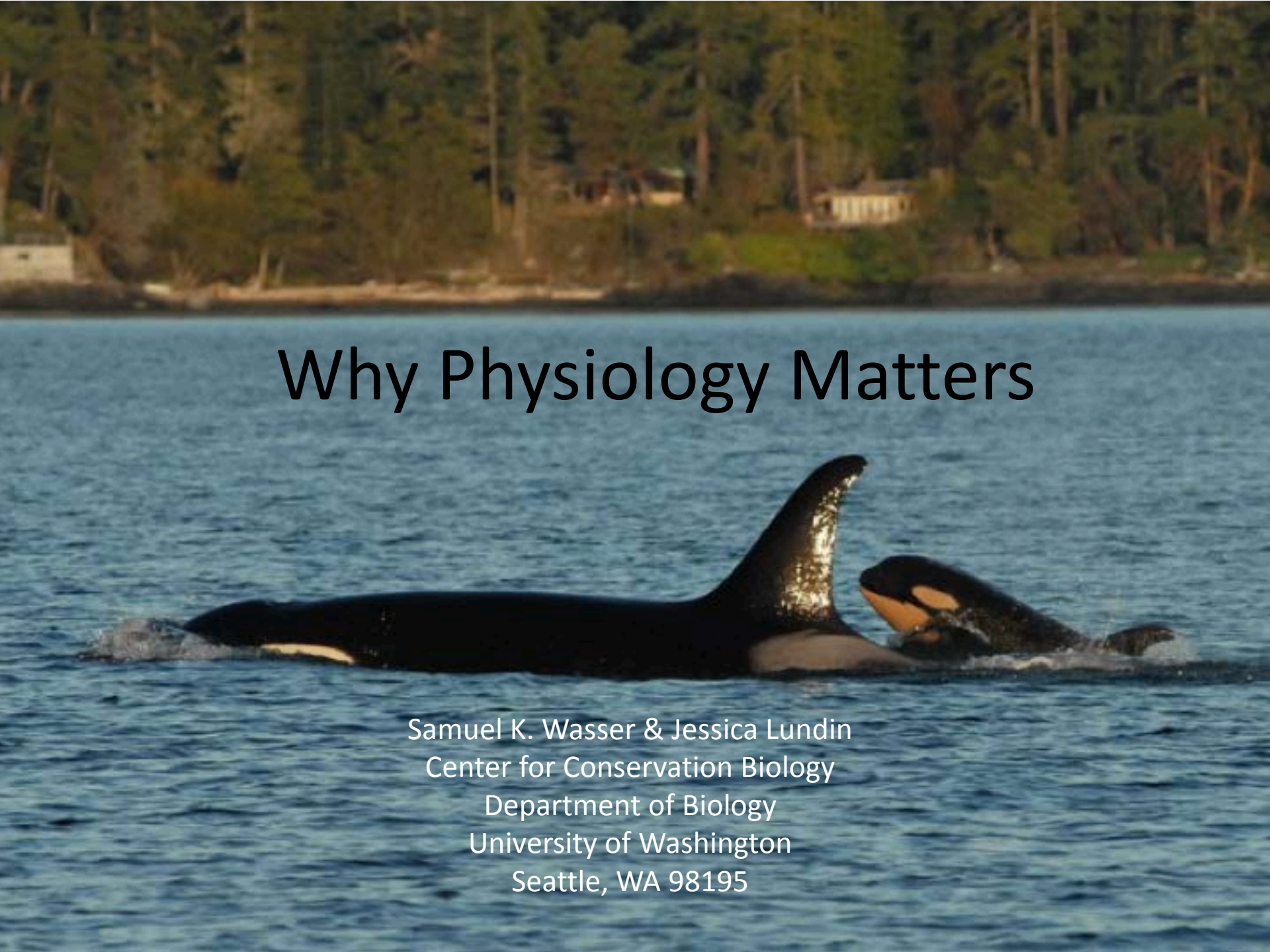
# Why Physiology Matters



Samuel K. Wasser & Jessica Lundin
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University of Washington
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# Challenges to Assessing Recovery

- Long time span between event and impacts on population growth
  - Difficult to assign cause

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- Long time span between event and impacts on population growth
  - Difficult to assign cause
- SRKW is particularly problematic
  - Marked transitions between winter, spring and summer-fall in Salish Sea
- Reproduction (recruitment) is the most variable component of population growth
  - But we miss the most variable part of reproduction
    - conception through early post-partum

# Physiology is a bridge

- Allostatic load = the animals physiological well being
  - stress (GC), nutrition (GC, T3), … mechanisms
    - change in response to the primary environmental pressures likely to impact population growth

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    - Triggered by changes in allostatic load (Wasser and Barash 1983)

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REPRODUCTIVE SUPPRESSION AMONG FEMALE MAMMALS: IMPLICATIONS FOR BIOMEDICINE AND SEXUAL SELECTION THEORY

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DAVID P. BARASH
*Animal Behavior Program, Department of Psychology, University of Washington, Seattle, Washington 98195*

ABSTRACT

*Female mammals experience a very high and often unappreciated rate of reproductive failure. Among human pregnancies alone, over 50 per cent fail between conception and parturition, and the majority of these failures are unexplained. These findings present important problems for evolutionary theory as well as for health care practice. This paper addresses these high rates of reproductive failure among mammals, by extending the work of a number of evolutionary biologists regarding the reproductive consequences of environmental adversity. The basic model upon which we elaborate, termed the Reproductive Suppression Model, argues that females can optimize their lifetime reproductive success by suppressing reproduction when future conditions for the survival of offspring are likely to be sufficiently better than present ones so as to extend the costs of the suppression itself. These costs are a function of reproductive time lost and the direct phenotypic effects of the suppression itself. To evaluate the benefits and costs of suppression, the following types of cues should be assessed: the female's physical and mental health, her stage of reproduction, the physical and genetic status of her offspring, and the external conditions at the time of birth.*

*We also examine various issues of social suppression, whereby the conditions for survival of offspring are a function of the reproduction and support of other group members. Under such conditions, some females may be able to improve current conditions for reproduction by suppressing the reproduction of others. Field data from our own work are presented, describing socially mediated reproductive competition among continuously breeding female yellow baboons and among female hoary marmots.*

*Social suppression in other mammals is also evaluated, including that in human beings, and we conclude with some implications of the Reproductive Suppression Model for sexual selection theory regarding female-female reproductive competition, as well as human health care.*

INTRODUCTION

ONE OUT OF every two human pregnancies fails between conception and parturition (Shepard and Fazzol, 1979). Comparable data exist for a variety of other mammals (Bramhell, 1948; Wynne Edwards, 1962; Hendricks and Nelson, 1971; Eleftherion and Sprott, 1975; Asdenmacher and Farner, 1976; Cohen, Malpas, and Klein, 1980). If we add neonatal mortality (1.3% of all human births: Health United States, 1980), and the ovulations and conceptions that should occur but do not (a quantity that may be greater than all of the above combined: Carenza and Zichella, 1979), there is a much greater incidence of unsuccessful reproductive attempts in mammals than of successful ones. This is an important problem, both for evolutionary theory and also for health care practitioners. For example, in a well-known study predicting reproductive risks among women, Hobel, Youkelen, and Forsythe (1973) clas-

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# Physiology is a bridge

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- Reproduction
  - Multiple physiological mechanisms suppress reproduction under harsh conditions (David Lack 1954, GC Williams 1966)
    - Triggered by changes in allostatic load (Wasser and Barash 1983)

- The ability to temporally connect these features makes the bridge
  - linking events [e.g., fish (GC, T3), boats (GC), toxin exposure] to their growth outcomes (e.g., low P4 in reproductive females, few recognized births, survivorship)

Many factors may influence a given hormone

That is more of a strength than a weakness of these measures

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Need to monitor hormone changes in response to **multiple** changing pressures over time

Many factors may influence a given hormone

That is more of a strength than a weakness of these measures

Need to monitor hormone changes in response to **multiple** changing pressures over time

The efficiency of scat sampling with dogs makes this possible

# Fecal progesterone pregnancy index in genetically sex-assigned caribou

0 –

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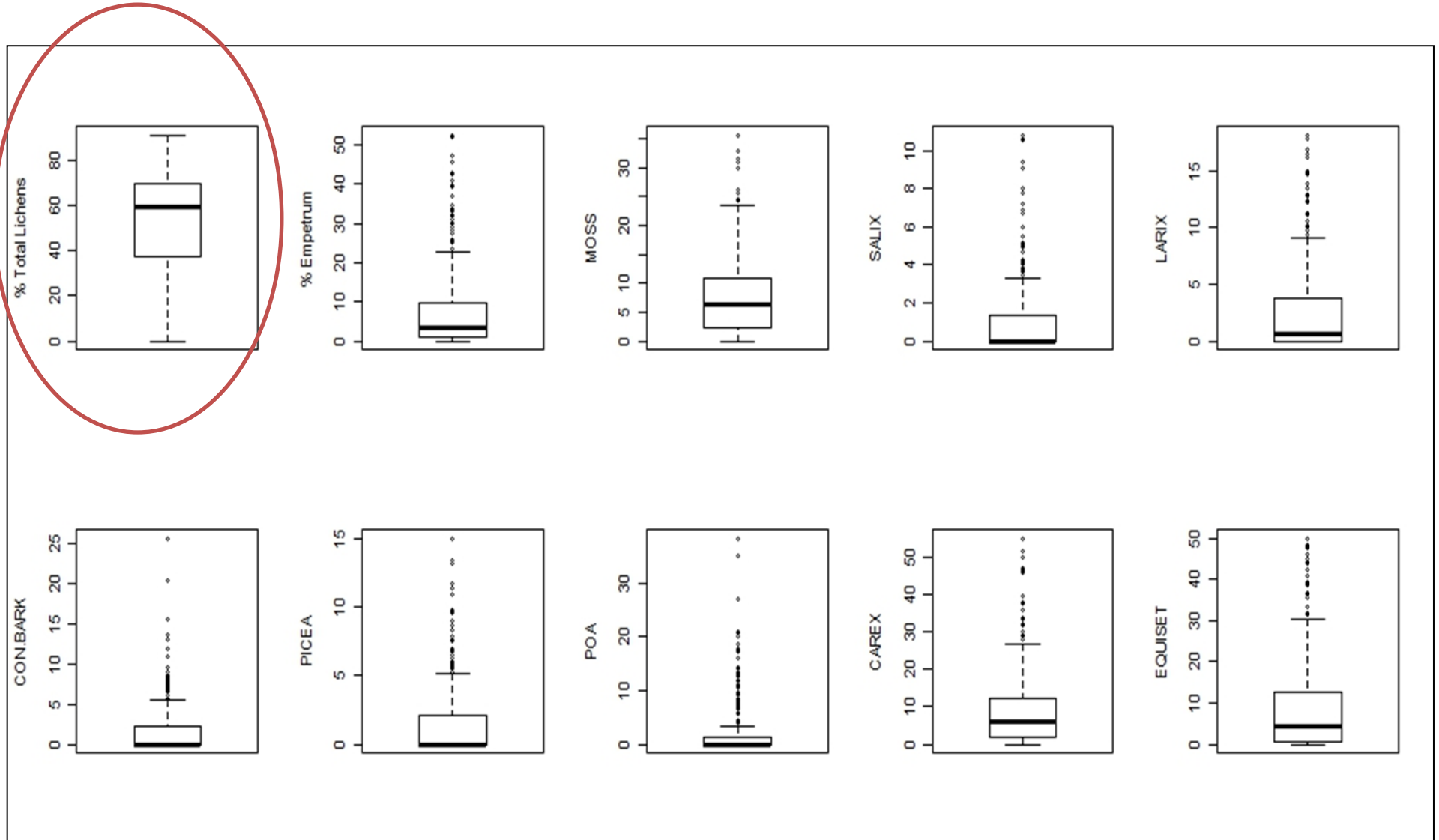
0 –

