Size-weight modeling refinements for EBS crab stocks: May 2021 update

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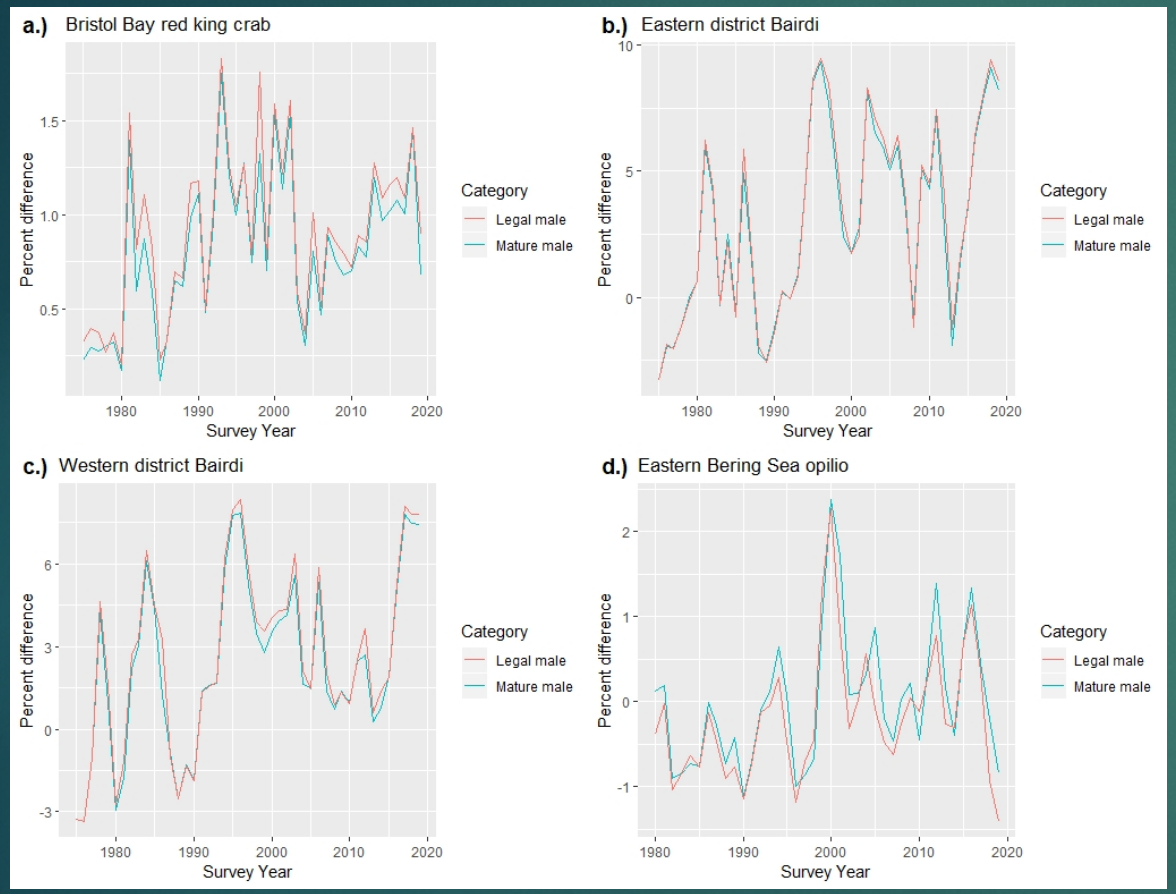
Refresher

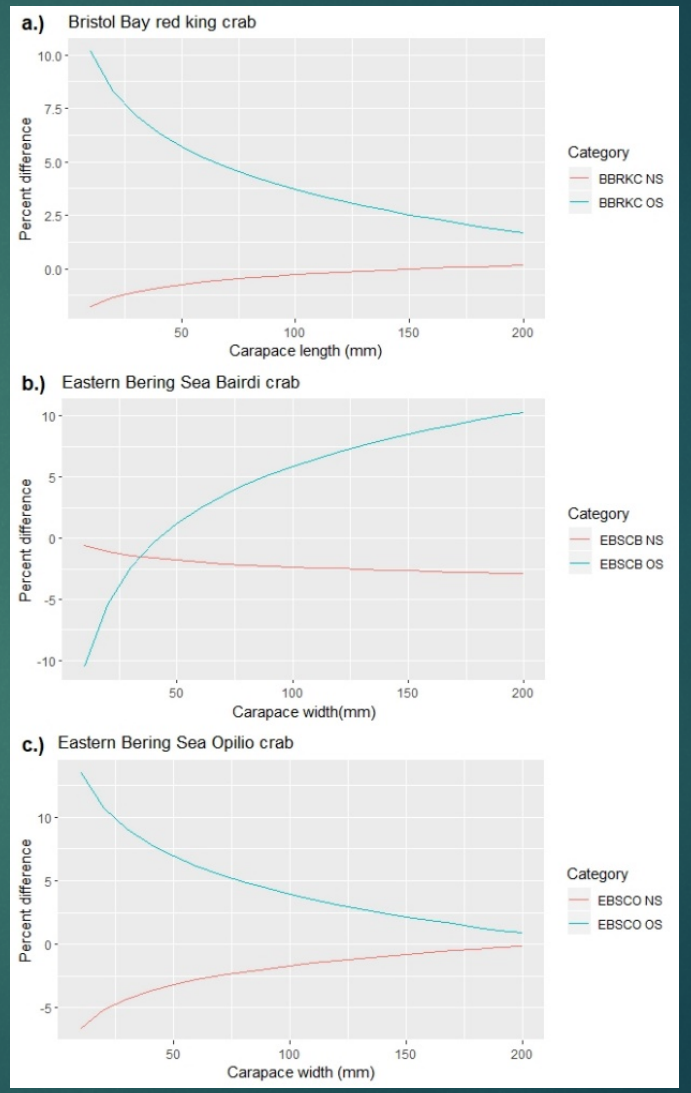
- Update model parameters used to calculate biomass estimates based on size-weight relationships
  - Allowing for factors affecting the relationships that were not accounted for in work that developed currently used parameters (Chilton 2009, 2011)
- Red king crab, tanner crab, opilio crab
  - Shell condition
- Red king crab only
  - Thermal regime of given survey year

Refresher 2

	N
Male BBRKC - NS	1756
Male BBRKC - OS	552
Male BBRKC - NS - cold	1265
Male BBRKC - NS - warm	491
Male Tanner crab - NS	3314
Male Tanner crab - OS	2064
Male Opilio crab - NS	4531
Male Opilio crab - OS	1979

Refresher 3


a.) Bristol Bay red king crab
b.) Eastern district Bairdi
c.) Western district Bairdi
d.) Eastern Bering Sea opilio
Percent difference
Survey Year
Category
Legal male
Mature male


a.) Bristol Bay red king crab
Percent difference
Carapace length (mm)
Category
BBRKC NS
BBRKC OS
b.) Eastern Bering Sea Bairdi crab
Carapace width(mm)
EBSCB NS
EBSCB OS
c.) Eastern Bering Sea Opilio crab
Carapace width (mm)
EBSCO NS
EBSCO OS

