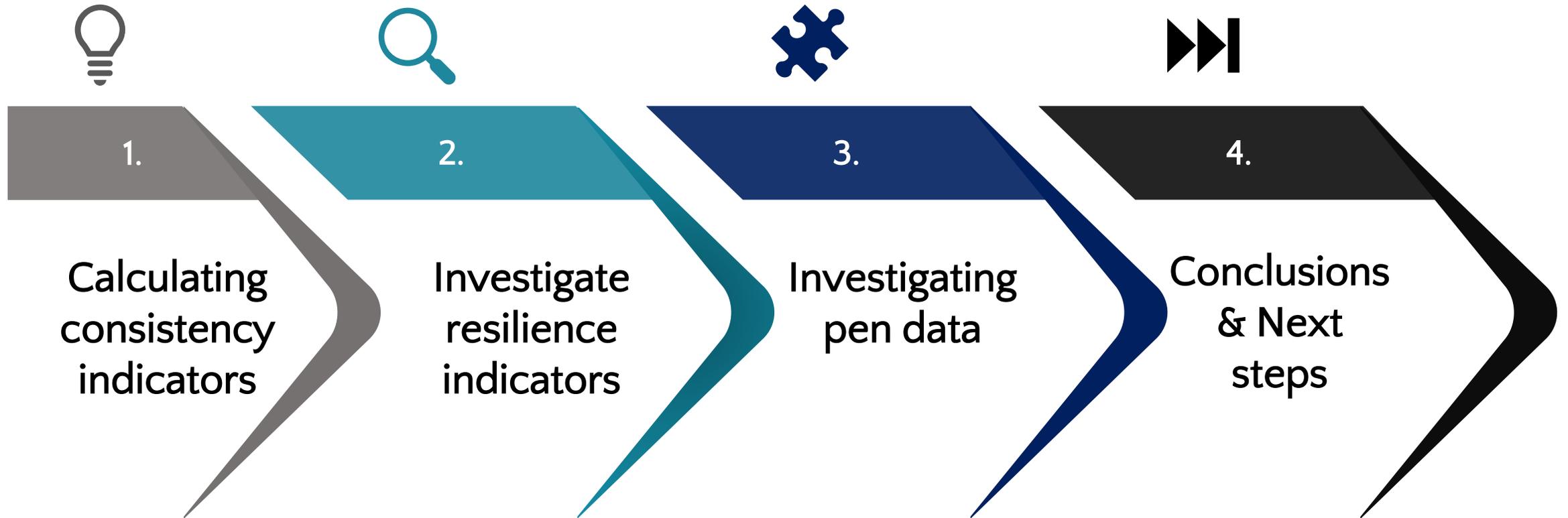


Genetic analysis of lactation consistency using daily milk weights in U.S. Holsteins

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ICAR Annual Meeting – Toledo, Spain
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1. Calculating consistency indicators

What is consistency?

A level of performance that does not vary greatly in quality over time.

Why measure consistency?

The ability of an animal to perform in variable or suboptimal conditions has been largely ignored.

Where is the opportunity?

PLF technologies offer an opportunity to monitor behavior and physiology and develop tools for adaptive management of resilience.

Athlete performance → hurling

Player 1 → 4 goal average



Opposition team level	Average # of goals
Less challenging	9
Challenging	2
Very challenging	1
Overall	4

