Article Type: Research Article

Profiling Small-Scale Oil Discharges on Canada's East Coast: the Impact of Surveillance Method and Preliminary Spatial Trends

David J. Lieske[1,2], Matthew Mahoney[3], Patrick O'Hara[4], Sabina Wilhelm[5], Rebecca Whittam[6], Ronald Pelot[7]

[1] Department of Geography and Environment, Mount Allison University, 144 Main Street, Sackville, NB, Canada, E4L 1A7.

[2] Corresponding author: dlieske@mta.ca

[3] Environment Canada, 17 Waterfowl Lane, Sackville, NB, Canada, E4L 1G6.

[4] Canadian Wildlife Service, Institute of Ocean Science, Sidney, BC, Canada, V8L 4B2

[5] Canadian Wildlife Service, Environment Canada, 6 Bruce Street, Mount Pearl, NL, Canada, A1N 4T3

[6] Bird Studies Canada, Atlantic Region, P.O. Box 6227, Sackville, NB, Canada, E4L 1G6

[7] Faculty of Engineering, Dalhousie University, Halifax, NS, Canada, B3J 2X4

Keywords: Oil discharges; Oil spills; Oil spill detection; National Aerial Surveillance Program; Side-looking airborne radar; Maritime Canada

Abstract

Through a retrospective analysis of the Canadian National Aerial Surveillance Program (NASP) we compared the effectiveness of side-looking airborne radar (SLAR) with unaided surveillance, and examined the spatial pattern of maritime oil pollution events. Overall, 84 oil discharges were encountered over 333 surveillance flights (0.25 discharges per flight), which was somewhat lower than the encounter rate for British Columbia (0.34 discharges per flight). SLAR-enabled aircraft were substantially more effective than unaided ones, inspecting 16x as much area and encountering more oil discharges (0.30 vs. 0.16 oil discharges / flight). In terms of oil-spill loading, unaided surveillance yielded an average oil spill density of 0.18 ± 0.094 SE (x 10^{-4}) discharges per km^2, compared to 0.026 ± 0.007 (x10^{-4}) discharges per km^2 for SLAR-enabled surveys. We provide a map of the distribution of small-scale oil pollution, and relate regional patterns to differences in the nature and volume of marine traffic.

1. Introduction

Chronic, small-scale oil pollution is a significant threat to marine ecosystems. Of the various types of oil pollution inputs into marine environments (see National Research Council 2003, GESAMP 2007), accidental or deliberate ship-source oily discharges are thought to pose the most serious problem because of their tendency to form coherent slicks that are more likely to impact organisms that live near the ocean surface such as seabirds, marine mammals, and emergent vegetation (Baker 1983, Boilé et al. 2005). Effects are felt at the ecosystem-level, primarily through the disruptions of food webs (National Research Council 2003) but also at the organismal level through impacts on survival, behaviour, and physiology (Burger and Fry 2003, Burger

