:? ? - - - - ? ? ?	Offshore: -	100
	Changes/kills in zoobenthos and fish kills	Not assessed		
	Organic carbon/organic matter	Not assessed		
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)	Not assessed		

Key to the Score

+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters
- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters
? = Not enough data to perform an assessment or the data available are not fit for the purpose

Table A14.12: Results of the OSPAR Comprehensive Assessment 2016 for the Scottish Continental Shelf, 2006-2014. PA = Problem Area, NPA = Non Problem Area.

Key to the table

NI Riverine inputs and direct discharges of total N and total P
DI Winter DIN and/or DIP concentrations
NP Increased winter N/P ratio
Ca 90th percentile, maximum and mean chlorophyll *a* concentration
Ps Area-specific phytoplankton indicator species
Mp Macrophytes including macroalgae
O_2 Oxygen deficiency
Ck Changes/kills in zoobenthos and fish kills
Oc Organic carbon/organic matter
At Algal toxins (DSP/PSP mussel infection events)

\+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters
\- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters
? = Not enough data were available for assessments. These data were not required or used to confirm Non Problem Status
Note: Categories I, II and/or III/IV are scored '+' in cases where one or more of its respective assessment parameters is showing an increased trend, elevated levels, shifts or changes.

Area	**Category I** Degree of nutrient enrichment		**Category II** Direct effects		**Category III and IV** Indirect effects/ other possible effects				Initial classification	Overall appraisal of all relevant information (concerning the harmonised assessment parameters, their respective assessment levels and the supporting environmental factors)	Final classification	Assessment period
Scottish Continental Shelf – coastal water	NI	-	Ca	-	O_2	?	At		NPA	• There is no evidence that the area is nutrient enriched (high confidence) based on nutrient data of moderate representivity. • There is evidence that there is no accelerated growth (high confidence) based on chlorophyll data of moderate representivity. • There are no data on undesirable disturbance. It is confirmed that this area remains a Non Problem Area (high confidence) based on the available evidence. Nutrient inputs are decreasing.	NPA	2006-2014
	DI	-	Ps		Ck							
	NP	-	Mp		Oc							
Scottish Continental shelf – offshore water	NI	-	Ca	-	O_2	-	At		NPA	• There is evidence that this area is not nutrient enriched (high confidence) based on nutrient data of moderate representivity. • There is good evidence that there is no accelerated growth (high confidence) based on chlorophyll data of moderate	NPA	2006-2014
	DI	-	Ps		Ck							
	NP	-	Mp		Oc							

								representivity. • There is good evidence that there is no undesirable disturbance (high confidence) based on oxygen concentrations with low representivity. It is confirmed that this area remains a Non Problem Area (high confidence) based on the available evidence. Nutrient inputs to the area are decreasing.		

25 Annex 15 – Atlantic and North-West Approaches (Region 8)

25.1 Description of the area:

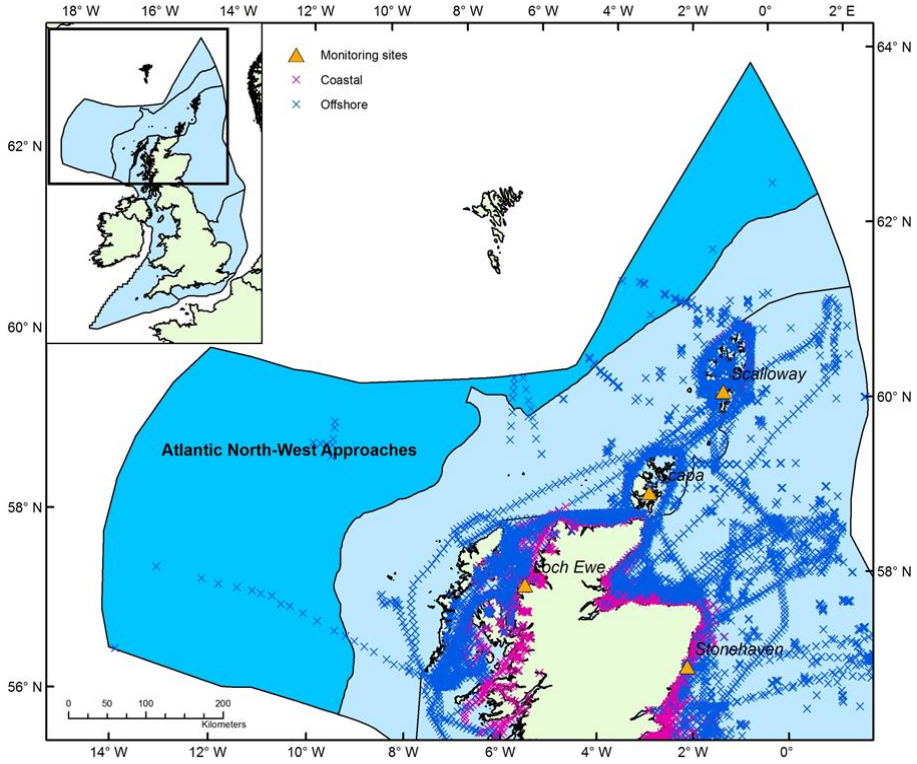


Figure A15.1: Map showing the location of the Atlantic and North-West Approaches (Region 8, dark blue). The locations of sites (X) where data were available from 2006 onwards are shown: red = coastal (salinity 30-34.5), blue = offshore sites (salinity >34.5).

25.2 Description of monitoring design in relation to spatial and temporal variability of assessment parameters in the area

This section should include information on how the monitoring design addresses the particular typology and main hydrographical dynamics in the area, so as to provide evidence of representativeness of monitoring.

This is an offshore region and, like all marine waters off Scotland, has previously been screened out as a Non Problem Area. There is no requirement to assess parameters other than nutrients and chlorophyll over time scales sufficient to confirm status or detect any changes in status. However, due to the distance from the coast and the direct anthropogenic input of nutrients, there is no monitoring in this region. Available data (chlorophyll and oxygen concentrations) originate from other sources, such as research cruises.

25.3 Assessment

Available data on chlorophyll indicate that all assessment parameters were well below the respective assessment thresholds (Figure A15.2).

Overall, the status of the region remains that of Non Problem Area.

Chlorophyll:

Data were available for assessment in all years (2006-2014). The 90th percentile values were low (<3 µg l^{-1}, Table A15.1) and well below the assessment threshold for offshore waters (10 µg l^{-1}). Confidence levels ranged from 47% to94%, depending on the number of data points (Table A15.1). Overall confidence levels were 100% (Table 6 in main report).

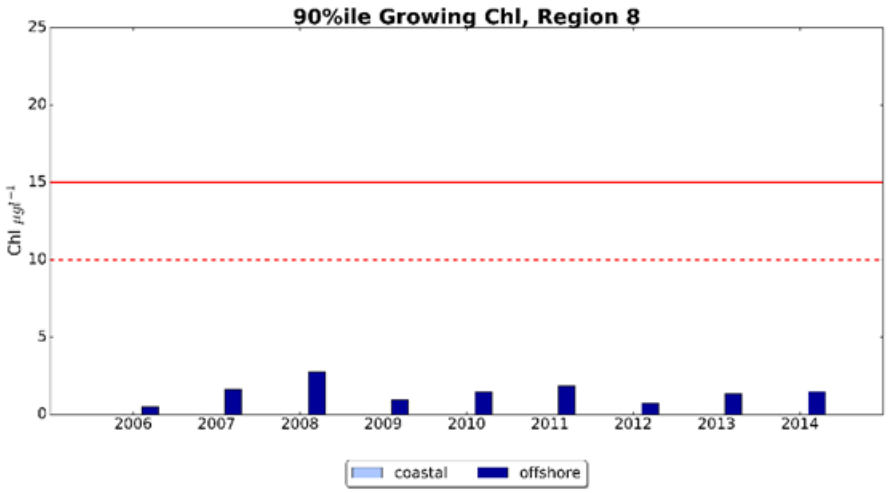


Figure A15.2: Growing season chlorophyll per year in the the Atlantic and North-West Approaches during the assessment period, 2006 to 2014, shown as 90th percentiles. There are no coastal waters and results for this offshore region are shown using data from all depths sampled. Assessment thresholds for coastal (15 µg l^{-1}, solid red line) and offshore waters (10 µg l^{-1}, dashed red line) are shown.

Table A15.1. Chlorophyll growing season 90th percentiles in Atlantic and North-West Approaches, and confidence levels per year. The table shows the assessment threshold, the number of available data points (n), the number of data points below the threshold, and the % of samples below the threshold. nan = no data. All = overall values and confidence levels (see Table 6 in main report). All = overall values and confidence levels (see Table 6 in main report).

Region	Location	Assessm Threshold (µg l^{-1})	Year	90th percentile	Mean	Std Dev	Number of Samples (n)	95% Conf Limit lower	95% Conf Limit upper	Number (n) below the assessment threshold	Confidence level (%)
8	Offshore	10	2006	0.51	0.34	0.17	11	0.34	0.79	11	68.62
8	Offshore	10	2007	1.6	1.09	0.4	12	1.12	2.03	12	71.76
8	Offshore	10	2008	2.74	1.46	0.86	27	1.88	3.65	27	94.19
8	Offshore	10	2009	0.93	0.67	0.22	8	0.83	1.05	8	56.95
8	Offshore	10	2010	1.44	1.28	0.12	6	1.23	1.52	6	46.86
8	Offshore	10	2011	1.85	0.83	0.58	16	1.1	1.92	16	81.47
8	Offshore	10	2012	0.74	0.49	0.2	18	0.64	0.83	18	84.99
8	Offshore	10	2013	1.35	0.94	0.45	7	1.3	1.37	7	52.17
8	Offshore	10	2014	1.48	0.95	0.4	6	0.85	1.55	6	46.86
			All	1.61	0.93	0.66	111	1.41	2.48	111	100

Oxygen:

Sufficient data for assessments were not available in any one year during the assessment period (2006-2014, Table A15.2). The overall confidence level for concluding Non Problem Area was high (100%, Table A15.2), based on 8 data points available during this period.

Table A15.2: Near-bed dissolved oxygen (mg l^{-1}) inAtlantic and North-West Approaches, and confidence levels per year. The table shows the threshold used, the mean and standard error in the lowest quartile of the data (Q25), the number of available data points in the lowest quartile and in the available dataset (total), and confidence levels in assessment outcomes. Minimum (Min) and maximum (Max) values in the total dataset are also shown. nan = no data. All = overall values and confidence levels (see Table 6 in main report).

Region	Location	Assessm Threshold (mg l^{-1})	Year	Min Value	Max Value	Mean (Q25)	Std Error (Q25)	Number of Samples (Q25)	Number of Samples (total)	Confidence Level (%) for concluding Non Problem
8	Offshore	6	2006	nan	nan	nan	nan	nan	0	nan
8	Offshore	6	2007	nan	nan	nan	nan	nan	0	nan
8	Offshore	6	2008	nan	nan	nan	nan	nan	0	nan
8	Offshore	6	2009	nan	nan	nan	nan	nan	0	nan
8	Offshore	6	2010	9.17	9.17	9.17	nan	1	1	nan
8	Offshore	6	2011	7.80	9.66	7.80	nan	1	2	nan
8	Offshore	6	2012	9.28	9.34	9.28	nan	1	2	nan
8	Offshore	6	2013	9.02	9.13	9.02	nan	1	2	nan
8	Offshore	6	2014	9.57	9.57	9.57	nan	1	1	nan
			All	7.80	9.66	8.41	0.61	2	8	97.1

Assessment Outcomes for the Atlantic and North-West Approaches

2003 - In OSPAR integrated report, 1995-2001: Non Problem Area.

2008 - Period 2001-2005: Non Problem Area.

2014 - Third application of the Common Procedure (2006-2014):

Initial and final classification for northern North Sea: Non Problem Area (2006-2014).

Table A15.3: Results of the OSPAR Comprehensive Assessment 2016 for the Atlantic and North-West Approaches, 2006-2014. PA = Problem Area, NPA = Non Problem Area.

Key to the table

NI Riverine inputs and direct discharges of total N and total P
DI Winter DIN and/or DIP concentrations
NP Increased winter N/P ratio
Ca 90th percentile, maximum and mean chlorophyll *a* concentration
Ps Area-specific phytoplankton indicator species
Mp Macrophytes including macroalgae
O_2 Oxygen deficiency
Ck Changes/kills in zoobenthos and fish kills
Oc Organic carbon/organic matter
At Algal toxins (DSP/PSP mussel infection events)

\+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters
\- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters
? = Not enough data were available for assessments. These data were not required or used to confirm Non Problem Status

Note: Categories I, II and/or III/IV are scored '+' in cases where one or more of its respective assessment parameters is showing an increased trend, elevated levels, shifts or changes.

Area	**Category I** Degree of nutrient enrichment		**Category II** Direct effects		**Category III and IV** Indirect effects/ other possible effects				Initial classification	Overall appraisal of all relevant information (concerning the harmonised assessment parameters, their respective assessment levels and the supporting environmental factors)	Final classification	Assessment period
Atlantic and North-West Approaches – Offshore	NI	-	Ca	-	O_2	-	At		NPA	• There are no data on nutrient concentrations in this region. • There is good evidence that there is no accelerated growth (high confidence) based on chlorophyll data of moderate representivity. • There is evidence that there is no undesirable disturbance (high confidence) based on oxygen concentrations with low representivity. It is confirmed that this area remains a Non Problem Area (high confidence) based on the available evidence. Nutrient inputs to the area are decreasing.	NPA	2006-2014
	DI		Ps		Ck							
	NP		Mp		Oc							

26 Annex 16 – Representativeness of data

The representativeness in time and space of the data used in the assessment has been calculated using a modified version of the OSPAR guidance in Annex 8 (see Sections B1, B2 and B3; see also Brockmann and Topcu 2014). The temporal and spatial distributions of DIN data (split by latitude and longitude) and the minimum and maximum values are given as an example (Figures A16.1 to A16.3). The monitoring gaps in time and space are shown in these figures. In addition, the maximum and minimum values give an idea of the existing temporal and spatial gradients. Figures A16.4 to A16.12 show the same outputs for TOxN, chlorophyll and dissolved oxygen.

A confidence value (or score) for the temporal and spatial (in latitude and longitude) representativeness was calculated per variable, per region, with the overall score being the worst of the three. The results for DIN, TOxN, Chloropyll and DO are shown in Tables A16.1 to A16.4, respectively. The overall representativeness is shown in Table A16.5.