January CPT comments

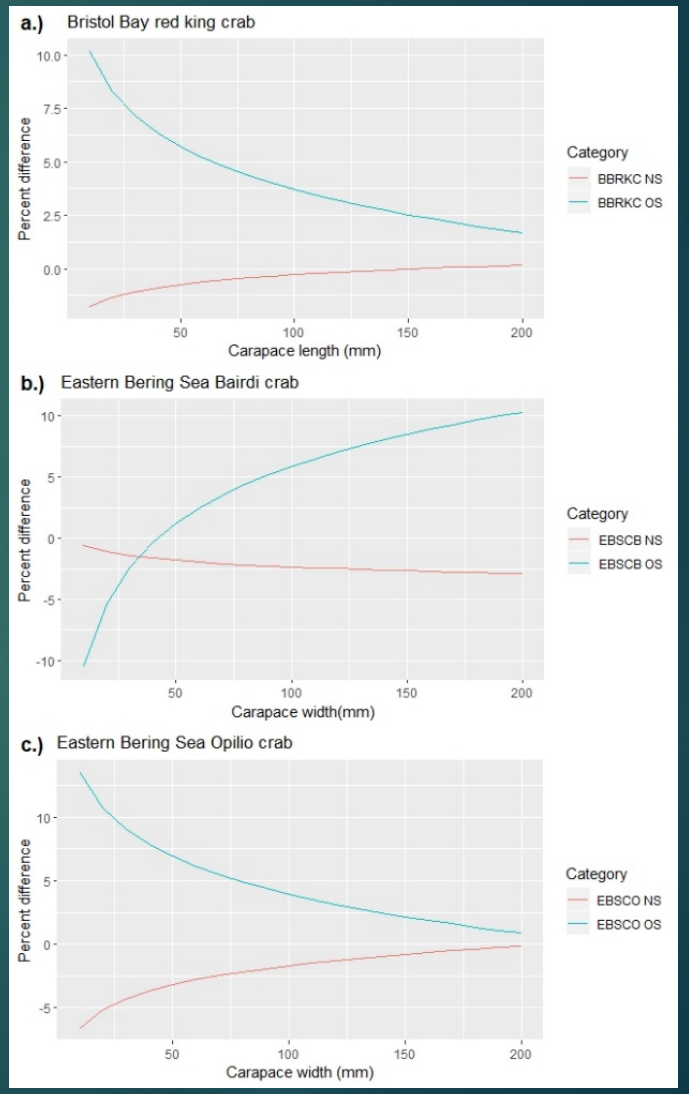
- Apply bias correction methods (Brodziak 2012)
  - Bias correction procedures implemented for all stocks and will be presented
- Provide biological basis for reevaluating size-weight parameters
  - Chris Long consulted, and biological basis provided
- Include Bering Sea blue king crab stocks
  - St. Matthew Blue King crab included
- Include females for major stocks
  - Females analyzed
    - Maturity status (requested approach)
    - Clutch state; immature + barren vs clutch bearing mature (current approach)

January CPT comments

- Treat temperature as a continuous variable instead of designating warm/cold years
  - Working on implementing this
  - January meeting?
- Use all available historical data
  - Currently used data is from 2000 onwards
  - Good sample sizes
  - Only data previous to 2000 is from 1975 (Bairdi and opilio)

Why reevaluate size-weight relationships?

- Shell condition influences the size-at-weight relationship
  - Carapace composition
  - Tissue fill within carapace
- Temperature
  - Delayed molt timing,
    - Reduced tissue fill in cold years due to reduced time between molt and sampling
  - Thermal stress
- Models used for current parameters did not account for these (Chilton 2009, 2011)
- Biomass estimates may be biased to varying degrees in any given year, due to for example shell condition proportions



Methods

Methods I

- Up to date size-weight data
- 2000 – 2019
- Collected randomly on the EBS summer bottom trawl survey
- Clean (no/minimal epibionts), intact (no carapace cracks or missing/regenerating limbs)
- Weight (g)
  - Digital scale
- Carapace size (CL/CW) to 0.1mm
  - Vernier caliper (prior to 2016)
  - Digital caliper (2016 to present)

Methods II

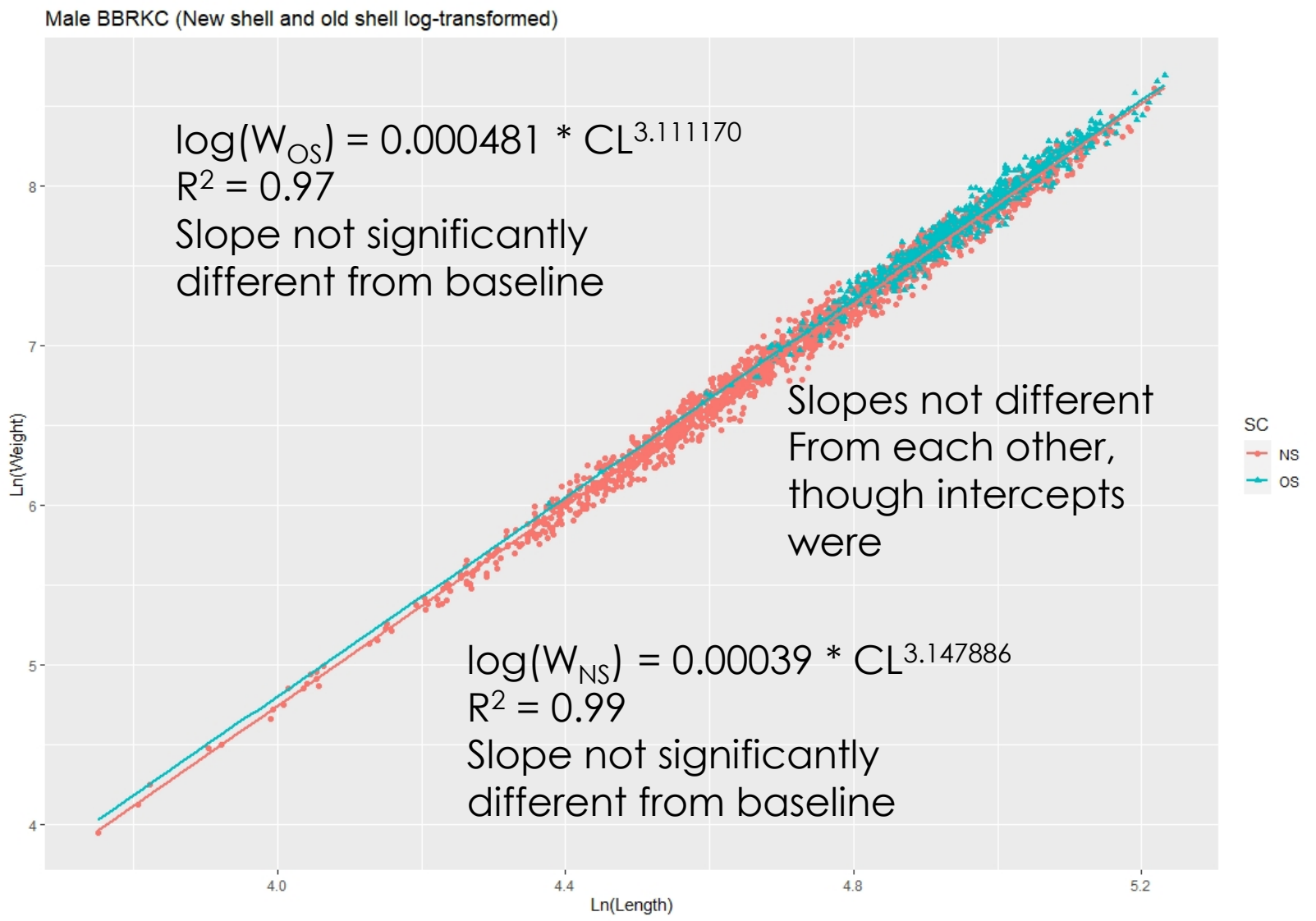
- Stock specific data grouped based on variable of interest
- Male Bristol Bay red king crab, SMBKC, EBS Bairdi, EBS opilio
  - Shell condition
- Female Bristol Bay red king crab
  - Maturity and ovigerous state
    - Shell condition not examined
- Female St Matthew blue king crab
  - Maturity status only
    - Limited data
- Female opilio and Bairdi
  - Maturity and ovigerous state
    - Shell condition for mature and ovigerous crab