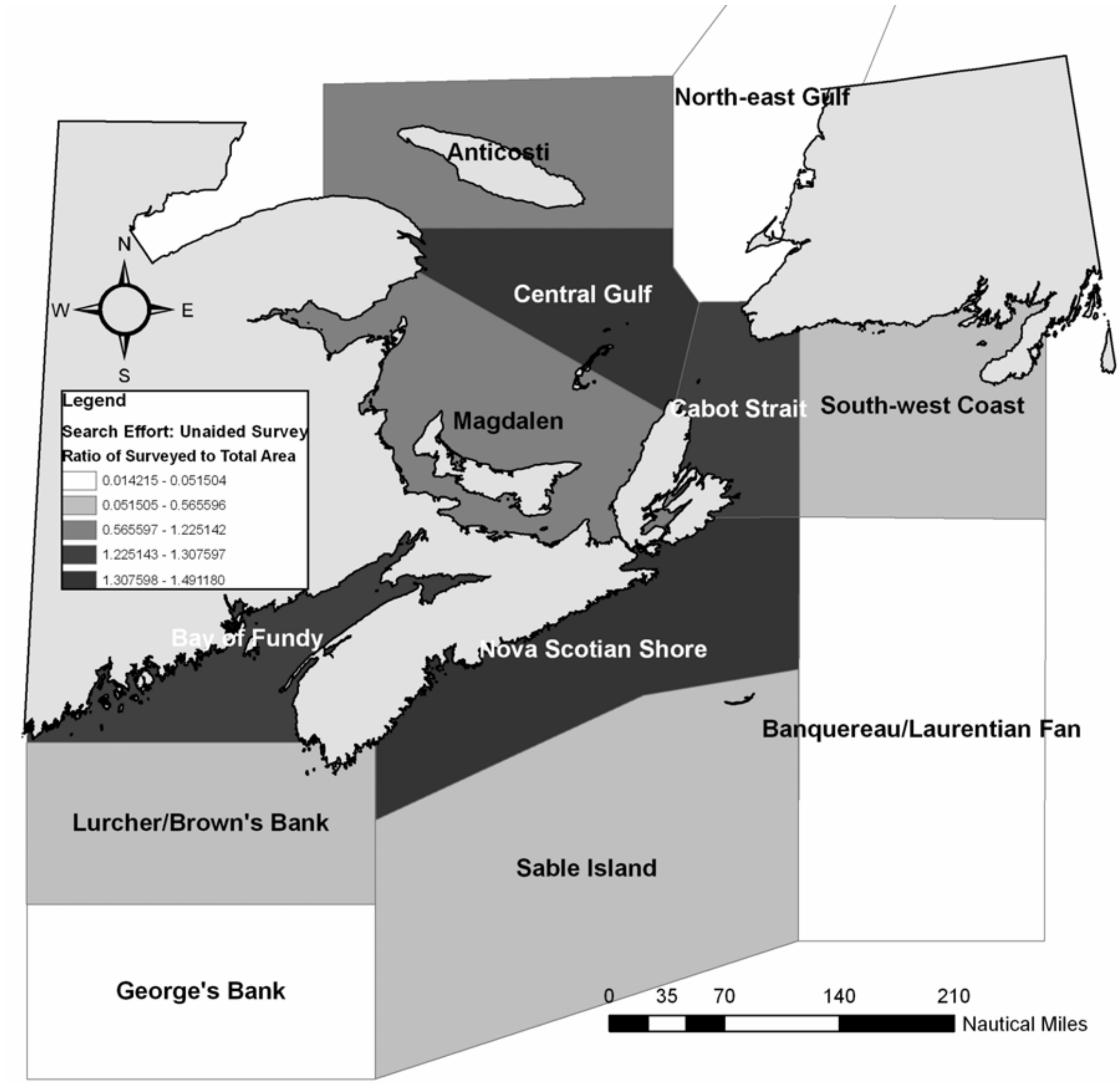

North-east Gulf
Anticosti
Central Gulf
N
W
E
S
Legend
Search Effort: Unaided Survey
Ratio of Surveyed to Total Area
0.014215 - 0.051504
0.051505 - 0.565596
0.565597 - 1.225142
1.225143 - 1.307597
1.307598 - 1.491180
Magdalen
Cabot Strait
South-west Coast
Bay of Fundy
Nova Scotian Shore
Banquereau/Laurentian Fan
Lurcher/Brown's Bank
Sable Island
George's Bank
0 35 70 140 210
Nautical Miles

Figure 1a.

