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Biogeochemical cycling of polybrominated diphenyl ethers (PBDEs) in the Strait of Georgia

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Biogeochemical Cycling of Polybrominated Biphenyl Ethers (PBDEs) in the Strait of Georgia

Presenter: Yuanji Sun (ysun@eoas.ubc.ca)

Supervisor: Dr. Roger Francois & Dr. Maria Maldonado

Apr 5th, 2018

Why PBDEs?

- POPs with 209 congeners (tri-, tetra-, penta-, hexa-, etc.)
- Increasingly used in recent decades as flame retardants in many consumer products



- Wide dispersal, persistence, toxicity, and tendency to bioaccumulate up the trophic chain

(Image credit: Gadget Review, Independent Balkan News Agency, Herman Miller)

- Have been found everywhere in the world

The image is a screenshot of a BBC Earth News article. The top navigation bar includes the BBC logo, a 'Sign in' button, and links for News, Sport, Weather, Capital, TV, Radio, and More... A search bar is also present. The article title is 'Banned flame retardants show up in new babies', posted by Jim Hanchett-Indiana on July 6th, 2017. The author's name is listed as 'Posted by Jim Hanchett-Indiana | July 6th, 2017'. Below the title is a 'Share Article' section with icons for Facebook, Twitter, and Email. To the right of this is a Creative Commons Attribution 4.0 International license notice. Further right is a 'Follow Futurity' section with icons for RSS, Twitter, Facebook, and Email. The article text begins with 'Trace amounts of flame retardants, banned in the United States for more than a decade, are still passing through umbilical cord blood from mothers to their babies. The chemicals are linked to a variety of health concerns including...'. On the left side of the screenshot, there is a sidebar with the 'nature' logo and 'International week' text. Below this are navigation links for Home, News & Comment, Research, and Careers. A secondary navigation bar shows 'News & Comment', 'News', '2018', and 'Ma'. The sidebar also contains a 'NATURE | NEWS' section with a headline 'Man-made pollutants found in ocean trenches' and a sub-headline 'Crustaceans at depths of 10,000 metres do some animals in coastal waters.' by Jane Qiu, dated 20 June 2016, in SHANGHAI. Another article snippet for 'Arctic polar bear' by Matt Walker is visible. A small image of a polar bear is shown at the bottom of the article preview.

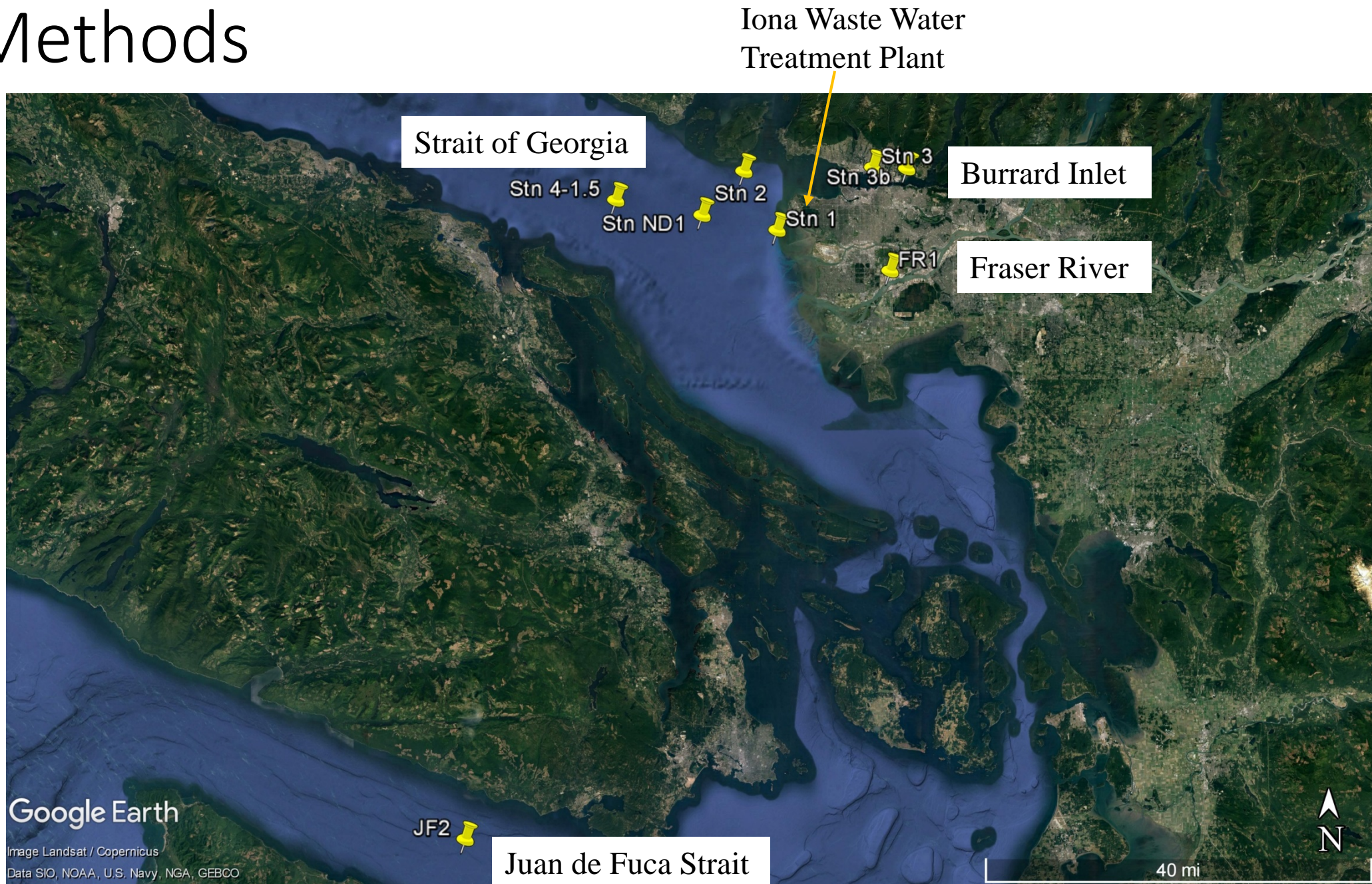
Lack quantitative understanding of their biogeochemical cycling in the environment, particularly in the marine environment

Key Questions

Quantify the sources, sinks and biogeochemical cycling of PBDEs in the coastal waters of British Columbia

- Compare the relative importance of main sources of PBDEs to the Strait of Georgia
- Contrast their removal to sediments by adsorption on sinking particles, bioaccumulation in the food chain, and export to the Pacific by circulation

