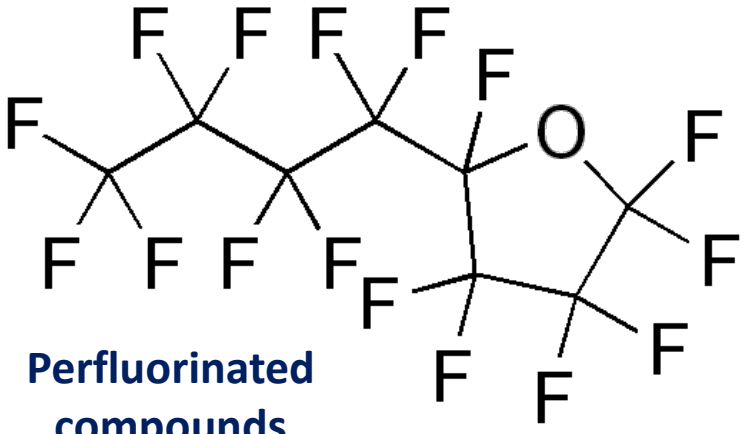
Community-Based Participatory Research on Saint Lawrence Island

How Yupik Residents are Helping to Identify Persistent Pollutants in Their Communities

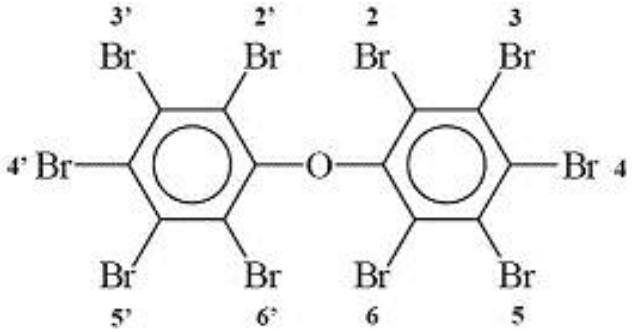
Frank von Hippel, Northern Arizona University

Alaska Collaborative on Health and the Environment
Teleconference
December 13, 2017

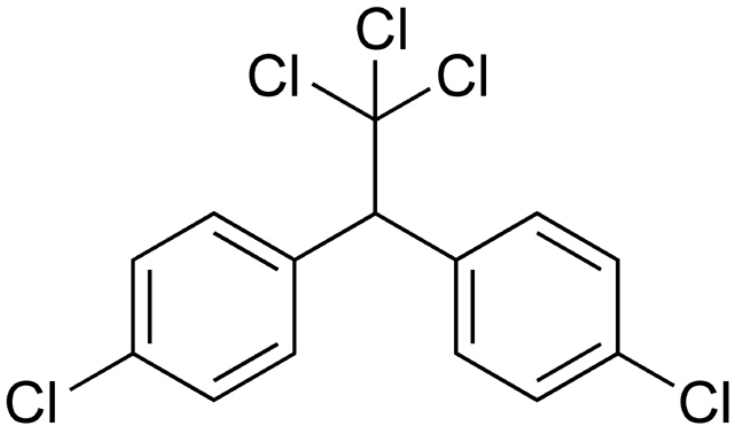
Persistent Organic Pollutants



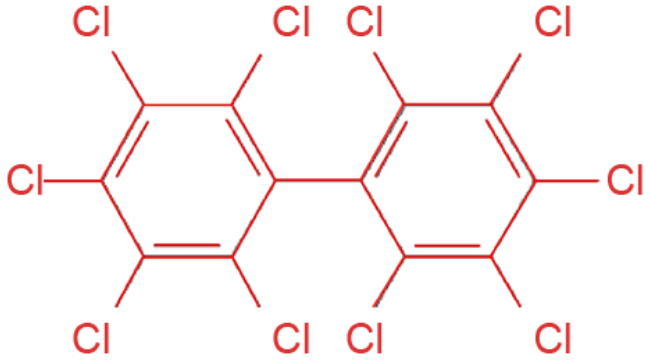
Perfluorinated compounds (PFCs)



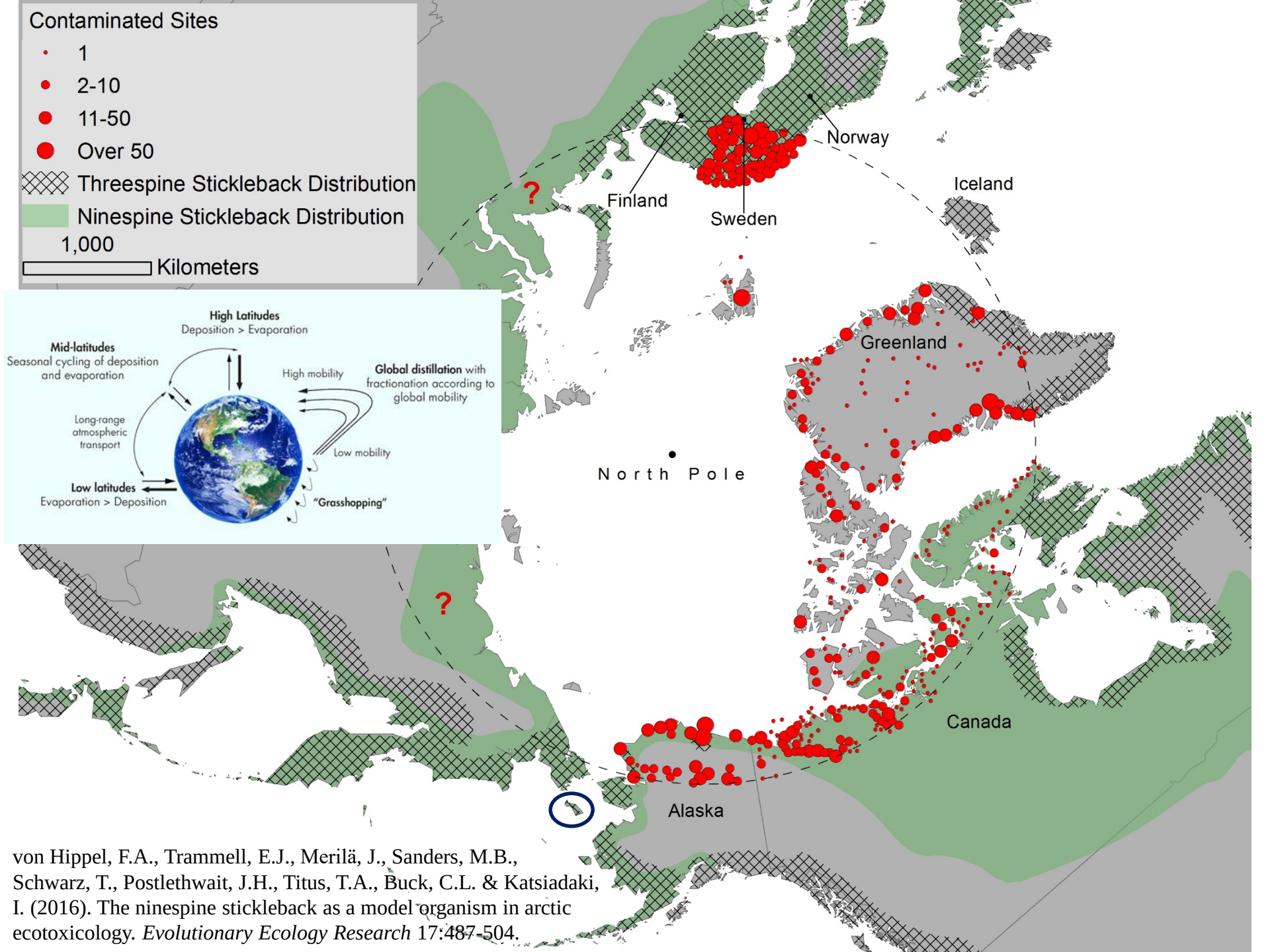
Polybrominated diphenyl ethers (PBDEs)



Chlorinated pesticides



Polychlorinated biphenyls (PCBs)