Player 2 → 3 goal average

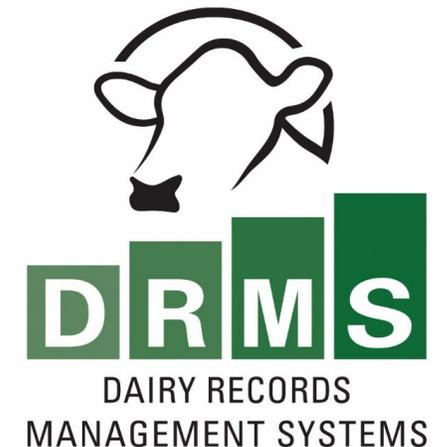
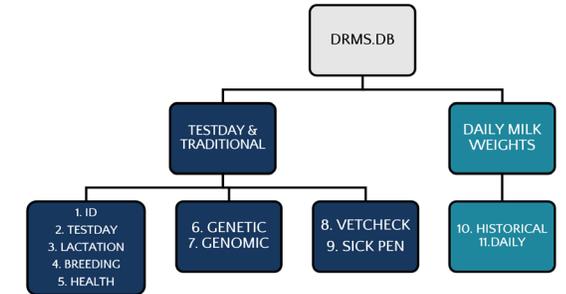


Opposition team level	Average # of goals
Less challenging	3
Challenging	3
Very challenging	3
Overall	3

1. Calculating consistency indicators

Data

- **Number of records:**
 - 275 million individual daily milk weights
 - 82 million historical aggregated daily milk weights
 - 9.3 million test day records
 - 4.4 million health records
 - 2.6 million breeding records
- **Number of herds:** 311 herds in 37 states across the U.S.
- **Number of cows:** 499,460

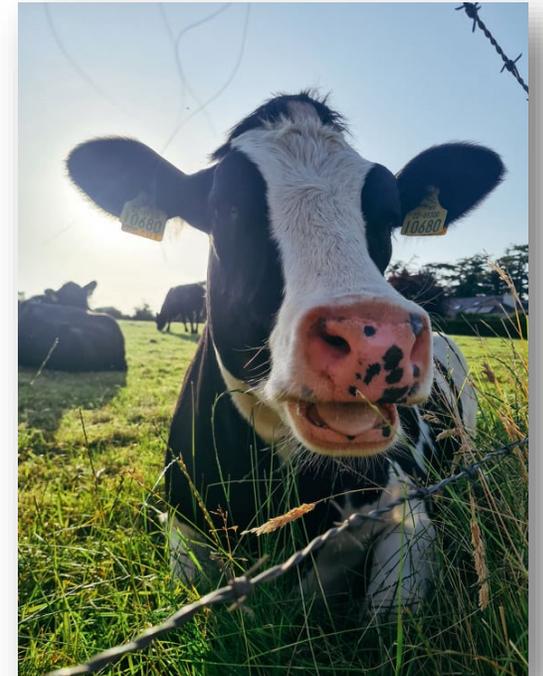


Data edits

- First parity
- Holstein
- 3X milking
- No Automatic Milking Systems
- No estimated records
- Outliers removed
- DIM 5 – 305
- ≥ 100 daily milk weights per lactation
- Milkings from 2018 – 2023

