Transatlantic surveys of seabirds, cetaceans and turtles, July 2013 and July 2018

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Ewan D. Wakefield*

Institute of Biodiversity, Animal Health, and Comparative Medicine
Graham Kerr Building, University of Glasgow, Glasgow, G12 8QQ, UK.

*Ewan.Wakefield@glasgow.ac.uk

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Summary

Analysis of multi-species tracking data suggest that an area of the deep northwest Atlantic bounded by Flemish Cap, Charlie-Gibbs Fracture Zone and Mid-Atlantic Ridge (MAR) has a relatively high abundance and diversity of pelagic seabirds. It is also thought to be important for other wide-ranging, air-breathing higher predators, including cetaceans and tunas. The area's oceanography is dominated by a system of banded zonal fronts associated with the North Atlantic Current and this may be responsible for levels of diversity and abundance that are unusual for oceanic waters. The area is currently therefore being considered by the OSPAR Committee as a candidate high seas Marine Protected Area (cMPA). The seabird distribution patterns inferred from tracking data were confirmed in part by research cruise DY080, which surveyed the area in June 2017. However, weather during that cruise was not ideal for detecting small and medium deep-diving cetaceans and relatively few other at-sea surveys have been carried out in the deep northwest Atlantic. Here, I summarise seabird, cetacean and turtle sightings from surveys carried out opportunistically during transatlantic crossings aboard a cruise ship in July 2013 and July 2018, which passed though the cMPA. In 2013, 180 km of track was surveyed, with the weather being ideal for detecting cetaceans in the southwest of the cMPA. In 2018, 470 km of track was surveyed. The weather was poorer for detecting cetaceans in the cMPA but ideal to the east of the MAR. Seabird data support the findings of previous studies, showing high seabird diversity and abundance between the Flemish Cap and the Mid-Atlantic Ridge. During the cruises, great shearwaters, northern fulmars and Cory's shearwaters dominated the avifauna of cMPA. Long-tailed and south polar skuas were also relatively abundant and a Fea's petrel was sighted for the first time at sea in the cMPA, confirming tracking observations of this species. In 2013, a high diversity of cetaceans was recorded in the southwest of the cMPA, including *Kogia* and *Mesoplodon* spp. and in 2018 common minke whales were recorded for the first time in the cMPA. These results suggest that the cMPA has a relatively high diversity of cetaceans. An area of high cetacean diversity, including Sowerby's beaked whales and northern bottlenose whales, was also encountered east of the MAR in 2018, in the vicinity of the Thulean Rise.

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Introduction

Air breathing higher predators, such as seabirds and cetaceans, form an important component of pelagic ecosystems (Brooke 2004, Murphy et al. 2007). They are abundant consumers, usually highly mobile, and often exhibit marked seasonal changes in distribution. These taxa have been studied extensively in neritic waters but until recently what little was known about their distribution in more remote oceanic waters, beyond the continental shelves. Latterly, tracking technology has allowed the distribution of many pelagic seabirds and turtles, as well as some large fish and cetaceans to be mapped (Hart and Hyrenbach 2010). Combining tracking data from multiple species has revealed areas of particularly high diversity and abundance (Block et al. 2011, Lascelles et al. 2016, Wakefield et al. 2017). Using seabird tracking data, one such area has been identified in the North Atlantic (Wakefield and and 54 others 2012, BirdLife International 2017). The area is bounded by to the north by the Charlie-Gibbs Fracture Zone (CGFZ), to the west and east by the Flemish Cap and Mid-Atlantic Ridge respectively, and to the south by the Azores (Fig. 1). It is dominated by a system of banded zonal fronts associated with the North Atlantic Current, the most prominent of which is the sub-polar front, which crosses the north of the area (Belkin and Levitus 1996). Tracking data show that at least 25 species of pelagic seabird forage in the area, which is estimated to support a maximum of 2.9 - 5.0 million seabirds at different times of the year (BirdLife International 2017). The OSPAR Committee, under the Convention for the Protection of the Marine Environment of the North-East Atlantic, is currently considering designating the area as high seas Marine Protected Area (hereafter referred to as the candidate MPA or cMPA).

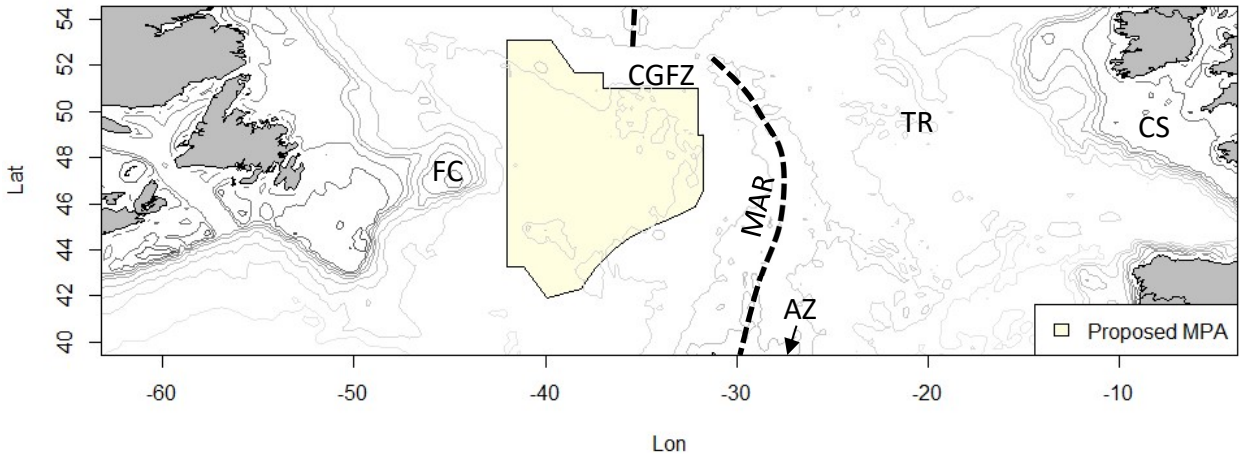


Figure 1. Location of the North Atlantic Current and Evlanov Seamount candidate Marine Protected Area (cMPA) and topographic features mentioned in the text: AZ = Azores (off the map), FC = Flemish Cap, CGFZ = Charie-Gibbs Fracture Zone, CS = Celtic Sea, MAR = MidAtlantic Ridge, TR = Thulean Rise.

Although the analysis leading to the identification of the cMPA was primarily considered seabird tracking data, tracking studies on other taxa, as well as at-sea survey data were also reviewed (BirdLife International 2017). These data suggest that the cMPA is not only be important for seabirds but also for cetaceans, tunas, sharks and turtles. Systematic at-sea surveys of seabirds in the deep North Atlantic were first conducted in the early twentieth century, (Jespersen 1924,

1930, Wynne-Edwards 1935) but surveys of seabirds and cetaceans in the deep North Atlantic using modern techniques did not begin until the end of the end century and coverage remains relatively poor in the vicinity of the cMPA (Boertmann 2011, Kaschner et al. 2012, Silva et al. 2014). For example, the large scale North Atlantic Sightings Surveys (NASS) and Trans-North Atlantic Sightings Surveys (T-NASS) undertook line transect surveys of cetaceans in the summer months between 1987 and 2015 (Anonymous 2008, Kaschner et al. 2012, Víkingsson et al. 2013). In July and August 1989 seabirds and cetaceans were surveyed by one NASS ship in the northern part of the CGFZ (Skov et al. 1995) but apart from this, survey effort in deep water was concentrated north of 55° so most of the cMPA was not covered. More recently, a number of smaller scale surveys have covered parts of the cMPA: In September, 2006 Boertmann (2011) surveyed seabirds along a meridional transect from Southern Greenland to the Azores, passing through the CGFZ. As part of a multidisciplinary MAR-ECO study of the ecology of the Mid-Atlantic Ridge (Priede et al. 2013), seabirds and cetaceans were surveyed along a similar track in June, 2004 (Waring et al. 2009) and along a north-westward transect through the CGFZ in July and August, 2007 (Priede 2007). Wilson et al. (2011) surveyed seabirds and cetaceans along a great circle route between Ireland and Newfoundland and back in January, February and March, 2011, then in April, 2014 - 2016 the University College Cory surveyed seabirds and cetaceans along the same route (Bennison and Jessopp 2015). In June 2014, the Canadian Wildlife Service surveyed seabirds along a transect running northwest through the CGFZ (Carina Gjerdrum *in litt.*). The most comprehensive survey of seabirds and cetaceans in the cMPA to date was undertaken in June, 2017 during cruise DY080, which covered 5180 km of largely zonal transects, concentrated between 29° and 41° W and 44° and 53° N (Lacey 2017, Wakefield 2018).

Despite these efforts, there remains considerable uncertainty about the distribution of some air-breathing higher predators in the cMPA. This is both because many of the surveys to-date were conducted in poor weather, when cetaceans, smaller seabirds, turtles, etc. can be difficult to detect (Lacey 2017) and because surveys have tended to concentrate on the CGFZ and Mid-Atlantic Ridge, with poorer coverage in the central, southern and western parts of the cMPA. Additional at-sea data would be therefore be useful, both to validate seabird distribution patterns inferred from tracking data, which can contain both known and unknown biases and to establish the presence and distribution of taxa and life history stages that for technical reasons have not yet been tracked (e.g. immature seabirds, most cetaceans, etc.). In July 2013 and 2018 I had the opportunity to survey seabirds and cetaceans during transatlantic crossings aboard the *RMS Queen Mary II*, which I took up with the aim of filling some of these data gaps. During the 2013 crossing in particular, I encountered periods exceptionally good weather in the central and western part of the cMPA, allowing some of the more difficult to detect taxa to be surveyed more effectively than during DY080. This report details the species seen during both cruises, with notes on their relative abundance and distribution, followed by a brief discussion.

Methods

I made observations during two transatlantic cruises aboard the *RMS Queen Mary II* (20^{th}–27^{th} July 2013, Southampton to New York, Southampton to New York; 6^{th}-13^{th} July 2018, New York to Southampton). Above winds of Beaufort 3 - 4, forward-facing outside decks on the *Queen Mary II* are closed to passengers. During frequent periods of poor weather in 2013, I therefore made observations from the forward port or starboard rail of deck 7, 28 m above sea level. From

this vantage point the view ~ 20° either side of the bow is obscured so I simply recorded the occurrence of seabird species and the approximate number seen in an arc from 20° to 90° of the bow in timed watches. Data from deck 7 should be therefore be regarded *presence only* (with an approximate indication of relative abundance) and a lack of detections of any particular species does not necessarily indicate its true absence. During these periods the sea state was generally too high to detect cetaceans.

When the weather permitted (generally in winds < Beaufort 5), I made observations from deck 11, which has an unobstructed view forward of the ship (eye height, 41 m above sea level). Using standard single platform distance sampling methods, I recoded all cetaceans, sharks and turtles detected during timed watches in a 180° arc forward of the ship (Buckland et al. 2001). In brief, I scanned this arc regularly using 10x40 binoculars and recorded the range and bearing to animals at the first sighting, as well as group size, behaviour, etc. Simultaneously, I recorded seabirds using standard European Seabirds at Sea/Easter Canadian Seabirds at Sea strip and distance sampling methods (Tasker et al. 1984, Webb and Durinck 1992, Camphuysen et al. 2004, Gjerdrum et al. 2012). In brief, I searched for birds with the naked eye in an arc 90° on one or other side of the ships track, the side with being chosen to minimise any deleterious effects of sun glare, etc. I recorded birds first detected on the water in four distance bands, A-D, spaced 0-50, 50-100, 100-200 and 200-300 m from the track line. I recorded all birds first detected in flight within 300 m of the track line, flagging as 'in transect' those that were within a 300 m square box during 'snapshots', which occurred every 300 m. I recorded standard environmental conditions at the beginning and end of each watch and when any appreciable change occurred. Whenever practicable, I also photographed animals using a digital camera (2013 - Nikon D50 + Sigma DG 28-300 mm lens; 2018 - Nikon D7000 + Sigma DG 150-400 mm image-stabilised lens), time synced to a handheld GPS. Subsequently, I used these images to check counts and species identification.

Results

Survey effort and conditions

In 2013, high winds or fog precluded observations being made for much of the cruise, resulting in 198 km/9.9 hours survey effort from deck 7 (seabirds, presence only) and 179 km/7.9 hours full survey effort (cetaceans and seabirds, using distance sampling methods) from deck 11 (Fig. 1, Table 1). During observations from deck 7, wind speed ranged from Beaufort 4 to 5.5 and wave height from 2 to 3 m. Survey from deck 11 was carried out in wind speeds ranging from Beaufort 1.5 to 5 and wave heights of 1 – 2 m. Conditions were particularly calm (wind speed 2.5, falling to 1.5) and therefore favourable for detecting cetaceans during bouts 7 – 9, in the western part of the cMPA. Visibility during survey bouts was generally greater than 10 km but fell as low as 2 km when fog was encountered south of the Grand Banks (bouts 10 and 11).
The weather in 2018 was generally more favourable for surveying, allowing 468.1 km/22.7 hours of full seabird and cetacean survey effort from deck 11. Moreover, effort was spread more evenly across the mid-Atlantic, with good coverage in the eastern half of the cMPA (Fig. 2). Wind speed during survey bouts fell from 4.5 to 1 – 2 as the cruise proceeded from west to east. Concurrently, the wave height declined from 1.5 to 0.5 m. As such, conditions for detecting cetaceans were poor in the western part of the cMPA but good in the east. Visibility was at least

15 km and usually > 20 km in 2018. Speed averaged 19 knots in 2013 (range 15 – 25 knots) and 21 knots in 2018 (range 18 – 23 knots).

Table 1. Survey effort and weather conditions.