Methods

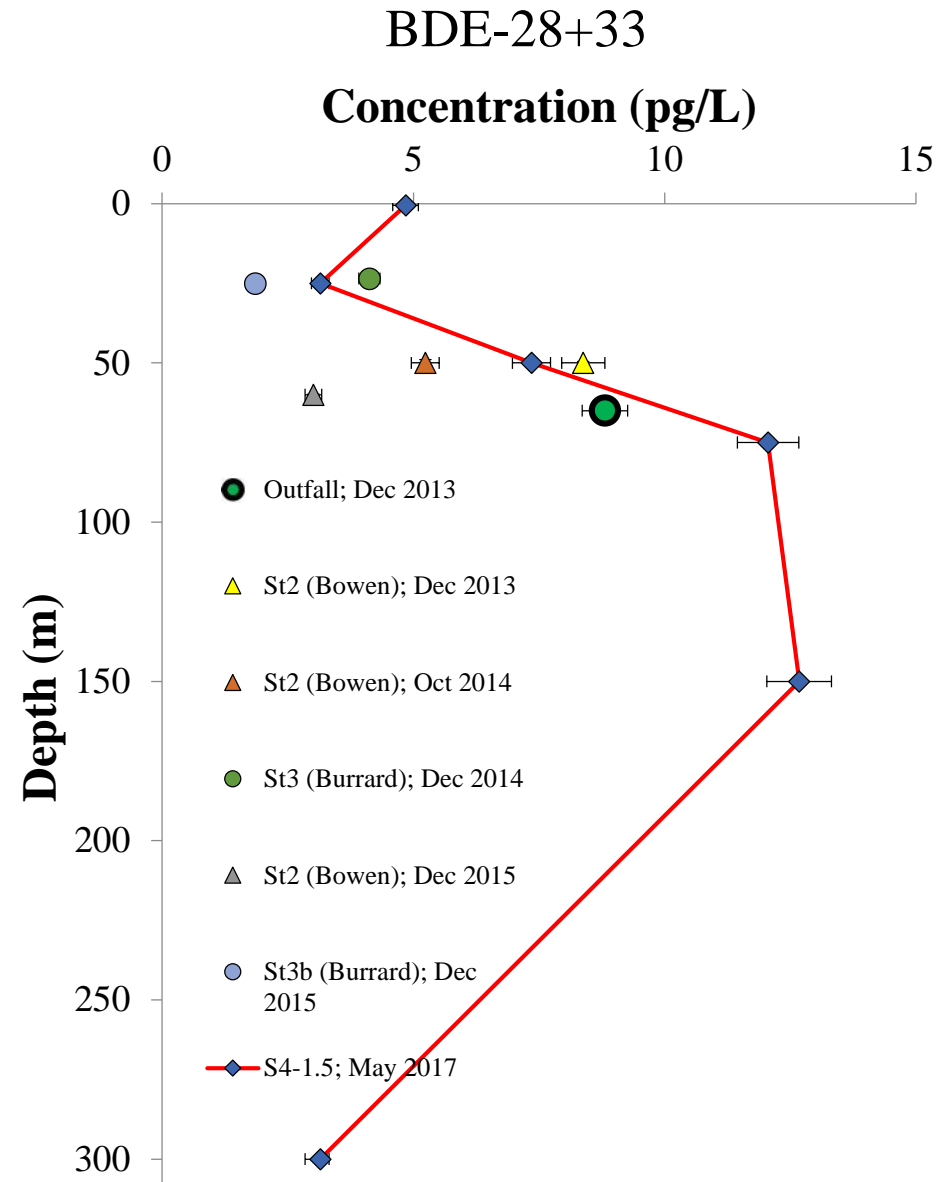
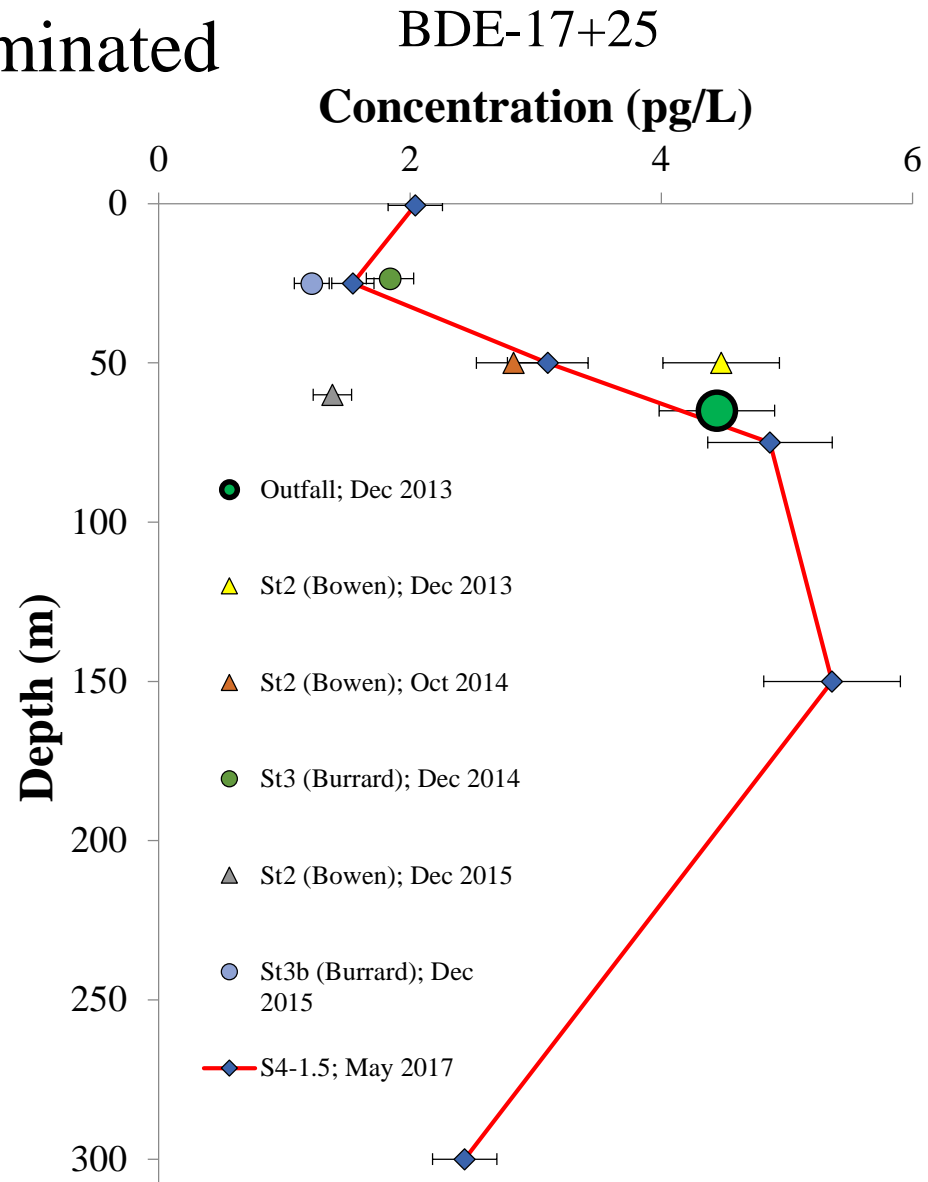