*Table A16.1: Representativeness of the data (as a %) in time and space (by longitude and latitude): **winter DIN (µM)** in the regional seas. Per region, the lowest score gives overall representativeness.*

Region	Temporal representativeness	Longitude representativeness	Latitude representativeness	Overall representativeness
1	92.73	80.3	92.22	80.3
2	72.54	83.3	91.22	72.54
3	39.75	82.06	75.0	39.75
4	38.78	81.48	88.74	38.78
5	90.81	92.31	88.56	88.56
6	91.47	95.65	96.55	91.47
7	67.07	66.16	62.96	62.96
8	x	x	x	x

*Table A16.2: Representativeness of the data (as a %) in time and space (by longitude and latitude): **winter TOxN (µM)** in the regional seas. Per region, the lowest score gives overall representativeness.*

Region	Temporal representativeness	Longitude representativeness	Latitude representativeness	Overall representativeness
1	100.0	80.3	94.87	80.3
2	94.44	83.3	91.34	83.3
3	35.82	81.73	75.0	35.82
4	61.35	81.53	90.08	61.35
5	98.19	96.15	88.83	88.83
6	94.68	95.65	96.55	94.68
7	94.97	67.01	62.96	62.96
8	x	x	x	x

*Table A16.3: Representativeness of the data (as a %) in time and space (by longitude and latitude): **growing season chlorophyll data (µg l^{-1})** in the regional seas. Per region, the lowest score gives overall representativeness.for in all regional seas.*

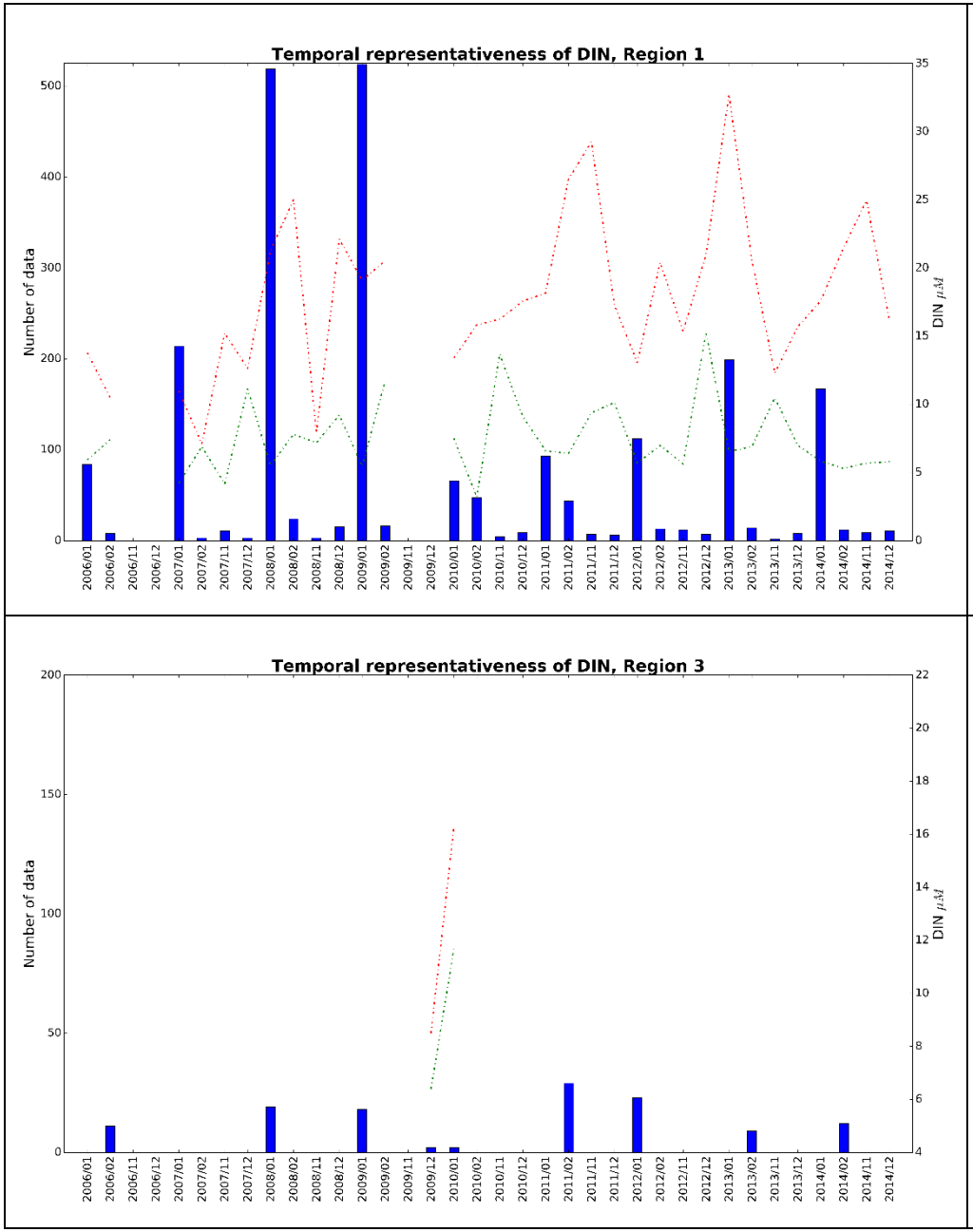
Region	Temporal representativeness	Longitude representativeness	Latitude representativeness	Overall representativeness
1	91.54	81.06	71.23	71.23
2	99.15	70.41	88.23	70.41
3	19.21	30.44	41.67	19.21
4	12.52	41.54	47.0	12.52
5	72.81	92.31	88.42	72.81
6	84.77	94.99	78.41	78.41
7	76.06	62.56	59.04	59.04
8	33.92	38.77	30.29	30.29

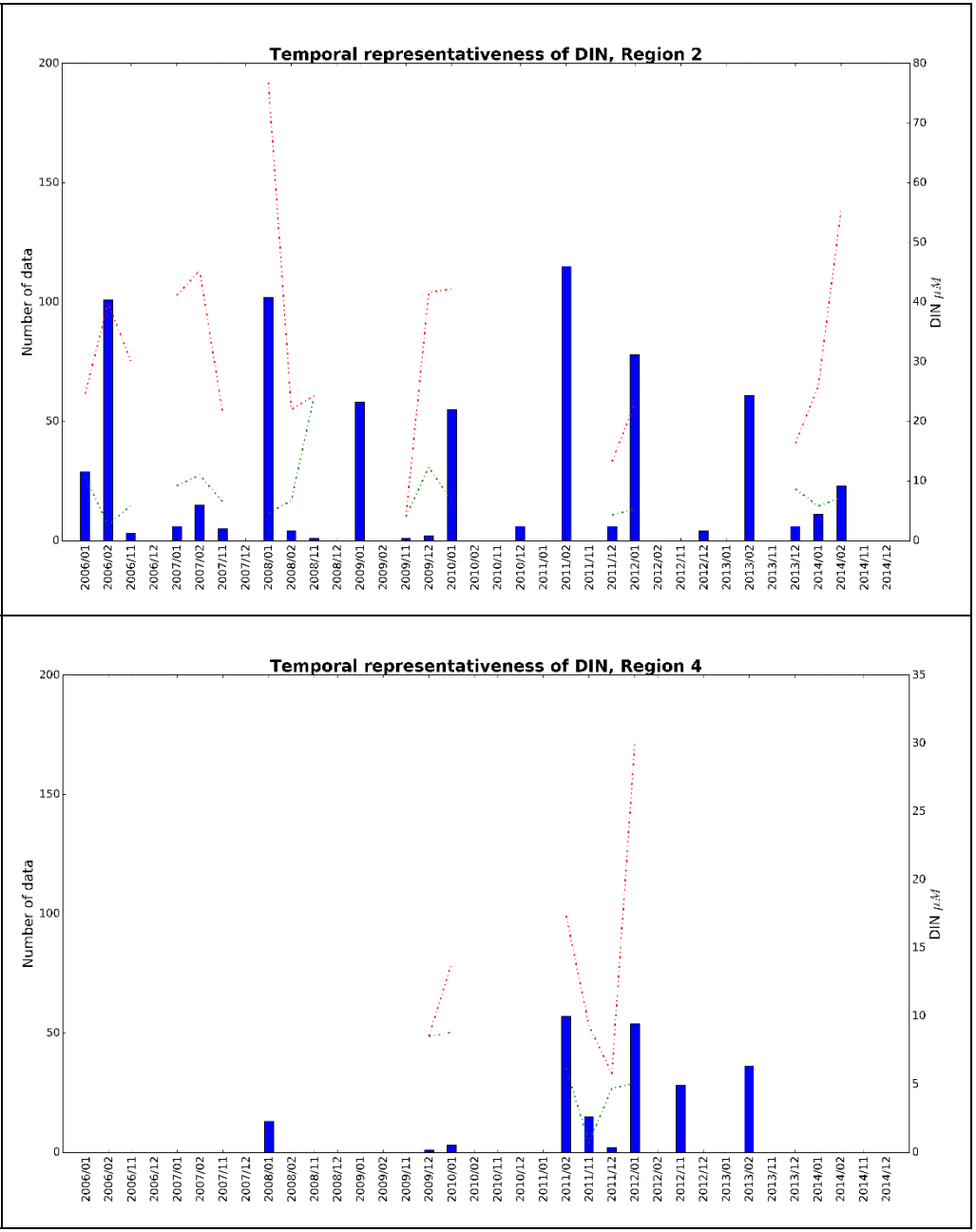
*Table A16.4: Representativeness of the data (as a %) in time and space (by longitude and latitude): **near-bed dissolved oxygen concentrations (mg l^{-1})** in the regional seas. Per region, the lowest score gives overall representativeness.*

Region	Temporal representativeness	Longitude representativeness	Latitude representativeness	Overall representativeness
1	82.57	44.62	39.63	39.63
2	63.49	30.6	25.77	25.77
3	5.56	4.17	16.67	4.16
4	8.33	13.44	23.82	8.33
5	14.51	35.72	10.81	10.81
6	50.62	71.48	46.30	46.30
7	54.7	7.66	12.73	7.66
8	18.83	1.57	2.82	1.57

Table A16.5. Summary of lowest % scores for temporal and spatial representativeness of data per parameter. These provide the final score for the overall representivity of the data. X = no data.

Assessment region	DIN	TOxN	Chlorophyll	DO
1	80.30	80.30	71.23	39.63
2	72.54	83.33	70.41	25.77
3	39.75	35.82	19.21	4.17
4	38.78	61.35	12.52	8.33
5	88.56	88.83	72.81	10.81
6	91.47	94.68	78.41	46.3
7	62.96	62.96	59.04	7.66
8	x	x	30.29	1.57


Temporal representativeness of DIN, Region 1
Number of data
DIN µM


Temporal representativeness of DIN, Region 2
Number of data
DIN µM

Temporal representativeness of DIN, Region 3
Number of data
DIN µM

Temporal representativeness of DIN, Region 4
Number of data
DIN µM

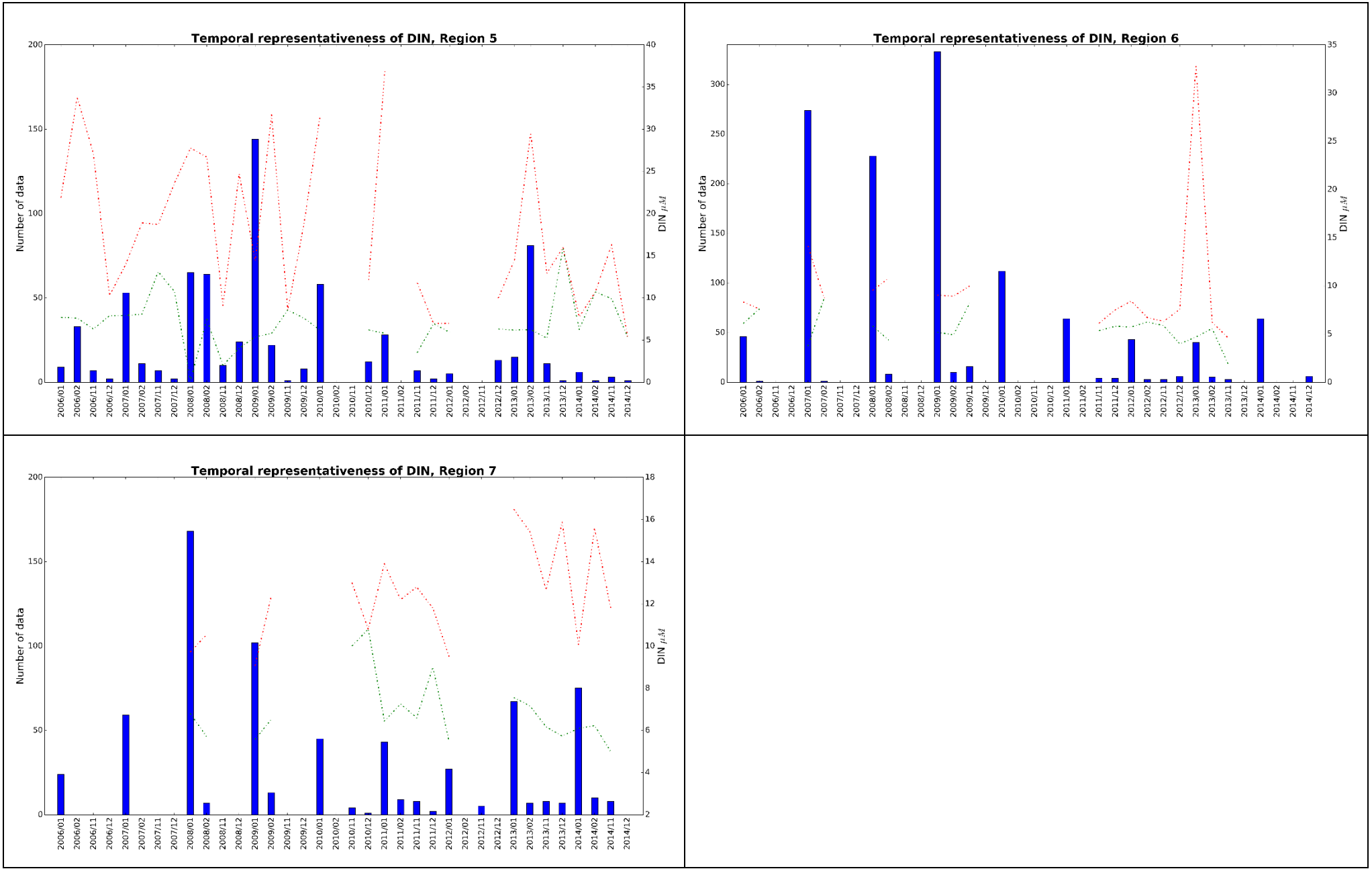
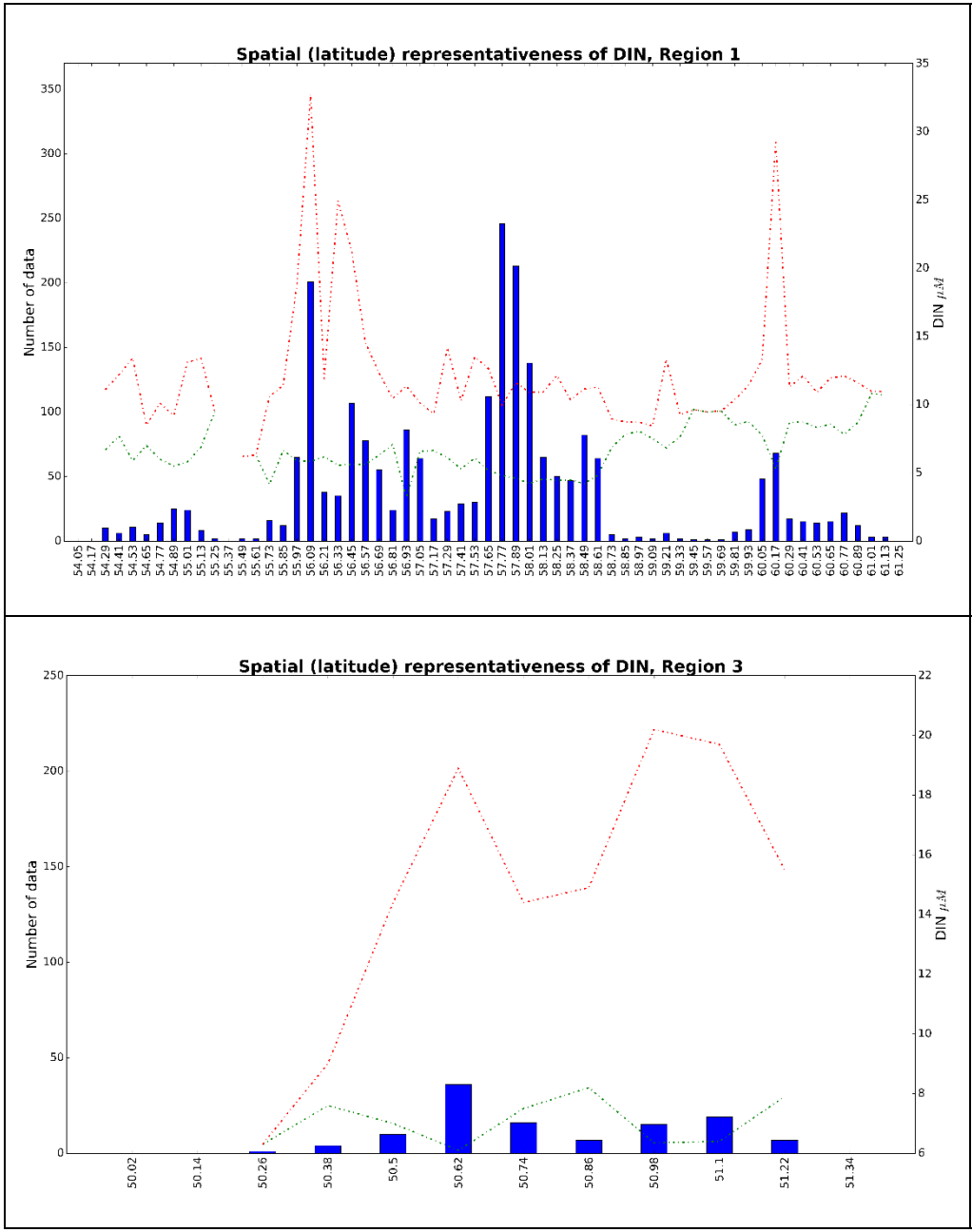


Figure A16.1. Plots showing the distribution of all DIN (µM) data along time for Regions 1 to 7. The bars represent the number of data (left y axis) in each time interval of 1 month. The red dashed line represents the maximum concentration of DIN (right axis) in each time interval and the green dashed line depicts the minimum DIN concentration (right axis) per time interval.