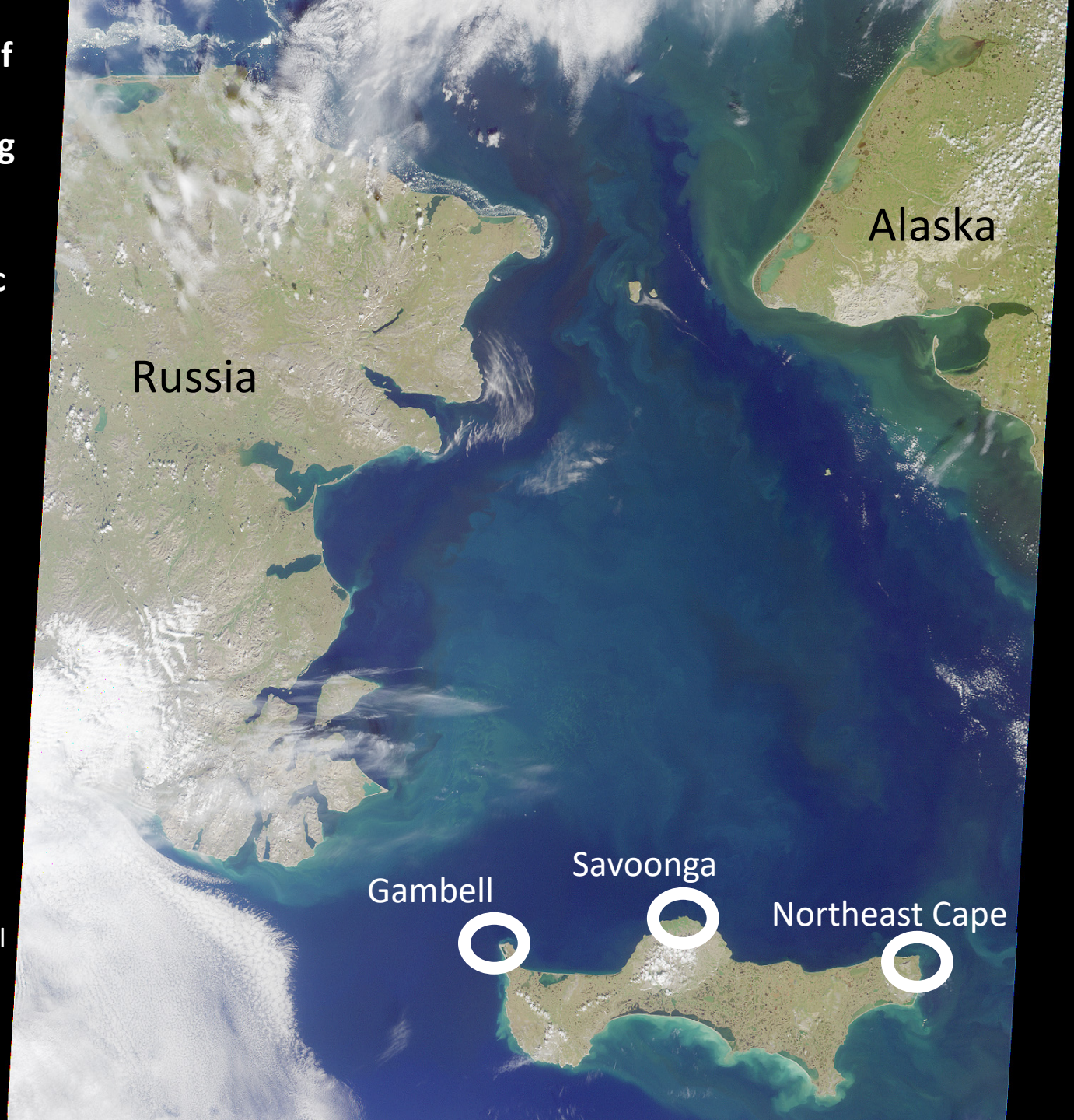
von Hippel, F.A., Trammell, E.J., Merilä, J., Sanders, M.B., Schwarz, T., Postlethwait, J.H., Titus, T.A., Buck, C.L. & Katsiadaki, I. (2016). The ninespine stickleback as a model organism in arctic ecotoxicology. *Evolutionary Ecology Research* 17:487-504.

Threespine Stickleback Distribution
Ninespine Stickleback Distribution
Military
Mining
Oil and Gas Wells
Other Contaminated Sites
N
500
Kilometers

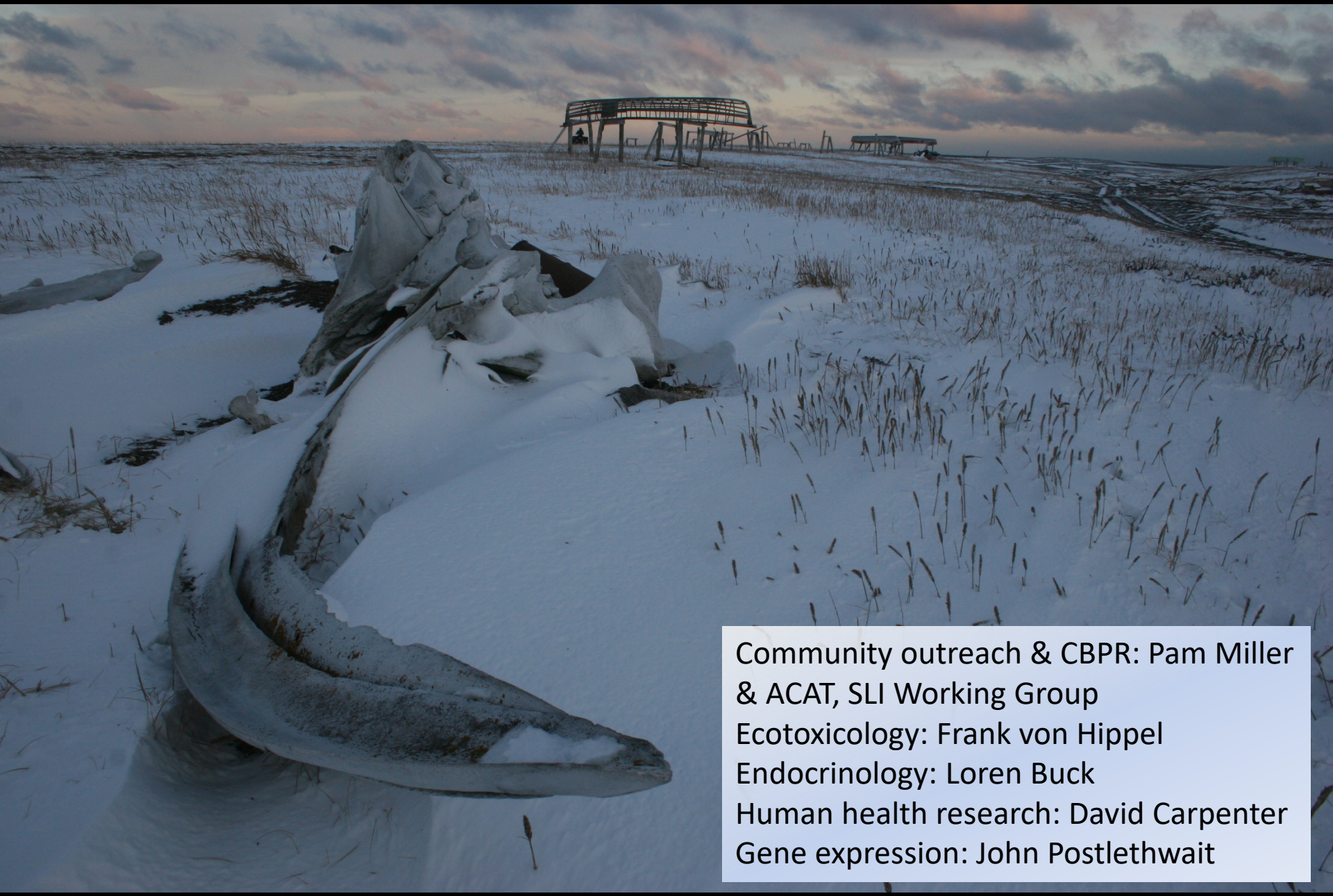
Health Patterns of Concern

- Cancers
- Thyroid disease
- Diabetes
- Heart disease
- Birth defects, low birthweight babies, premature births, stillbirths, miscarriages
- Other reproductive health problems

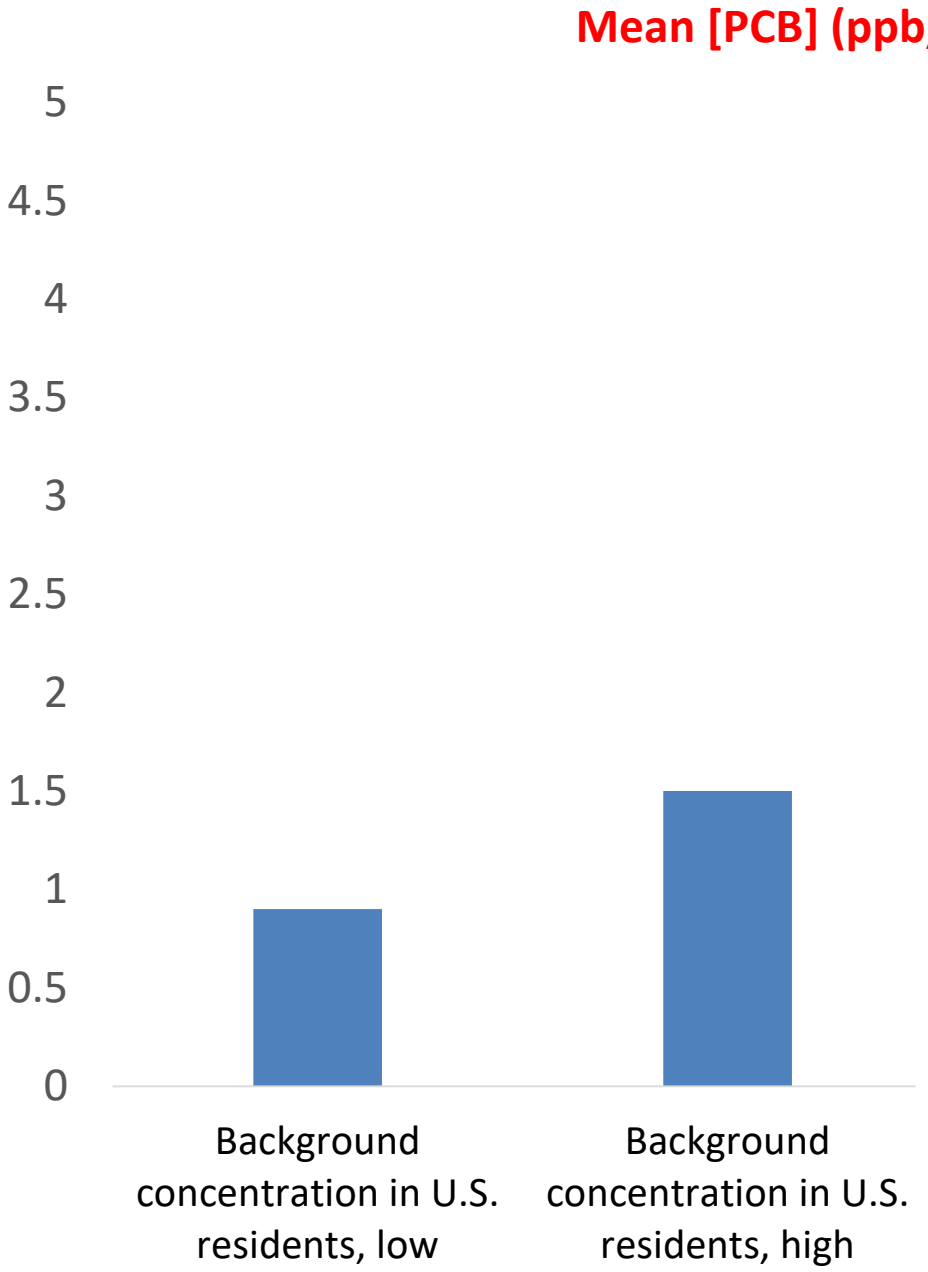
“Protecting the Health of Future Generations: Assessing and Preventing Exposures to Endocrine-Disrupting Chemicals in Two Alaska Native Arctic Communities on St. Lawrence Island”