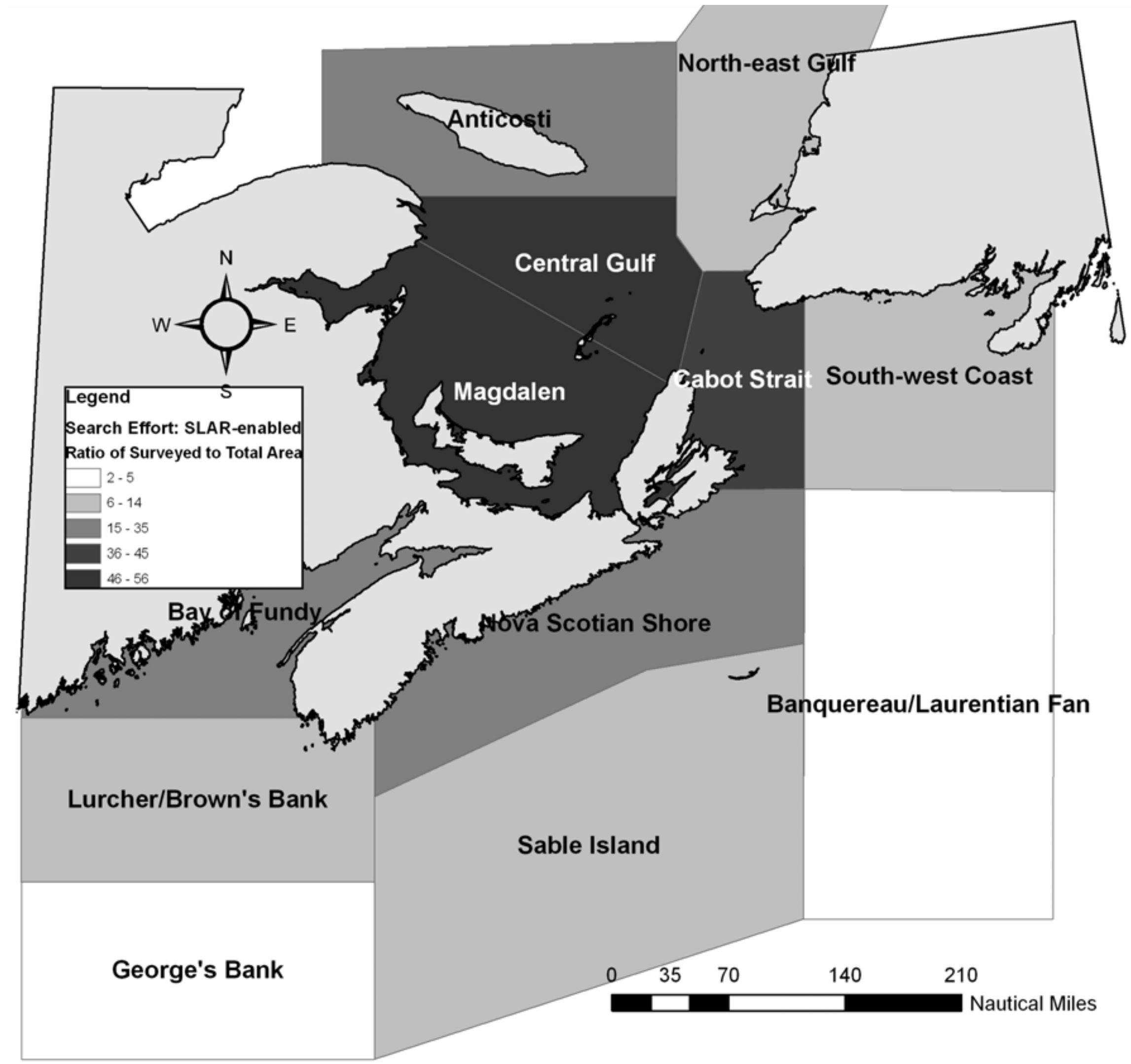

North-east Gulf
Anticosti
Central Gulf
N
W
E
S
Cabot Strait
South-west Coast
Magdalen
Legend
Search Effort: SLAR-enabled
Ratio of Surveyed to Total Area
2 - 5
6 - 14
15 - 35
36 - 45
46 - 56
Bay of Fundy
Nova Scotian Shore
Banquereau/Laurentian Fan
Lurcher/Brown's Bank
Sable Island
George's Bank
0 35 70 140 210
Nautical Miles

Figure 1b.