Year	Date	Bout	Method[1]	Effort		Wind		Wave	Sea
				km	hours	Direction	Beaufort	height (m)	state
2013	21-Jul	1	Full	31.3	1.5	E	5.0	1.0	4.0
	21-Jul	2	Full	37.8	2.0	SE	4.0	2.0	3.0
	22-Jul	3	Pr.	28.6	1.3	NW	4.0	2.0	4.0
	22-Jul	4	Pr.	33.2	1.6	NW	4.4	2.0	4.0
	22-Jul	5	Full	12.6	0.5	Var	2.5	2.0	2.0
	23-Jul	**6**	**Pr.**	**26.7**	**1.4**	**NW**	**5.0**	**2.0**	**4.0**
	23-Jul	**7**	**Full**	**27.7**	**1.6**	**NW**	**2.5**	**2.0**	**2.0**
	23-Jul	**8**	**Full**	**63.0**	**3.6**	**Var**	**2.0**	**1.0**	**2.0**
	23-Jul	9	Full	15.5	1.0	E	1.5	1.0	1.0
	24-Jul	10	Full	14.4	1.0	SW	3.0	1.0	3.0
	24-Jul	11	Full	10.1	0.5	SW	3.5	2.0	3.0
	25-Jul	12	Pr.	14.7	1.0	SW	5.0	3.0	5.0
	25-Jul	13	Pr.	22.0	1.3	SW	5.0	2.0	4.0
	25-Jul	14	Pr.	22.6	1.3	S	5.5	3.0	5.0
	25-Jul	15	Pr.	17.1	1.1	S	5.0	2.0	4.0
		Total effort, deck 7		198.0	9.9				
		Total effort, deck 11		179.3	10.8				
2018	09-Jul	1	Full	43.3	2.0	SW	4.5	1.0	4.0
	09-Jul	2	Full	47.1	2.5	SW	4.5	1.5	4.0
	09-Jul	**3**	**Full**	**18.6**	**1.0**	**SW**	**4.5**	**1.5**	**4.5**
	10-Jul	**4**	**Full**	**39.6**	**2.1**	**SW**	**4.0**	**1.0**	**4.0**
	10-Jul	**5**	**Full**	**53.0**	**2.7**	**SW**	**4.0**	**1.5**	**4.0**
	10-Jul	**6**	**Full**	**32.9**	**1.7**	**W**	**3.5**	**1.5**	**3.5**
	10-Jul	7	Full	35.1	1.6	W	3.0	1.0	3.0
	11-Jul	8	Full	51.2	2.3	SW	2.0	1.0	2.0
	11-Jul	9	Full	40.7	2.1	SW	2.5	1.0	2.0
	11-Jul	10	Full	40.9	1.8	W	1.0	0.5	1.0
	12-Jul	11	Full	65.7	3.0	N	2.0	0.5	2.0
		Total effort, deck 11		468.1	22.7				

[1] 'Full' indicates that seabirds and cetaceans were surveyed from deck 11 using distance sampling methods; 'Pr.' indicates that the presence of seabird species was recorded from deck 7. Bouts in **bold** were within the cMPA.

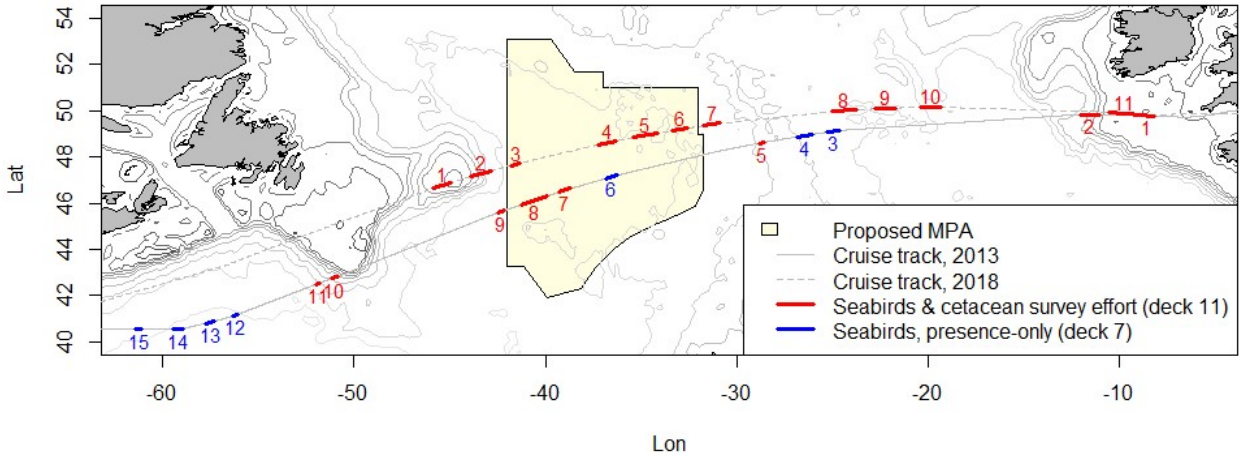


Figure 2. Cruise tracks and bouts of survey effort, July 2013 and 2018 (numbers indicate sequence of bouts). In light winds (generally Beaufort 3 - 4 or less), seabird and cetacean data were collected from the forward viewing area of deck 11, using distance sampling methods. In poorer weather, seabird presence-only data were collected from deck 7, which has a restricted view forward of the ship.

Seabirds

Overall observed diversity and abundance was greater in 2018 than 2013 (123 vs 918 individuals and 11 vs. 18 species), probably because survey effort was greater in 2018. The three most abundant species recorded in 2013 were northern gannets, Cory's shearwaters and great shearwaters, whereas in July, 2018 they were great shearwaters, northern fulmars and Cory's shearwaters (Table 2). Considering only the cMPA, the three most abundant species were great shearwaters, Cory's shearwaters and large skua spp. (probably south polar skuas – see below) in 2013 and great shearwaters, Cory's shearwaters, northern fulmars in 2018. This agrees closely with observations made during cruise DY080 in June, 2017 (Wakefield 2018) and by earlier cruises crossing the area (Boertmann 2011, Bennison and Jessopp 2015). Diversity in the cMPA was higher in 2018 (10 spp. confirmed) than in 2013 (4 spp. confirmed). This is in part due to the greater survey effort in 2018 but may also be because effort in 2018 was concentrated in the northeast of the area, whereas in 2013 it was concentrated in the southwest. Observations made during DY080 suggest that in mid-summer, diversity is higher in the northeast of the cMPA. In 2018, two species were recorded in the cMPA for the first time, as far as I am aware, from a ship-based survey: Fea's petrel and Audubon's shearwater. This confirms the results of geolocator studies that suggest that both species use the cMPA routinely in the summer (Neves et al. 2012a, Ramírez et al. 2013).

Table 2. Raw, uncorrected counts of seabirds during each survey and within the North Atlantic Current and Evlanov Seamount candidate Marine Protected Area (cMPA) only. Note that weather conditions were better, and therefore effort greater, in 2018 than in 2013.

Species[1]		Count (or presence[2])			
		Overall		In cMPA	
		2013	2018	2013	2018
Northern Fulmar	***Fulmarus glacialis***	3	122	✓	8
Pterodroma sp.	***Pterodroma* sp.**		1		1
Fea's Petrel[3]	***Pterodroma feae***		1		1
Large shearwater sp.	***Calonectris/Ardenna* sp.**	9		1	
Cory's Shearwater	***Calonectris borealis***	33	98	14	18
Great Shearwater	***Ardenna gravis***	52	534	39	412
Sooty Shearwater	***Ardenna griseus***	✓	3		2
Small shearwater sp.	***Puffinus sp.***	1	4	✓	4
Manx Shearwater	*Puffinus puffinus*		2		
Audubon's Shearwater[4]	***Puffinus lherminieri***	✓	2		2
Storm petrel sp.	***Hydrobatidae/Oceanitidae* sp.**	2	1	1	
Wilson's Petrel	*Oceanites oceanicus*	✓	1		
White-faced Petrel	*Pelagodroma marina*	✓			
European Storm Petrel	*Hydrobates pelagicus*		1		
Leach's Petrel	***Oceanodroma leucorhoa***	1	3		1
Northern Gannet	*Morus bassanus*	14	17		
Arctic Skua	*Stercorarius parasiticus*		1		
Long-tailed Skua	***Stercorarius longicaudus***		14		8
Large skua sp.	***Catharacta sp.***	3	6	3	1
South Polar Skua	***Catharacta maccormicki***	4	4	1	1
Auk sp.	*Alcidae* sp.		44		
Puffin	*Fratercula arctica*		1		
Common Guillemot	*Uria aalge*		55		
Arctic Tern	***Sterna paradisaea***		2		2
Lesser Black-backed Gull	*Larus fuscus*	1			
Yellow-legged Gull	*Larus michahellis*		1		

[1] Species in **bold** were recorded in the cMPA.
[2] ✓ presence-only recorded from deck 7, 2013.
[3] The nominate ssp. or *P. f. desertae* (some authorities regard these taxa as full species).
[4] One bird in 2013 appeared to be the nominate ssp.; the remainder were ssp. *baroli.*

Fulmarine petrels

Northern fulmars were seen in small numbers throughout the 2018 cruise, with concentrations in the north-eastern corner of the cMPA and on the Flemish Cap in 2018 (Fig. 3). The vast majority (94%) were light plumaged (type *LL*) but four birds on the Flemish Cap and in the cMPA (4%) were type *L* one bird was dark (type *D*) indicating a more northerly origin than type *LL* birds.

10% of birds seen, spread throughout the cruise, were visibly in wing moult, indicating that they were non-breeders, and perhaps immatures.

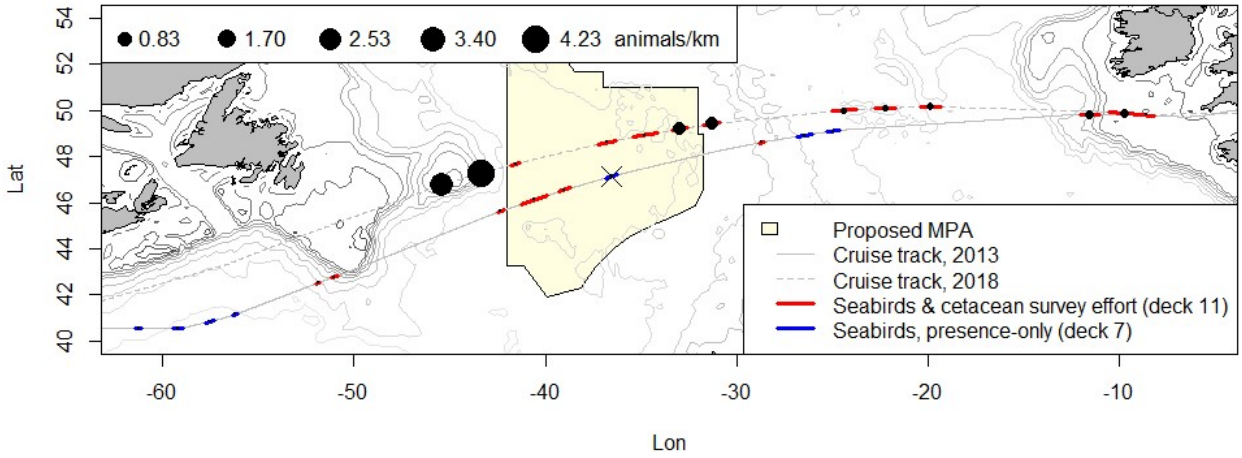
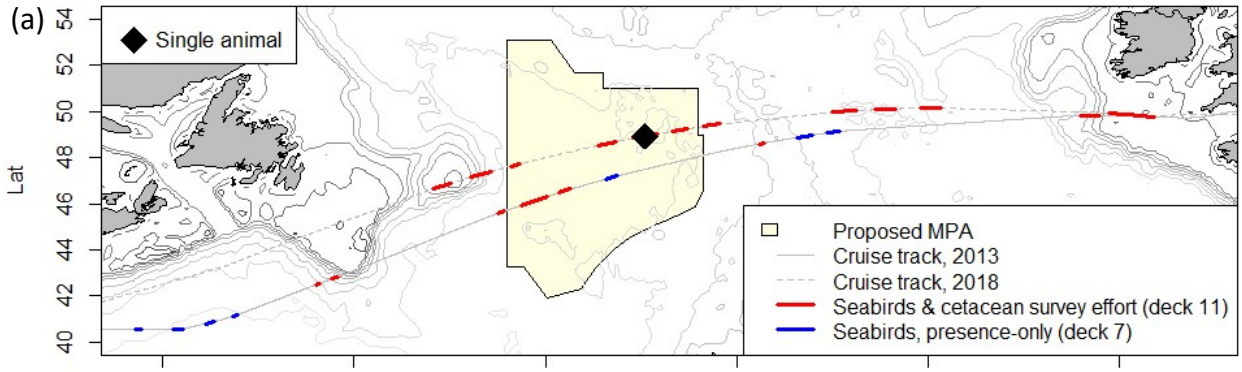


Figure 3. Sightings of northern fulmars (black cross indicates a presence recorded during poor weather watches from deck 7).

Pterodroma petrels

Two Pterodroma petrels were recored, both on the 10th of July, 2018 within the cMPA (Fig. 4). The first, was seen briefly at 13:50 at a range of about 300 flying away from the ship. The second was seen and photographed at a similar range but flying across the ship's track (Fig. 4). Based on its heavy build, relatively large head, bull neck, deep chest and heavy bill, this bird was identified as Fea's petrel *Pterodroma feae* of the nominate (Cape Verde) or *desertae* (Desertas) subspecies (Robert Flood *in litt.*). Some authorities treat these taxa as full species (Flood et al. 2013). Geolocator data suggest that the latter occurs in the cMPA in summer (Paiva et al. 2010a). It is likely that the first bird was also this species.



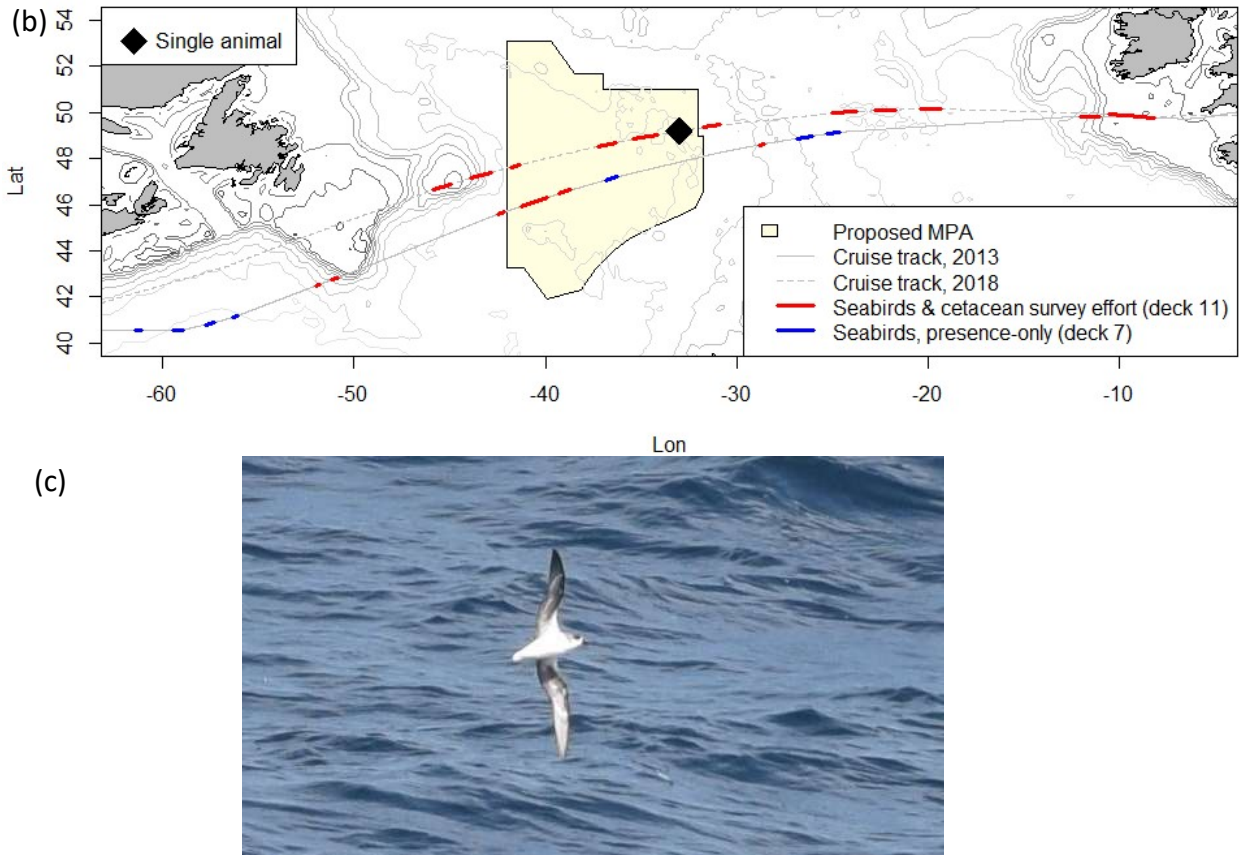


Figure 4 Locations where (a) an unidentified Pterodroma petrel and (b) a Fea's Petrel were sighted; (c) the Fea's petrel.