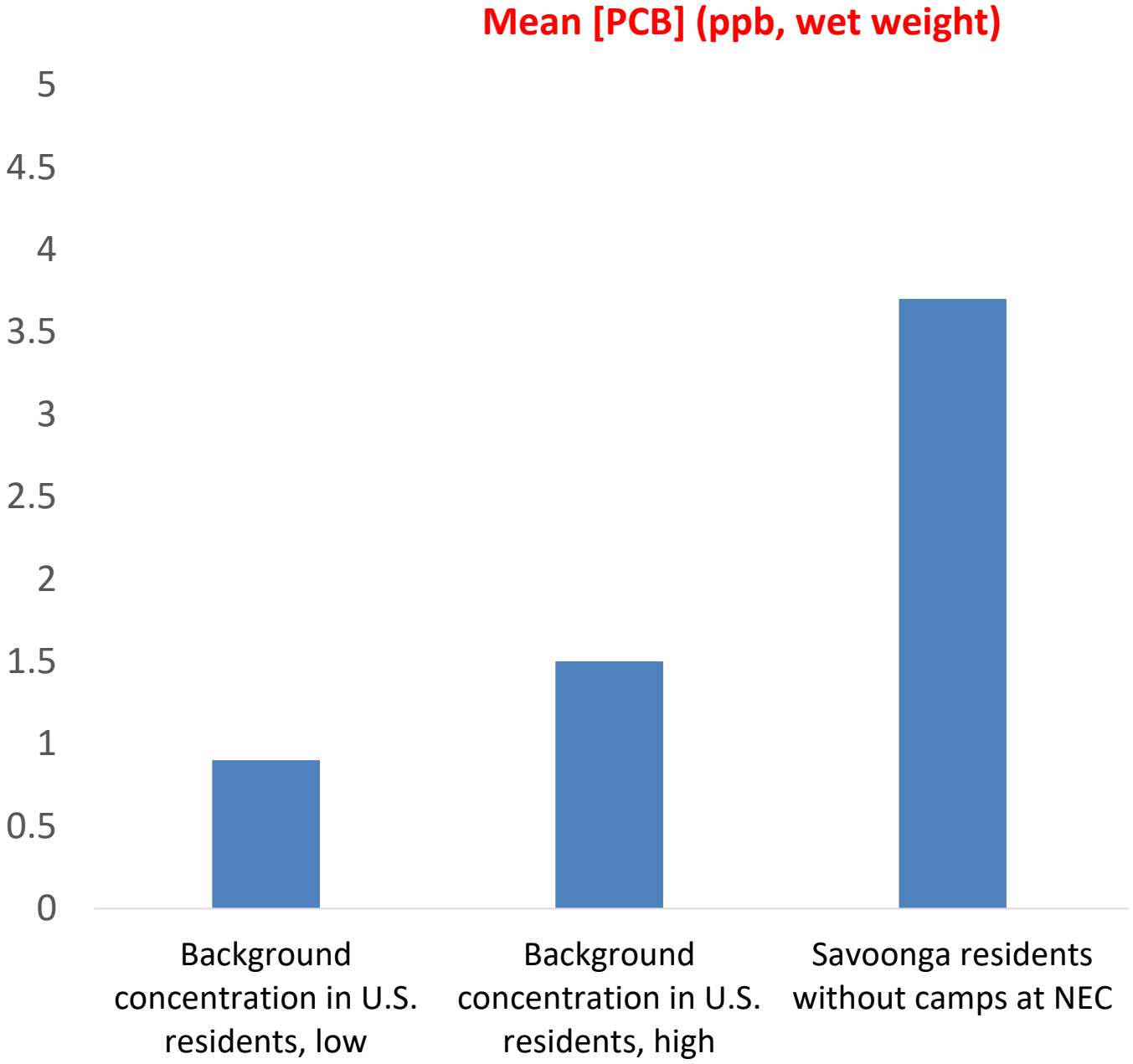


National Institute of Environmental Health Sciences RO1, 2011-2016
Miller, P.K., von Hippel, F.A., Buck, C.L. & Carpenter, D.
NIEHS 1RO1ES019620

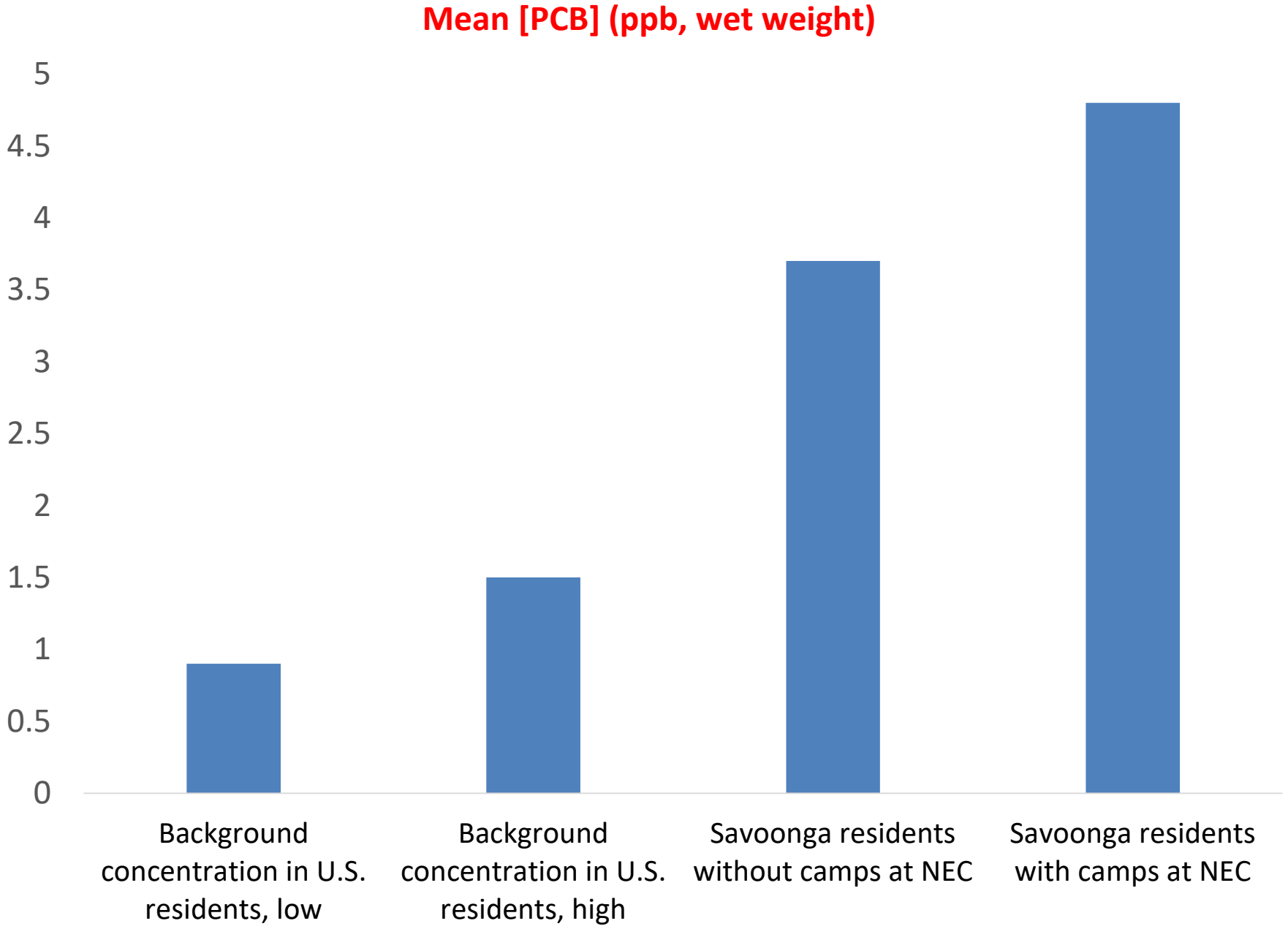

Community outreach & CBPR: Pam Miller & ACAT, SLI Working Group
Ecotoxicology: Frank von Hippel
Endocrinology: Loren Buck
Human health research: David Carpenter
Gene expression: John Postlethwait