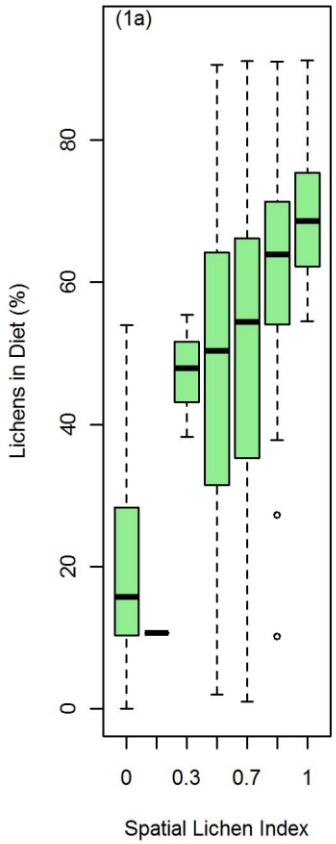
# Fecal progesterone pregnancy index in genetically sex-assigned caribou

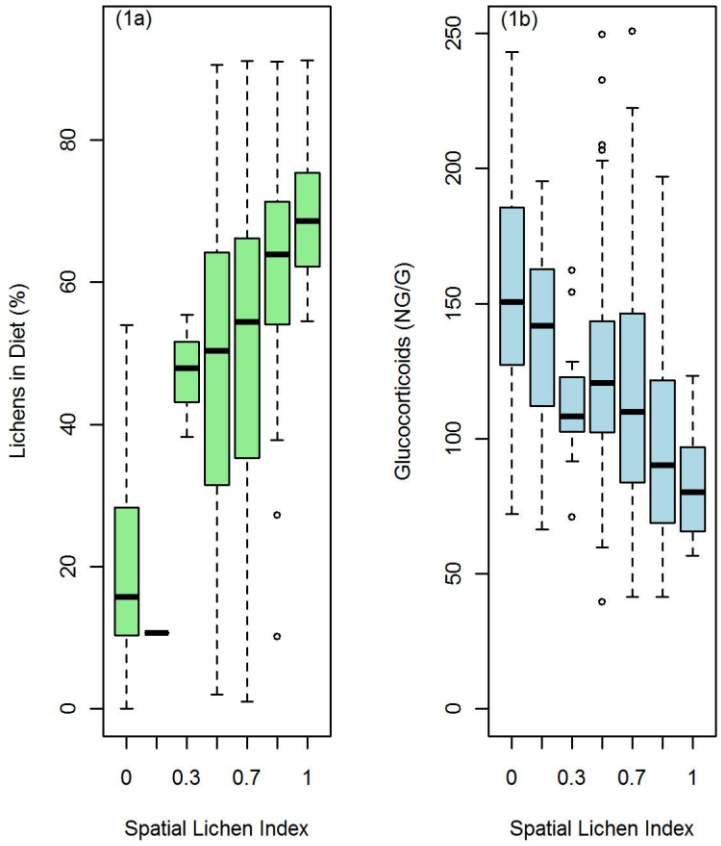
0 –

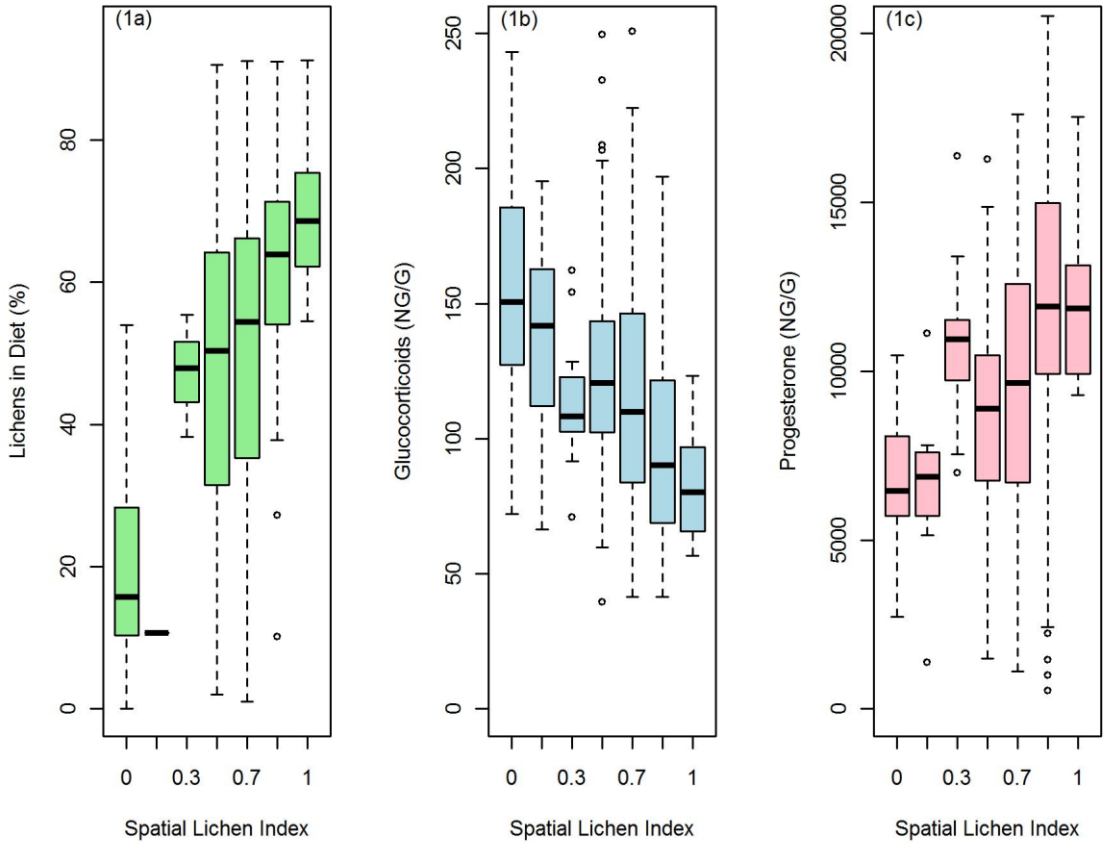
0 –

# Caribou Winter Diet




(1a)
Lichens in Diet (%)
0
20
40
60
80
0
0.3
0.7
1
Spatial Lichen Index

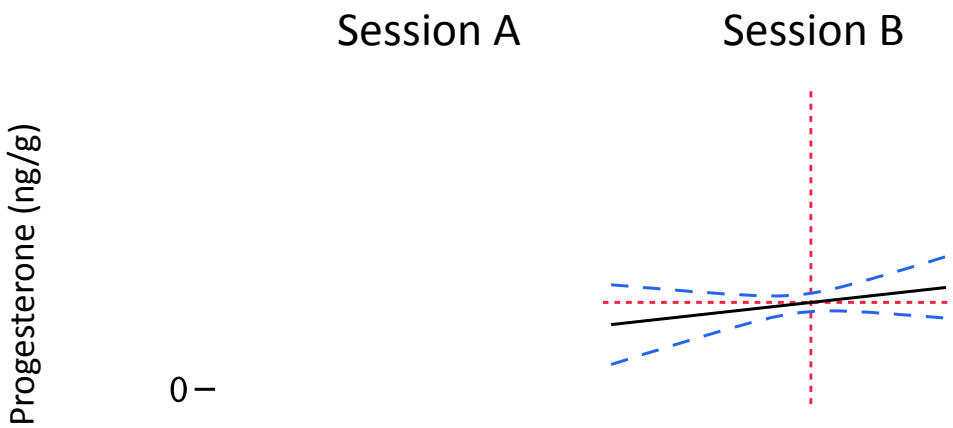

(1a)
Lichens in Diet (%)
0
20
40
60
80
0
0.3
0.7
1
Spatial Lichen Index
(1b)
Glucocorticoids (NG/G)
0
50
100
150
200
250
0
0.3
0.7
1
Spatial Lichen Index

