

Spatial coverage and movement of marine anthropogenic structures as a pathway of aquatic invasive species spread

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Photo: J. Nichols

Moveable, non-propelled structures

Biofouling risk:

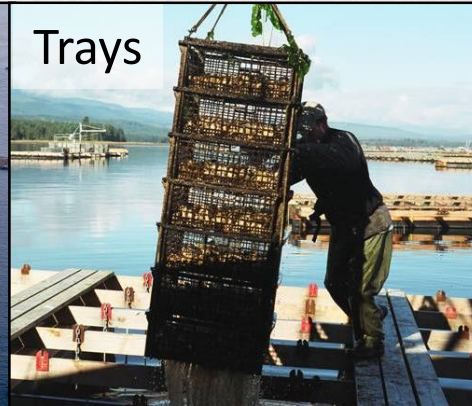
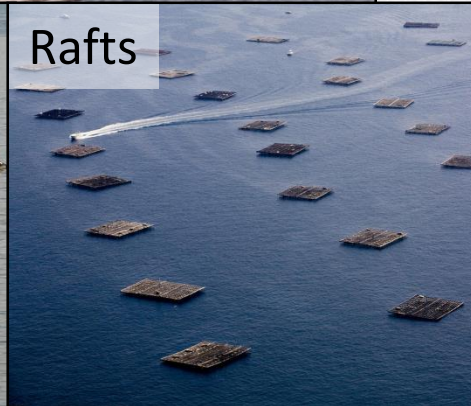
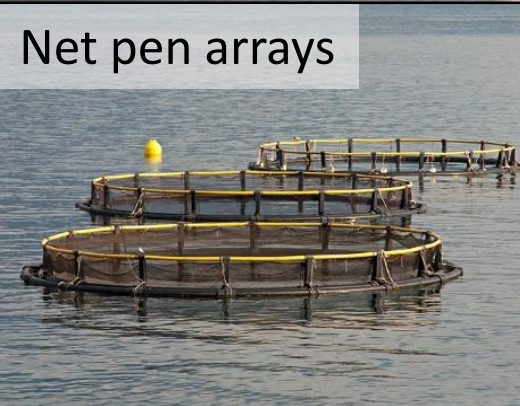
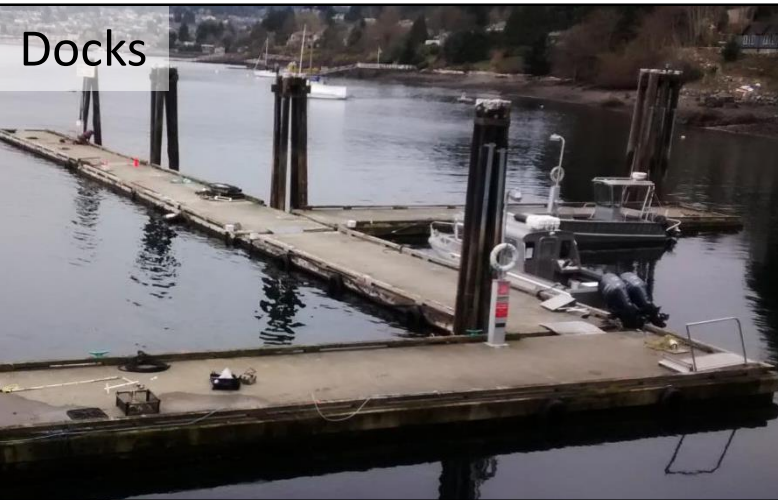
- 1) Infrequent, often sporadic movement
- 2) Residence time often orders of magnitude longer than vessels (months to years) promoting buildup of biofouling organisms prior to translocation
- 3) Movements usually involve slow towing and little hydrodynamic stress to remove organisms during transit

Problem:

- 1) Little/no documentation of movements
- 2) Little/no management of anti-fouling and/or movements



Structure types



Fouling of non-propelled structures

Structure type	*AIS	Algae	Annelids	Ascidians	Bryozoans	Crustaceans	Echinoderms	Hydroids	Molluscs
Docks		X*	X*	X*	X*	X*	x	X*	x
Buoys		X*	X*	X*	X*	X*			x
Barges		x		x	X*	X*	X*	X*	x
Derelict vessels		x	X*	x	X*	X*		X*	X*
Finfish gear (net pen arrays)		x	x	X*	x	X*		x	X*
Shellfish gear (trays)			x	X*	X*	X*	x	x	X*
Floating lodges									



Buoys

Location data

- Transport Canada (buoys) and Canadian Coast Guard (navigational aids)
- 375 navigational aids, 88 mooring buoys, and 88 marker buoys