PCBs in blood serum of St. Lawrence Island people

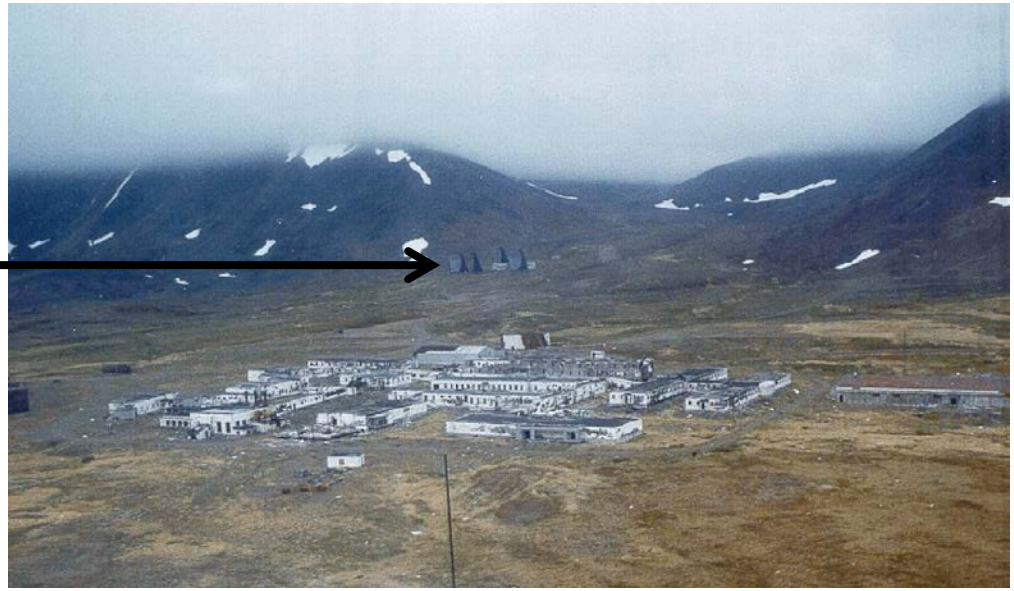

Mean [PCB] (ppb, wet weight)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Background concentration in U.S. residents, low
Background concentration in U.S. residents, high

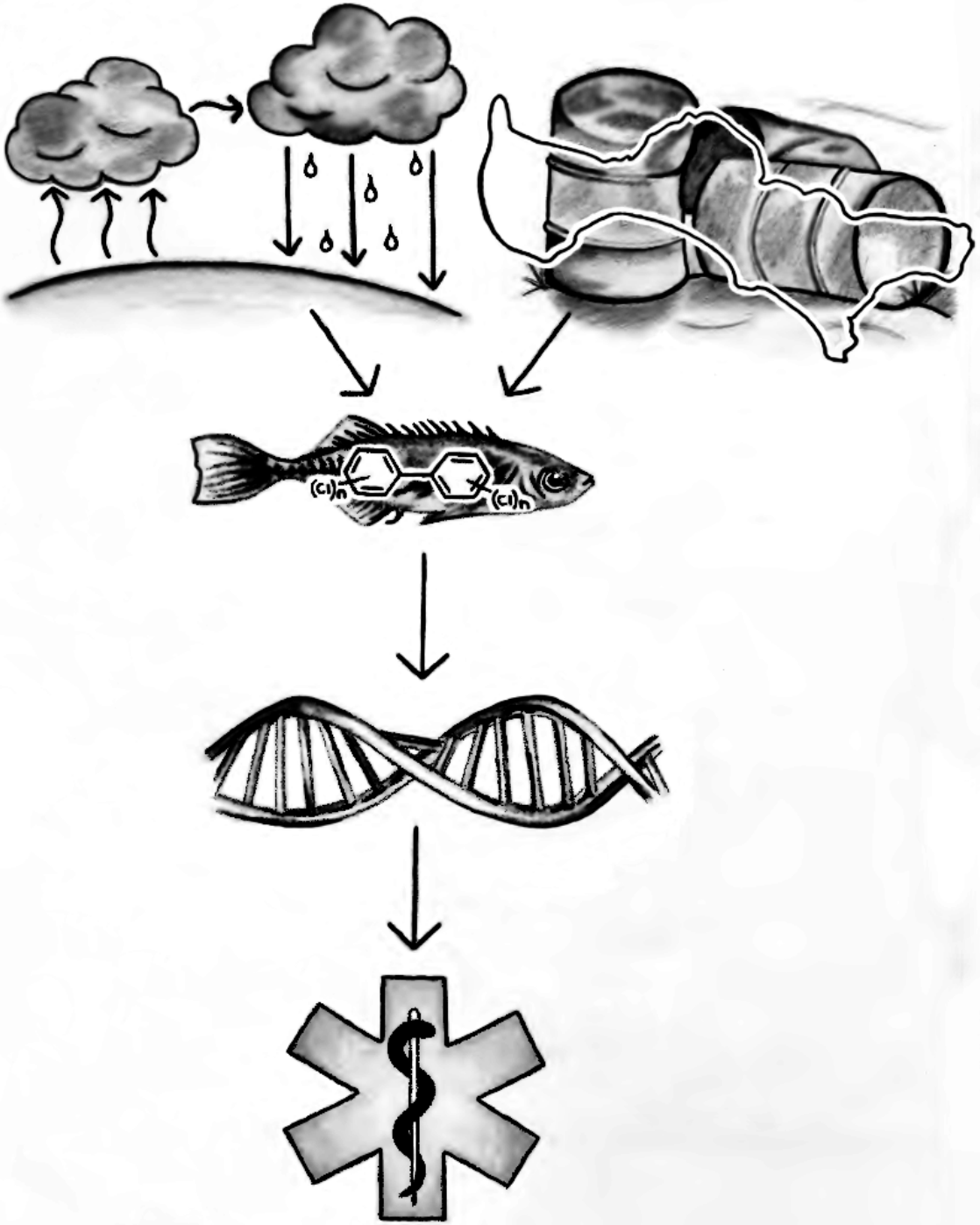


data from Carpenter & Miller (2011)

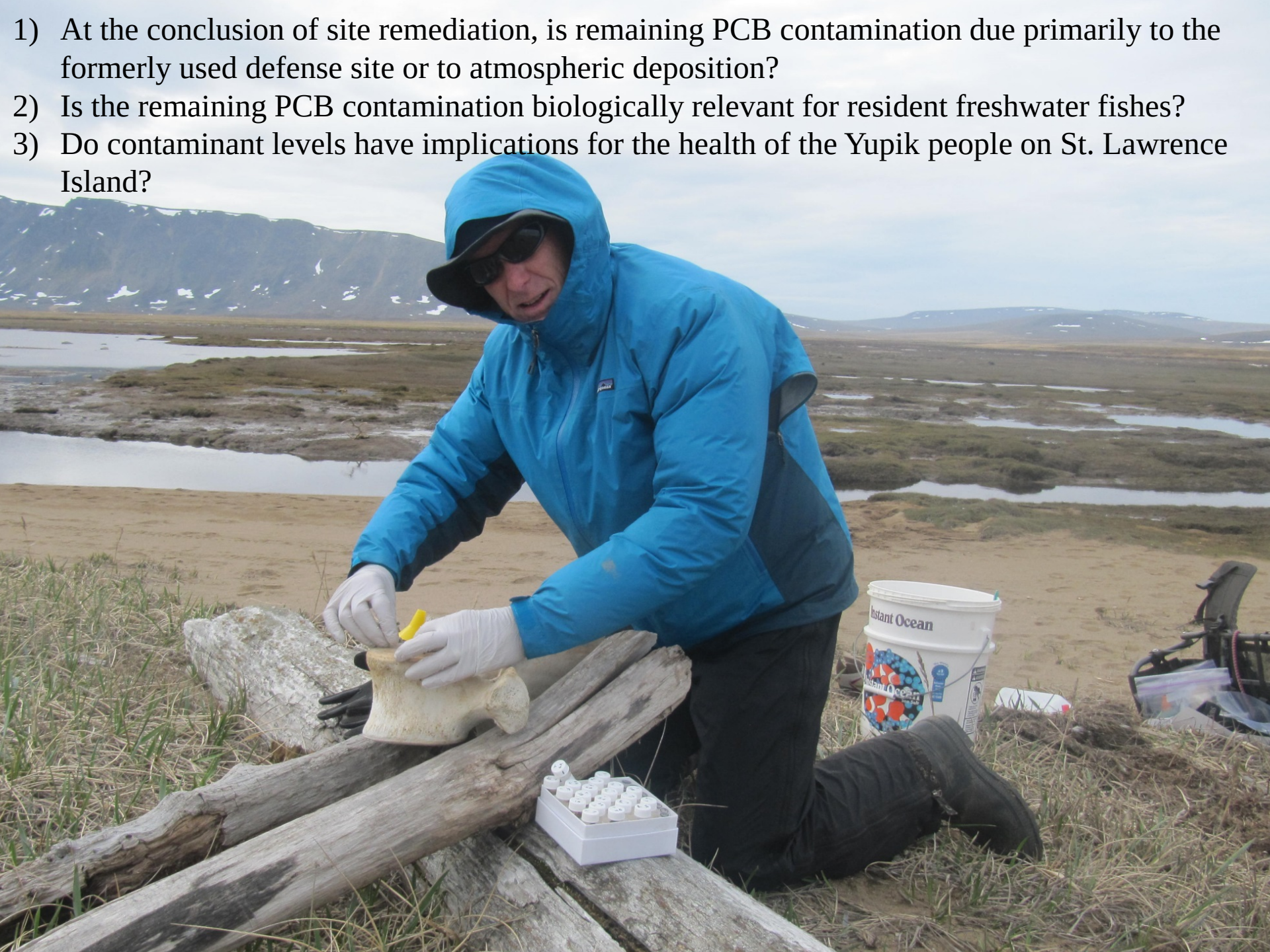

Mean [PCB] (ppb, wet weight)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Background concentration in U.S. residents, low
Background concentration in U.S. residents, high
Savoonga residents without camps at NEC
Savoonga residents with camps at NEC
data from Carpenter & Miller (2011)