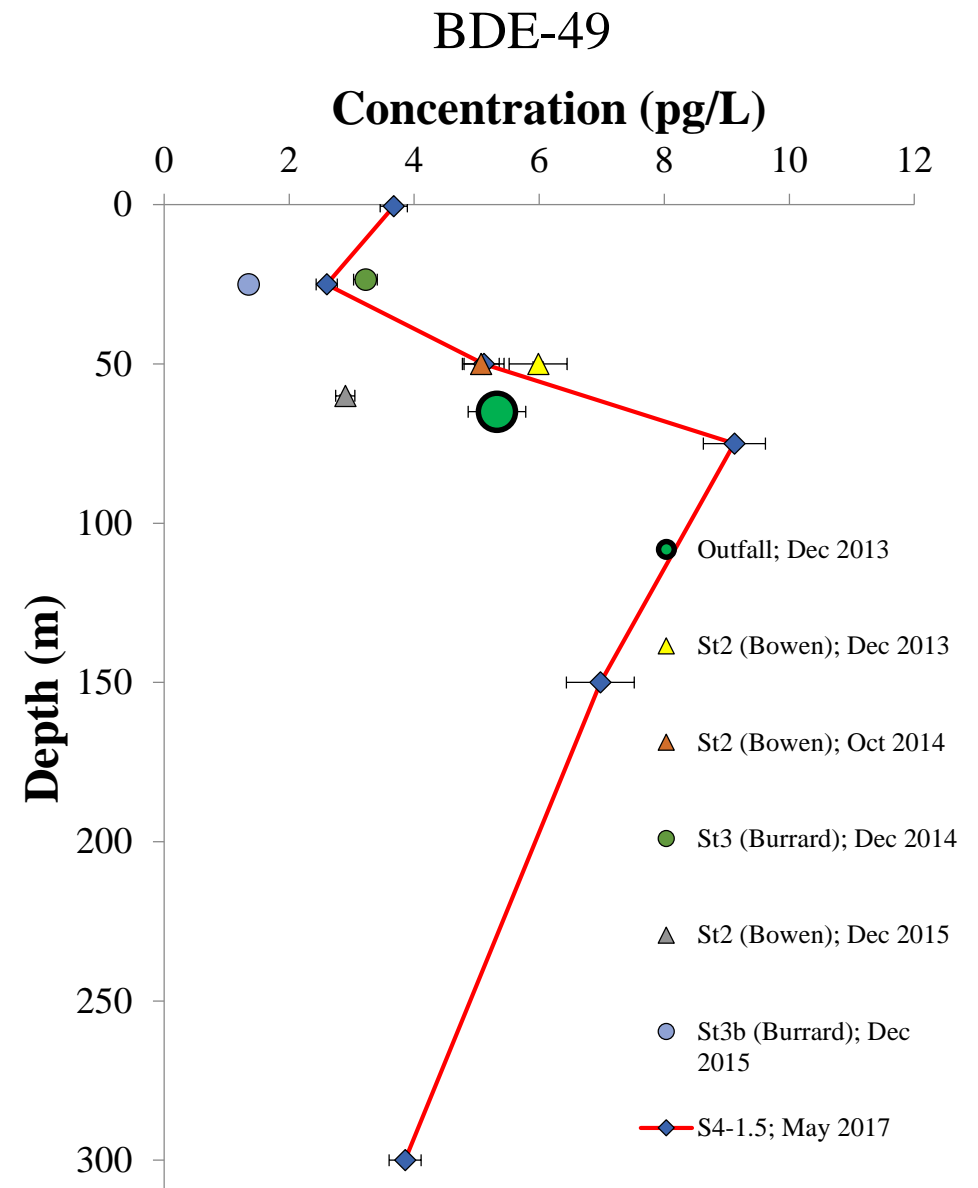
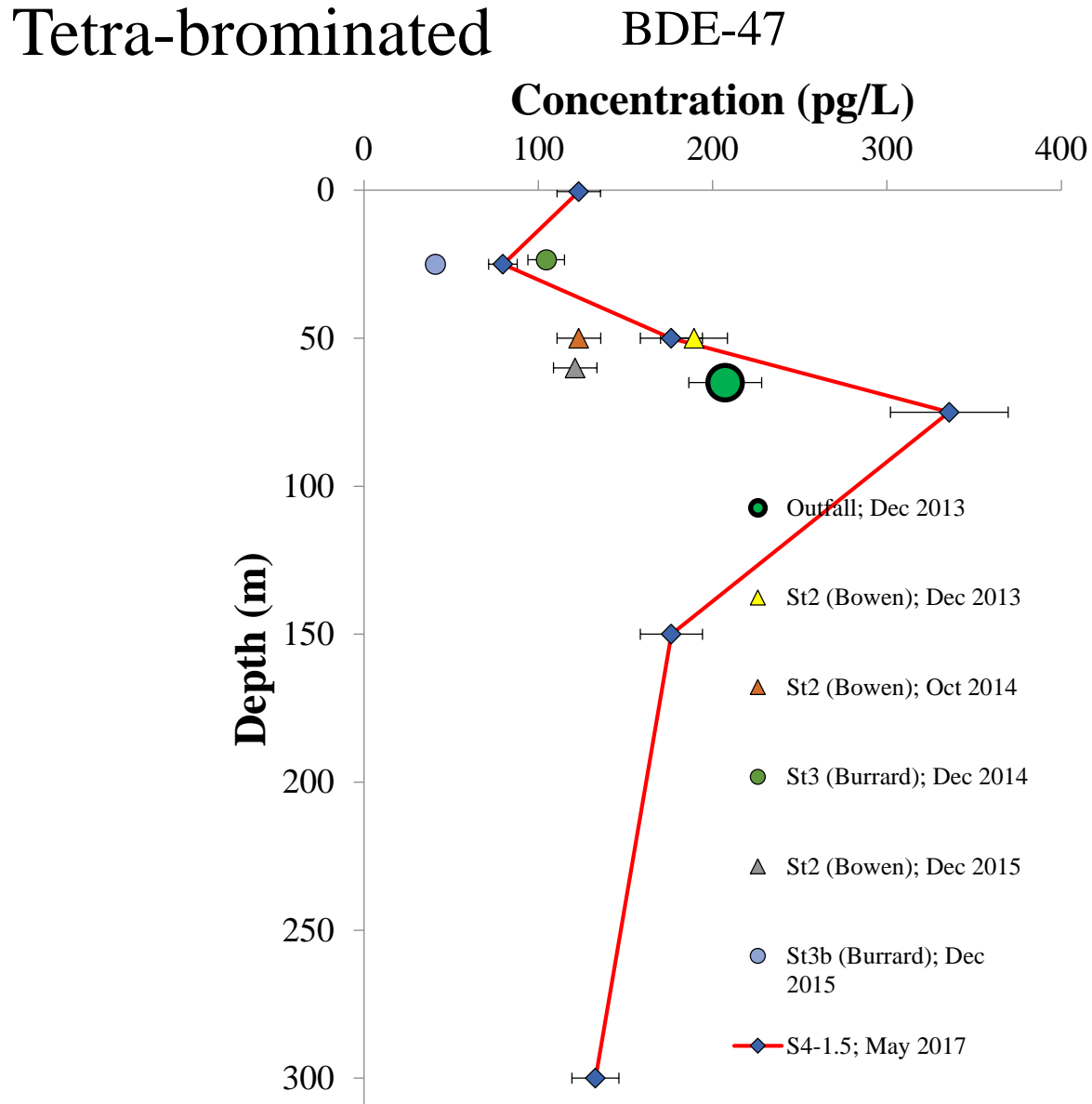
PBDE sampling in the Strait of Georgia



