Apr 4th, 4:30 PM - 4:45 PM

Are Southern Resident killer whales on a path to extinction?

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Population growth is limited by nutrition and toxin impacts on pregnancy success in endangered Southern Resident Killer Whales

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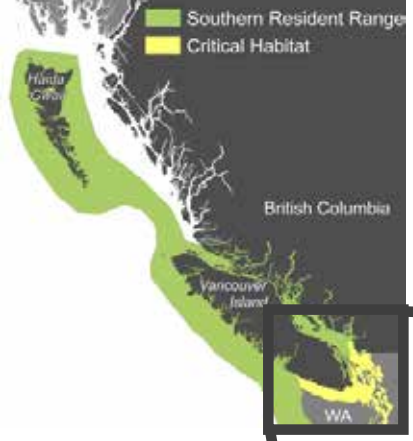
Center for Conservation Biology
University of Washington
Seattle, WA

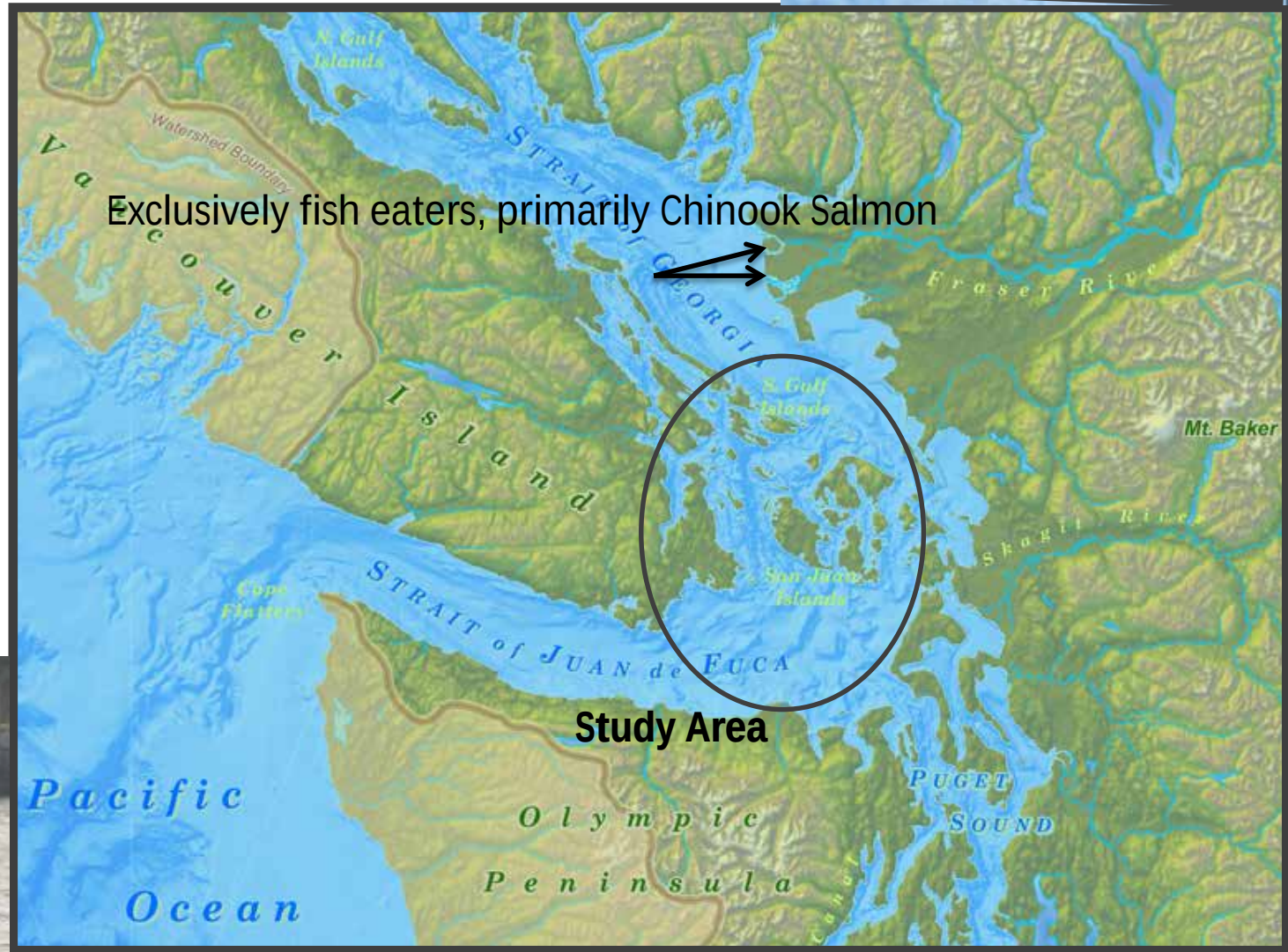


Southern Resident Killer Whales (May-Oct)