White Alice Communication Site, operational 1957-1972
Above ground structures & debris removed in 2003
$123 million spent on site remediation

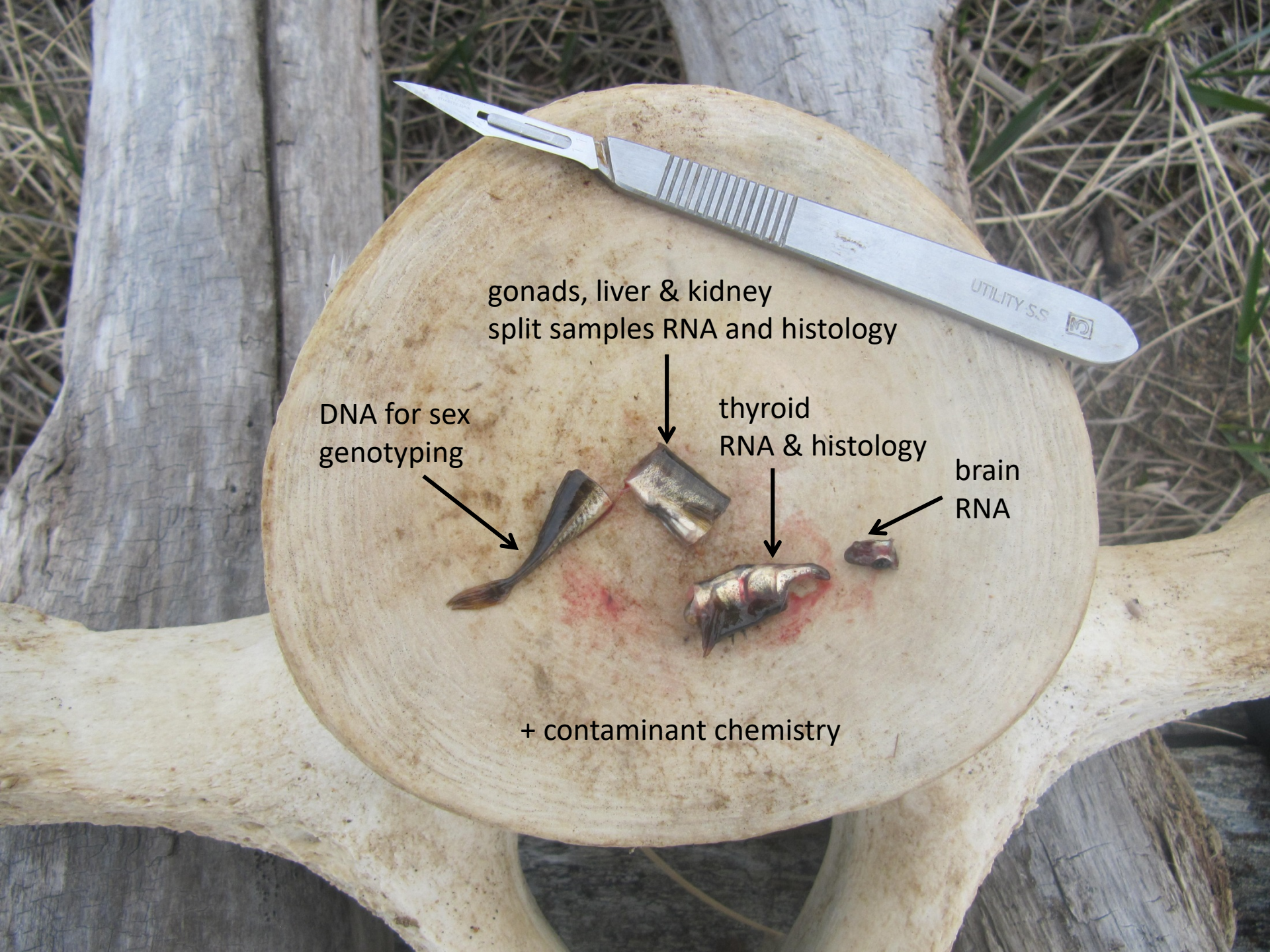


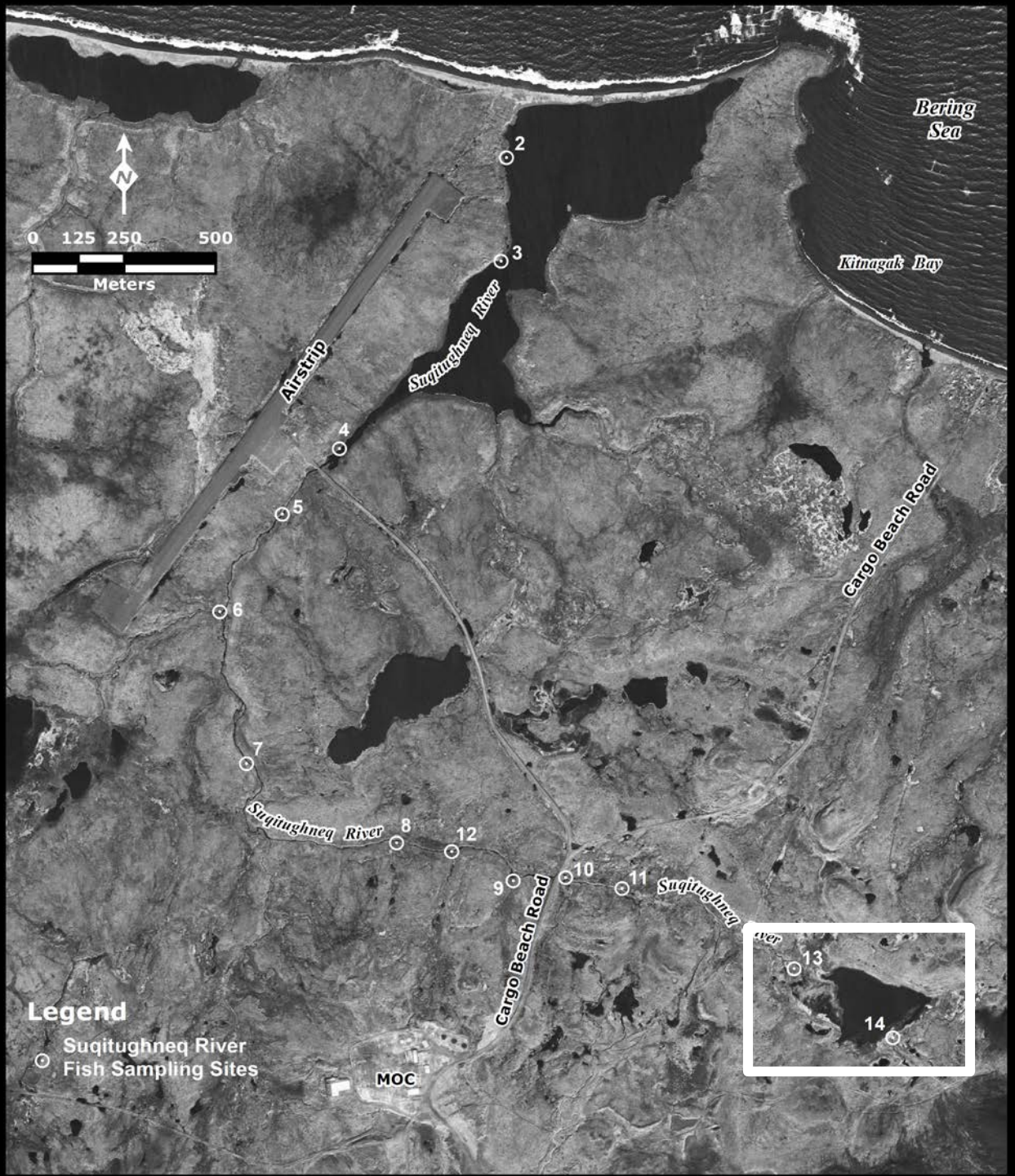

(Cl)n
(Cl)n

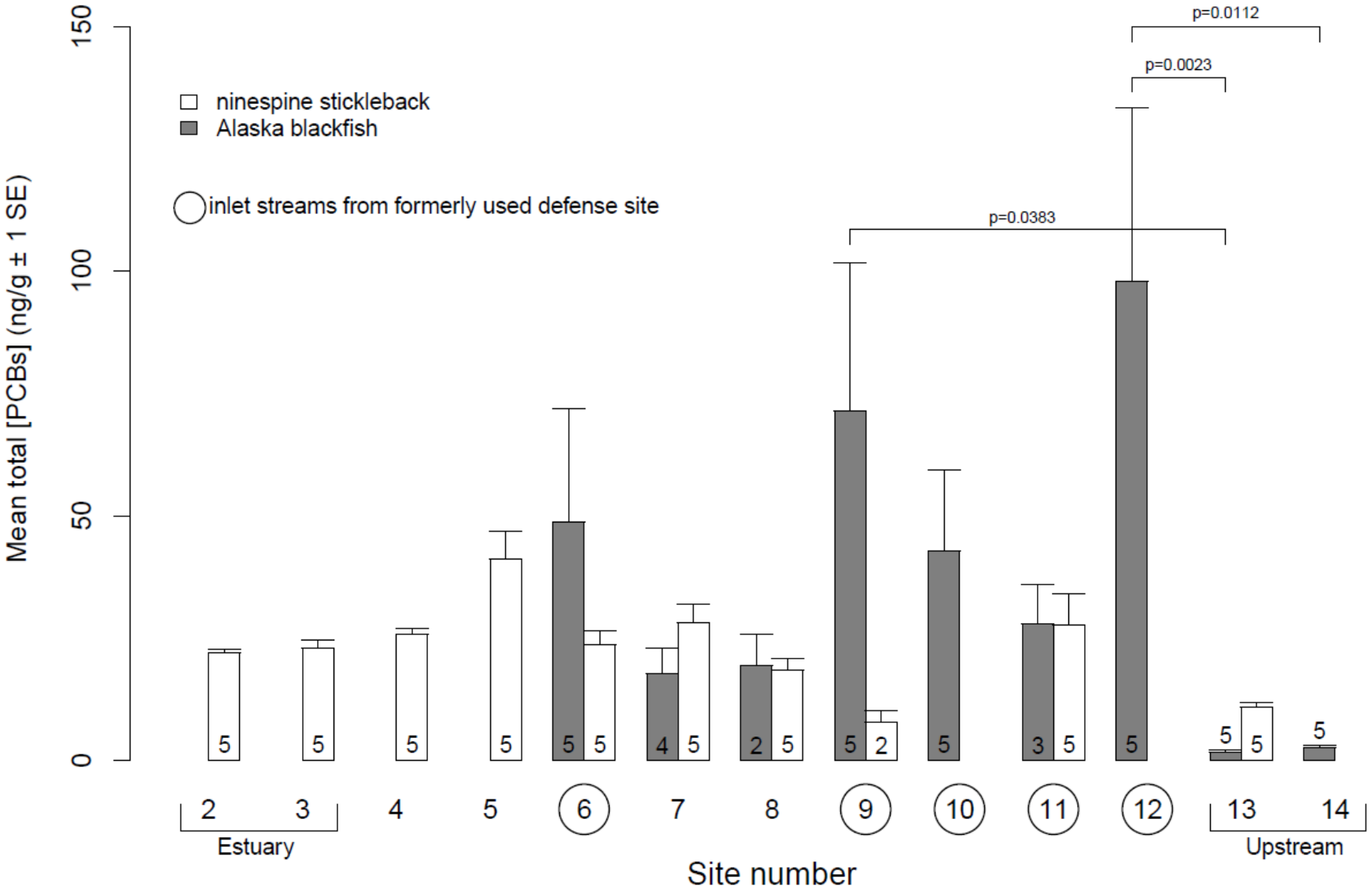
1) At the conclusion of site remediation, is remaining PCB contamination due primarily to the formerly used defense site or to atmospheric deposition?
2) Is the remaining PCB contamination biologically relevant for resident freshwater fishes?
3) Do contaminant levels have implications for the health of the Yupik people on St. Lawrence Island?



Ziploc


gonads, liver & kidney
split samples RNA and histology
DNA for sex
genotyping
thyroid