Methods III

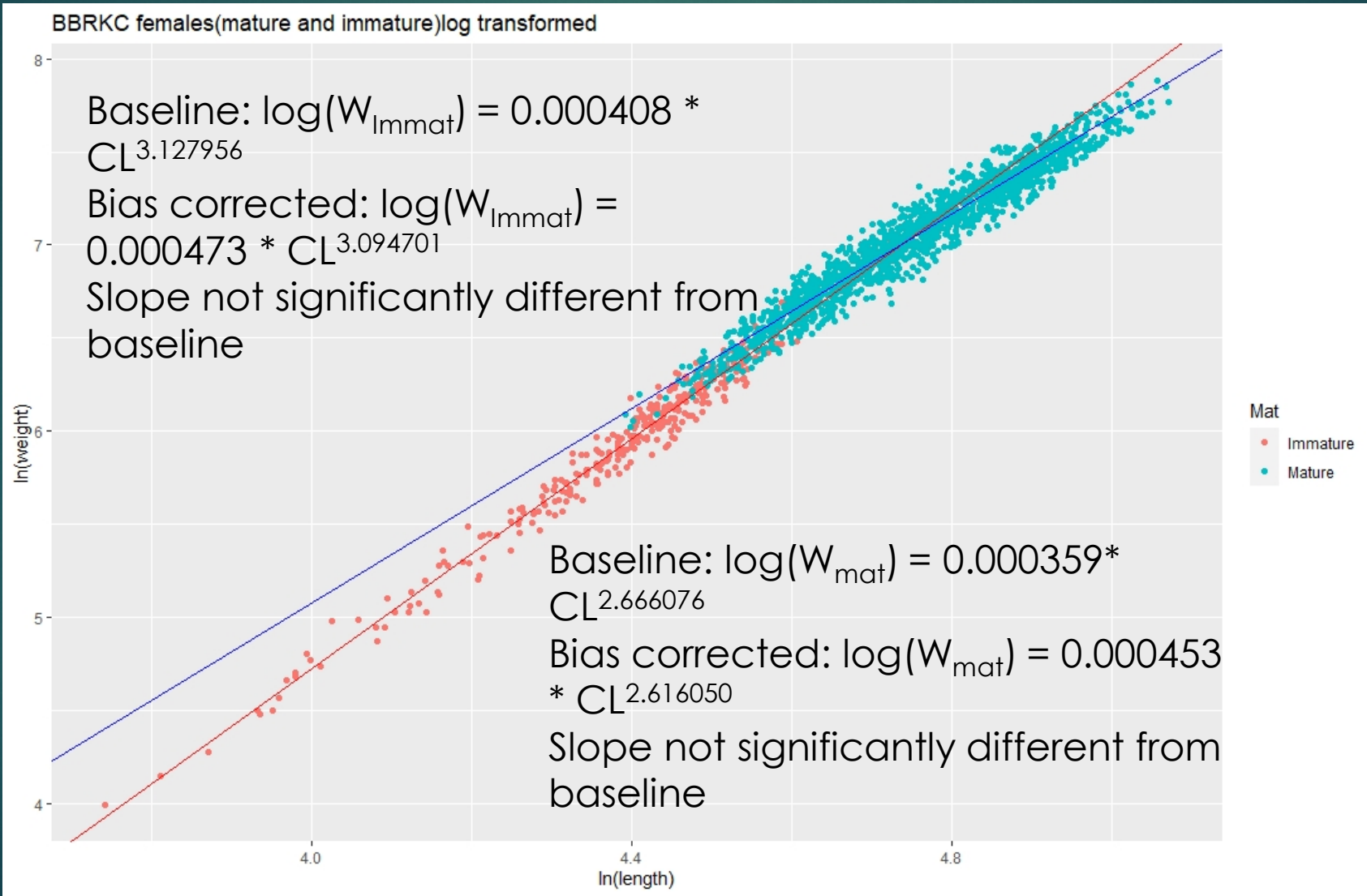
- Weight (g) = a *(Carapace size (mm))^b
- Parameters a and b estimated separately
  - linear regression fitted to log-transformed size-weight data
  - Parameter a is the intercept in log-scale and $\log_{-1}$
    - Bias corrected as per Brodziak (2012)
  - Parameter b is the slope
- Slopes compared to baseline estimates using t-tests
- Biomass estimates calculated using final parameter estimates, and compared to baseline estimates calculated using current parameters