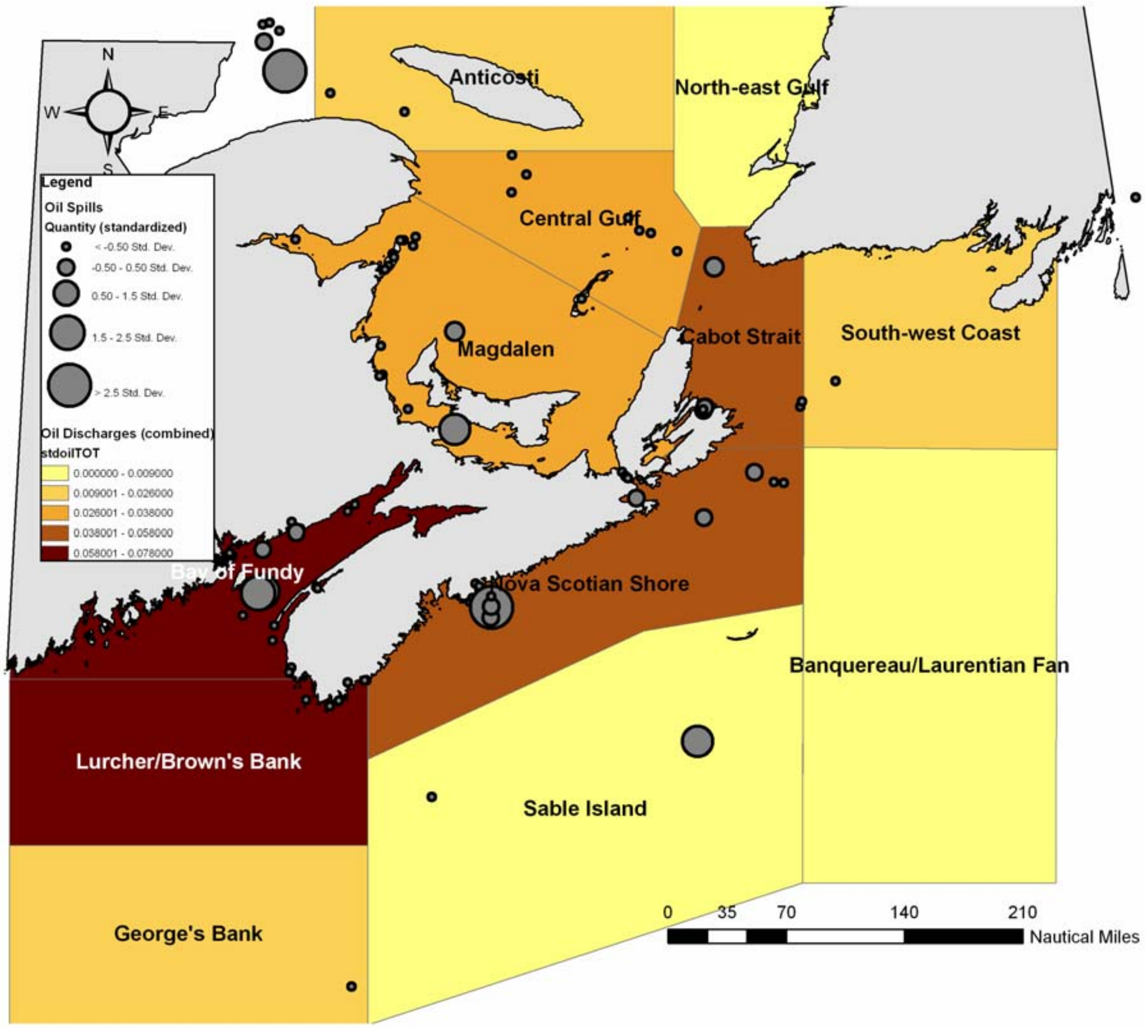

N
W
E
S
Legend
Oil Spills
Quantity (standardized)
< -0.50 Std. Dev.
-0.50 - 0.50 Std. Dev.
0.50 - 1.5 Std. Dev.
1.5 - 2.5 Std. Dev.
> 2.5 Std. Dev.
Oil Discharges (combined)
stdoilTOT
0.000000 - 0.009000
0.009001 - 0.026000
0.026001 - 0.038000
0.038001 - 0.058000
0.058001 - 0.078000
Anticosti
North-east Gulf
Central Gulf
Magdalen
Cabot Strait
South-west Coast
Bay of Fundy
Nova Scotian Shore
Banquereau/Laurentian Fan
Lurcher/Brown's Bank
Sable Island
George's Bank
0 35 70 140 210
Nautical Miles

Figure 2.