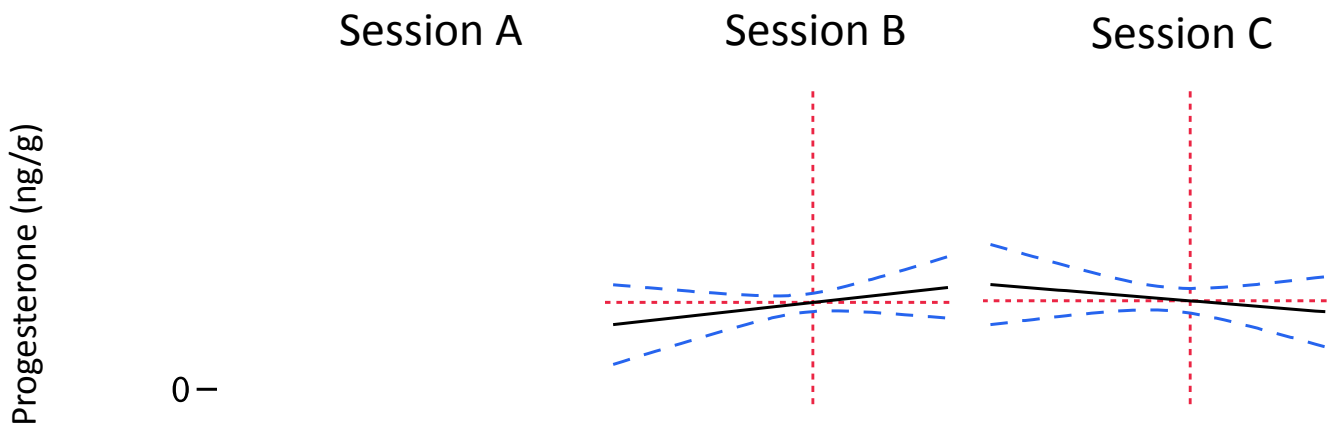

(1a)
Lichens in Diet (%)
0
20
40
60
80
0
0.3
0.7
1
Spatial Lichen Index
(1b)
Glucocorticoids (NG/G)
0
50
100
150
200
250
0
0.3
0.7
1
Spatial Lichen Index
(1c)
Progesterone (NG/G)
0
5000
10000
15000
20000
0
0.3
0.7
1
Spatial Lichen Index

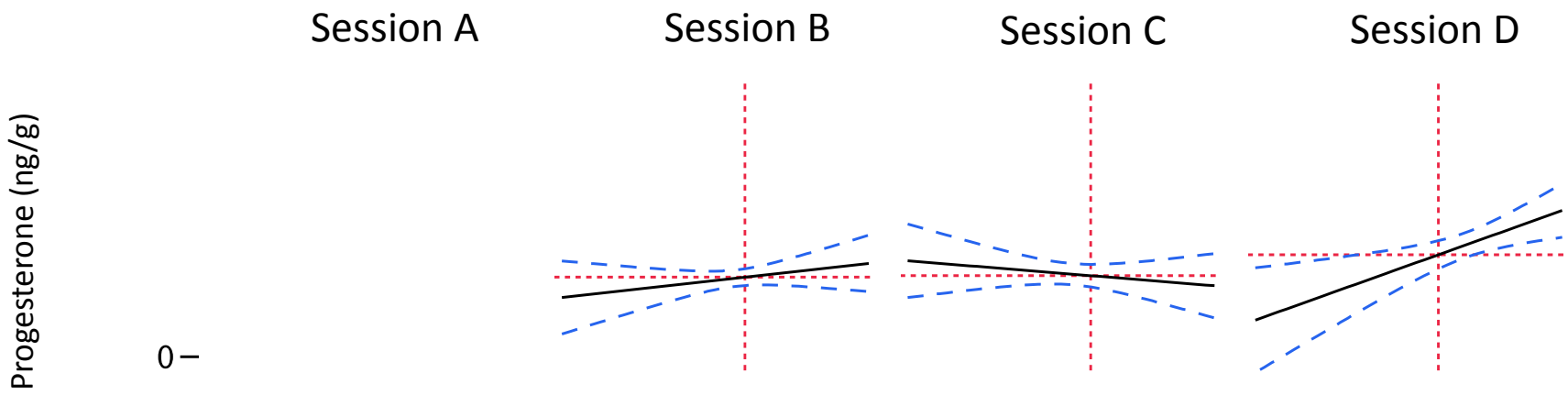
Session A

Progesterone (ng/g)

0 –


Session A
Session B
Progesterone (ng/g)
0


Session A
Session B
Session C
Progesterone (ng/g)
0

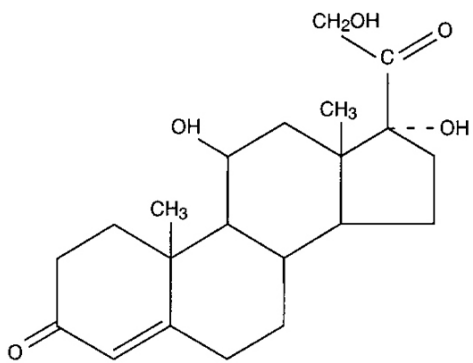

Session A
Session B
Session C
Session D
Progesterone (ng/g)
0

Detection dogs sample pods from front to back

—> hopscotch fashion

Samples are genotyped to ID

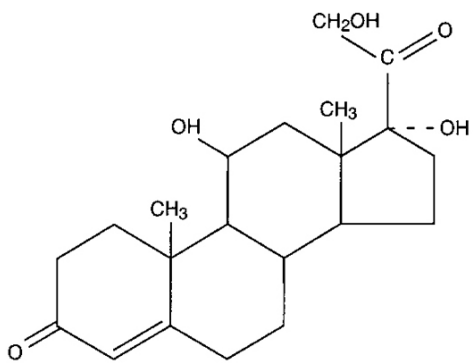
# Glucocorticoids or “GCs”




- Increases with **psychological and nutritional stress**
- Rapid mobilization of glucose

- Fast acting

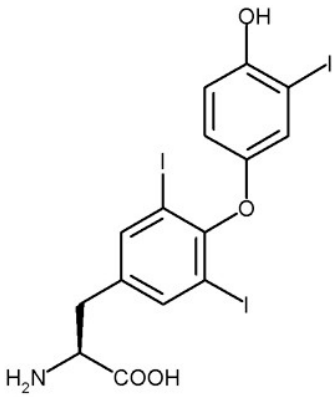
# Glucocorticoids or “GCs”




- Increases with **psychological and nutritional stress**
- Rapid mobilization of glucose

- Fast acting

# Thyroid Hormone or “T3”




- Decreases with **nutritional stress**
- Regulates metabolism
- Conserve energy

- Slower acting

# SRKW

- GC: Since fish and boats peak around same time
  - GCs should be highest at the boat/fish peak if driven by boats but lowest if driven by fish

# SRKW

- T3: Nutrition only, controls metabolism, changing on a slower time scale
  - T3 at time of arrival should reflect food conditions prior to transitioning to these new conditions
    - becoming more affected by present conditions with time

**Data from 2008-2011**

- Low food intake or high boat stress
- Increase GC

3

**Data from 2008-2011**

- Low food intake or high boat stress
- Increase GC

3

3

# Data from 2008-2011

3

3

## Data from 2008-2011

- Low food intake
- Decrease T3

3 –

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- Low food intake
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3 –

3 –

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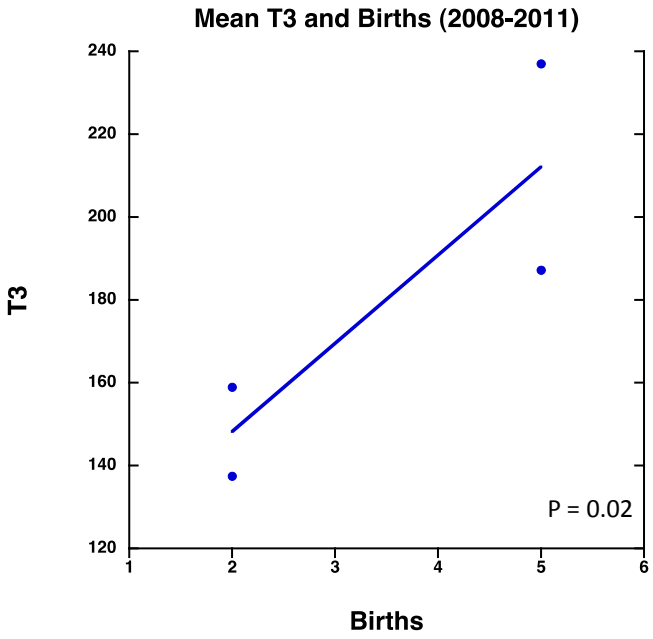
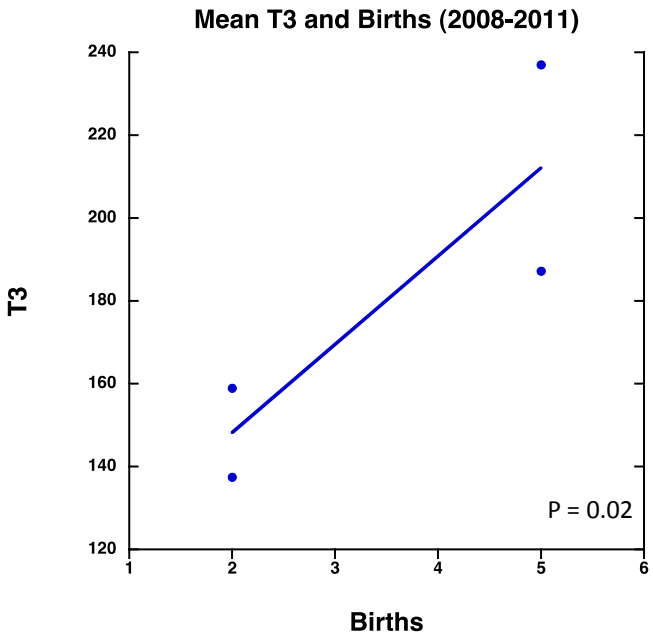
3 –