Dissolved PBDEs

Tri-brominated

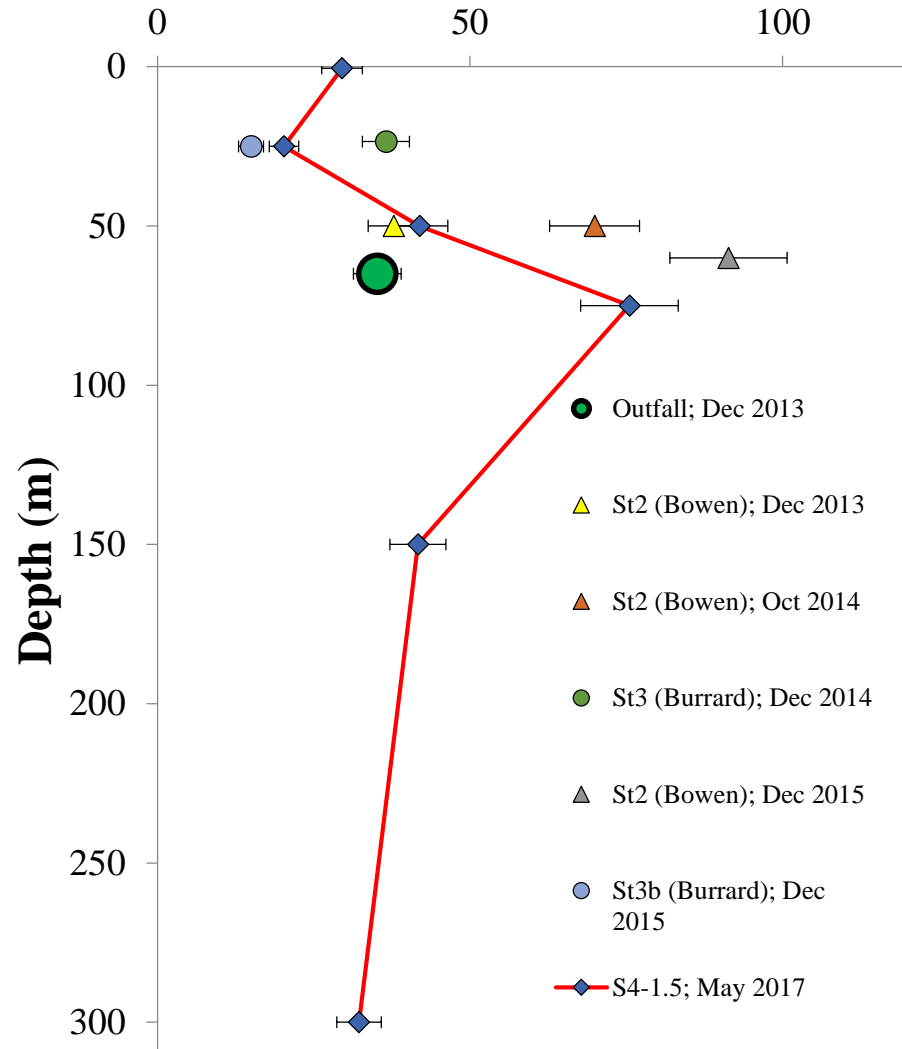




Penta-brominated

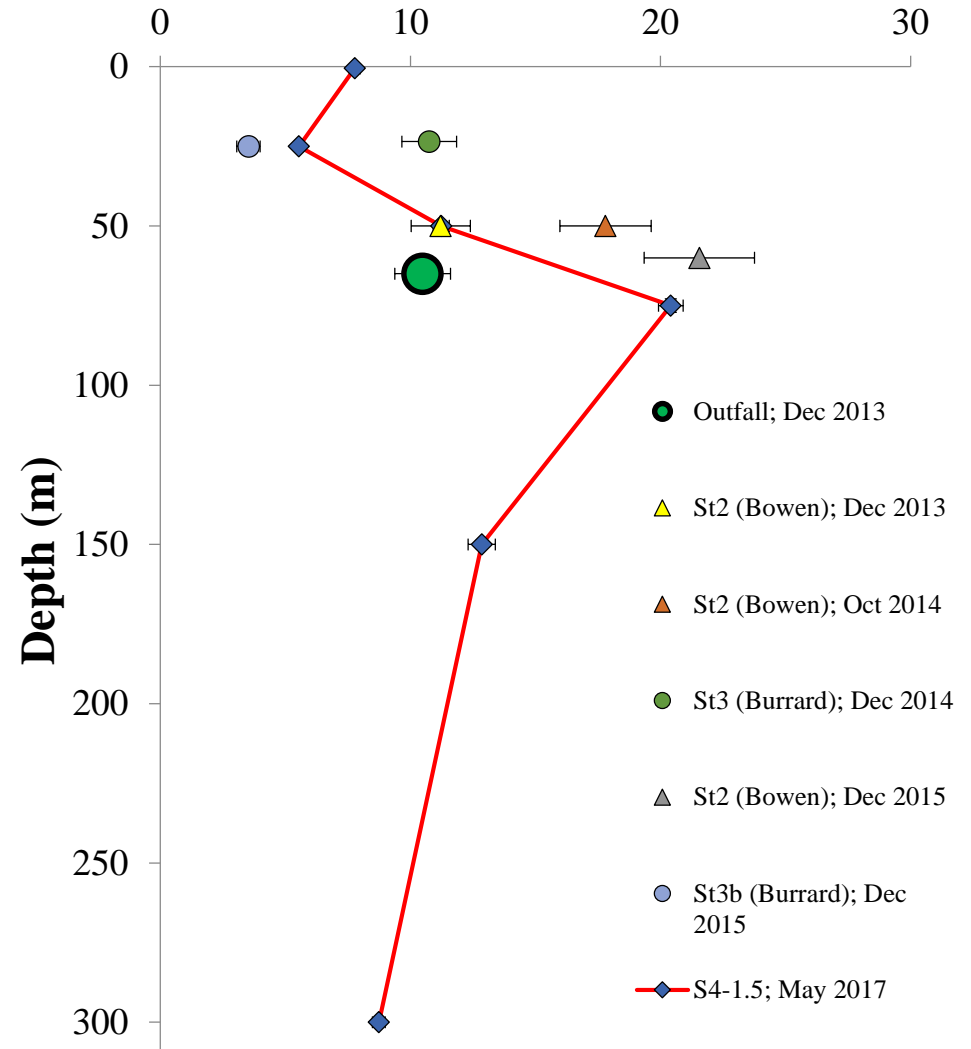
BDE-99

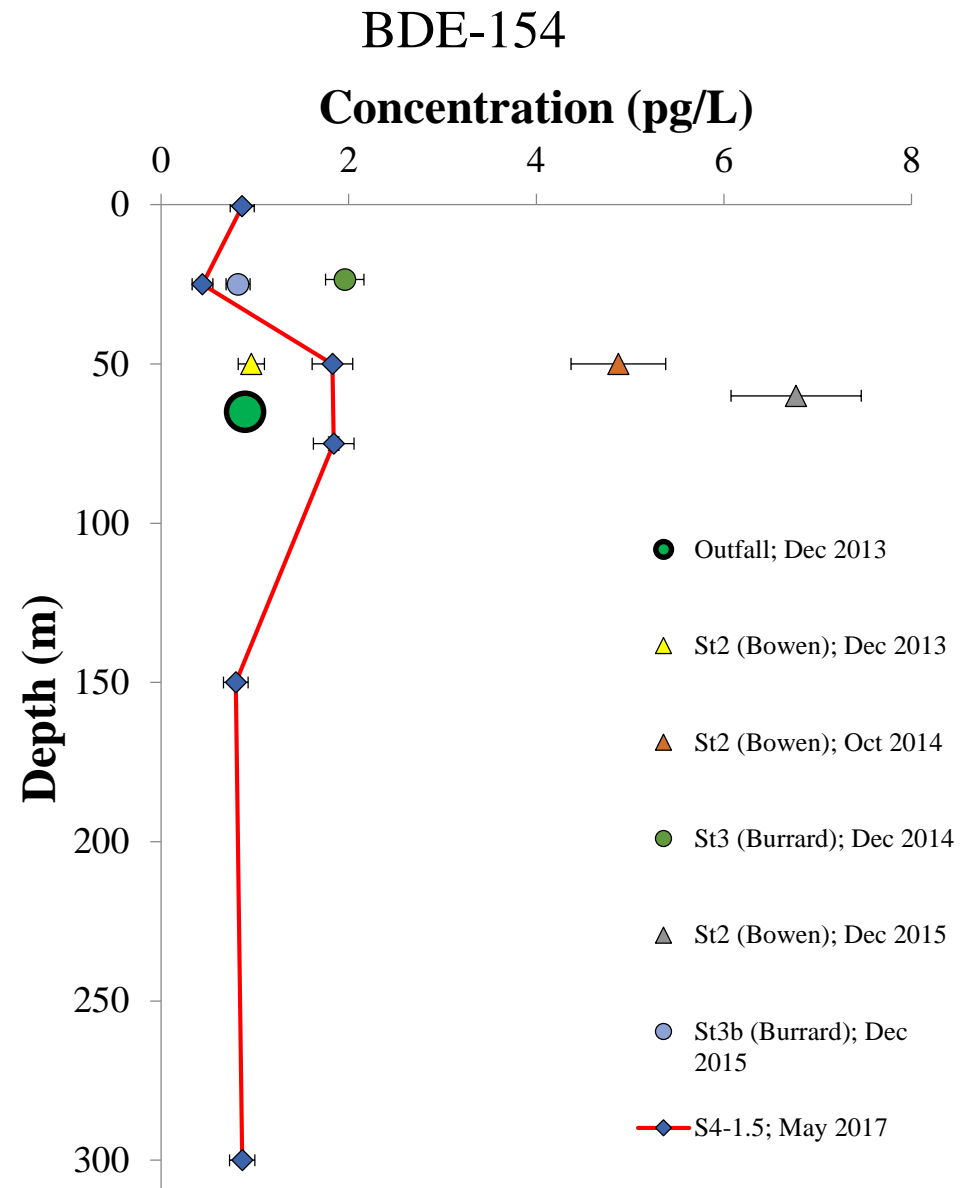
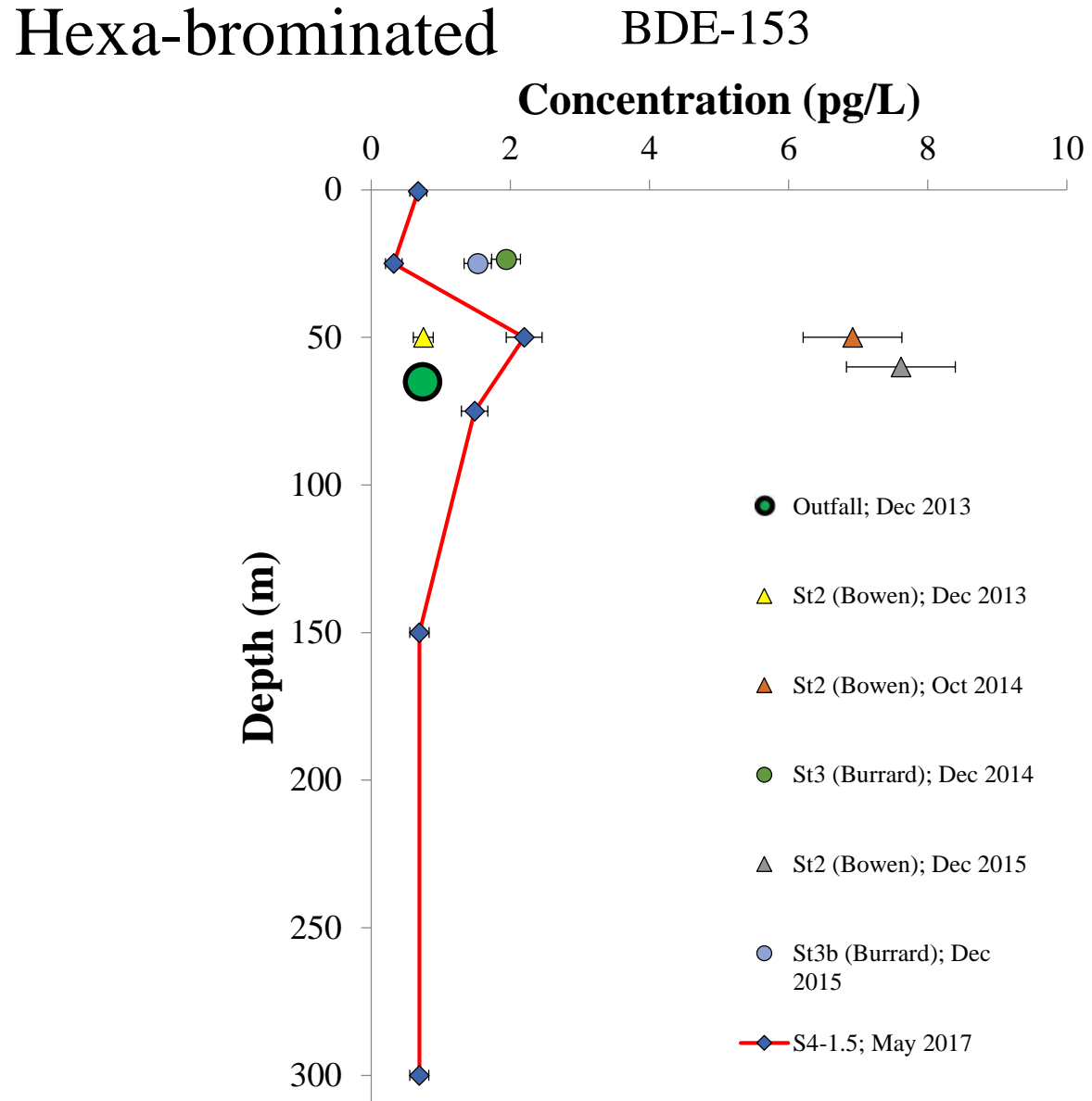
Concentration (pg/L)