Declined by 20% in late '90s, never recovered

Listed as Endangered Population under ESA

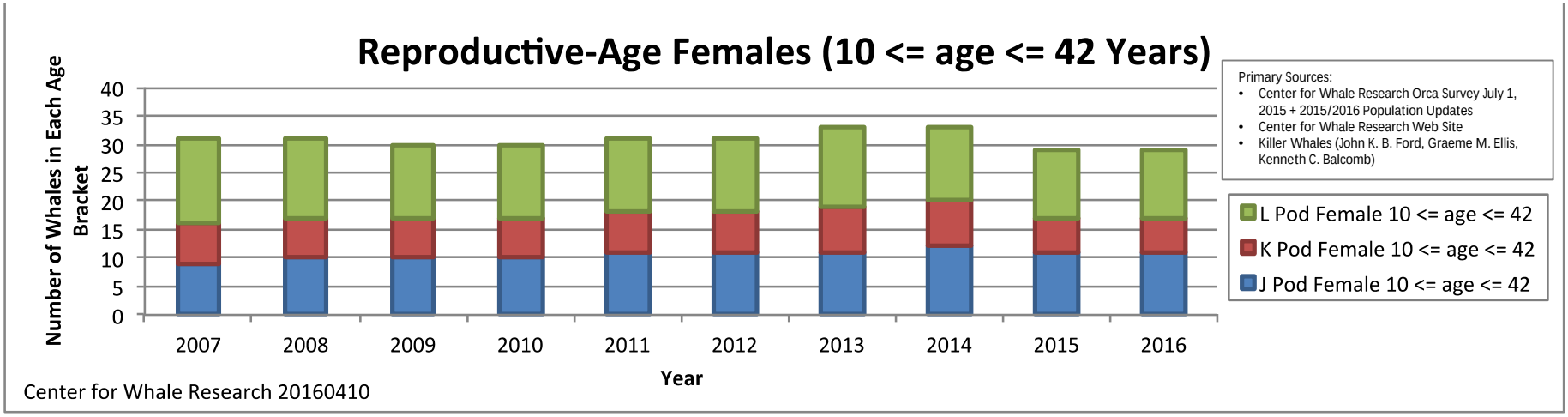
Three pods; J, K and L

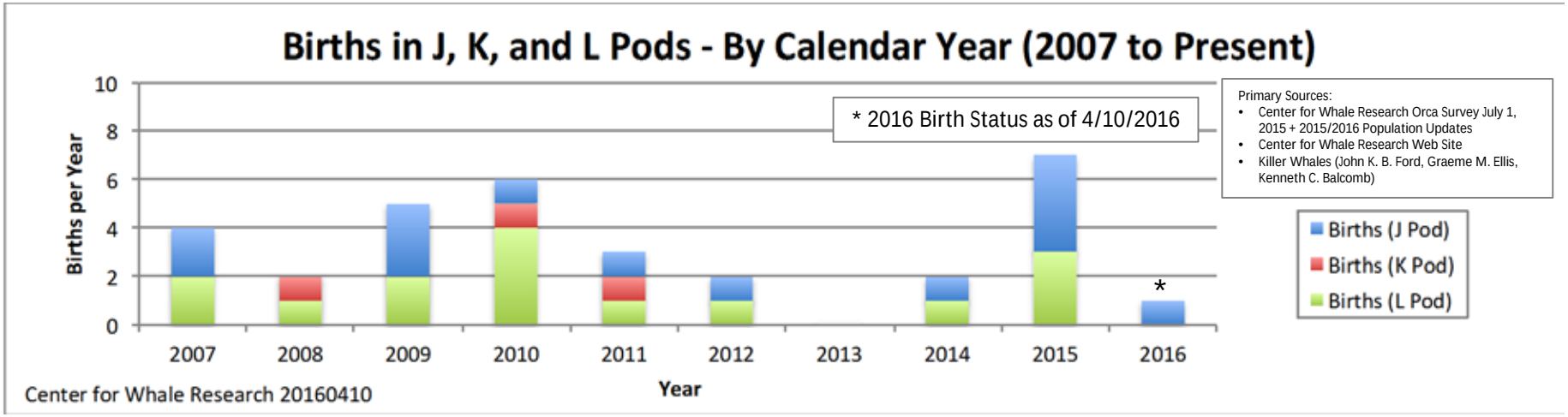


Exclusively fish eaters, primarily Chinook Salmon

Southern Resident Population Data

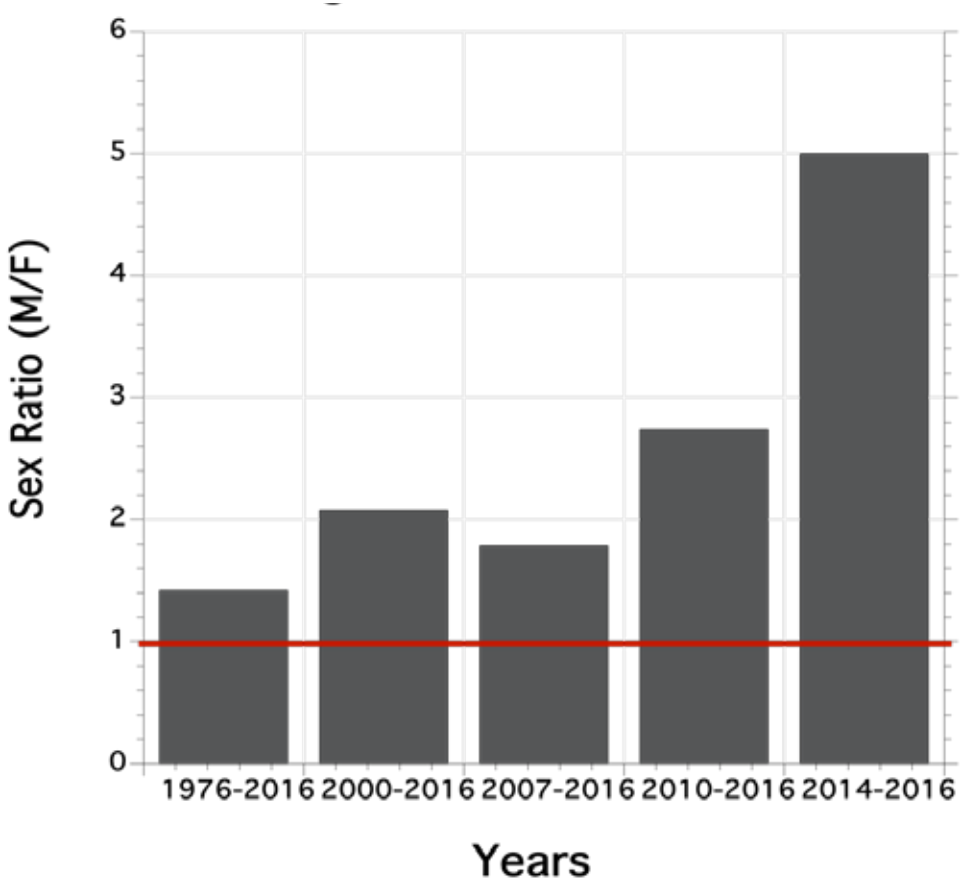
Center for Whale Research (2007 to Present)



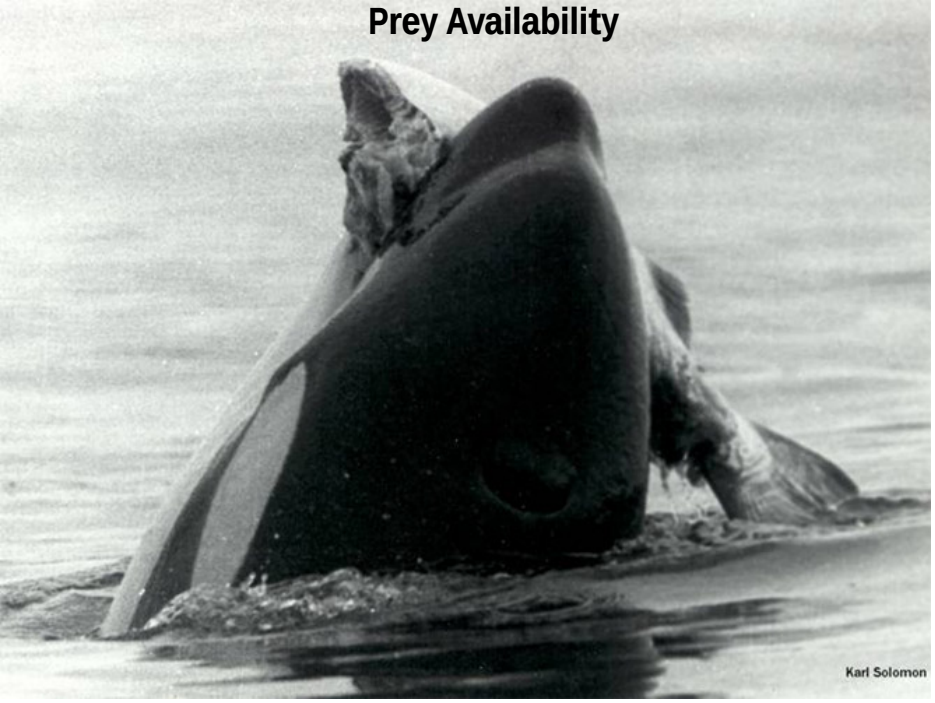


SRKWs experienced a population bottleneck (Ford et al 2011)
No matings outside population
At risk for inbreeding

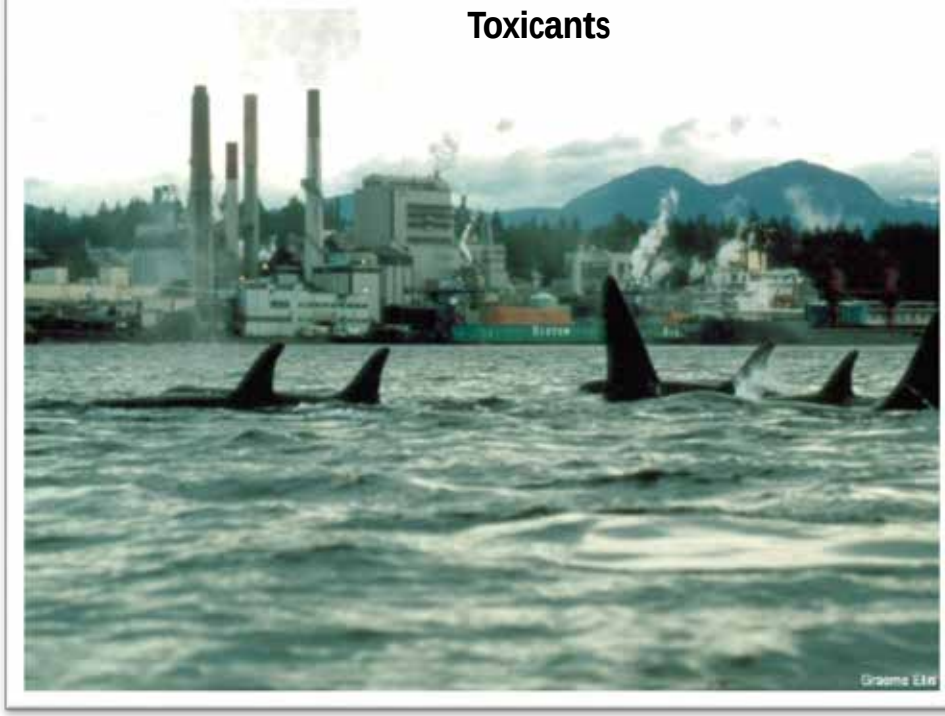
Sex Ratio at birth has become increasingly male-biased