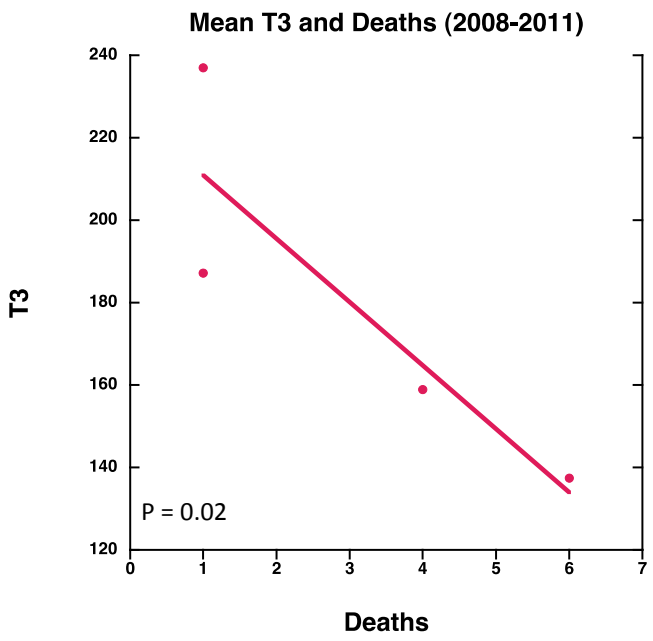
3 –

# Data from 2008-2011



# Data from 2008-2011



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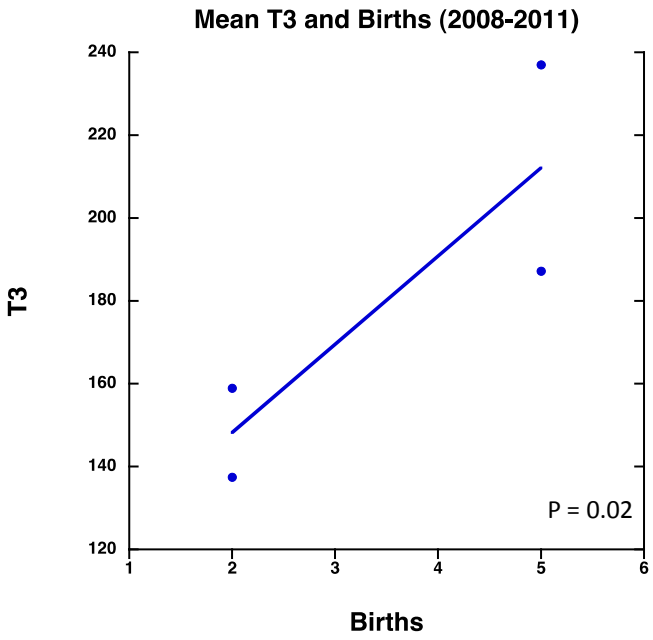


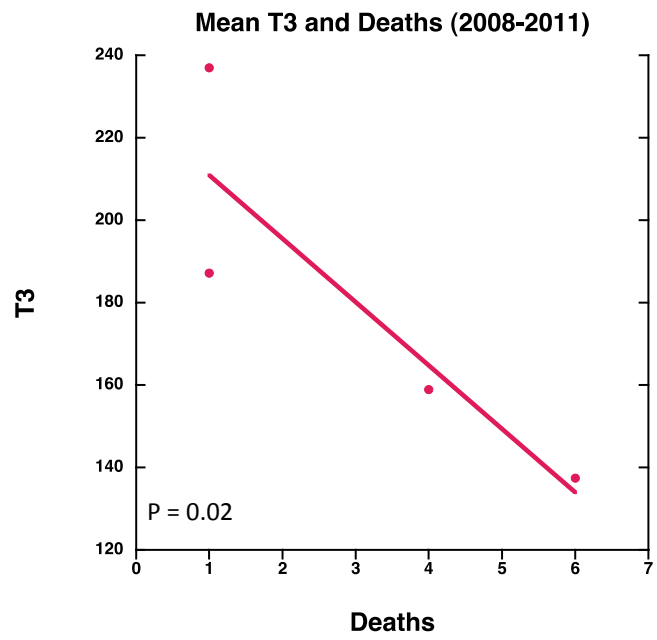


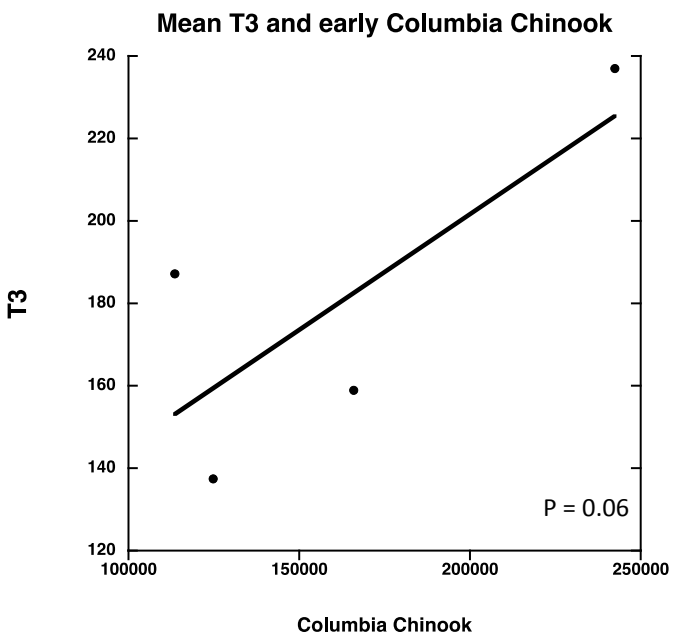

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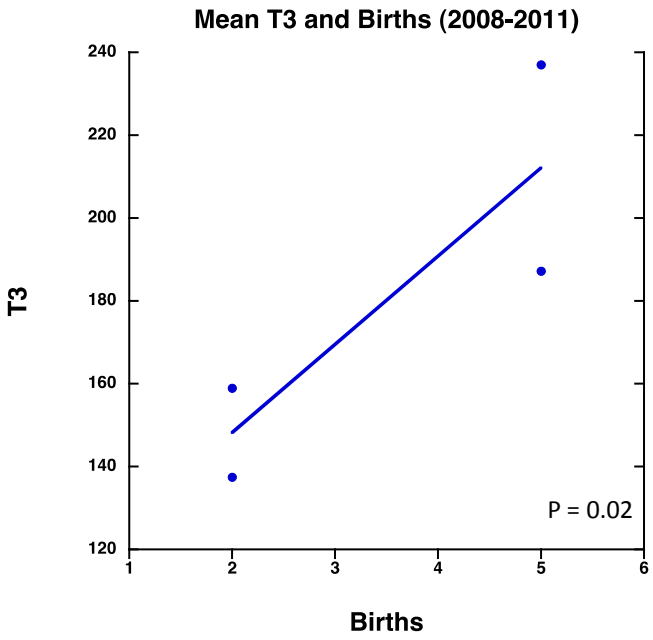
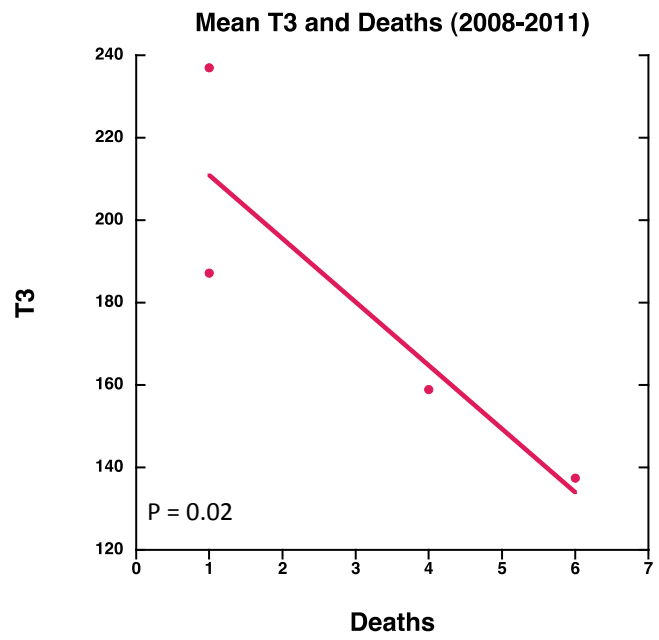
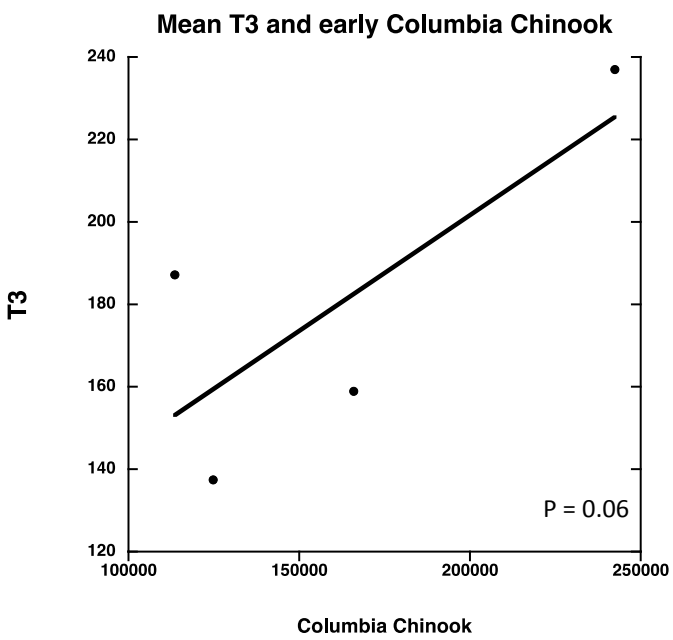
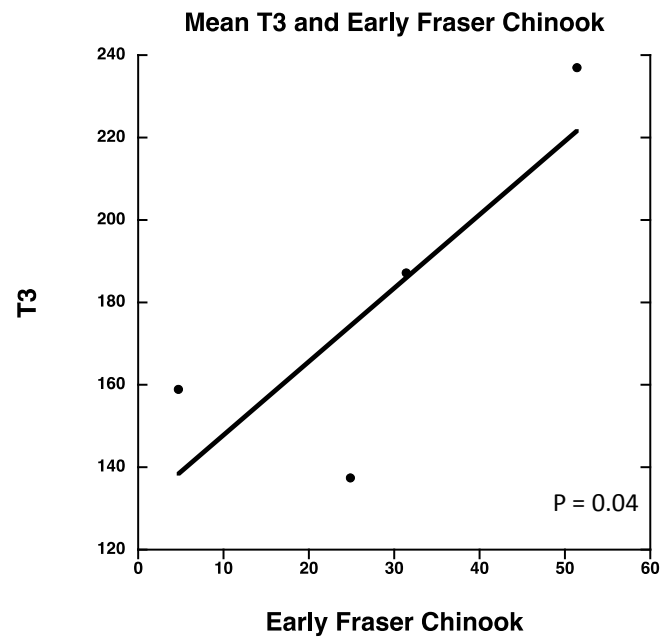
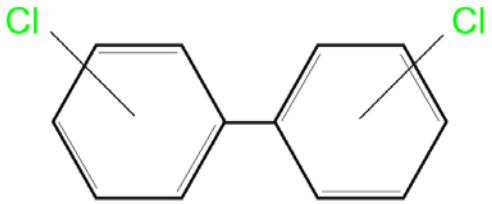