Large shearwaters

Several birds seen during poor weather in 2013 were recorded simply as large shearwaters (Cory's or great shearwaters; Fig. 5). However, the vast majority of large shearwaters recorded in 2013 and all of those recorded in 2018 were identified to species. Both Cory's and great shearwaters were seen throughout each cruise but the latter were more abundant, both within and outside the cMPA (Fig. 4). Within the cMPA great shearwaters were concentrated in the northeast of the area, which was also the area of highest abundance during DY080. Three sooty shearwaters were seen in this area in 2018. This species was also noted as present offshore of the Gulf of Maine but was otherwise absent. Tracking data suggest that sooty shearwaters move out of the cMPA into neritic waters in June, following their annual moult (Hedd et al. 2012). Concentrations of Cory's shearwaters occurred in the southwest of the cMPA and between 24 and 29° west. In both cases, these were probably breeding birds from colonies in the Azores (Magalhaes et al. 2008, Paiva et al. 2010a, Paiva et al. 2010b). As during DY080, Cory's shearwaters were noted feeding with striped and common dolphins in the cMPA, a behaviour which may be common (Martin 1986). They were twice noted associating with flying fish, either because they were predating directly on them (Neves et al. 2012b) or feeding in association with subsurface predators (dolphins or tuna) that disturbed the flying fish.

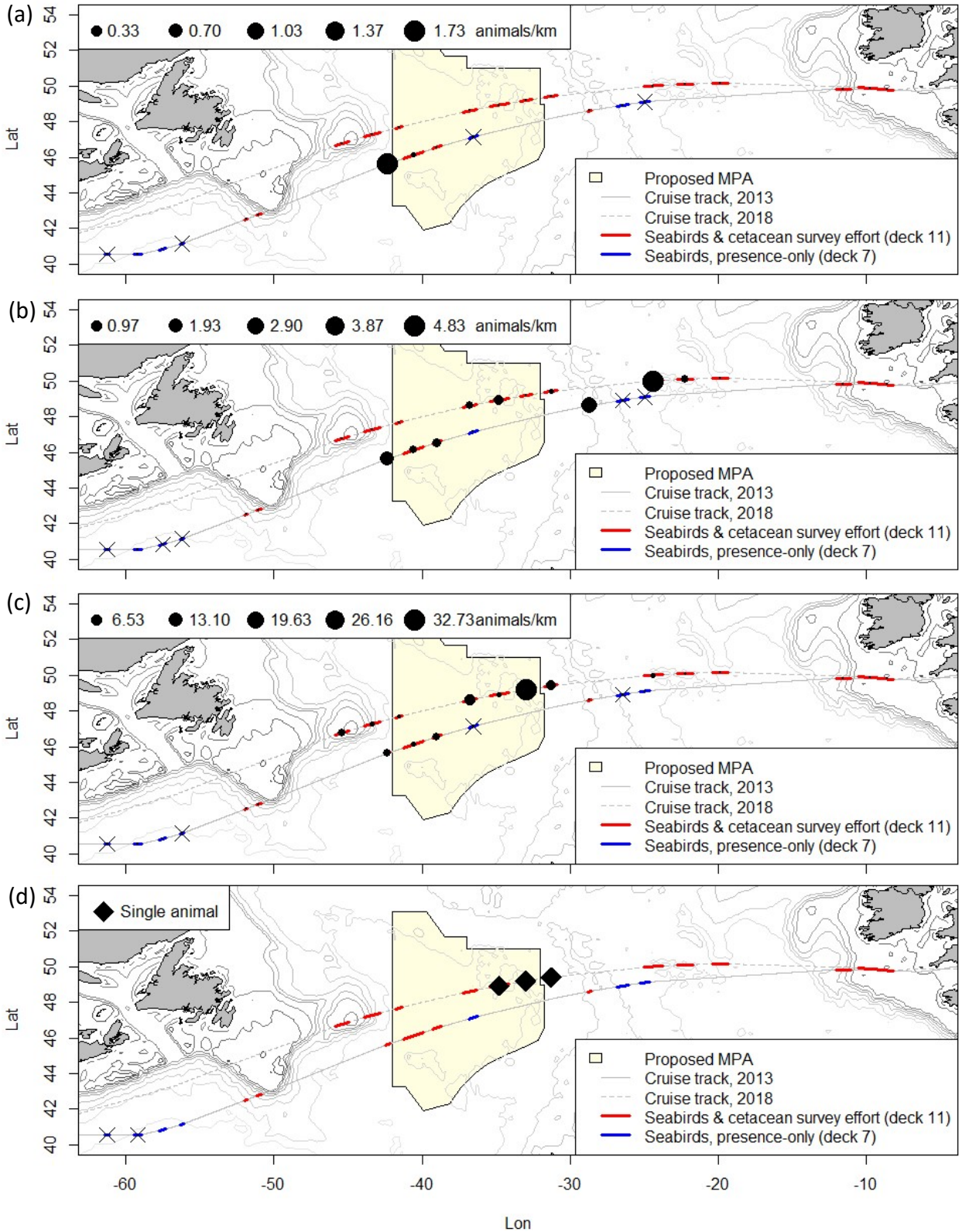
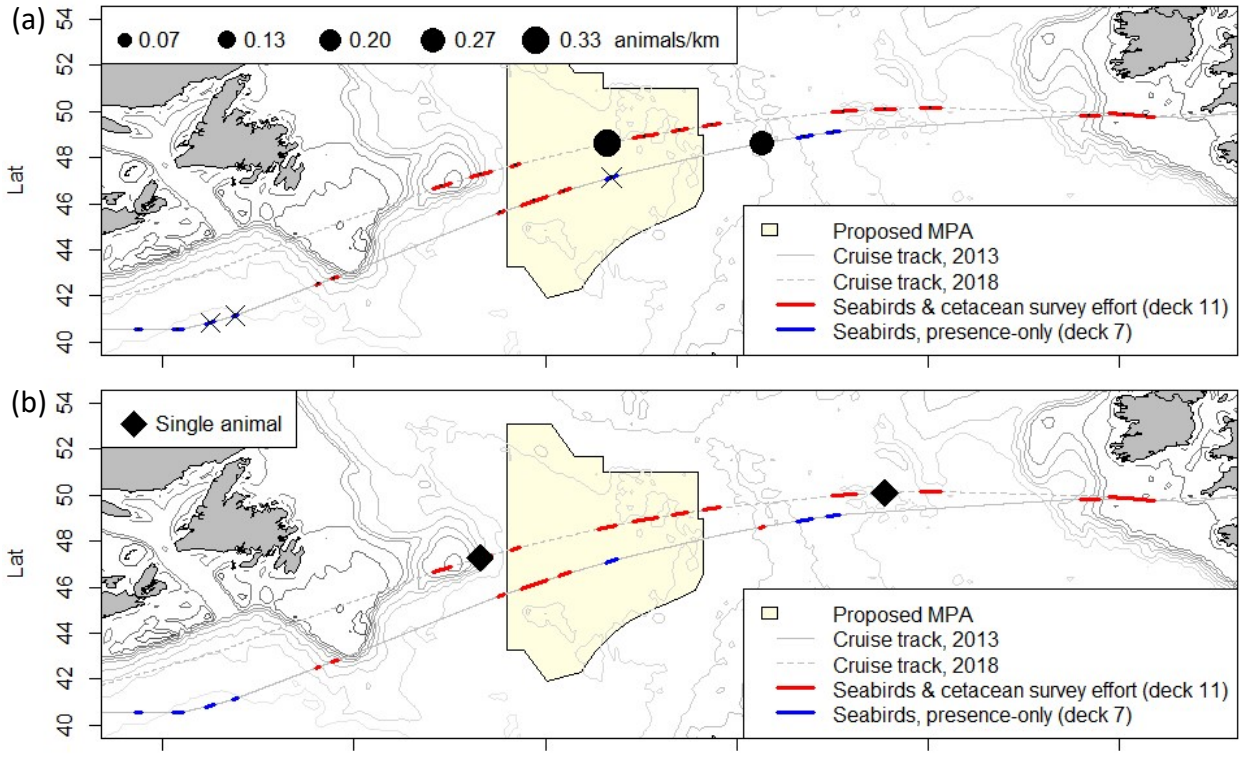


Figure 5. Sightings of large shearwaters: (a) Unidentified large shearwaters (Cory's or great), (b) Cory's shearwaters, (c) great shearwaters and (d) sooty shearwaters. Black crosses indicate presence recorded during poor weather watches from deck 7.

Small shearwaters

Small shearwaters (i.e. *Puffinus* spp.) were seen very infrequently (Fig. 6). North Atlantic members of this genus can be difficult to separate at sea and their taxonomy has undergone several recent revisions (Carboneras et al. 2016), complicating the assignment of sightings to particular taxa. Of the thirteen birds noted, eight were only identifiable with confidence as *Puffinus* sp. Two confirmed Manx shearwaters *P. puffinus* were seen in 2018 – at the Flemish Cap shelf break and one in deep water between the Mid-Atlantic Ridge and the Celtic Sea and two of the unidentified *Puffinus* sp. seen in the cMPA in 2018 were probably also this species. Three Audubon's shearwaters of the Macaronesian ssp. (*P. lherminieri baroli*) were recorded: One in deep water east of the Mid-Atalantic Ridge in 2013 and two in the cMPA in 2018. One of the latter was seen at the same time as the Fea's petrel mentioned above. Two unidentified *Puffinus* sp. seen in poor weather in 2013 in deep water southeast of Nova Scotia had plumage characteristic of the nominate Audubon's subspecies and tracking data suggest that birds found in the latter area in summer are *P. l. lherminieri*, while those found further north and east are *P. l. baroli* (Neves et al. 2012a; http://seabirdtracking.org).



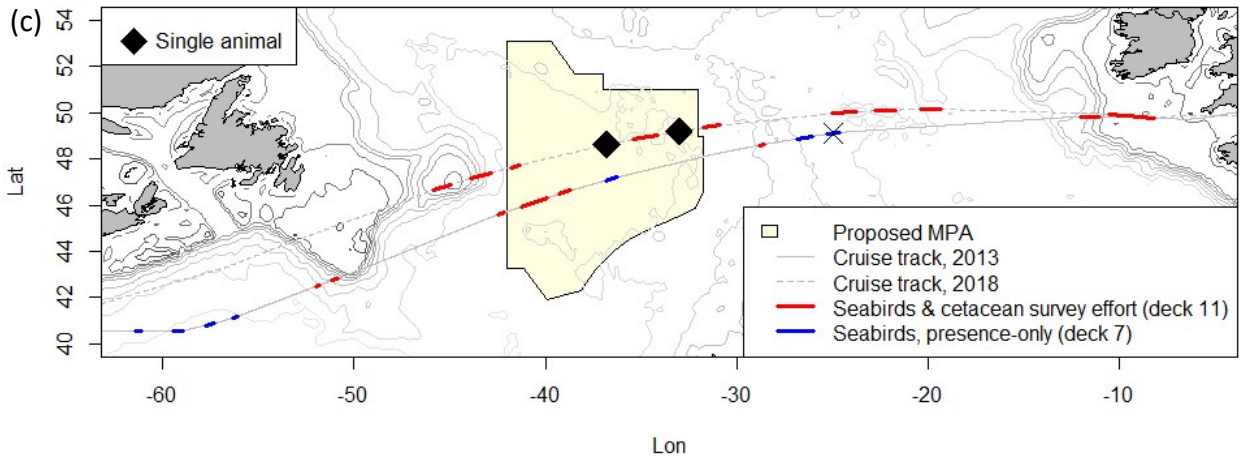
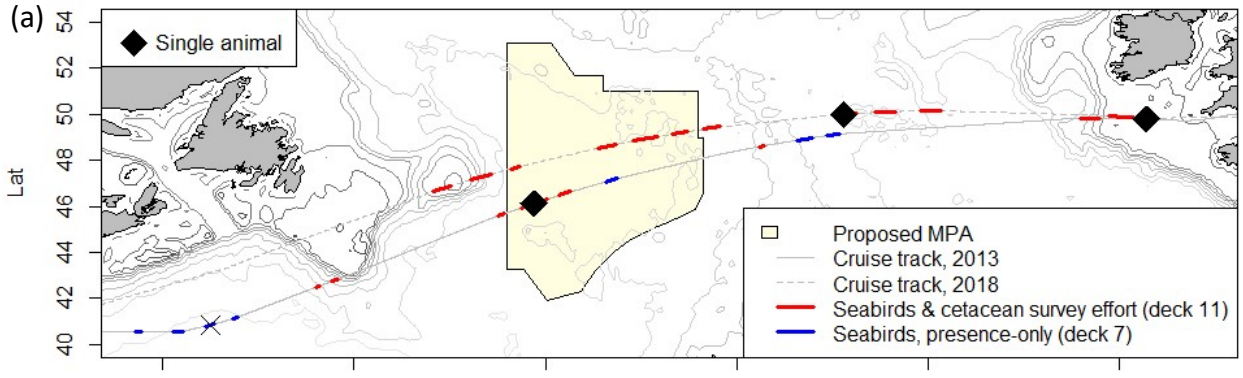


Figure 6. Sightings of small shearwaters: (a) Unidentified small shearwaters, (b) Manx shearwaters and (c) Audubon's shearwaters. Black crosses indicate presence recorded during poor weather watches from deck 7.