Prey Availability

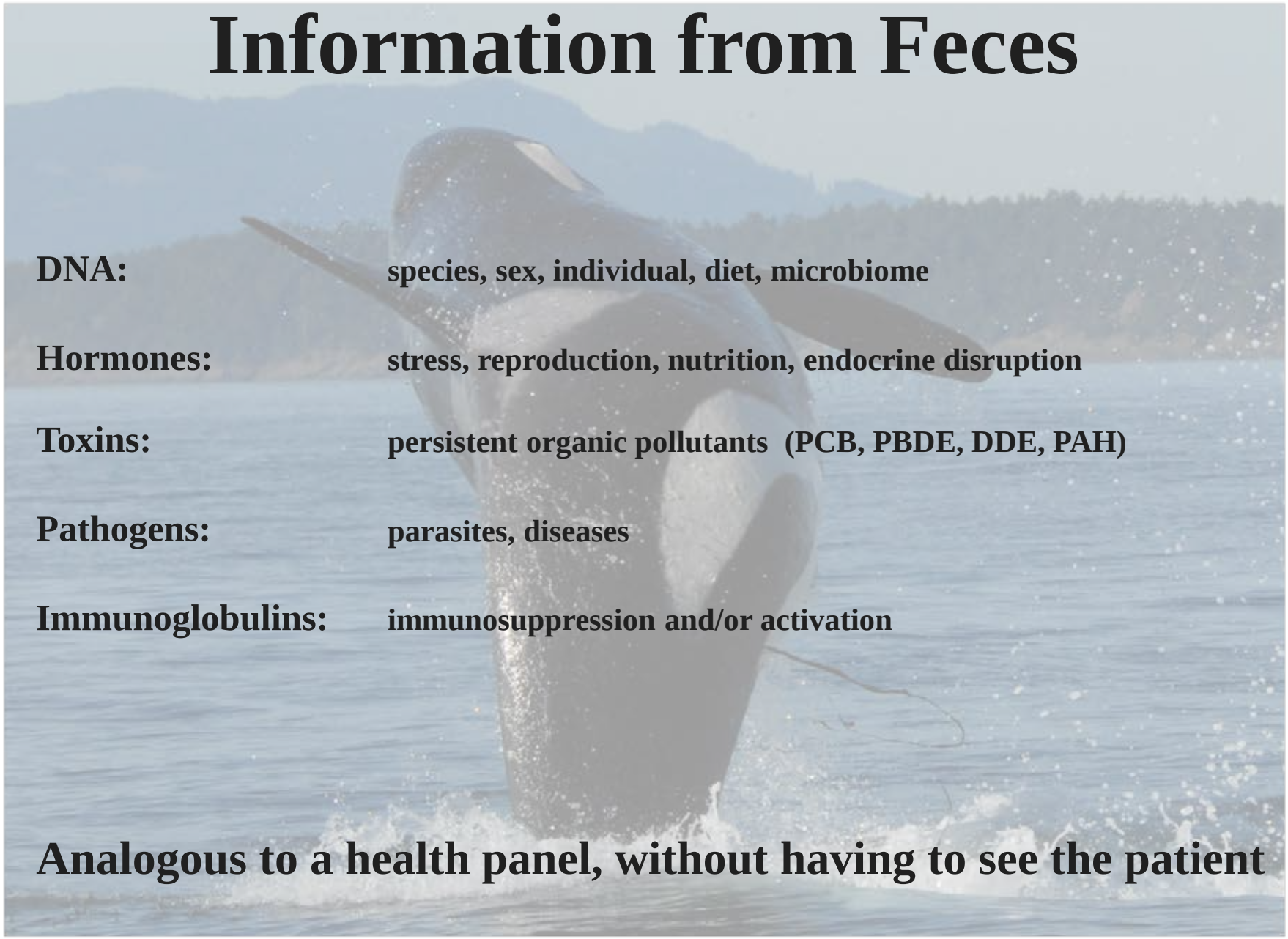


Toxicants



Vessels

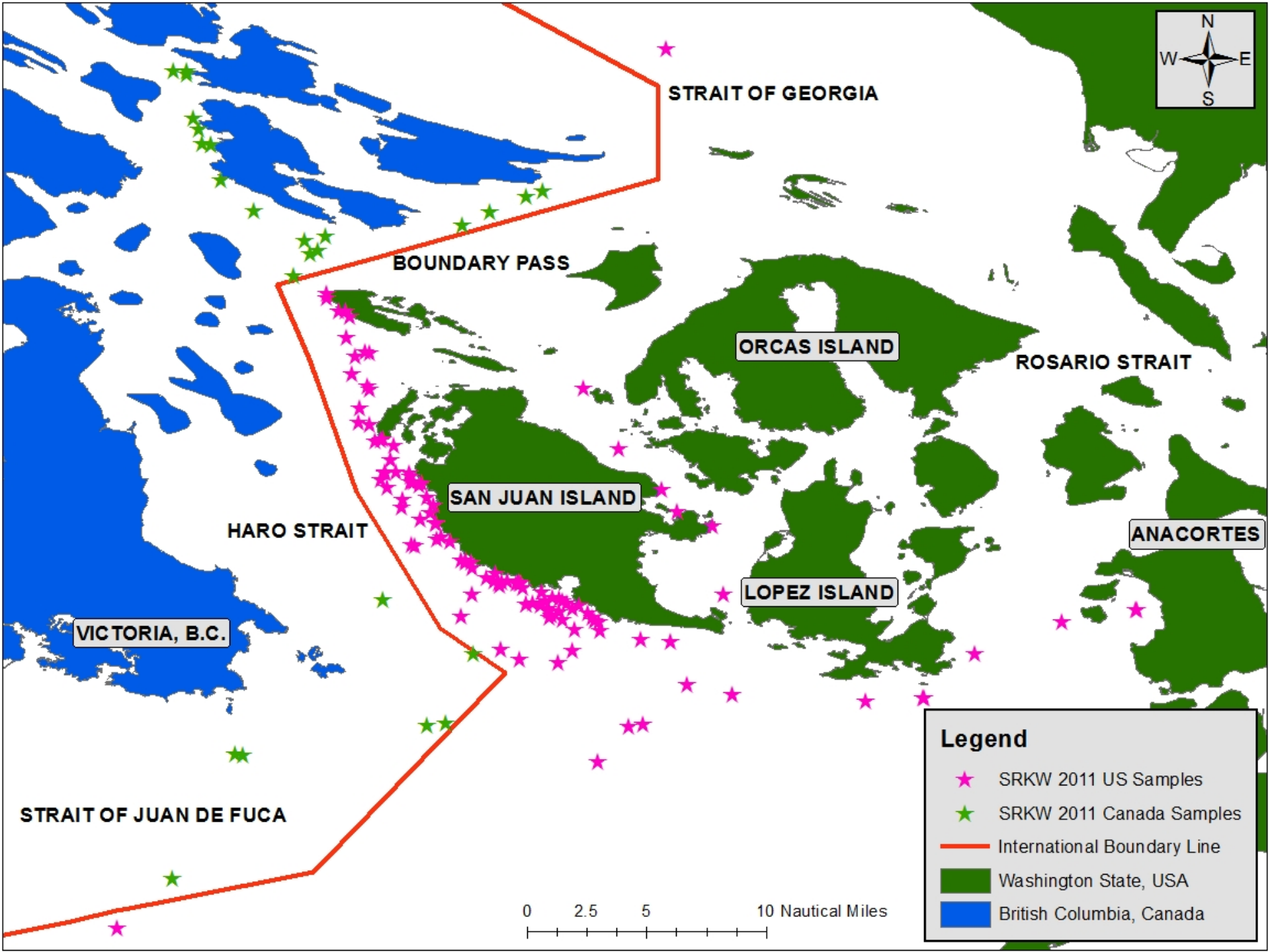
Information from Feces



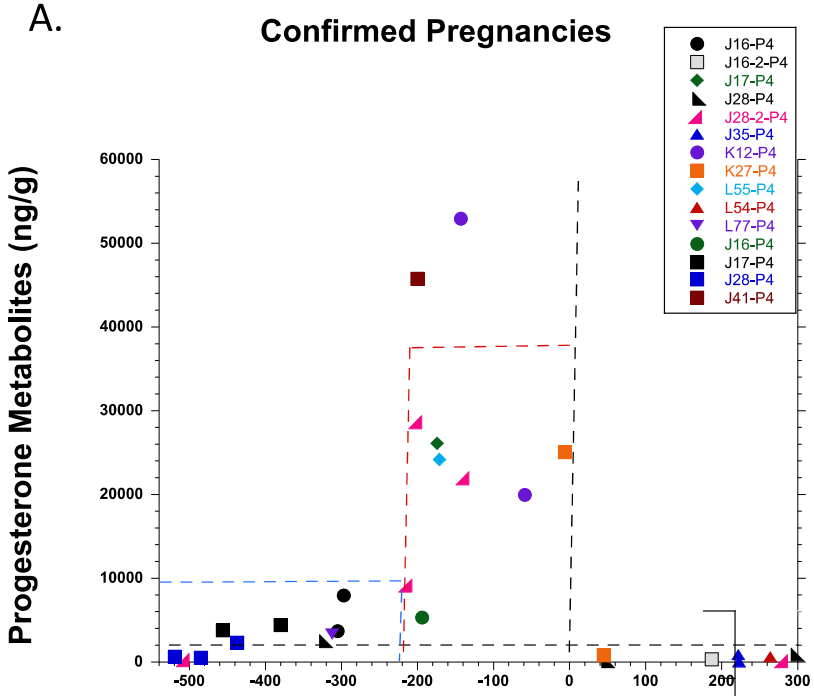
DNA:	**species, sex, individual, diet, microbiome**
Hormones:	**stress, reproduction, nutrition, endocrine disruption**
Toxins:	**persistent organic pollutants (PCB, PBDE, DDE, PAH)**
Pathogens:	**parasites, diseases**
Immunoglobulins:	**immunosuppression and/or activation**

Analogous to a health panel, without having to see the patient

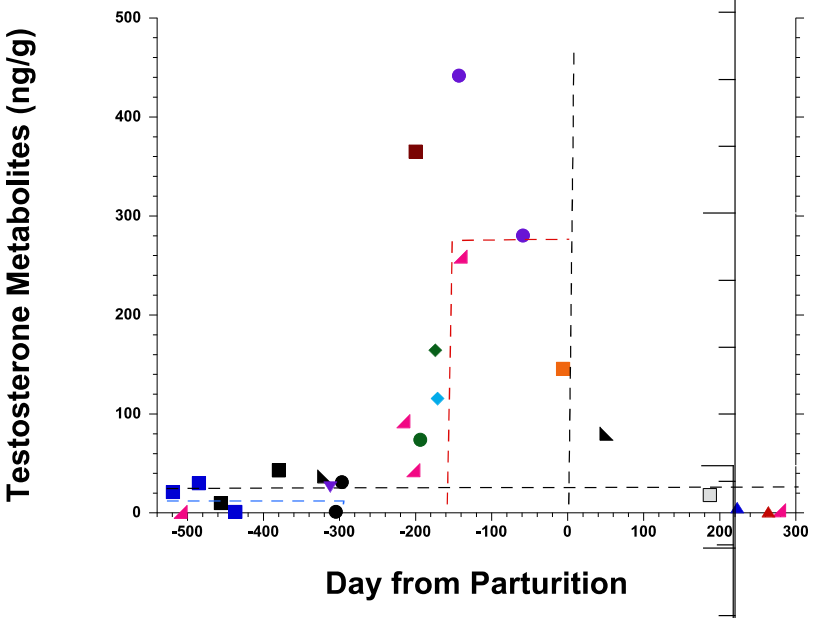
Detection dogs sample pods, front to back to front
Samples are genotyped to the individual

