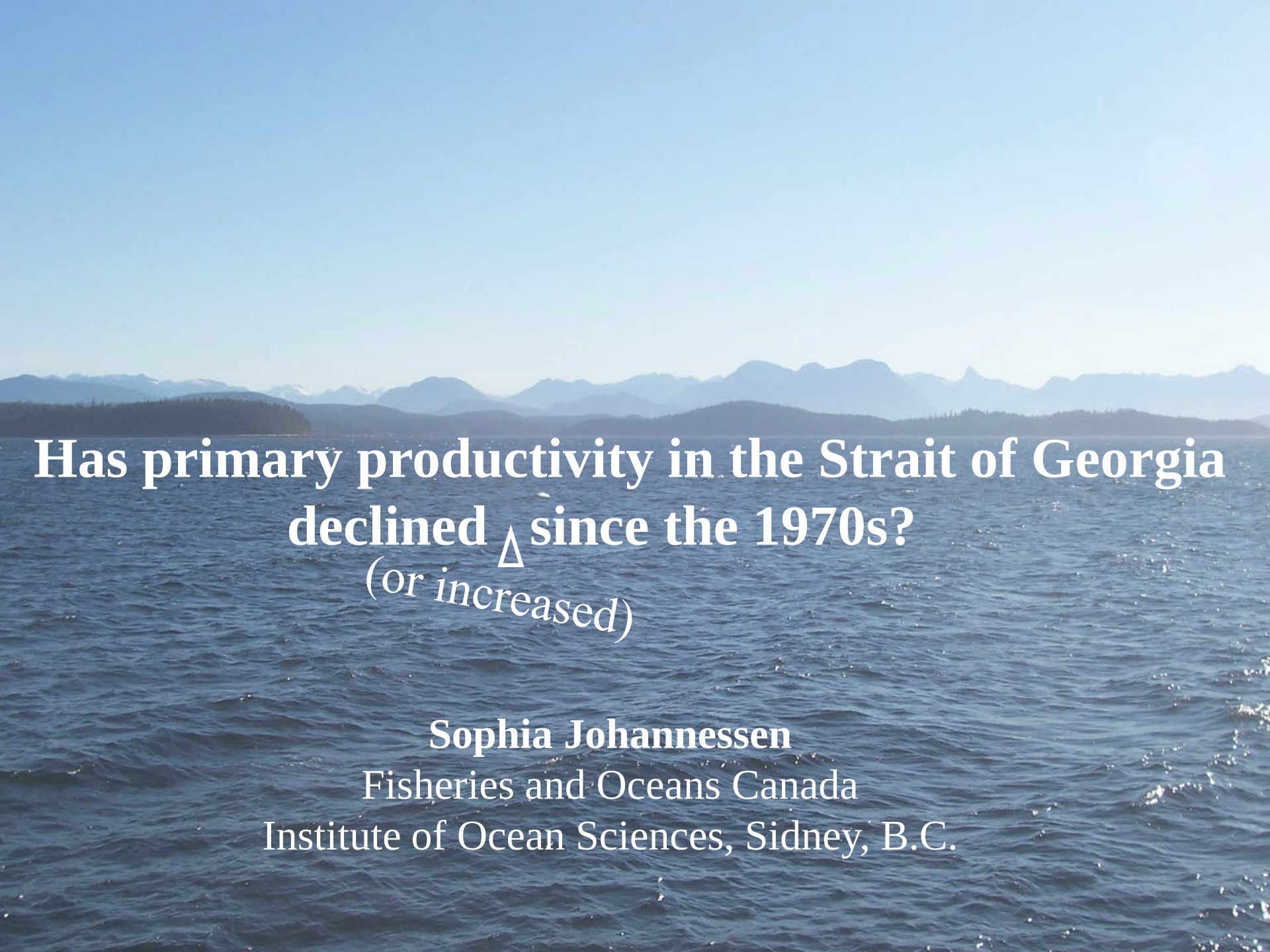
Apr 5th, 11:15 AM - 11:30 AM

Has primary productivity declined in the Strait of Georgia since the 1970s?

Sophia Johannessen
Fisheries and Oceans Canada, Canada, sophia.johannessen@dfo-mpo.gc.ca



Has primary productivity in the Strait of Georgia declined Δ since the 1970s?

(or *increased*)

Sophia Johannessen
Fisheries and Oceans Canada
Institute of Ocean Sciences, Sidney, B.C.

Primary productivity in the 1970s

Parsons, 1970: 120 gC m^{-2} yr^{-1}

Stockner, 1979: 345 gC m^{-2} yr^{-1}

Eutrophication?

Harrison et al., 1983: 280 gC m^{-2} yr^{-1}
Can. J. Fish. Sci.

Two geochemical approaches

1. Nitrogen Budget (Jill Sutton, Robie Macdonald)
2. Sediment cores (Robie Macdonald, Jill Brandenberger, Li-Jung Kuo)

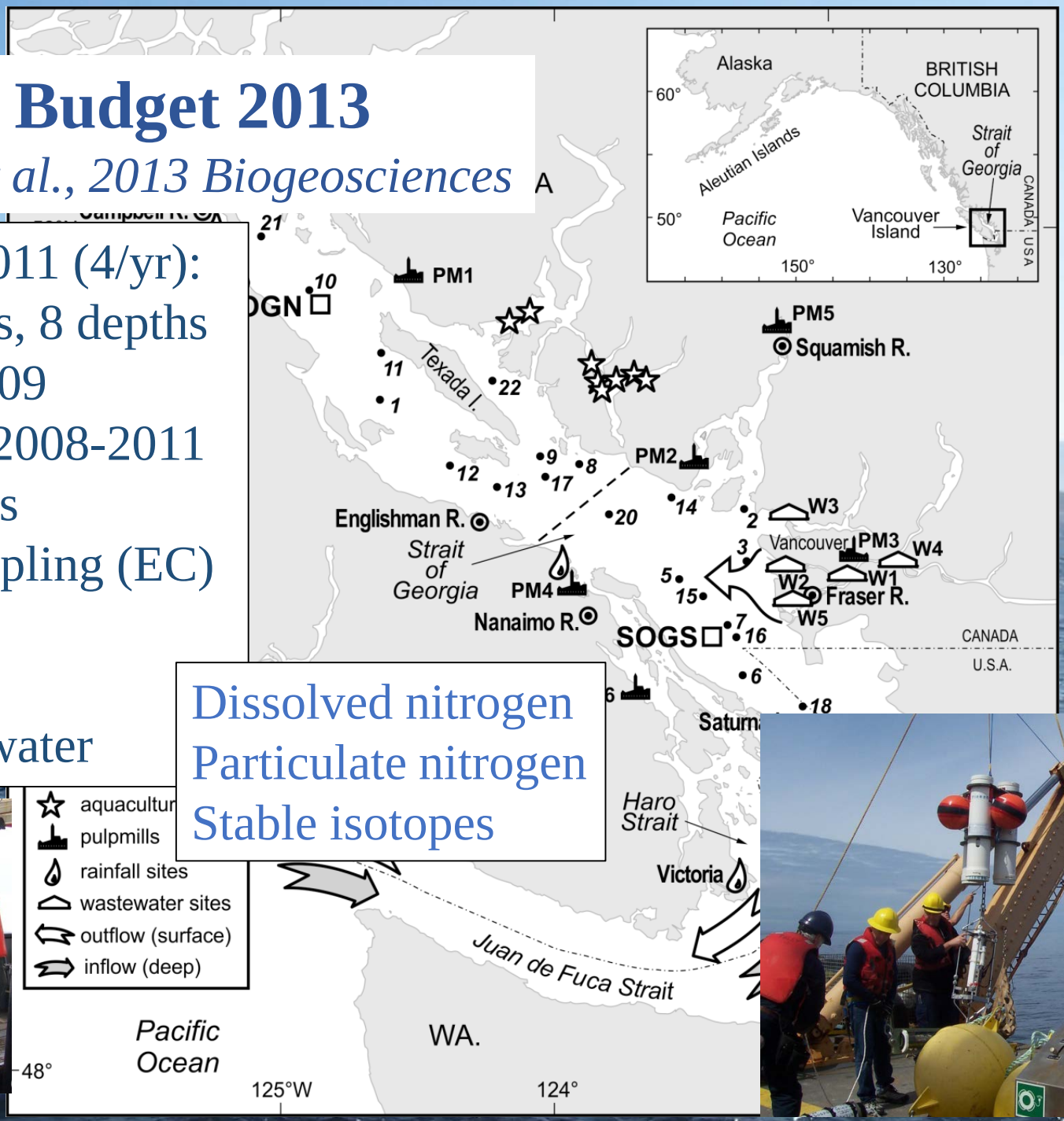
Funding:
Metro Vancouver
DFO's Strait of Georgia Ecosystem Research Initiative