Common movement pattern

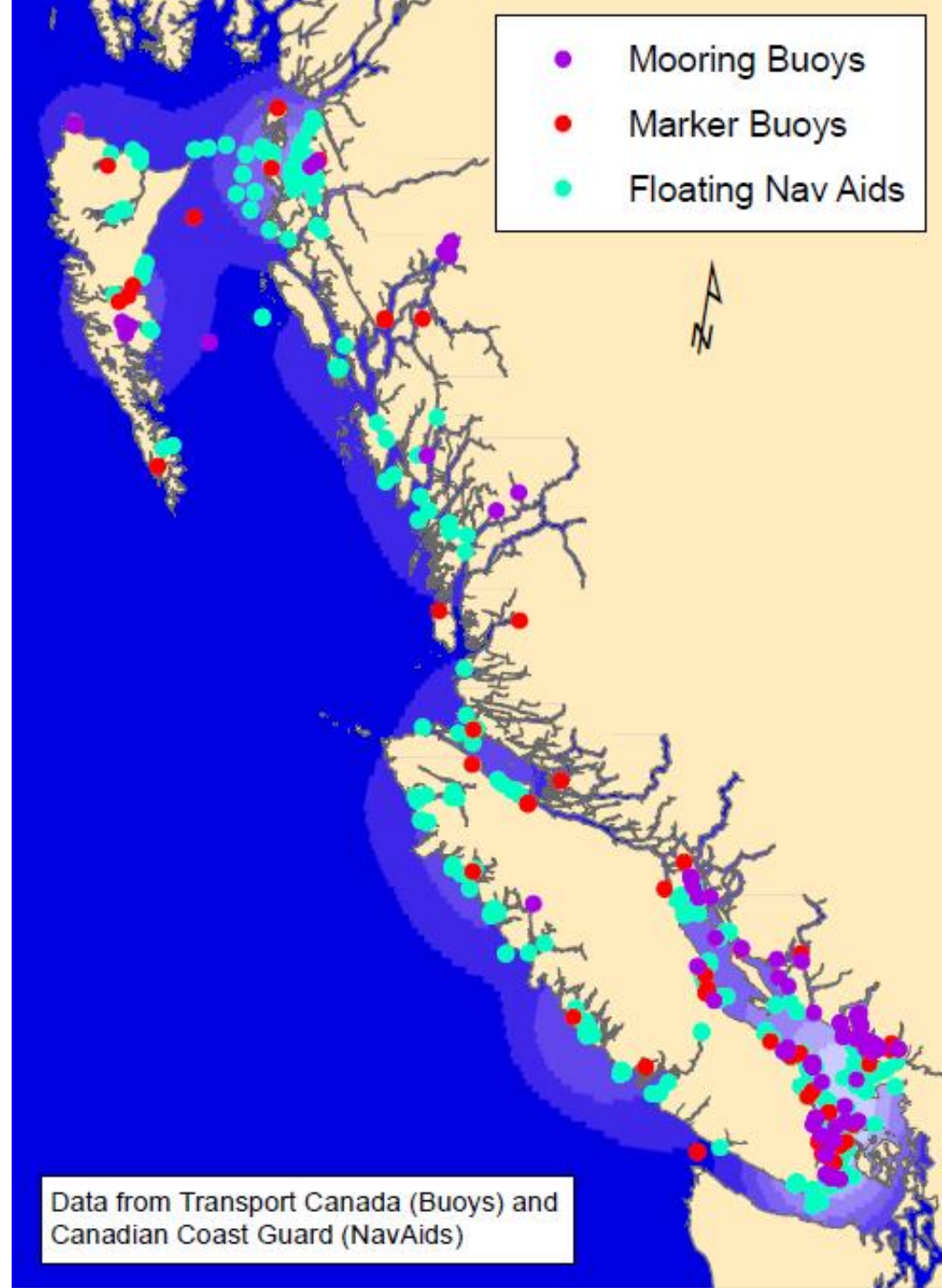
None/limited

Reasons for movement

BC nav. buoys: only moved if drifted from set location

Anti-fouling measures

BC nav. buoys: 2-4 yr clean/paint cycle



Aquaculture gear

Location data

- Site inspection reports (shellfish) and licensing (finfish)
- Moveable, subtidal gear only
 - Shellfish: trays, rafts, floats
 - Finfish: net pen arrays
- 130 shellfish locations
- 119 finfish locations

Common movement pattern

Shellfish: seasonal, Finfish: recurrent

Reasons for movement

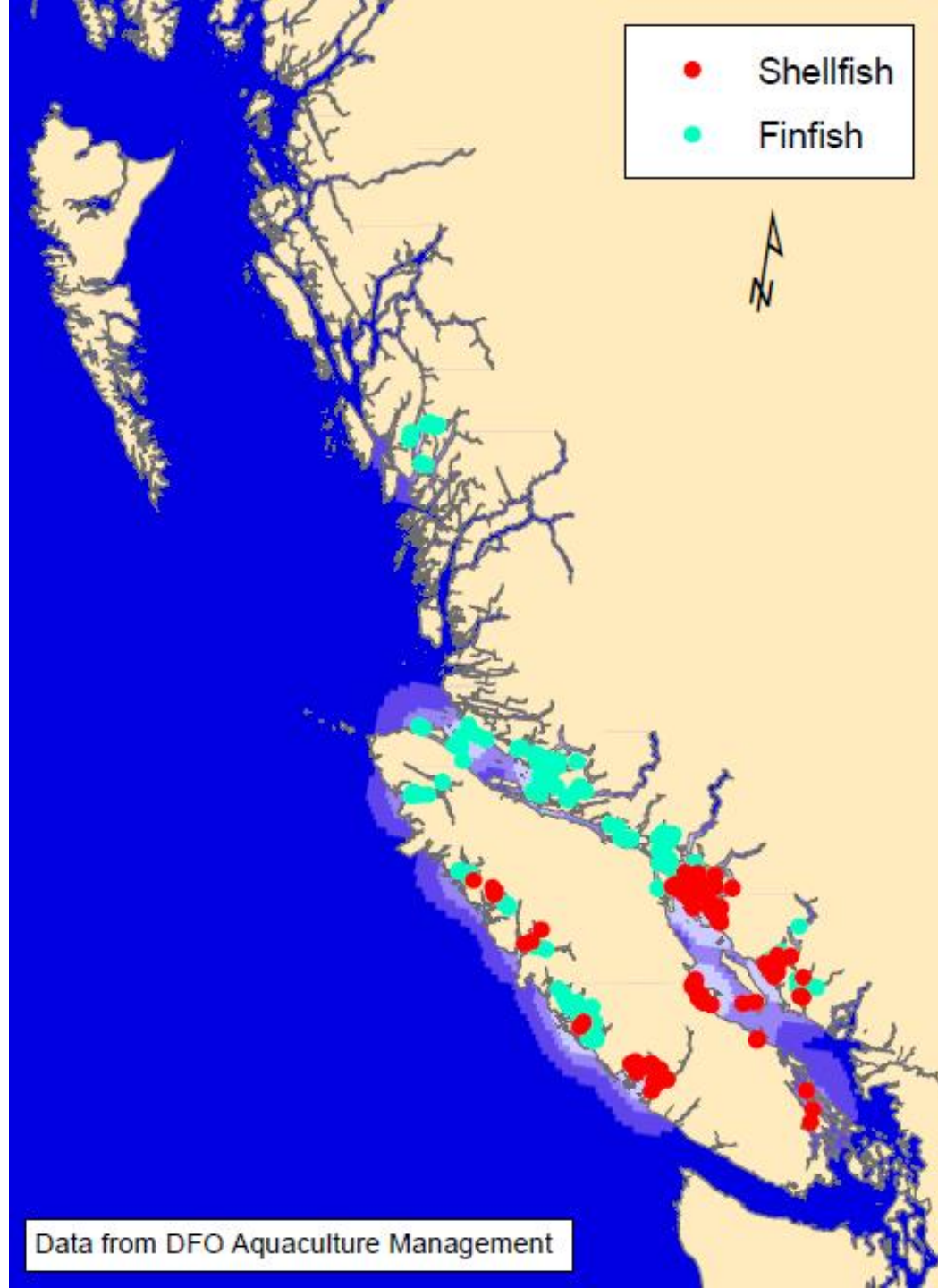
Shellfish: Grow out cycles and market sales, repair or license end