Storm petrels

Storm petrels (Hydrobatidae/Oceanitidae sp.) include some of the smallest of the pelagic birds, making them relatively hard to detect and identify from ships. Four unidentified storm petrels were noted (Fig. 7). Of the storm petrels that were identified to species level, Leach's petrels were the most commonly seen, with a notable preponderance between 30° and 40°, including the western side of the cMPA. DY080 results showed that Leach's petrels occur throughout the western half of cMPA (Wakefield 2018). These birds tended to be in flight feather moult and may therefore have been immatures. Tracking data show that breeding Leach's petrels from colonies on the north-eastern seabird of North America regularly forage along the shelf-break and shelf slope, including in this area (Hedd et al. 2018). One Wilson's petrel was seen on the Flemish Cap and one European storm petrel in the Celtic Sea in 2018. In 2013 a white-faced storm petrel was seen and photographed during a poor weather watch from deck 7, when the ship was in oceanic waters beyond the continental shelf east of Nova Scotia.



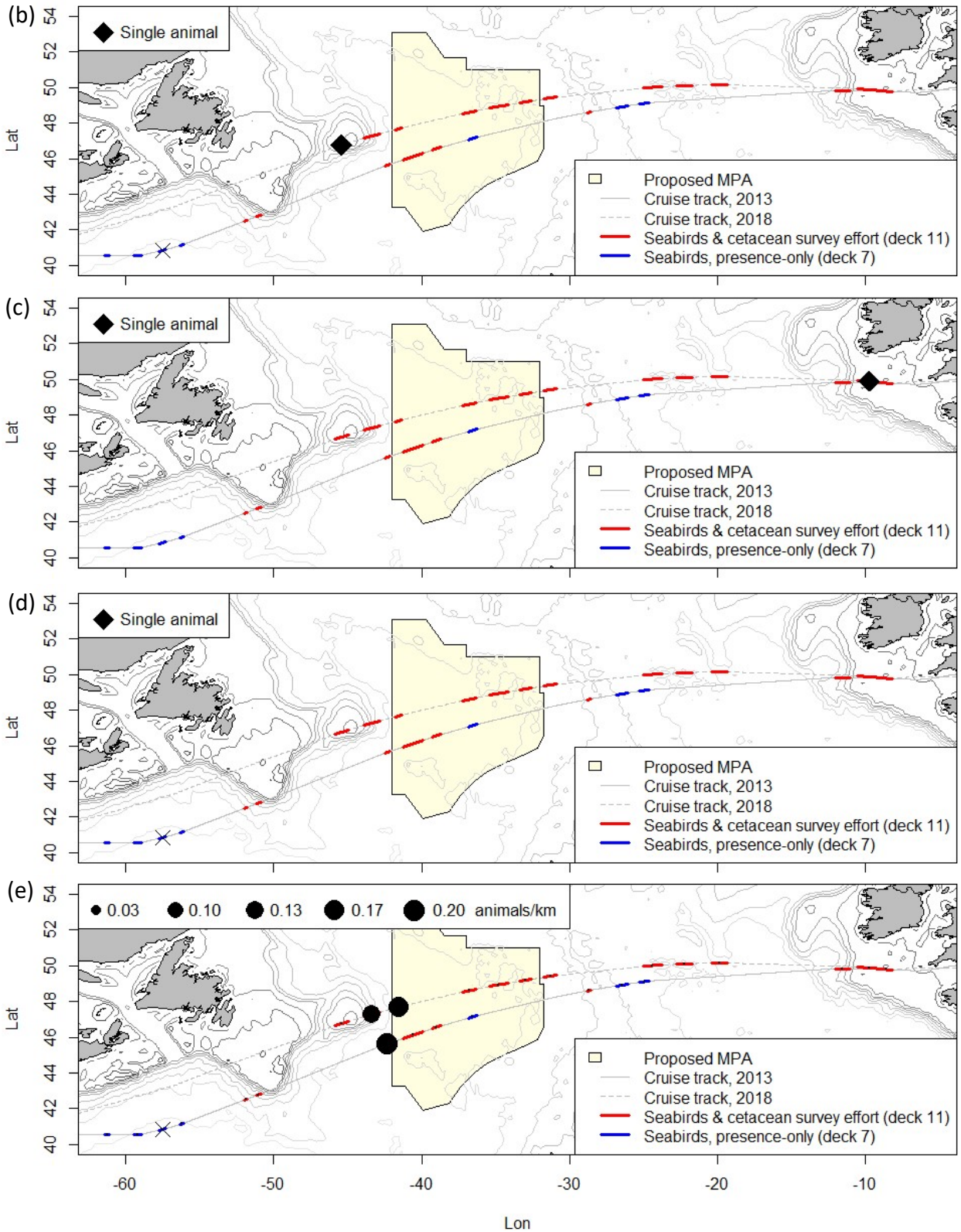


Figure 7. Sightings of storm petrels: (a) Unidentified storm petrels, (b) Wilson's petrel, (c) European storm petrel, (d) white-faced petrel and (e) Leach's petrels. Black crosses indicate presence recorded during poor weather watches from deck 7.

Gannets

As is well known, gannets were abundant in the Celtic Sea (Fig. 8). Sightings in oceanic areas (i.e. between the North American and European continental shelves) were limited to a fourth calendar year type bird, seen in deep water east of the Mid-Atlantic Ridge.

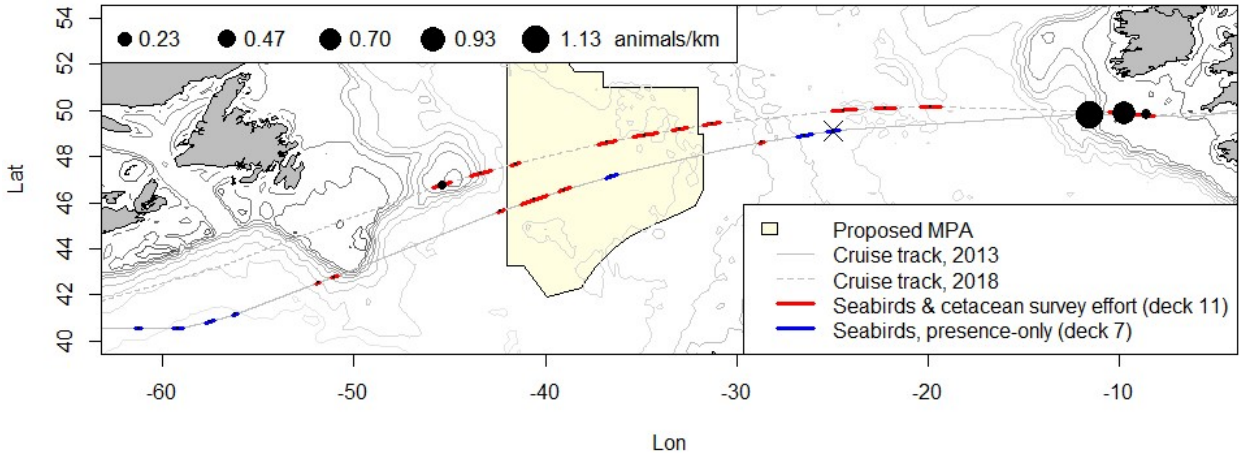
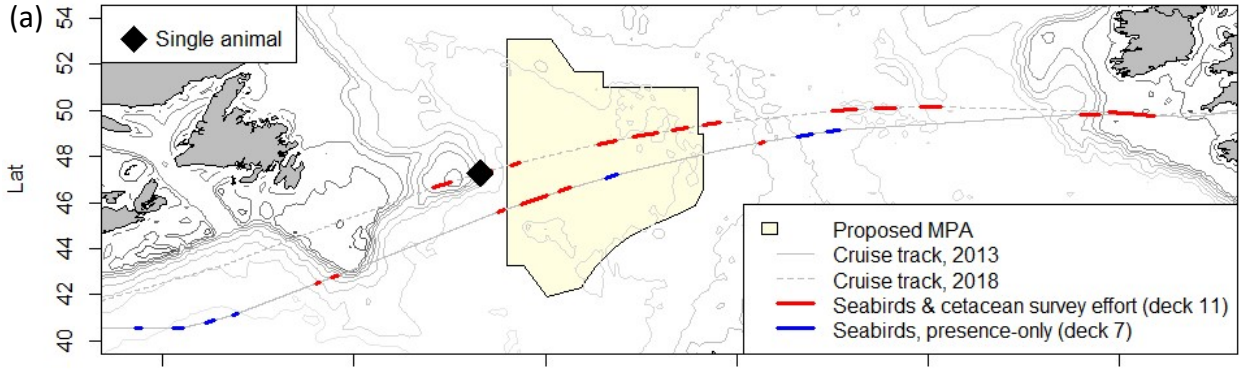


Figure 8. Sightings of northern gannets.

Skuas

Skuas were seen regularly but in small numbers between the Flemish Cap and the Mid-Atlantic Ridge, with the majority in the cMPA (Fig. 9). The most abundant in 2018 were long-tailed skuas, seen singly or in groups of four or five. No long-tailed skuas were seen in 2013 but at-sea data from DY080 and Boertmann (2011), as well as tracking data (Sittler et al. 2011, Gilg et al. 2013), show that this species occurs regularly in cMPA in summer. The majority seen in 2018 were in intermediate plumage. All of those that could be aged based on plumage characteristics (12 out of 14 birds) were immature, which again accords with observations from DY080 (Wakefield 2018). One Arctic skua was seen – a dark-phase adult at the Flemish Cap's eastern shelf-break in 2013.



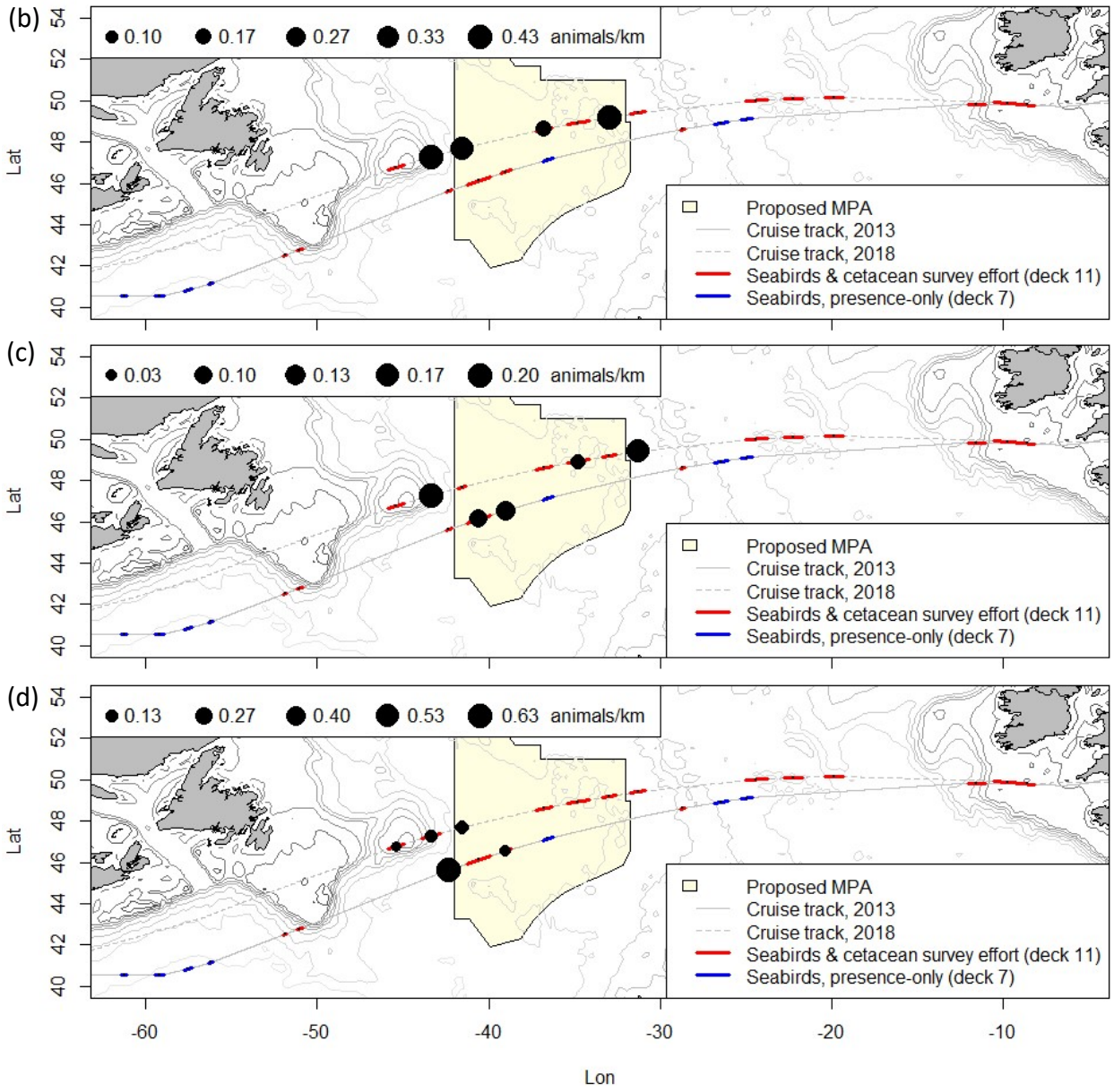


Figure 9. Sightings of skuas: (a) Arctic skuas, (b) long-tailed skuas, (c) unidentified large skuas and (d) south polar skuas. Black crosses indicate presence recorded during poor weather watches from deck 7.

In both 2013 and 2018, large *Catharacta* skuas were encountered regularly between the Flemish Cap and the Mid-Atlantic Ridge, notably in the southwest of the cMPA. The two members of this genus that routinely occur in the northwest Atlantic – the south-polar *C. maccormicki* and the great skua *C. skua* – are difficult to separate at sea (Lee 1989). When possible, I therefore photographed and identified *Catharacta* spp. from their plumage and primary moult scores (Newell et al. 2013). Four out of seven large skuas in 2013 and four out of ten in 2018 were confirmed as south polar skuas. Tracking data and at-sea data observations during DY080 show that *C. maccormicki* are concentrated in the west of the study area in the summer (Kopp et al. 2011, Weimerskirch et al. 2015, Wakefield 2018) whereas adult *C. skua* occur there the winter

(Magnusdottir et al. 2011). However, ringing recoveries suggest that immature *C. skua*, which are easily confused with *C. maccormicki*, may occur in the cMPA in the summer (Furness 2010, Newell et al. 2013) so the unidentified birds could have been of either species.