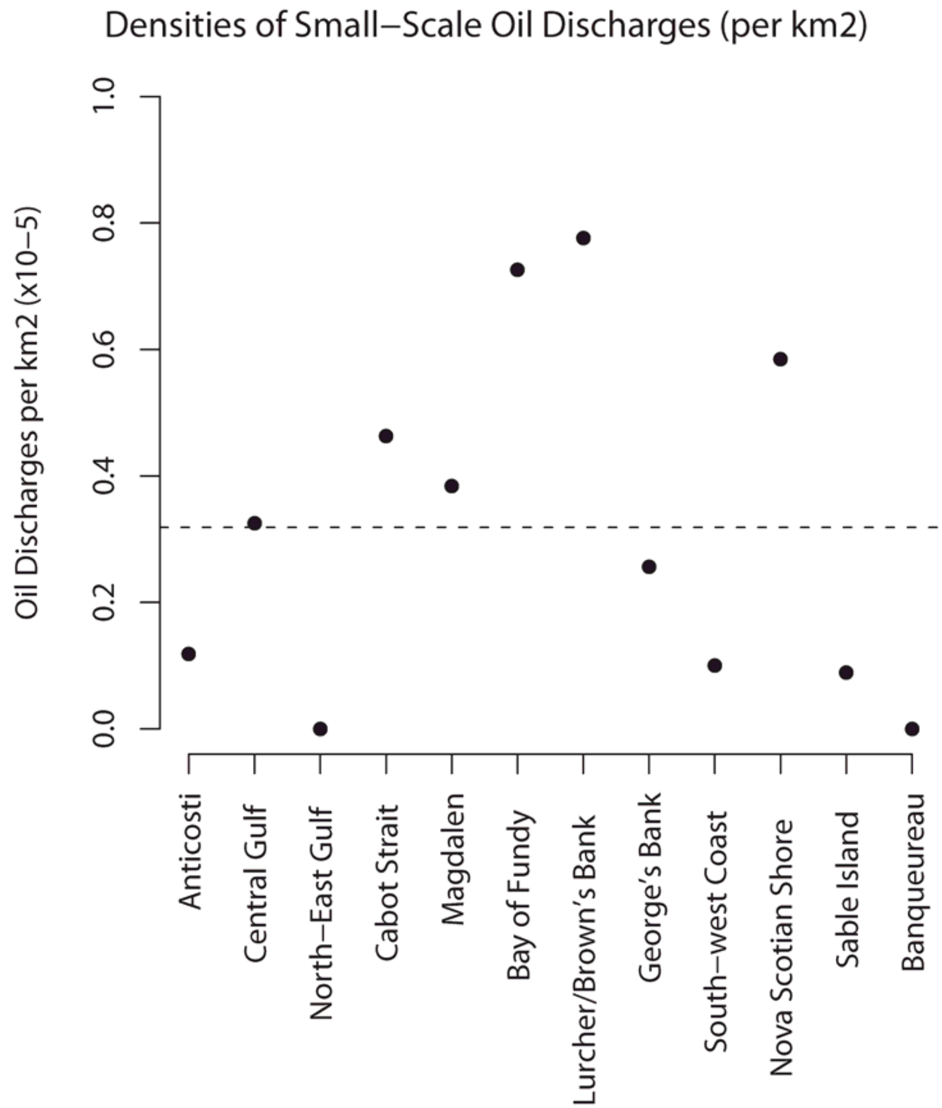