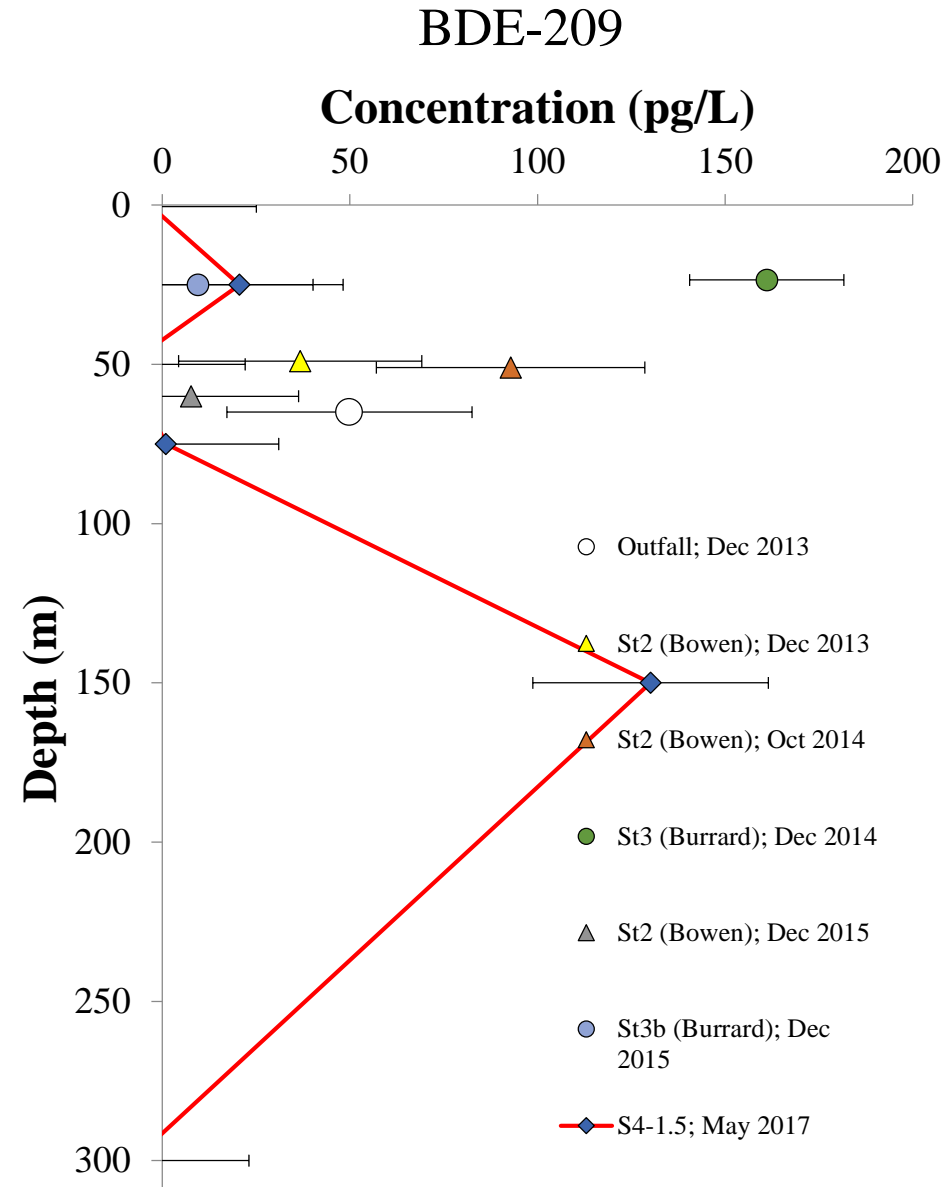
BDE-100

Concentration (pg/L)

