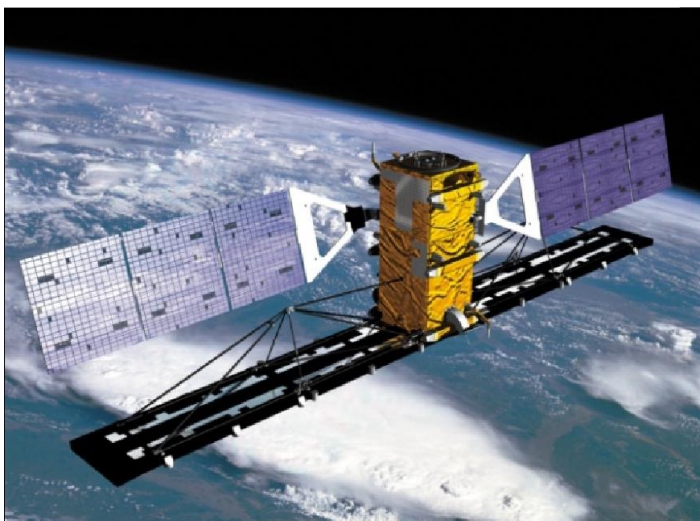


Monitoring marine conservation areas effectiveness using aerial & RADARSAT vessel detection



Lily Burke, lily.burke@dfo-mpo.gc.ca
Marine Spatial Ecology and Analysis Section

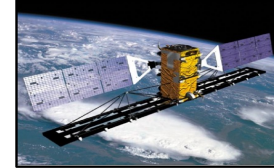
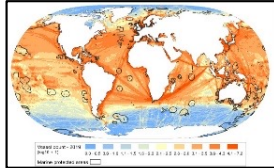


Fisheries and Oceans
Canada

Pêches et Océans
Canada

Evaluating vessel activity & fishing in Canada's Marine Protected Areas & fishing closures using vessel tracking datasets

Josephine Iacarella*, Lily Burke, Georgia Clyde, Emily Rubidge, Anya Dunham, Adam Wicks (Ebb & Flow Analytics) & Global Fishing Watch

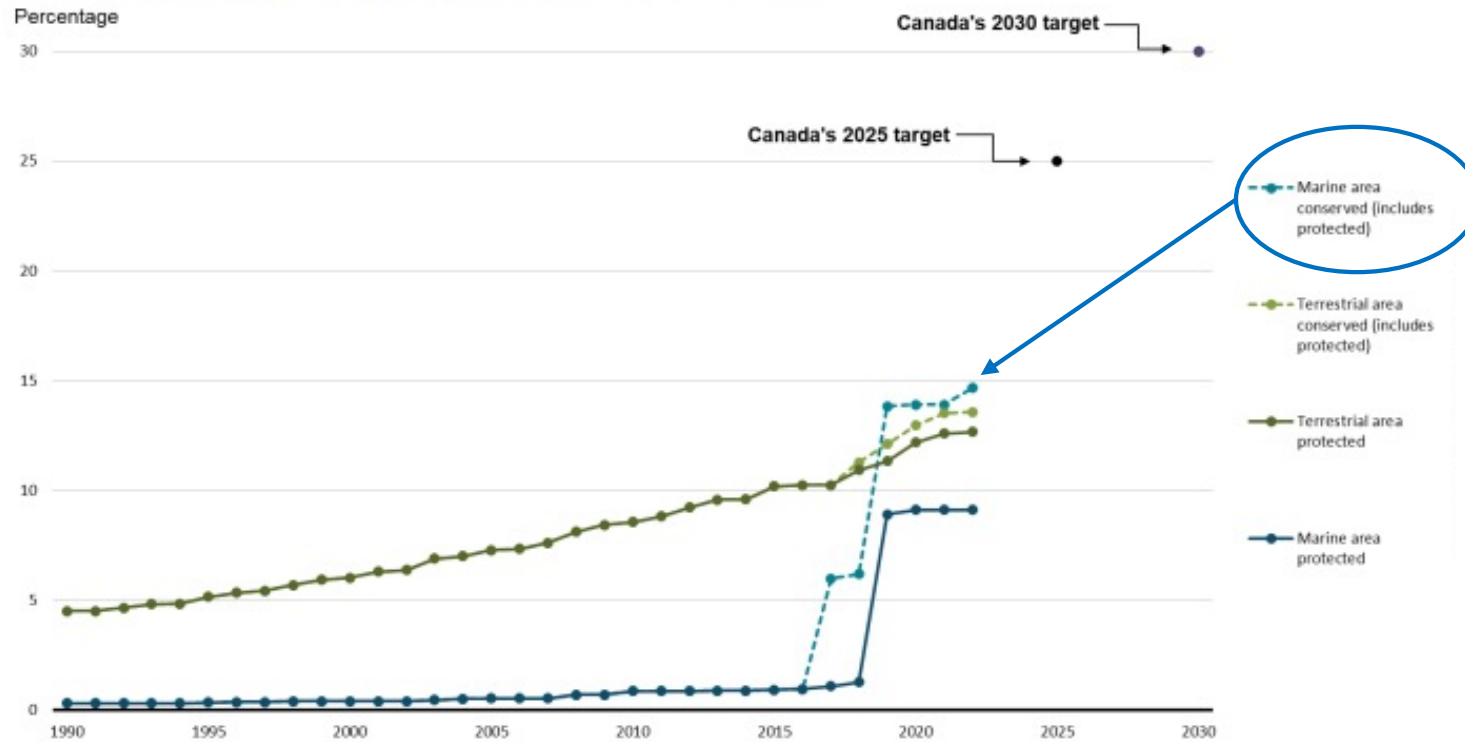


1. Iacarella, J.C., G. Clyde, and A. Dunham. (2020) Vessel tracking datasets for monitoring Canada's conservation effectiveness. Can. Tech. Rep. Fish. Aquat. Sci. 3387.
2. Iacarella, J.C., G. Clyde, B.J. Bergseth, and N.C. Ban. (2021) A synthesis of the prevalence and drivers of non-compliance in marine protected areas. Biological Conservation, 255, 108992
3. Burke, L., G. Clyde, B. Proudfoot, E. Rubidge, and J.C. Iacarella. (2022) Monitoring Pacific marine conservation area effectiveness using aerial and RADARSAT-2 (Synthetic Aperture Radar) vessel detection. Can. Tech. Rep. Fish. Aquat. Sci. 3479.
4. Iacarella, J.C., L. Burke, G. Clyde, A. Wicks, T. Clavelle, A. Dunham, E. Rubidge, and P. Woods. (2023) Application of AIS- and flyover-based methods to monitor illegal and legal fishing in Canada's Pacific marine conservation areas. Conserv. Sci. and Prac., 5(6), e12926.
5. Iacarella, J.C., L. Burke, G. Clyde, A. Wicks, T. Clavelle, A. Dunham, E. Rubidge, and P. Woods. (2023) Monitoring temporal and spatial trends of illegal and legal fishing in marine conservation areas across Canada's three oceans. Conserv. Sci. and Prac., 5(6), e12919.

Expansion of MPAs & other marine conservation areas

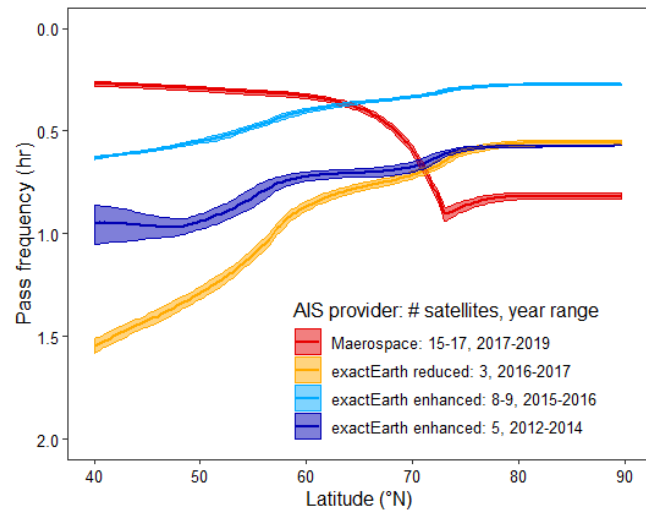
Canada committed to conserving 25% of our oceans by 2025 & 30% by 2030 ([Reaching Canada's marine conservation targets \(dfo-mpo.gc.ca\)](https://www.dfo-mpo.gc.ca/reaching-targets)).

Figure 1. Proportion of area conserved, Canada, 1990 to 2022



Conducted a national overview of GoC vessel tracking datasets*

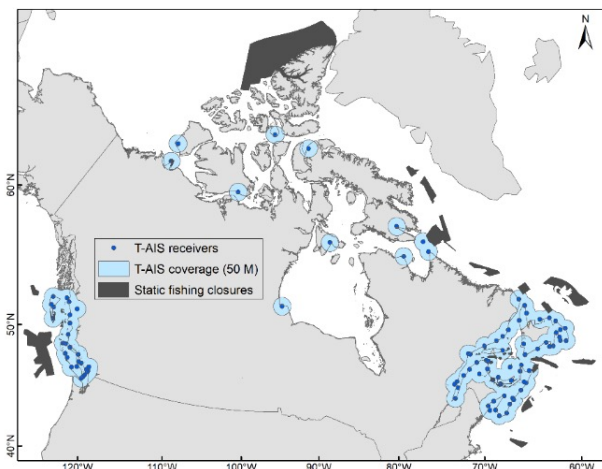
Satellite AIS



RADARSAT



Terrestrial AIS



Aerial surveillance



*Iacarella, J.C., G. Clyde, and A. Dunham. (2020) Vessel tracking datasets for monitoring Canada's conservation effectiveness. Can. Tech. Rep. Fish. Aquat. Sci. 3387.