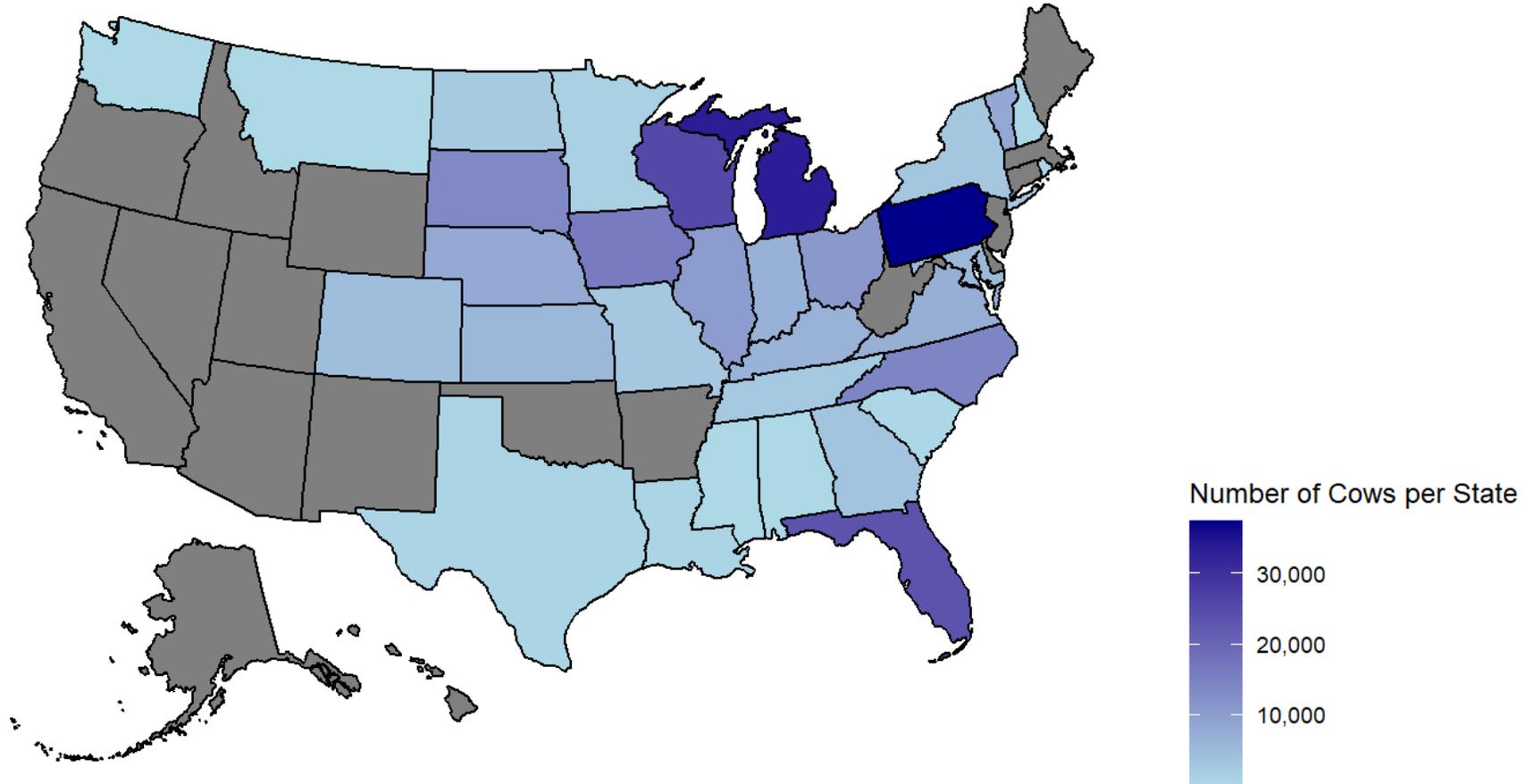
Final dataset

- 21,781,768 observations
 - 102,216 cows
 - 213 herds
 - 30 states



1. Calculating consistency indicators

Number of cows per state