Finfish: Cycling among tenures every few years, or for changes in equipment

Anti-fouling measures

Shellfish: Cleaned if moving across zones

Finfish: Cleaned in water or put on barge then land to be cleaned, monthly or more as needed



Data from DFO Aquaculture Management

Floating lodges

Location data

- Transport Canada (float homes & buildings), Google searches & validation with Environment Canada
- 105 float homes & buildings
- 39 floating fishing & resort lodges
- 6 fishing lodges currently known to move seasonally

Common movement pattern

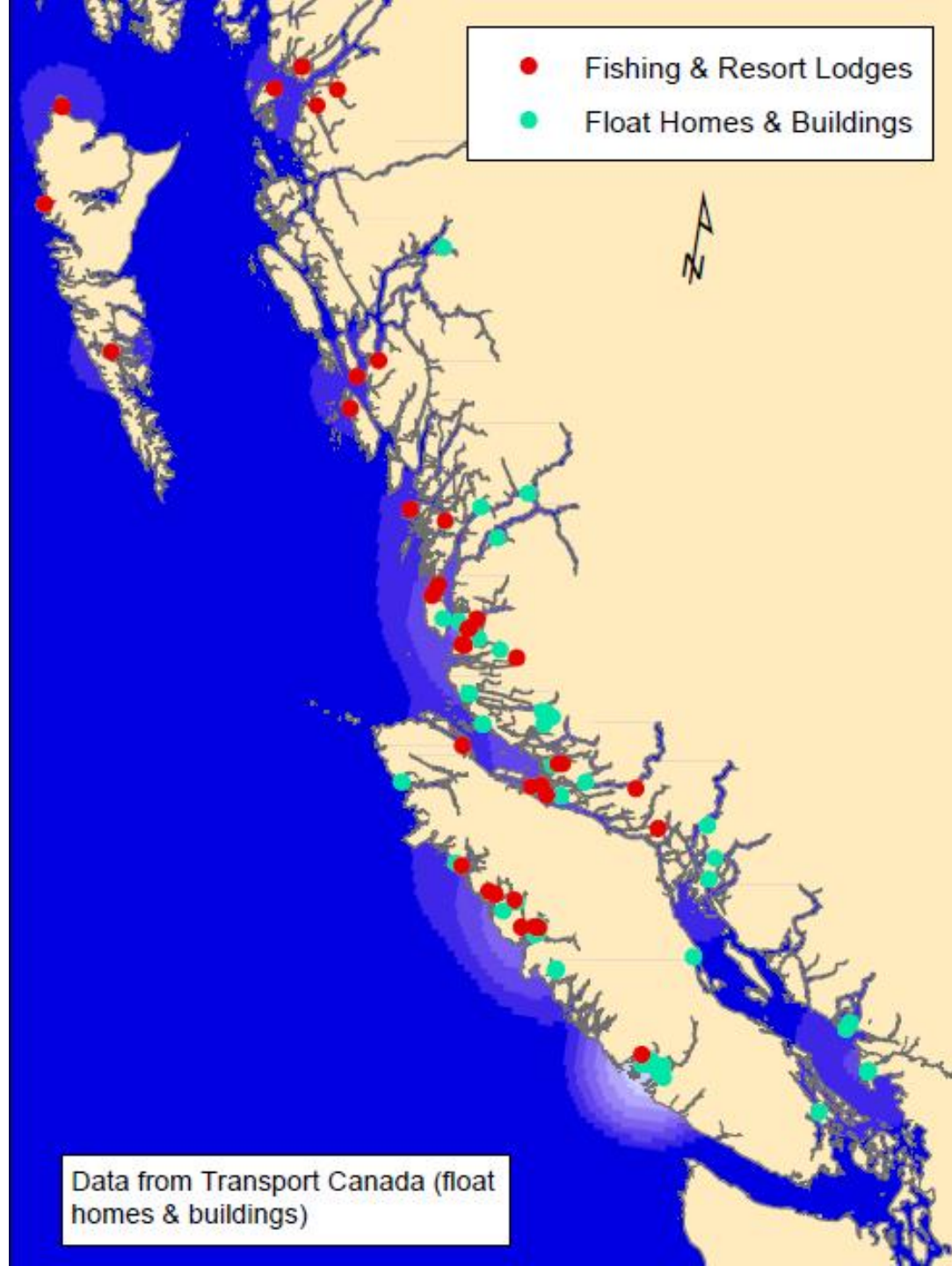
Seasonal

Reasons for movement

Winter storage, opportunistic fishing

Anti-fouling measures

None?



Tug boat path densities

Pathway data

- Proxy of non-propelled vessel movement
- Hourly Automatic Identification System tracking for 2016
- 412 tug boats tracked in BC waters