Monitoring Pacific marine conservation area effectiveness using aerial & RADARSAT (Synthetic Aperture Radar) vessel detection

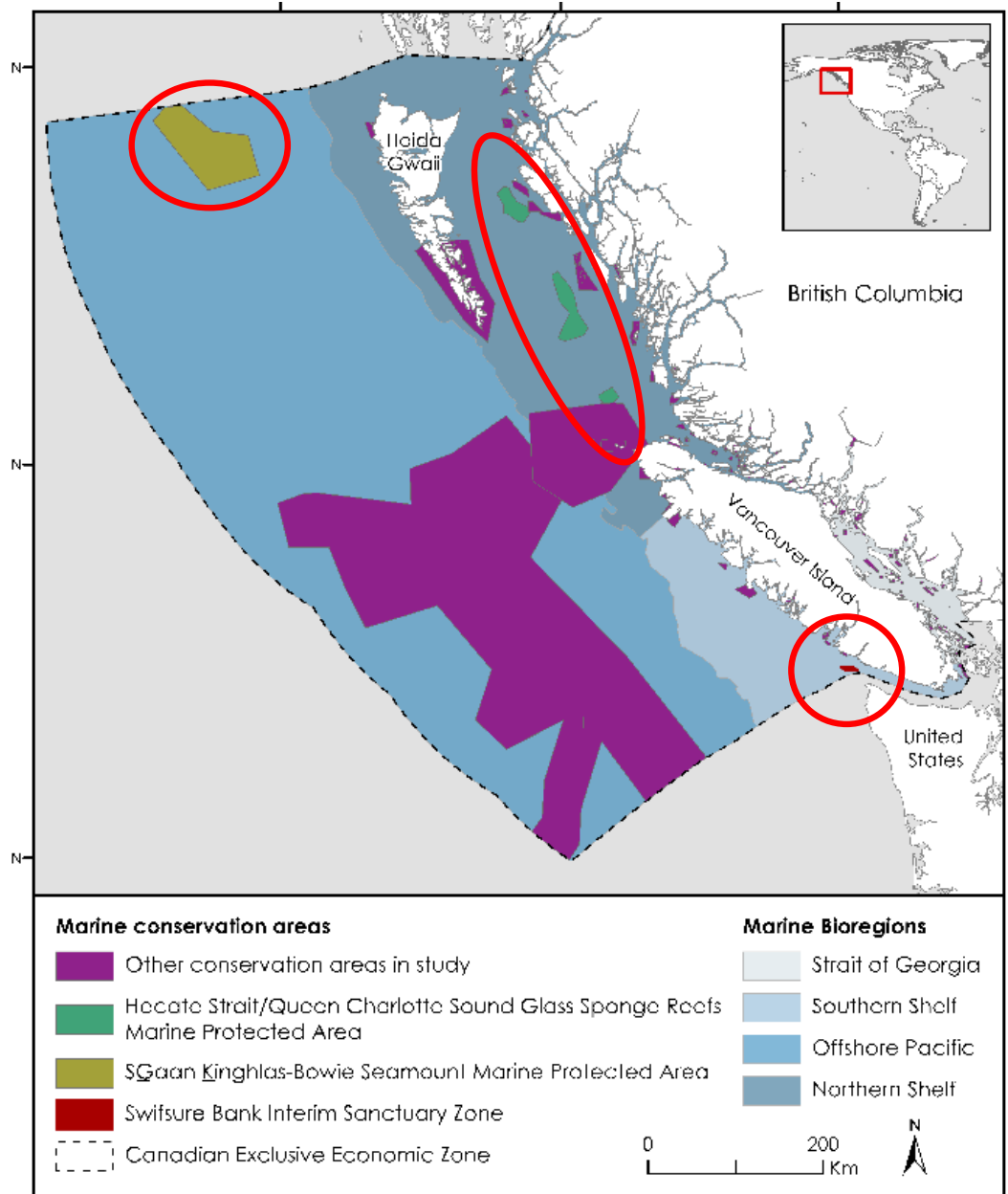
Lily Burke, Georgia Clyde, Beatrice Proudfoot, Emily Rubidge, and Josephine Iacarella
Can. Tech. Rep. Fish. Aquat. Sci. 3479.*

- Present satellite & aerial surveillance vessel density & surveillance effort within & surrounding Pacific closures for 2020
- Demonstrate how these vessel tracking methods can monitor compliance in marine conservation areas using 3 case-studies
- Provide guidance for monitoring vessel density & for adaptive management/surveillance



Data: Pacific marine conservation areas

- 188 marine conservation areas
- MPAs, RCAs, Strait of Georgia/Howe Sound glass sponge reefs marine refuges, Offshore Pacific Seamounts & Vents Closure, National Marine Conservation Area Reserve, marine National Wildlife Area & Interim Sanctuary Zone
- All areas have vessel-related restrictions or prohibitions
- 3 case-studies: Hecate Strait/Queen Charlotte Sound glass sponge reefs MPA, SGaan-Kinghlas-Bowie (SK-B) Seamount MPA, & Swiftsure Bank Interim Sanctuary Zone



Data: Aerial Surveillance

- Conservation & Protection (C&P) Aerial Surveillance Program - surveillance & enforcement of DFO regulated closures (e.g., MPAs, RCAs)
- Transport Canada (TC) National Aerial Surveillance Program - surveillance of Hecate, SK-B & Endeavour MPAs

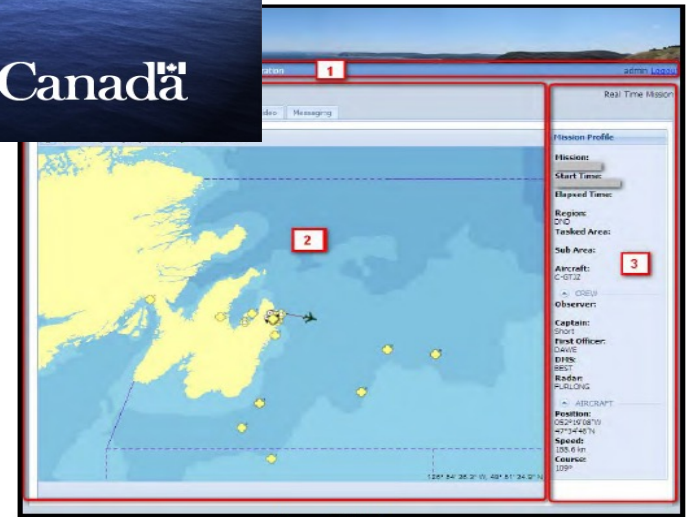


Figure 9: GIII areas



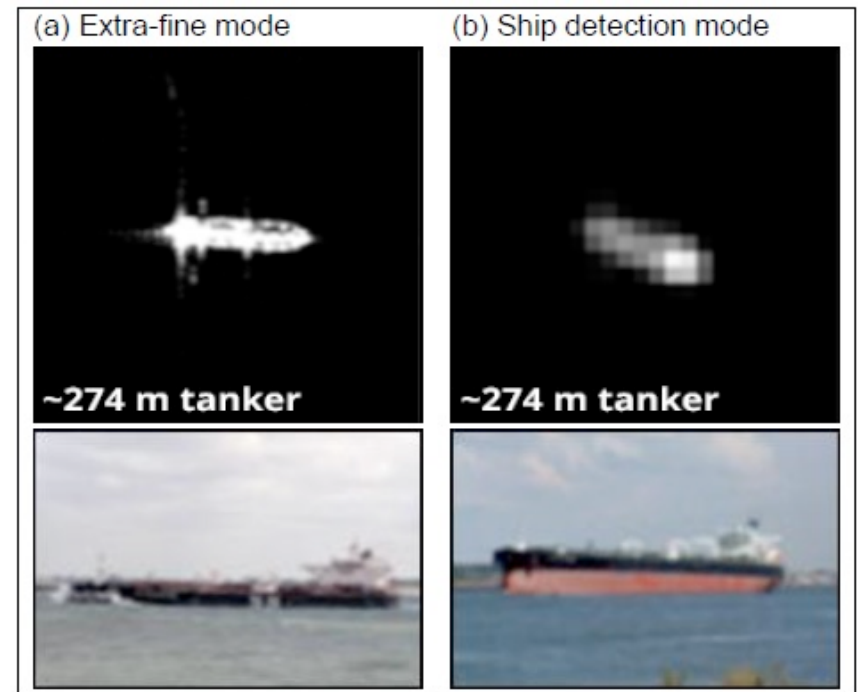
OBSERVATION SUMMARY				
Approx. Time (hours):	Overflow (Y/N):	Vessel(s) within MPA (Type, AIS, Name, Fishing, Course):		
0.2	Y			
Sponge Reefs	Central Reefs	0.2	Y	None
	Southern Reef	0.1	Y	None
	SGaan Kinghlas-Bowie Seamount	-	N	-
	Endeavour Hydrothermal Vents	-	N	-

ADDITIONAL DETAILS REGARDING ANY OBSERVATIONS (ATTACH IMAGERY/MAP IMAGES): Images and DBExport file attached.