Spatial (latitude) representativeness of DIN, Region 1
Number of data
DIN μM
Spatial (latitude) representativeness of DIN, Region 2
Number of data
DIN μM
Spatial (latitude) representativeness of DIN, Region 3
Number of data
DIN μM
Spatial (latitude) representativeness of DIN, Region 4
Number of data
DIN μM

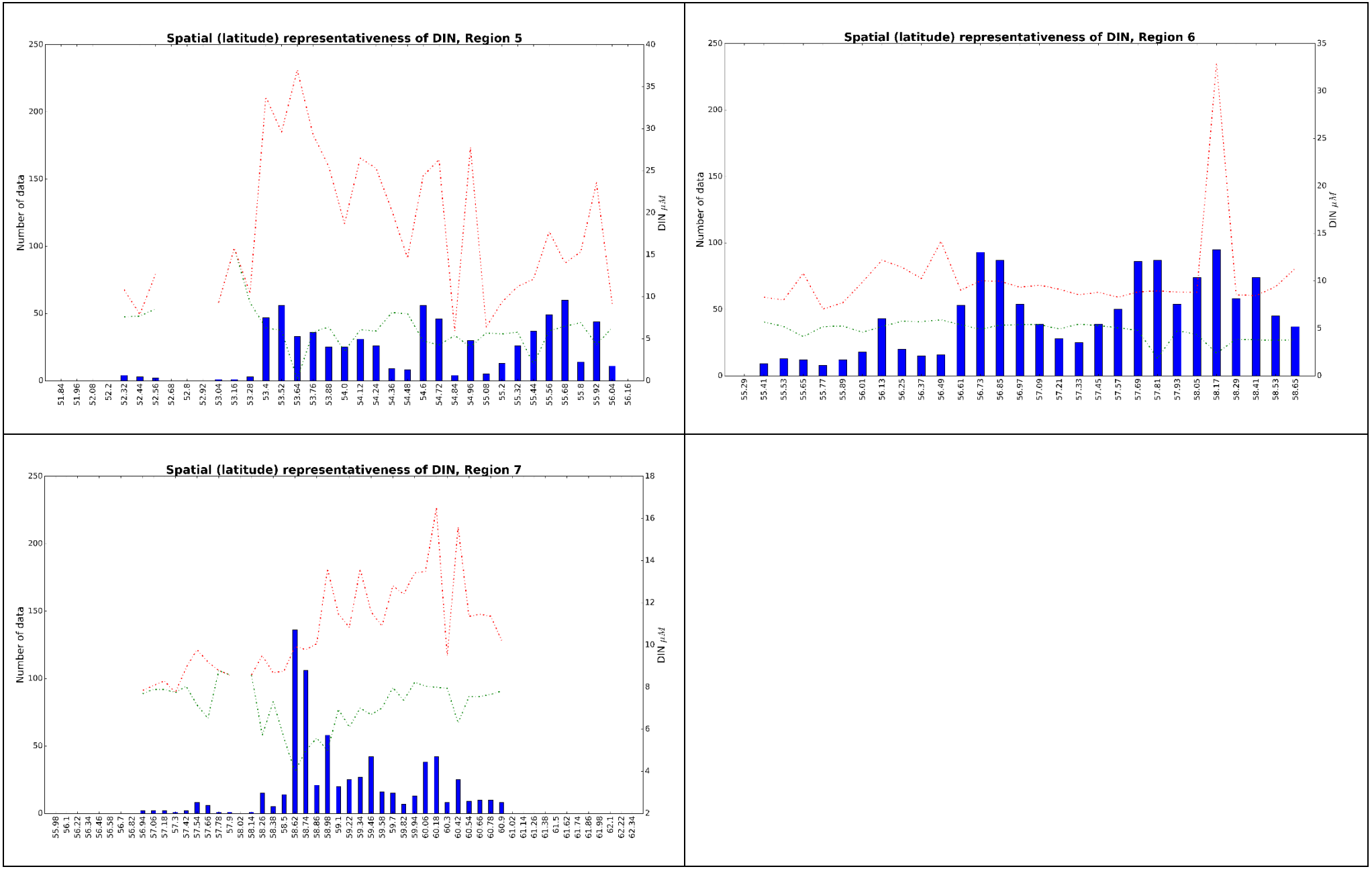
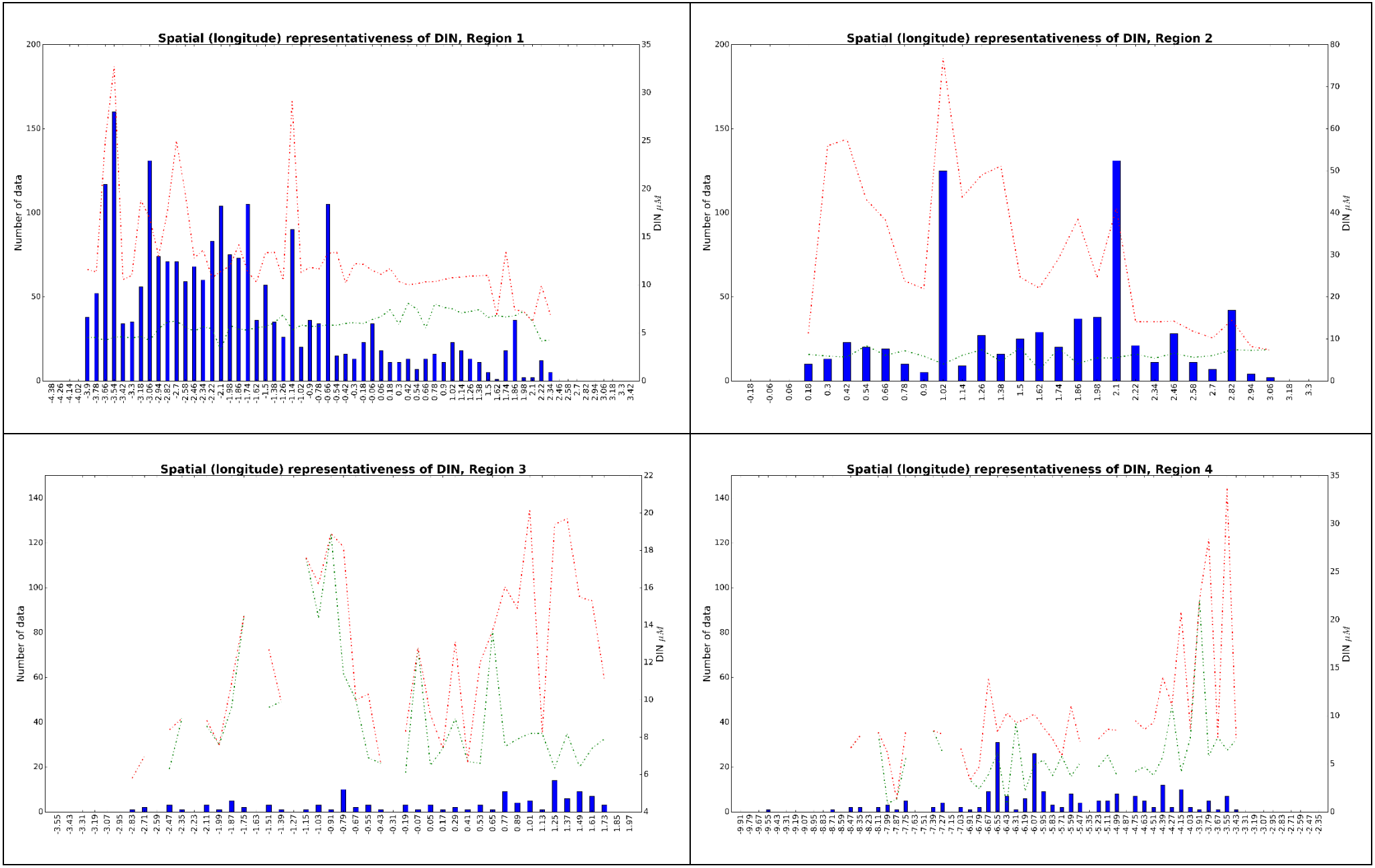


Figure A16.2. Plots showing the distribution of all DIN (µM) data along latitude for Regions 1 to 7. The bars represent the number of data (left y axis) in each latitudinal interval of 3/25 degrees. The red dashed line represents the maximum concentration of DIN (right axis) in each latitudinal interval and the green dashed line depicts the minimum DIN concentration (right axis) per latitudinal interval.


Spatial (longitude) representativeness of DIN, Region 1
Number of data
DIN µM
Spatial (longitude) representativeness of DIN, Region 2
Number of data
DIN µM
Spatial (longitude) representativeness of DIN, Region 3
Number of data
DIN µM
Spatial (longitude) representativeness of DIN, Region 4
Number of data
DIN µM

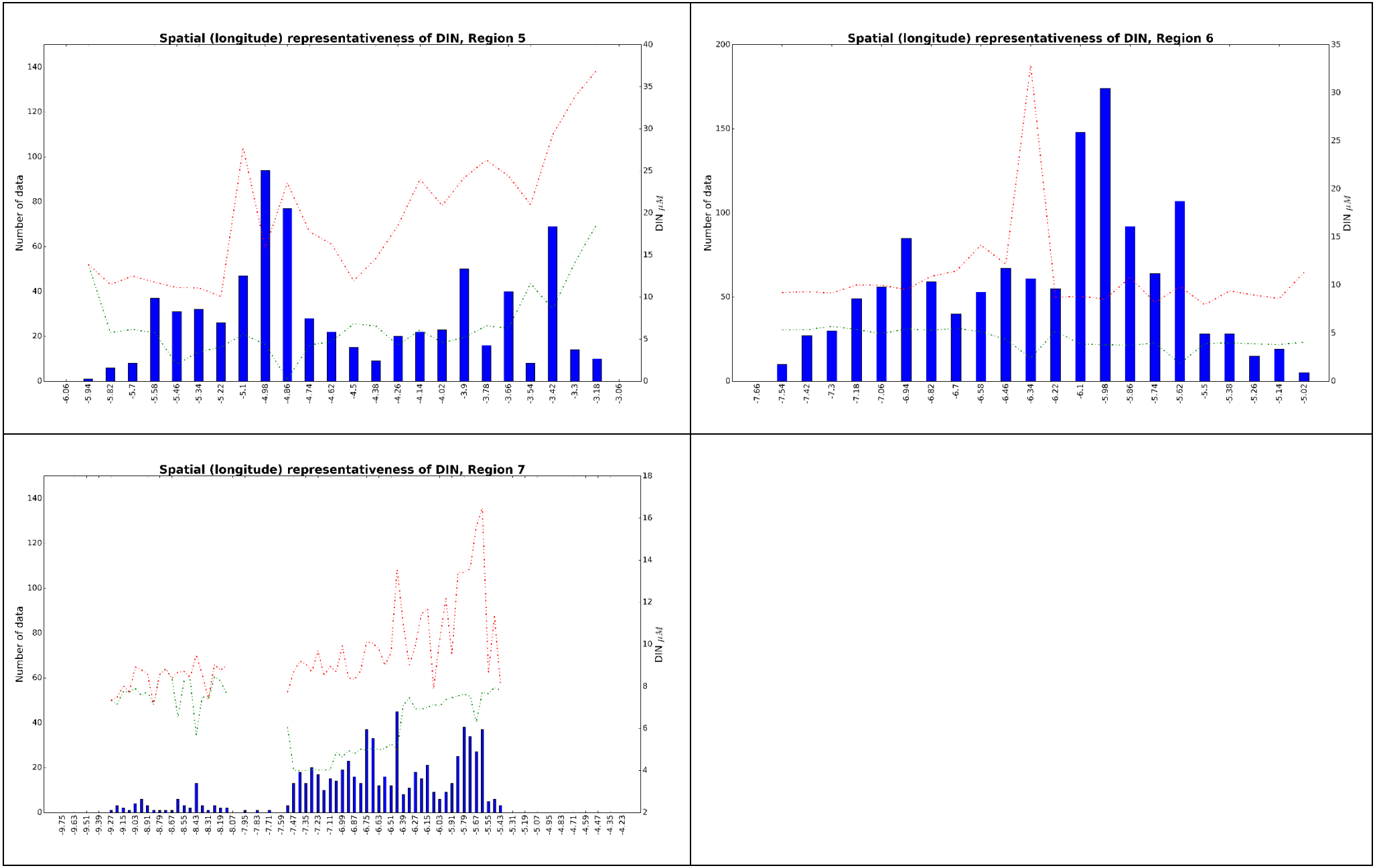
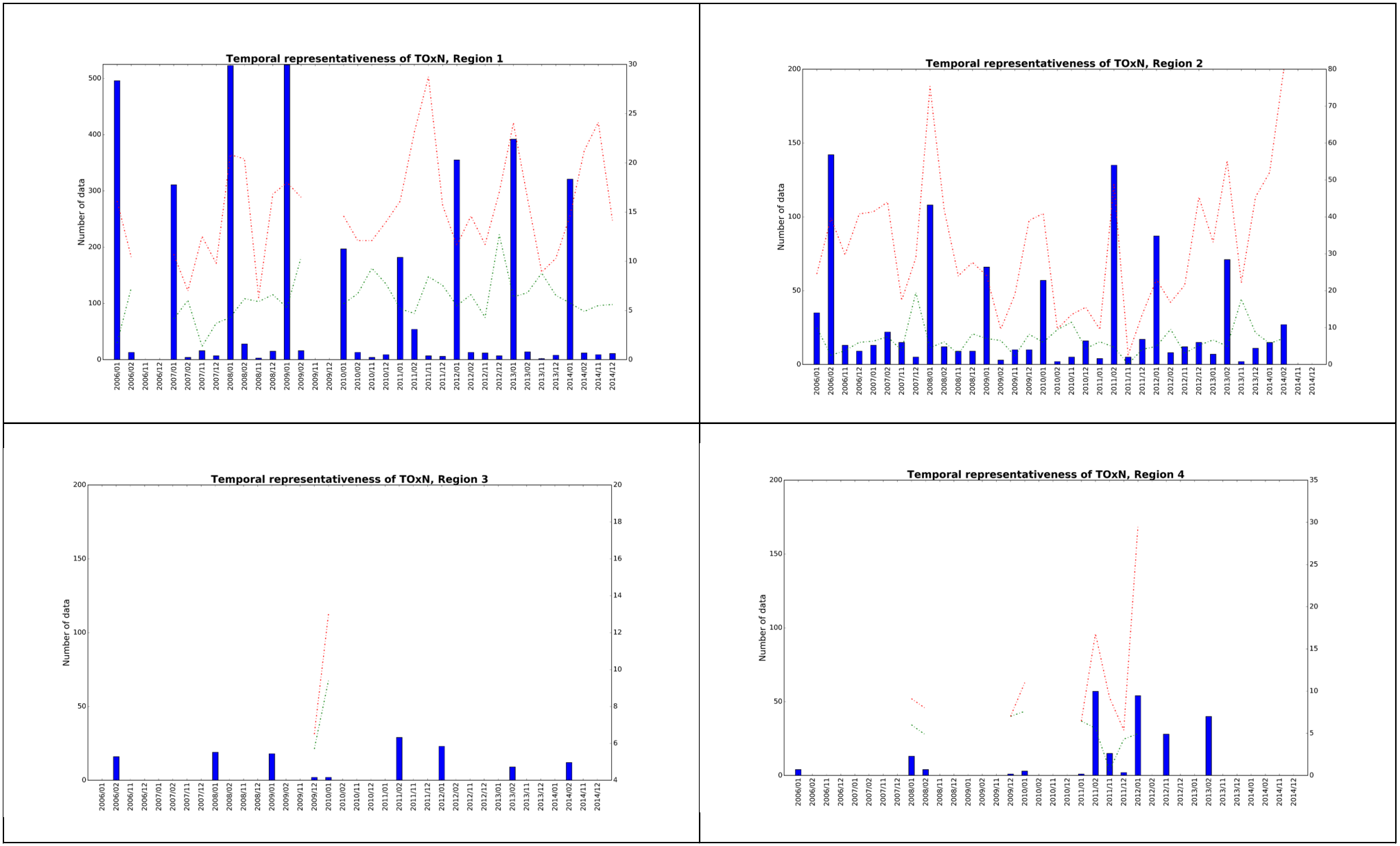


Figure A16.3. Plots showing the distribution of all DIN (µM) data along longitude for Regions 1 to 7. The bars represent the number of data (left y axis) in each longitudinal interval of 3/25 degrees. The red dashed line represents the maximum concentration of DIN (right axis) in each longitudinal interval and the green dashed line depicts the minimum DIN concentration (right axis) per longitudinal interval.