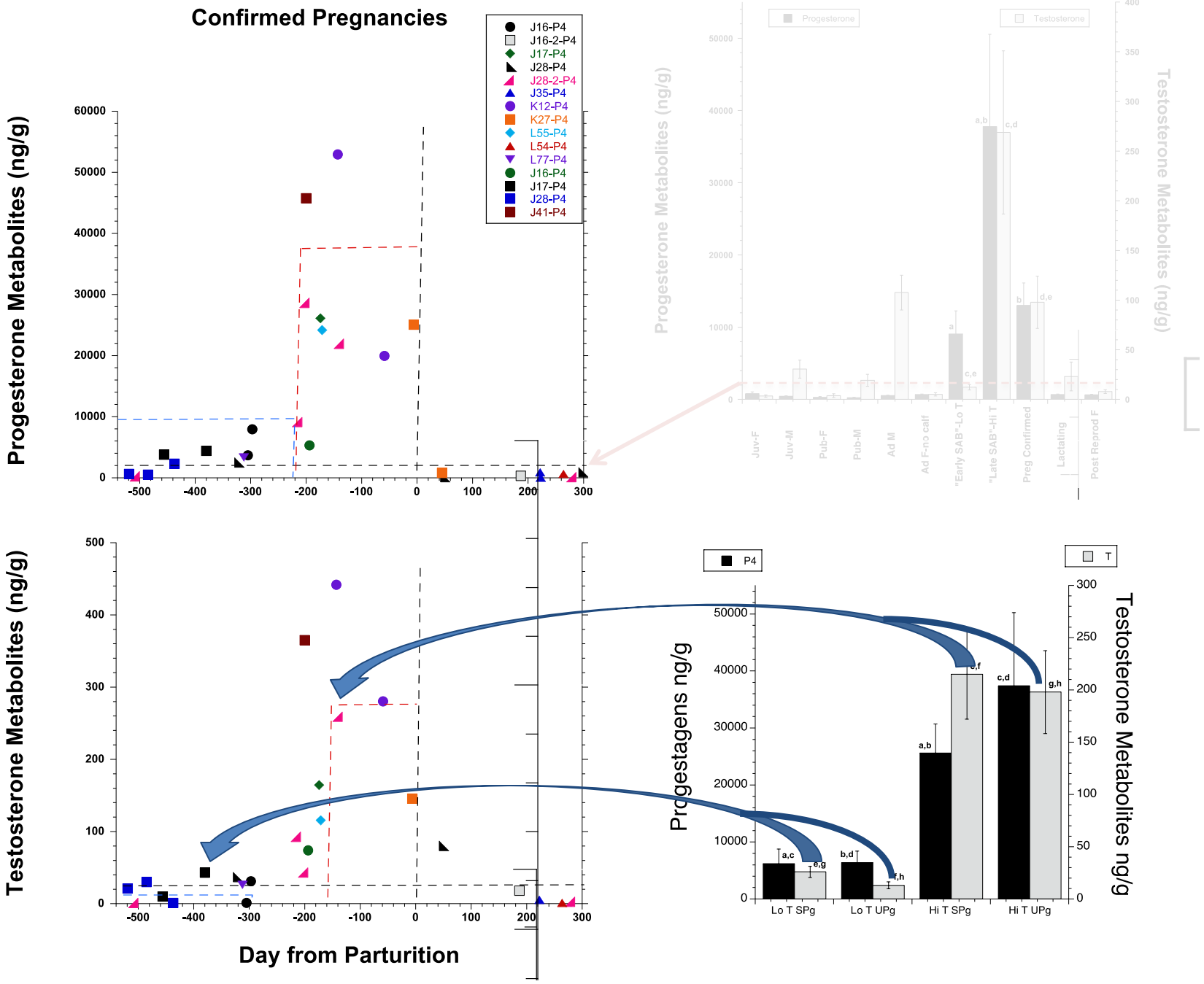

N
W
E
S
STRAIT OF GEORGIA
BOUNDARY PASS
ORCAS ISLAND
ROSARIO STRAIT
SAN JUAN ISLAND
HARO STRAIT
ANACORTES
LOPEZ ISLAND
VICTORIA, B.C.
STRAIT OF JUAN DE FUCA
0
2.5
5
10 Nautical Miles
Legend
SRKW 2011 US Samples
SRKW 2011 Canada Samples
International Boundary Line
Washington State, USA
British Columbia, Canada

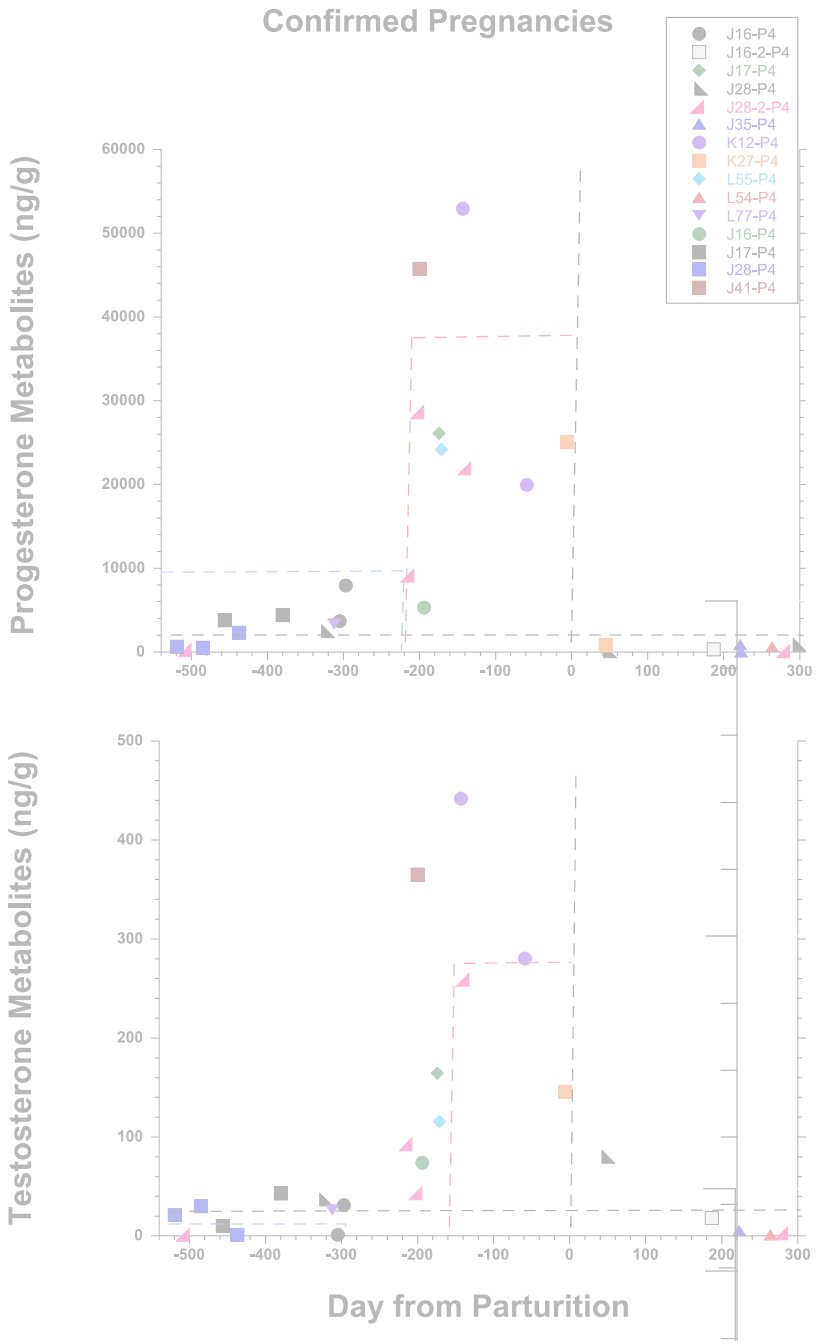
A.


Confirmed Pregnancies
J16-P4
J16-2-P4
J17-P4
J28-P4
J28-2-P4
J35-P4
K12-P4
K27-P4
L55-P4
L54-P4
L77-P4
J16-P4
J17-P4
J28-P4
J41-P4
Progesterone Metabolites (ng/g)
60000
50000
40000
30000
20000
10000
0
-500
-400
-300
-200
-100
0
100
200
300

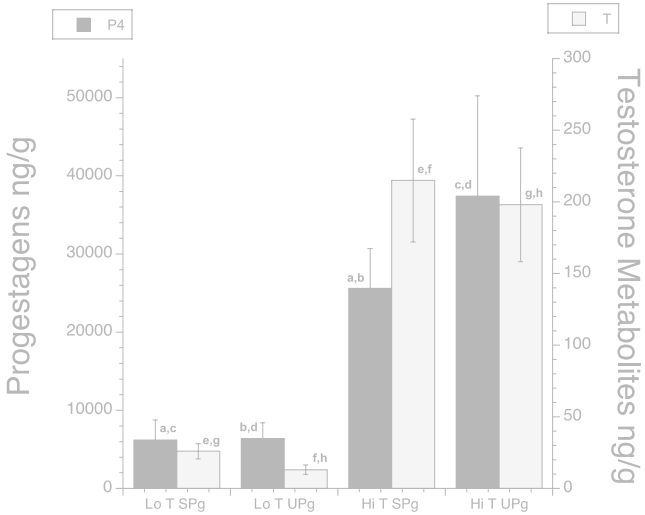
B.


Testosterone Metabolites (ng/g)
500
400
300
200
100
0
-500
-400
-300
-200
-100
0
100
200
300
Day from Parturition


Confirmed Pregnancies
Progesterone Metabolites (ng/g)
J16-P4
J16-2-P4
J17-P4
J28-P4
J28-2-P4
J35-P4
K12-P4
K27-P4
L55-P4
L54-P4
L77-P4
J16-P4
J17-P4
J28-P4
J41-P4
Testosterone Metabolites (ng/g)
Day from Parturition
Progesterone
Testosterone
Juv-F
Juv-M
Pub-F
Pub-M
Ad M
Ad F-no calf
"Early SAB"-Lo T
"Late SAB"-Hi T
Preg Confirmed
Lactating
Post Reprod F
P4
T
Progestagens ng/g
Lo T SPg
Lo T UPg
Hi T SPg
Hi T UPg



69% of detectable pregnancies abort;
33% of these occur during late pregnancy



Does Nutritional Stress Play a role?

Glucocorticoids (GCs)

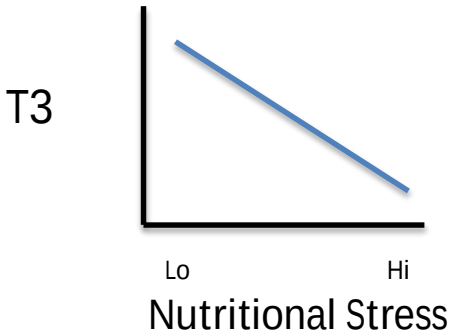
Rapid mobilization of glucose

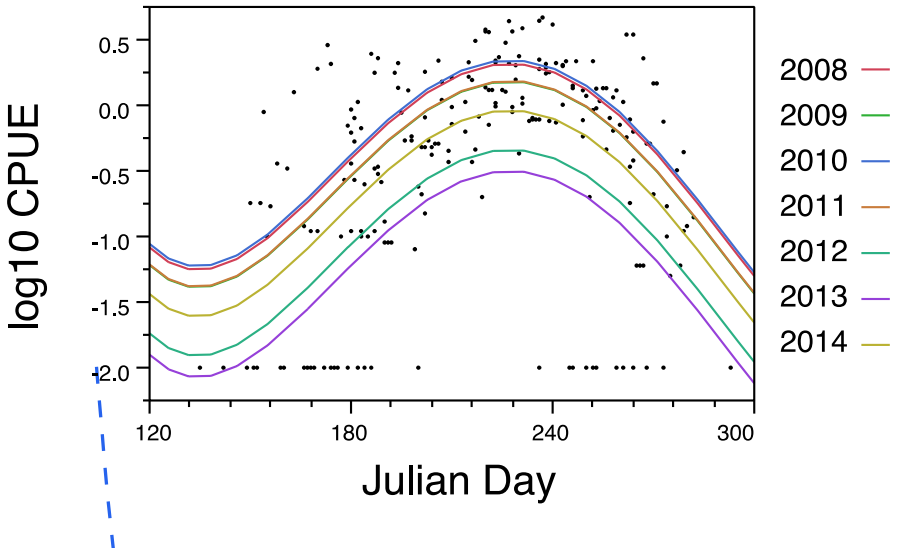
Fast acting

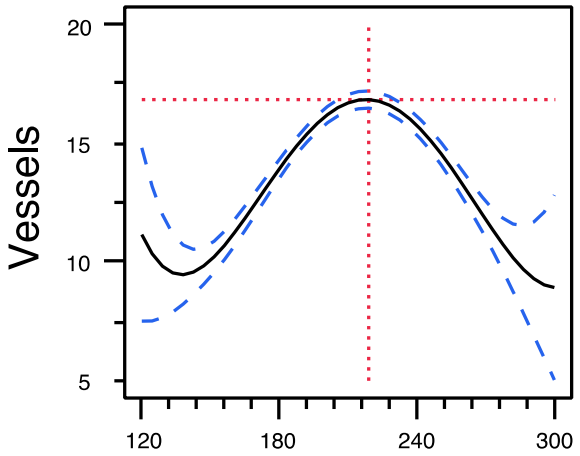
Thyroid Hormone (T3)