Common movement pattern

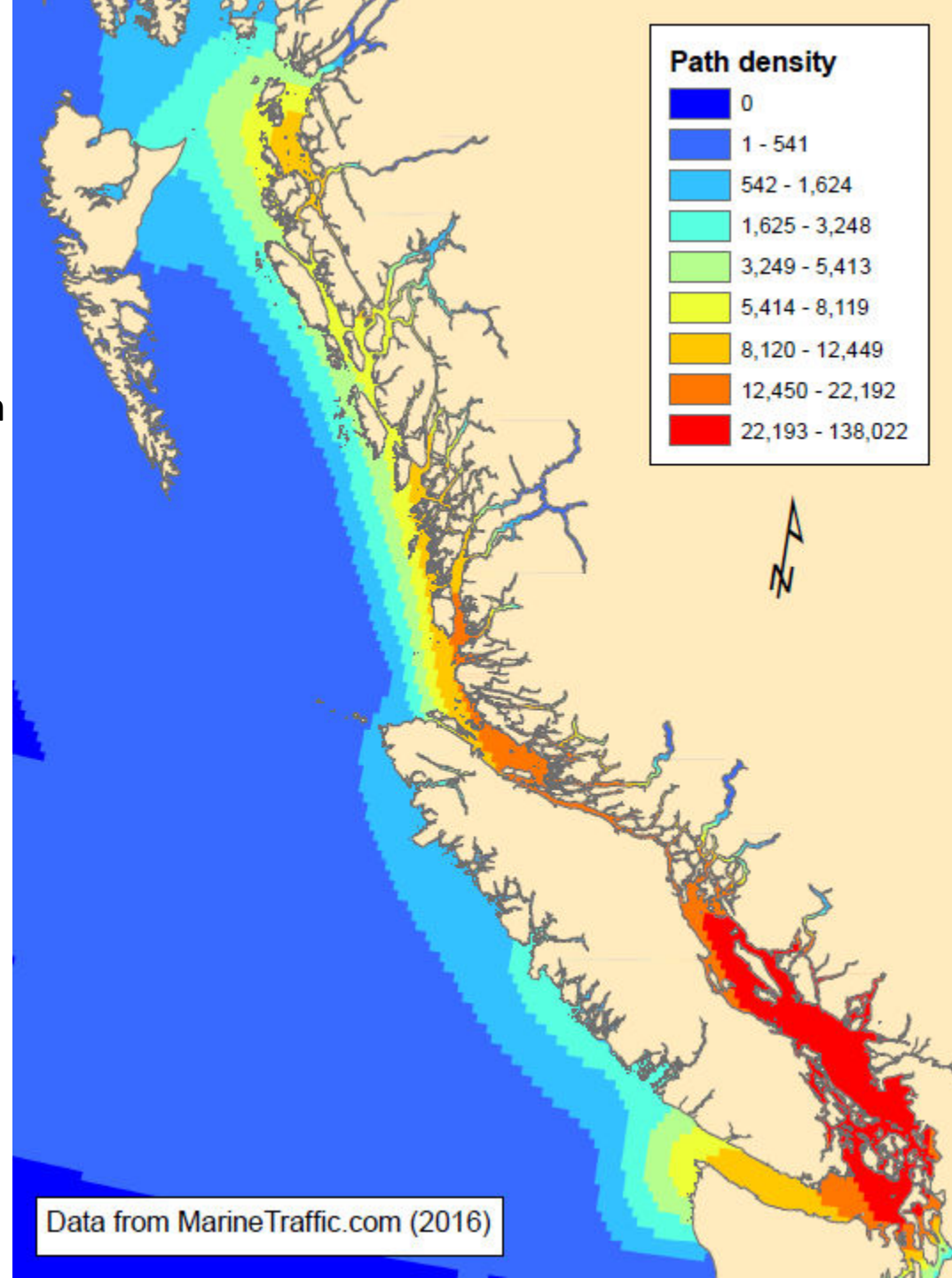
Stochastic

Reasons for movement

Construction, marine infrastructure relocation, logging

Anti-fouling measures

Not usually cleaned or coated with anti-fouling paint (fuel efficiency not critical; GISP, 2008)



Derelict vessels

Location data

- Survey by Transport Canada in 2012
- 213 total floating derelict vessels
- 41 reported by Small Craft Harbours
- Approx. 100 to be reported in 2017 by S.C.H.