Results

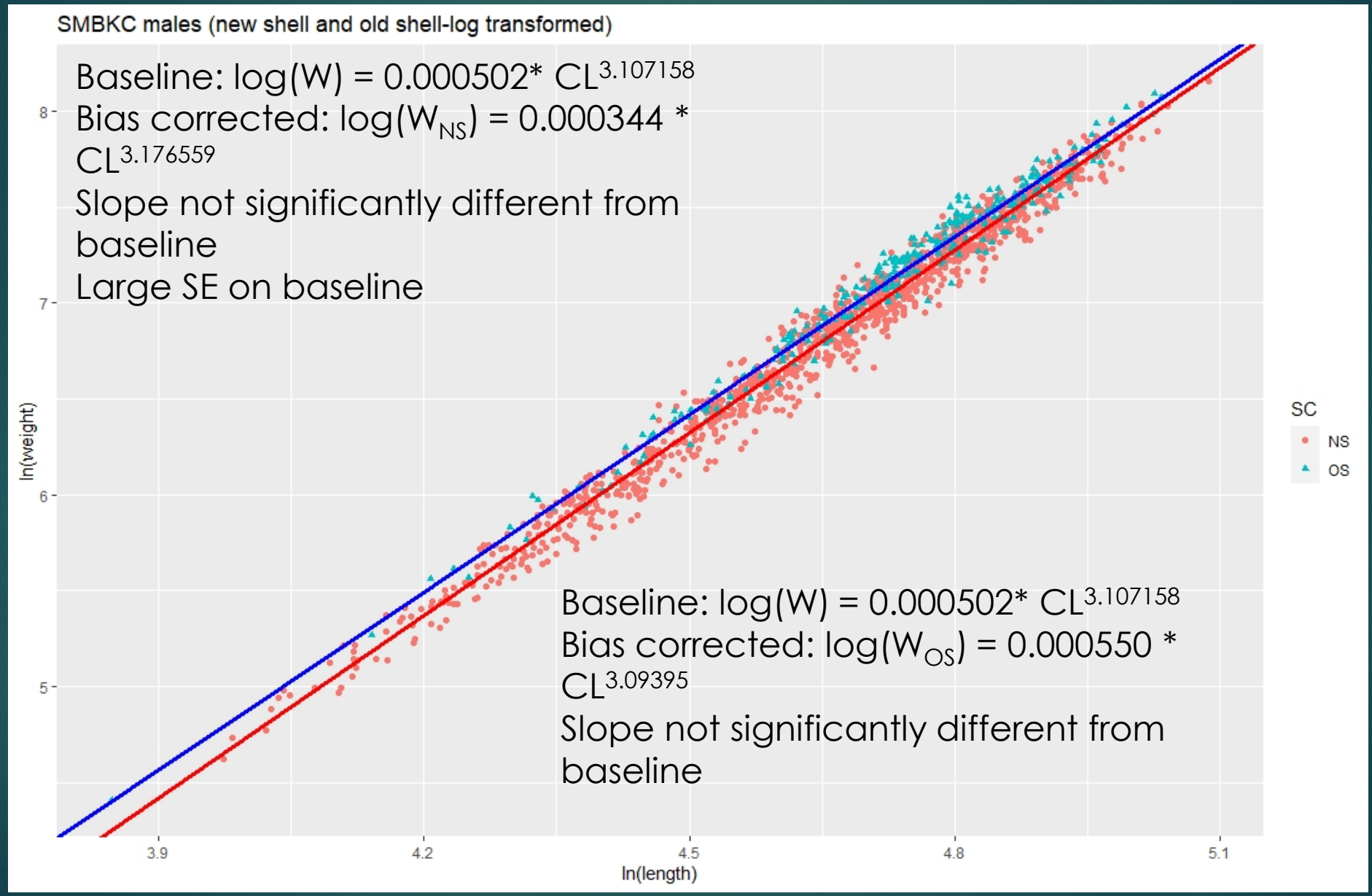
Male red king crab – shell condition



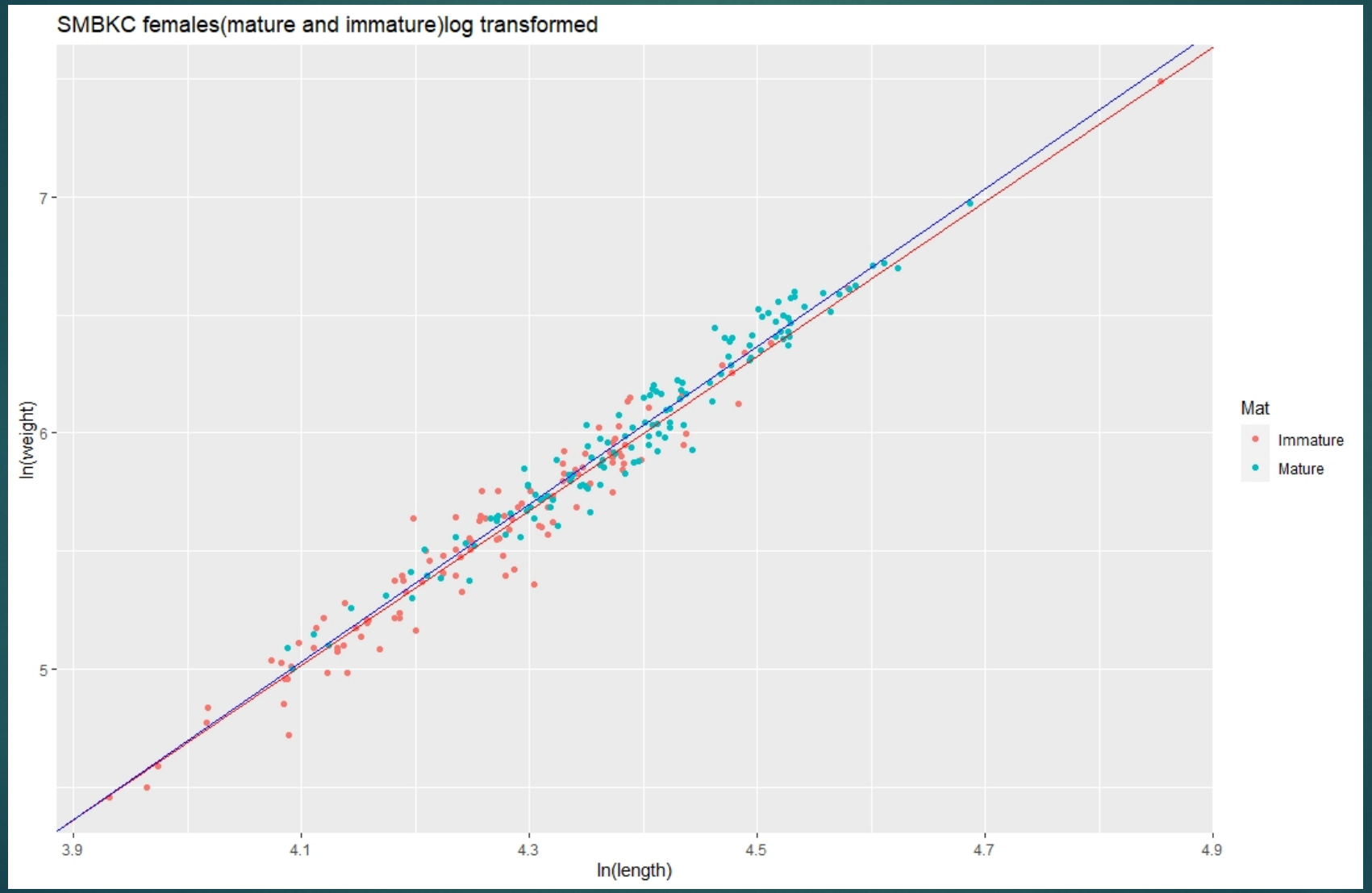
Female red king crab – maturity



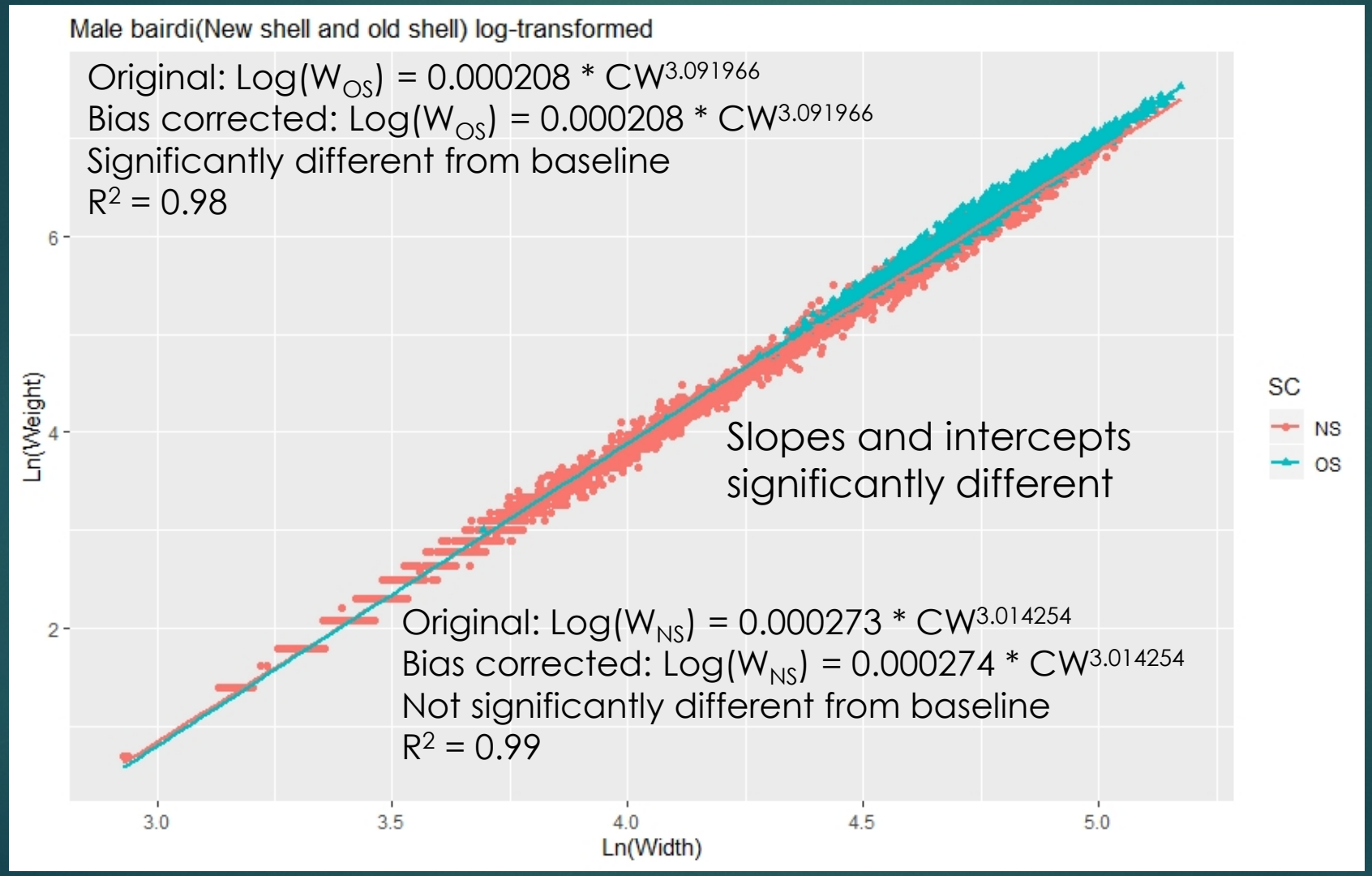