Auks

Sightings of auks occurred only on the Flemish Cap (Fig. 10). These comprised flocks of three and 44 common guillemots, the latter including one Atlantic puffin; and a flock of 52 unidentified large auks. The latter were probably all common guillemots but may have included some Brünnich's guillemots *Uria lomvia*). Auks may have been present but undetected in other areas because they are difficult to detect from large ships in poor weather.

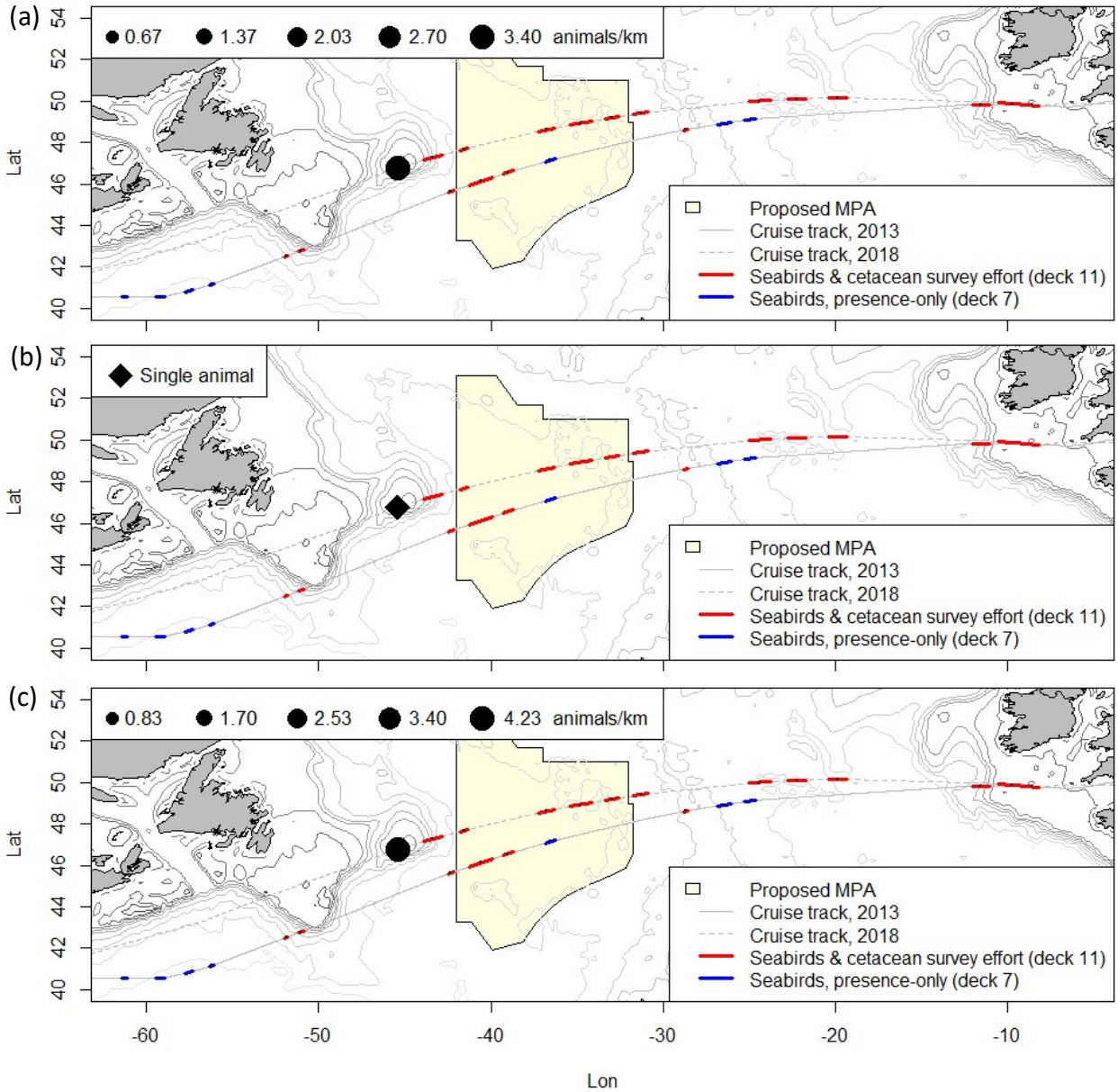


Figure 10. Sightings of auks: (a) Unidentified auks, (b) Atlantic puffins and (c) common guillemots.

Gulls and terns

Two Arctic terns were seen – both in the cMPA in 2018 (Fig. 11). One was an adult in breeding plumage and the other was a second calendar year bird. The latter was roosting on a large mass of plastic sheeting. A second calendar yellow-legged gull, apparently of the Azorean subspecies *Larus michahellis atlantis*, was seen in deep water, east of the Mid-Atlantic Ridge in 2018. Am adult lesser black-backed gull was seen in the Celtic Sea in 2018.

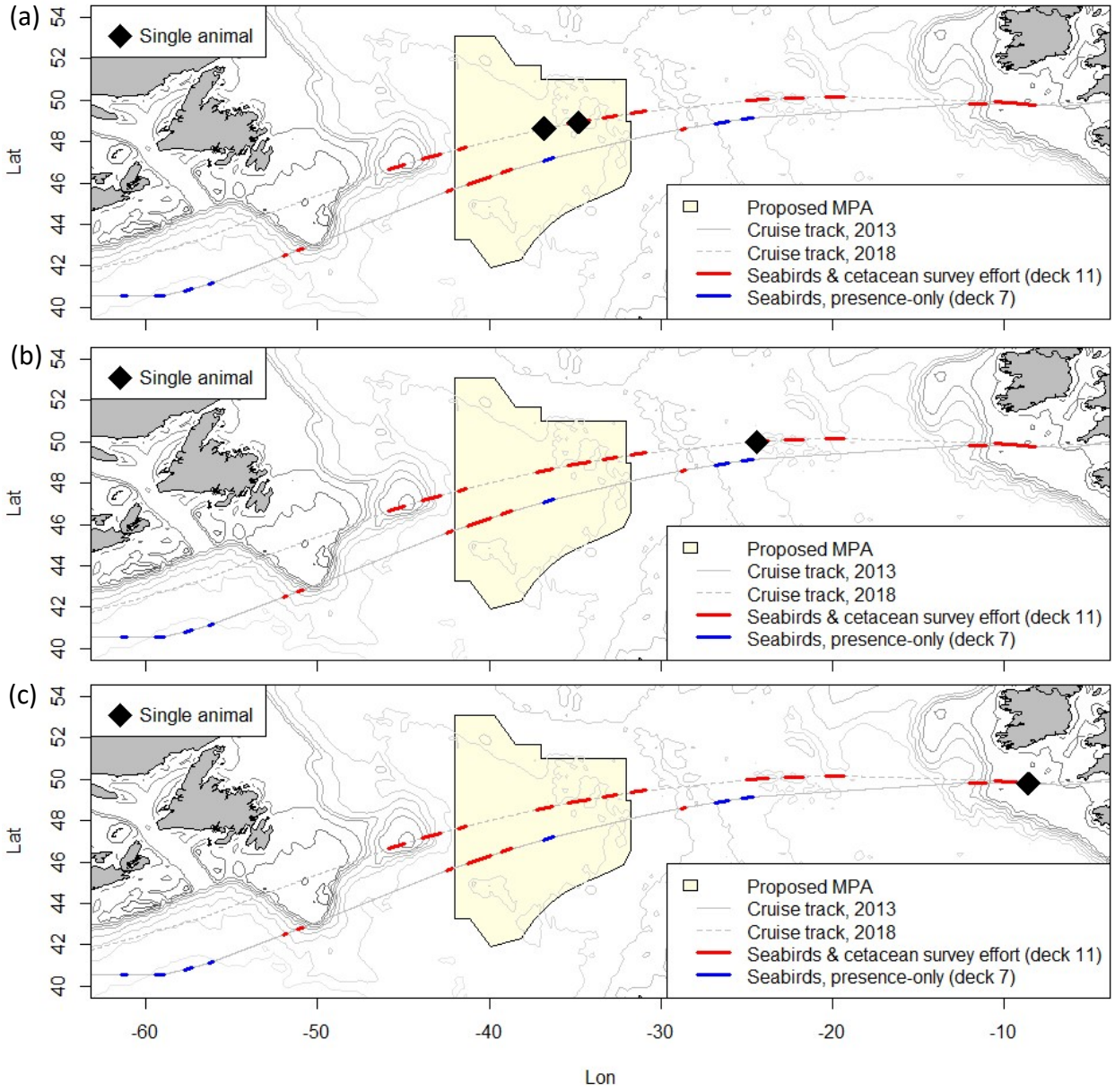


Figure 11. Sightings of gulls and terns: (a) Arctic terns, (b) yellow-legged gull and (c) lesser black-backed gull.

Cetaceans

Sea conditions were generally better for detecting and identifying cetaceans in 2018 than in 2013. The best conditions for surveying cetaceans (wind < Beaufort 3) occurred during bouts 7-9 (total 106 km) in 2013 and 8-11 in 2018 (total 199 km; Table 1). In 2013, eight species of cetacean were detected during the cruise as a whole and six in the cMPA, while in 2018, despite the greater survey effort and better weather, fewer species were recorded, both during the cruise as a whole (seven species) and within the cMPA (four species). This discrepancy is partly explained by the high diversity recorded in the cMPA during bout 8 in 2013, when six species were recorded in an 83 km long bout of survey effort. The most abundant taxa seen, both during each cruise as a whole and within the cMPA only, were unidentified dolphins in 2013 and striped dolphins in 2018 (Table 3). The majority of sightings were identified to species or at least genus but two animals, detected from their blows and fleeting glimpses of their backs at approximately 2.5 and 4 km respectively, were recorded simply as large cetacean species (Fig. 12).

Table 3. Raw, uncorrected counts of cetaceans during each survey and within the North Atlantic Current and Evlanov Seamount candidate Marine Protected Area (cMPA) only. Note that weather conditions were better, and therefore effort greater, in 2018 than in 2013.

Species[1]		Count			
		Overall		In cMPA	
		2013	2018	2013	2018
Large cetacean sp.		1	1		
Baleen whale sp.			1		1
Common minke whale	***Balaenoptera acutorostrata***		4		3
Fin whale	***Balaenoptera physalus***	1	7		4
Sperm whale	***Physeter macrocephalus***	3		3	
Pygmy/dwarf sperm whale	***Kogia* sp.**	2		2	
Beaked whale sp.	***Ziphiidae* sp.**	11	10	4	
Mesoplodon sp.	***Mesoplodon* sp.**	9	5	9	
Sowerby's beaked whale	*Mesoplodon bidens*		4		
Northern bottlenose whale	*Hyperoodon ampullatus*		16		
Small cetacean sp.			10		
Dolphin sp.		295	87	270	20
Pilot whale sp.[2]	***Globicephala* sp.**	58	15	20	
Common dolphin	***Delphinus delphis***	80	133	15	5
Striped dolphin	***Stenella coeruleoalba***	261	144	211	50
Bottlenose dolphin	*Tursiops truncatus*	15			

[1] Species in **bold** were recorded in the cMPA.
[2] Presumably all long-finned pilot whales, *G. melas* (see below).

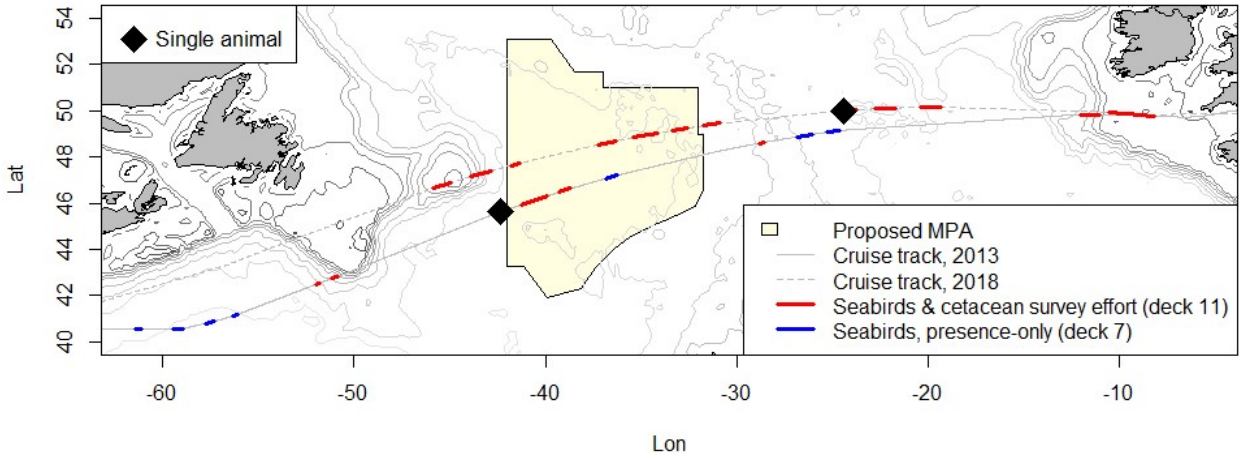
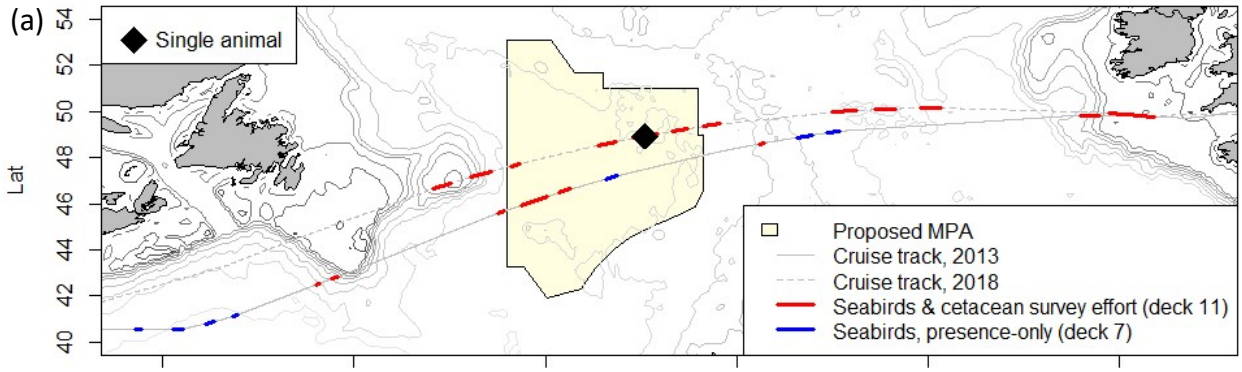


Figure 12. Unidentified large cetaceans.