Temporal representativeness of TOxN, Region 1
Number of data
Temporal representativeness of TOxN, Region 2
Number of data
Temporal representativeness of TOxN, Region 3
Number of data
Temporal representativeness of TOxN, Region 4
Number of data

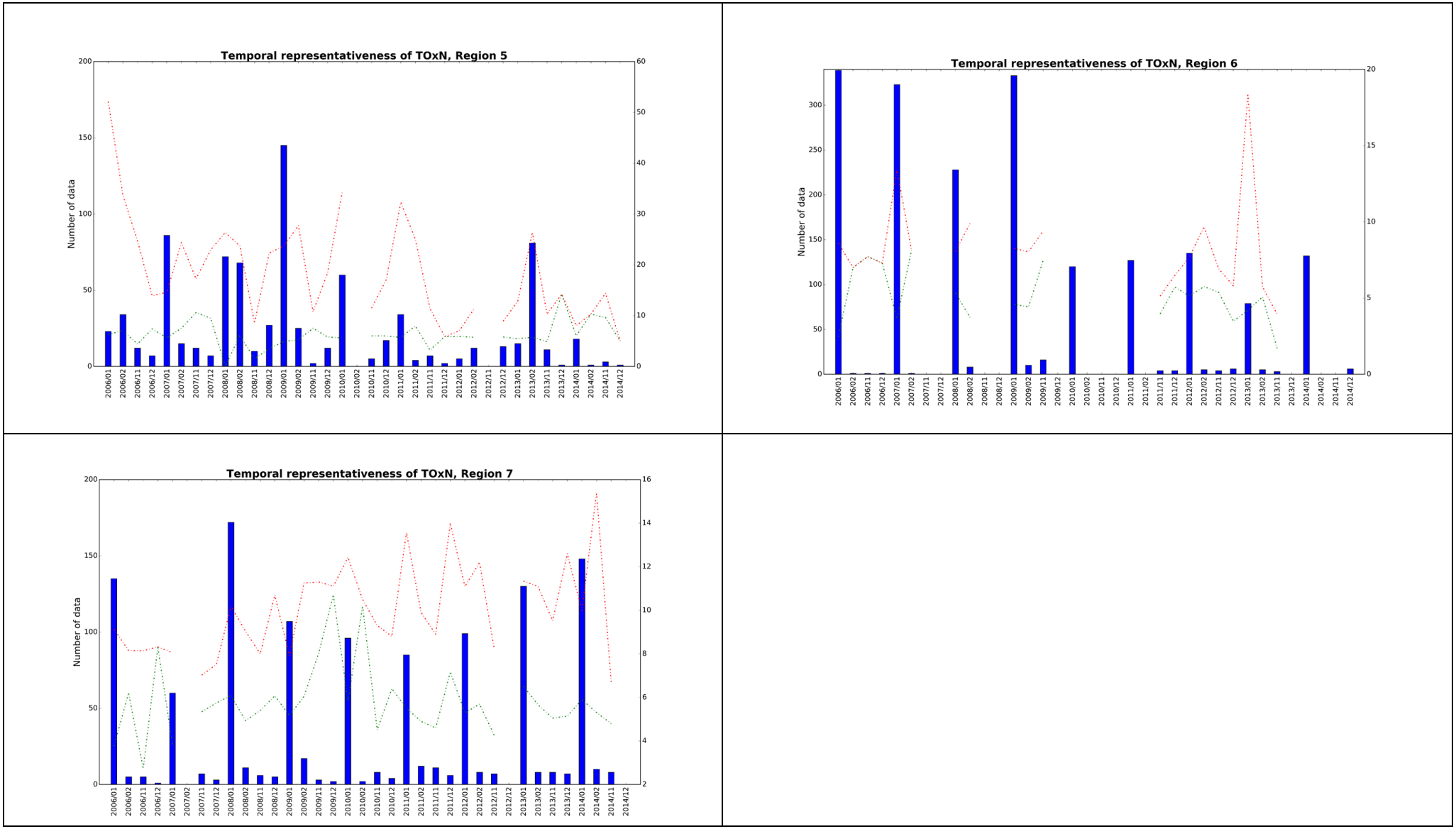
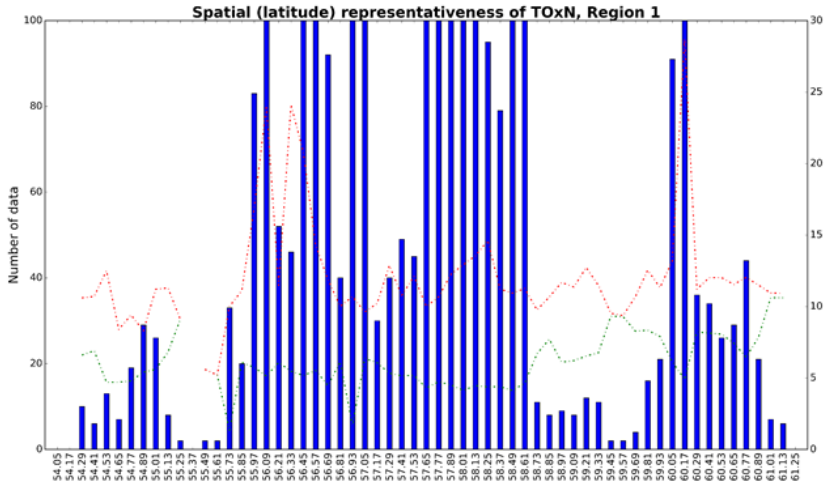
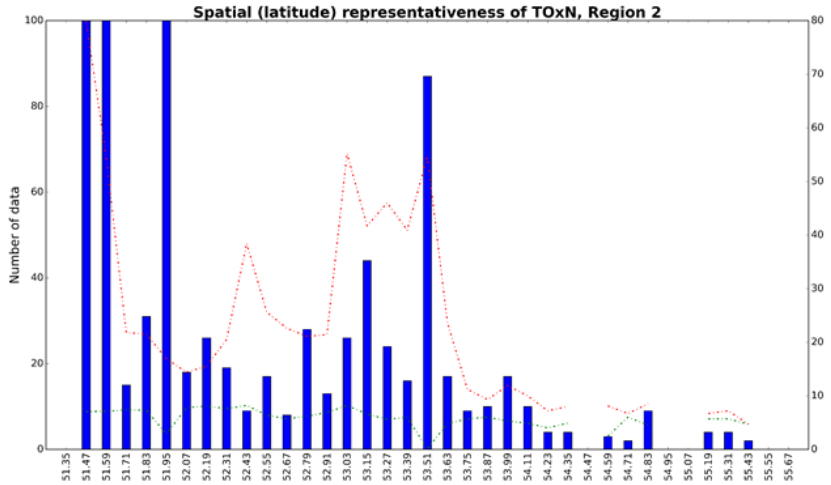
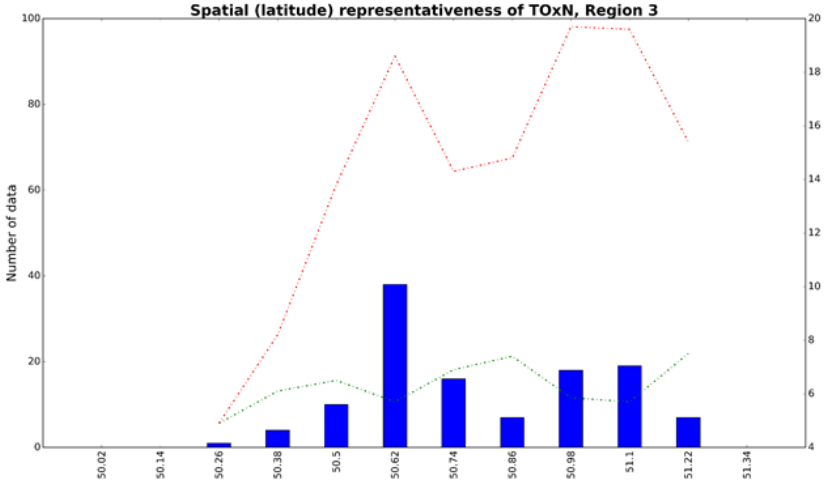
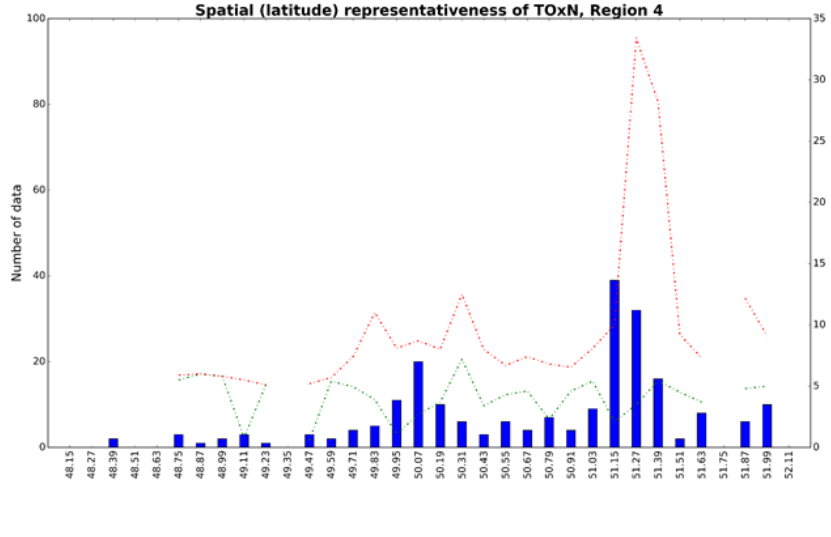


Figure A16.4. Plots showing the distribution of all TOxN (µM) data along time for Regions 1 to 7. The bars represent the number of data (left y axis) in each time interval of 1 month. The red dashed line represents the maximum concentration of TOxN (right axis) in each time interval and the green dashed line depicts the minimum TOxN concentration (right axis) per time interval.


Spatial (latitude) representativeness of TOxN, Region 1
Number of data


Spatial (latitude) representativeness of TOxN, Region 2
Number of data


Spatial (latitude) representativeness of TOxN, Region 3
Number of data


Spatial (latitude) representativeness of TOxN, Region 4
Number of data

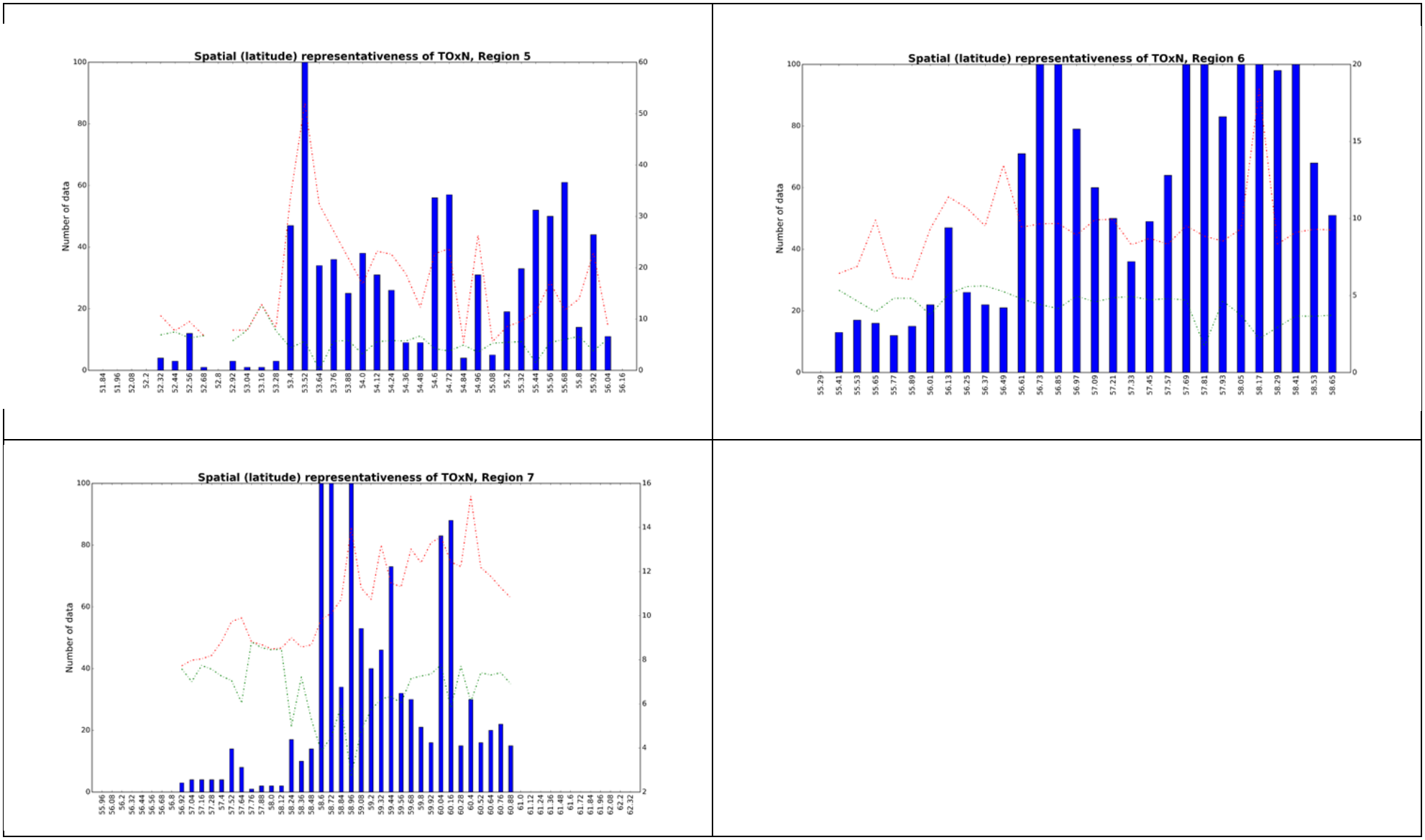
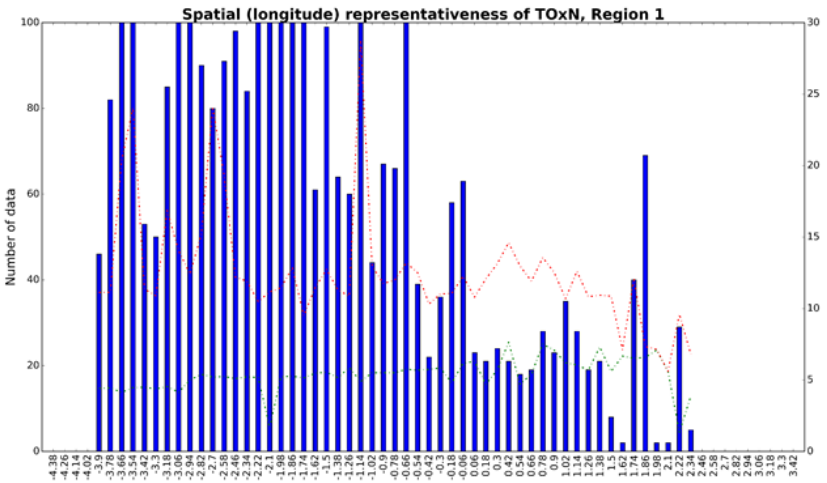
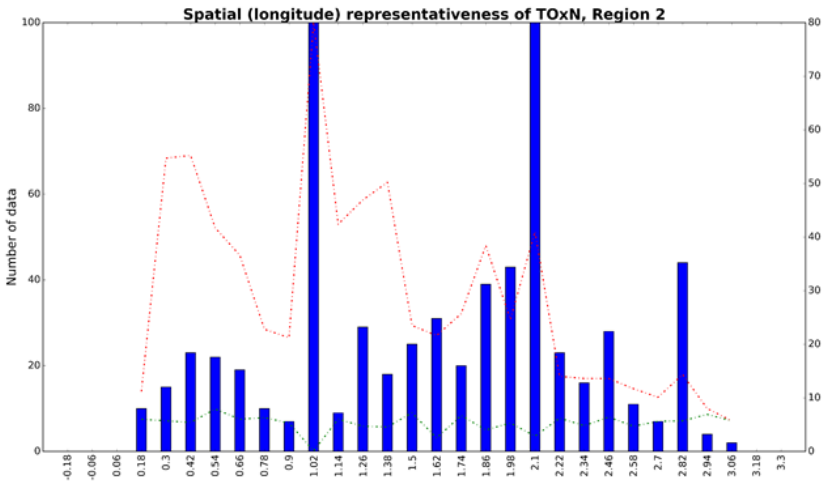
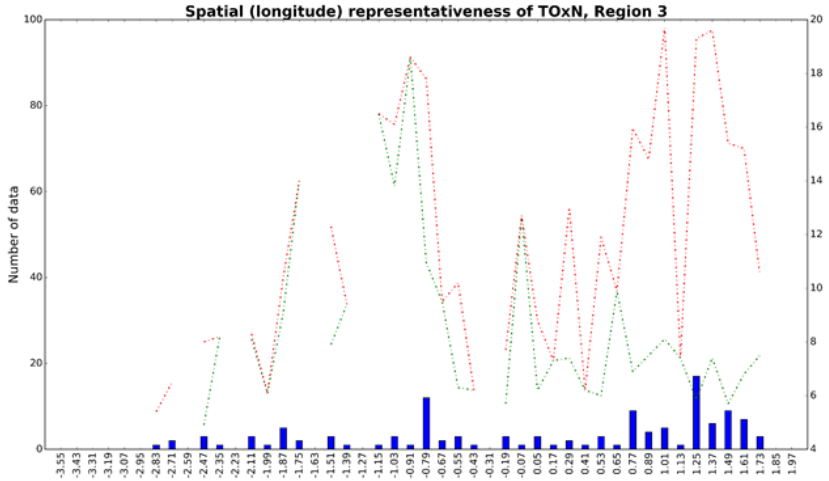
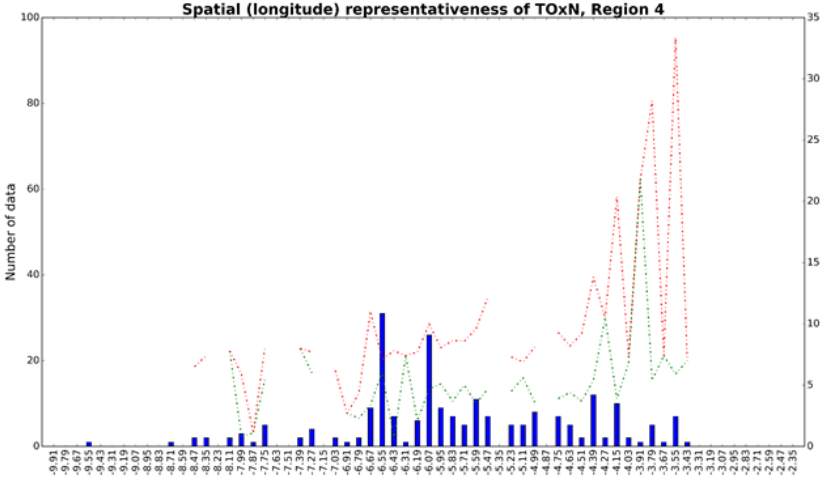