FLIGHT DATE (DAY/MO/YR):	06 October 2020
REGION:	Pacific
APPROX. TOTAL TIME WITHIN MPA's (HRS):	0.5

Data: RADARSAT satellite imagery

- Department of National Defence (DND) national surveillance & C&P surveillance of Hecate, SK-B & Offshore seamounts
- Detected ship lengths ≥ 8 m (Hecate until July 15, 2020) & ≥ 25 m (all of BC EEZ, Hecate post July 15, 2020)
- DND currently providing RADARSAT data at no cost to support the DFO-Pacific MPA program on a non-interference basis

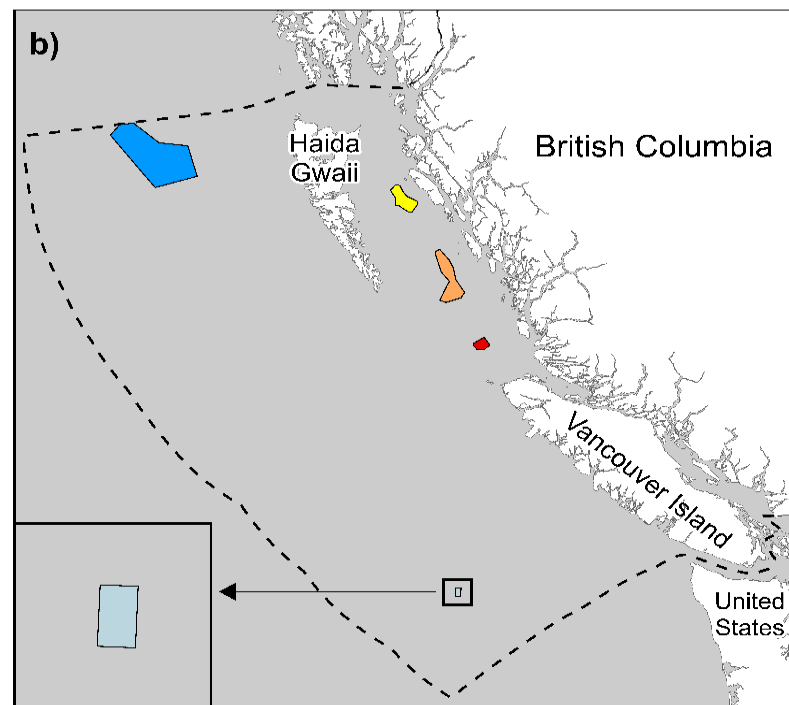
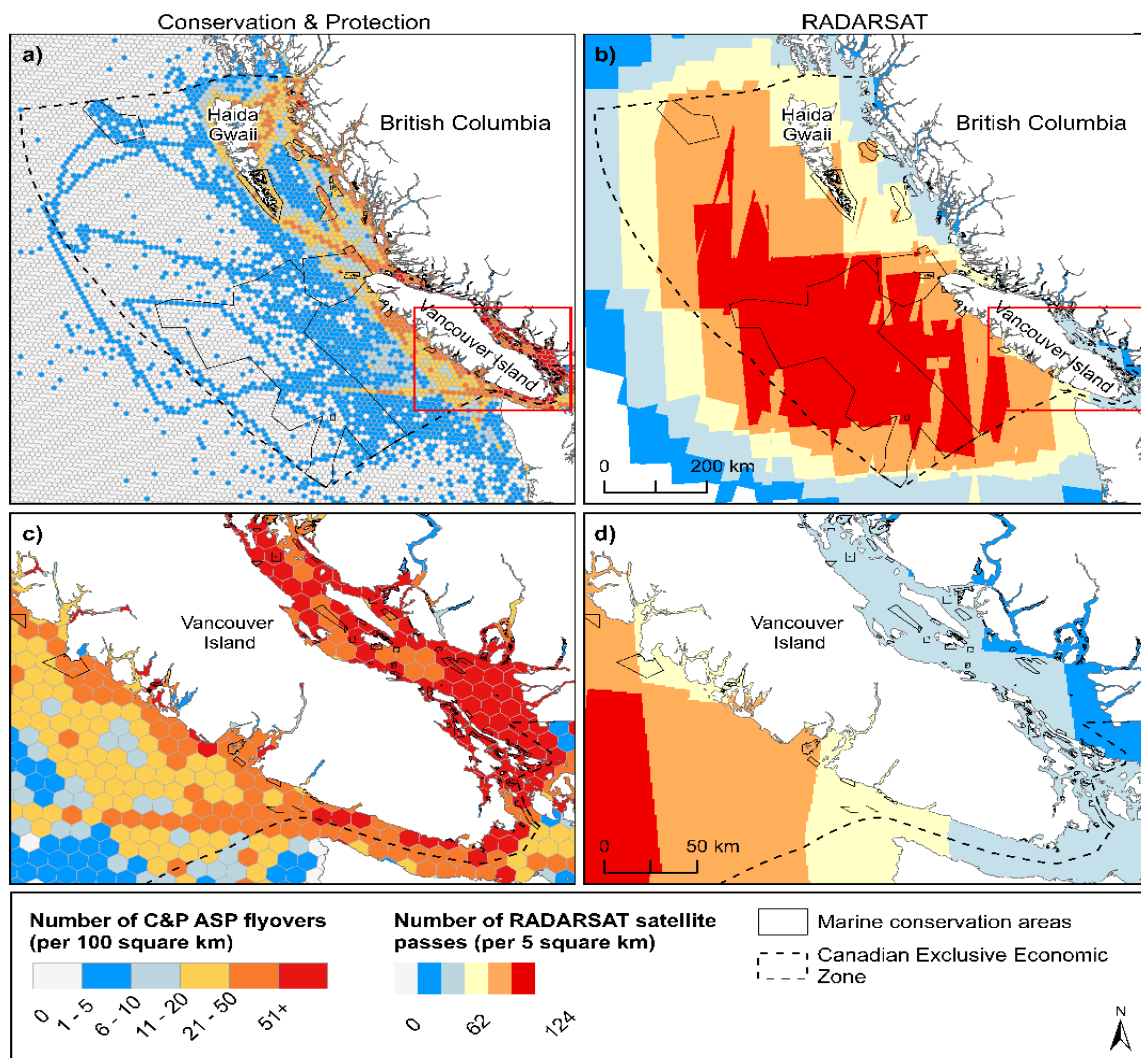


Surveillance effort

C&P: 199 flyovers,
higher surveillance
in coastal areas

RADARSAT: 310 swaths,
higher surveillance in
offshore area

TC: 122 flyovers, most in Hecate MPA



Vessel detections

Source	AIS vessels	Non-AIS vessels	Total vessels
C&P ASP	64, 272 (85%)	11,509 (15%)	75,781
TC NASP	44 (90%)	5 (10%)	49
RADARSAT	8,781 (59%)	6,157 (41%)	14,938

C&P:

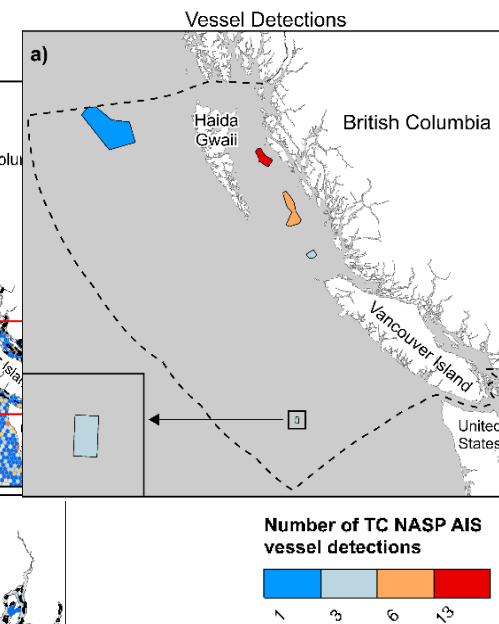
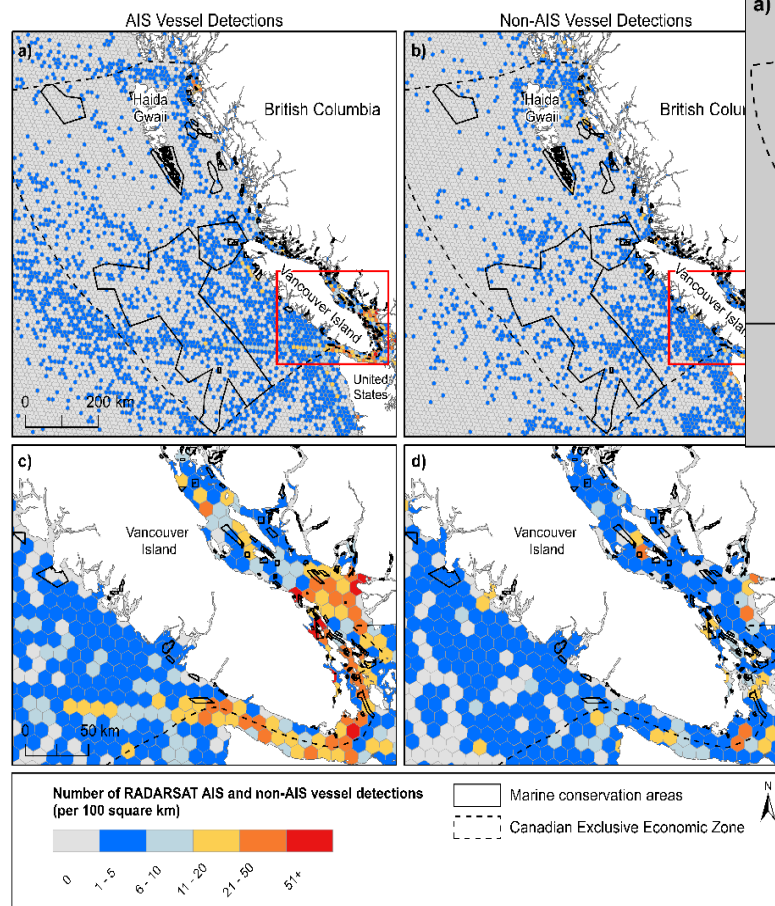
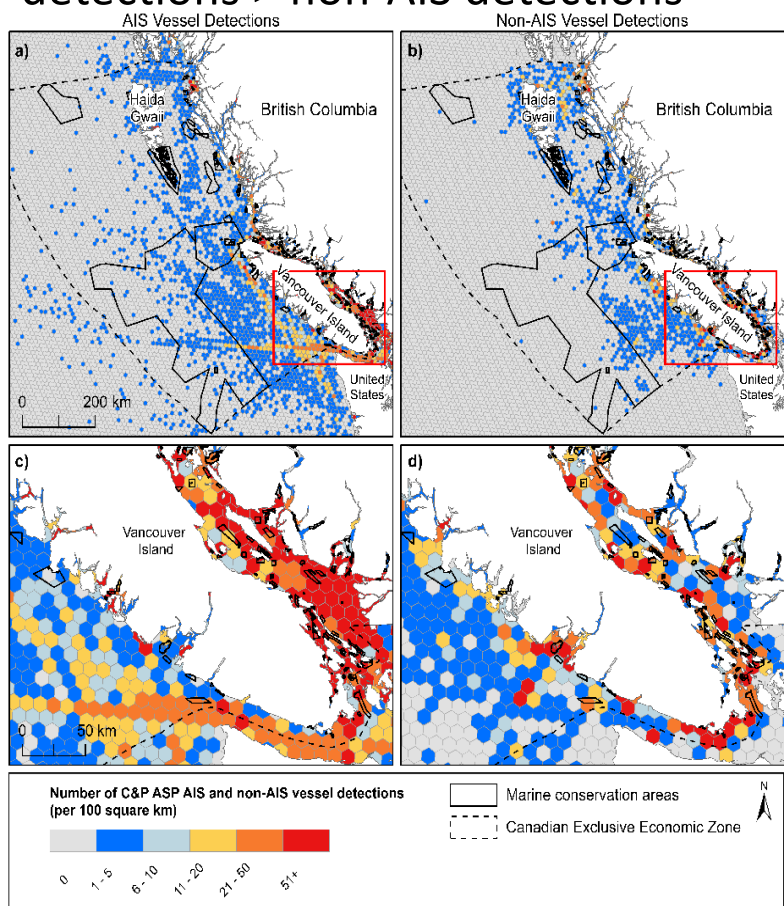
More vessels overall, more vessels in coastal areas, AIS detections > non-AIS detections