Baleen whales

The majority of *Balaenoptera* whales (8 out of 13) were seen in the cMPA, west of the mid-Atlantic ridge (Fig. 13). One animal recorded on leg 5 in 2018 (Fig. 12a) had a dorsal fin and surfacing sequence typical of a sei whale. This species is abundant just north of the area, where is aggregates the sub-polar front (Skov et al. 2008, Waring et al. 2009) and has been tracked migrating northwards through the cMPA (Prieto et al. 2014). However, the possibility that it was a fin whale could not be completely excluded. In 2018 a fin whale was recorded at the Celtic Sea shelf break. In 2018, four fin whales were recorded in deep water west of the Mid-Atlantic Ridge in the cMPA and three in deep water east of the Mid-Atlantic Ridge, in the vicinity of the East Thulean Rise. These sightings are typical of distribution of this species, which is the most abundant *Balaenoptera* in the deep temperate North Atlantic (Víkingsson et al. 2013). Common minke whales were also recorded in these two regions, including two in the cMPA in 2018. As far as I am aware, this is the first time that common minke whales have been recorded in the cMPA during a cetacean survey (none were recorded in deep water west of the Mid-Atlantic Ridge during DY080) but there are many records from the deep North Atlantic (Van Waerebeek et al. 1999). Moreover, tracking and acoustic data suggest that this species migrates up and down the Mid-Atlantic Ridge (Nieukirk et al. 2004, Risch et al. 2014, Vikingsson and Heide-Jorgensen 2015) and may therefore occur in the cMPA regularly.



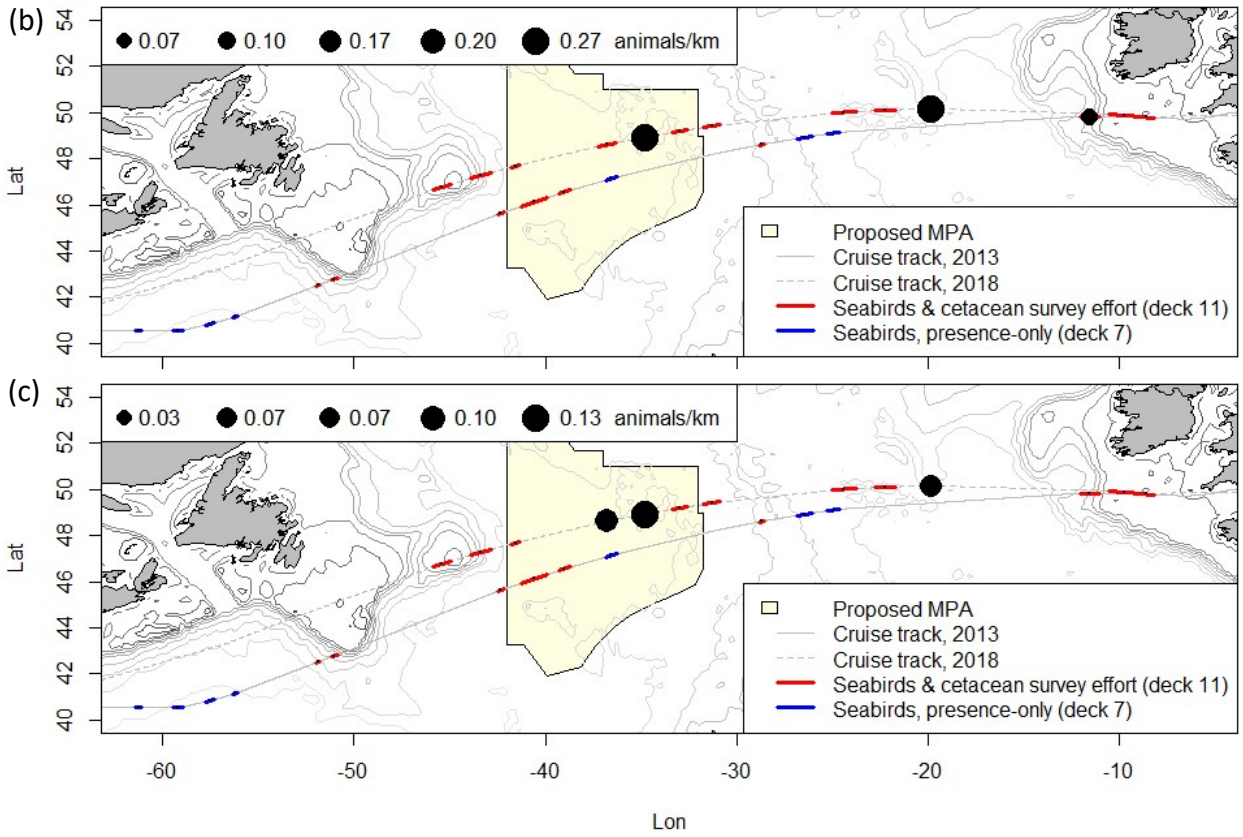


Figure 13. Sightings of baleen whales: (a) Unidentified baleen whales, (c) fin whales and (b) common minke whales.

Sperm whales

Three sperm whales were recorded during the surveys, all in 2013 in the southwest of the cMPA (Fig. 14). A small cluster of sperm whale sightings occurred in the same area during DY080 (Wakefield 2018). These animals may have been associated with isolated seamounts that occur in this area. The unidentified large cetacean seen during bout 8 in deep water east of the Mid-Atlantic Ridge in 2018 appeared to have an angled blow and may therefore have also been a sperm whale. Wind speed was Beaufort 2 at the time so the wind is unlikely to have caused the blow to be angled. In mid-summer, sperm whales may be more abundant north of the CGFZ but these may move into or through the cMPA in the winter (Skov et al. 2008, Waring et al. 2009).

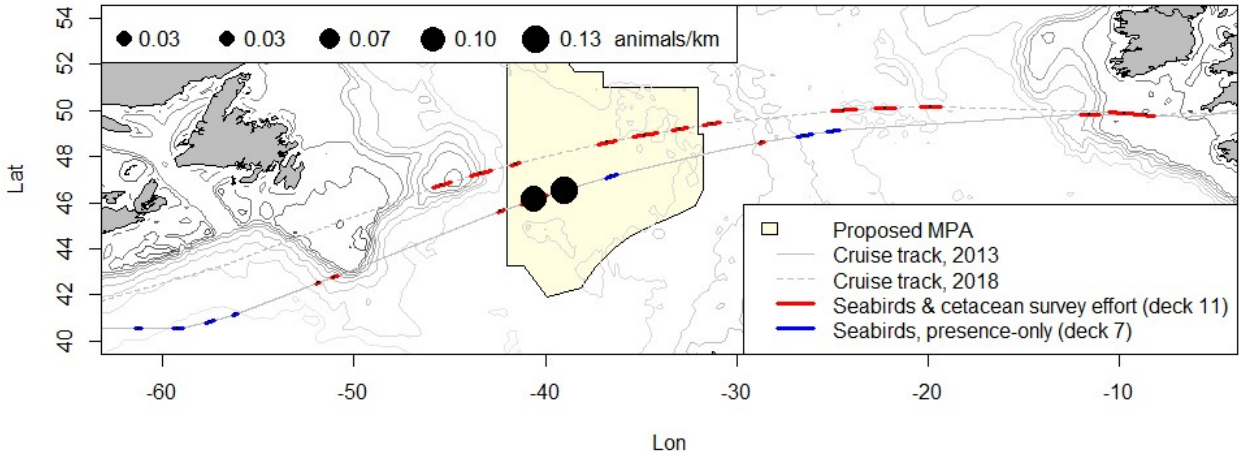


Figure 14. Sightings of sperm whales.

Kogia sp.

Two *Kogia* sp. were seen in 8 km apart in the southwest of the cMPA in 2013 (Fig. 15). Both were logging when first seen but sank horizontally below the surface in the manner characteristic of this genus as the ship approached. The second animal was photographed, the images showing a rounded head and a slightly humped body. The dorsal fin was located at end of visible part of the body, and was relatively large and erect, with a strait trailing edge. The tip occurred at the highest point of the fin. These characteristics make it likely that this animal (and presumably the one seen earlier) was a dwarf sperm whale *K. sima*, rather the morphologically very similar pygmy sperm whale *K. breviceps* (Jefferson et al. 2015). However, what little is known about the offshore distribution of *Kogia* spp. makes *K. breviceps* more likely, because this species is thought to range further north than *K. sima*. If the animals I saw were *K. sima* it would indicate that the species occurs further north than previously supposed. This could be due to the subtropical water masses which *K. sima* primarily inhabits penetrating northwards with the Gulf Stream/North Atlantic Current in the vicinity of the cMPA. This current system would also tend to advect any dead specimens away from the coast biasing range estimates southwards (sightings of *Kogia* sp. at sea are very rare so their ranges tend to be inferred from coastal stranding data (Willis and Baird 1998)).

Regardless of the species of the sightings this is the first time, as far as I am aware, that *Kogia* sp. have been recorded during a cetacean survey in the cMPA. The lack of previous records could simply be because these species are small, unobtrusive and therefore difficult to detect, rather than a reflection of true scarcity (Willis and Baird 1998). It is noteworthy that in deep water off the continental shelf of the eastern USA, *Kogia* spp. usually occur in the same habitats as striped dolphins (Garrison et al. 2010), which were abundant in the area where I sighted them in 2013 (see below).An unidentified cetacean I recorded in 2018, during bout 5 in the northeast of the cMPA (Fig. 17a), may also have been of this genus but I could not photograph the animal to confirm its identity.

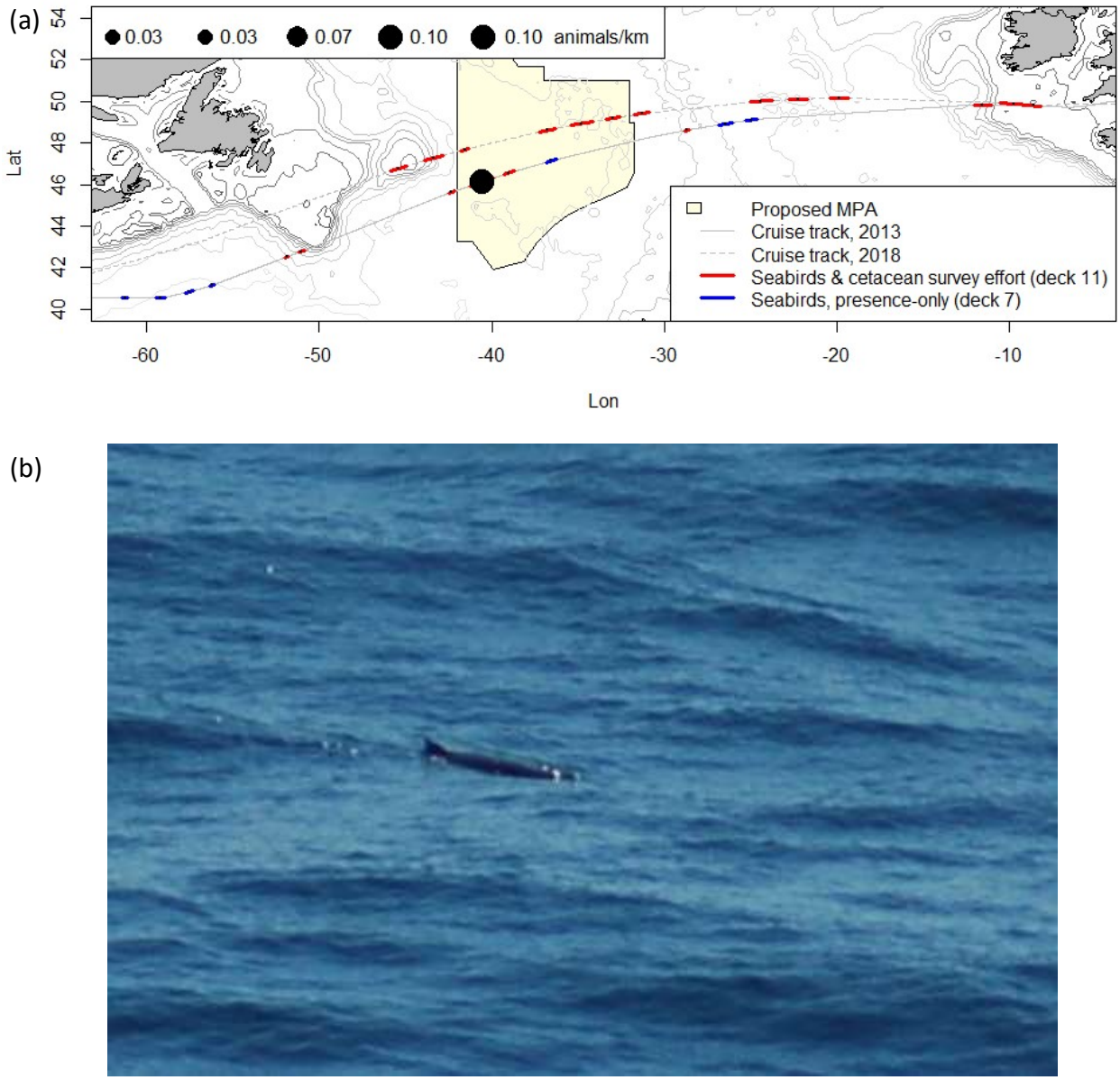


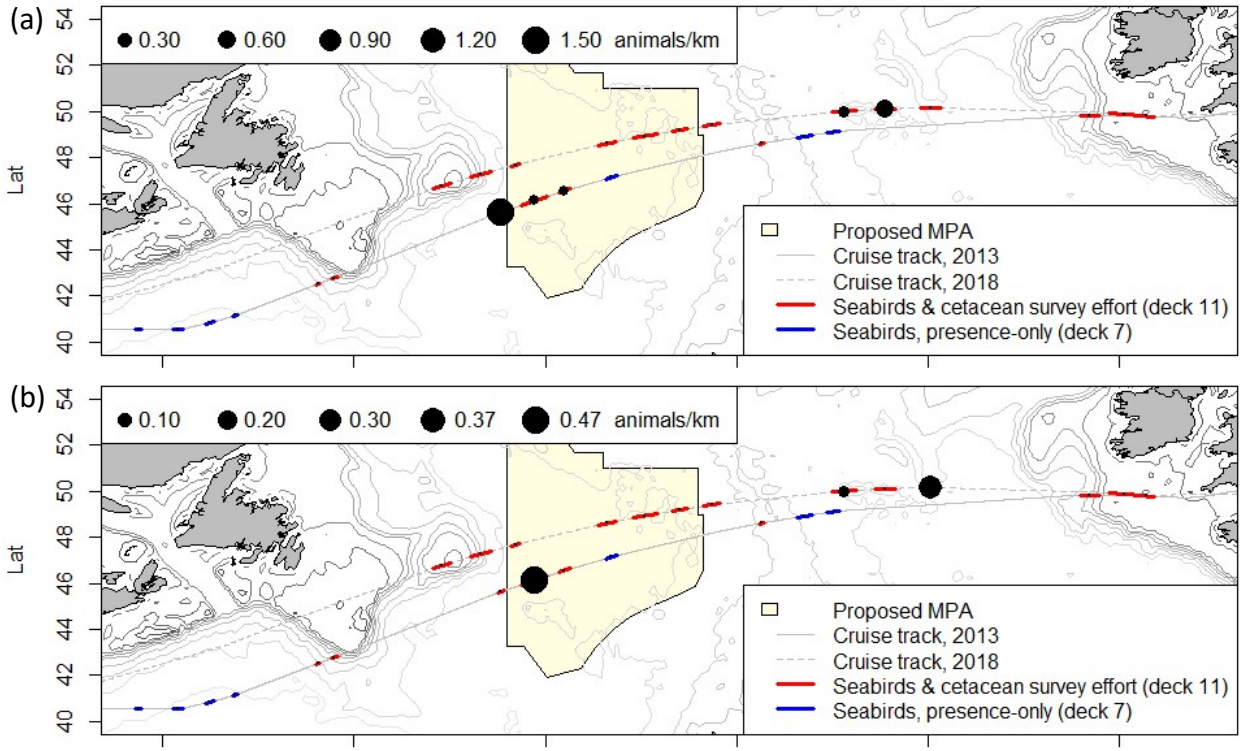
Figure 15. (a) Sightings of *Kogia* sp. and (b) a putative dwarf sperm whale *K. sima* seen on leg 8, 2013.