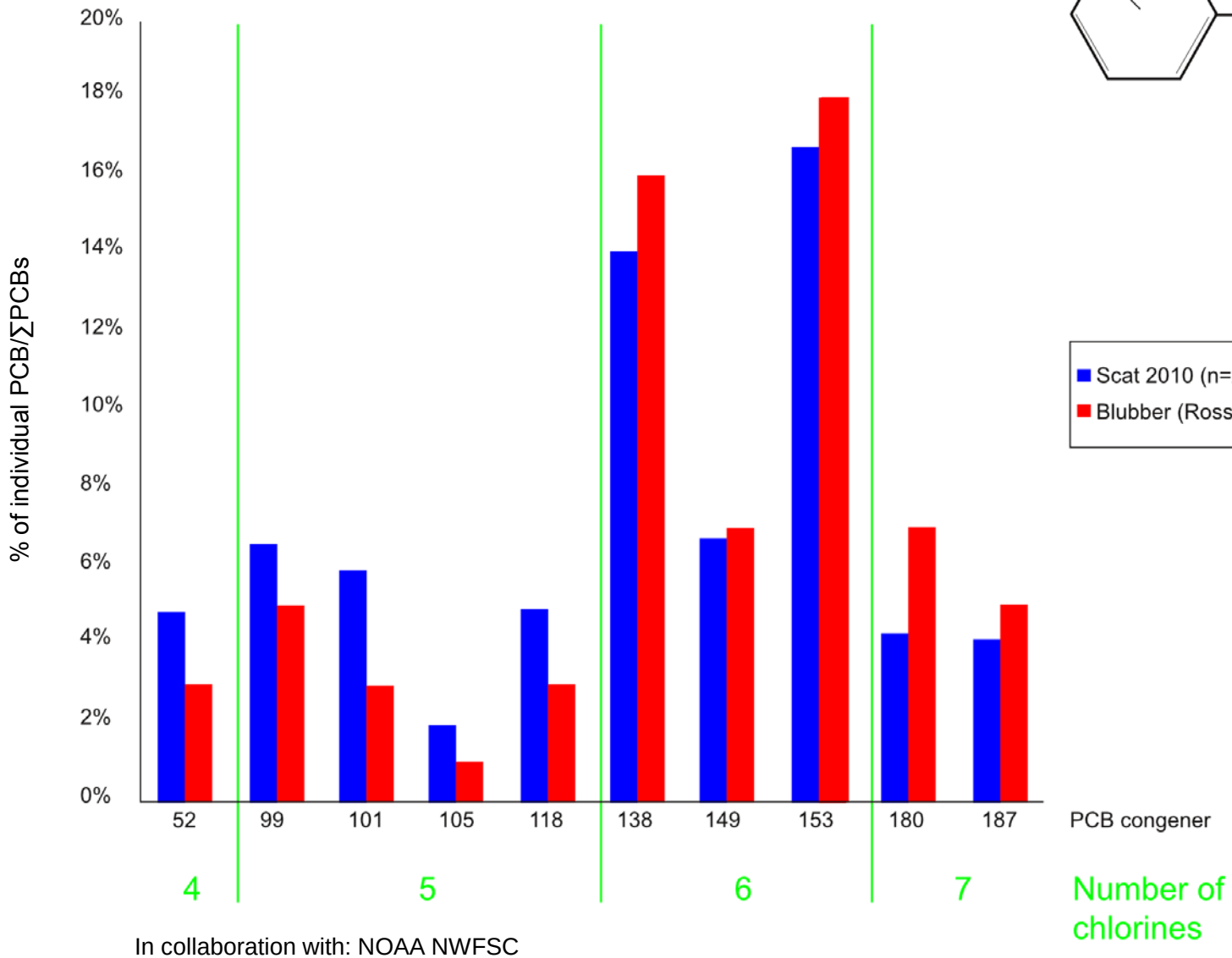



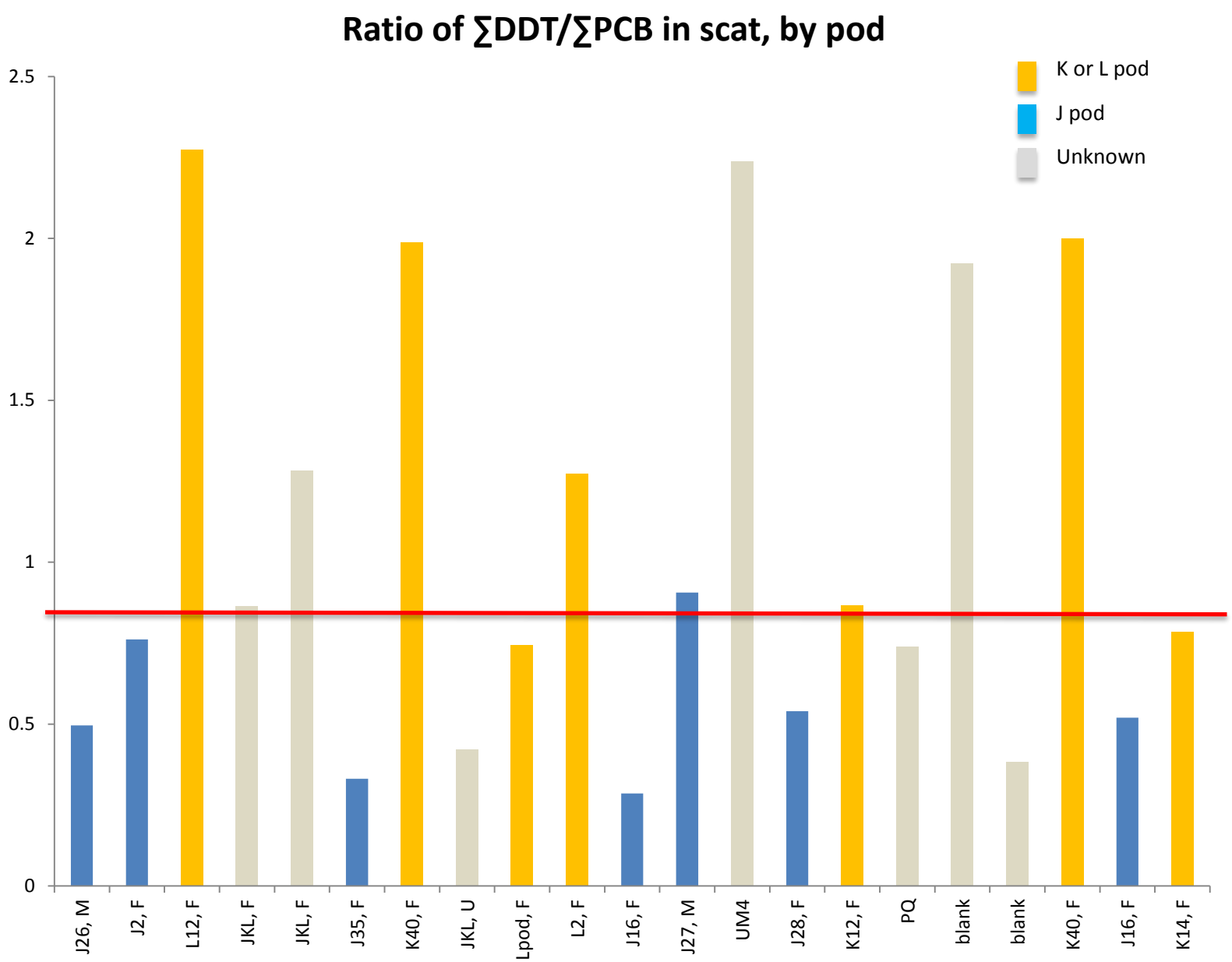



# Percent of individual PCB/∑PCBs, scat vs blubber




In collaboration with: NOAA NWFSC


Ratio of ∑DDT/∑PCB in scat, by pod
K or L pod
J pod
Unknown
2.5
2
1.5
1
0.5
0
J26, M
J2, F
L12, F
JKL, F
JKL, F
J35, F
K40, F
JKL, U
Lpod, F
L2, F
J16, F
J27, M
UM4
J28, F
K12, F
PQ
blank
blank
K40, F
J16, F
K14, F

# Guide Mitigation

- If fish matters most, and increases impacts of toxins and boats, recovering fish should be our top priority
  - It buys time to fix everything else

- Timing of run may be key
  - Delaying fishery may also help

- Measuring the physiological response over time could also indicate how things improve in response to mitigation

- Few tools can offer that

- Other benefits: L90 (boat vs abortion)

RESEARCH
WN 3930 NW

# Acknowledgements


**Funding**

Washington Sea Grant (2010-2013)

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NOAA, Northwest Fisheries Science Center