RADARSAT:

More vessels in Offshore, AIS/non-AIS detections similar

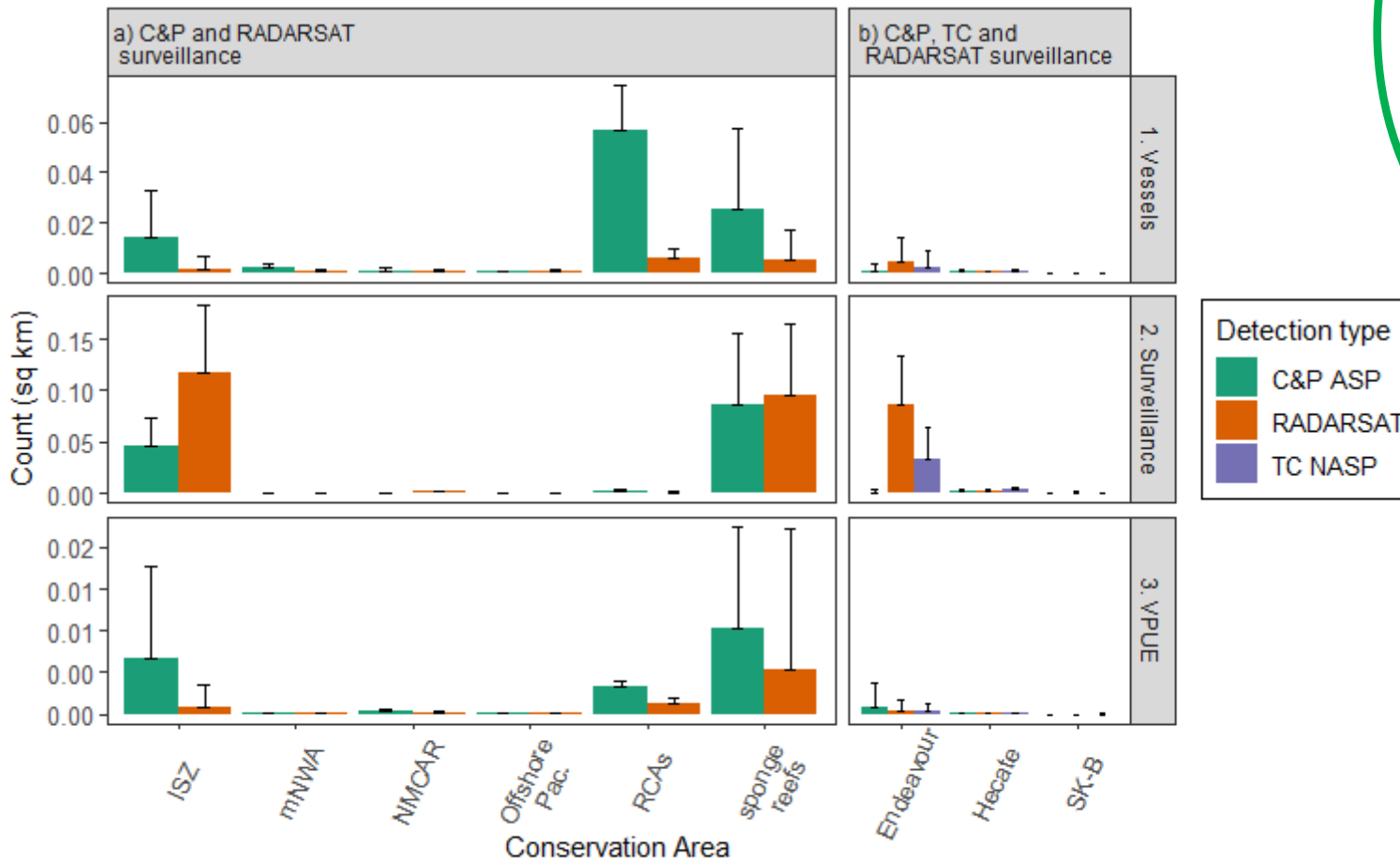
TC:

Most in Hecate



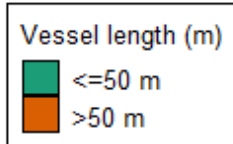
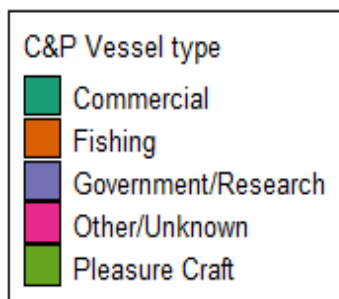
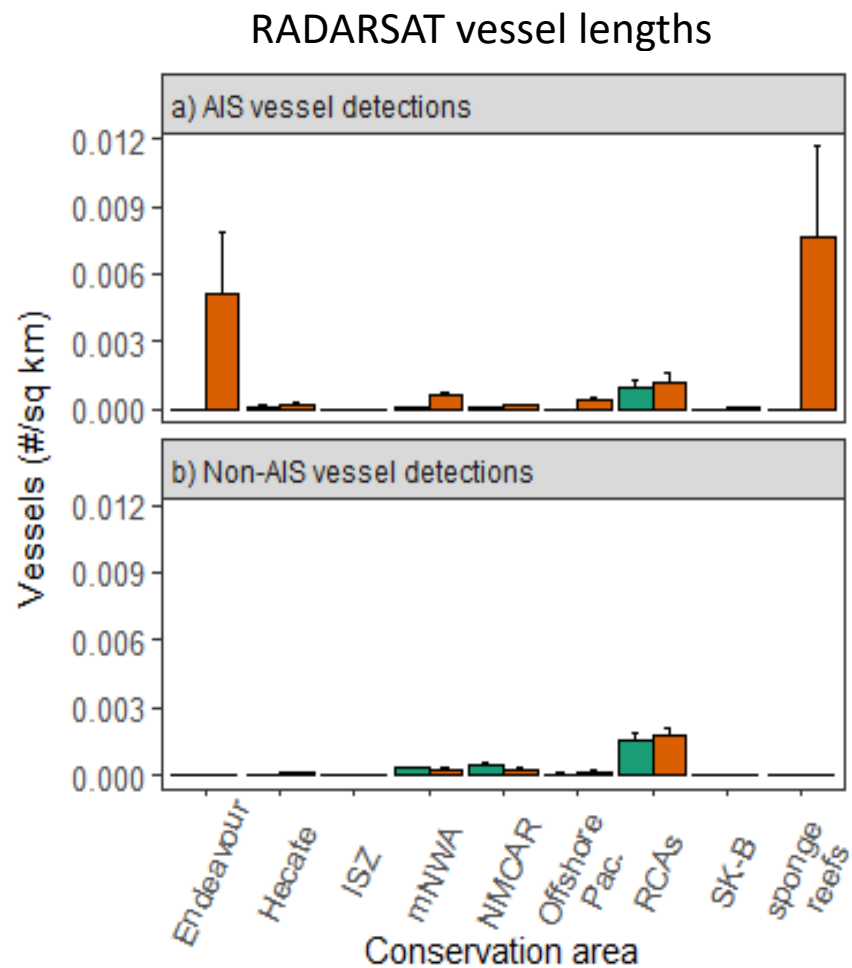
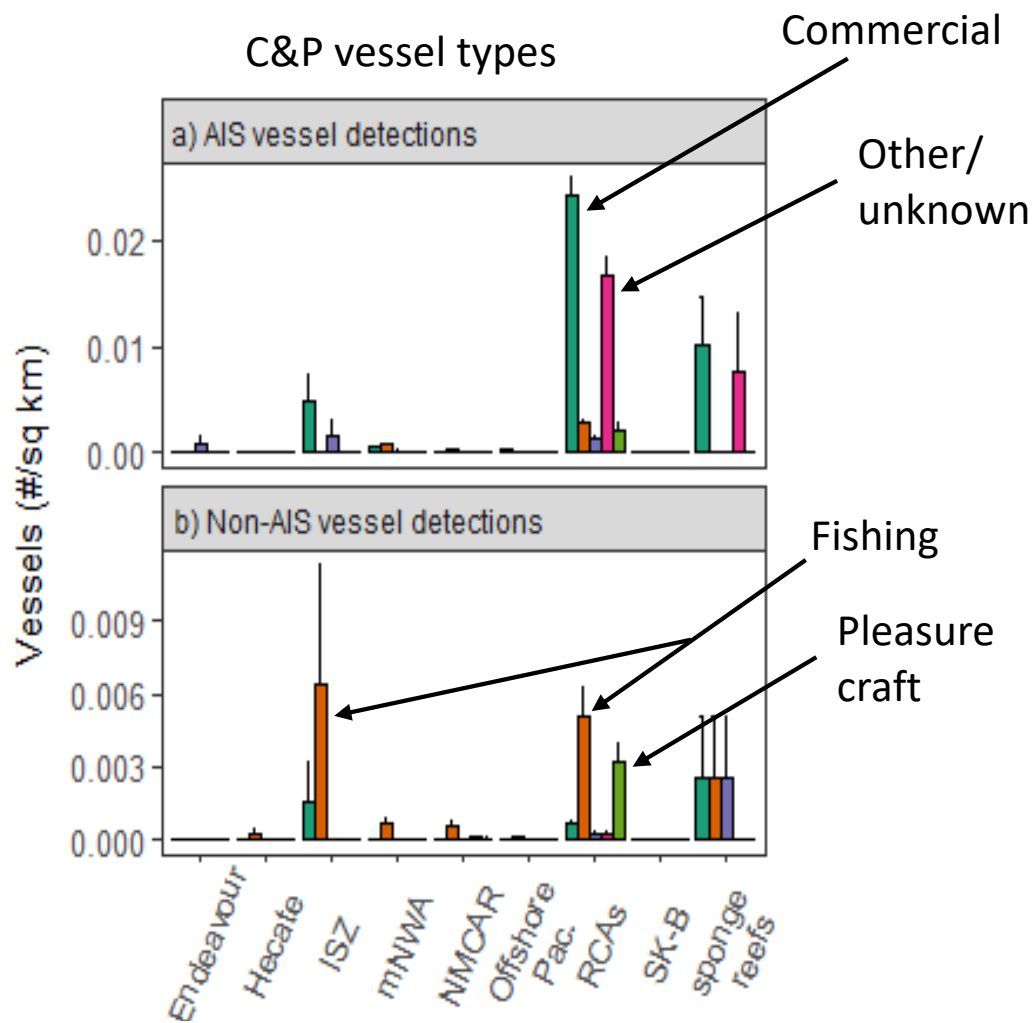
Vessel detections in conservation areas