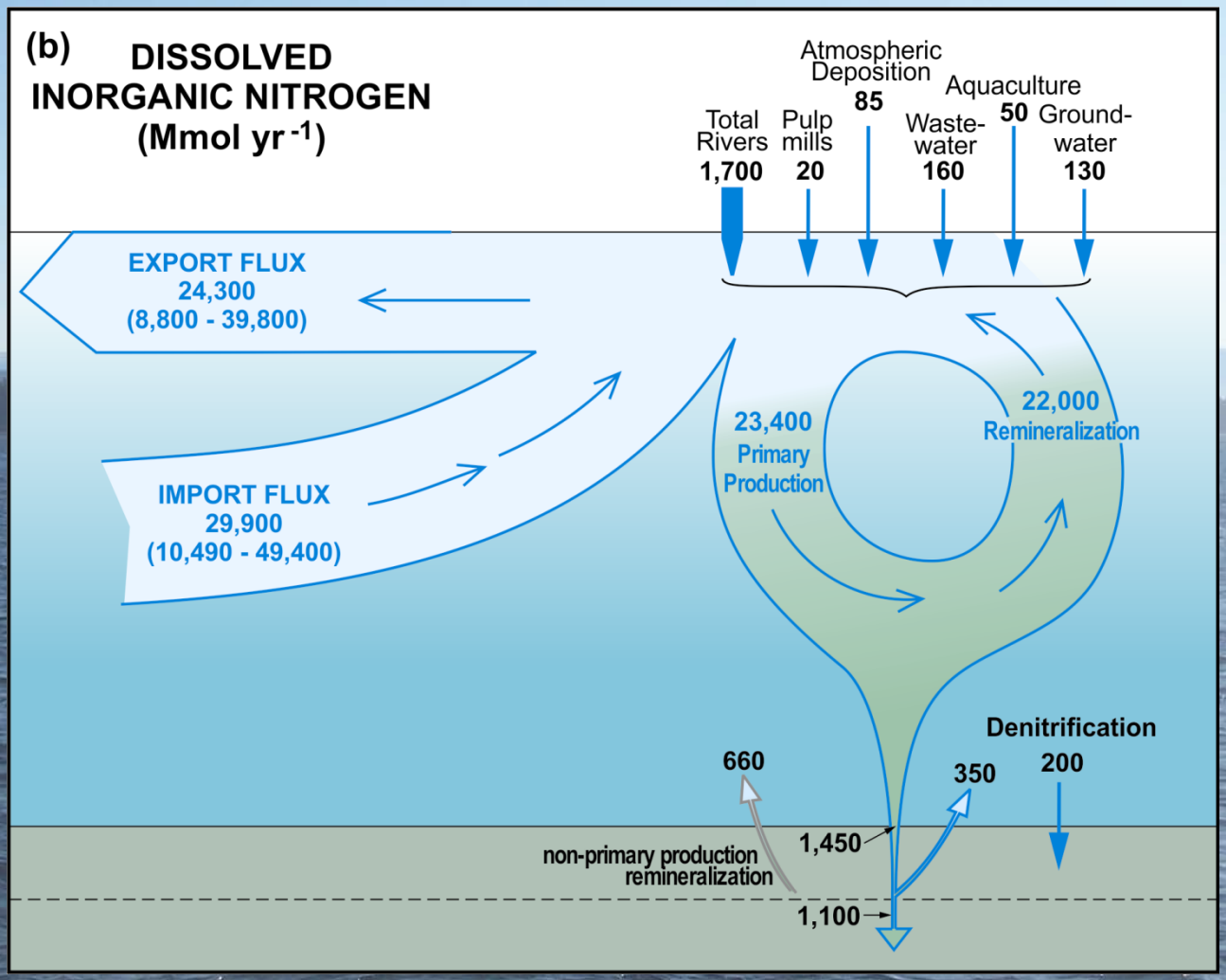
Nitrogen Budget 2013

Jill Sutton et al., 2013 Biogeosciences

Seawater 2001-2011 (4/yr):
20 stns, 8 depths
8 Rivers 2008-2009
2 sediment traps 2008-2011
20 Sediment cores
Atmospheric sampling (EC)
Pulp mills
Aquaculture
Municipal wastewater

Dissolved nitrogen
Particulate nitrogen
Stable isotopes





Sutton et al., 2013. Biogeosciences

Primary productivity in the Strait of Georgia

1970s (Harrison et al., 1983): **280** gC m^{-2} yr^{-1}

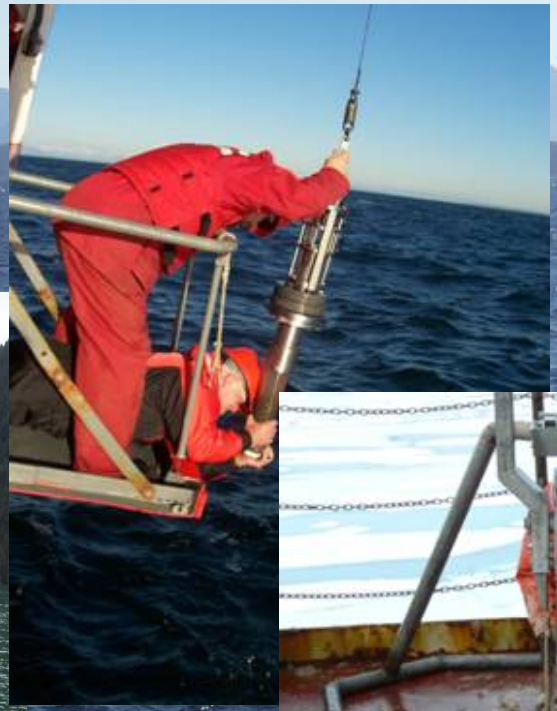
2000s (Sutton et al., 2013): **280 ± 20** gC m^{-2} yr^{-1}

Productivity has neither increased nor decreased.

Puget Sound sediments suggest decline in productivity

(Brandenberger, 2011. Aquatic Geochemistry)

Compare Strait of Georgia Cores…



Stable isotopes of C and N: Has sedimented organic matter become more terrigenous over time?

$\delta^{13}C$

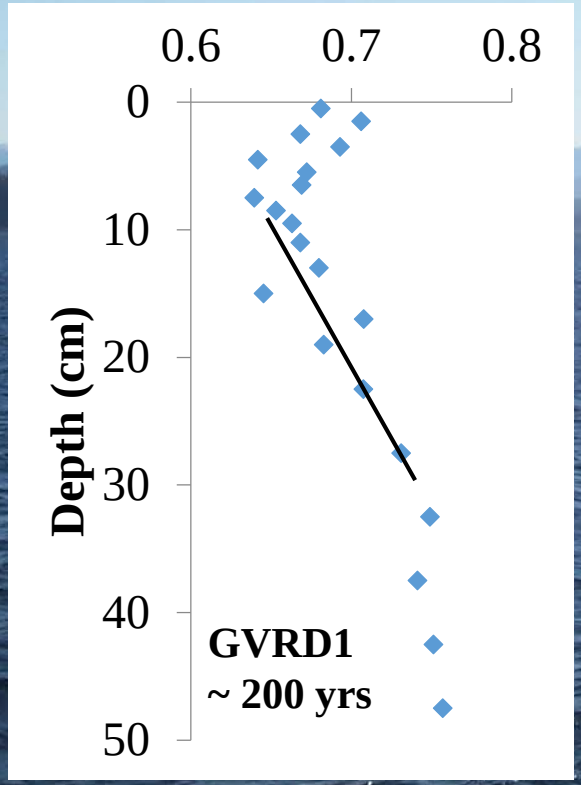
- marine / terrigenous source
- productivity