RNA & histology
brain
RNA
+ contaminant chemistry


Bering Sea
Kitnagak Bay
N
0 125 250 500
Meters
Airstrip
Suqitughneq River
Cargo Beach Road
2
3
4
5
6
7
8
9
10
11
12
13
14
Suqitughneq River
Cargo Beach Road
MOC
Legend
Suqitughneq River
Fish Sampling Sites



von Hippel, F.A., Miller, P.K., Carpenter, D.O., Dillon, D., Smayda, L., Katsiadaki, I., Titus, T.A., Batzel, P., Postlethwait, J.H. & Buck, C.L. (2017). Endocrine disruption and differential gene expression in sentinel fish on St. Lawrence Island, Alaska: health implications for indigenous residents. *Environmental Pollution* 234:279-287.

B) Alaska blackfish

Downstream; n=29
Upstream; n=10

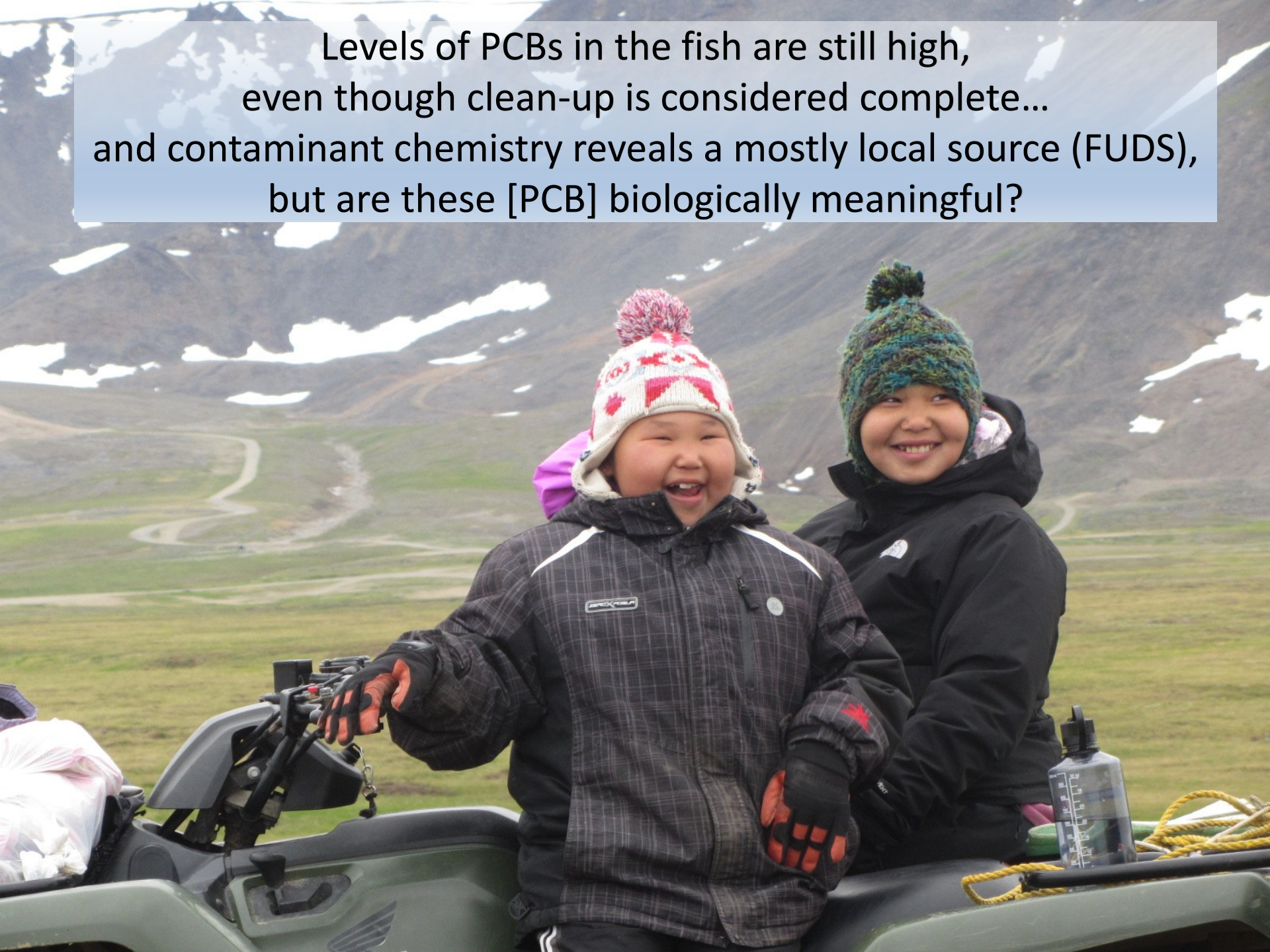
Mean [PCB] (ng/g ± 1 SE)