Source	AIS vessels in CA	Non-AIS vessels in CA	Total vessels in CA
C&P ASP	3,397 (81%)	819 (19%)	4,216
TC NASP	28 (100%)	0	28
RADARSAT	676 (54%)	585 (46%)	1,261

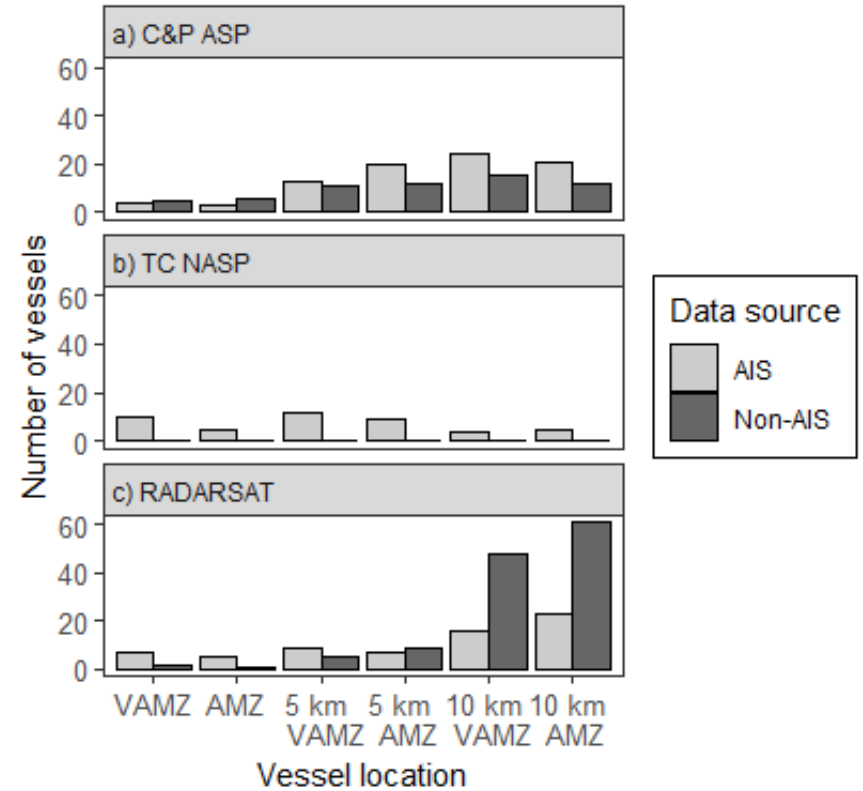
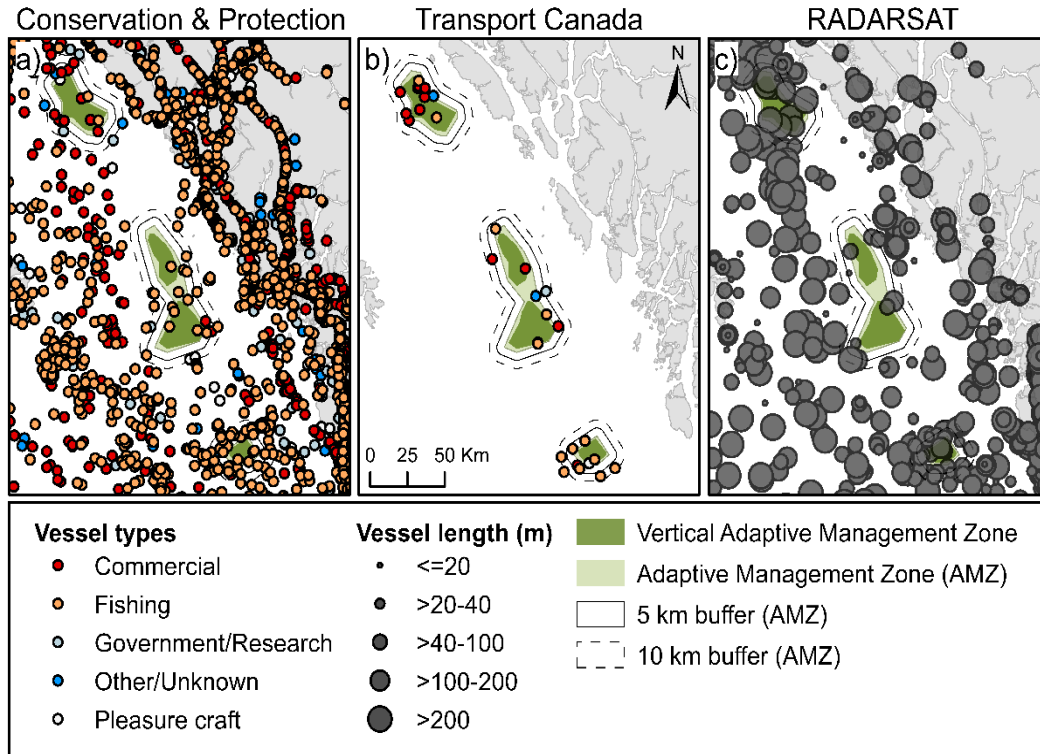


Most vessels in RCAs, sponge reefs, & Swiftsure ISZ, C&P detected more vessels in conservation areas

Vessel types & lengths in conservation areas

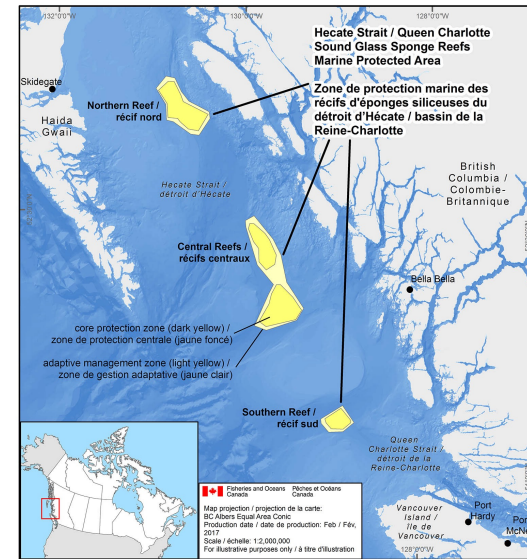
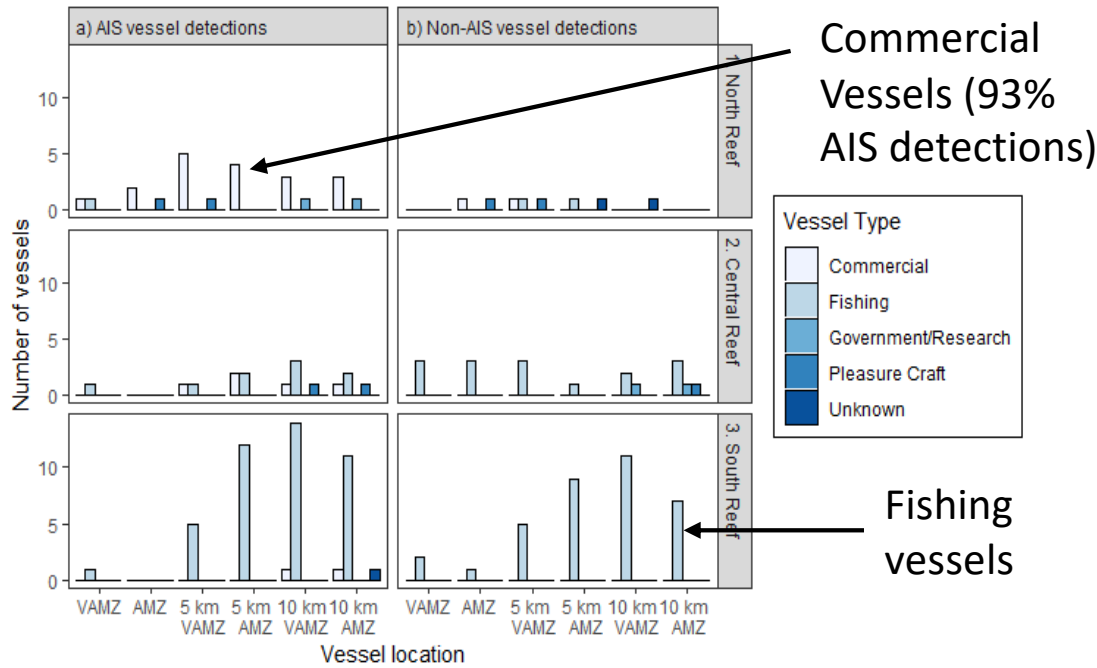