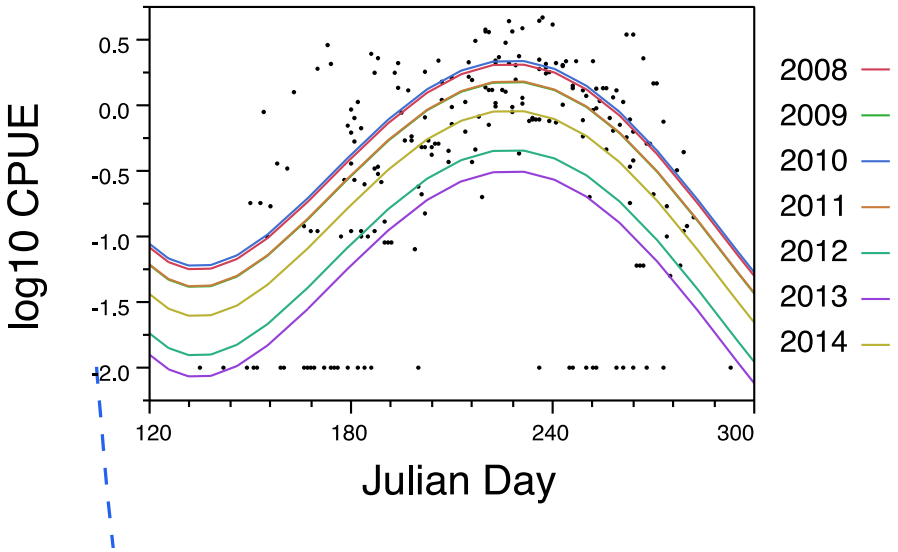
Slows metabolism

Slow acting




log10 CPUE
0.5
0.0
-0.5
-1.0
-1.5
-2.0
120
180
240
300
Julian Day
2008
2009
2010
2011
2012
2013
2014


Vessels
20
15
10
5
120
180
240
300


log10 CPUE
0.5
0.0
-0.5
-1.0
-1.5
-2.0
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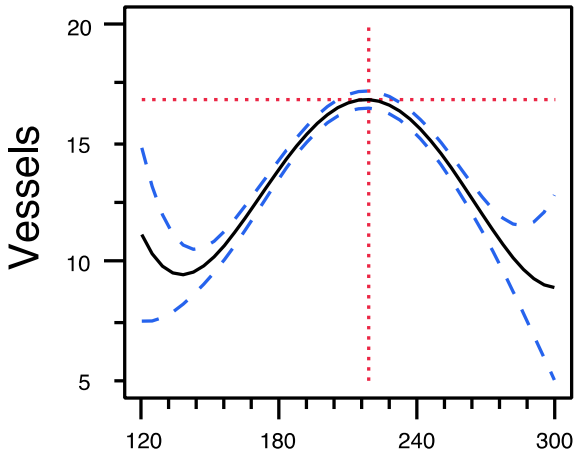
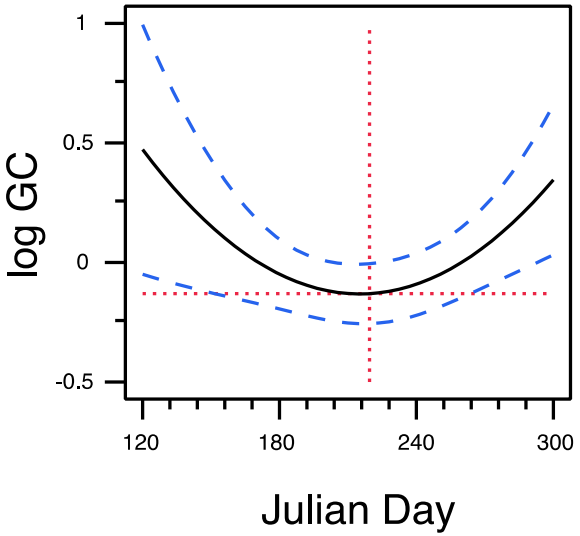
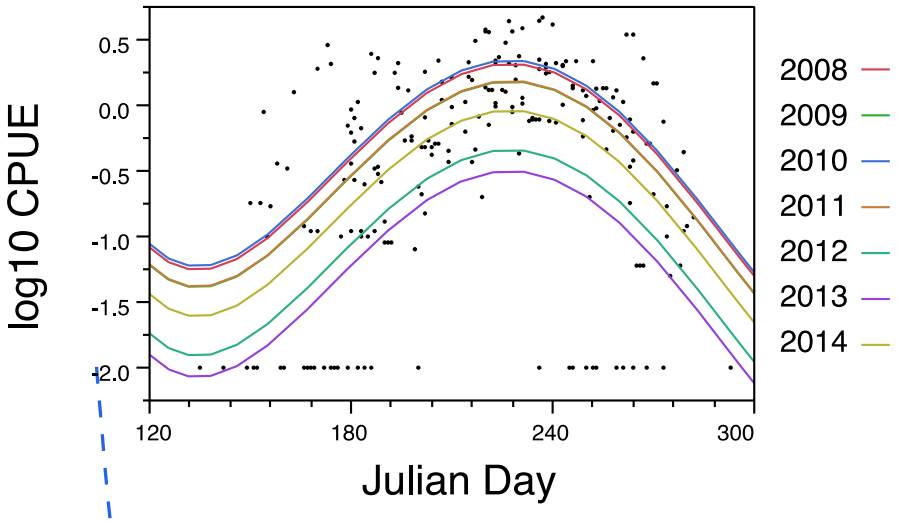
180
240
300
Julian Day
2008
2009
2010
2011
2012
2013
2014


Vessels
20
15
10
5
120
180
240
300


log GC
1
0.5
0
-0.5
120
180
240
300
Julian Day


log10 CPUE
0.5
0.0
-0.5
-1.0
-1.5
-2.0
120
180
240
300
Julian Day
2008
2009
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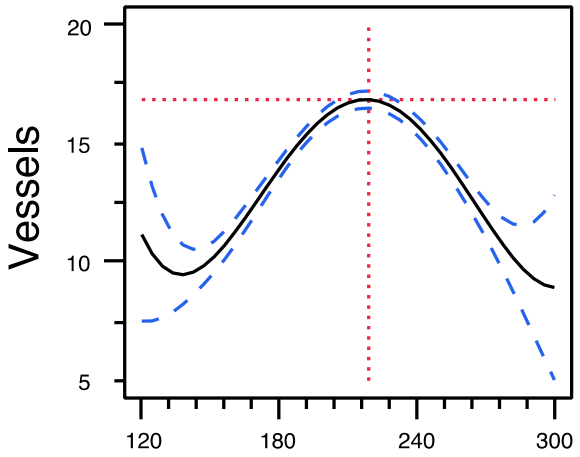
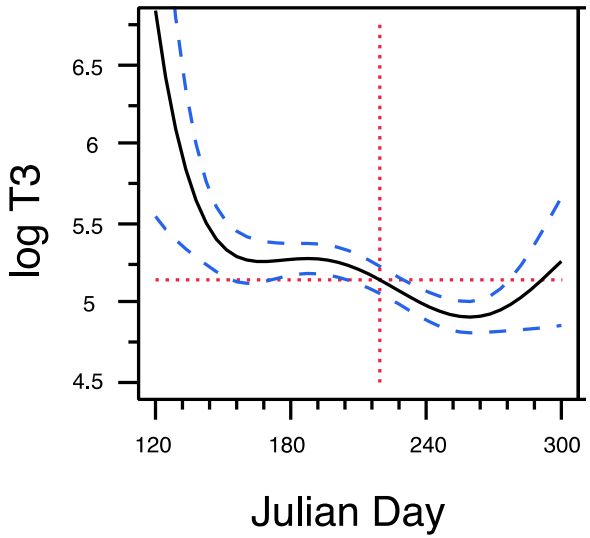
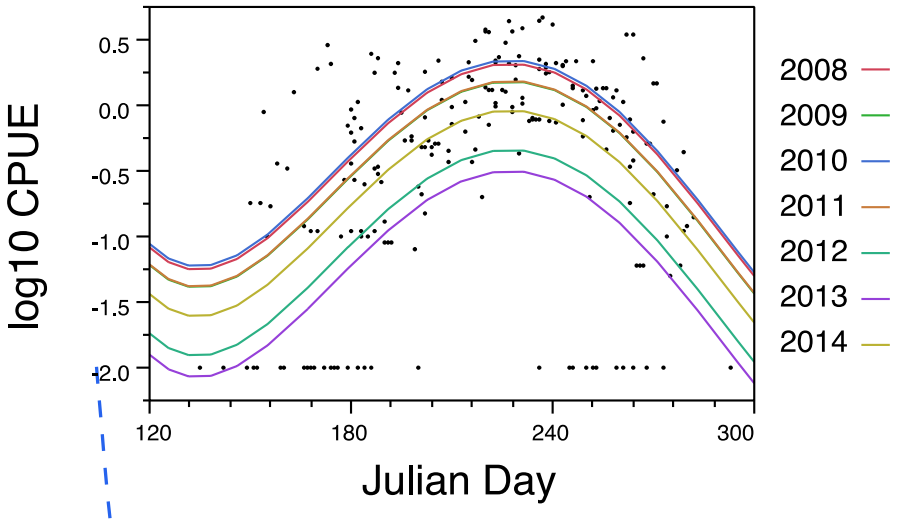
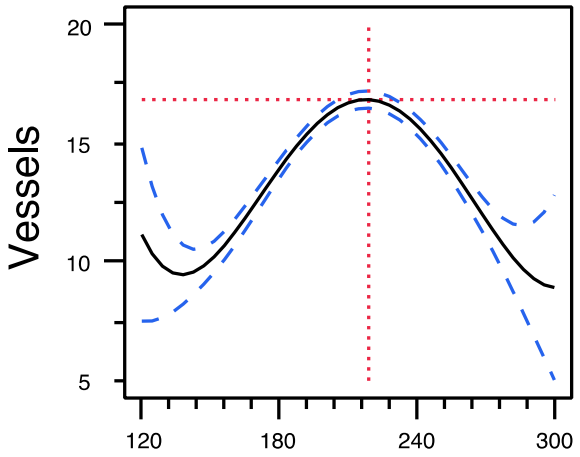
2011
2012
2013
2014