Figure A16.5. Plots showing the distribution of all TOxN (µM) data along latitude for Regions 1 to 7. The bars represent the number of data (left y axis) in each latitudinal interval of 3/25 degrees. The red dashed line represents the maximum concentration of TOxN (right axis) in each latitudinal interval and the green dashed line depicts the minimum TOxN concentration (right axis) per latitudinal interval.


Spatial (longitude) representativeness of TOxN, Region 1
Number of data


Spatial (longitude) representativeness of TOxN, Region 2
Number of data


Spatial (longitude) representativeness of TOxN, Region 3
Number of data


Spatial (longitude) representativeness of TOxN, Region 4
Number of data

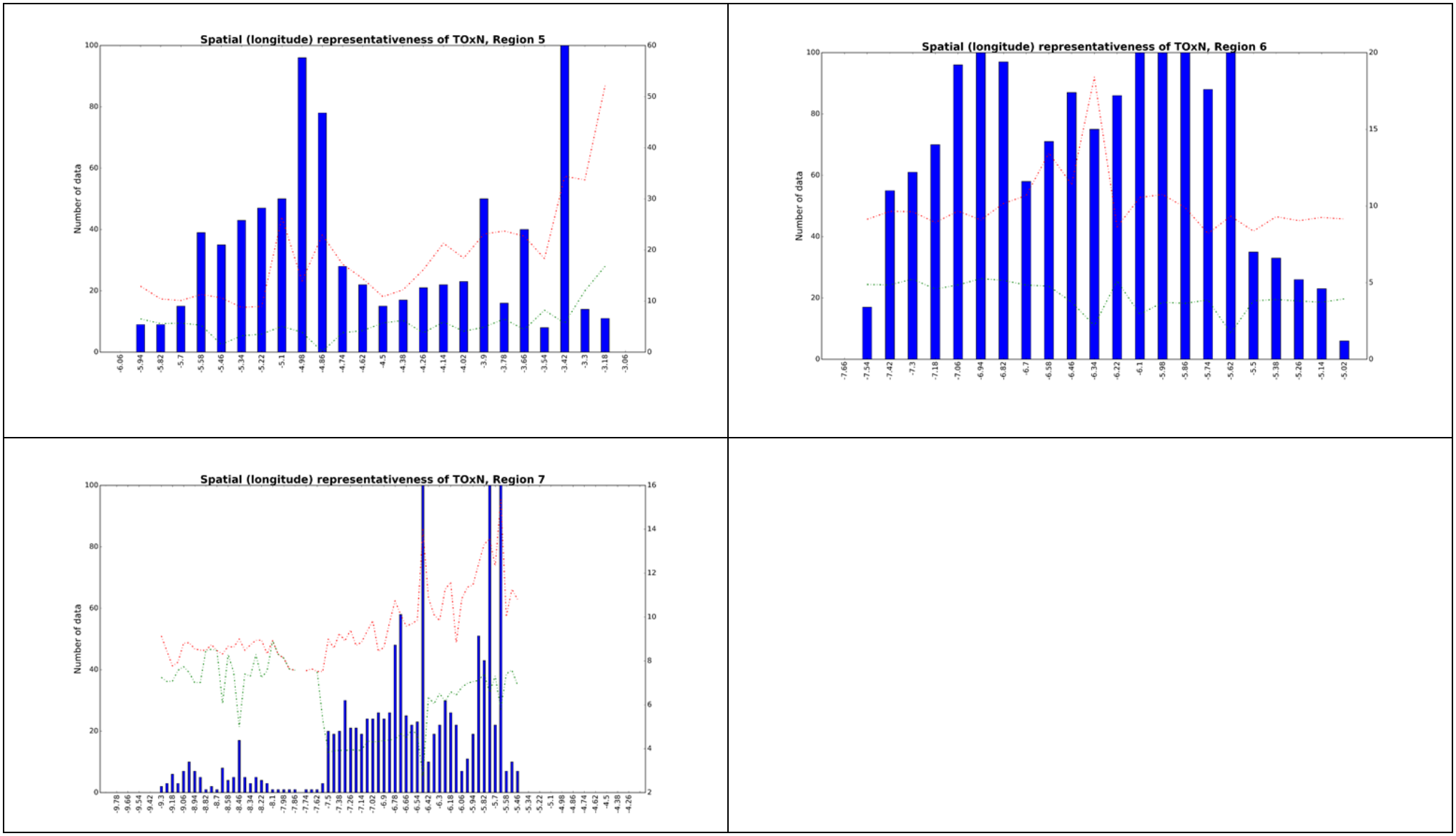
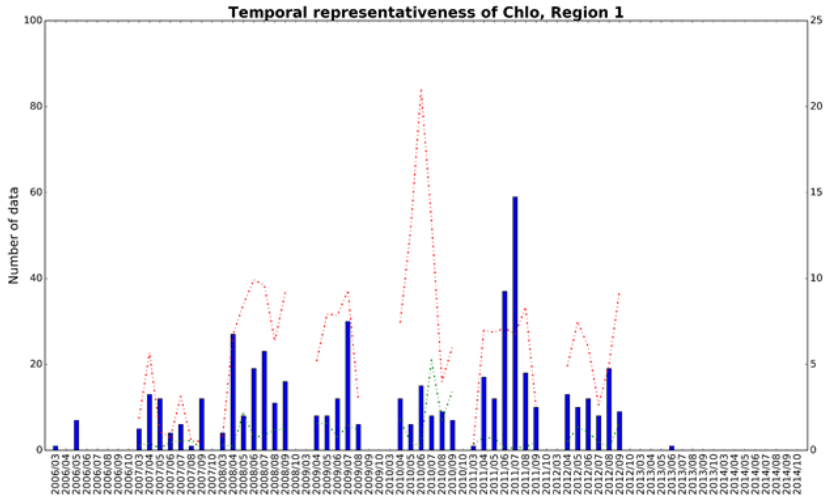
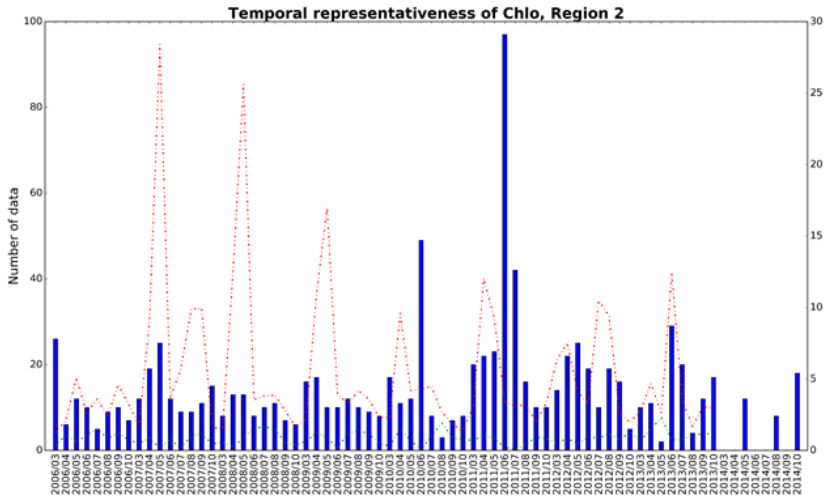


Figure A16.6. Plots showing the distribution of all TOxN (µM) data by longitude for Regions 1 to 7. The bars represent the number of data (left y axis) in each longitudinal interval of 3/25 degrees. The red dashed line represents the maximum concentration of TOxN (right axis) in each latitudinal interval and the green dashed line depicts the minimum TOxN concentration (right axis) per latitudinal interval.


Temporal representativeness of Chlo, Region 1
Number of data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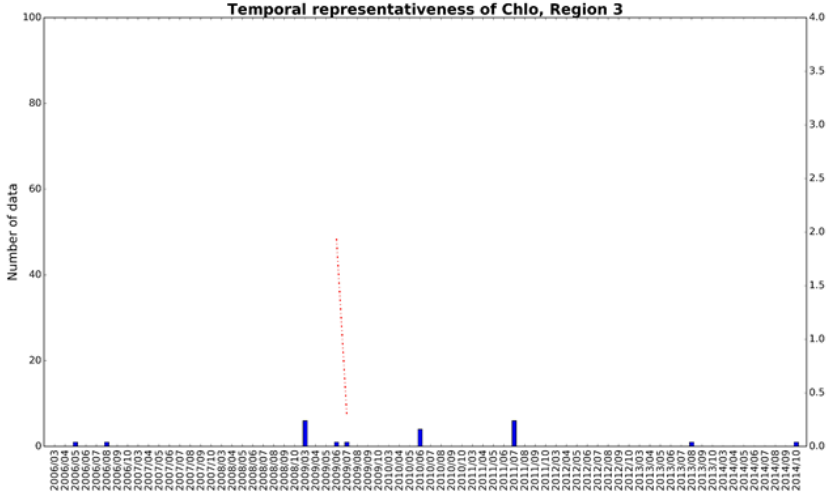
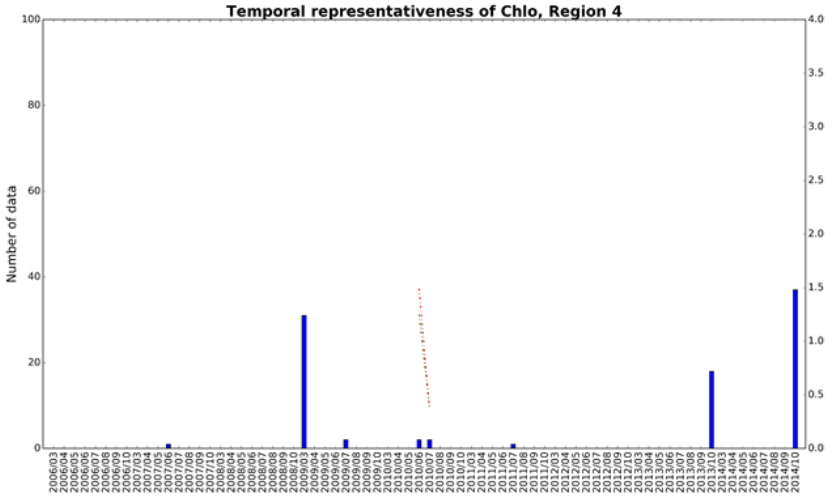
Number of data