UW Center for Conservation Biology

Canadian Consulate General

Northwest Science Association

**Collaborations**

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Center for Whale Research

Cascadia Research

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Fred Felleman

Rebecca Booth

Mike Ford

Linda Parks

Gina Ylatalo

Liz Welch

Field assistants

Conservation Canine Program

Center for Conservation Biology

The Whale Museum

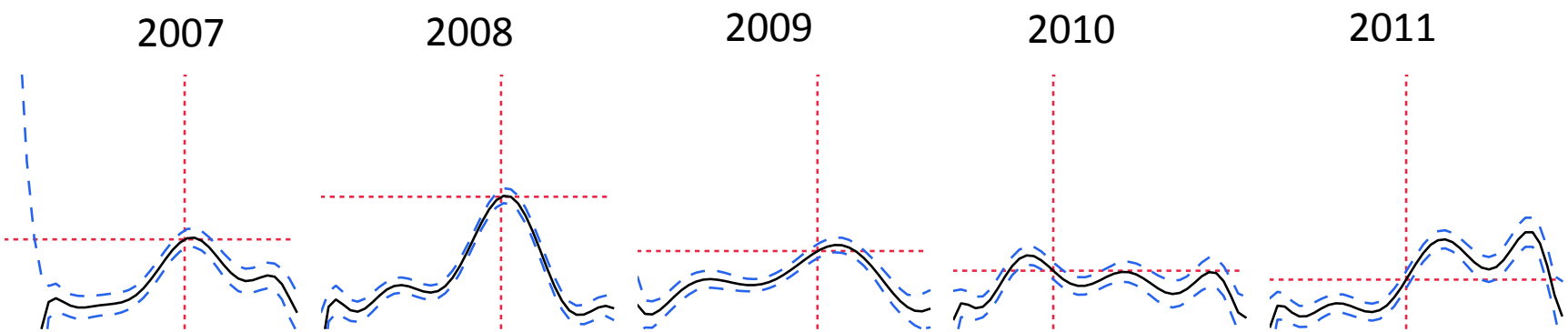
Orca Network

National Marine Fisheries Servic

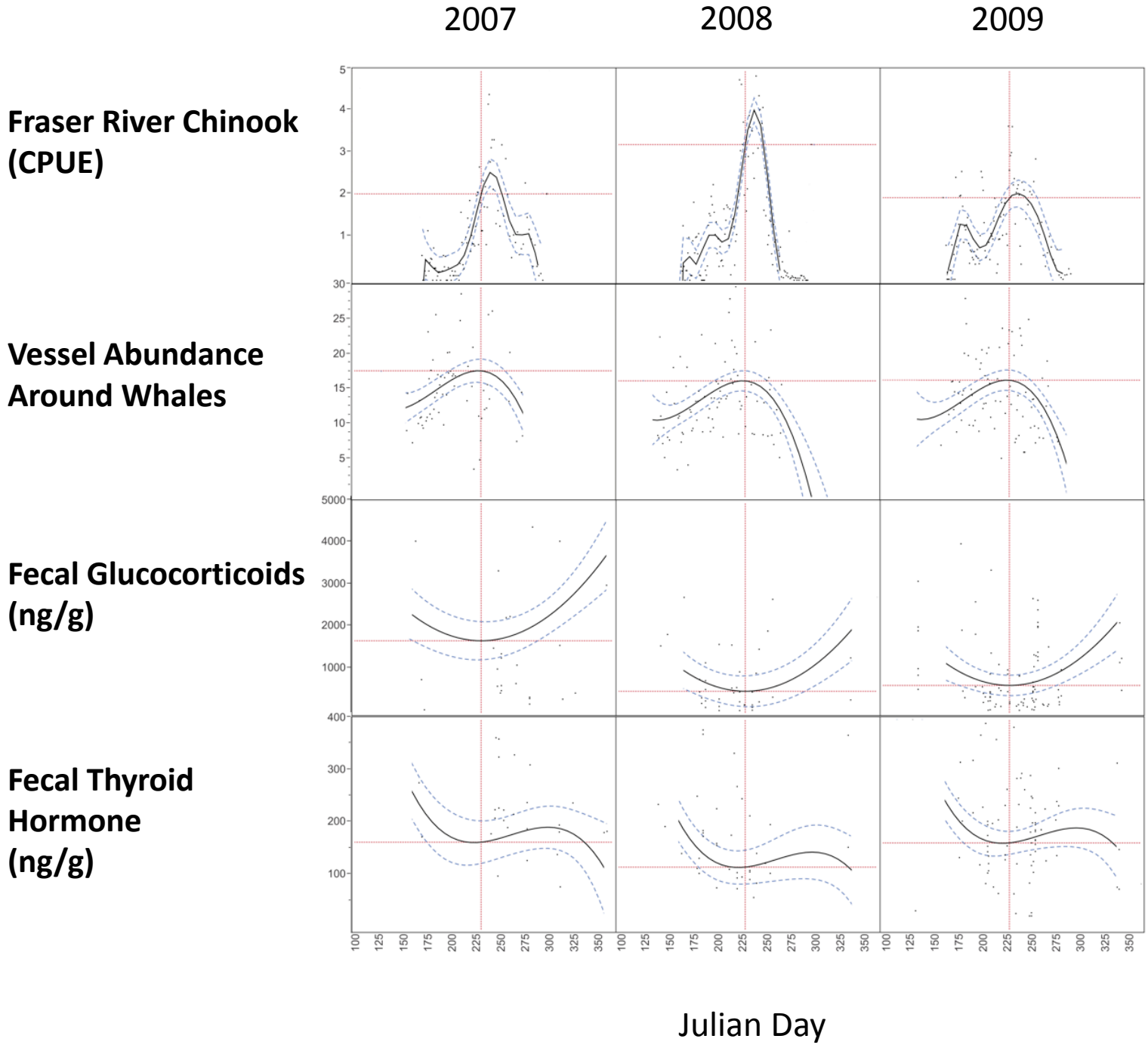
JISAO

Many, many more!!

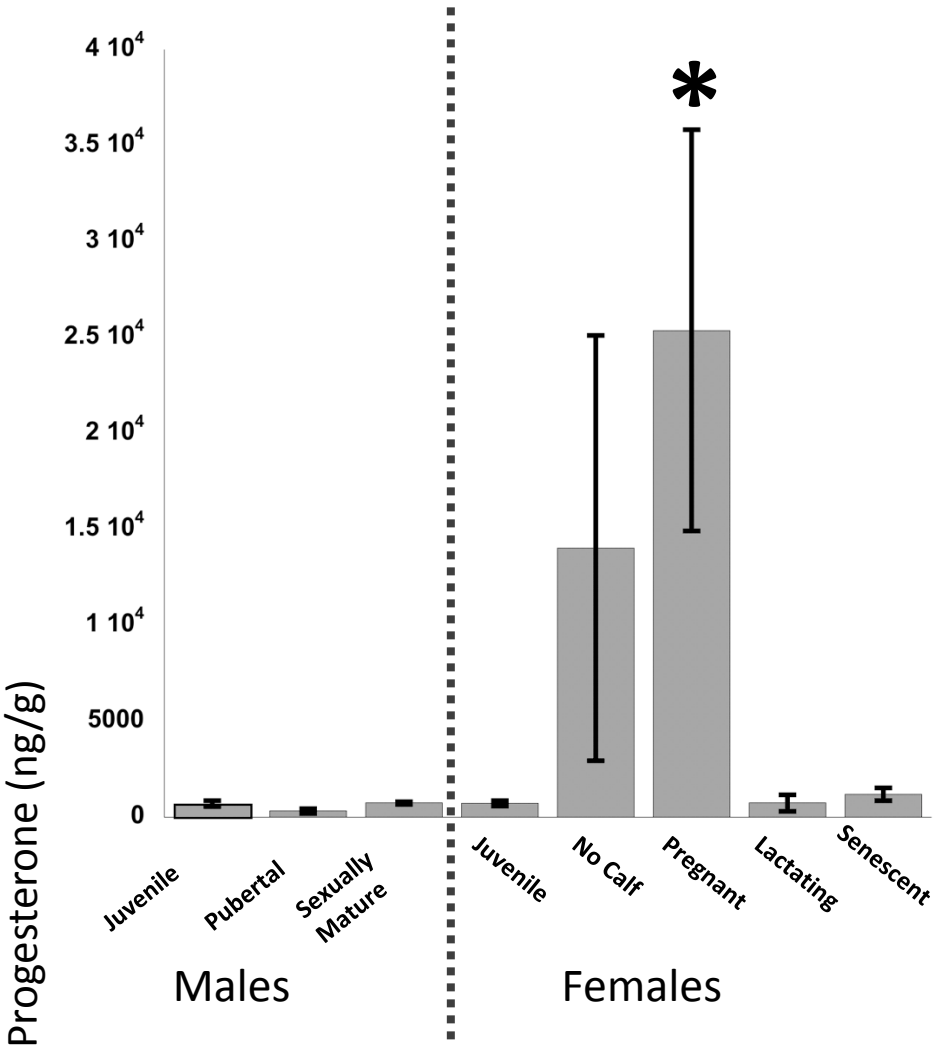
# Variation in Fraser River Chinook 2007-2011, based on Albion CPUE




| | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|
| Bonn AUC 4/1-5/31 | 66,209 | 124,815 | 113,560 | 242,442 | 165,966 |


2007
2008
2009
Fraser River Chinook (CPUE)
Vessel Abundance Around Whales
Fecal Glucocorticoids (ng/g)
Fecal Thyroid Hormone (ng/g)
Julian Day

# Progestins and testosterone across sex/reproductive state



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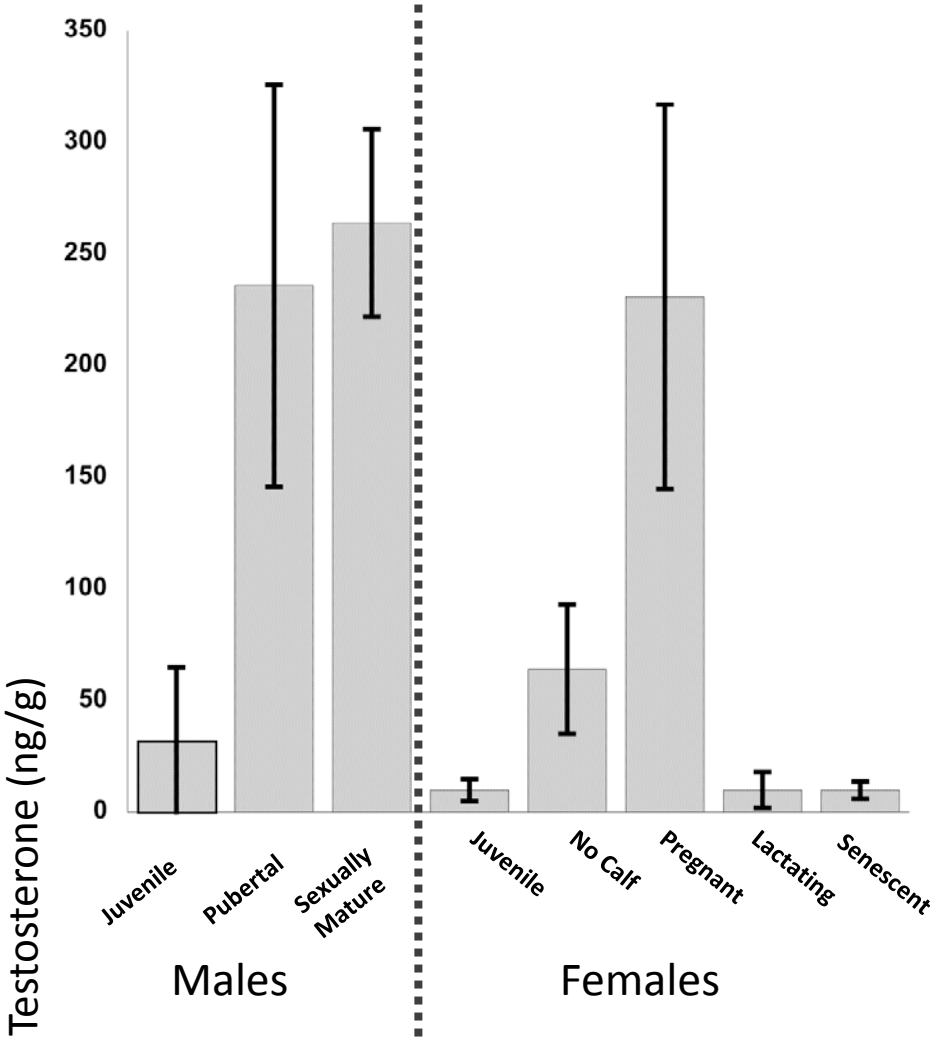