Male SMBKC- shell condition

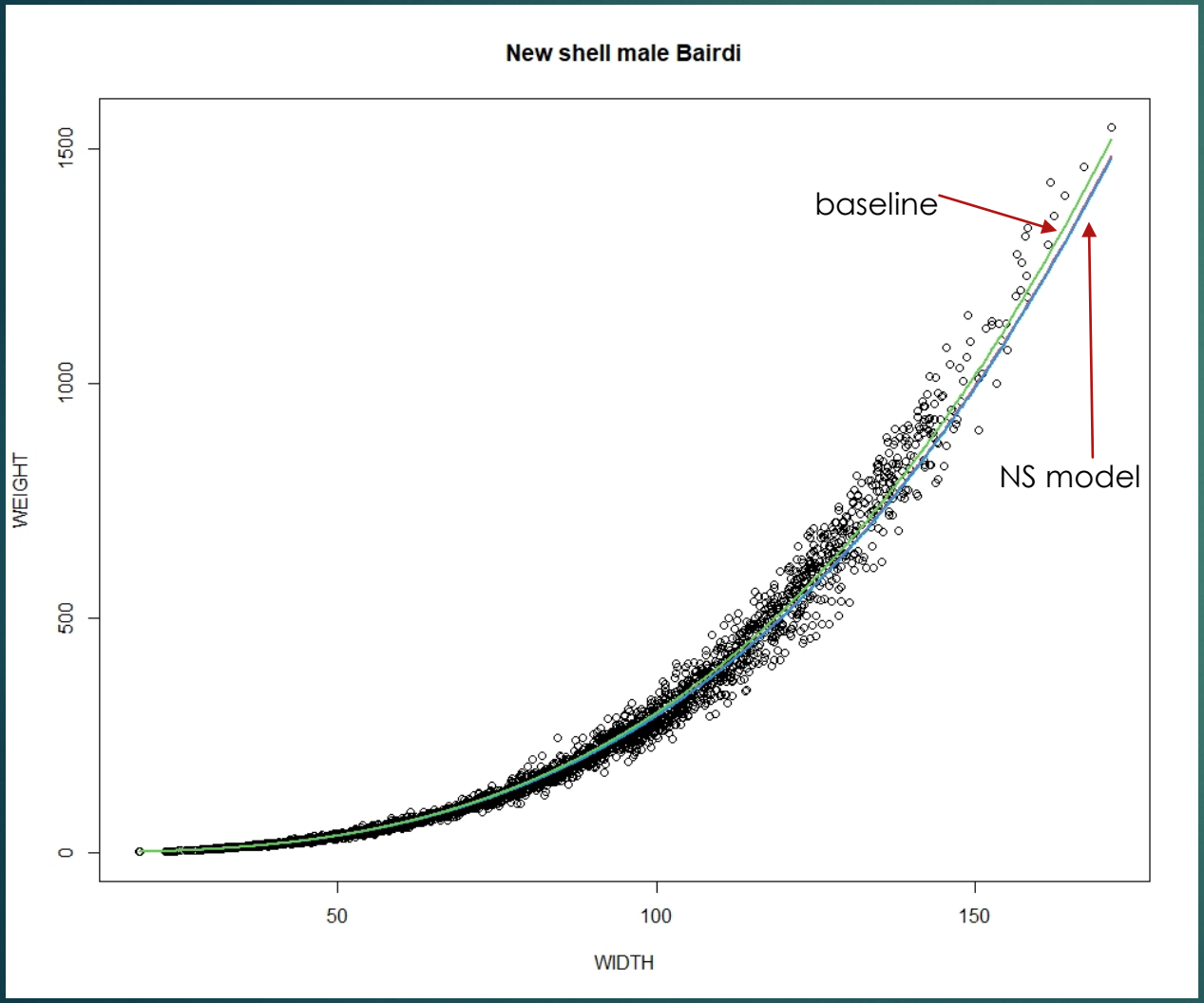


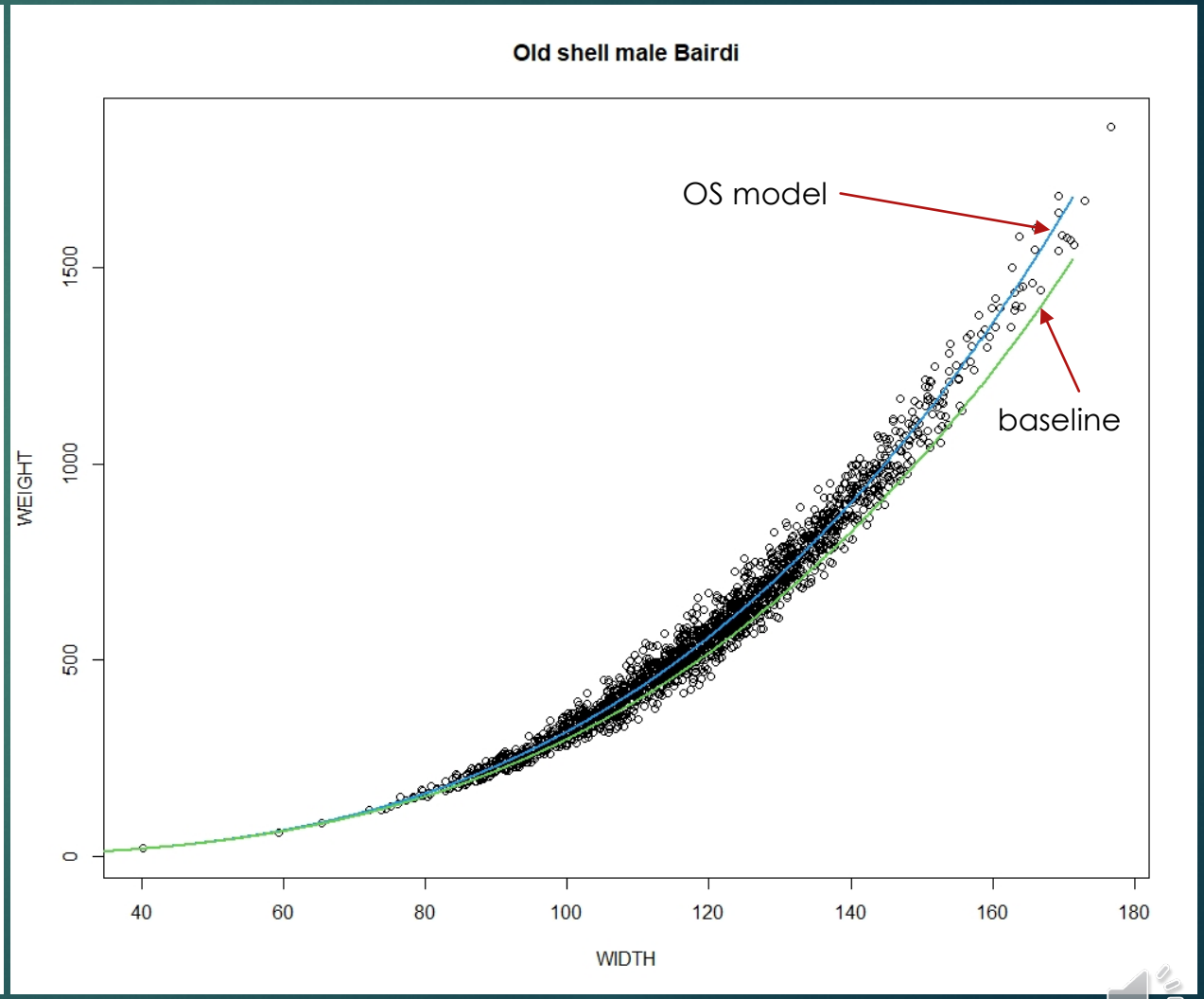
SMBKC females – maturity status



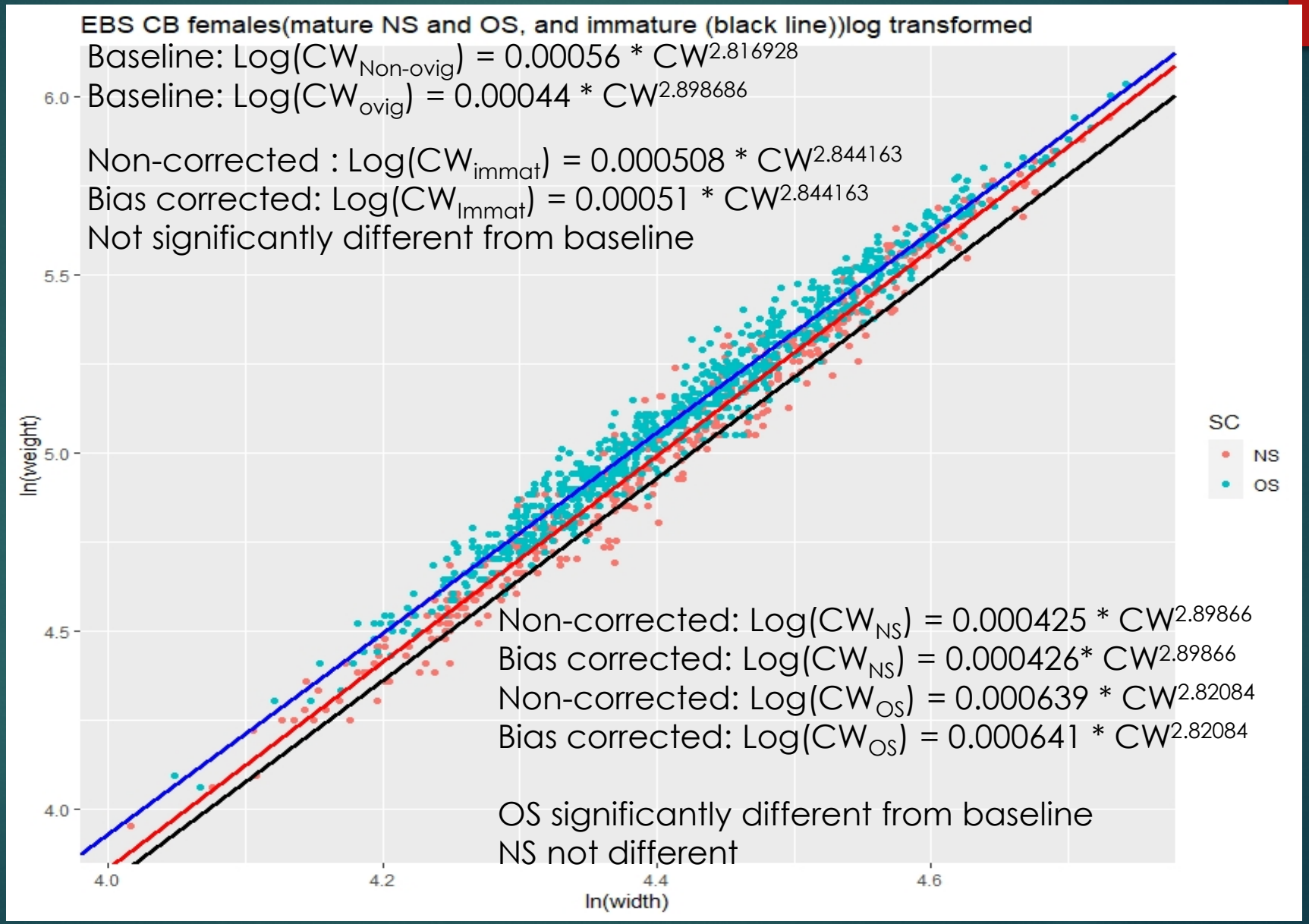
Male Bairdi crab – shell condition