Temporal representativeness of Chlo, Region 3
Number of data


Temporal representativeness of Chlo, Region 4
Number of data

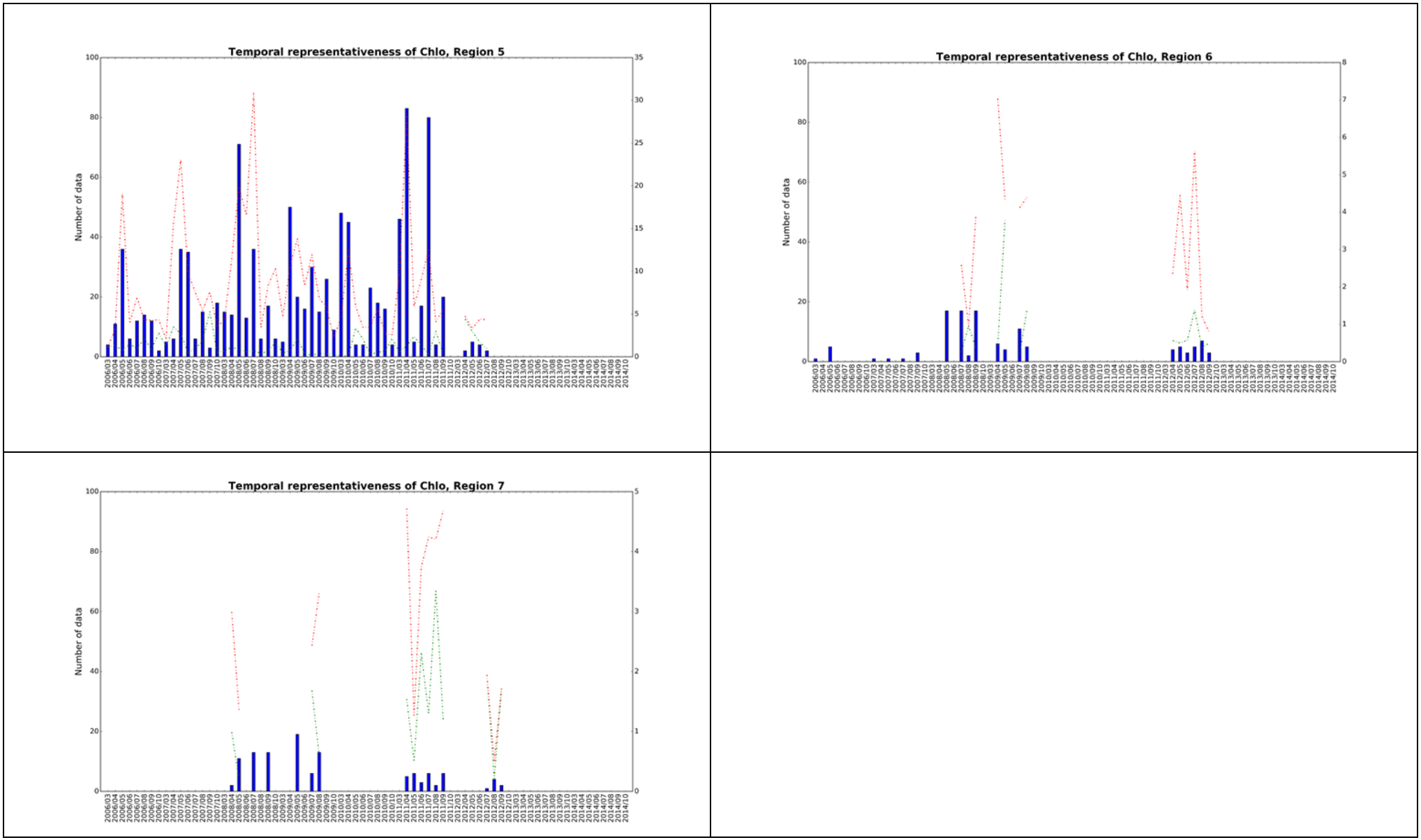
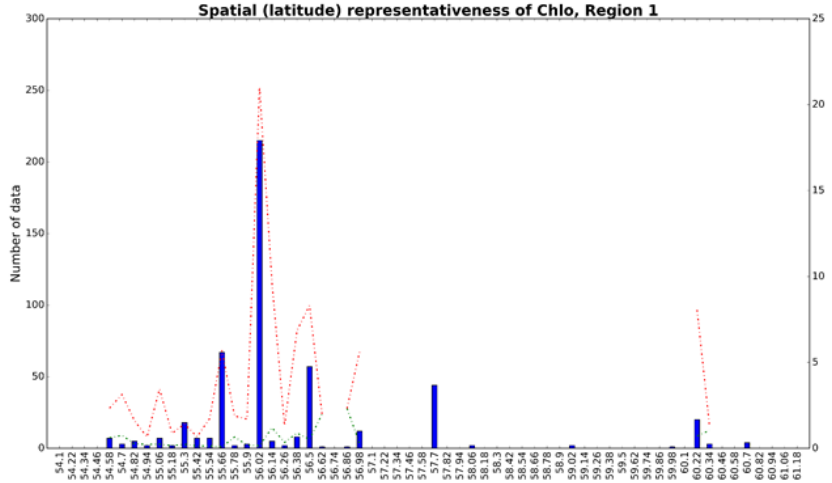
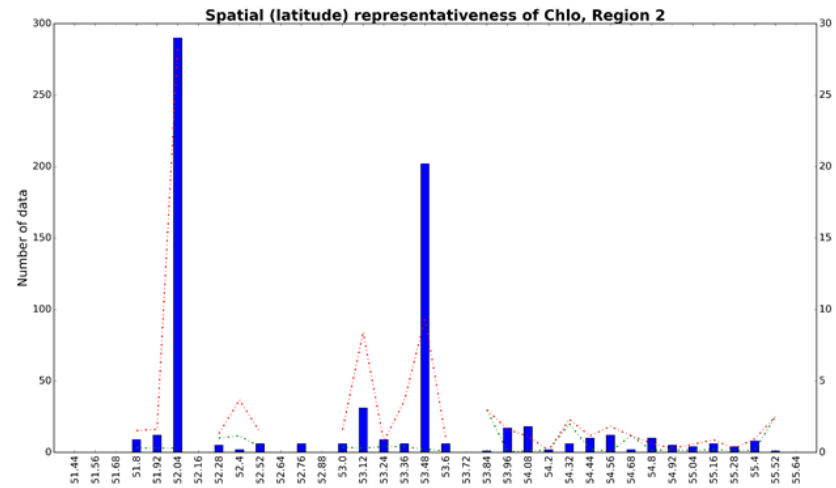
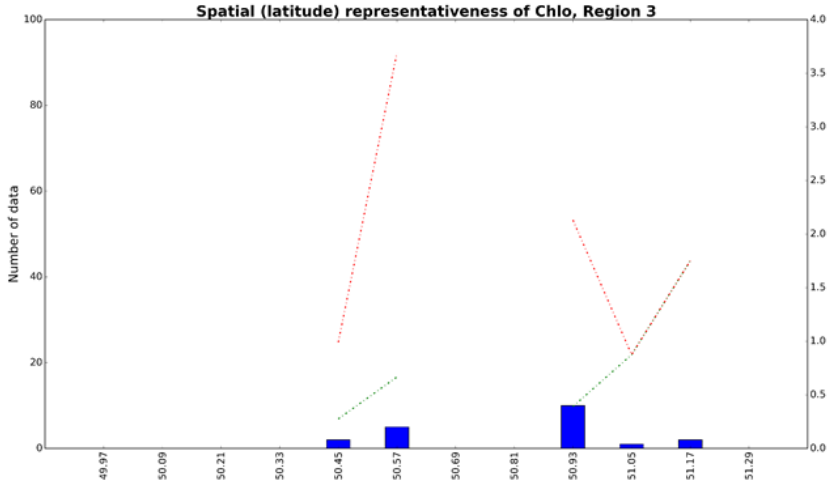
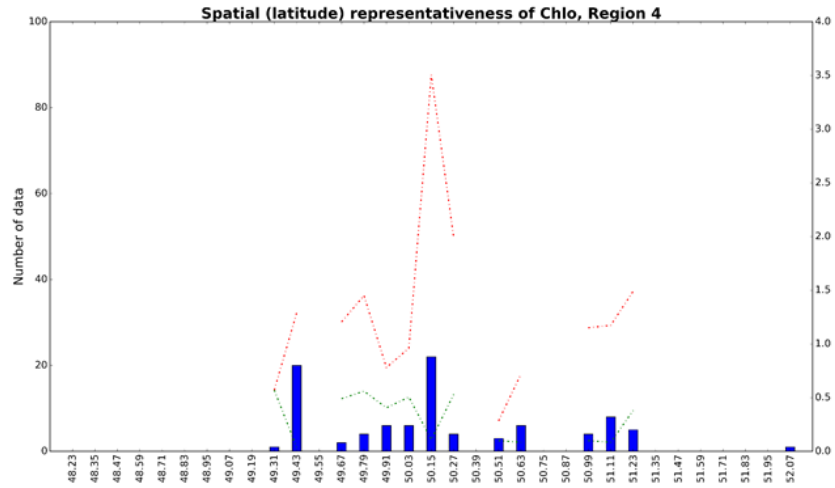


Figure A16.7. Plots showing the distribution of all chlorophyll (µg l^{-1}) data along time for Regions 1 to 7. The bars represent the number of data (left y axis) in each time interval of 1 month. The red dashed line represents the maximum concentration of chlorophyll (right axis) in each time interval and the green dashed line depicts the minimum chlorophyll concentration (right axis) per time interval.


Spatial (latitude) representativeness of Chlo, Region 1
Number of data


Spatial (latitude) representativeness of Chlo, Region 2
Number of data


Spatial (latitude) representativeness of Chlo, Region 3
Number of data


Spatial (latitude) representativeness of Chlo, Region 4
Number of data

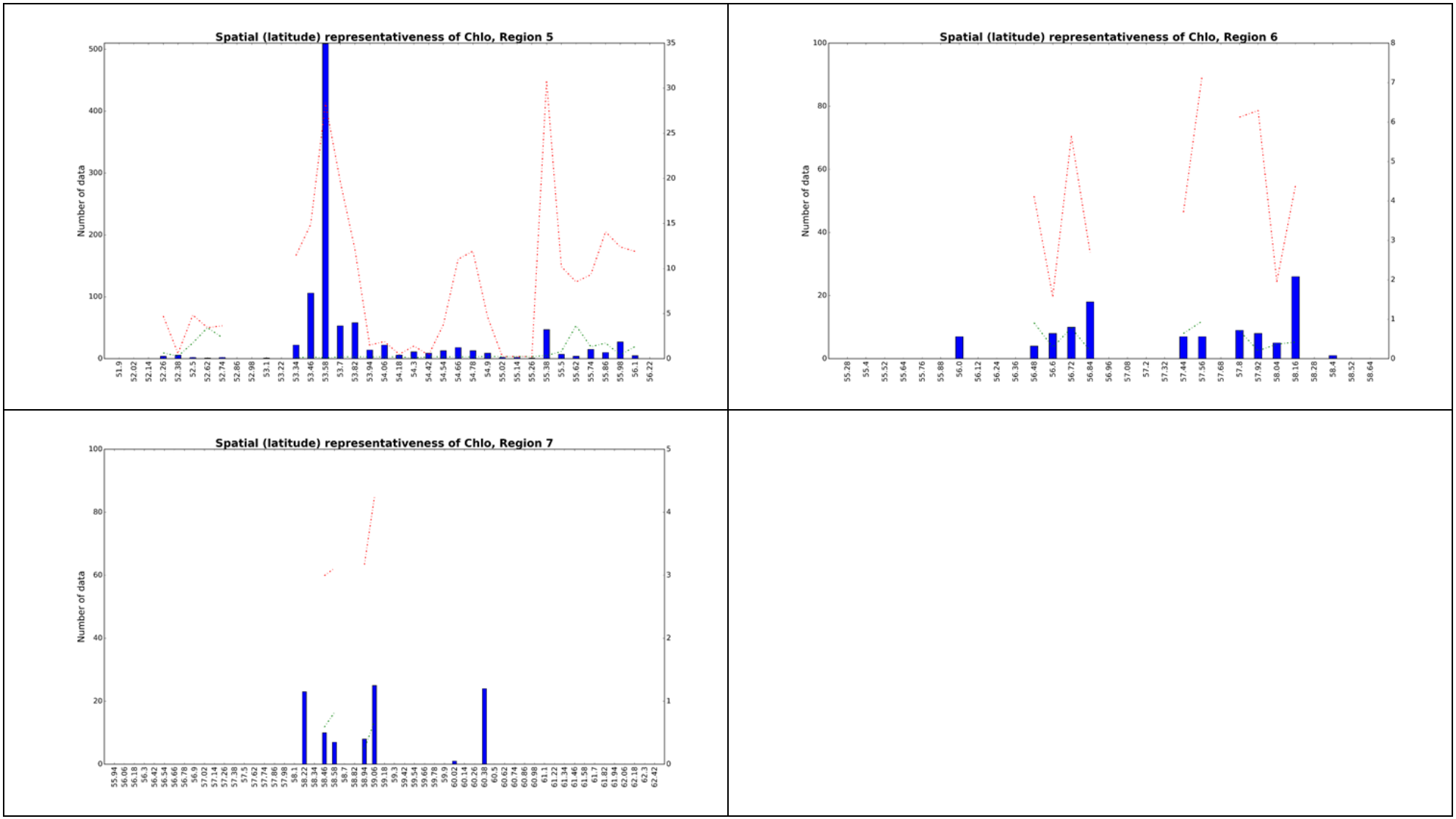
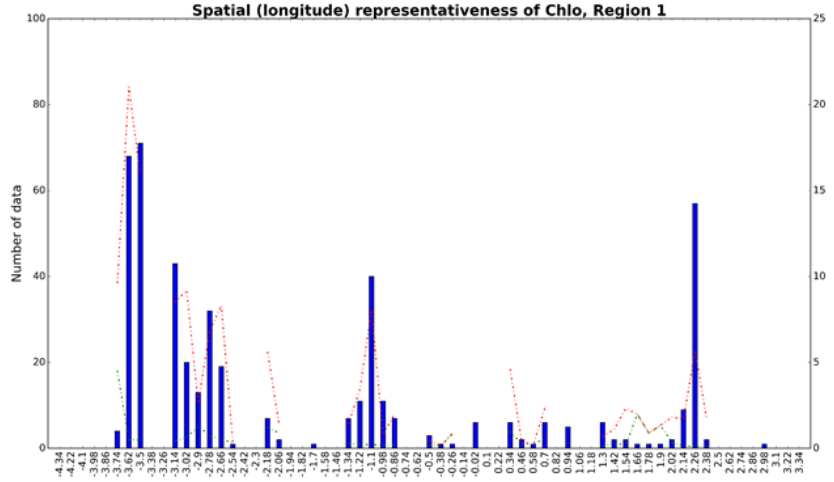
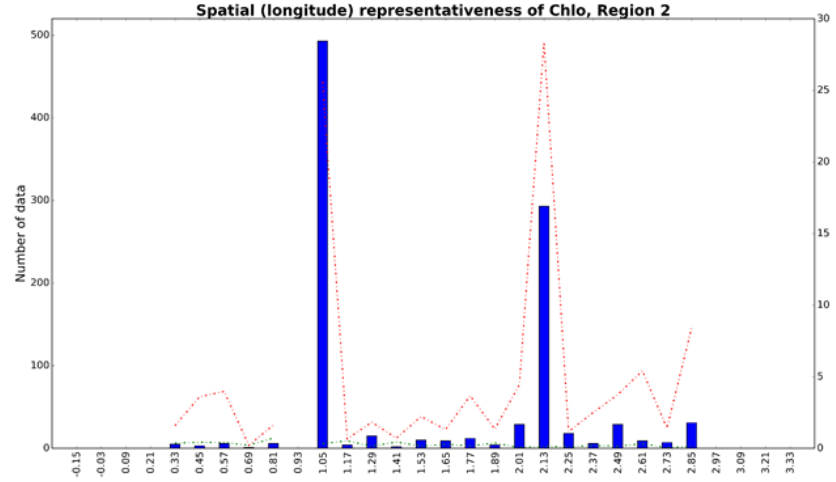
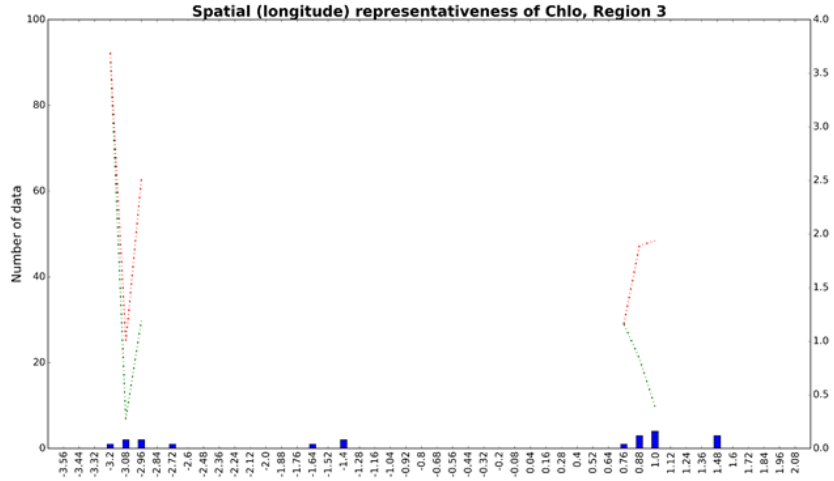
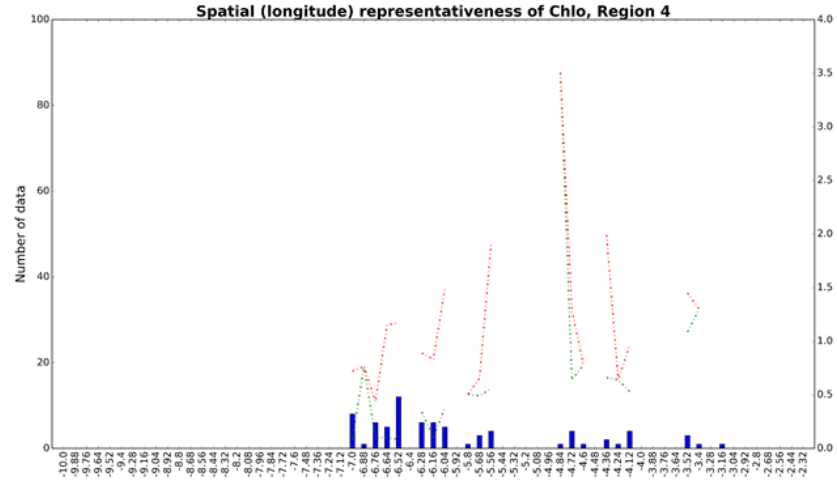


Figure A16.8. Plots showing the distribution of all chlorophyll (µg l^{-1}) data along latitude for Regions 1 to 7. The bars represent the number of data (left y axis) in each latitudinal interval of 3/25 degrees. The red dashed line represents the maximum concentration of chlorophyll (right axis) in each latitudinal interval and the green dashed line depicts the minimum chlorophyll concentration (right axis) per latitudinal interval.