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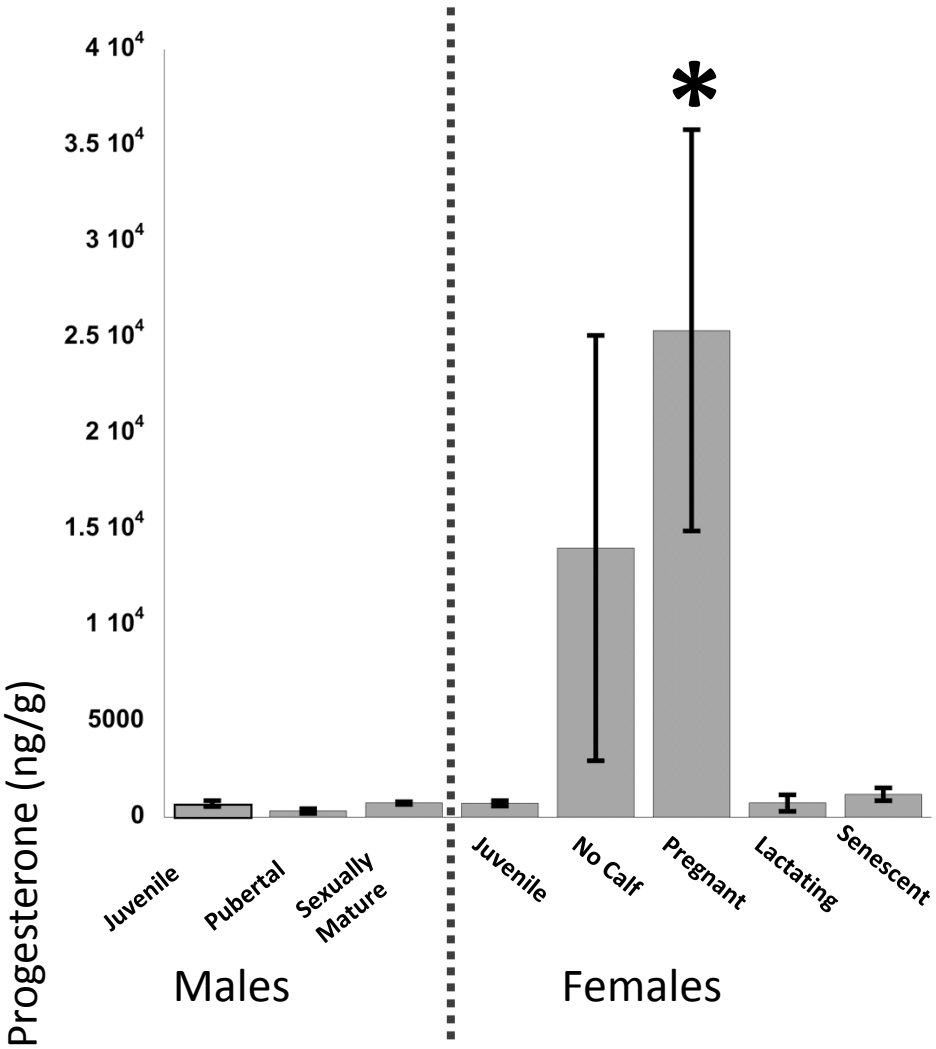
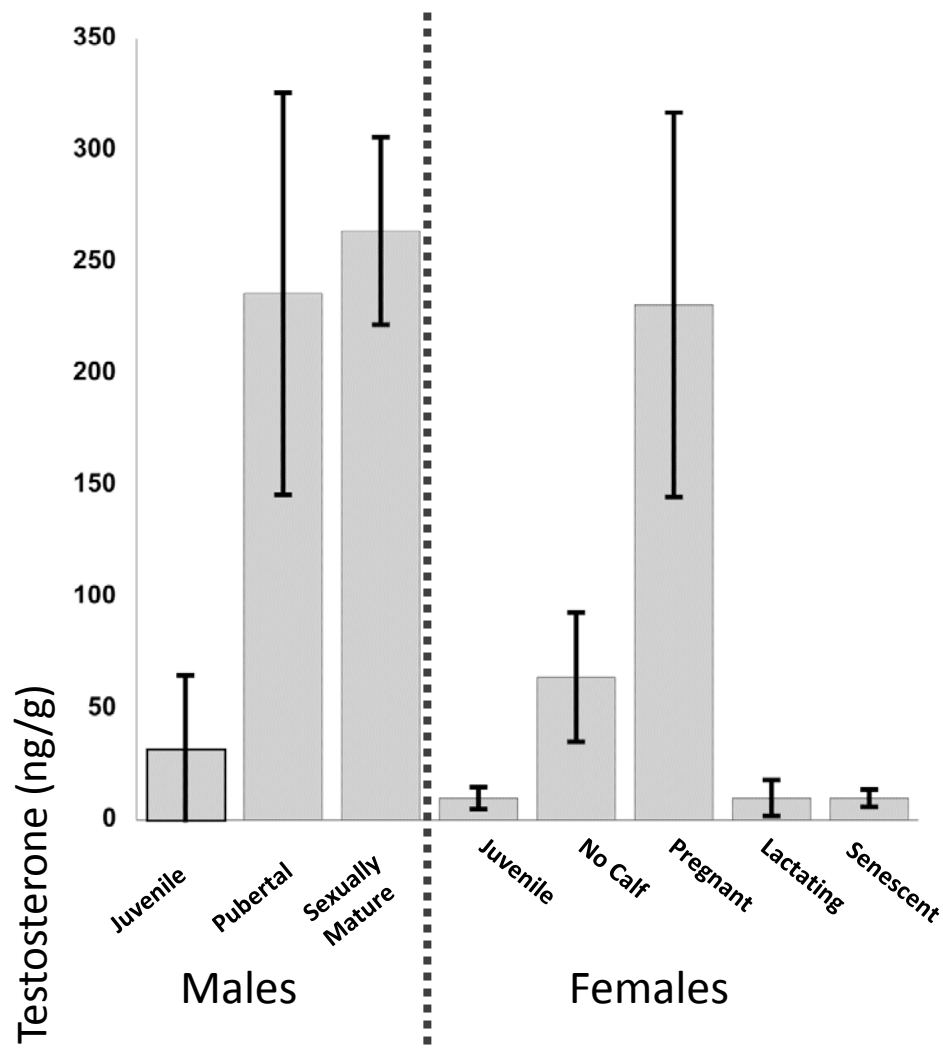
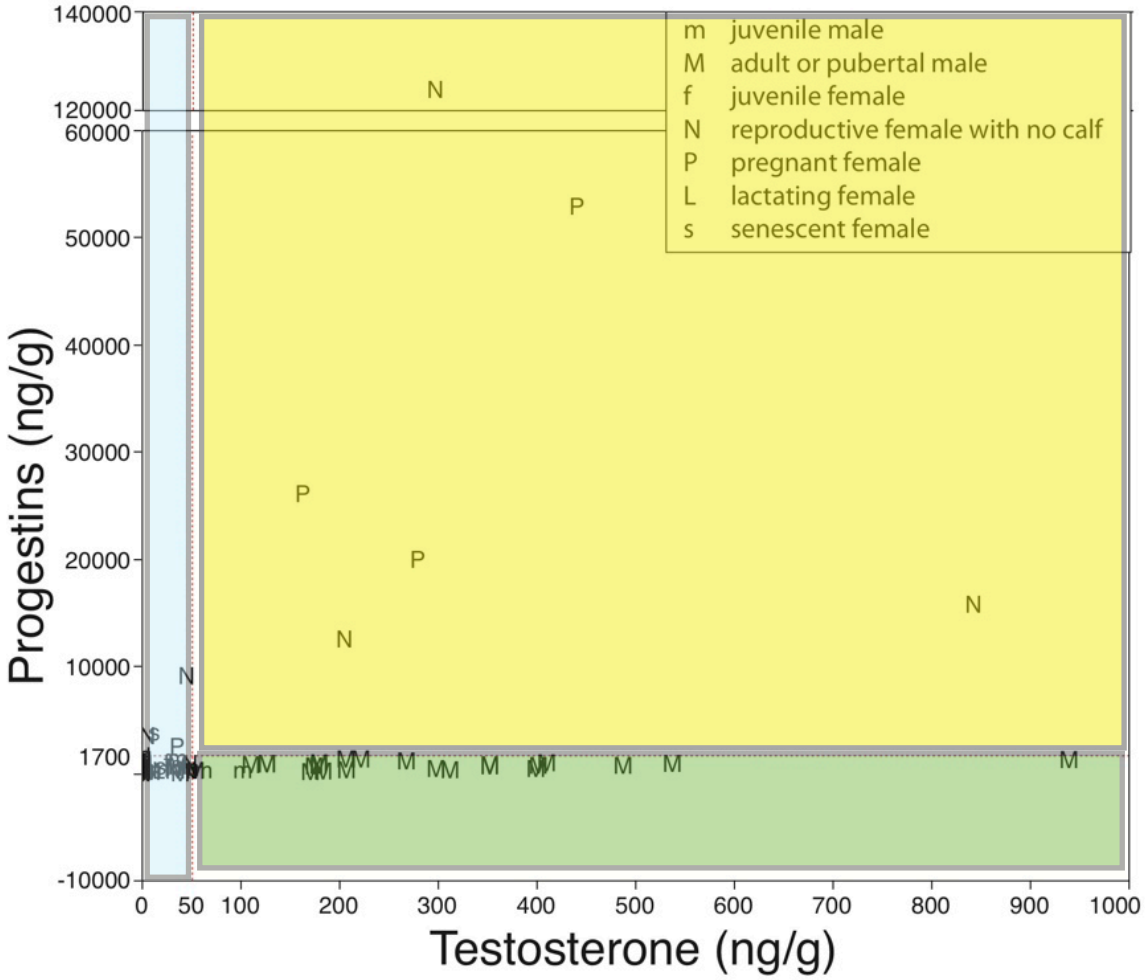