Common movement pattern

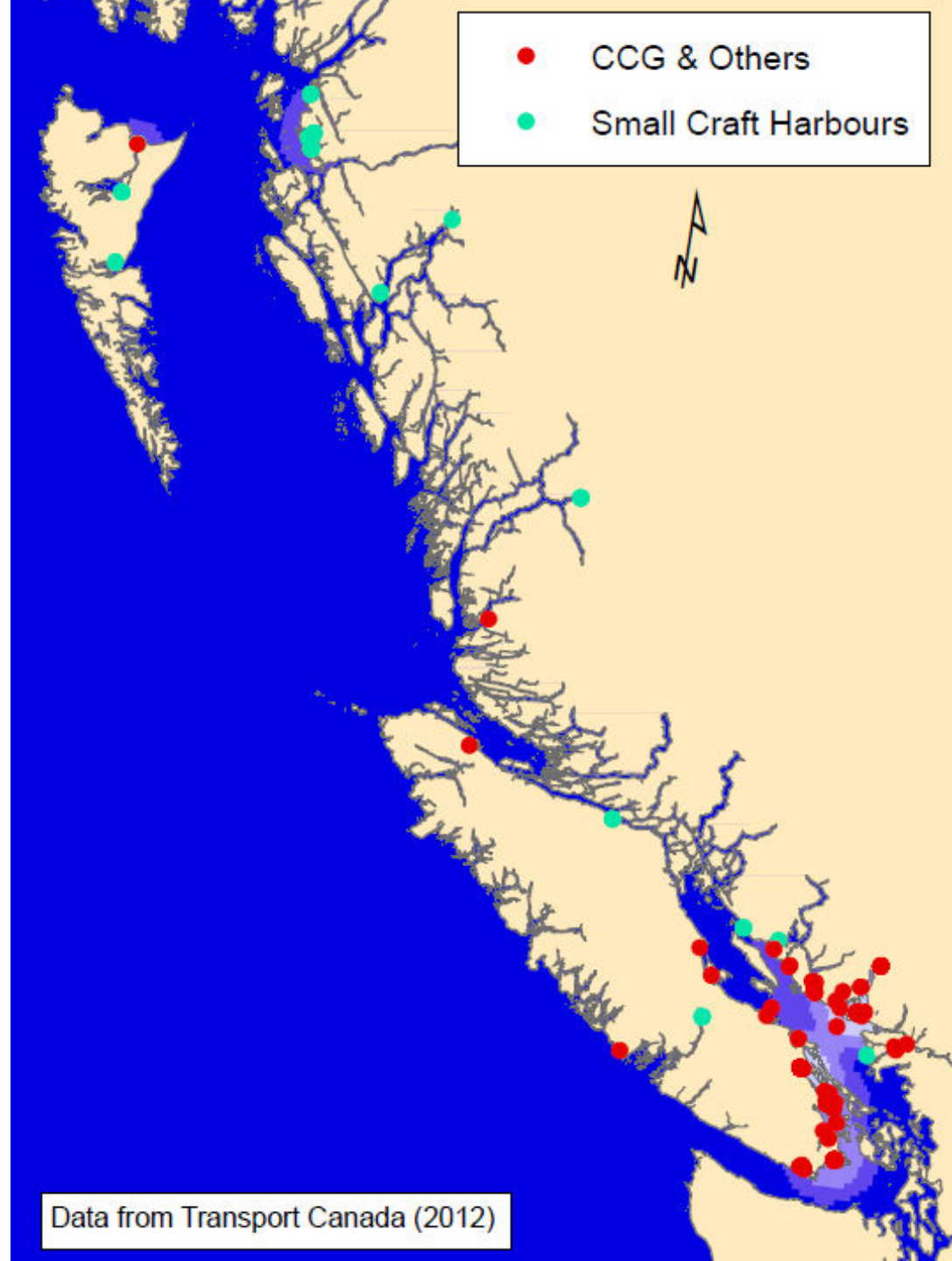
Stochastic

Reasons for movement

Sale/scraping, relocation from high-risk area, drifting

Anti-fouling measures

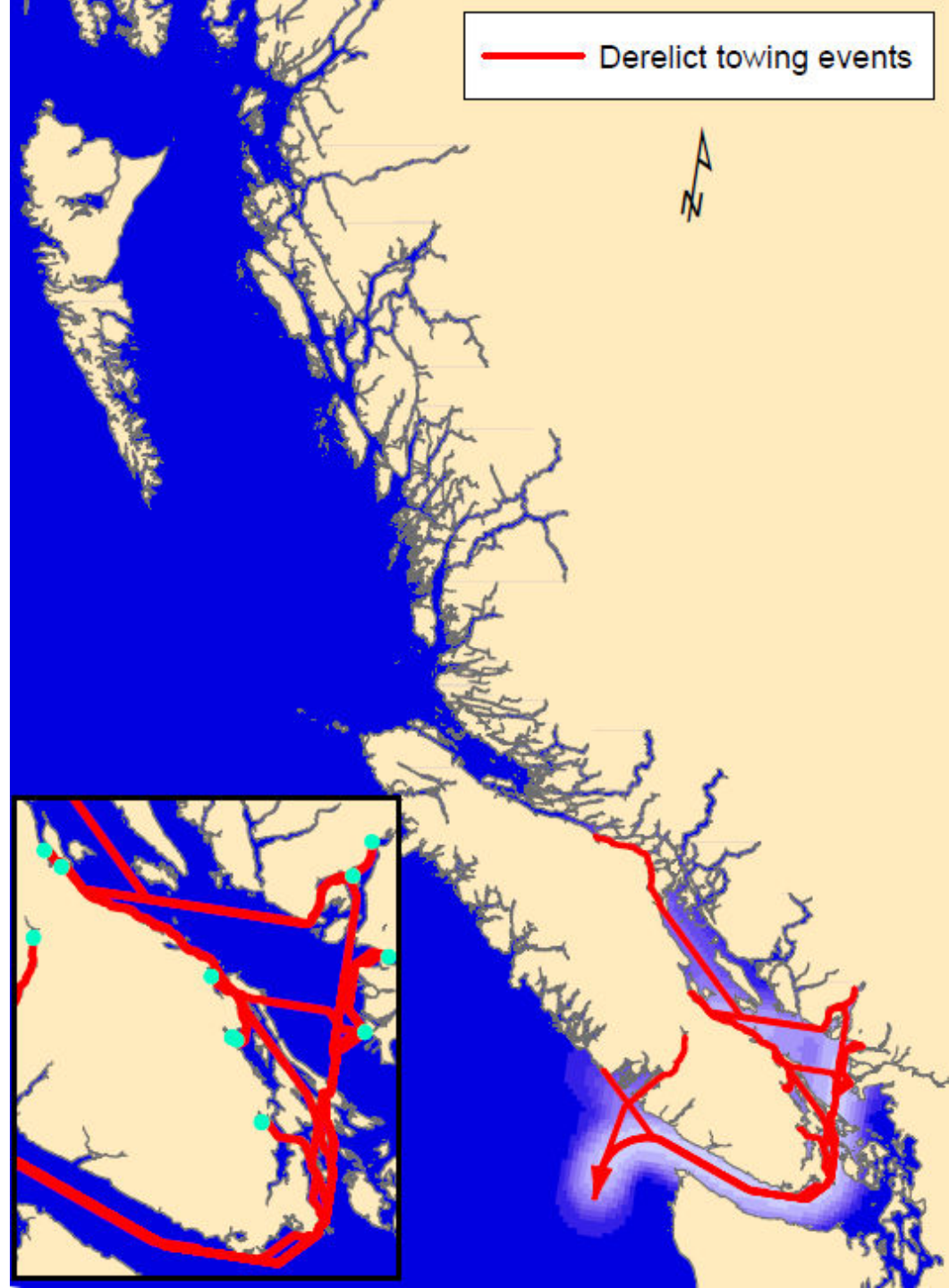
None?



Derelict vessel towing movements

Pathway data

- News reports, cases as early as 2000
- 19 events identified



Derelict vessel movements

Ship name	Duration, 1st location	Duration, 2nd location	Towing distance w/in BC waters (km)
EXAMPLES OF DERELICT VESSELS			
Silver King	Unknown	Remains since 2016?	107
Viki Lyne II	Unknown	4 yrs	35
MV Sun Sea	2 yrs	Remains since 2012	61
Laurier II	4+ yrs	Remains since 2016?	107
Dominion I	6 yrs	Towed to Mexico	
Queen of Saanich (renamed Owen Belle)	3 yrs	10 months	261
EXAMPLES OF RETIRED OR SOLD SHIPS			
Queen of Prince Rupert (renamed Lomaiviti Princess)	2+ yrs	Towed to Fiji	
Queen of Vancouver	3 yrs	3 wks, then towed to Mexico	142
Queen of Esquimalt (renamed Princess Jacqueline)	3 yrs	Towed to Mexico	
Canadian Princess	30+ yrs	1 yr (as of 2016), to be scrapped in 2017	286
Pacificat Explorer, Discovery, & Voyager	3 yrs	6 yrs, then towed to Egypt	40

Docks

Location data

- GEOBC, Marinas.com, Google Earth
- 612 marina locations
- Will be extended to all private docks