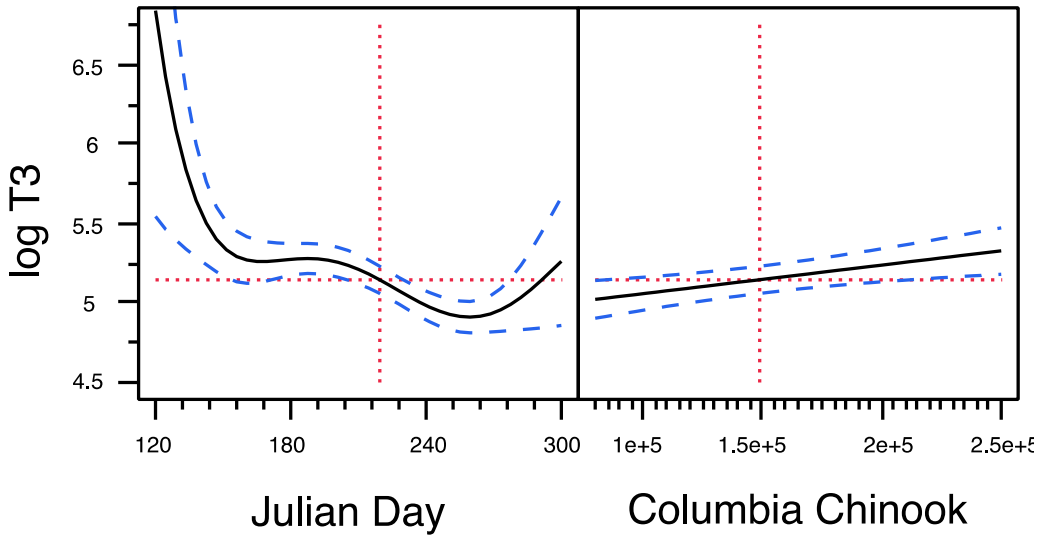

Vessels
20
15
10
5
120
180
240
300


log T3
6.5
6
5.5
5
4.5
120
180
240
300
Julian Day

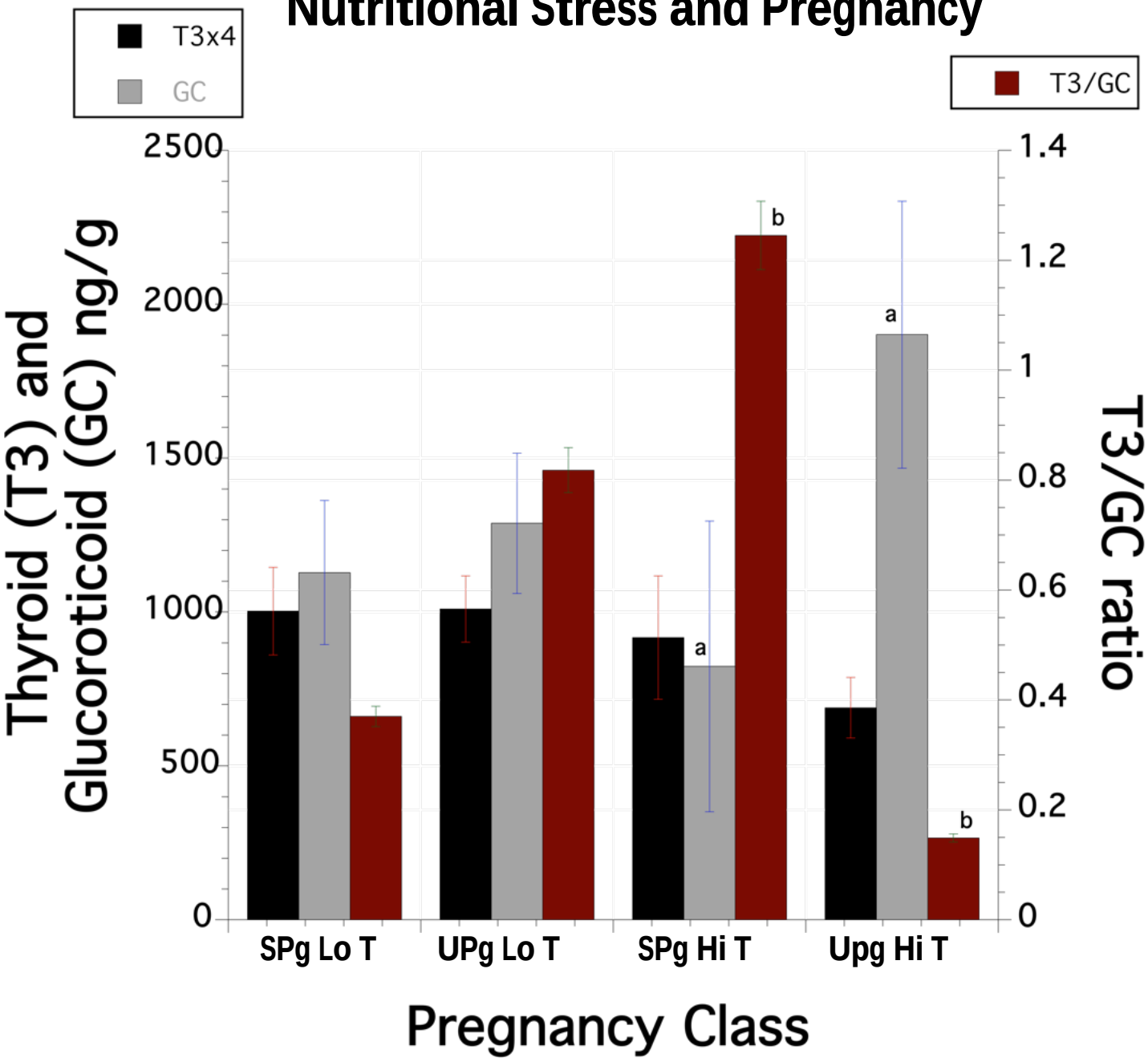

TILLAMOOK HEAD

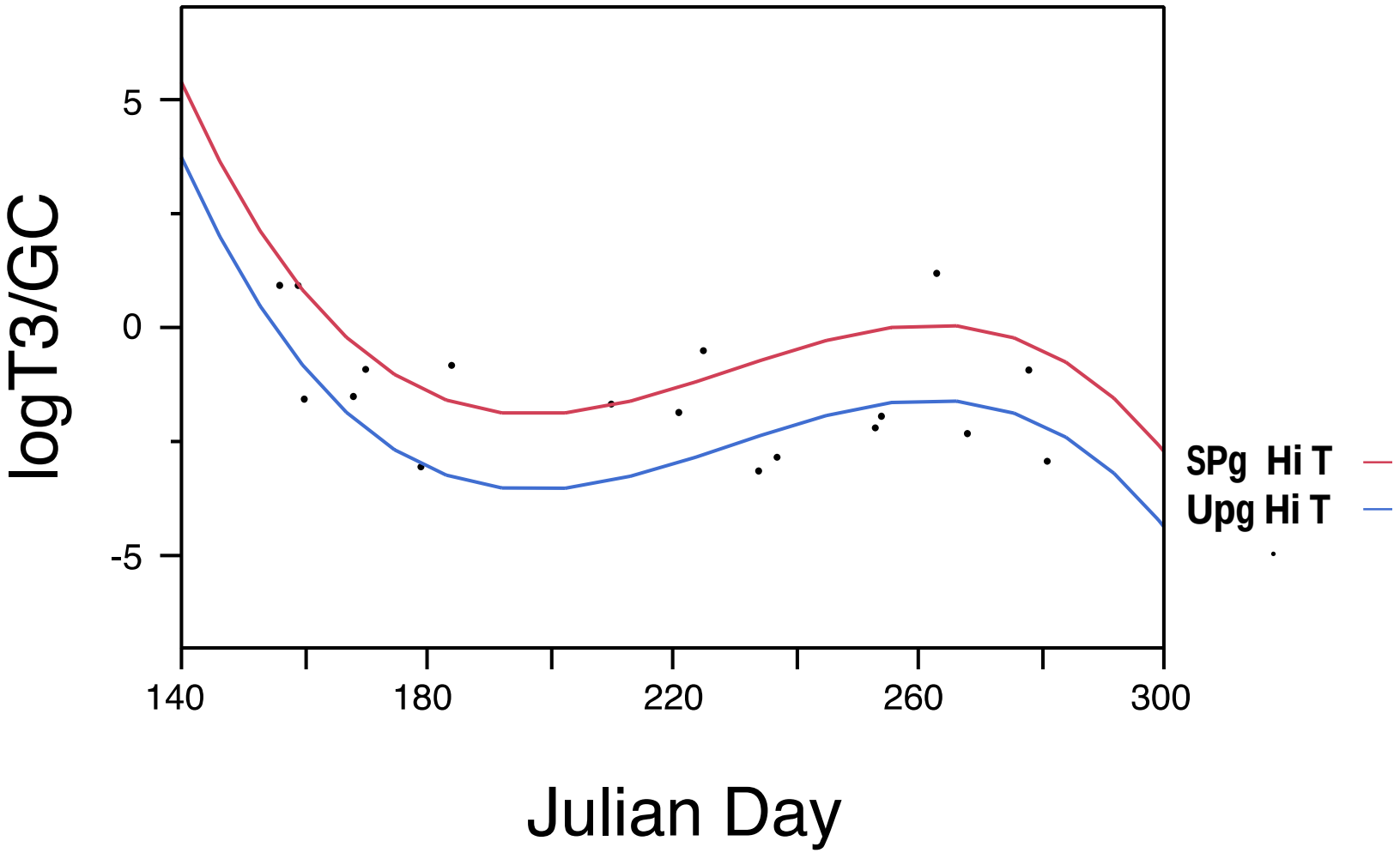

log10 CPUE
0.5
0.0
-0.5
-1.0
-1.5
-2.0
120
180
240
300
Julian Day
2008
2009
2010
2011
2012
2013
2014