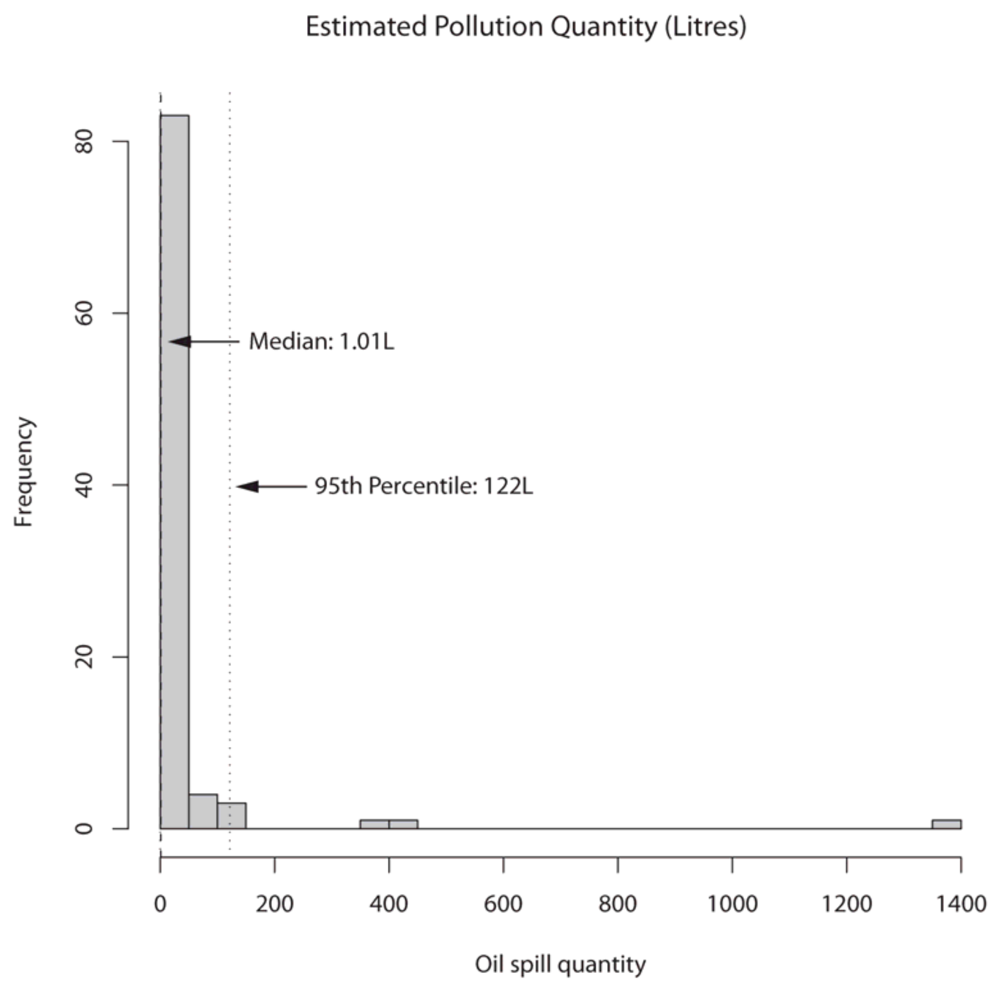