Spatial (longitude) representativeness of Chlo, Region 1
Number of data


Spatial (longitude) representativeness of Chlo, Region 2
Number of data


Spatial (longitude) representativeness of Chlo, Region 3
Number of data


Spatial (longitude) representativeness of Chlo, Region 4
Number of data

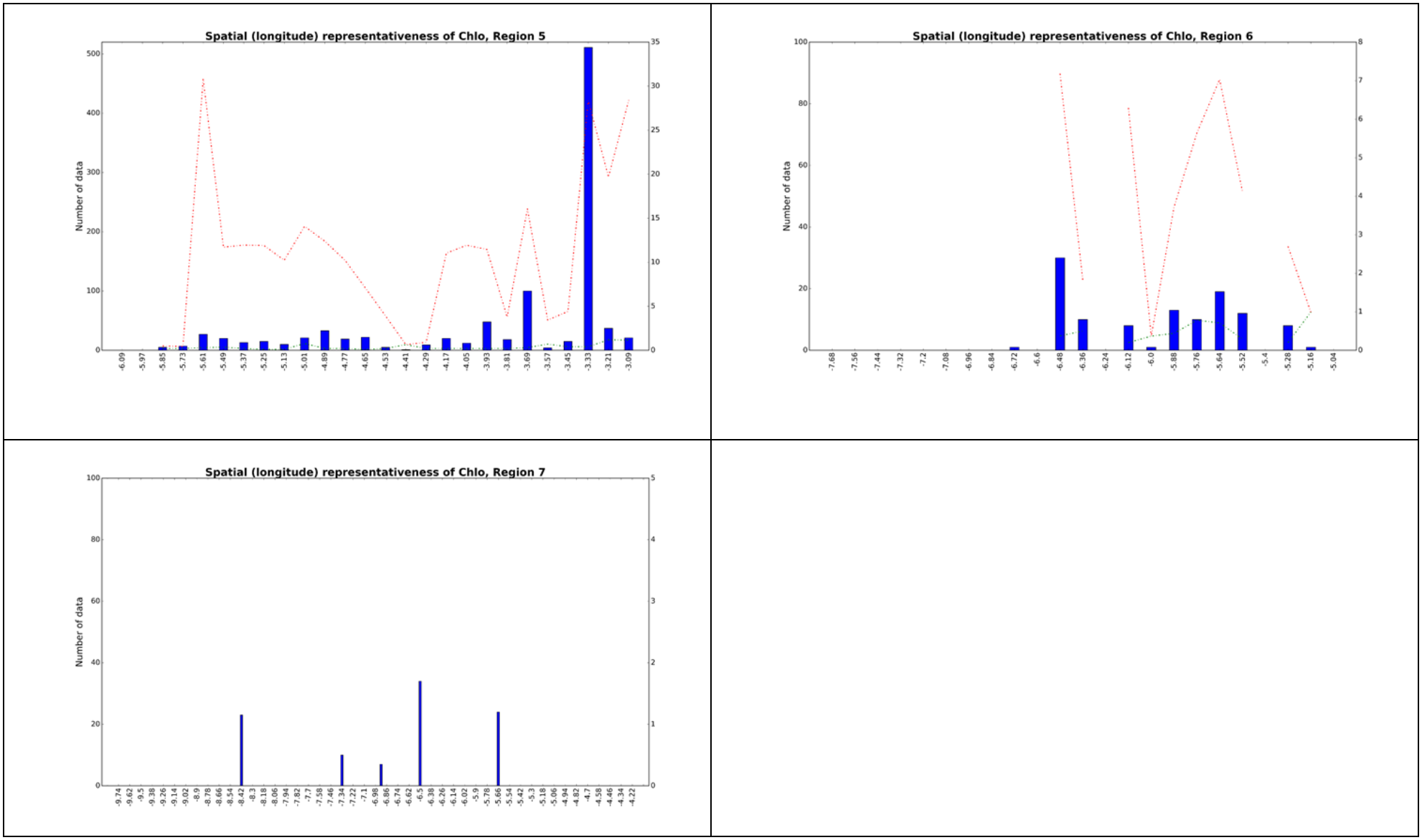
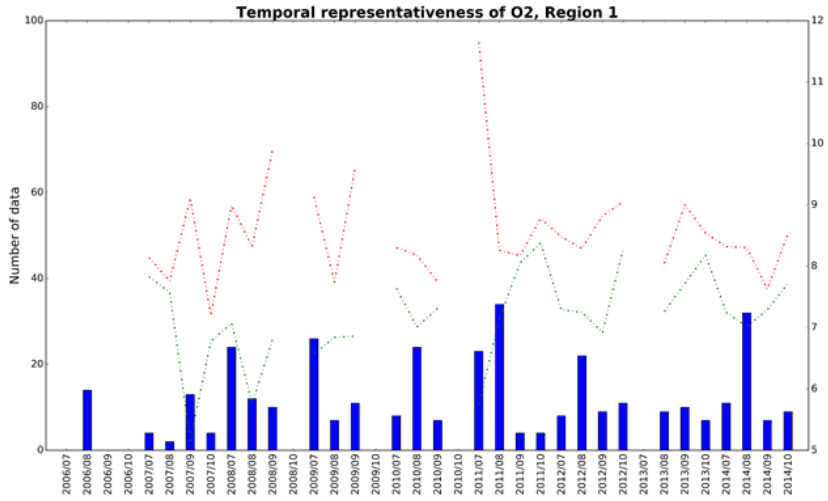
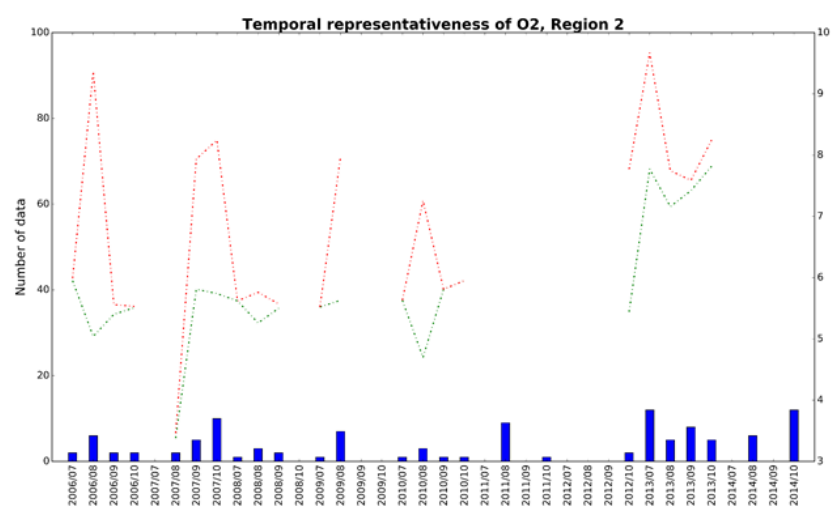


Figure A16.9. Plots showing the distribution of all chlorophyll (µg l^{-1}) data by longitude for Regions 1 to 7. The bars represent the number of data (left y axis) in each longitudinal interval of 3/25 degrees. The red dashed line represents the maximum concentration of chlorophyll (right axis) in each latitudinal interval and the green dashed line depicts the minimum chlorophyll concentration (right axis) per latitudinal interval.


Temporal representativeness of O2, Region 1
Number of data


Temporal representativeness of O2, Region 2
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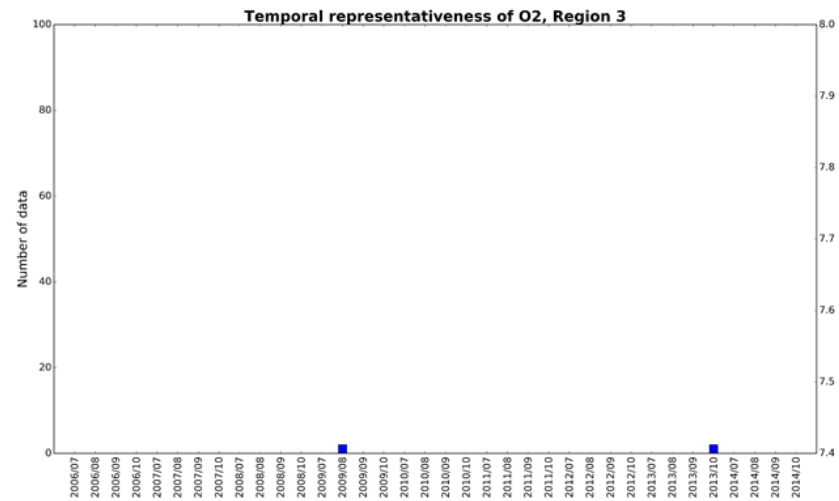
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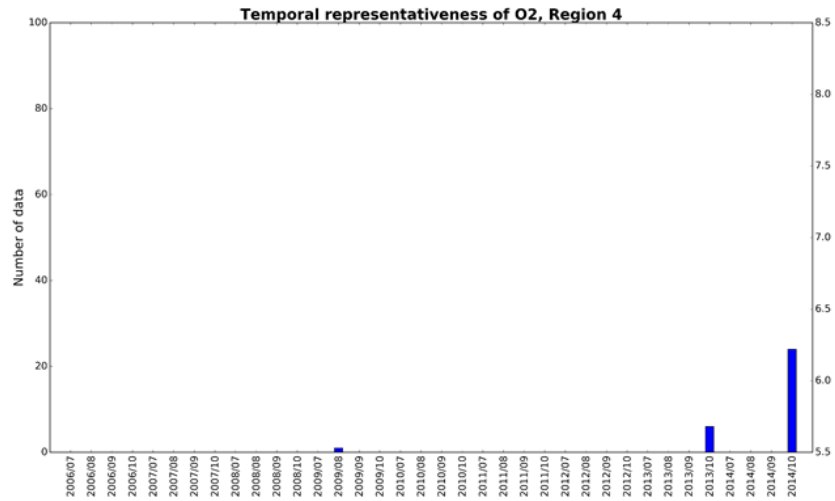
Temporal representativeness of O2, Region 4
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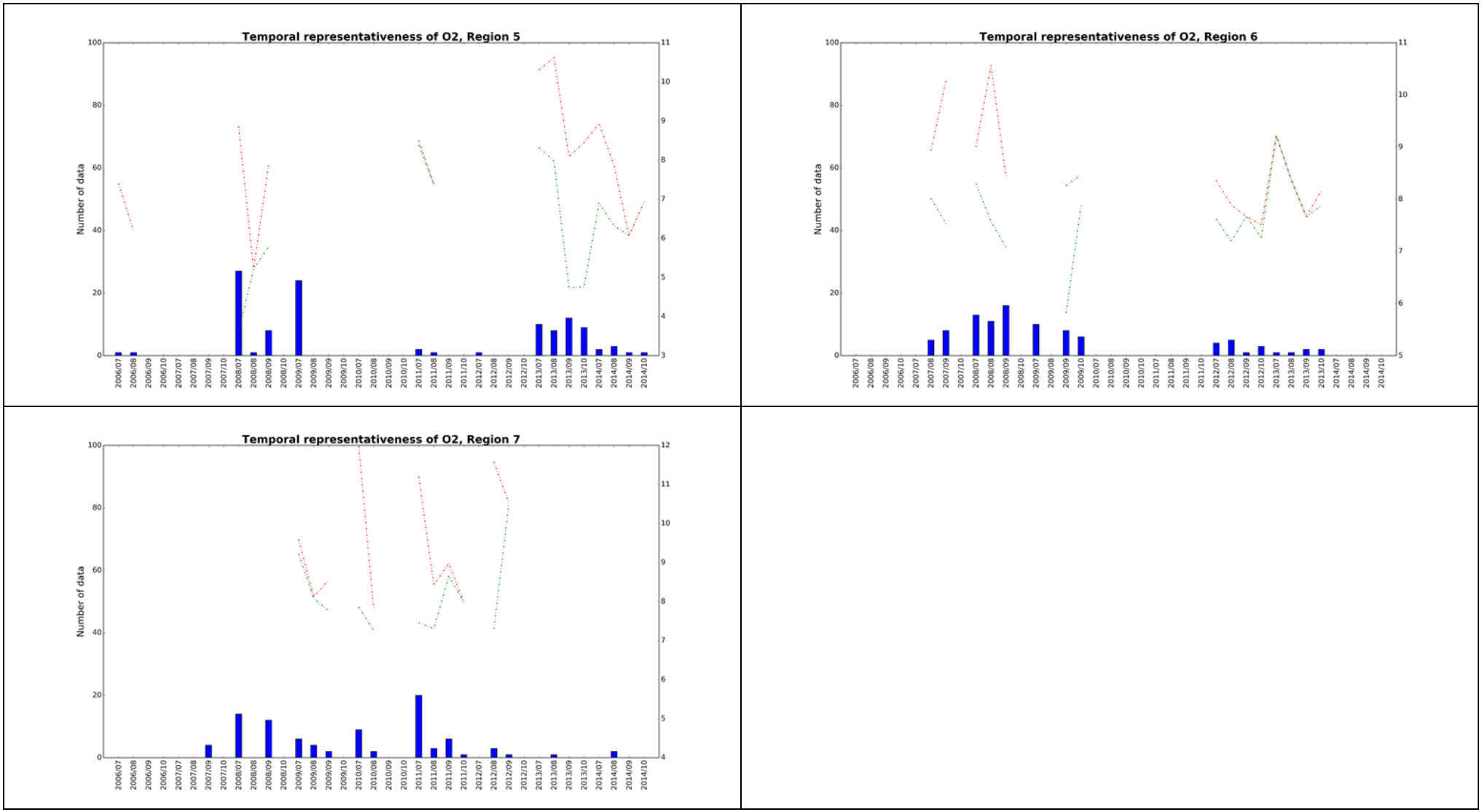
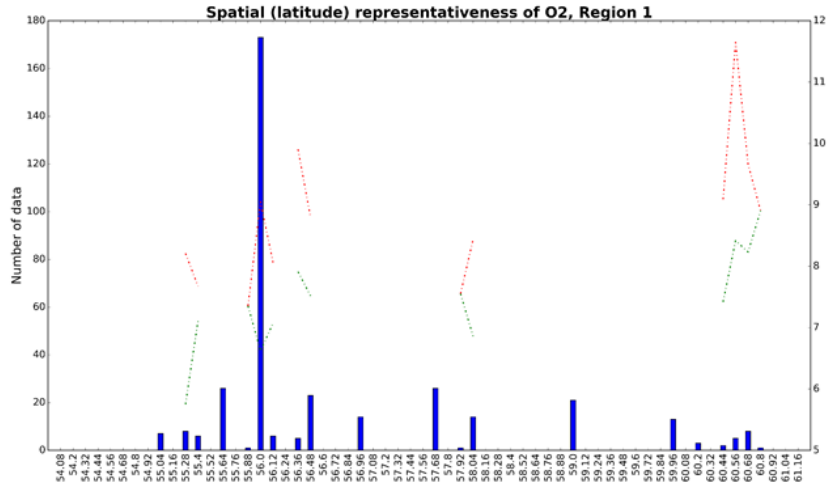
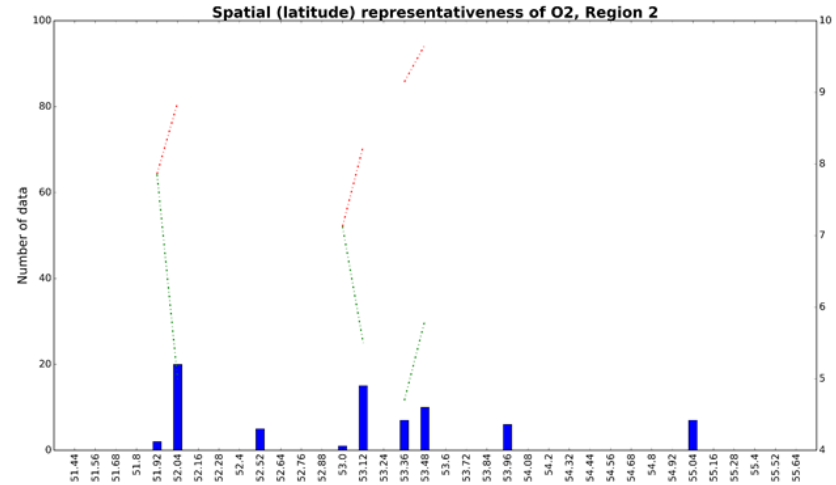
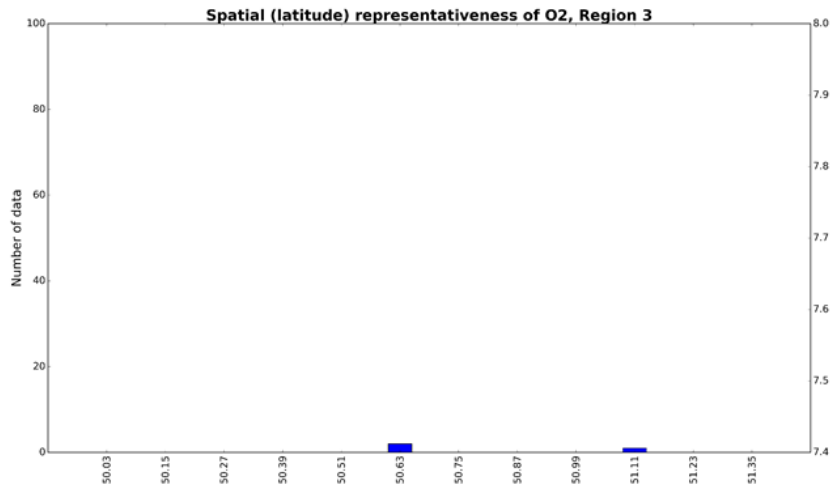
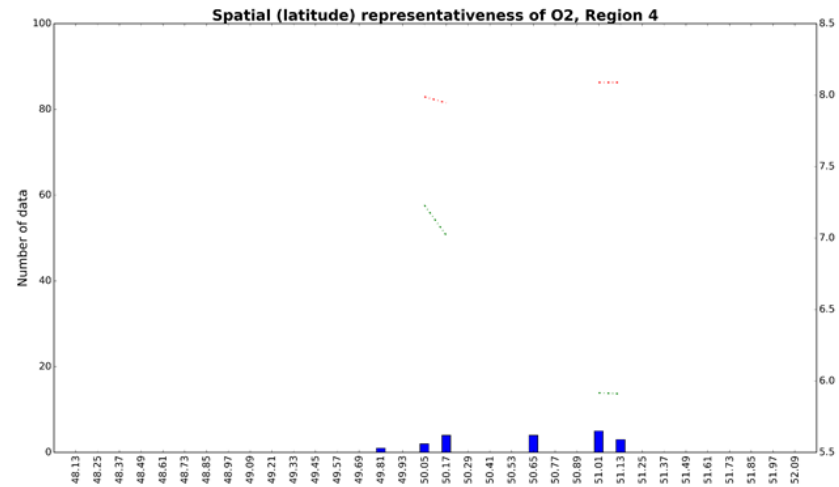


Figure A16.10. Plots showing the distribution of all dissolved oxygen (mg l^{-1}) data along time for Regions 1 to 7. The bars represent the number of data (left y axis) in each time interval of 1 month. The red dashed line represents the maximum concentration ofdissolved oxygen (right axis) in each time interval and the green dashed line depicts the minimum oxygen concentration (right axis) per time interval.