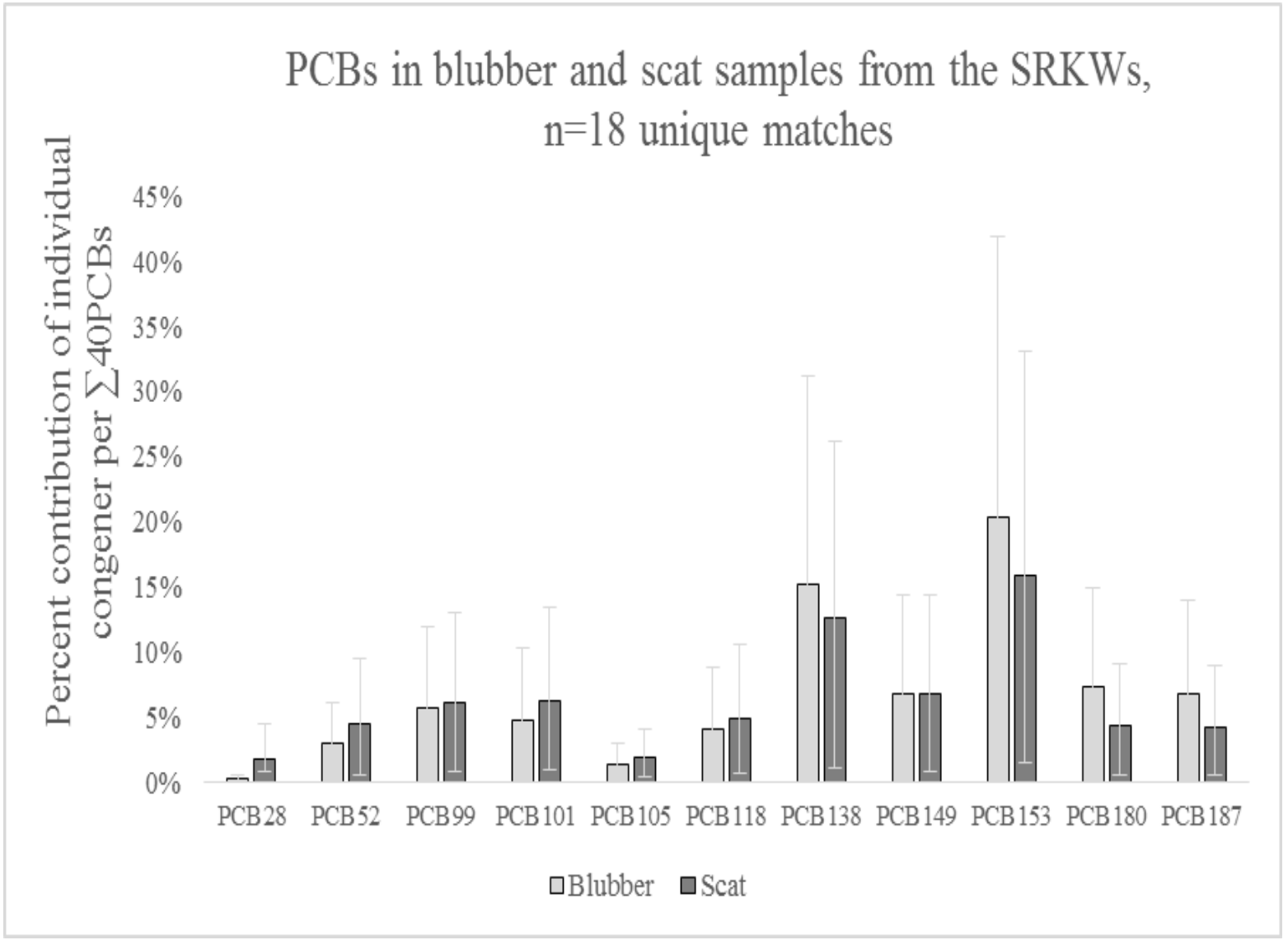

Vessels
20
15
10
5
120
180
240
300


log T3
6.5
6
5.5
5
4.5
120
180
240
300
1e+5
1.5e+5
2e+5
2.5e+5
Julian Day
Columbia Chinook