Beaked whales

In 2013, sightings of beaked whales occurred only on legs 7 – 9, in and adjacent to the southwest part of the cMPA (Fig. 16). In 2018, sightings occurred only on legs 8 – 10 in the vicinity of the East Thulean Rise. Beaked whales can be difficult to detect in rough weather and these clusters occurred in calm conditions. Therefore, distribution patterns cannot necessarily be inferred from these observations. Beaked whales, and especially those of the genus *Mesoplodon*, are difficult to identify at sea, even if photographed. Ten sightings, involving a total of 21 animals, were recorded simply as unidentified beaked whales. Seven of these, seen in three groups during bout

9 in 2018 over the East Thulean Rise, were probably also *Mesoplodon* sp. but this could not be confirmed beyond doubt. A further six groups of animals, comprising altogether 14 individuals, were identifiable using photographs to the genus *Mesoplodon* but could not be identified to species. However, all had relatively long beaks and strait mouth lines, suggesting that they were either Sowerby's beaked whales *M. bidens* or perhaps True's beaked whales *M. mirus* (Jefferson et al. 2015). A group of four animals seen over the East Thulean Rise in 2018 were confirmed using photographs to be *M. bidens*. This species was recorded during the Mar-Eco cruise to the Mid-Atlantic Ridge in July-August, 2007, although the location of the sighting is not stated (Priede 2007). It more abundant around the Azores than *M. mirus*, where both species are sighted only in mid-summer (Silva et al. 2014).

Two groups of northern bottlenose whales were recorded in 2018, in the vicinity of the East Thulean Rise. In both cases, the groups consisted of eight individuals. An unidentified beaked whale seen during bout 7, in the southwest of the cMPA in 2013 had characteristics (pale head; brown body; tall, falcate dorsal fin) that suggested it was probably also this species. No beaked whales were recorded during DY080, perhaps due to the relatively poor sea conditions encountered for much of that cruise (Wakefield 2018) and to my knowledge these the first records of beaked whales from any cetacean survey in the cMPA.



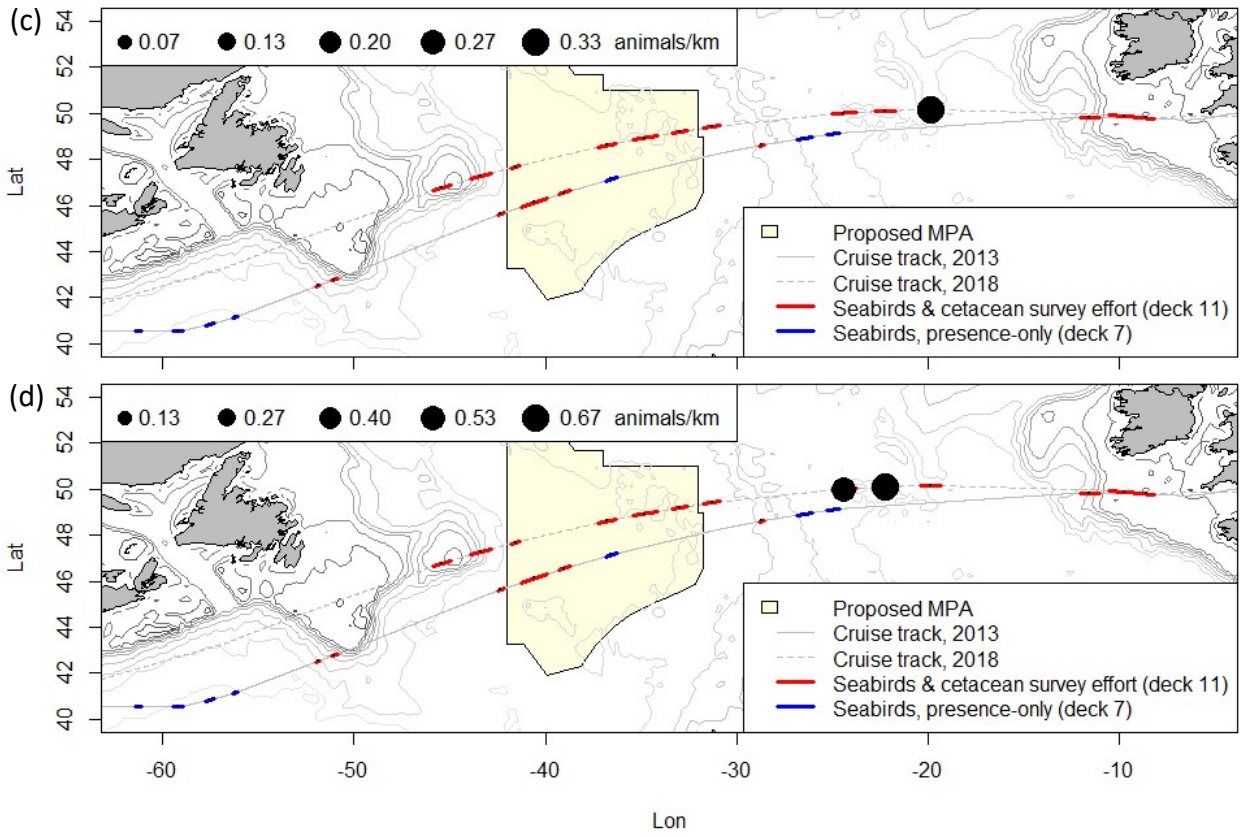


Figure 16. Sightings of beaked whales: (a) Unidentified beaked whales, (b) unidentified *Mesoplodon* sp., (c) Sowerby's beaked whales and (d) northern bottlenose whales.

Small cetaceans, pilot whales and dolphins

Two sightings of unidentified small cetaceans occurred (Fig. 17). One was the possible *Kogia* sp. described above. The other was of a group of approximately ten animals seen in the Celtic Sea in 2018, which were probably Risso's dolphins. Pilot whales occurred in six groups, ranging in size from 3 to 35 individuals, all in deep water beyond the continental shelf breaks (Fig. 18). Separation at sea of long-finned pilot whales (*Globicephala melas*) from short-finned pilot whales *G. macrorhynchus* is very difficult and either species could occur in the study area (Waring et al. 2009). However, all sightings were most likely to be *G. melas*, as *G. macrorhynchus* generally occurs at lower latitudes (Willis and Baird 1998, Jefferson et al. 2015). Moreover, during the 2018 cruise, I photographed a dead male pilot whale encountered near the eastern margin of the cMPA. Based on the number of teeth sockets (> 10) and the length of its pectoral fin bones, this animal was confirmed to be long-finned pilot whale *G. melas* (Sue Pemberton, *in litt.*).

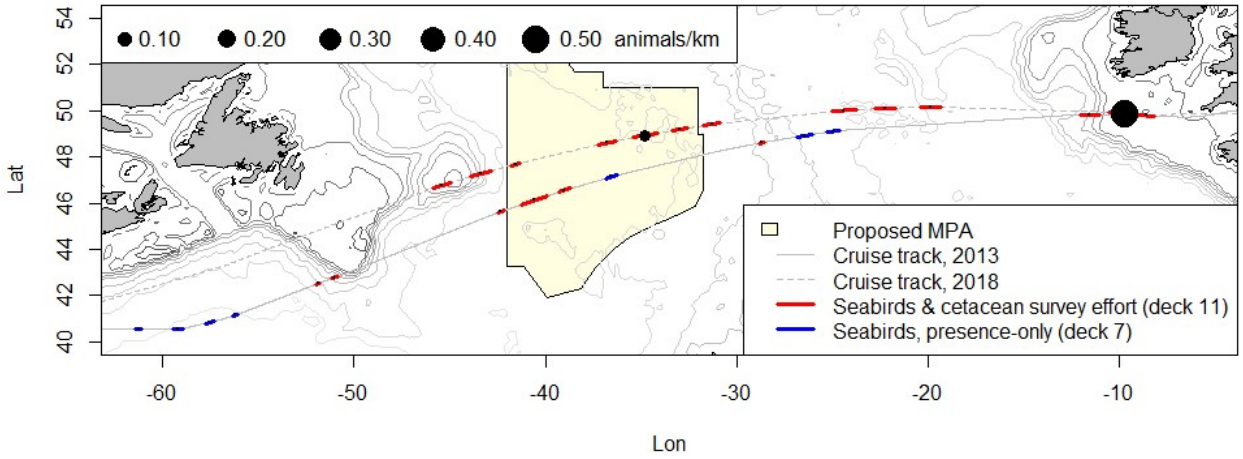


Figure 17. Unidentified small cetacean sightings.

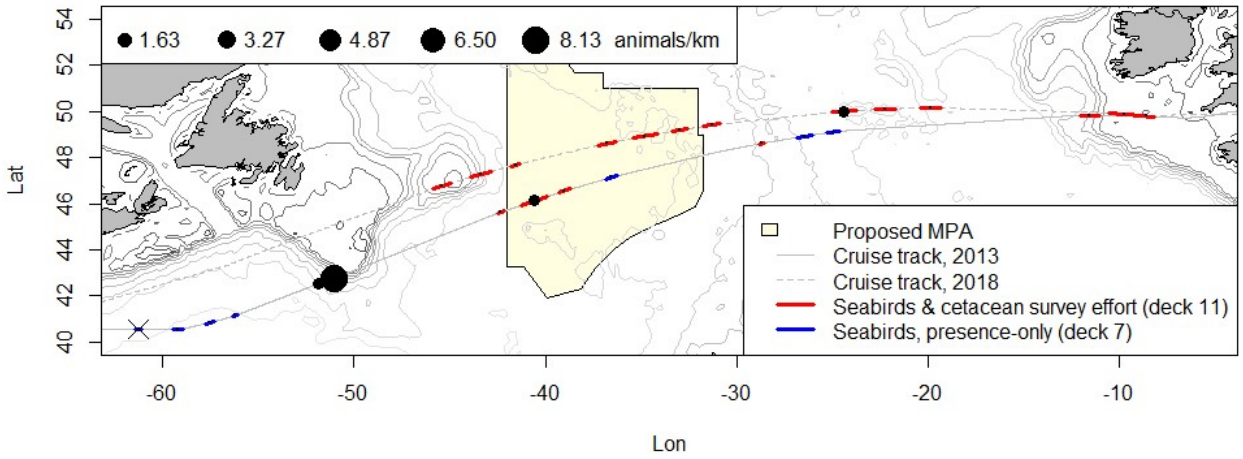


Figure 18. Pilot whale sightings.

Dolphins were encountered throughout both cruises (Fig. 19). More distant groups of animals could sometimes not be identified to species but were presumably either striped or short-beaked common dolphins. The latter were more often encountered east of the Mid-Atlantic Ridge, especially over the East Thulean Rise, in 2018, while the former were encountered regularly west of 20° west, with a notable concentration in the west of the cMPA in 2013. Median groups sizes were 18 (range 1 – 70, n = 18) for unidentified dolphins, 10 (2 – 30, n = 19) for common dolphins and 24 (3 – 55; n = 18) for striped dolphins. The highest abundance of dolphins occurred in 2013, in the southwest of the cMPA. Bottlenose dolphins were only seen on one occasion when a group of approximately 15 were recorded in the Celtic Sea.

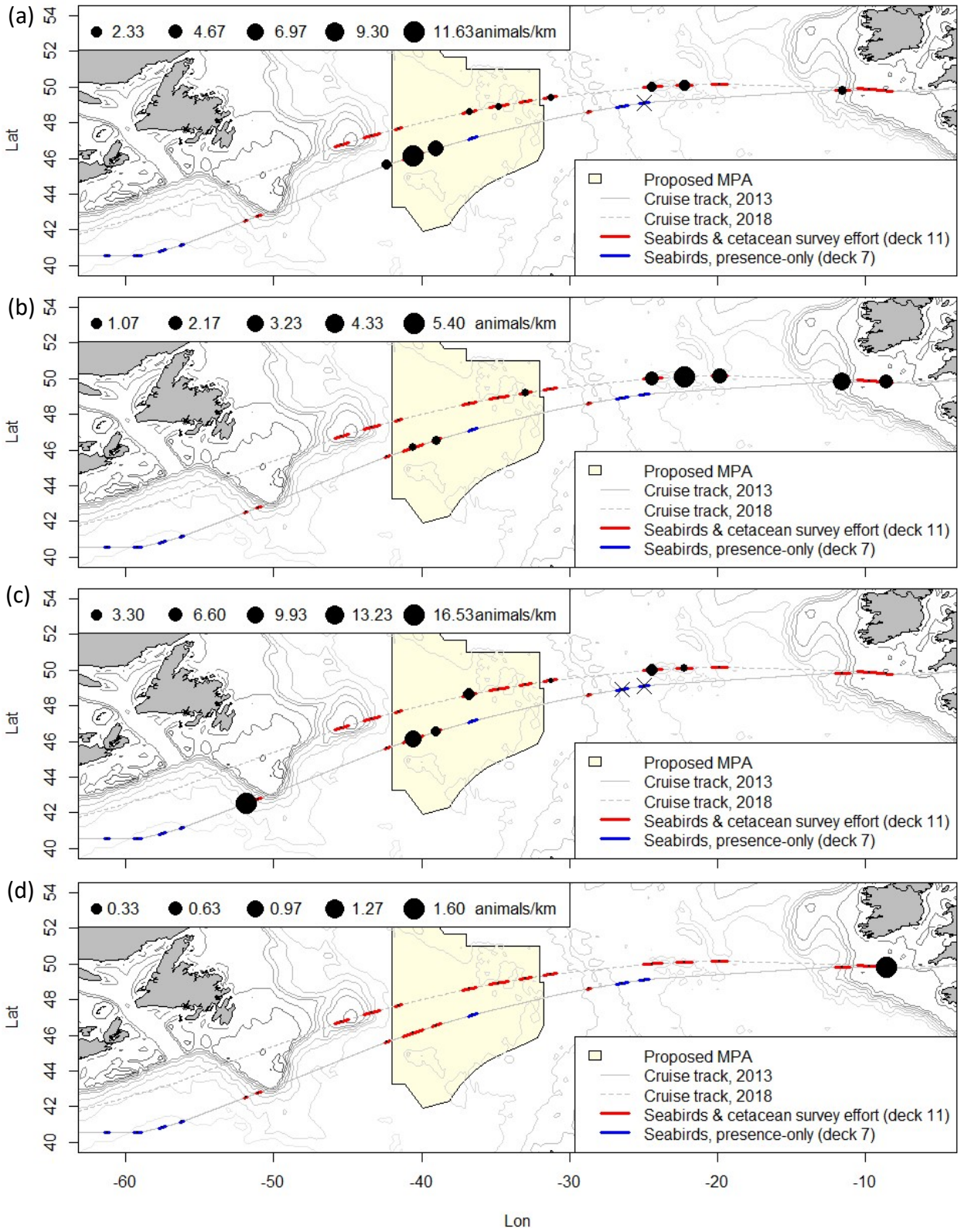


Figure 19. Sightings of dolphins: (a) Unidentified dolphins, (b) short-beaked common dolphins, (c) striped dolphins and (d) bottlenose dolphins.