0
5
10
15
20
25

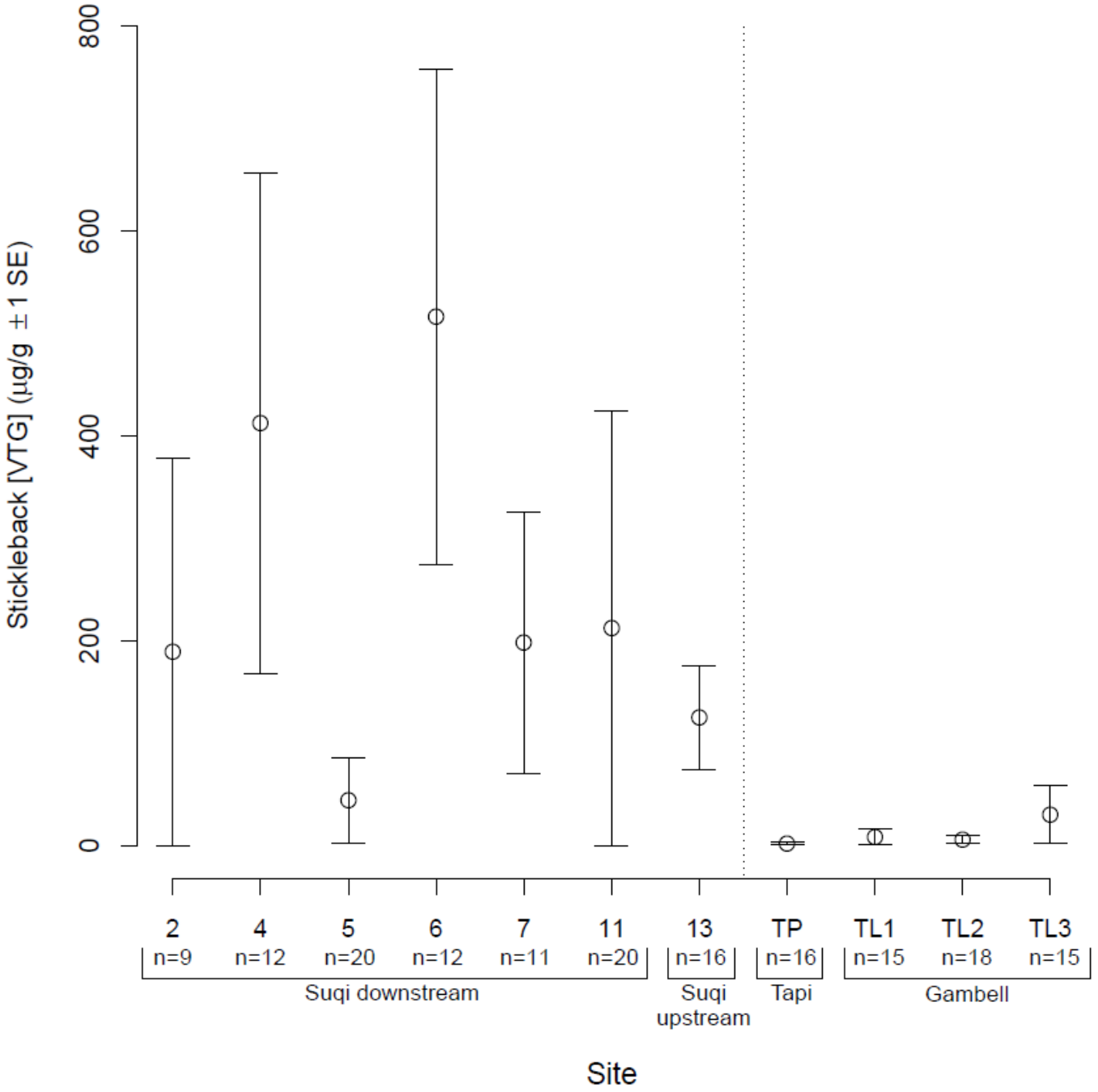
1 2 3 4 5 6 7 8 9 10

Number of chlorines

Suqitughneq; n=47
Tapisaggak; n=20
4 Cl
5 Cl
6 Cl
7 Cl
8 Cl
Stickleback % of sum PCBs
0
5
10
15
20
25
PCB52
PCB61_70_74_76
PCB83_99
PCB85_116_117
PCB86_87_97_108_119_125
PCB90_101_113
PCB92
PCB93_95_98_100_102
PCB105
PCB110_115
PCB118
PCB128_166
PCB129_138_160_163
PCB132
PCB135_151_154
PCB141
PCB146
PCB147_149
PCB153_168
PCB170
PCB171_173
PCB174
PCB177
PCB180_193
PCB183_185
PCB187
PCB194
PCB198_199
PCB203
PCB congeners


Levels of PCBs in the fish are still high,
even though clean-up is considered complete…
and contaminant chemistry reveals a mostly local source (FUDS),
but are these [PCB] biologically meaningful?

Is the endocrine system of the fish disrupted?


Stickleback [VTG] (µg/g ± 1 SE)
0
200
400
600
800
2
n=9
4
n=12
5
n=20
6
n=12
7
n=11
11
n=20
13
n=16
TP
n=16
TL1
n=15
TL2
n=18
TL3
n=15
Suqi downstream
Suqi upstream
Tapi
Gambell
Site

B) Alaska blackfish

PCB52
PCB61_70_74_76
PCB83_99
PCB90_101_113
PCB93_95_98_100_102
PCB110_115
PCB153_168

Mean [estrogenic PCBs] (ng/g ± 1 SE)