Common movement pattern

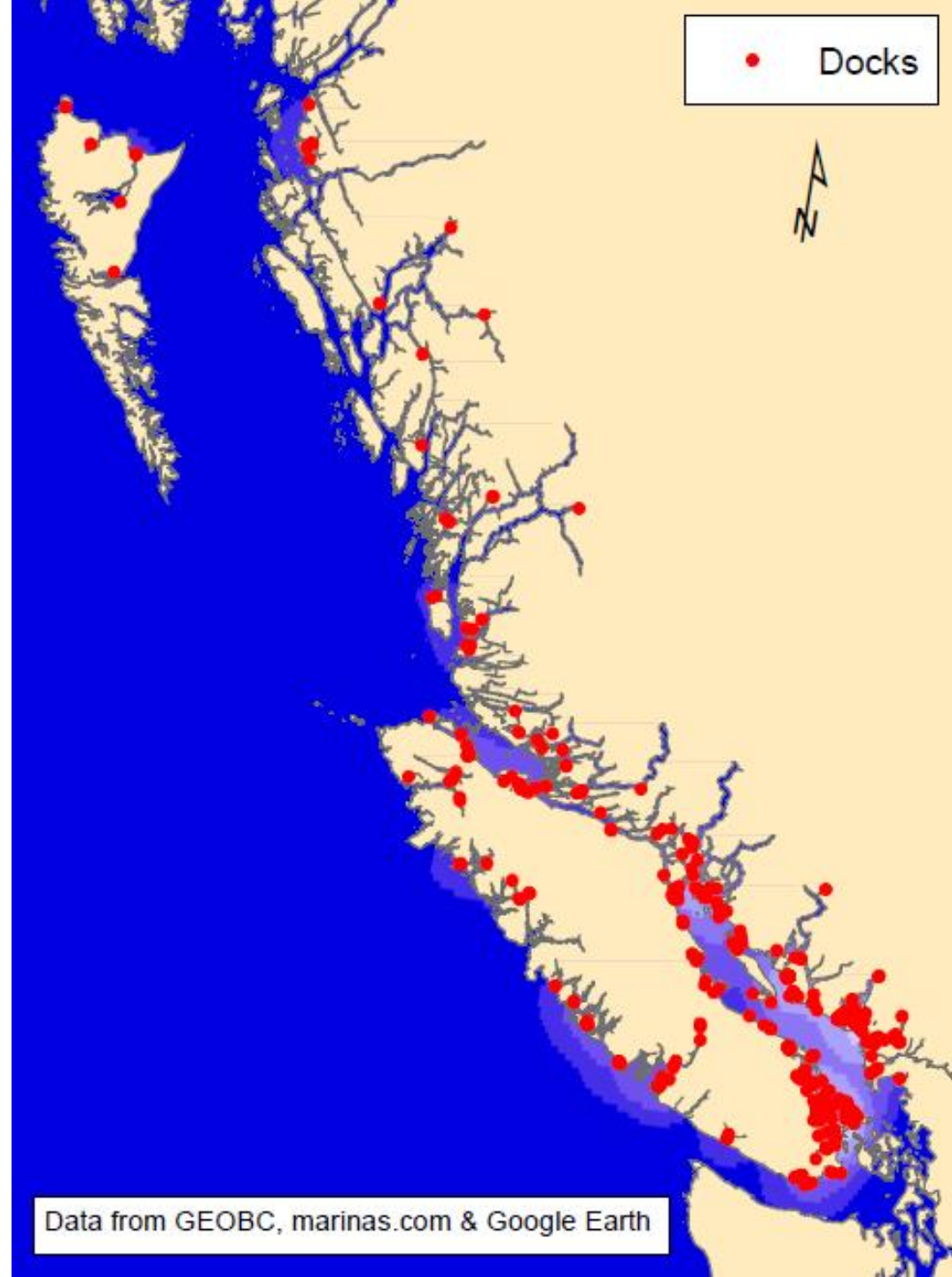
Seasonal & stochastic

Reasons for movement

Winter storage, renovations

Anti-fouling measures

None

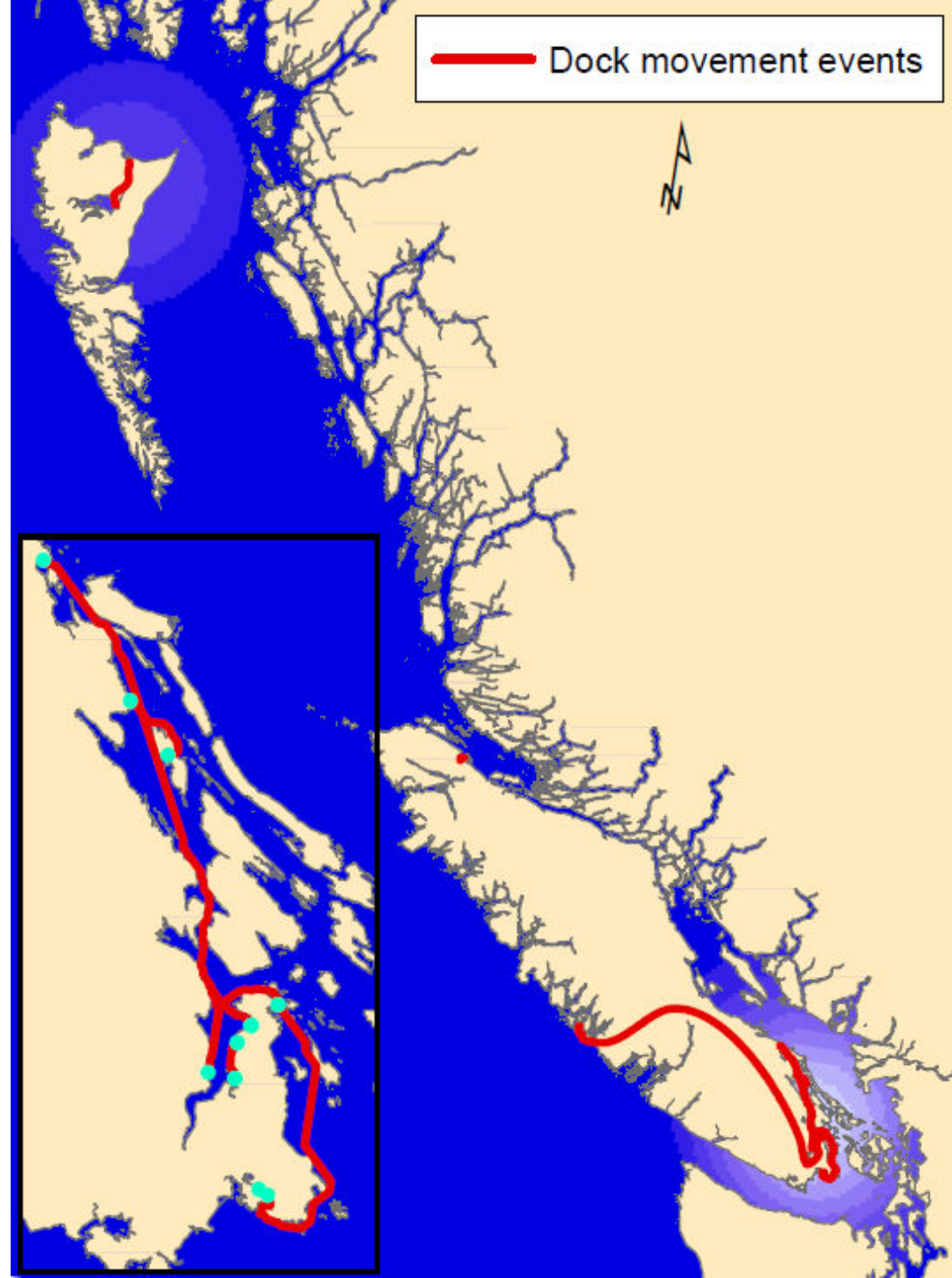


Data from GEOBC, marinas.com & Google Earth

Dock towing movements

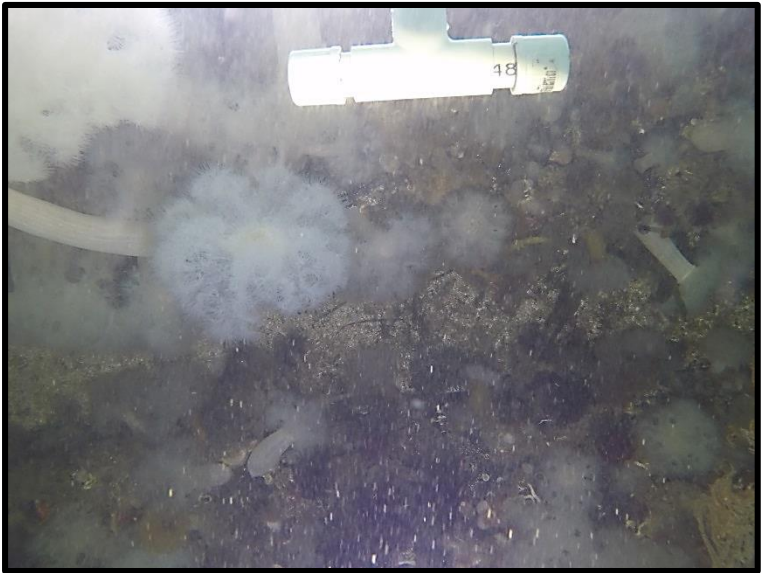
Pathway data