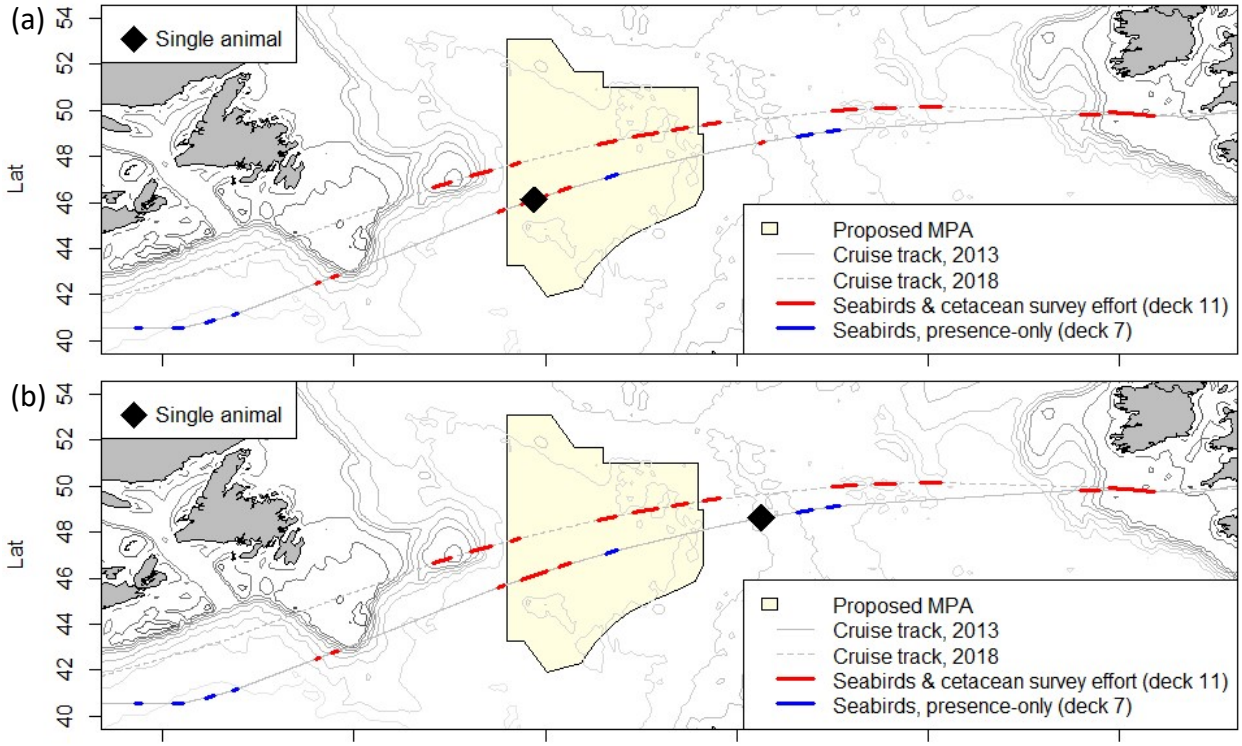
Turtles and sharks

Turtles were only detected in 2013 (Table 4): A small (<1 m diameter) unidentified turtle was seen in the southwest of the cMPA; a leatherback was seen just west of the Mid-Atlantic Ridge and a loggerhead was seen off the southern shelf-break of the Flemish Cap (Fig. 20). In addition, a shark, thought to be a blue shark Prionace glauca was seen over the Thulean Rise in 2018.

Table 4. Raw, uncorrected counts of turtles and sharks during each survey and within the North Atlantic Current and Evlanov Seamount candidate Marine Protected Area (cMPA) only. Note that weather conditions were better, and therefore effort greater, in 2018 than in 2013.

Species[1]		Count			
		Overall		In cMPA	
		2013	2018	2013	2018
Turtle sp.		1		1	
Loggerhead turtle	***Caretta caretta***	1			
Leatherback turtle	***Dermochelys coriacea***	1			
Shark sp.			1		

[1] Species in **bold** were recorded in the cMPA.



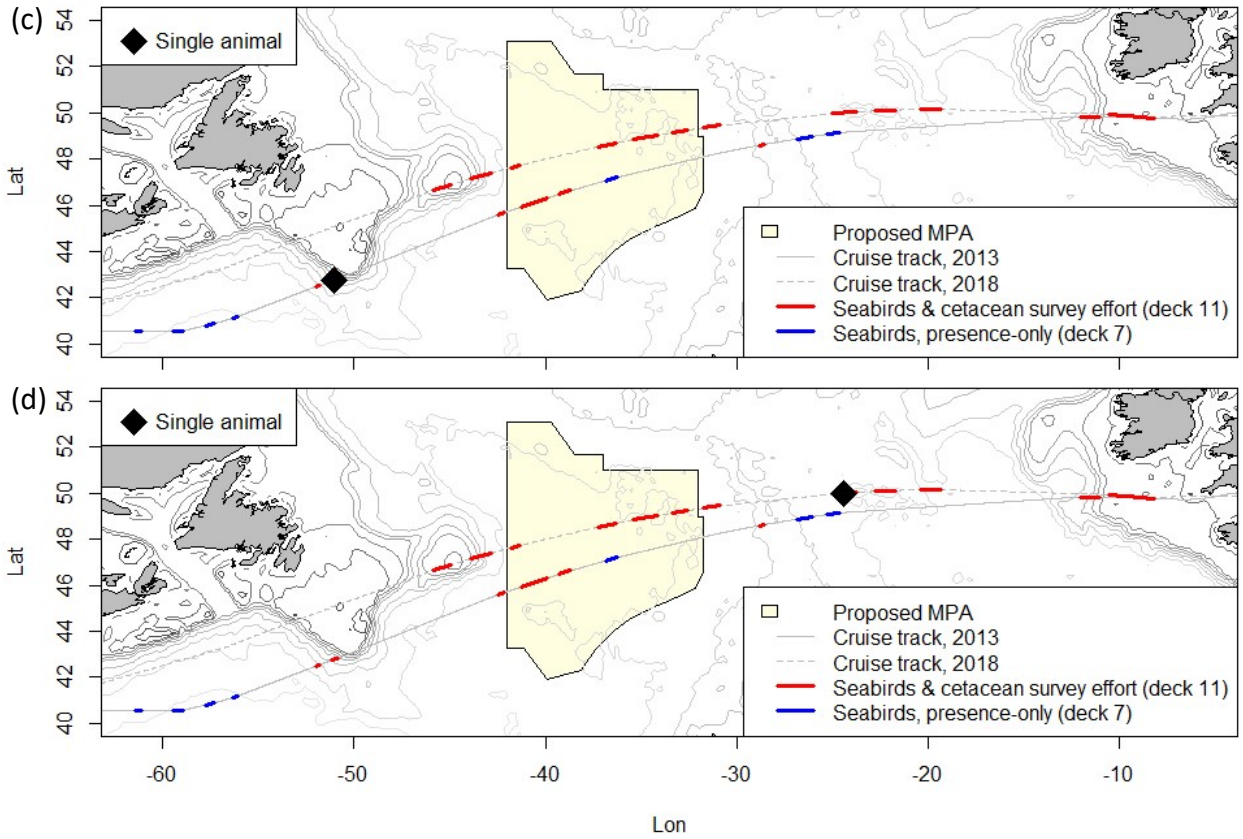


Figure 20. Sightings of turtles and sharks: (a) Unidentified turtle, (b) leatherback turtle, (c) a loggerhead turtle and (d) an unidentified shark.

Discussion

Data presented in this report are generally raw counts, with no correction for the tendency to the detectability of animals to decay with distance, increasing sea state, etc. (Buckland et al. 2001). Caution should therefore be exercised when comparing apparent abundance, both within this dataset and with other datasets. This caveat notwithstanding, my observations in July 2013 and 2018 support the inference drawn from analyses of tracking data that seabird diversity and abundance is relatively high in the area between the Flemish Cap and the Mid-Atlantic Ridge (Wakefield and and 54 others 2012, BirdLife International 2017), which has therefore been proposed by BirdLife International as a candidate Marine Protected Area. My results also support the conclusion of a more extensive at-sea survey carried out during June 2017 (cruise DY080) that in summer, the avifauna of this area is dominated by great shearwaters, northern fulmars and Cory's shearwaters (Wakefield 2018). Other species which are particularly abundant at this time are Leach's petrels, long-tailed skuas and south polar skuas. These species do not occur uniformly but apparently exhibit some degree of zonation, probably reflecting dominance of the area by a banded system of water masses, separated by east-west running fronts (Belkin and Levitus 1996). Fulmars, great shearwaters and baleen whales aggregate at the strongest of these, the sub-polar front, especially in the northeast of the area in the Charlie-Gibbs Fracture Zone (Waring et al. 2009, Boertmann 2011, Edwards et al. 2013, Víkingsson et al. 2013, Wakefield 2018). Species associated with subtropical waters, such as Cory's shearwaters, south

polar skuas and striped dolphins occur further south, while Leach's petrels have a westwards bias in their distribution (Magalhaes et al. 2008, Boertmann 2011, Kopp et al. 2011, Hedd et al. 2018, Wakefield 2018). Describing these patterns and determining their causes is part of my ongoing research.

Comparatively few at-sea surveys of seabirds and cetaceans have been carried out in the cMPA (See Introduction) and many of these occurred in sea states that would have made detection of beaked whales and *Kogia* sp. difficult (Boertmann 2011, Wilson et al. 2011, Lacey 2017). The cetaceans are small, unobtrusive and have long dive intervals, making them difficult to see in all but very calm conditions (Barlow 1999). These taxa may therefore be under represented in assessments of the biodiversity of the cMPA. Having encountered very calm conditions in 2013 in the southwest of the cMPA in 2013, I was able to search more thoroughly than normal for cetaceans. It was notable that at least six cetacean species were sighted in this area in just 90 km of survey track, comprising both deep divers (sperm whale, *Kogia* sp, *Mesoplodon* sp., *Globicephala* sp.) and epipelagic foragers (striped dolphin and short-beaked common dolphin). Great and Cory's shearwaters were also abundant in this area, often foraging in association with dolphins. Such high cetacean diversity may be typical of the cMPA, as beaked and baleen whales were also sighted in the east of the area in 2018 in less favourable conditions. Also notable in this area was the high density of gelatinous plankton, including *Physalia physalia*, colonial salps and *Cestida* comb jellies.

To my knowledge, neither *Mesoplodon* sp. (probably Sowerby's beaked whales *M. bidens*) nor *Kogia* sp. (probably dwarf sperm whales *K. sima*) have been recorded in the cMPA previously. More study could usefully be applied to stabling these status of these and other cetaceans in the cMPA. Given that most observations of beaked whales seen during surveys in the vicinity could not be identified (Priede 2007, Waring et al. 2009, Wilson et al. 2011)., this may require acoustic, as well as visual techniques. Similarly, the status of some scarce or difficult to identify bird taxa in the cMPA would benefit from further study. My sightings of common minke whales in 2018 were the first that I can find record of in the cMPA but this species probably occurs there regularly (Van Waerebeek et al. 1999, Risch et al. 2014, Silva et al. 2014) and is perhaps overlooked due to its small size compared to other baleen whales and lack of a visible blow. Similarly, Fea's petrel had not hitherto been recorded during a ship-based survey in the cMPA but tracking data show that birds from the Desertas population forage there in the summer (Paiva et al. 2010a).

Beyond the cMPA, another notable aggregation of cetaceans was recorded in 2018. This occurred during 128 km of survey effort over the Thulean Rise, in deep water between the Mid-Atlantic Ridge and the Celtic Sea. The cetacean assemblage there included common minke whale, fin whale, Sowerby's beaked whale, northern bottlenose whale, *Globicephala* sp., striped dolphin and short-beaked common dolphin. This area was crossed in very light winds (generally Beaufort 2 or less) so cetaceans were more detectable than in other areas traversed in 2018. Interestingly, this area did not have particularly high seabird abundance or diversity.

Line-transect survey effort for cetaceans has not increased in recent years, despite a growing awareness of the need to protect marine megafauna (Kaschner et al. 2012). Moreover, the focus of seabird distribution research has shifted from at-sea surveys to tracking studies. However,

even modest surveys, such as that reported here, can reveal valuable insights about the diversity of the high seas, which still remain poorly surveyed and understood. Today, there is probably more opportunity than ever before to carry out at-sea surveys at relatively small economic cost using platforms of opportunity, such as research ships and cruise ships. For example, the *Queen Mary II* follows a great circle route, passing through the North Atlantic Current and Evlanov Seamount candidate Marine Protected Area, approximately bimonthly between April to January. Repeated surveys along such routes could be used to build up a picture of how seabird and cetacean diversity and abundance varies throughout the year in deep ocean hotspots (Compton et al. 2007)

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