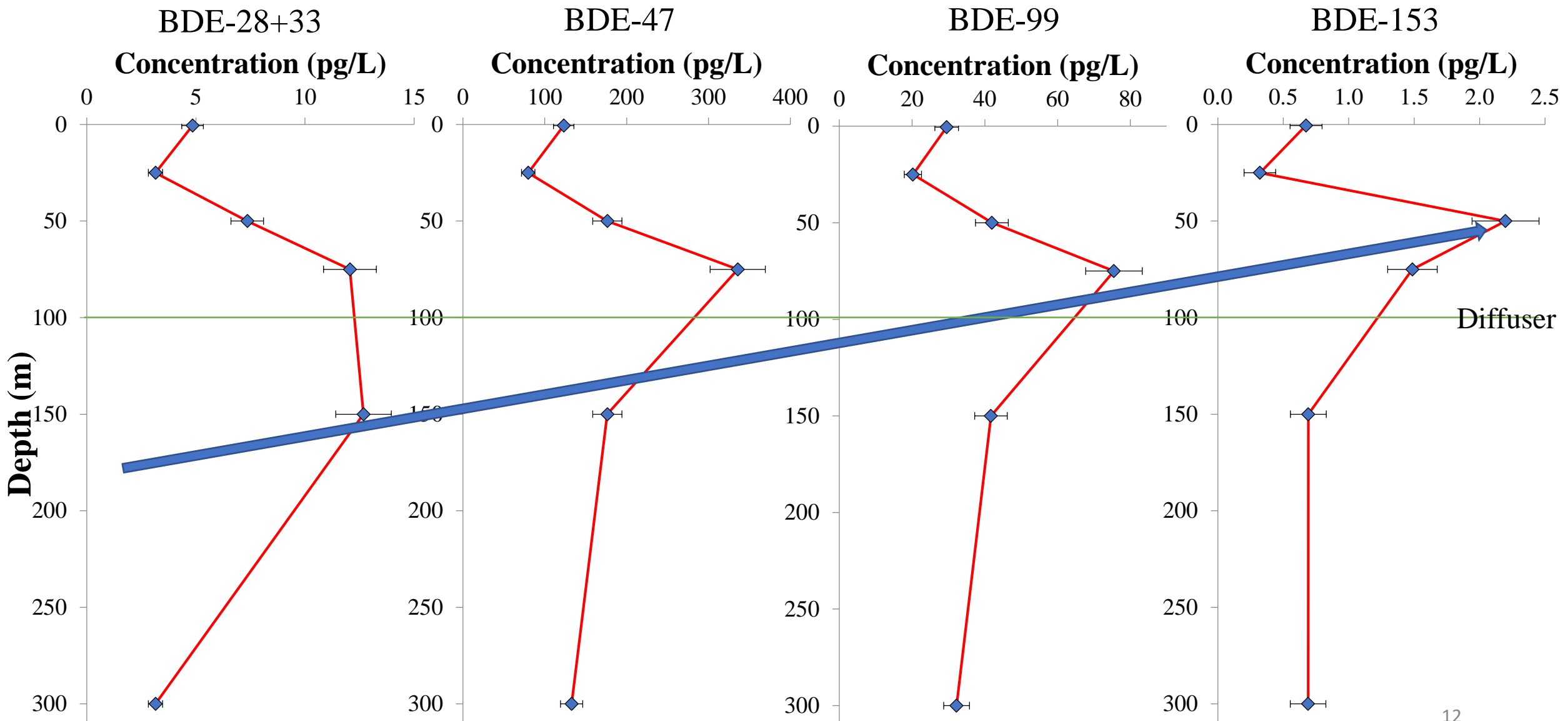




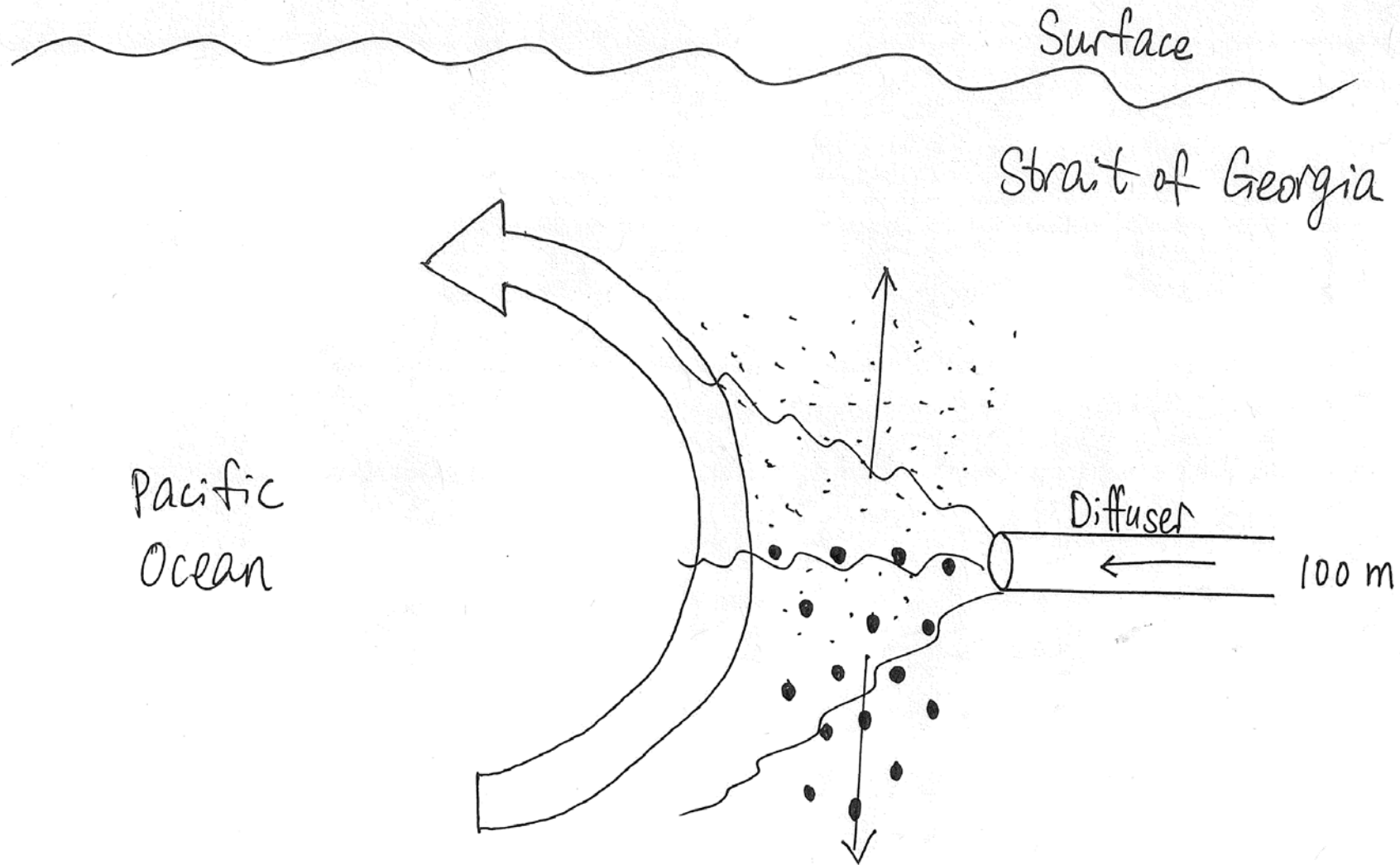
BDE-209 cannot be discussed due to high and variable blanks



Depth Profiles in May 2017 in Strait of Georgia

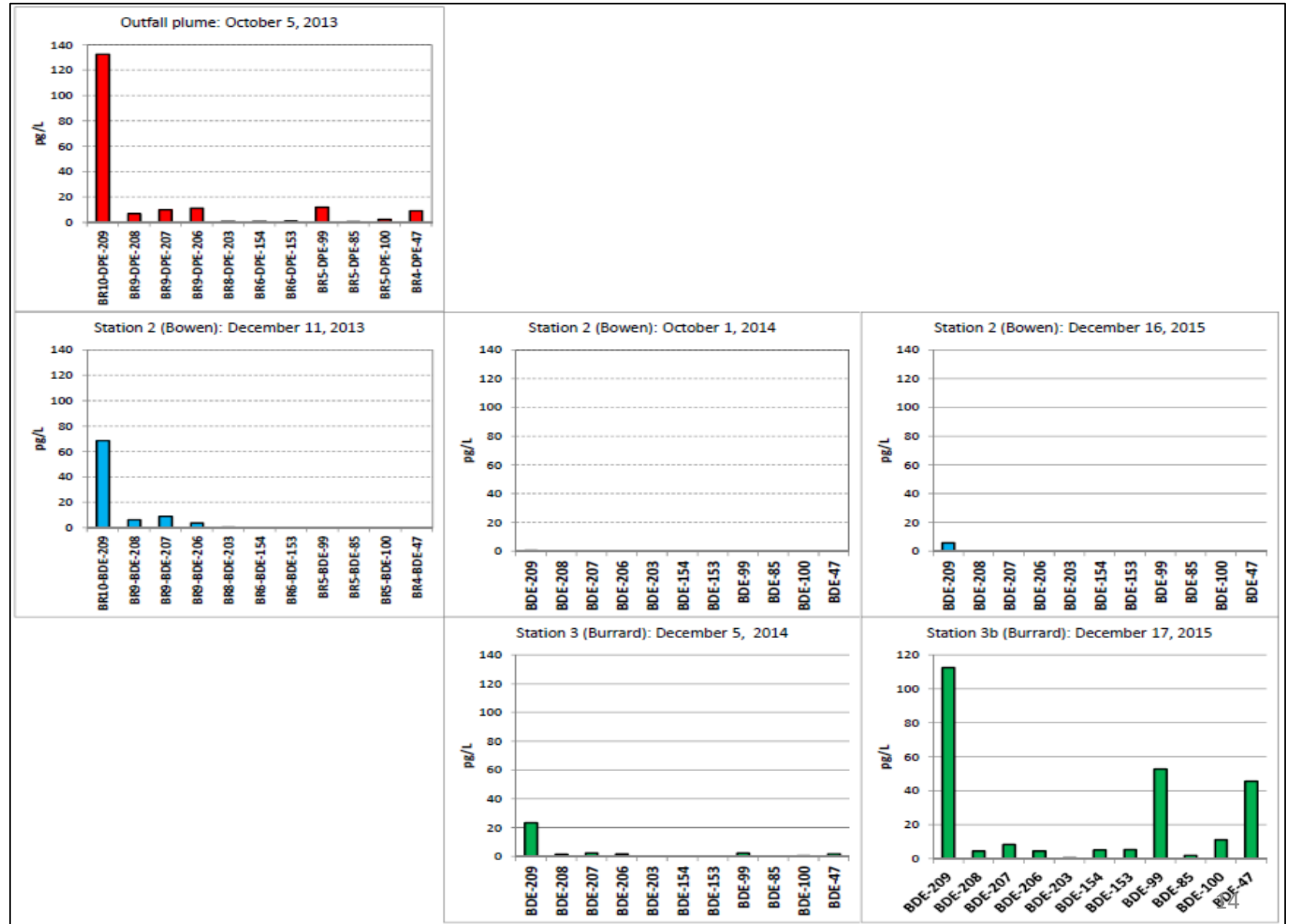


Slower desorption allows the particles to rise towards the surface as a result of the general estuarine circulation of SoG