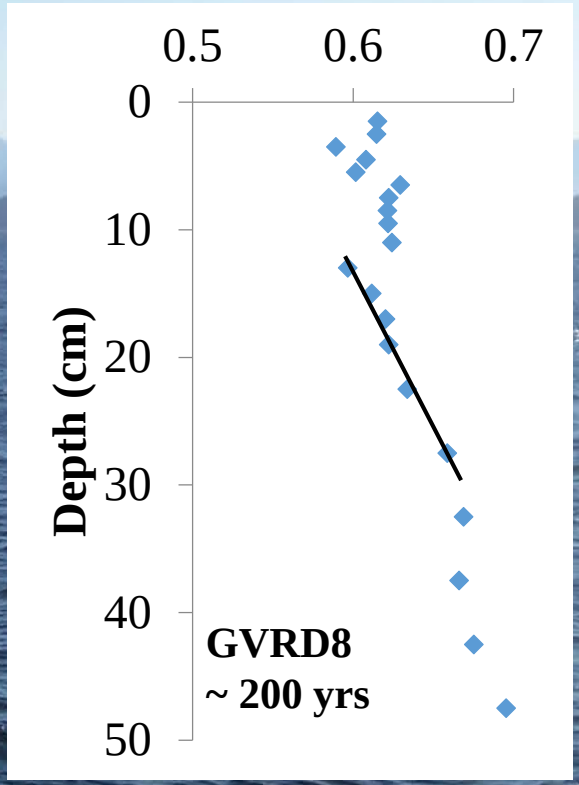
$\delta^{15}N$

- marine / terrigenous source
- length of food chain
- source of nutrients

Difficult to interpret isotopes individually, but we can interpret them together.

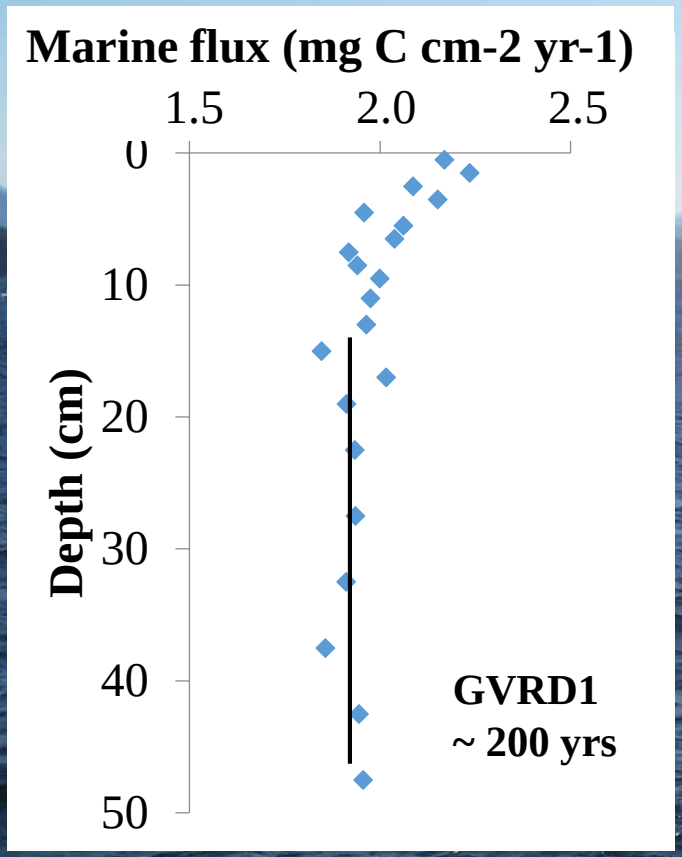
The fraction of marine-derived organic matter has declined over time in sediment cores from all over the Strait of Georgia.

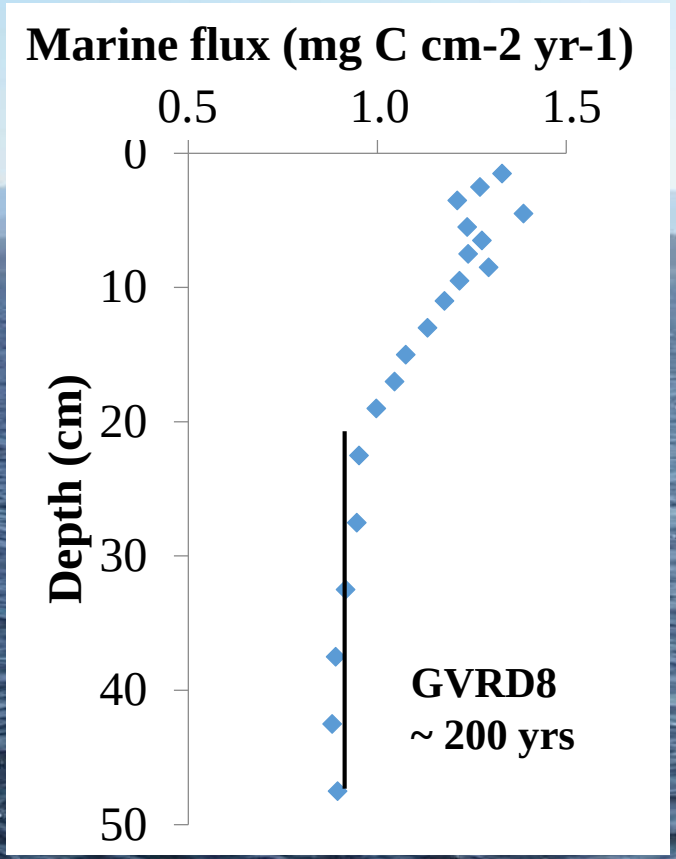




But a fraction is a ratio. What about flux?

The FLUX of marine-derived organic matter has Not declined in the last 200 years.

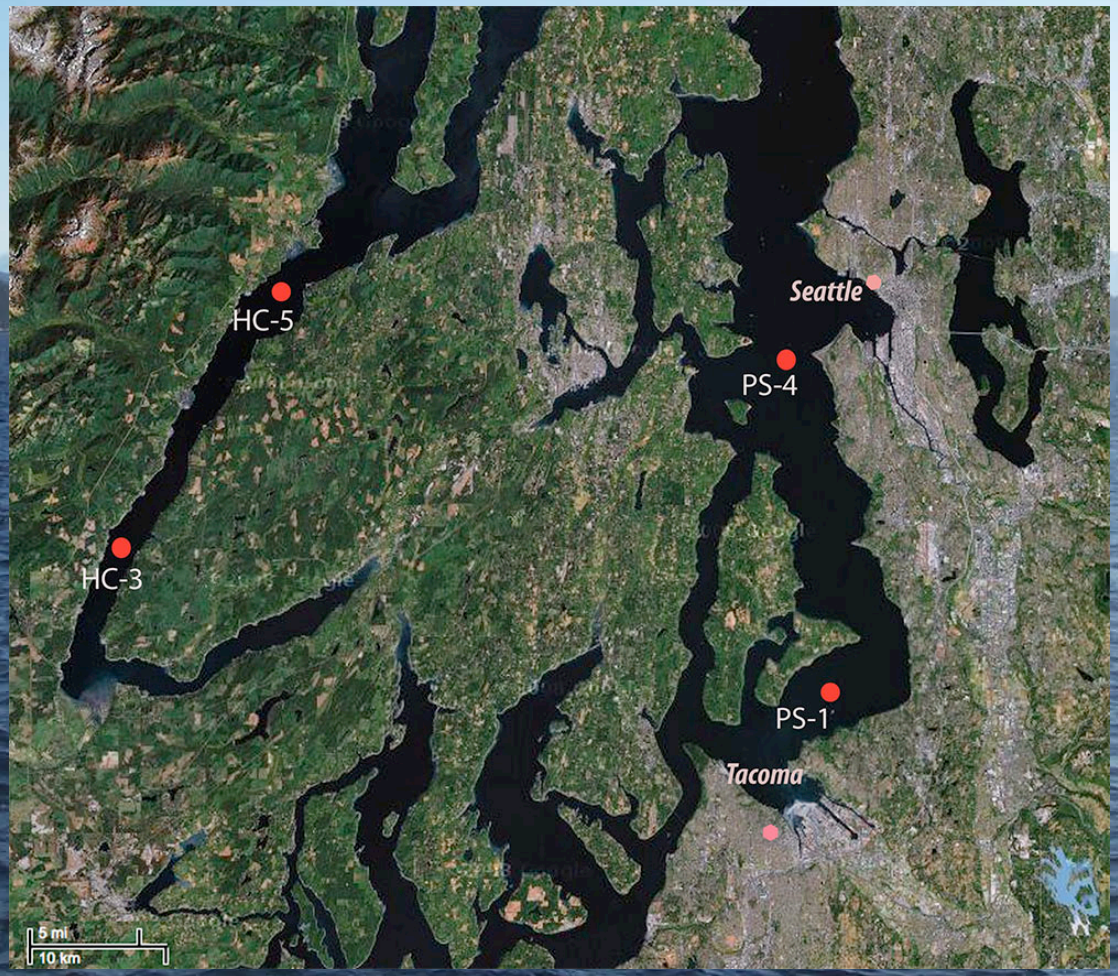




What about Puget Sound?