Hecate Strait/Queen Charlotte Sound Glass Sponge Reefs MPA

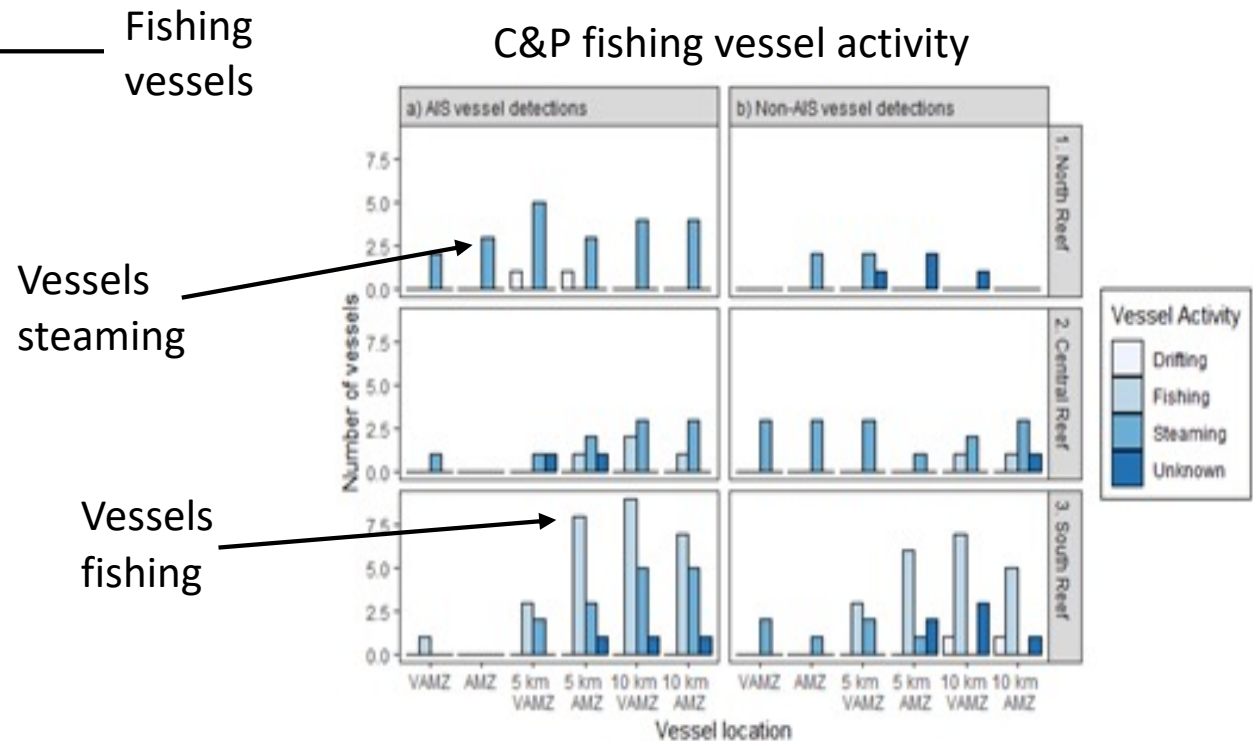


Hecate Strait/Queen Charlotte Sound Glass Sponge Reefs MPA

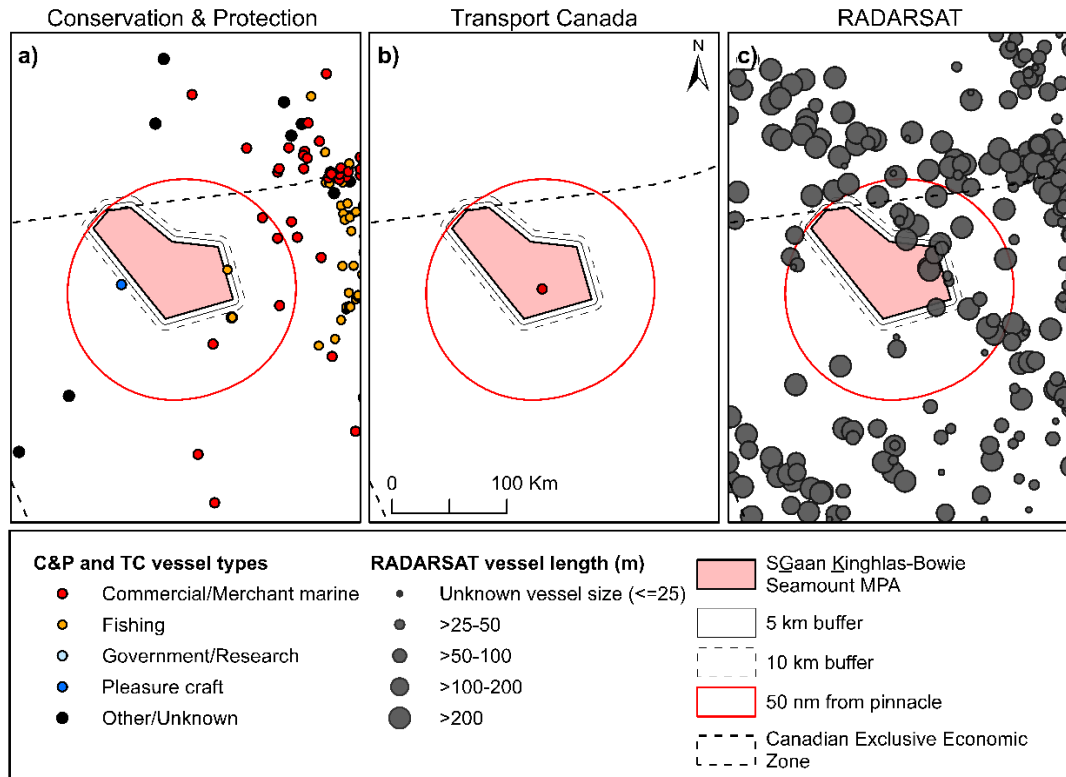
C&P vessel types



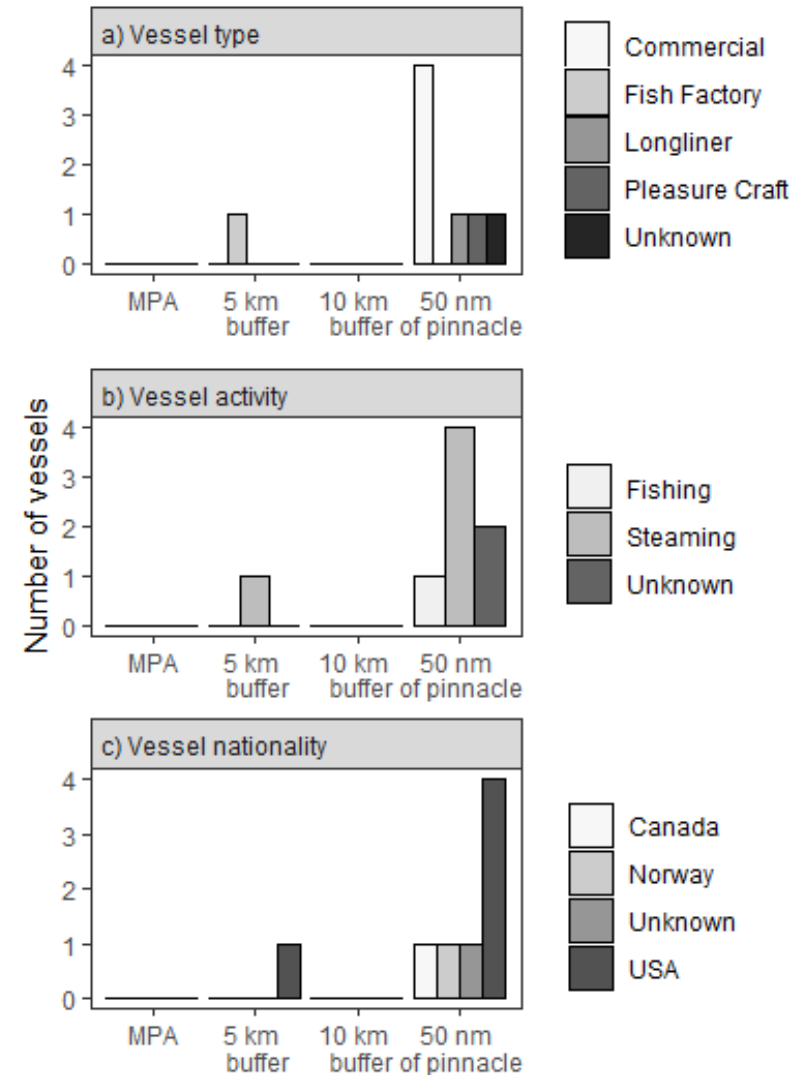
C&P fishing vessel activity



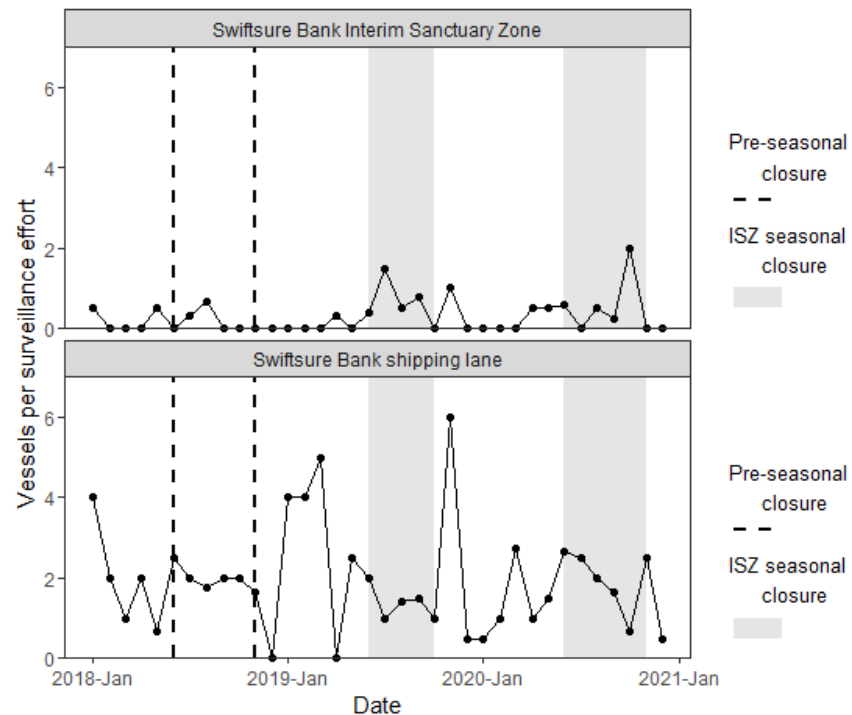
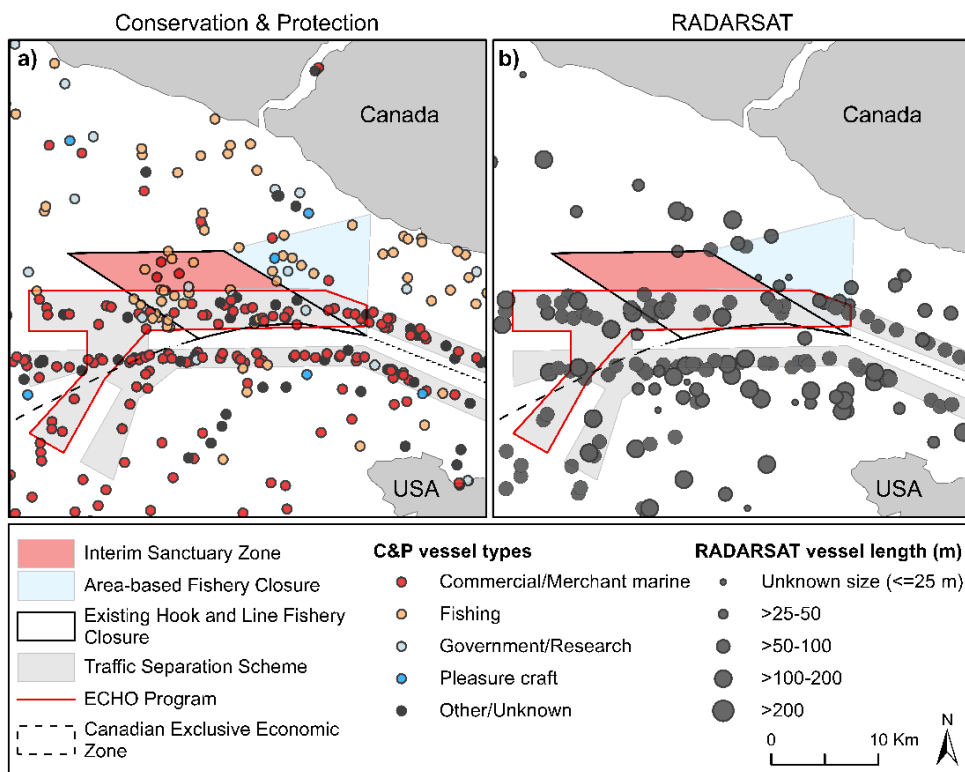
S_Gaan K_ingh_las-Bow_ie Seamount MPA



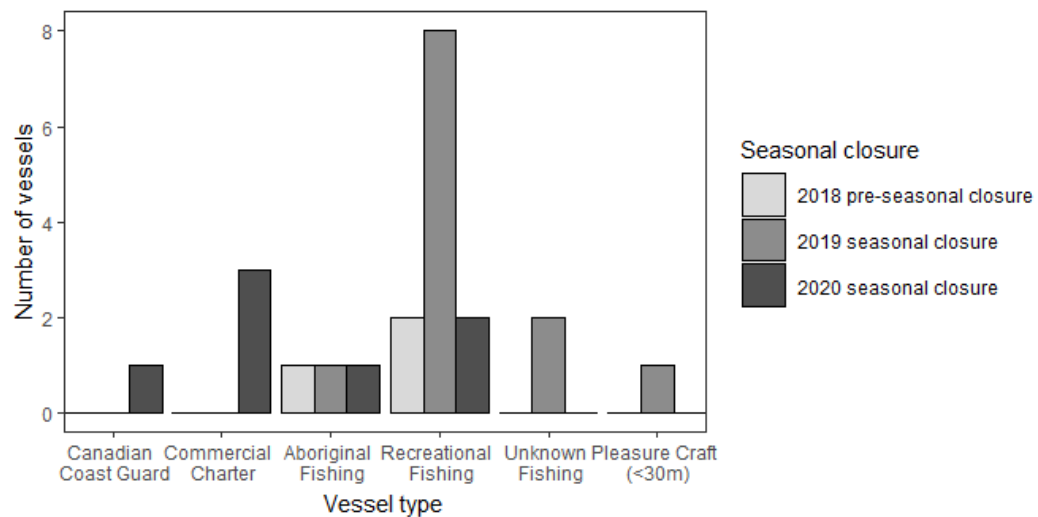
C&P vessel information



Swiftsure Bank Interim Sanctuary Zone



C&P vessel types



Potential non-compliant vessel activity in conservation areas

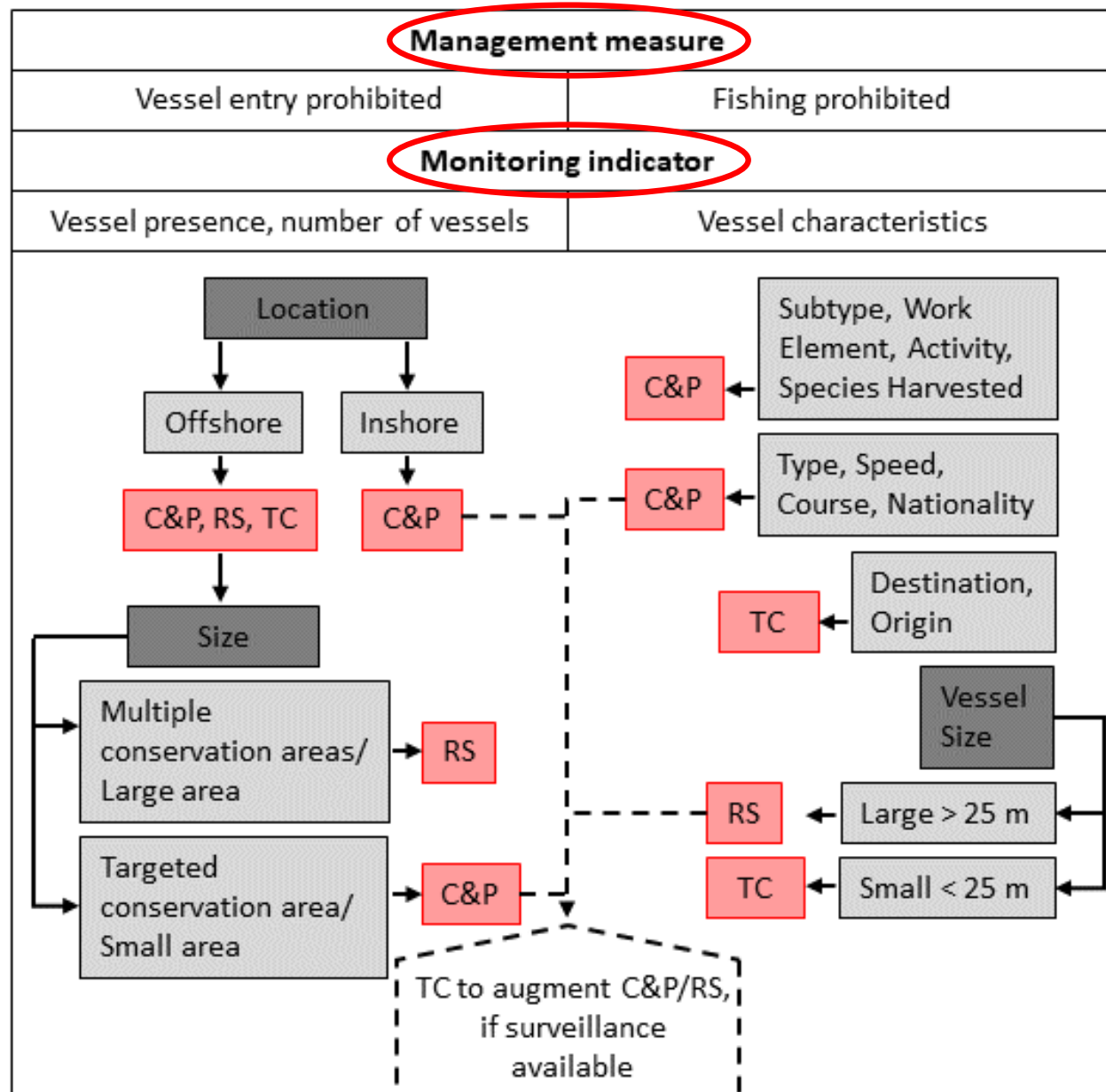
Conservation area	Management measure	Potential non-Compliance observed		
		C&P	TC	RS
Endeavour Hydrothermal Vents MPA	No bottom contact fishing	N	N	NA
Gwaii Haanas National Marine Conservation Area Reserve & Haida Heritage Site Restricted Access Zone	No commercial, recreational fishing	N	NA	NA
Gwaii Haanas National Marine Conservation Area Reserve & Haida Heritage Site Strict Protection Zone	No commercial, recreational fishing	Y	NA	NA
Hecate Strait/Queen Charlotte Sound Glass Sponge Reefs MPA Core Protection Zone	No fishing	Y	N	NA