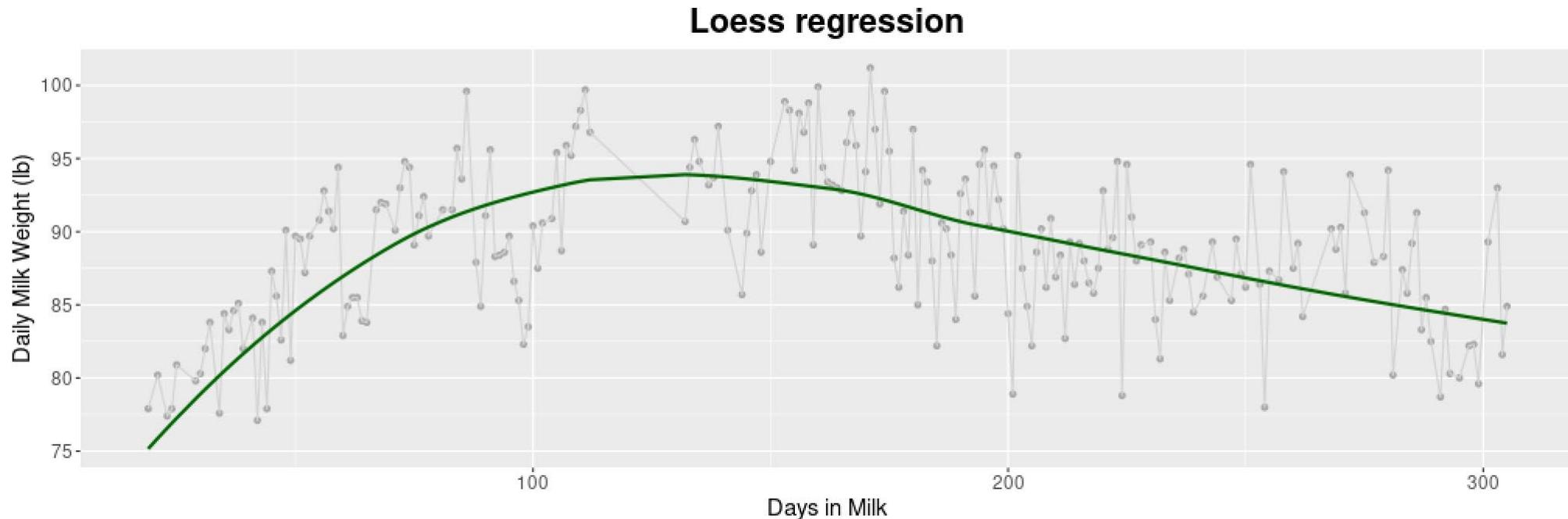


*Note: Grey states represent areas with no available data.

1. Calculating consistency indicators

How do we measure Consistency indicators?