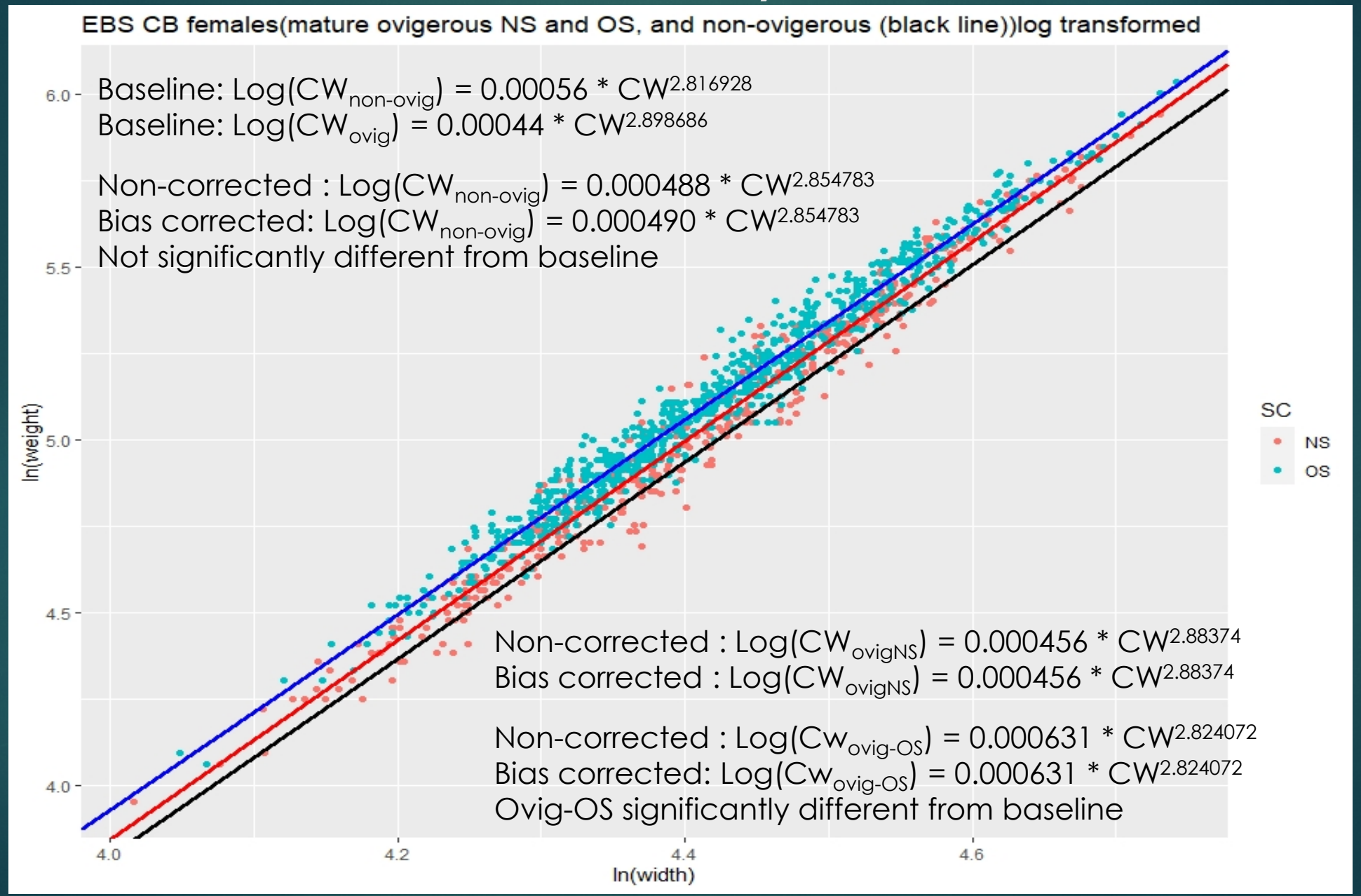

New shell male Bairdi
baseline
NS model
WEIGHT
WIDTH
0
500
1000
1500
50
100
150


Old shell male Bairdi
OS model
baseline
WEIGHT
WIDTH
0
500
1000
1500
40
60
80
100
120
140
160
180