Hecate Strait/Queen Charlotte Sound Glass Sponge Reefs MPA Vertical Adaptive Management Zone	No bottom contact fishing, no midwater trawl fishing for hake	Y	N	NA
Hecate Strait/Queen Charlotte Sound Glass Sponge Reefs Adaptive Management Zone	No commercial bottom contact fishing, no midwater trawl fishing for hake	N	N	NA
Other Effective Area-Based Conservation Measures (Strait of Georgia, Howe Sound Glass Sponge Reefs)	No bottom contact fishing	Y	NA	NA
Offshore Pacific Seamounts and Vents Closure	No bottom contact fishing	N	N	NA
Rockfish Conservation Areas	No groundfish bottom trawl; no hook-and-line for halibut, rockfish, lingcod, dogfish; no sablefish by trap; no salmon trolling, jigging, mooching; no spearfishing	Y	NA	NA
Scott Islands marine National Wildlife Area	Be within 300 m of the low water mark of Triangle, Sartine or Beresford Islands	N	NA	N
	Anchor vessel > 400 GT within 1 nm of the low water mark of Triangle, Sartine or Beresford Islands	N	NA	NA
SĠaan KĠnghlas-Bowie Seamount MPA	No bottom contact fishing	N	N	NA
	Large vessels encouraged to transit > 50 nm from SĠaan KĠnghlas-Bowie pinnacle	Y	Y	Y
Swiftsure Bank Interim Sanctuary Zone	No vessel entry June 1 – Nov. 31, 2020	Y	NA	N