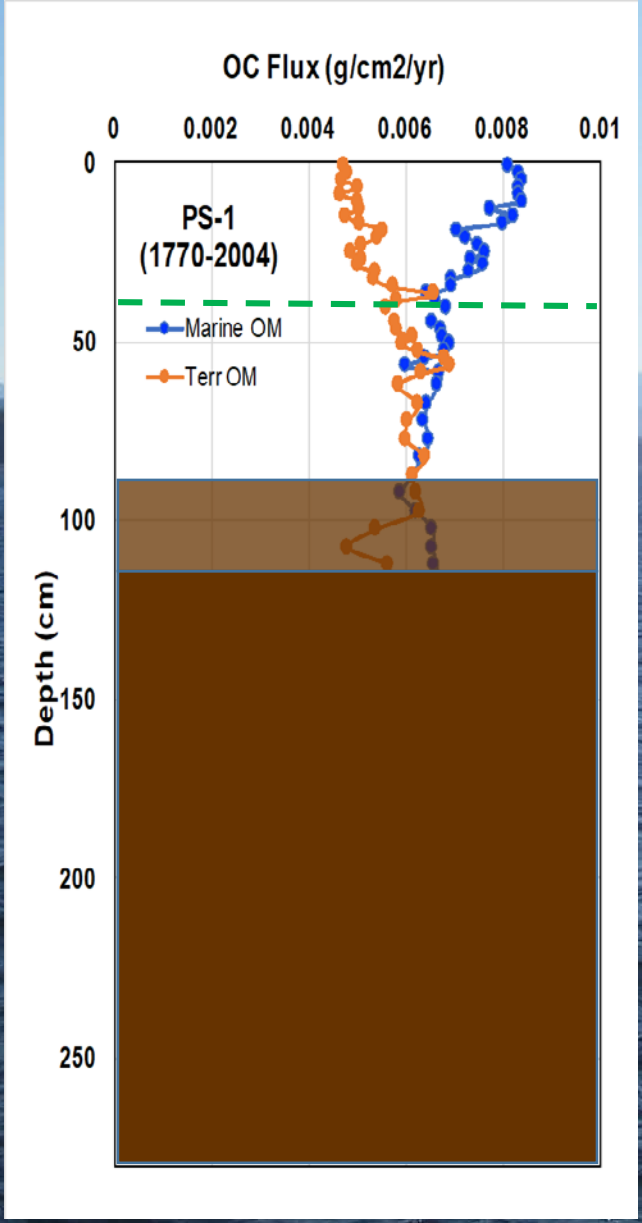
Puget Sound Cores

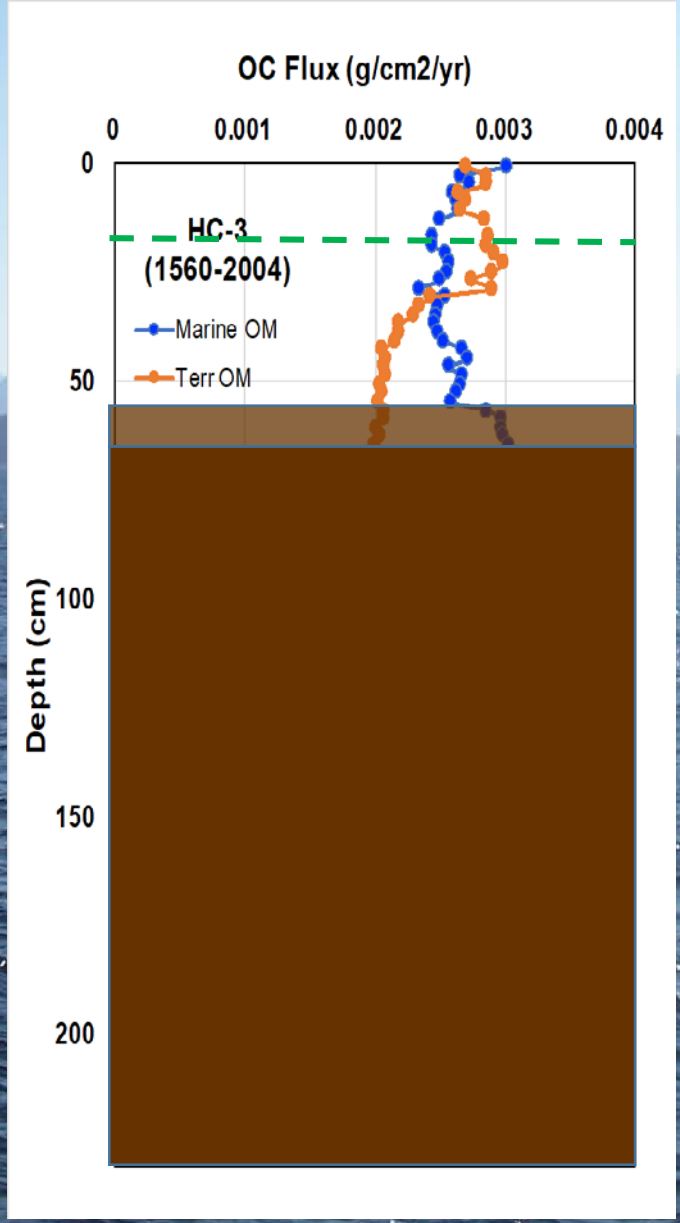
Brandenberger et al., 2011. Aquatic Geochemistry