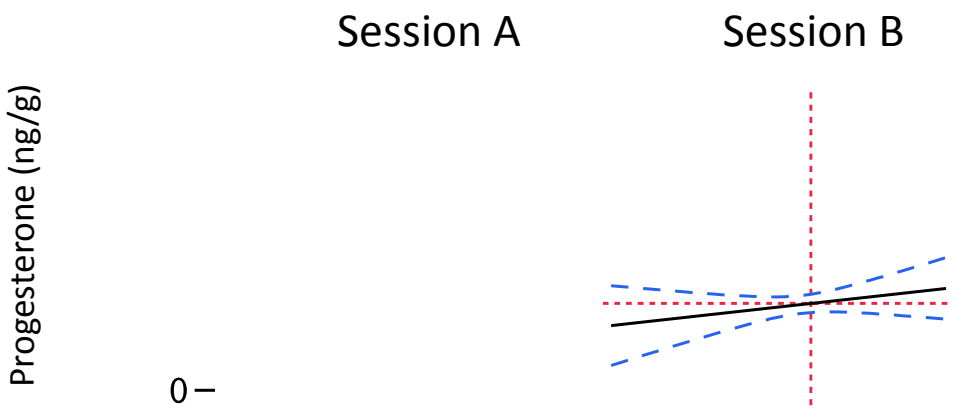
# Assignment Criteria

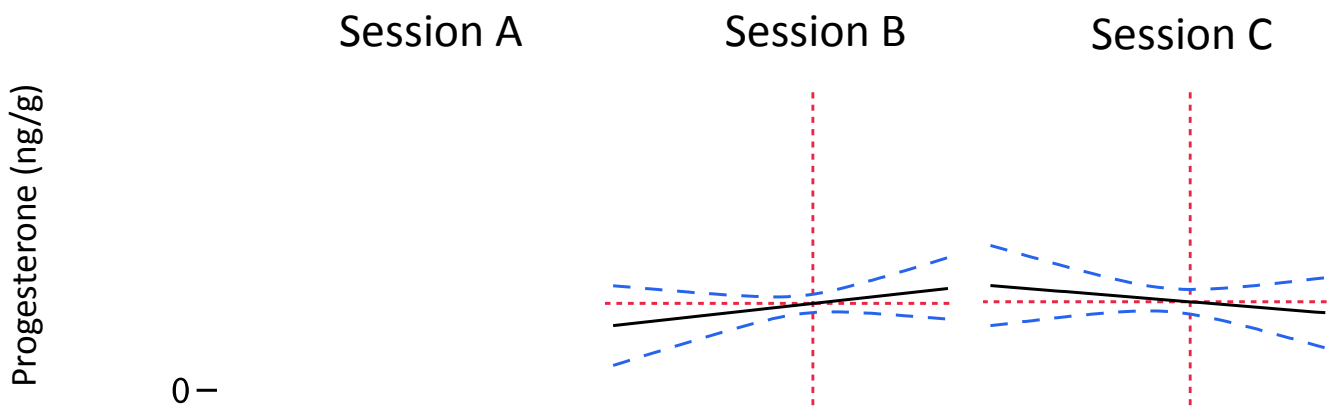


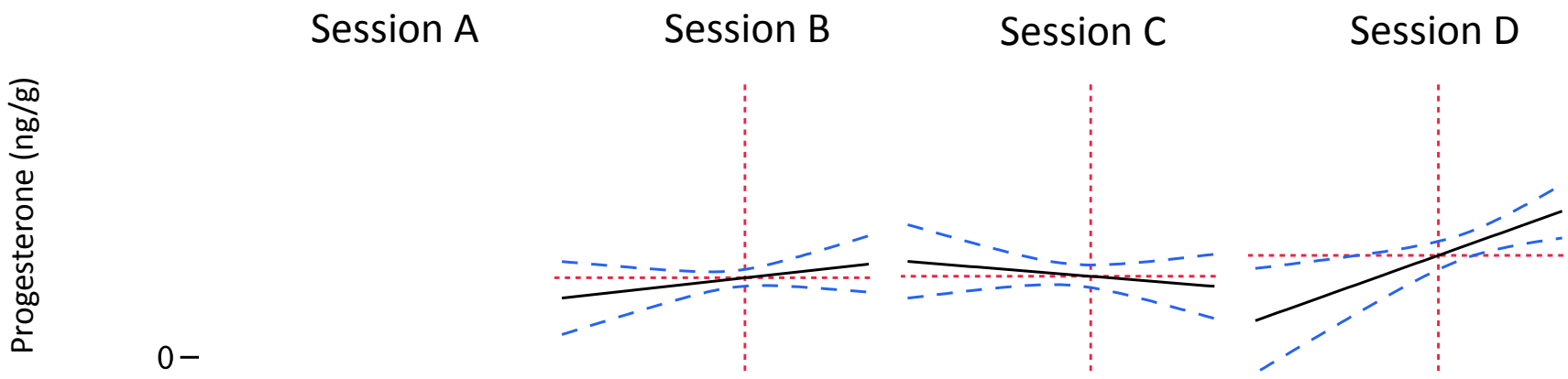
Session A

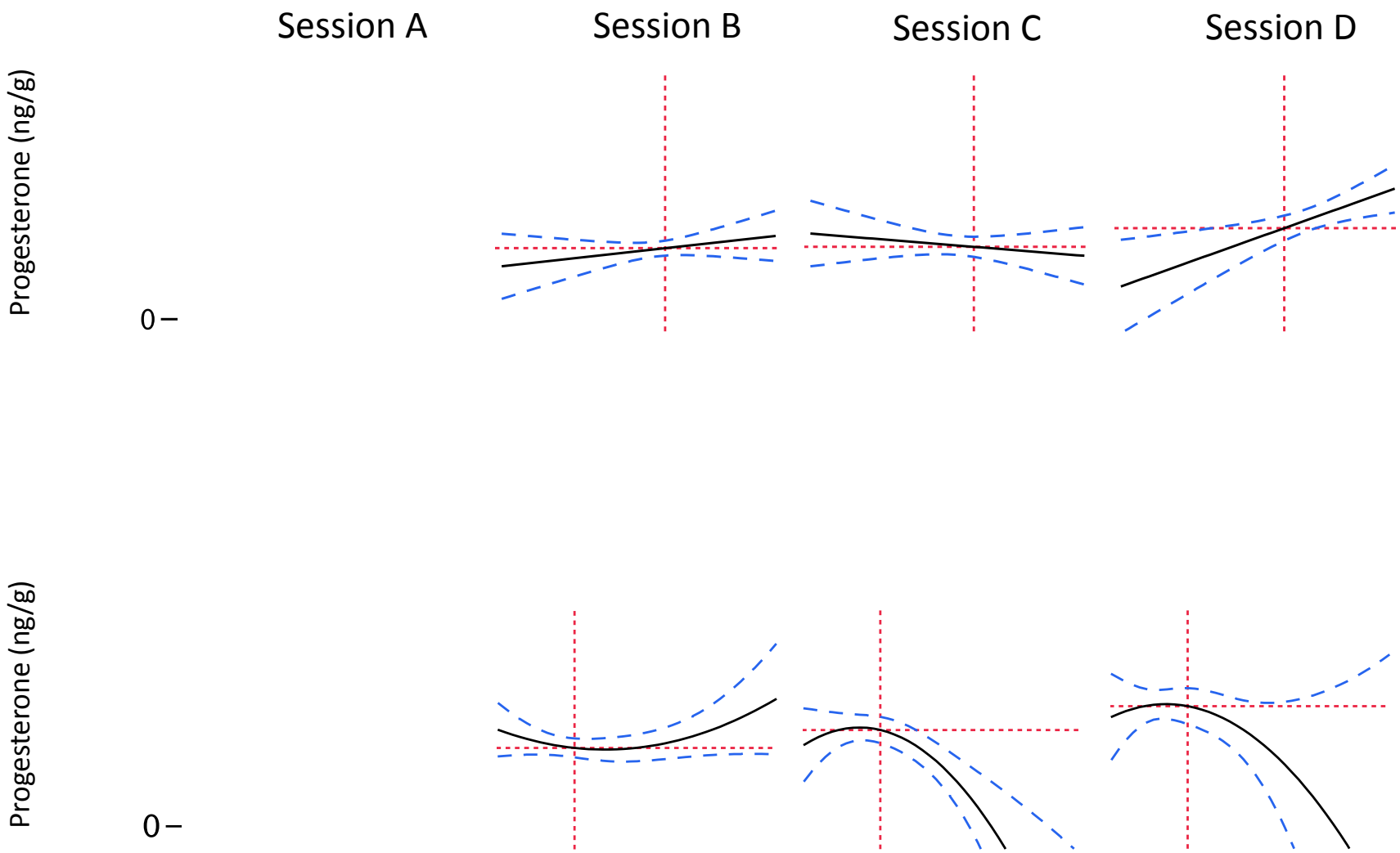
Progesterone (ng/g)

0 –


Session A
Session B
Progesterone (ng/g)
0


Session A
Session B
Session C
Progesterone (ng/g)
0


Session A
Session B
Session C
Session D
Progesterone (ng/g)
0


Session A
Session B
Session C
Session D
Progesterone (ng/g)
0
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LIGHT LOOP
RUFFWEAR
For Dogs On The Go

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