C&P evaluates compliance for all conservation areas or management measures

TC evaluates compliance for 3 MPAs

RADARSAT unable to evaluate compliance for many conservation areas or management measures

Decision tree: identify vessel tracking dataset/management measure



Conclusions

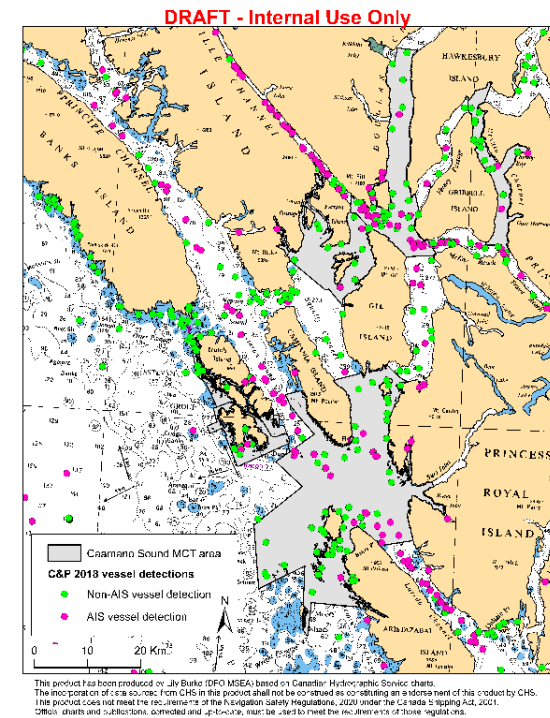
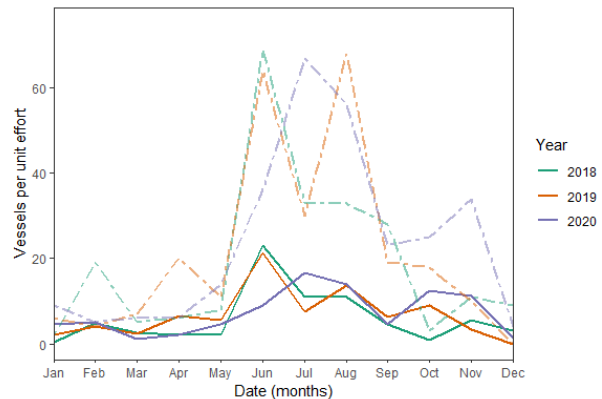
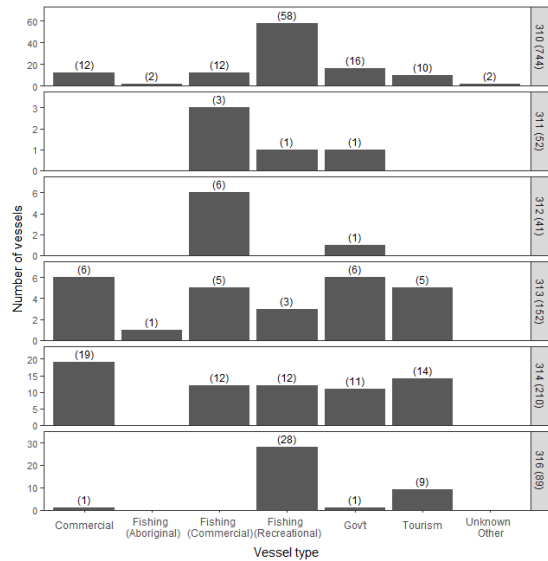
- Vessel tracking data sources are effective monitoring & evaluation tools for assessing human pressures within conservation areas & for evaluating compliance with regulations and/or guidelines.
 - Important to develop a repository for TC and RADARSAT data as currently historical & future data are being compiled & saved by single users
- Datasets are complimentary & fill in gaps from more accessible & commonly used AIS data as both AIS & non-AIS vessels were detected.

Conclusions

- Most (potential) non-compliance detected in conservation areas related to gear or user-group specific fishing prohibitions.
- C&P best evaluated management measures related to fishing prohibitions while both C&P & RADARSAT evaluated management measures regarding vessels prohibited from an area.
- C&P & TC collect valuable vessel information on vessel activity, vessel type, & species targeted (C&P), & this information best determined vessel compliance with conservation area regulations.
- TC data can augment C&P & RADARSAT data if assessing targeted MPAs.

Immediate uptake of results

- DFO Pacific Protected Areas Surveillance Report (DFO Oceans Program)
- Human use descriptions for Biophysical and Ecological Overview reports (e.g., Caamano Sound & Douglas Fjord System Network Zones & Haida Gwaii Network Zones)
- Monitoring Plans (RCAs, marine refuges)



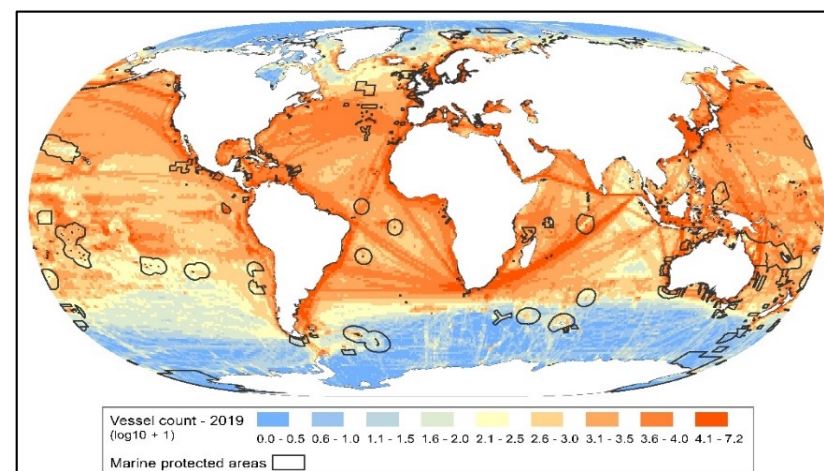
Acknowledgements

- Conservation & Protection
- Marine Security Operations Centre
- Ecosystems and Oceans Sciences
- Fisheries Management
- Ecosystems Management
- Canadian Coast Guard
- Transport Canada
- Canadian Space Agency
- Defence Research & Development Canada
- MDA Ltd.
- Global Fishing Watch
- Archipelago Marine Research Ltd.



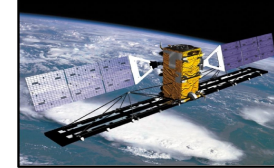
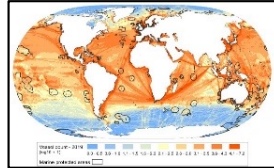
Following individuals:

- B. Banik, D. Browne, A. Bussell, G. Cauffope, S. Coffen-Smout, J. Foote, B. Gillard, R. Gionet, P. Hagell, S. Jepps, M. Kattilakoski, J. Knight, C. Manning, B. Merchant, J. Prior, A. Ravanelli, C. Robb, O. Rusticus, B. Thexton, P. Vachon, A. Williams, S. Wheeler



Evaluating vessel activity & fishing in Canada's Marine Protected Areas & fishing closures using vessel tracking datasets

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1. [Iacarella, J.C., G. Clyde, and A. Dunham. \(2020\) Vessel tracking datasets for monitoring Canada's conservation effectiveness. Can. Tech. Rep. Fish. Aquat. Sci. 3387.](#)
2. [Iacarella, J.C., G. Clyde, B.J. Bergseth, and N.C. Ban. \(2021\) A synthesis of the prevalence and drivers of non-compliance in marine protected areas. Biological Conservation, 255, 108992](#)
3. [Burke, L., G. Clyde, B. Proudfoot, E. Rubidge, and J.C. Iacarella. \(2022\) Monitoring Pacific marine conservation area effectiveness using aerial and RADARSAT-2 \(Synthetic Aperture Radar\) vessel detection. Can. Tech. Rep. Fish. Aquat. Sci. 3479.](#)
4. [Iacarella, J.C., L. Burke, G. Clyde, A. Wicks, T. Clavelle, A. Dunham, E. Rubidge, and P. Woods. \(2023\) Application of AIS- and flyover-based methods to monitor illegal and legal fishing in Canada's Pacific marine conservation areas. Conservat. Sci. and Prac., 5\(6\), e12926.](#)
5. [Iacarella, J.C., L. Burke, G. Clyde, A. Wicks, T. Clavelle, A. Dunham, E. Rubidge, and P. Woods. \(2023\) Monitoring temporal and spatial trends of illegal and legal fishing in marine conservation areas across Canada's three oceans. Conservat. Sci. and Prac., 5\(6\), e12919.](#)