Proportion of marine organic matter declining; biogenic Si declining

Puget Sound plots courtesy of Li-Jung Kuo and Jill Brandenberger





Conclusions

1. Total primary productivity in the Strait of Georgia unchanged since 1970s (and for ≥ 200 years).

2. Puget Sound: 3 of 4 cores show stable or increasing marine productivity.

3. TYPE of productivity might have changed. (Christopher Krembs – supported by decline in BiSi)

4. A mismatch in timing at a higher trophic level could explain model results that indicate lower prod.

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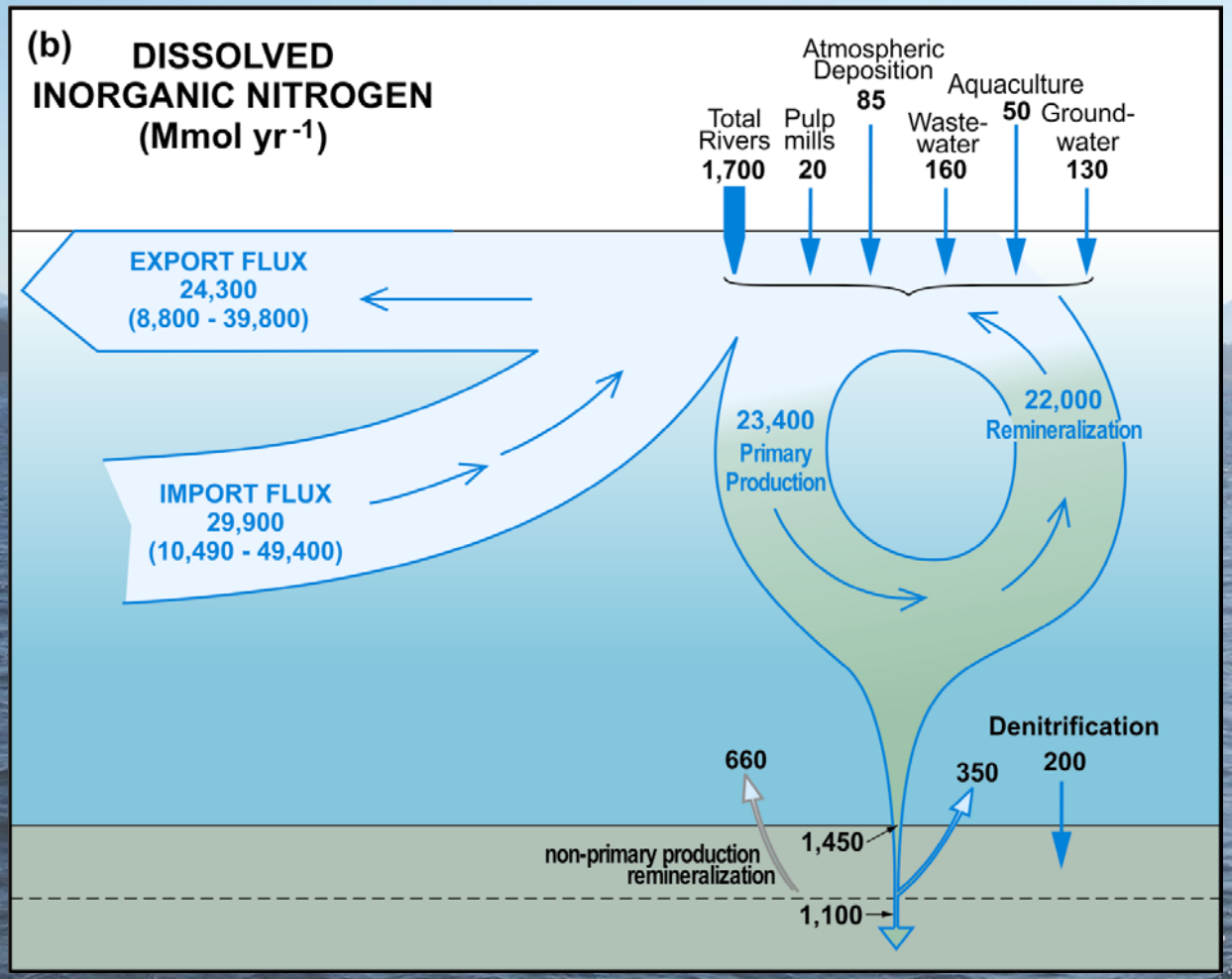
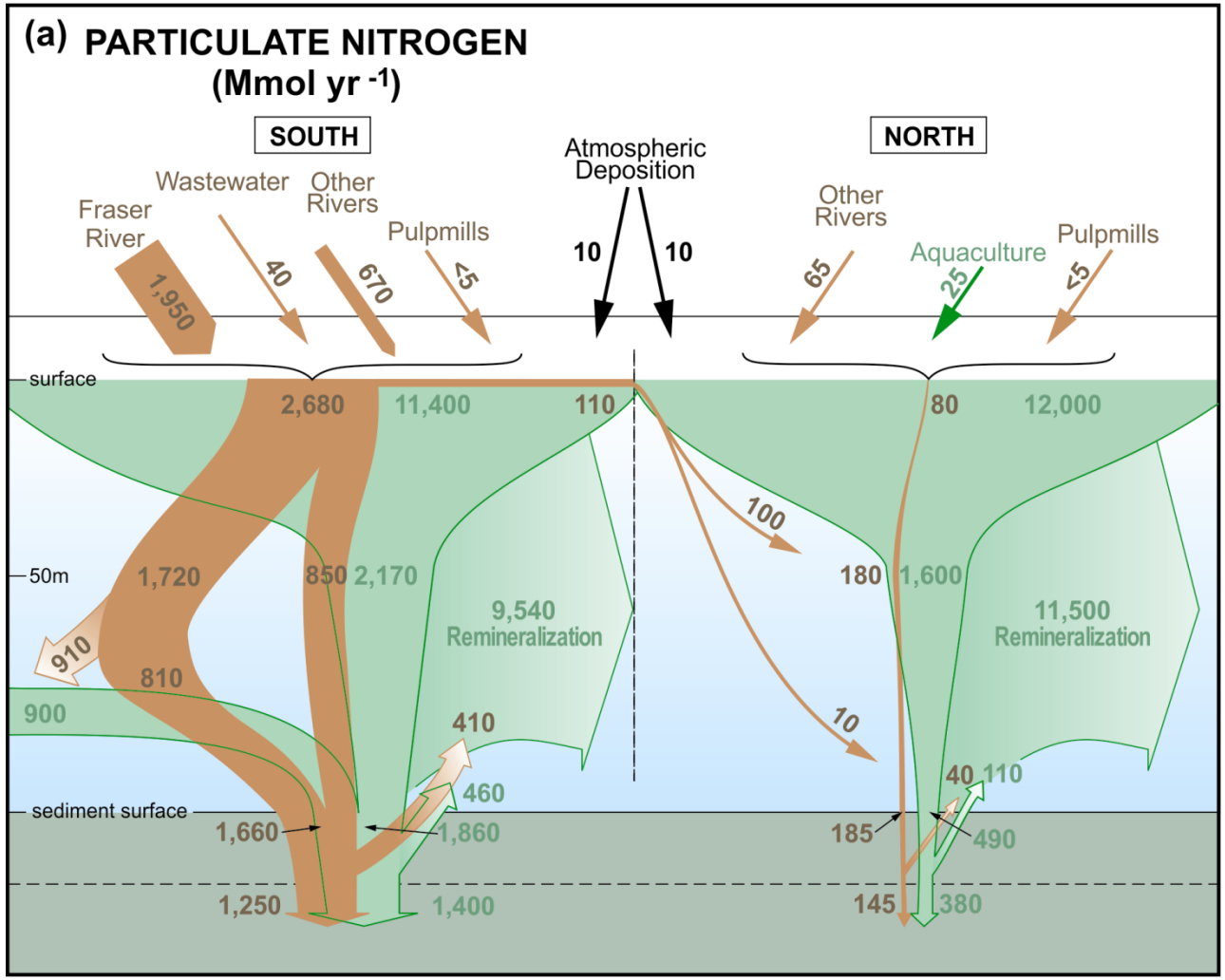
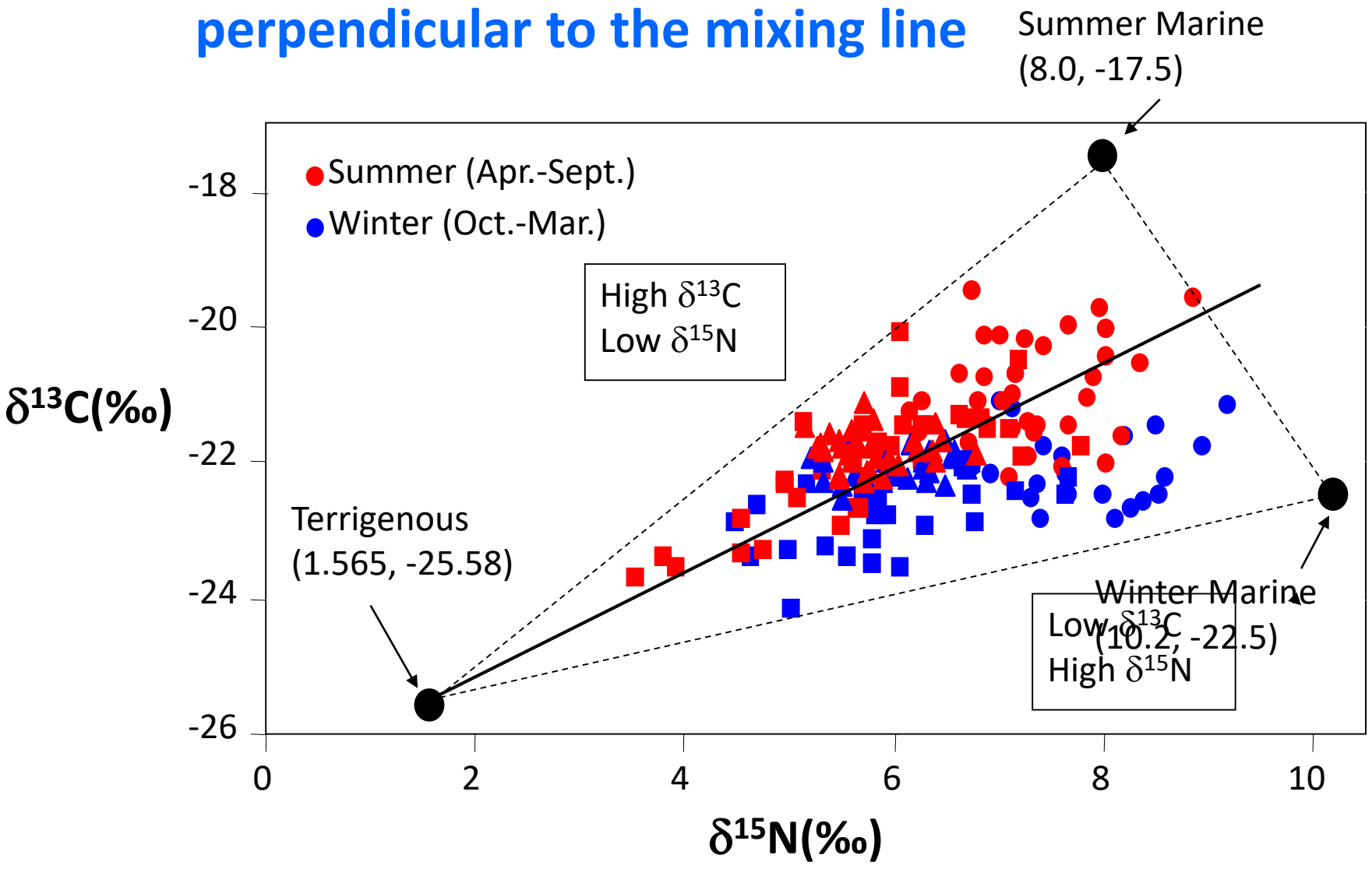