Densities of Small−Scale Oil Discharges (per km2)
Oil Discharges per km2 (x10−5)
0.0
0.2
0.4
0.6
0.8
1.0
Anticosti
Central Gulf
North−East Gulf
Cabot Strait
Magdalen
Bay of Fundy
Lurcher/Brown's Bank
George's Bank
South−west Coast
Nova Scotian Shore
Sable Island
Banqueureau

Figure 3.



Estimated Pollution Quantity (Litres)
Median: 1.01L
95th Percentile: 122L
Frequency
0
20
40
60
80
0
200
400
600
800
1000
1200
1400
Oil spill quantity

Figure 4.

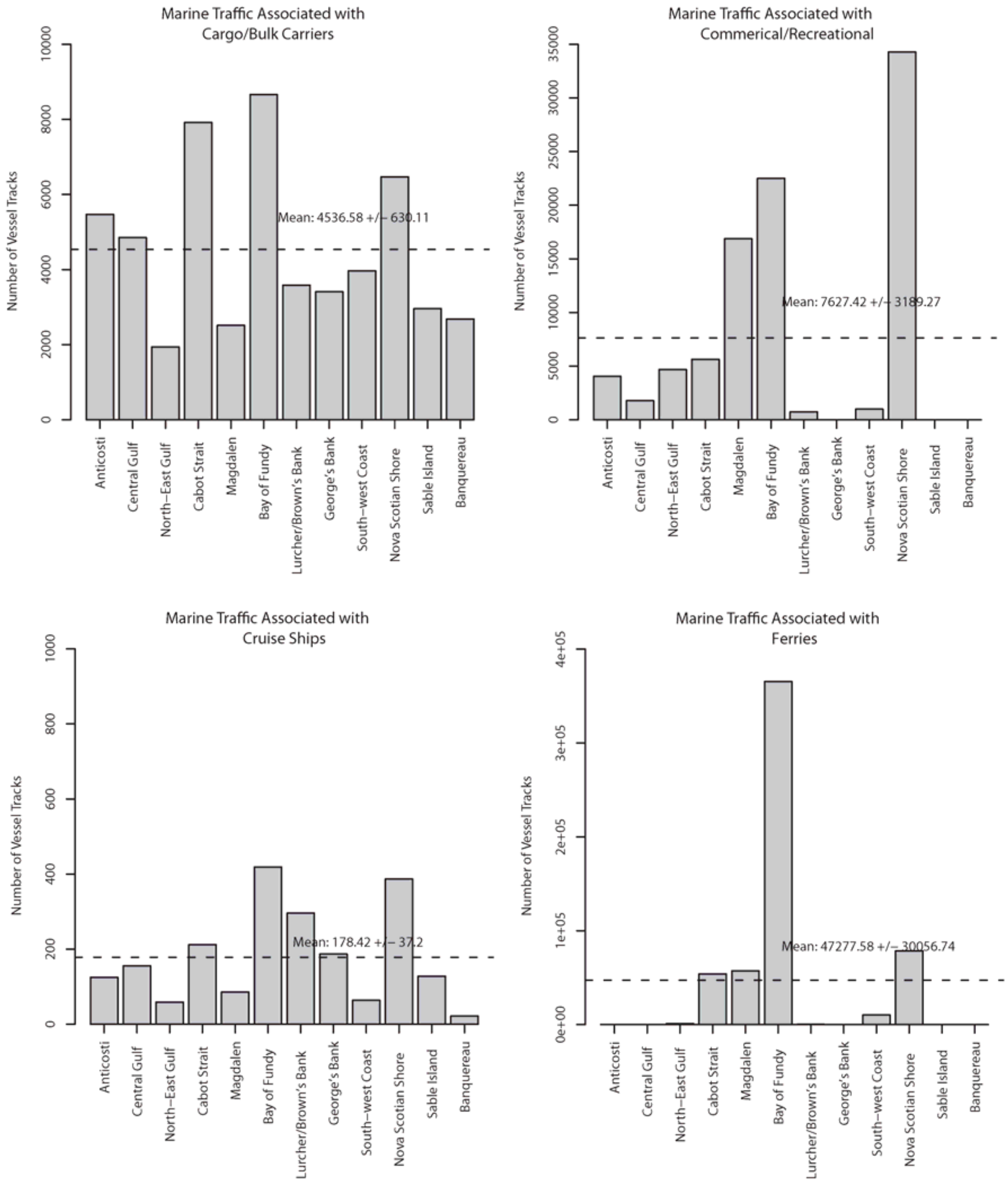

Marine Traffic Associated with Cargo/Bulk Carriers
Number of Vessel Tracks
0
2000
4000
6000
8000
10000
Mean: 4536.58 +/– 630.11
Anticosti
Central Gulf
North–East Gulf
Cabot Strait
Magdalen
Bay of Fundy
Lurcher/Brown's Bank
George's Bank
South–west Coast
Nova Scotian Shore
Sable Island
Banquereau
Marine Traffic Associated with Commerical/Recreational
Number of Vessel Tracks
0
5000
10000
15000
20000
25000
30000
35000
Mean: 7627.42 +/– 3189.27
Anticosti
Central Gulf
North–East Gulf
Cabot Strait
Magdalen
Bay of Fundy
Lurcher/Brown's Bank
George's Bank
South–west Coast
Nova Scotian Shore
Sable Island
Banquereau
Marine Traffic Associated with Cruise Ships
Number of Vessel Tracks
0
200
400
600
800
1000
Mean: 178.42 +/– 37.2
Anticosti
Central Gulf
North–East Gulf
Cabot Strait
Magdalen
Bay of Fundy
Lurcher/Brown's Bank
George's Bank
South–west Coast
Nova Scotian Shore
Sable Island
Banquereau
Marine Traffic Associated with Ferries
Number of Vessel Tracks
0e+00
1e+05
2e+05
3e+05
4e+05
Mean: 47277.58 +/– 30056.74
Anticosti
Central Gulf
North–East Gulf
Cabot Strait
Magdalen
Bay of Fundy
Lurcher/Brown's Bank
George's Bank
South–west Coast
Nova Scotian Shore
Sable Island
Banquereau