- Word-of-mouth, online ads, email inquiries
- 12 events identified to-date (10 mapped)
- All occurred within 2017, except 1 in 2016
- 5 re-occurring pathways for winter storage
- 7 one-time pathways for renovations

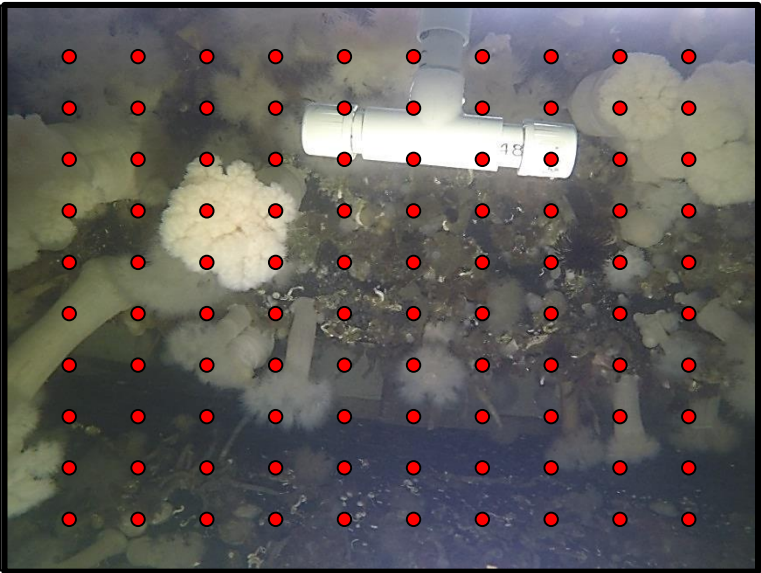


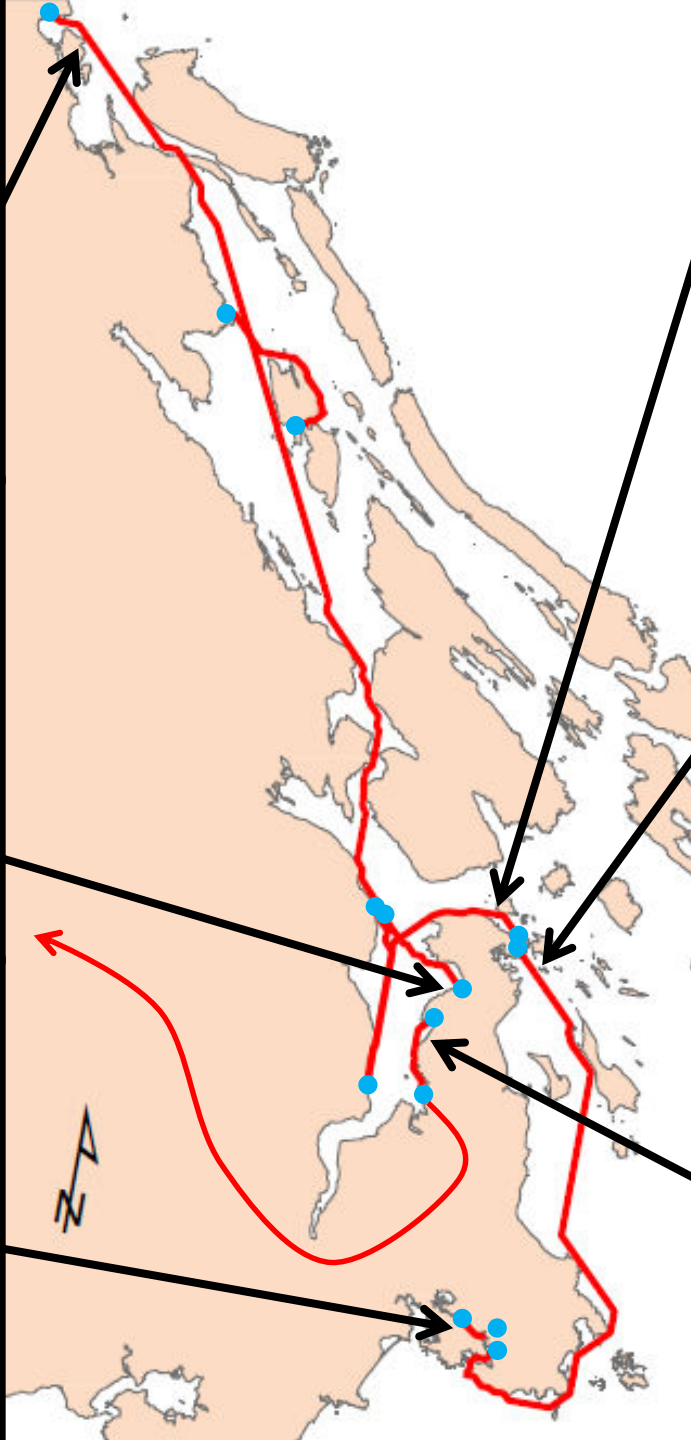
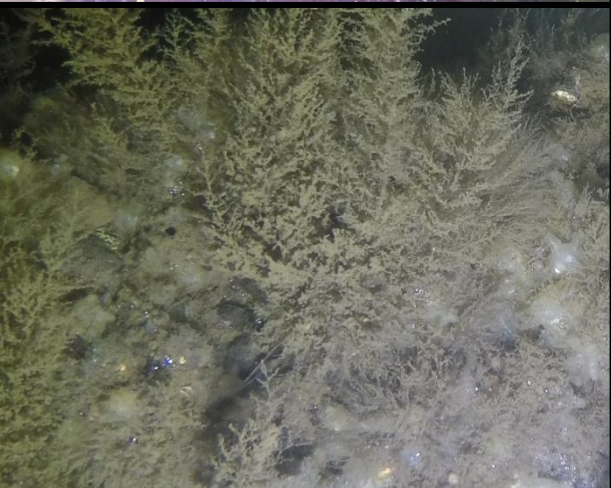
Dock surveys