(b)
DISSOLVED
INORGANIC NITROGEN
(Mmol yr -1)
Atmospheric
Deposition
85
Aquaculture
50
Total
Rivers
1,700
Pulp
mills
20
Waste-
water
160
Ground-
water
130
EXPORT FLUX
24,300
(8,800 - 39,800)
IMPORT FLUX
29,900
(10,490 - 49,400)
23,400
Primary
Production
22,000
Remineralization
Denitrification
660
350
200
1,450
non-primary production
remineralization
1,100

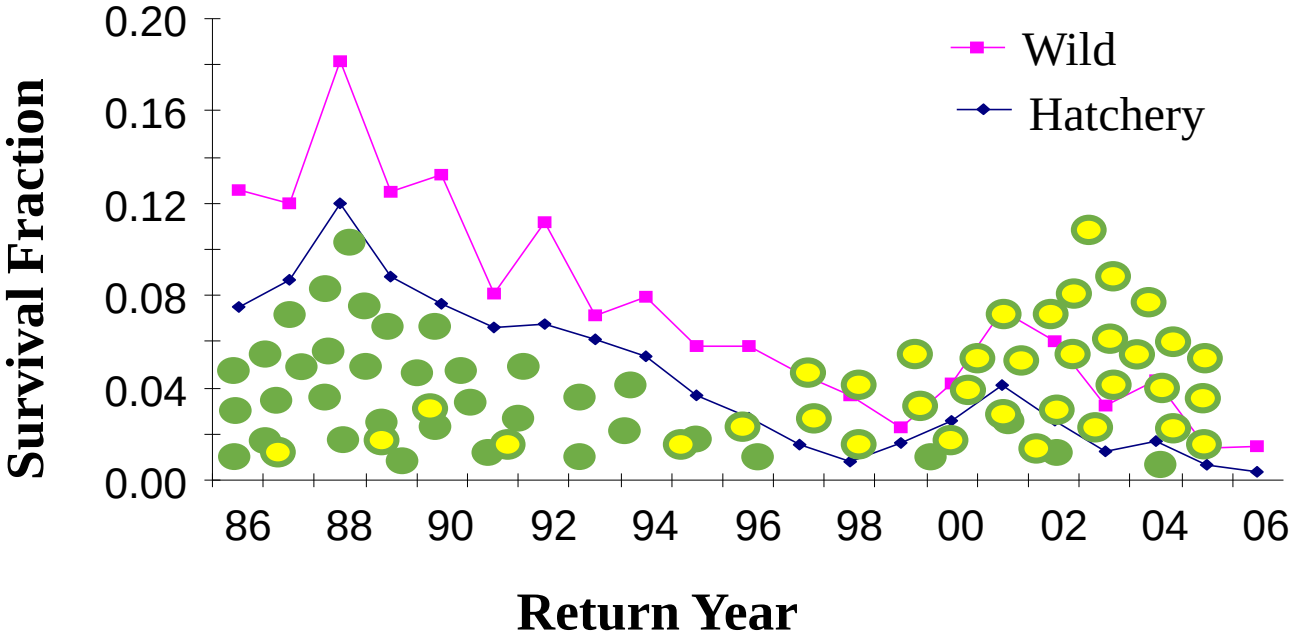

(a) PARTICULATE NITROGEN
(Mmol yr -1)
SOUTH
NORTH
Atmospheric Deposition
Fraser River
Wastewater
Other Rivers
Pulpmills
Other Rivers
Aquaculture
Pulpmills
1,950
40
670
<5
10
10
65
25
<5
surface
50m
sediment surface
2,680
11,400
110
80
12,000
100
180
1,600
1,720
850
2,170
9,540 Remineralization
11,500 Remineralization
910
810
900
410
460
10
40
110
1,660
1,860
185
490
1,250
1,400
145
380