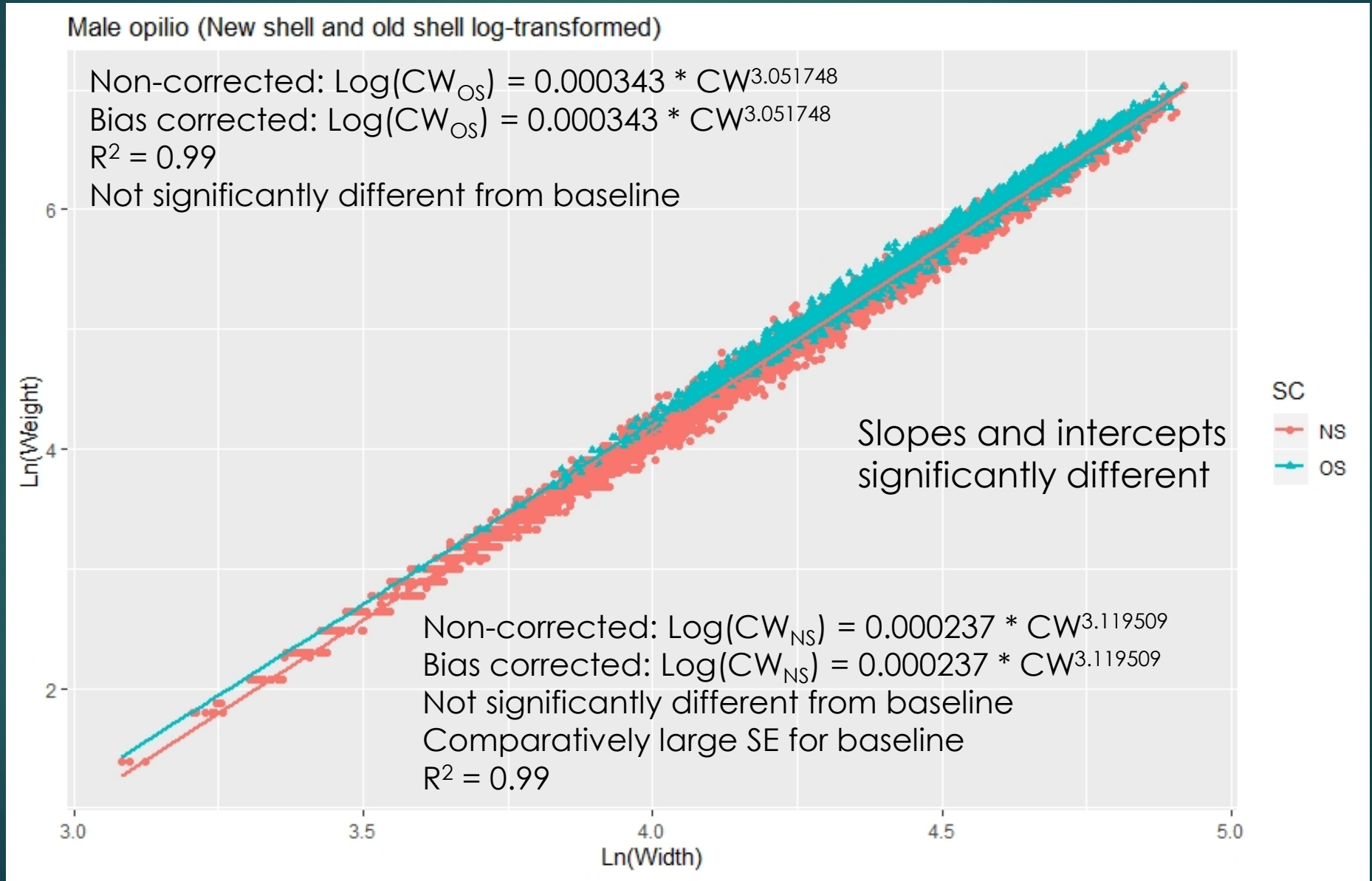
Female Bairdi – maturity/shell condition