Before



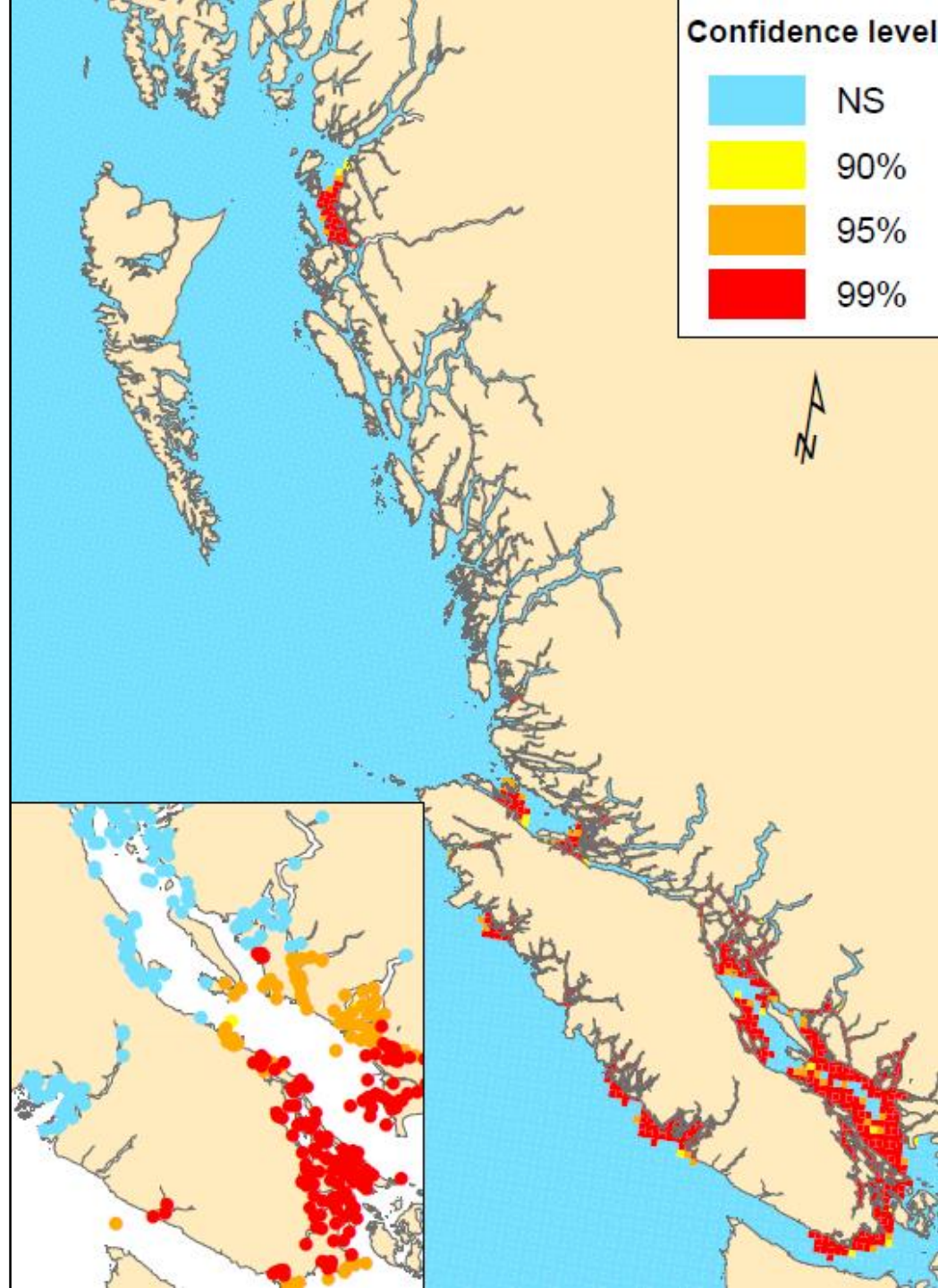
After





Hot spots

- Point locations
 - Buoys
 - Docks
 - Derelict vessels
 - Aquaculture gear
- Hot spots relative to ocean extent & to mapped locations (inset)



Next steps

The background of the slide is an underwater photograph. It shows a large, dense, yellowish-green structure, likely a coral or sponge, with a complex, porous texture. A fish is visible swimming near the structure. The water is a clear, light green color.

- Dock community assessments – before/after towing
- Shellfish gear movement questionnaire
- Extend to Washington and Alaska
- Predictive models of AIS distributions

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