Seasonal difference explains variation perpendicular to the mixing line

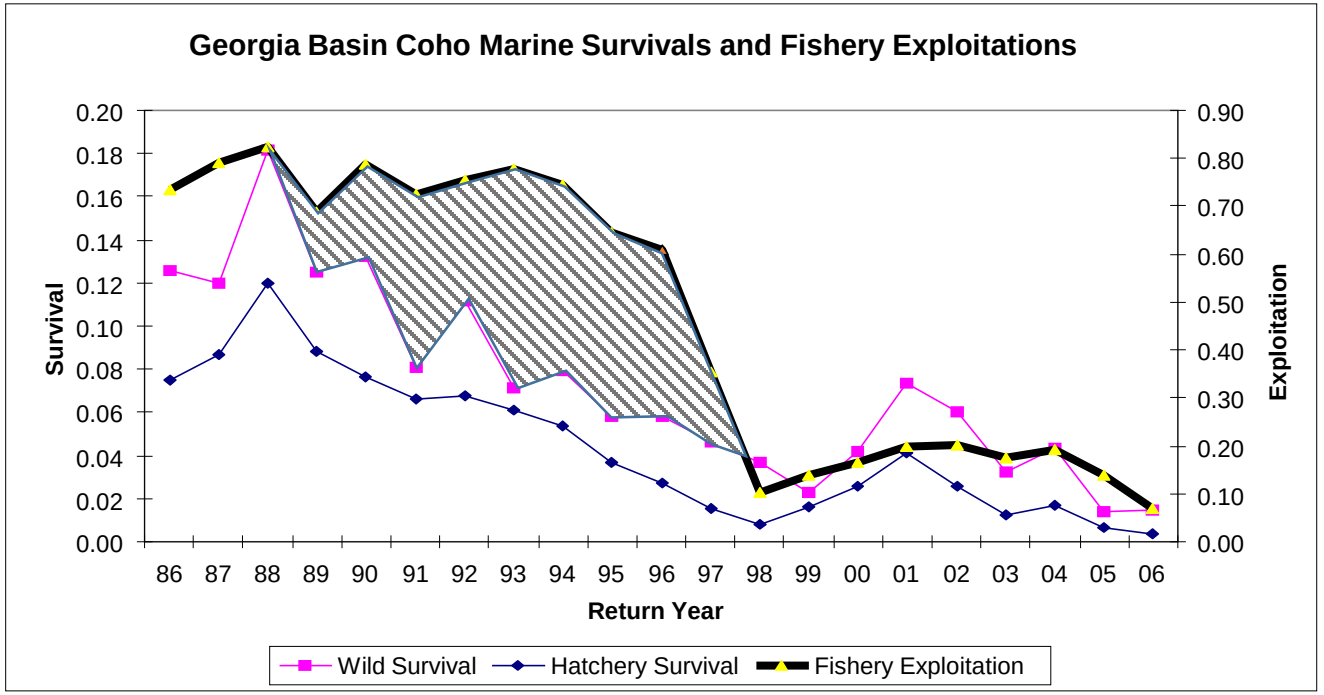


Johannessen et al., 2005. Marine Geology

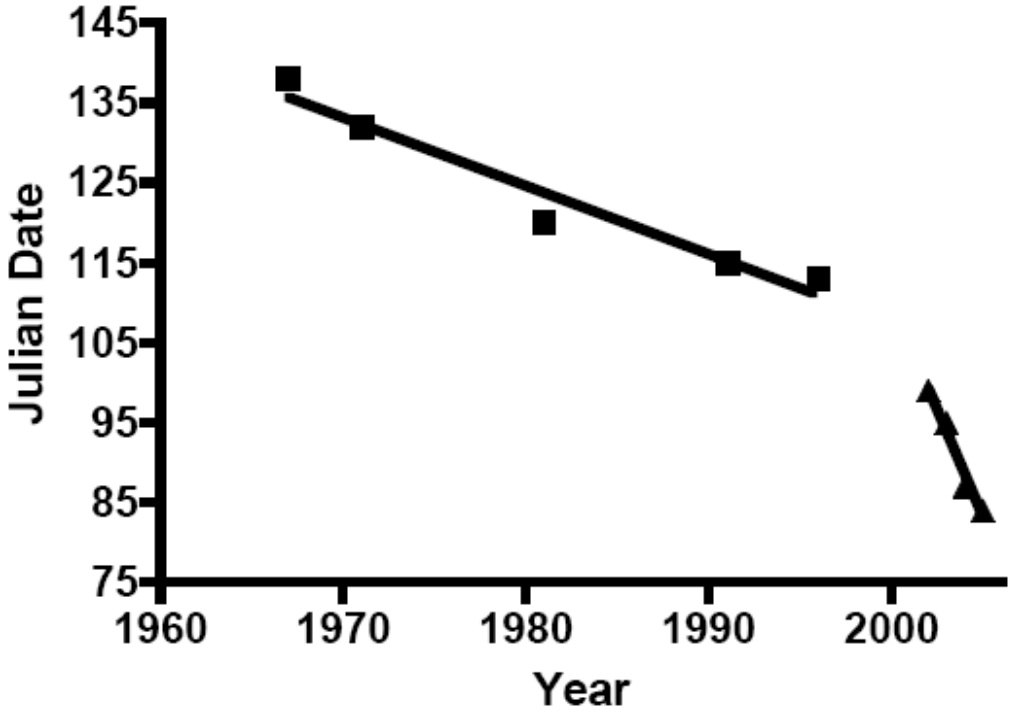
Has primary productivity decreased?
(…or increased?)



Sewage, eutrophication, declining oxygen…

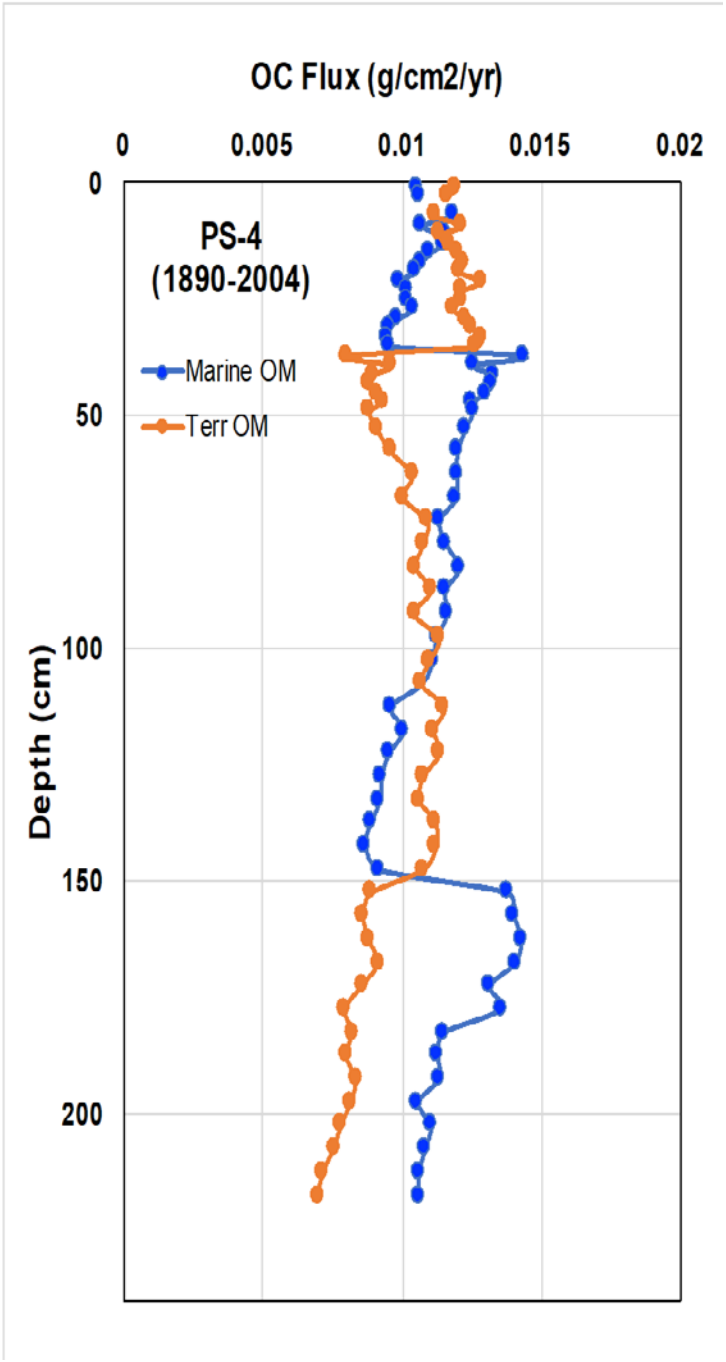


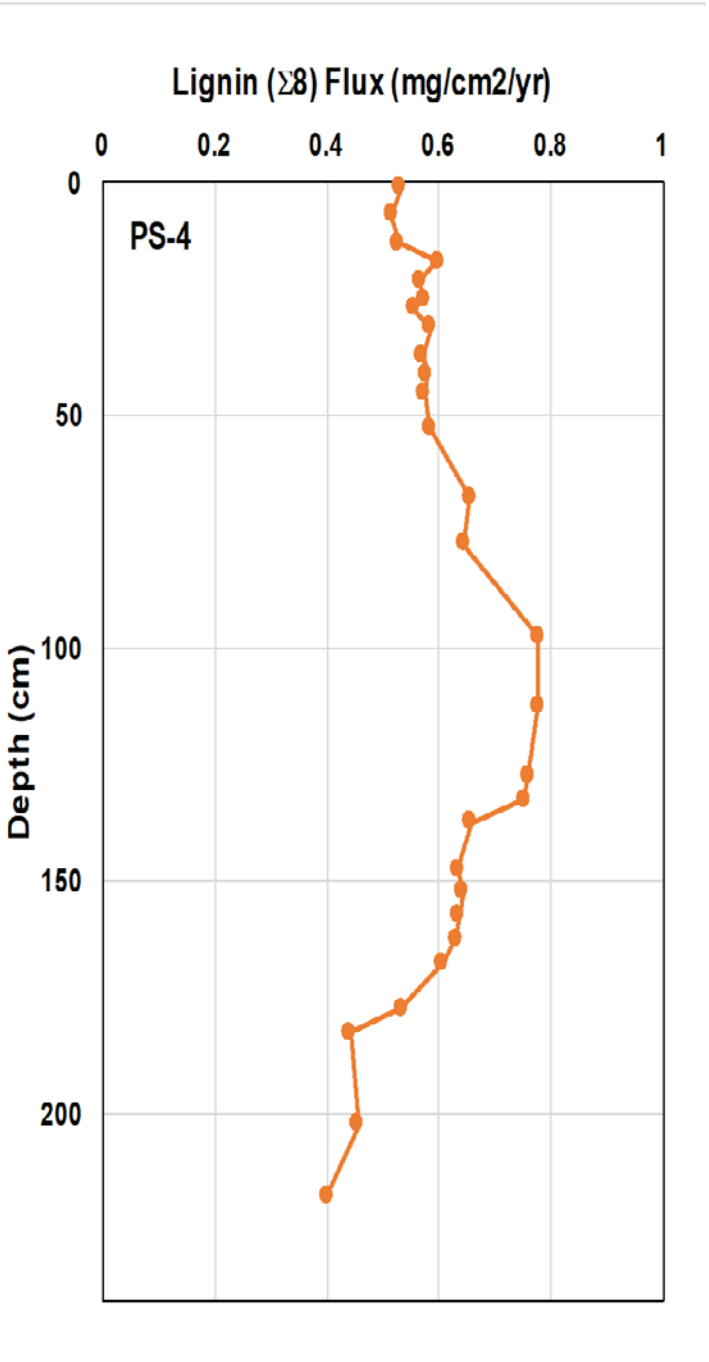
Modified from Johannessen & Macdonald, 2009, Environmental Reviews
Figure by Bruce McCarter, DFO Pacific Biological Station