Nutritional Stress and Pregnancy

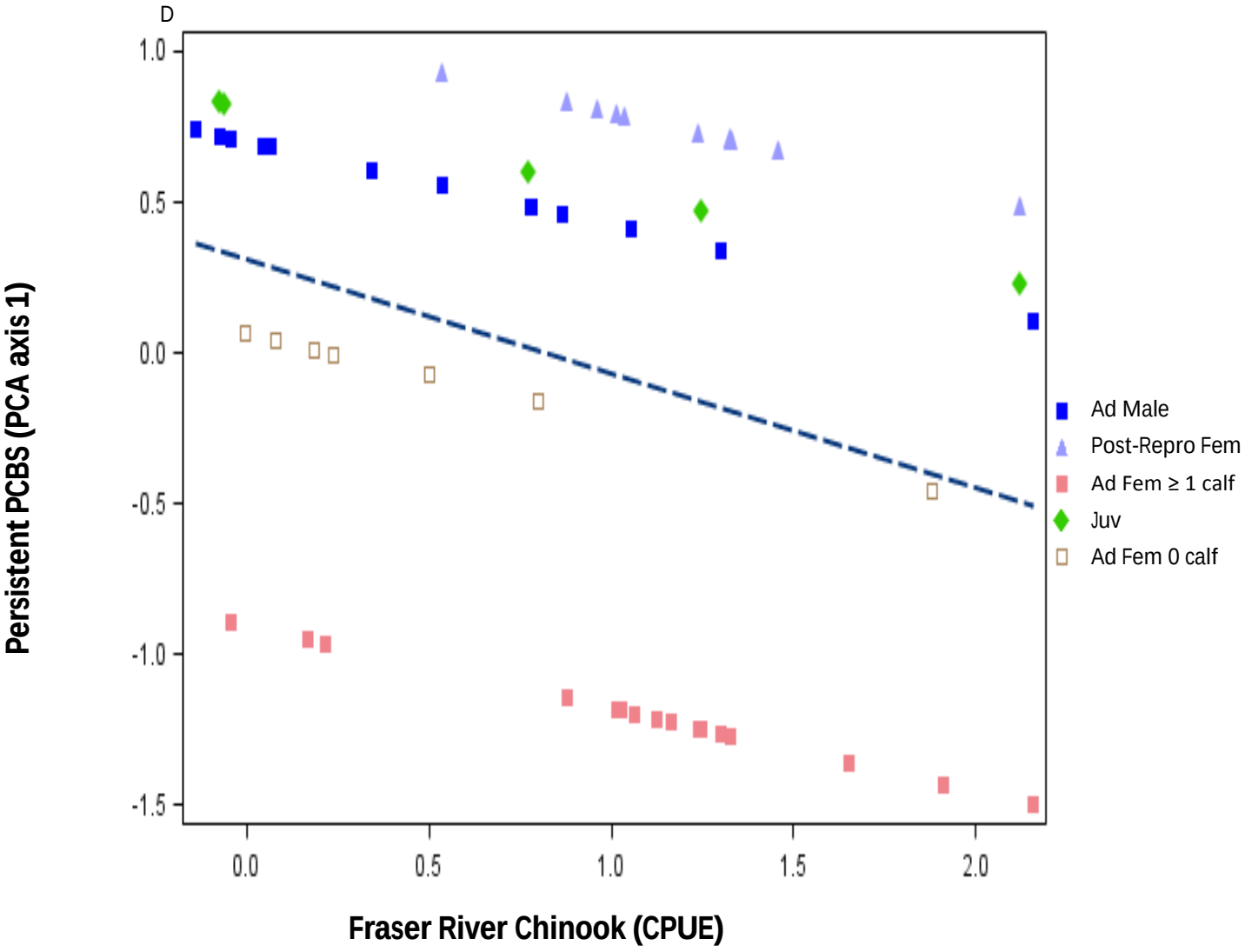



logT3/GC
5
0
-5
140
180
220
260
300
Julian Day
SPg Hi T
Upg Hi T



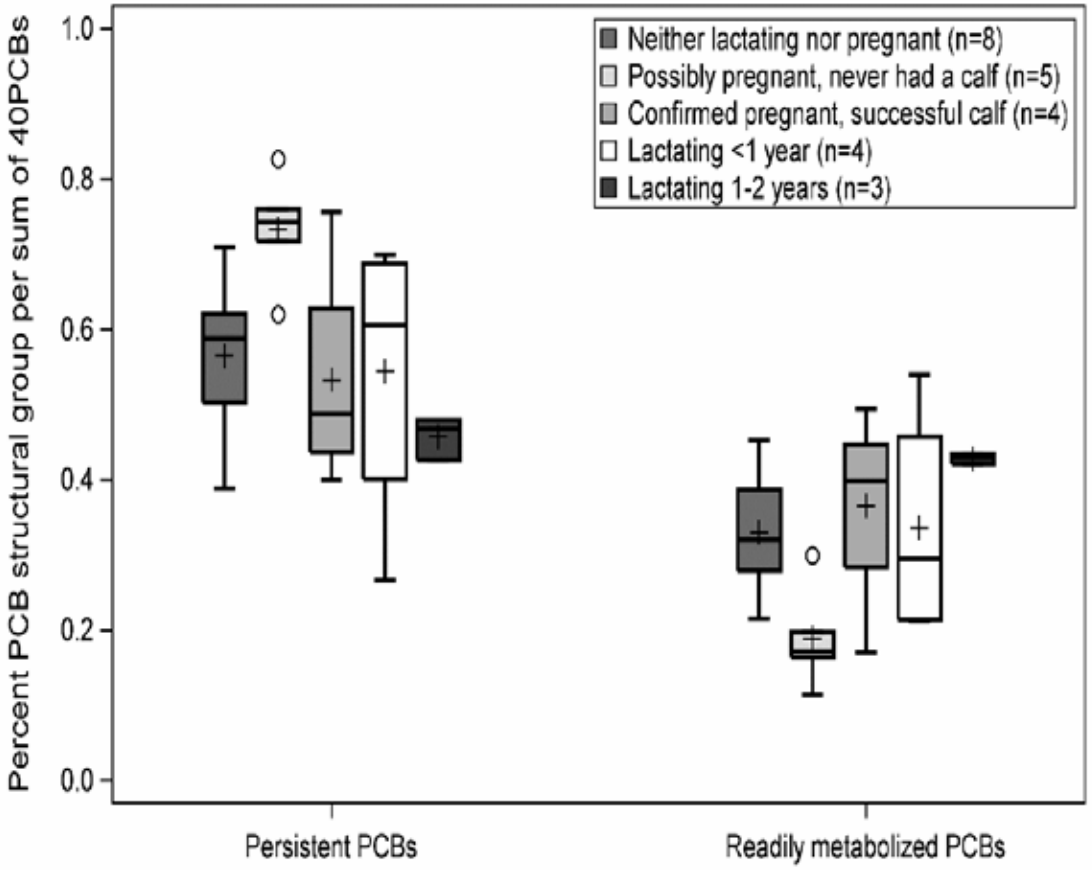
Lundin JI et al. 2015 Arch Environ Contam Toxicol

Persistent PCBs increase in scat (and thus in circulation) as fish availability decreases (burning fat)



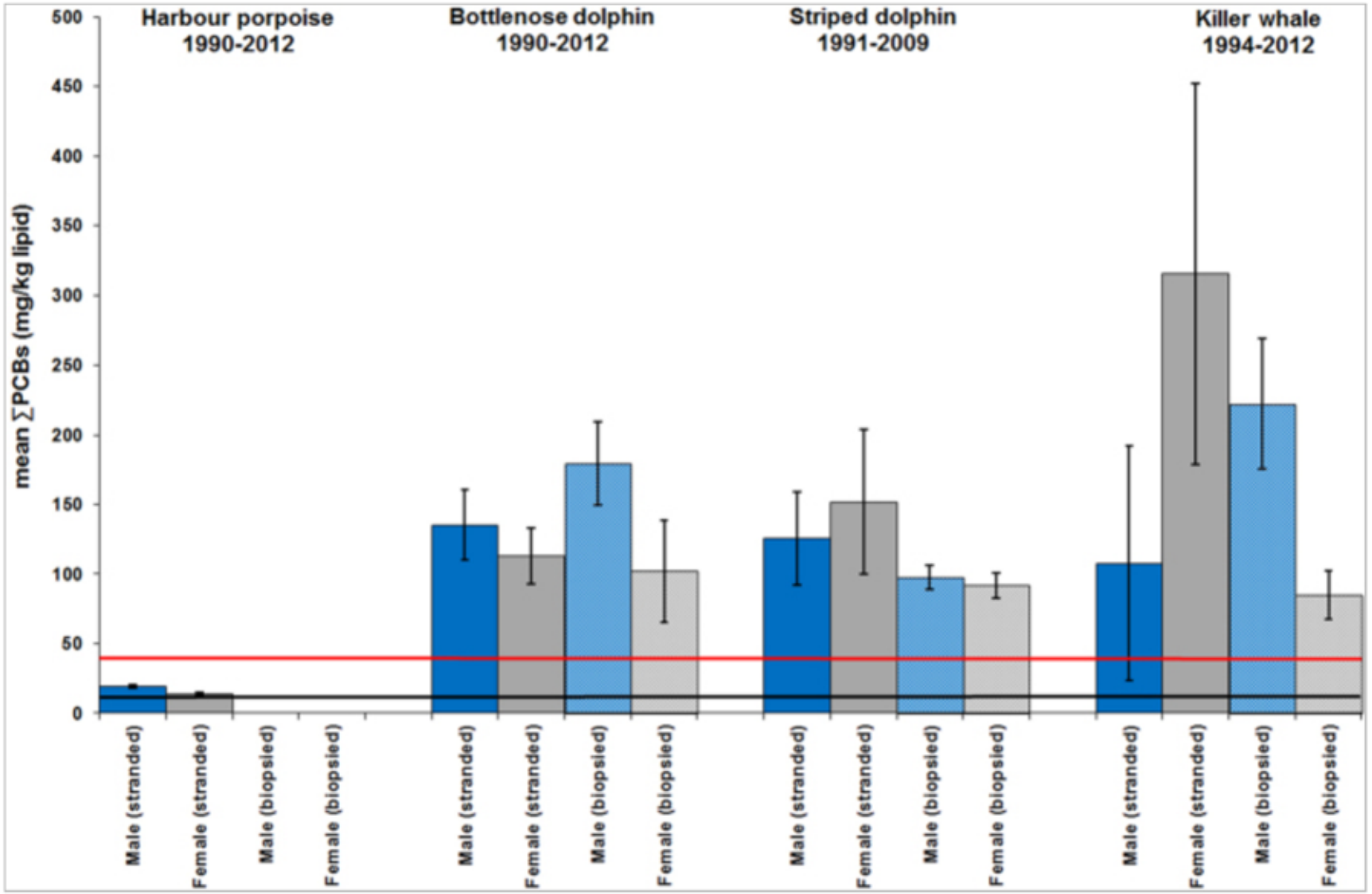
Lundin JI et al. 2016 Environ Sci Technol

Persistent and readily metabolized PCBs by female reproductive class



Persistent PCBs include all congeners in structural groups 1, 2, and 5
Readily metabolized PCBs include all congeners in structural groups 3 and 4

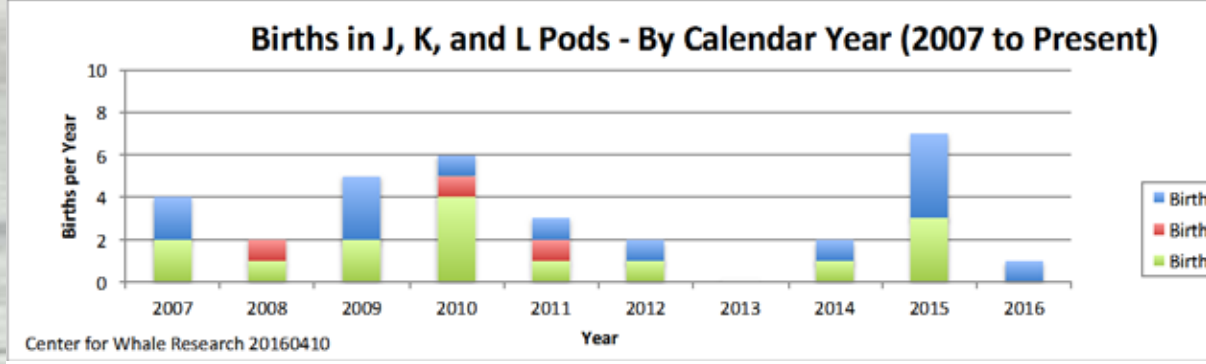
Lundin JI et al. 2016 Environ Sci Technol



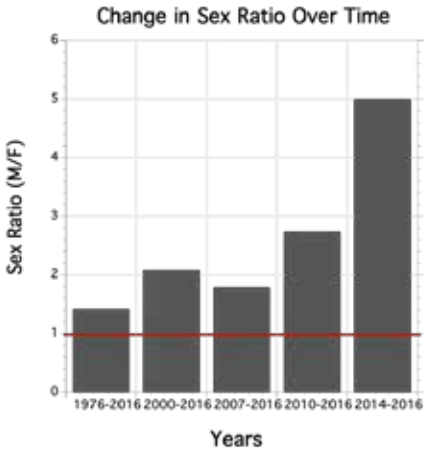
Mean ∑PCB concentrations in stranded and biopsied BNDs (1990–2012), SDs (1991–2009) and KWs (1994–2012) – all cetacean species (all ages).

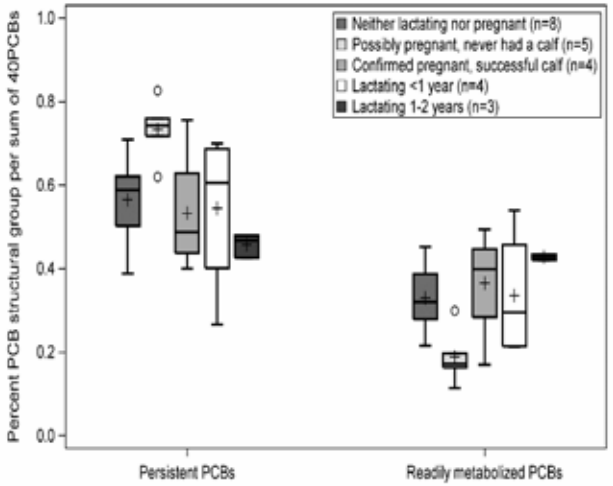
Jepson, P.D., et al. (2016) *Sci. Rep.* **6**, 18573; **doi**: 10.1038/srep18573

Food is the key



Loss of Genetic Diversity and Inbreeding





Persistent PCBs include all congeners in structural groups 1, 2, and 5
Readily metabolized PCBs include all congeners in structural groups 3 and 4

Acknowledgements and Next Steps

Funding

Washington Sea Grant (2010-2013)

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Fred Felleman

Mike Ford

Linda Parks

Gina Ylatalo

Ken Balcomb

Jane Cogan

Liz Welch

Collaborations

NOAA, Northwest Fisheries Science Center

Soundwatch

Center for Whale Research

Cascadia Research

The Whale Museum

Orca Network

National Marine Fisheries Service