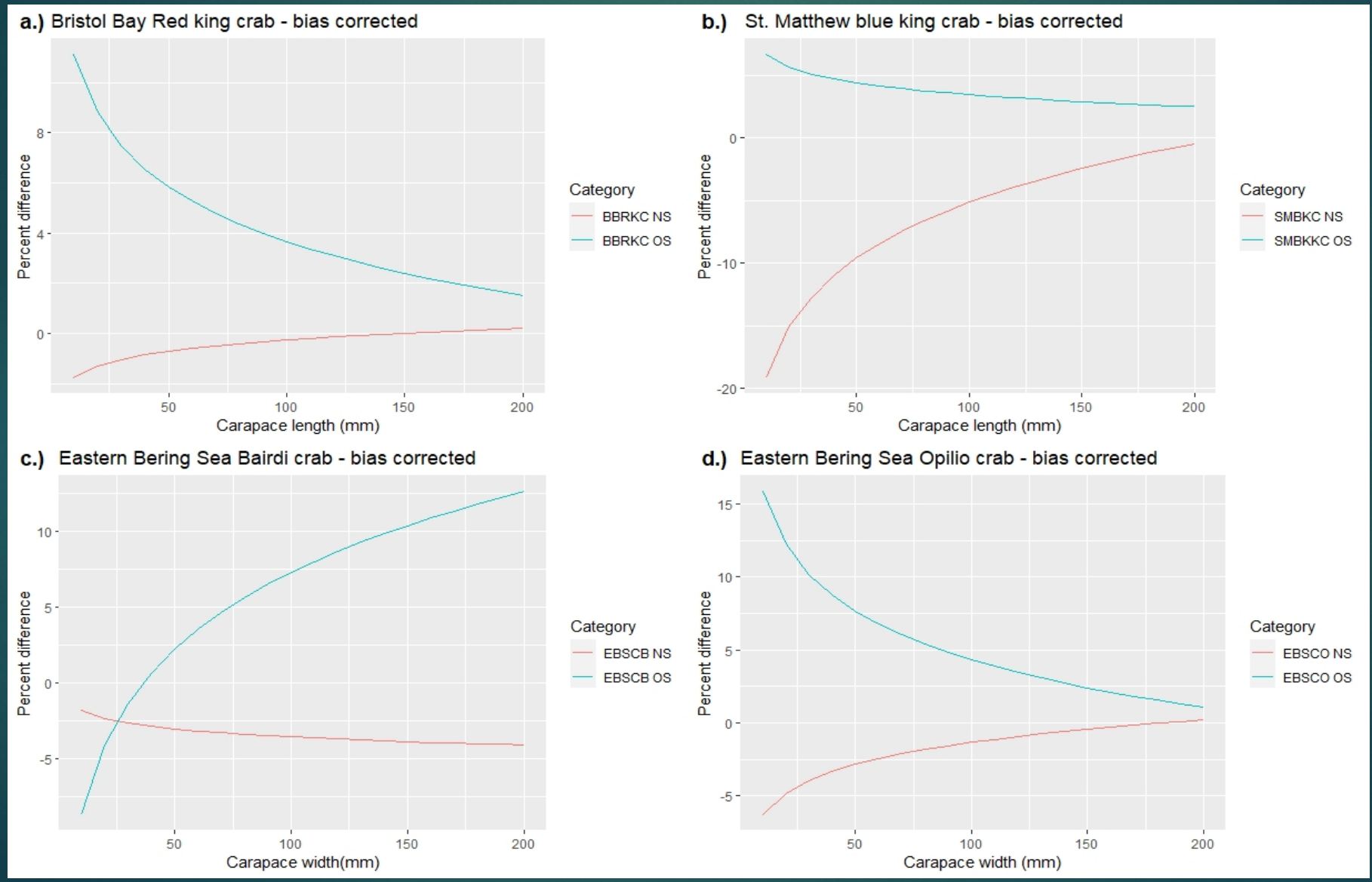
Female Bairdi- maturity/clutch status



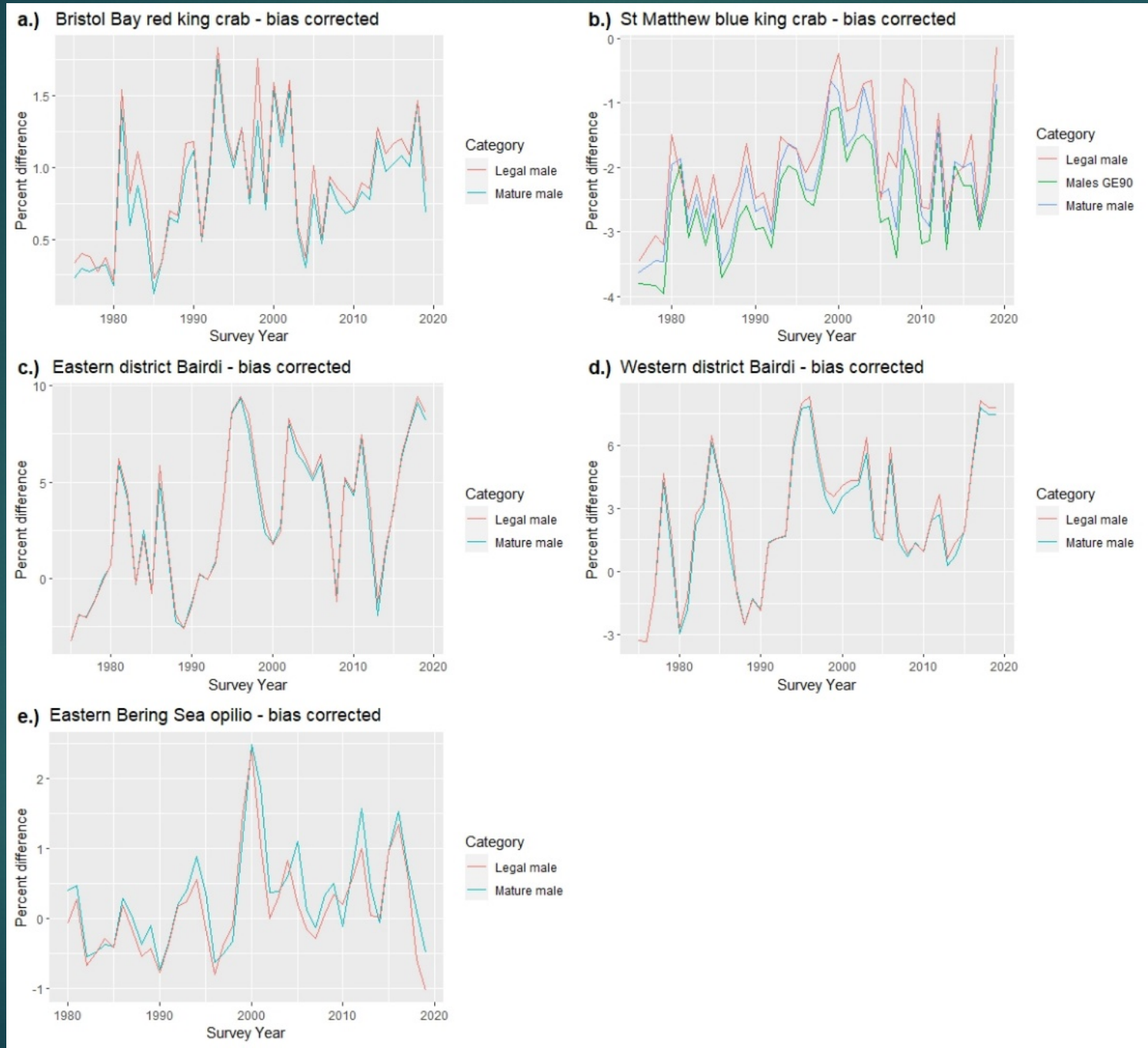
Male opilio crab – shell condition



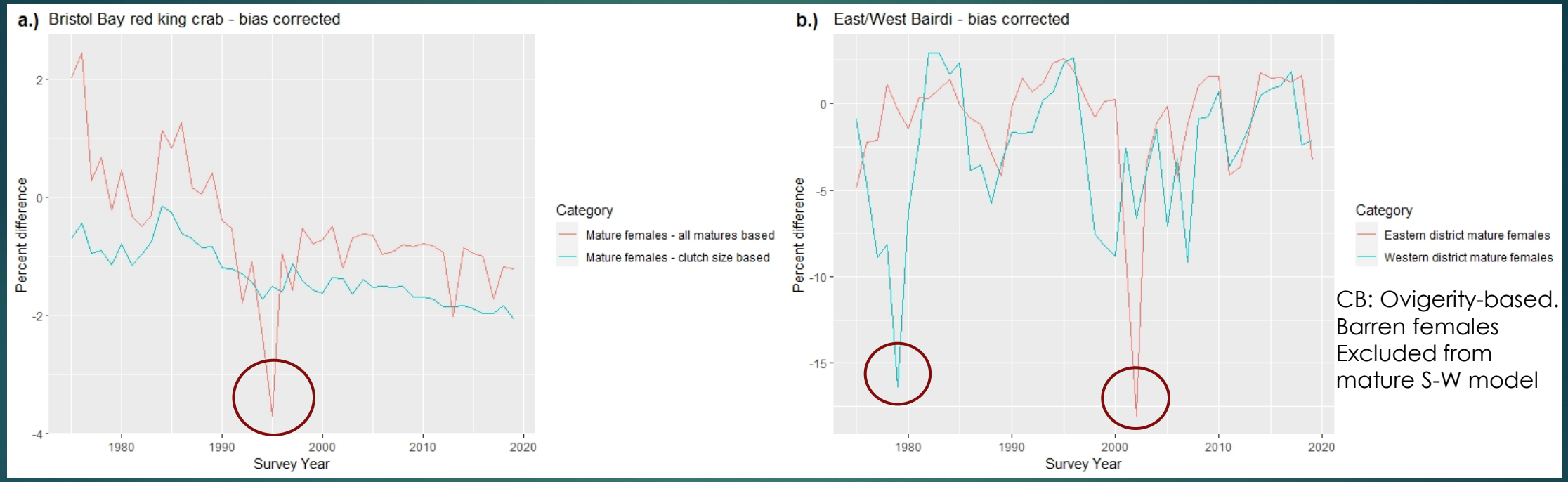
Calculated weight anomalies relative to current models



Males


a.) Bristol Bay red king crab - bias corrected
Percent difference
Survey Year
Category
Legal male
Mature male
b.) St Matthew blue king crab - bias corrected
Percent difference
Survey Year
Category
Legal male
Males GE90
Mature male
c.) Eastern district Bairdi - bias corrected
Percent difference
Survey Year
Category
Legal male
Mature male
d.) Western district Bairdi - bias corrected
Percent difference
Survey Year
Category
Legal male
Mature male
e.) Eastern Bering Sea opilio - bias corrected
Percent difference
Survey Year
Category
Legal male
Mature male

Females



CB: Ovigerity-based. Barren females Excluded from mature S-W model

Conclusions

- Bias corrections
  - minimally affect parameters/model output
- Shell condition
  - Minor effects (BBRKC, SMBKC, EBS CO)
  - SE (in new models ~ ½ to ¼ size of baseline)
- EBS CB
  - Greater effect
  - OS
- Statistical support for updating parameters is not there
  - OS Bairdi?

Future work

- Applying bias-correction procedures to current model parameters
- Nonlinear models for L-W parameters
  - Avoid log-transformation
- Finish female work
  - SMBKC
  - Investigate large anomalies
  - Investigate trends seen in BBRKC females
  - Temperature
  - Barren mature females

Literature cited

- Brodziak, J. 2012. Fitting length-weight relationships with linear regression using the log-transformed allometric model with bias-correction. Pacific Islands Fisheries Science Center Administrative Report H-12-03.
- Chilton, E.A. 2009. Updates to size-weight relationships of eastern Bering Sea commercial crab species. Presentation.
- Chilton, E.A. 2011. Size-weight relationships of commercial crab in the eastern Bering Sea.

Questions?