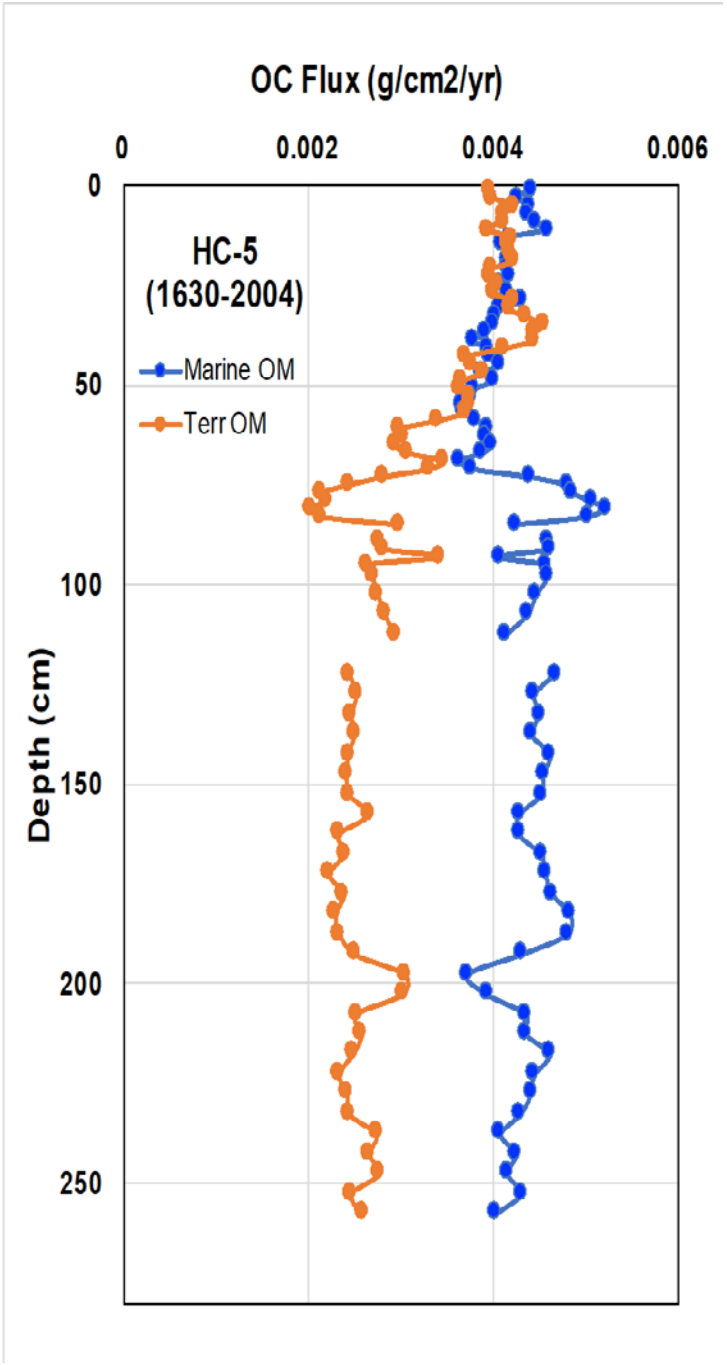


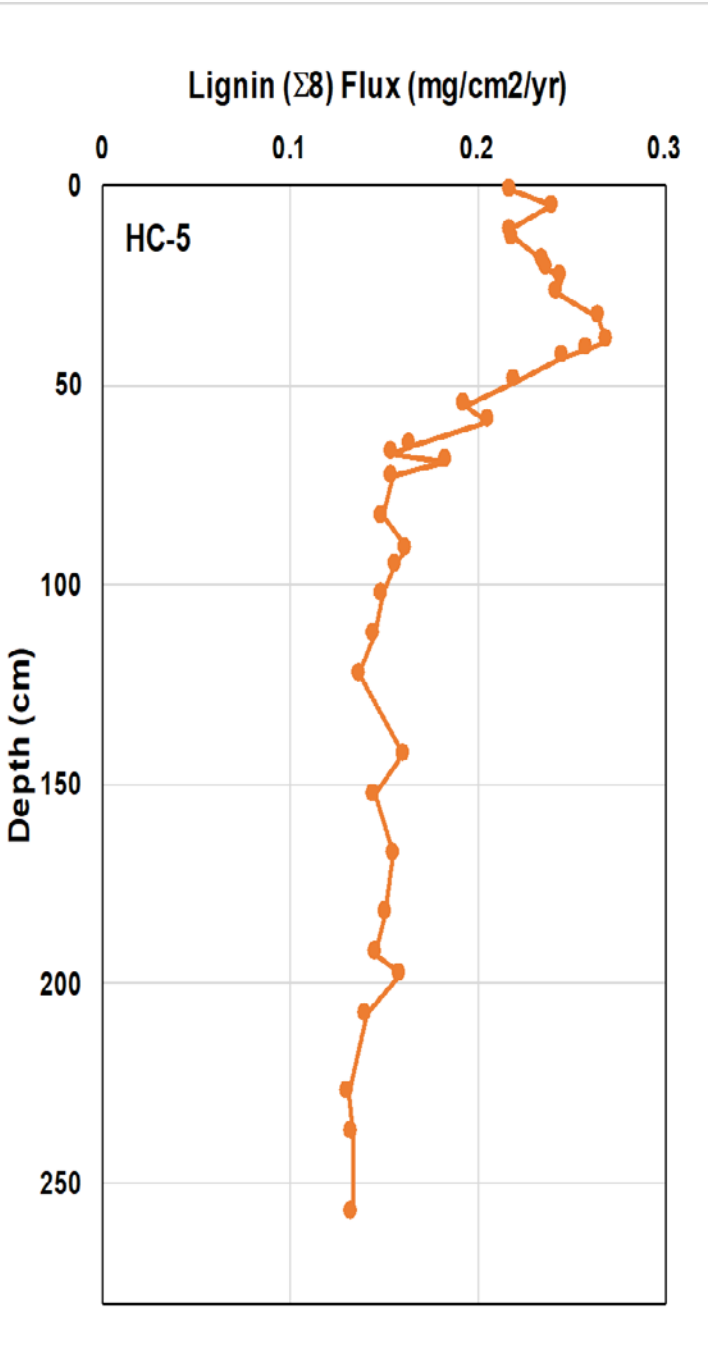
■ Bornhold 2000

▲ STRATOGEM estimates of *Neocalanus* abundance peak.


OC Flux (g/cm2/yr)
0
0.005
0.01
0.015
0.02
PS-4
(1890-2004)
Marine OM
Terr OM
Depth (cm)
0
50
100
150
200


Lignin (Σ8) Flux (mg/cm2/yr)
0
0.2
0.4
0.6
0.8
1
PS-4
Depth (cm)
0
50
100
150
200


OC Flux (g/cm2/yr)
0
0.002
0.004
0.006
HC-5
(1630-2004)
Marine OM
Terr OM
Depth (cm)
0
50
100
150
200
250


Lignin (Σ8) Flux (mg/cm2/yr)
0
0.1
0.2
0.3
HC-5
Depth (cm)
0
50
100
150
200
250