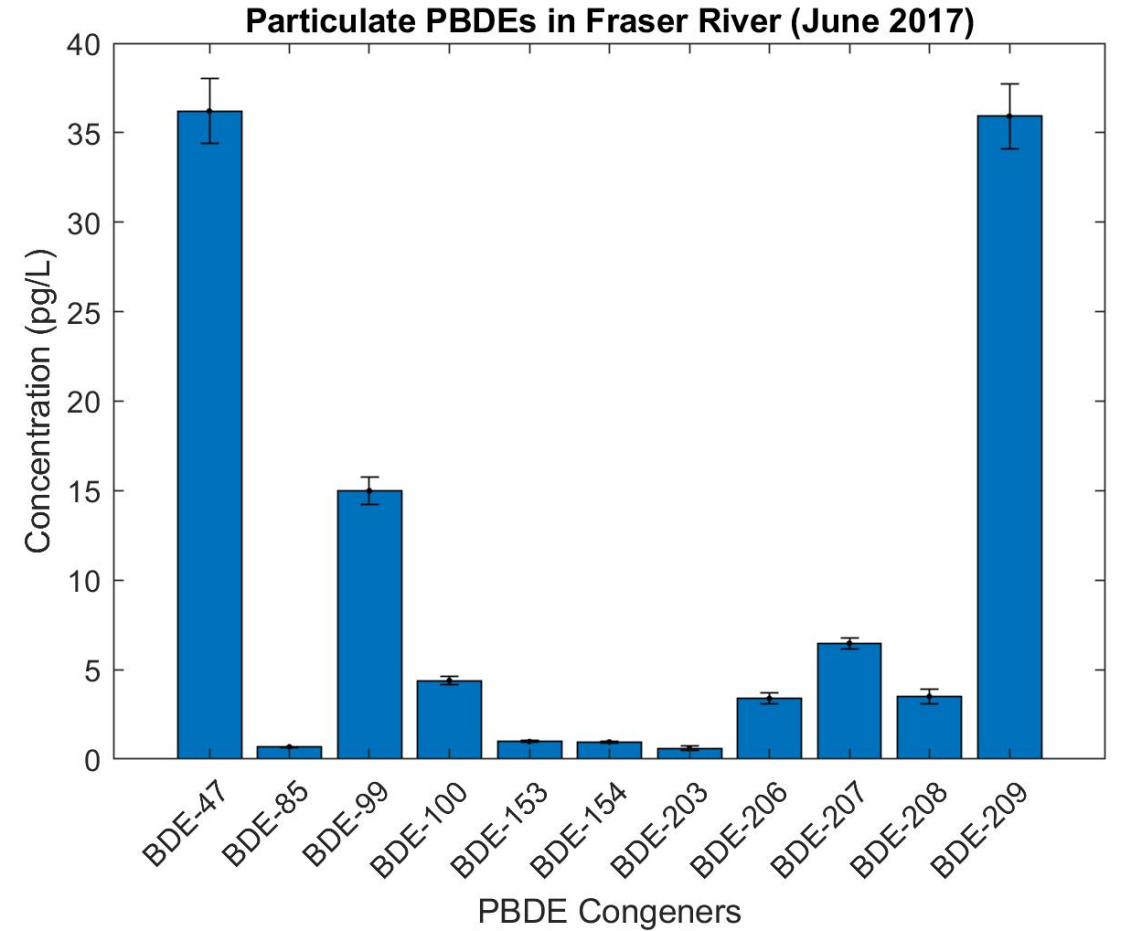
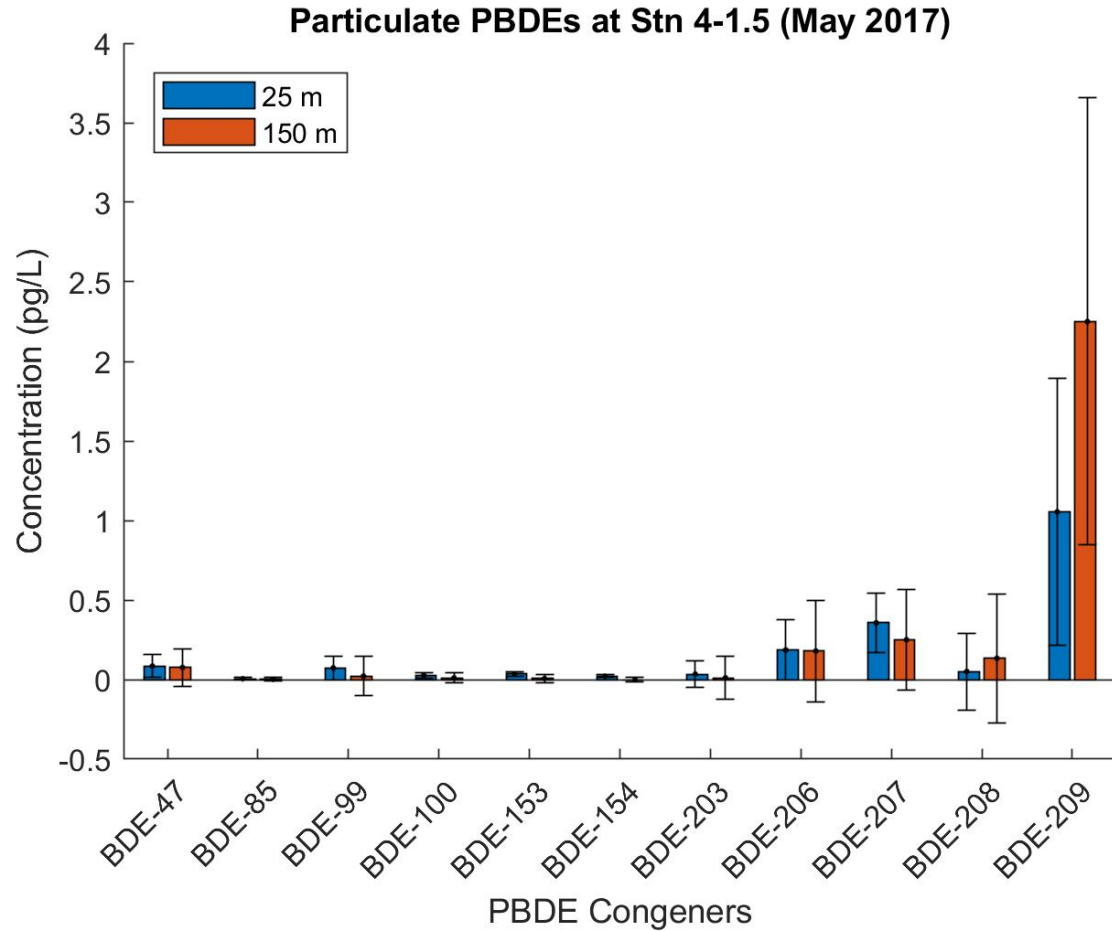


Particulate PBDEs

- Low concentration.
- High temporal & spatial variability.