Figure 5a

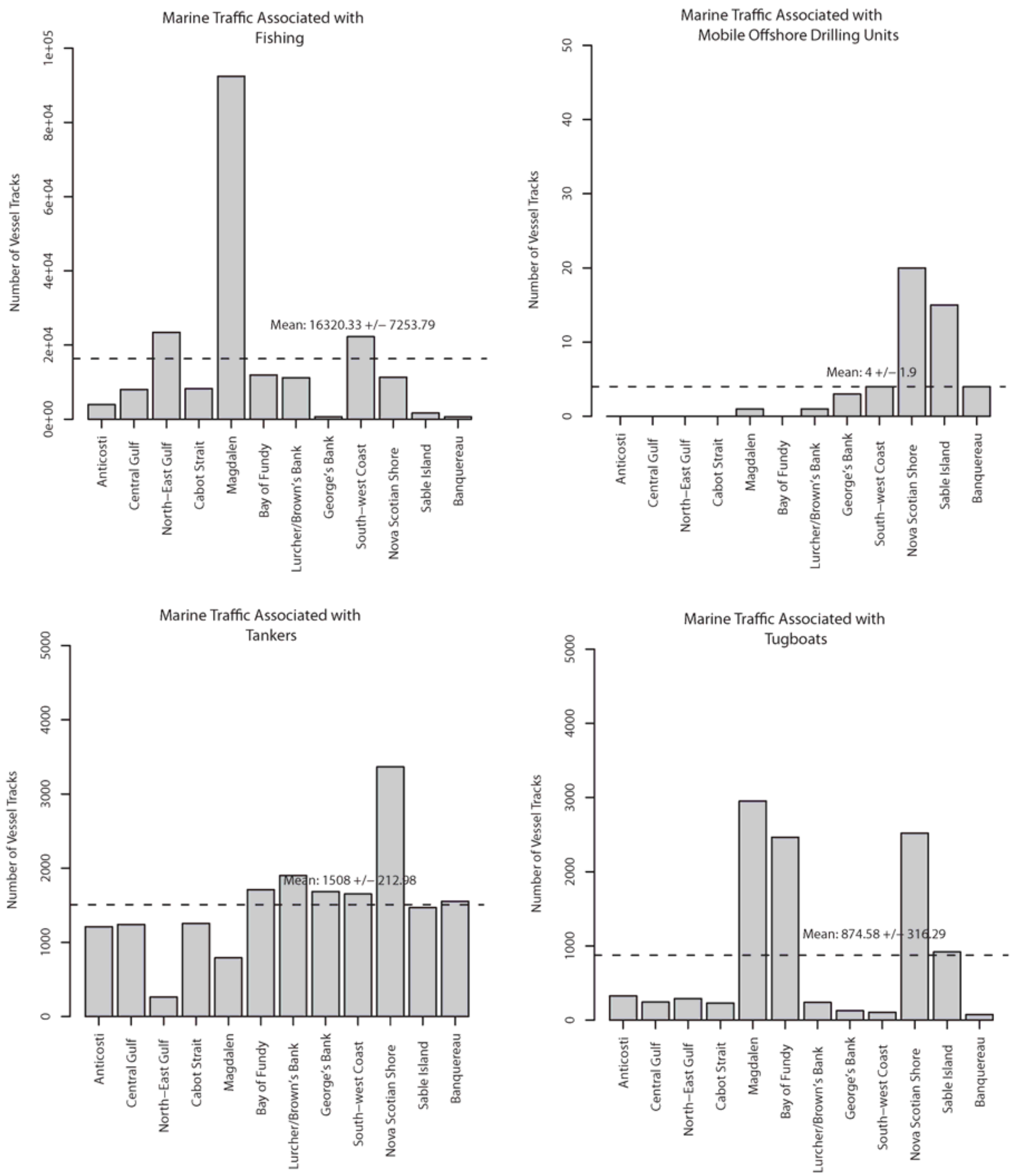

Marine Traffic Associated with Fishing
Number of Vessel Tracks
0e+00
2e+04
4e+04
6e+04
8e+04
1e+05
Mean: 16320.33 +/− 7253.79
Marine Traffic Associated with Mobile Offshore Drilling Units
0
10
20
30
40
50
Mean: 4 +/− 1.9
Marine Traffic Associated with Tankers
0
1000
2000
3000
4000
5000
Mean: 1508 +/− 212.98
Marine Traffic Associated with Tugboats
Mean: 874.58 +/− 316.29
Anticosti
Central Gulf
North−East Gulf
Cabot Strait
Magdalen
Bay of Fundy
Lurcher/Brown's Bank
George's Bank
South−west Coast
Nova Scotian Shore
Sable Island
Banquereau

Figure 5b.