Spatial (latitude) representativeness of O2, Region 1
Number of data


Spatial (latitude) representativeness of O2, Region 2
Number of data


Spatial (latitude) representativeness of O2, Region 3
Number of data


Spatial (latitude) representativeness of O2, Region 4
Number of data

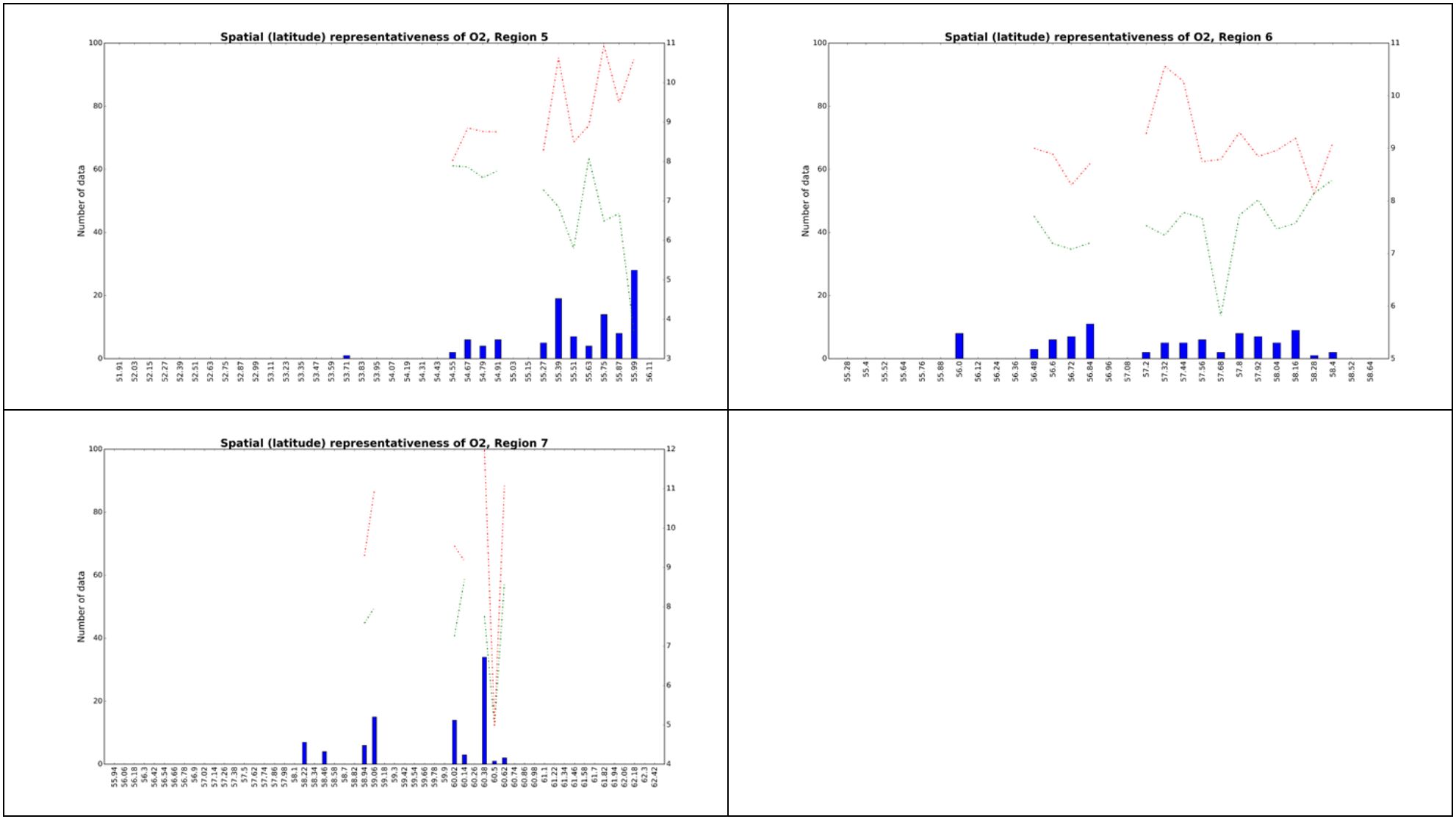
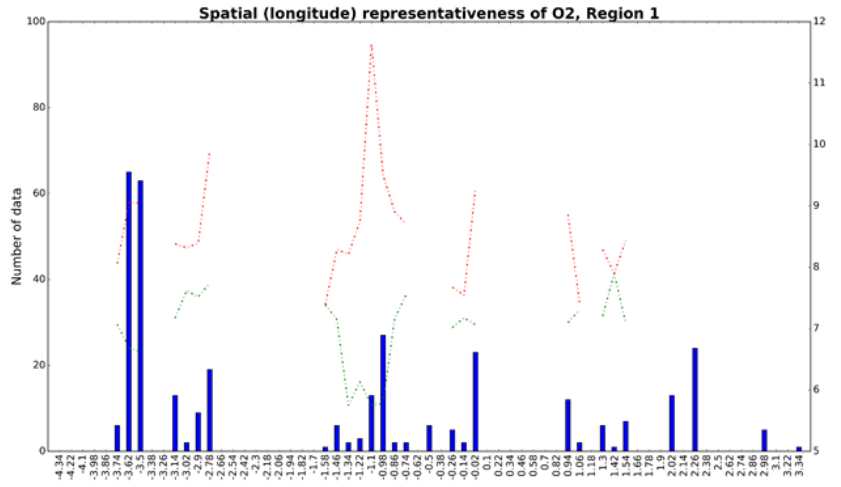
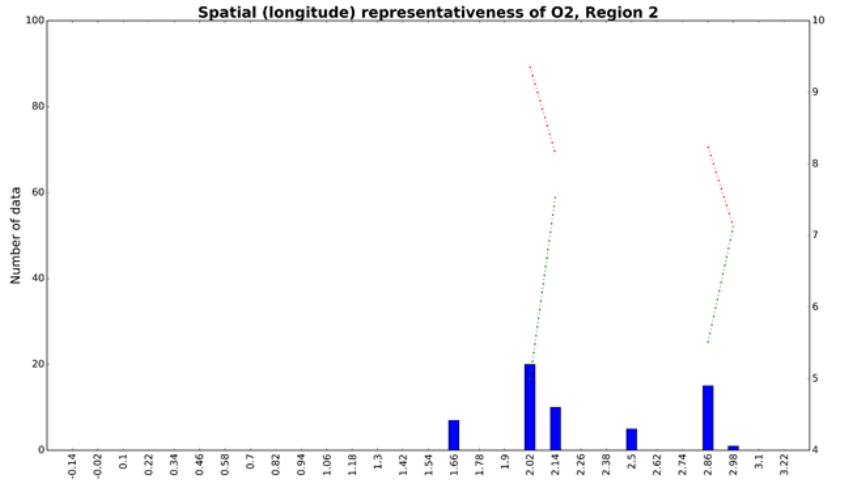


Figure A16.11. Plots showing the distribution of all dissolved oxygen (mg l^{-1}) data along latitude for Regions 1 to 7. The bars represent the number of data (left y axis) in each latitudinal interval of 3/25 degrees. The red dashed line represents the maximum concentration of dissolved oxygen (right axis) in each latitudinal interval and the green dashed line depicts the minimum oxygen concentration (right axis) per latitudinal interval.


Spatial (longitude) representativeness of O2, Region 1
Number of data


Spatial (longitude) representativeness of O2, Region 2
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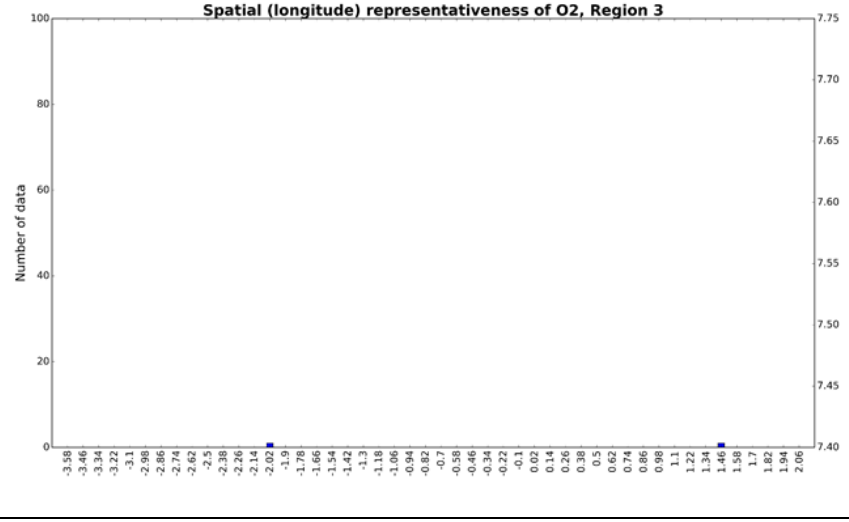
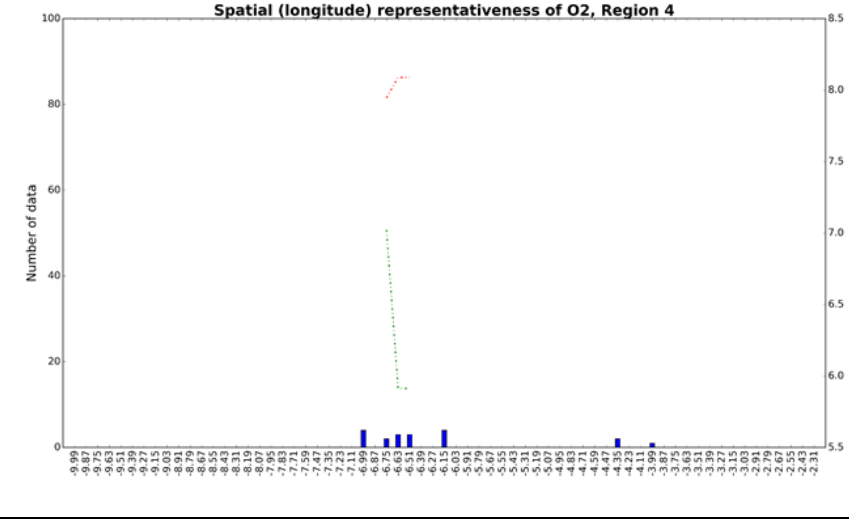

Spatial (longitude) representativeness of O2, Region 3
Number of data


Spatial (longitude) representativeness of O2, Region 4
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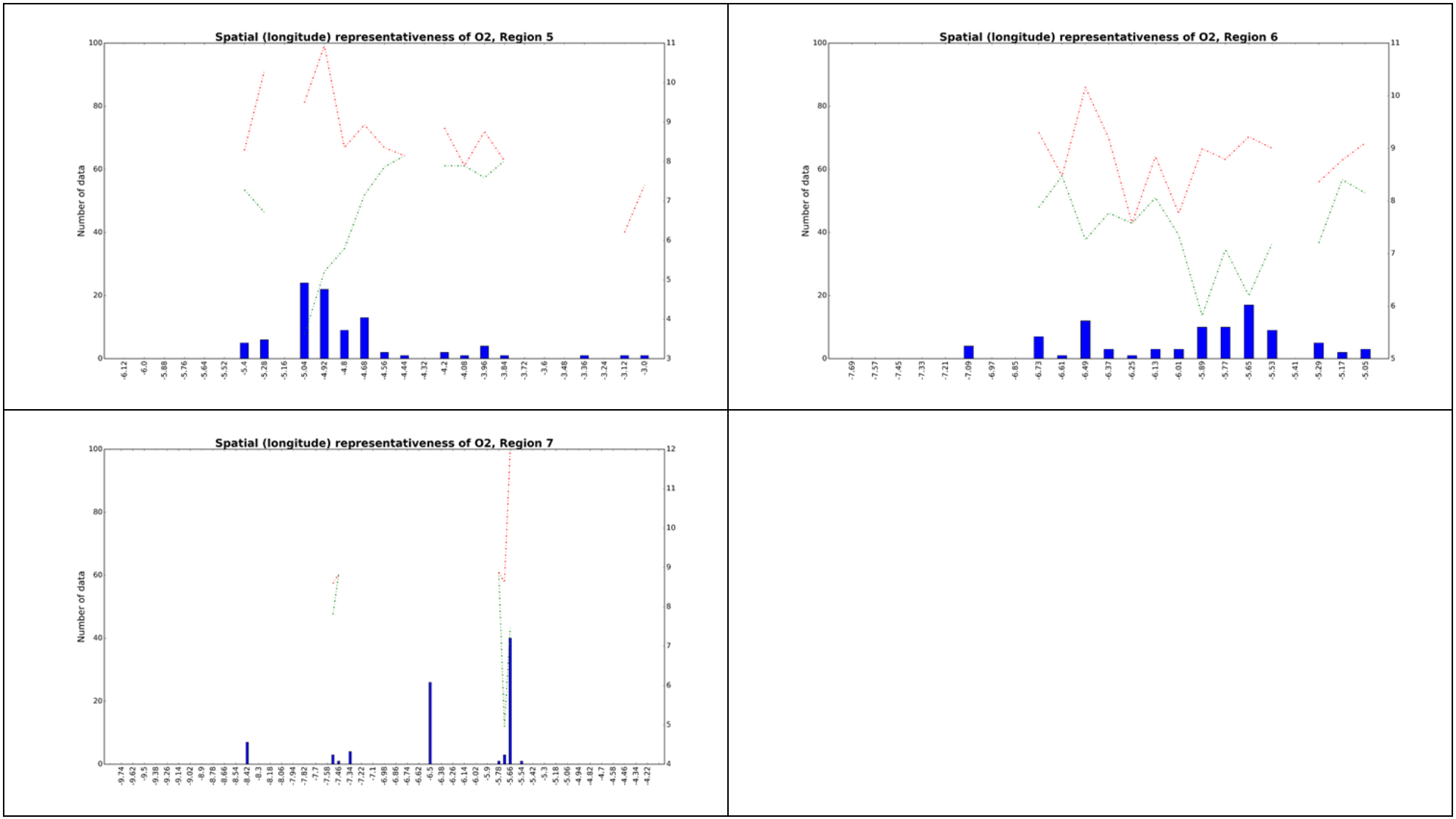

Figure A16.12. Plots showing the distribution of all dissolved oxygen (mg l^{-1}) data by longitude for Regions 1 to 7. The bars represent the number of data (left y axis) in each longitudinal interval of 3/25 degrees. The red dashed line represents the maximum concentration of dissolved oxygen (right axis) in each latitudinal interval and the green dashed line depicts the minimum oxygen concentration (right axis) per latitudinal interval.