Fraser River is an important source of particulate PBDEs into SoG



Particulate PBDE Flux

The PBDE discharge is increasing during the past 10 years

Depth [m]	Part. BDE-209 [pg/m ³]	²³⁴ Th Flux [dpm/(m ² d)]	BDE-209 Flux [pg/(cm ² yr)]
25	1054 ± 838	1286 ± 36	79 ± 64
150	2250 ± 1405	7186 ± 193	380 ± 243

Particulate PBDE flux calculated from literature between 2003 and 2005 (Grant et al 2011)

Congener	PBDE concentration in surface sediment [pg/g]	Sedimentation rate [g/cm ² /year]	PBDE sedimentation rate [pg/(cm ² yr)]
BDE-209	726	0.1	73

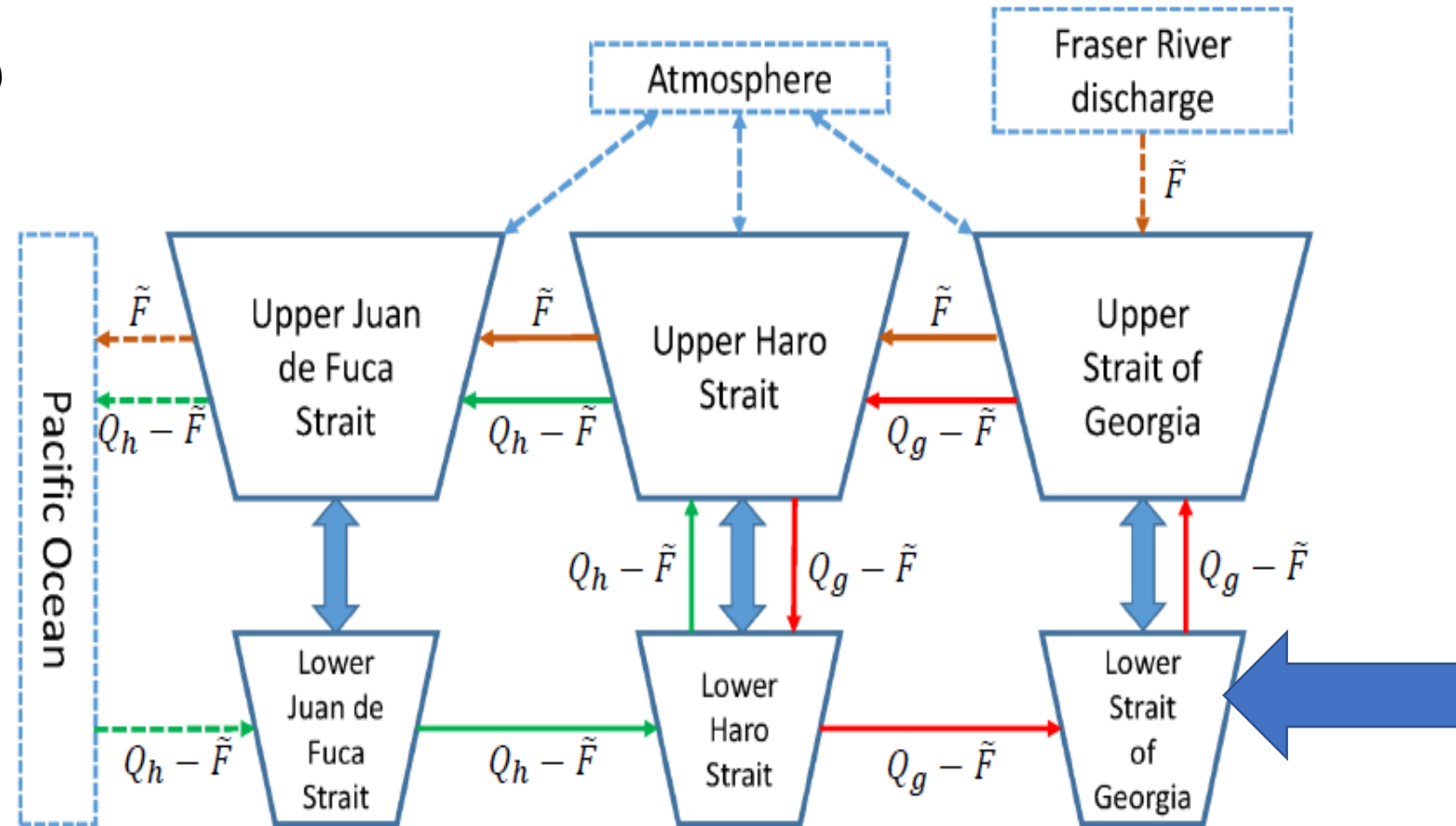
Box Model Simulation

Iona Plume Input data (10 years ago)

Congener	Flux (g/yr)
BDE-47	4100
BDE-99	4800
BDE-209	12000
Total PBDEs	24000

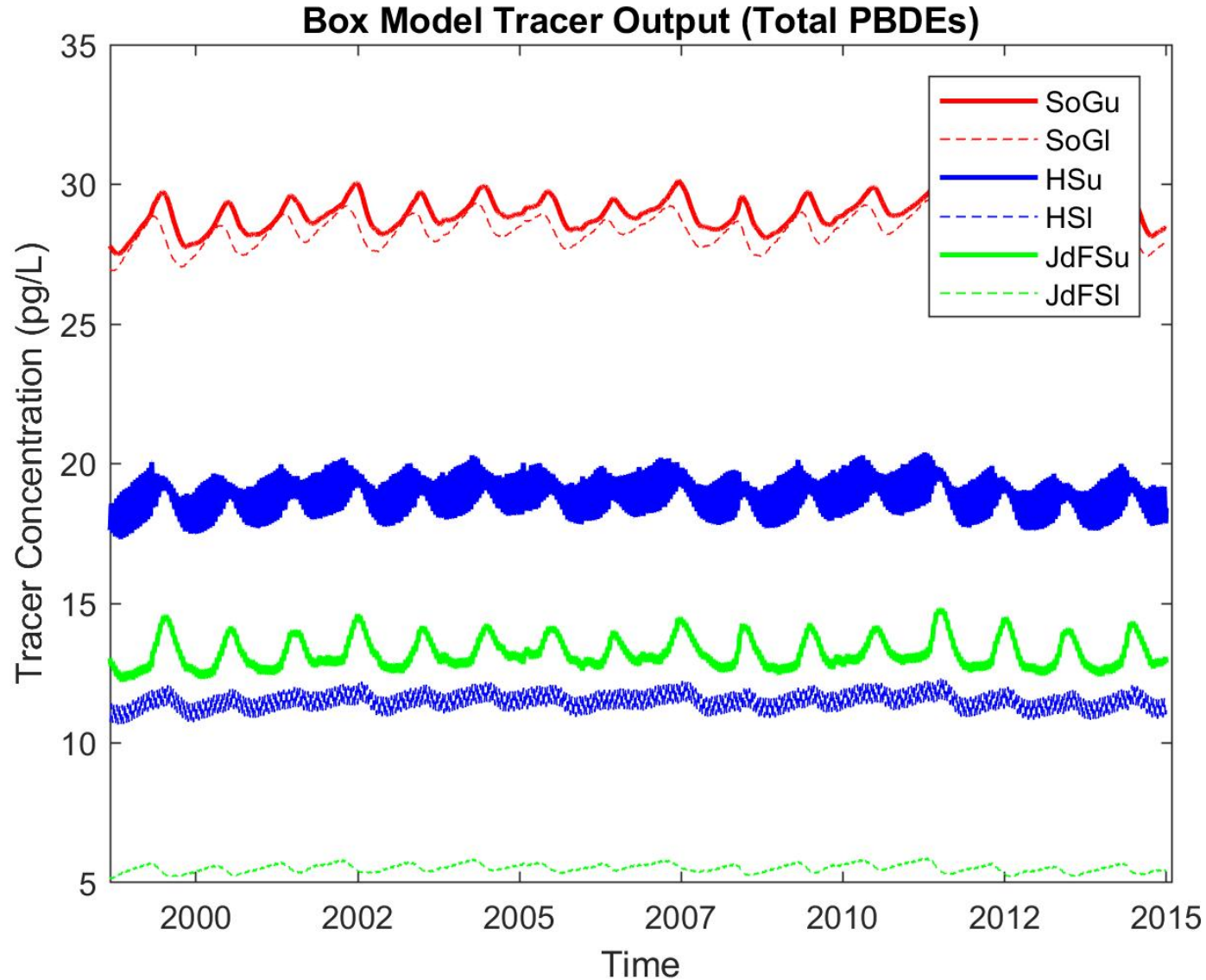
+ Fraser River input

(Dinn et al 2012, Johannessen et al 2015)



(Wang 2015)

Modeled results confirm other input sources



Total PBDEs measured in SoG:

280 pg/L

Total PBDEs in Haro Strait:

6.18~29.7 (average 18.1 ± 10.4) pg/L upper box

1.75~14.7 (average 6.46 ± 5.66) pg/L lower box

(Frouin et al 2013)

Conclusion

1. Dissolved PBDEs: high concentration, low temporal & spatial variability
Particulate PBDEs: low concentration, high temporal & spatial variability
2. Slower desorption allows the particles to rise towards the surface as a result of the general estuarine circulation of SoG
3. Fraser River & atmospheric deposition are important sources to SoG
4. PBDE flux and box model confirm higher PBDE discharge in recent years, and/or an additional yet unidentified source (maybe run-off from roads).

Acknowledgement

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