0
5
10
15

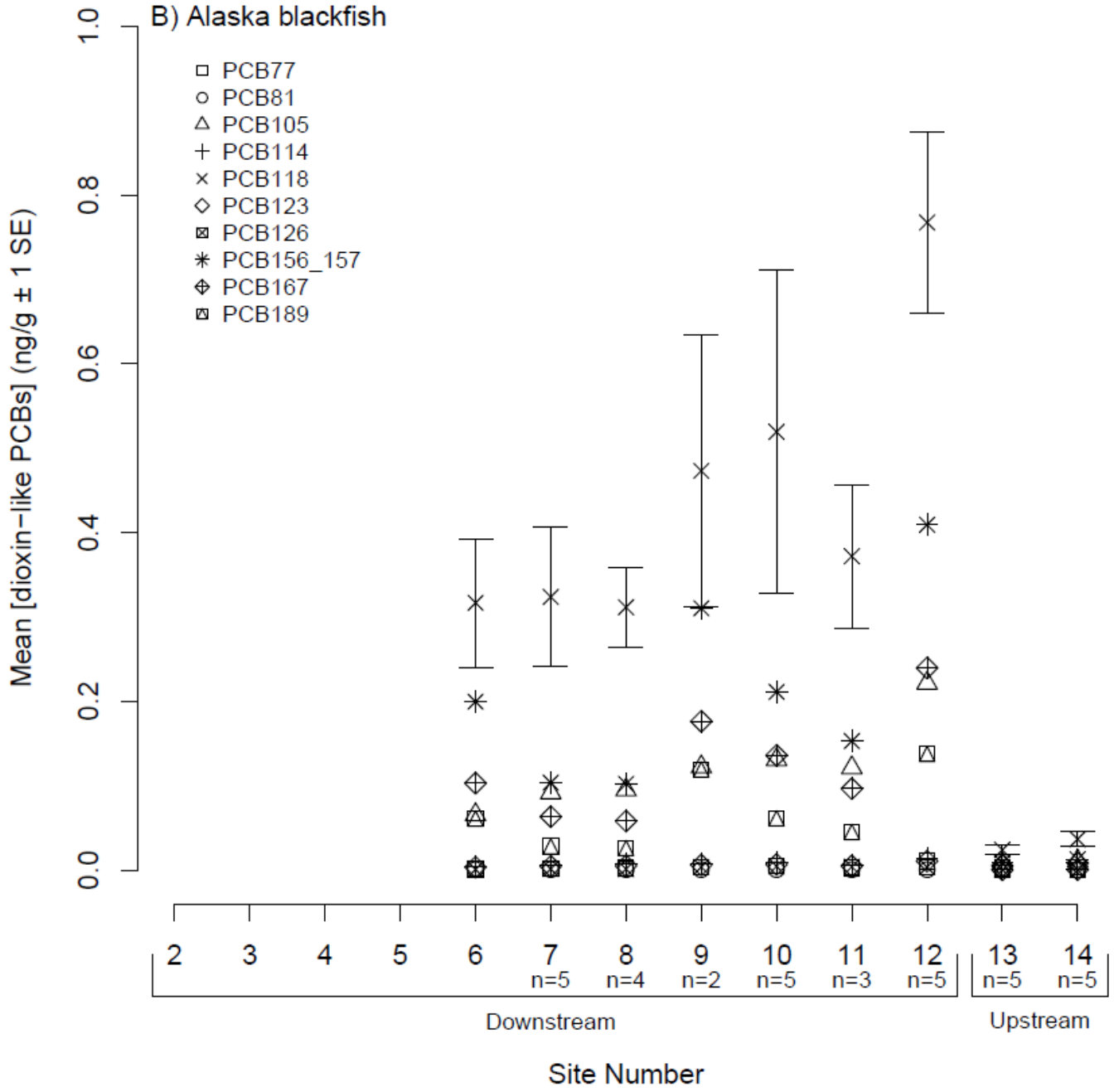
2 3 4 5 6 7 8 9 10 11 12 13 14

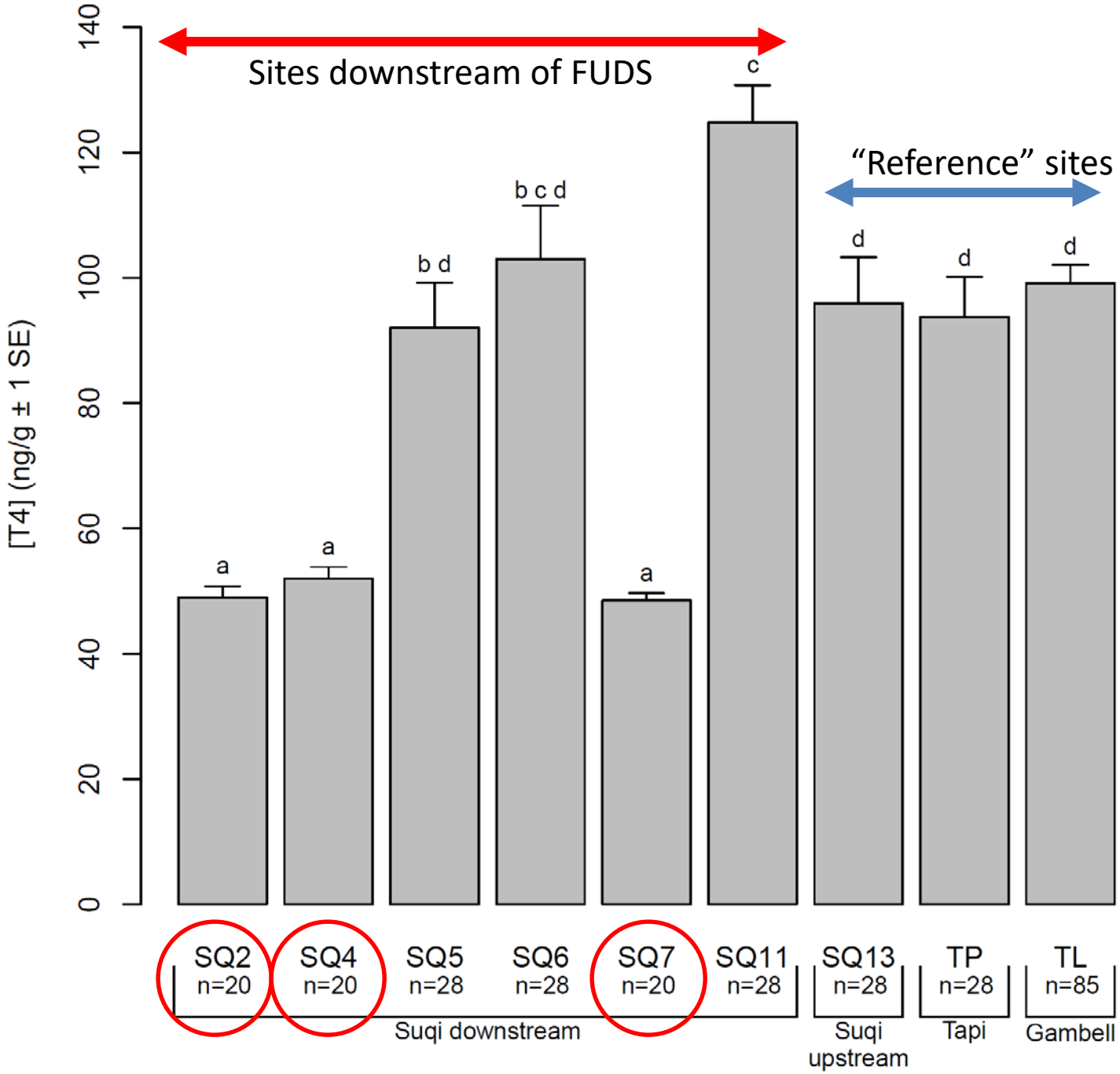
n=5 n=4 n=2 n=5 n=5 n=3 n=5 n=5 n=5

Downstream

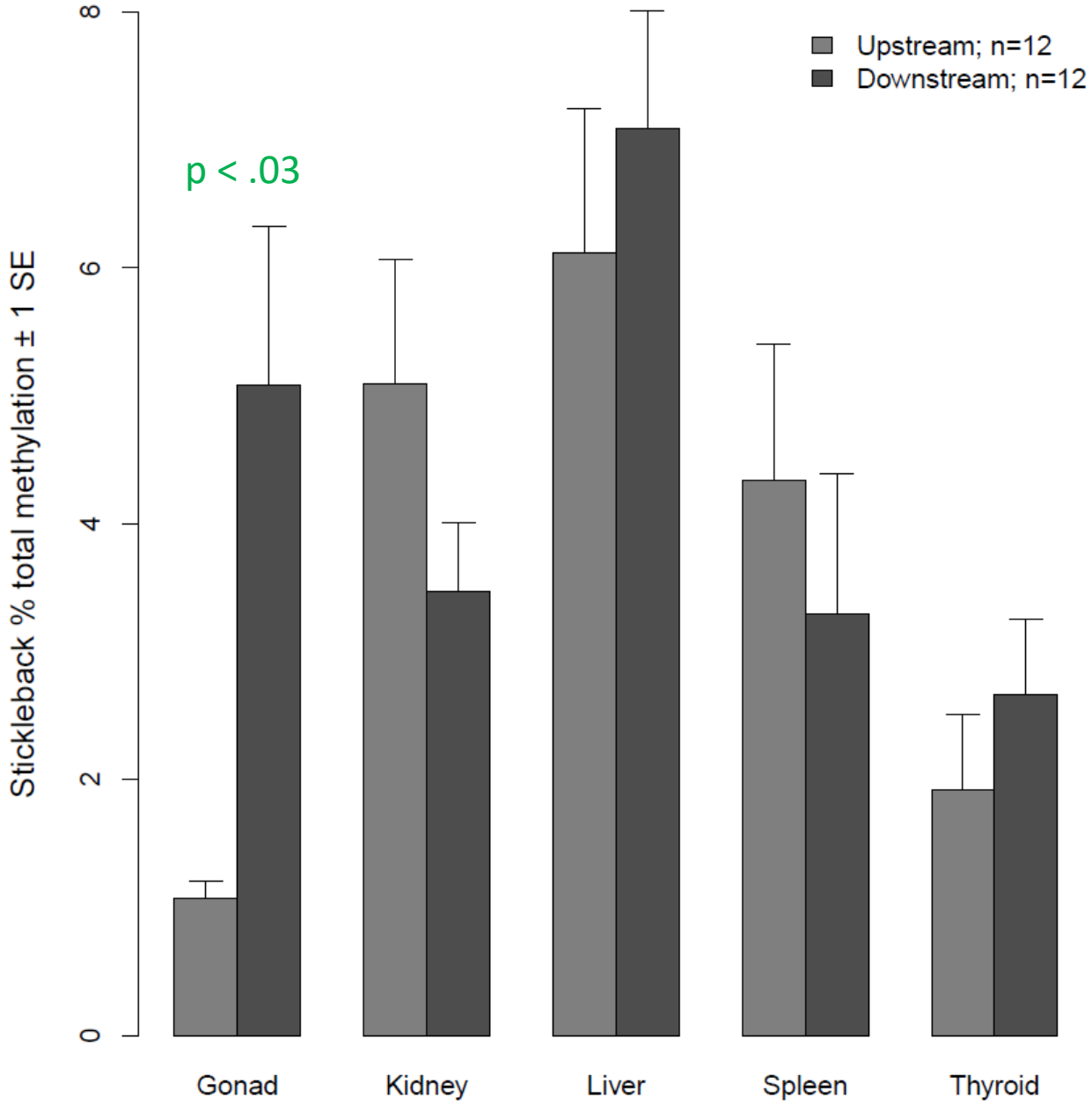
Upstream

Site Number


B) Alaska blackfish
PCB77
PCB81
PCB105
PCB114
PCB118
PCB123
PCB126
PCB156_157
PCB167
PCB189
Mean [dioxin−like PCBs] (ng/g ± 1 SE)
0.0
0.2
0.4
0.6
0.8
1.0
2
3
4
5
6
7
n=5
8
n=4
9
n=2
10
n=5
11
n=3
12
n=5
13
n=5
14
n=5
Downstream
Upstream
Site Number


Sites downstream of FUDS
"Reference" sites
[T4] (ng/g ± 1 SE)
0
20
40
60
80
100
120
140
a
a
b d
b c d
a
c
d
d
d
SQ2
n=20
SQ4
n=20
SQ5
n=28
SQ6
n=28
SQ7
n=20
SQ11
n=28
SQ13
n=28
TP
n=28
TL
n=85
Suqi downstream
Suqi upstream
Tapi
Gambell


Is gene expression of the fish disrupted?



5-mC DNA ELISA Kit

Gene expression results…

Stickleback collected at more contaminated reaches of the Suqitughneq River expressed numerous genes differentially compared to fish collected at less contaminated reaches, including genes relevant to DNA replication, response to DNA damage, and cell signaling.

Decreased expression of DNA repair genes could increase the accumulation of mutations and intensify the potential for carcinogenesis.

Reduced cell signaling might exacerbate the risk of carcinogenesis by decreasing normal pathways of cell cycle arrest and apoptosis for genetically damaged cells.

Conservation of the vertebrate endocrine system and genome...

What's next for St. Lawrence Island?

RO1 renewal:

- Mechanistic studies with stickleback to identify upstream biomarkers of human disease
- Focus on childhood development in Gambell & Savoonga

Potential solutions…

Practical implications for arctic communities

Environmental remediation standards

Prevalence of contaminated sites throughout the Arctic

CBPR is informing policy at the local, state, national, and international levels