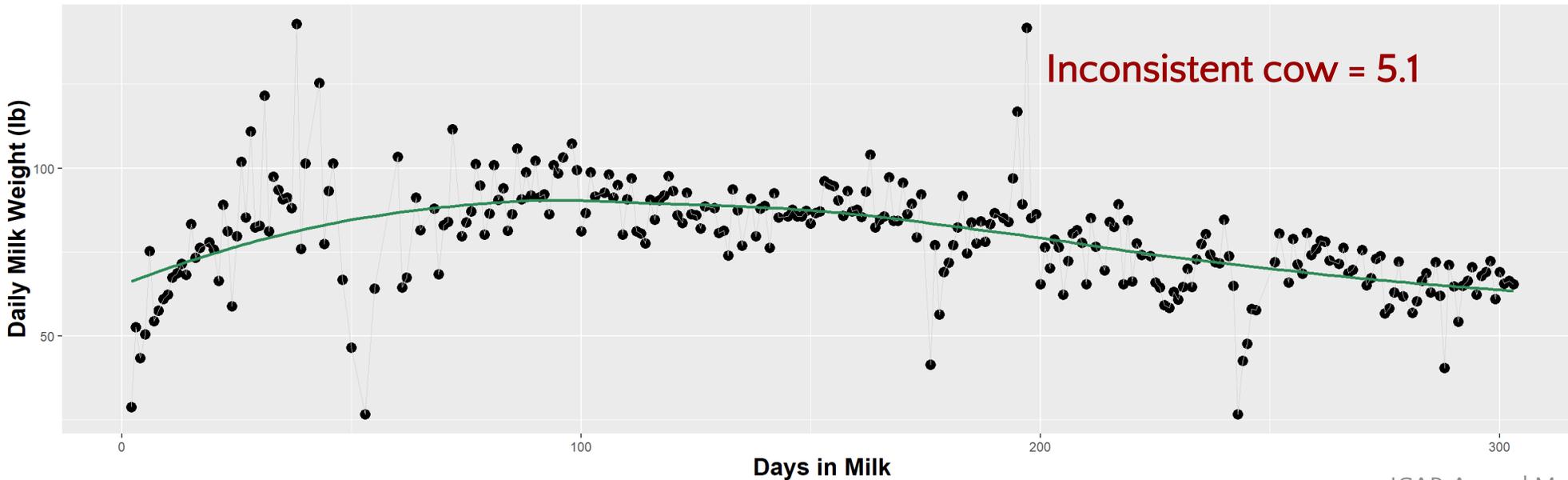
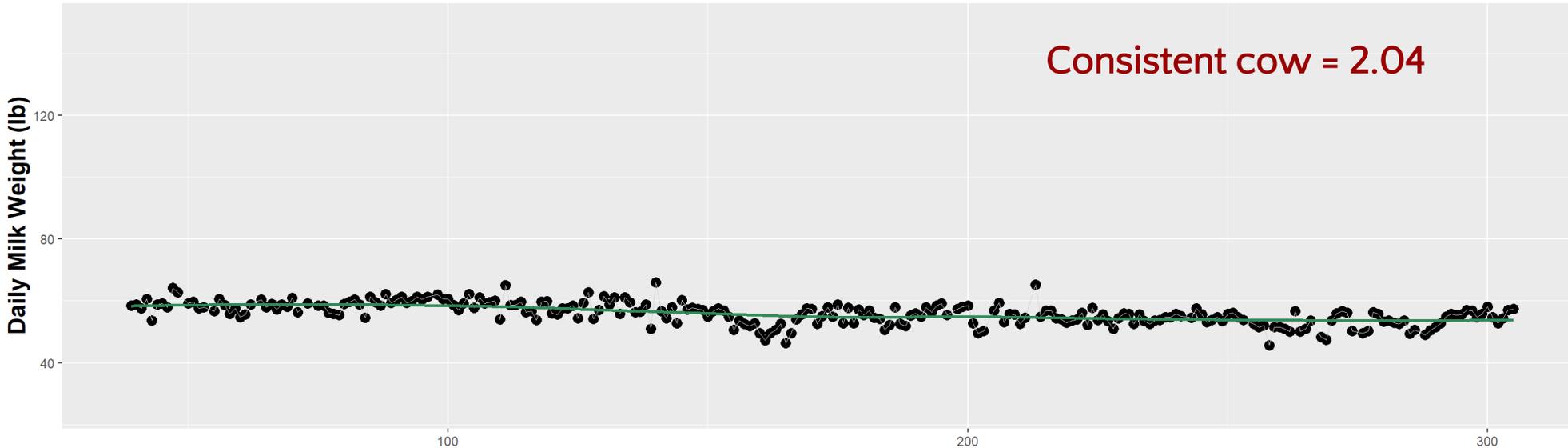
- Loess (non-parametric) regression to model lactation curve using daily milk weights



$$\text{Consistency indicator} \rightarrow \text{LnVar} (\sum (\text{yield} - \widehat{\text{yield}}))$$

1. Calculating consistency indicators

Consistent vs inconsistent cow from the same herd



Consistent cows have lower variation indicator over a lactation than inconsistent cows!

Consistency = total variance over a lactation. Less variation = more consistent!

Heritabilities

Model

$$y_{ijkl} = AFC_i + HYS_j + Cow_k + e_{ijkl}$$

Fixed effects

- Age at first calving (6 levels)
- Herd-year-season (2,347 levels)

Random effect

- Cow

Consistency is heritable!

$$h^2 = 0.236 (0.01)$$

Sire PTA Correlations with Consistency

Trait	Correlation
Milk	0.49
Somatic Cell Score	0.23
Productive Life	-0.32
Livability	-0.39
Daughter Pregnancy Rate	-0.35

Correlations with early postpartum health traits ranged from -0.34 to -0.06
→ More consistent cows = fewer health problems

Conclusions

- We can select for consistent cows $\rightarrow h^2 = 0.236$
- Consistent cows \rightarrow fewer health problems & increased longevity
- Useful for understanding resilience indicators



Resilience

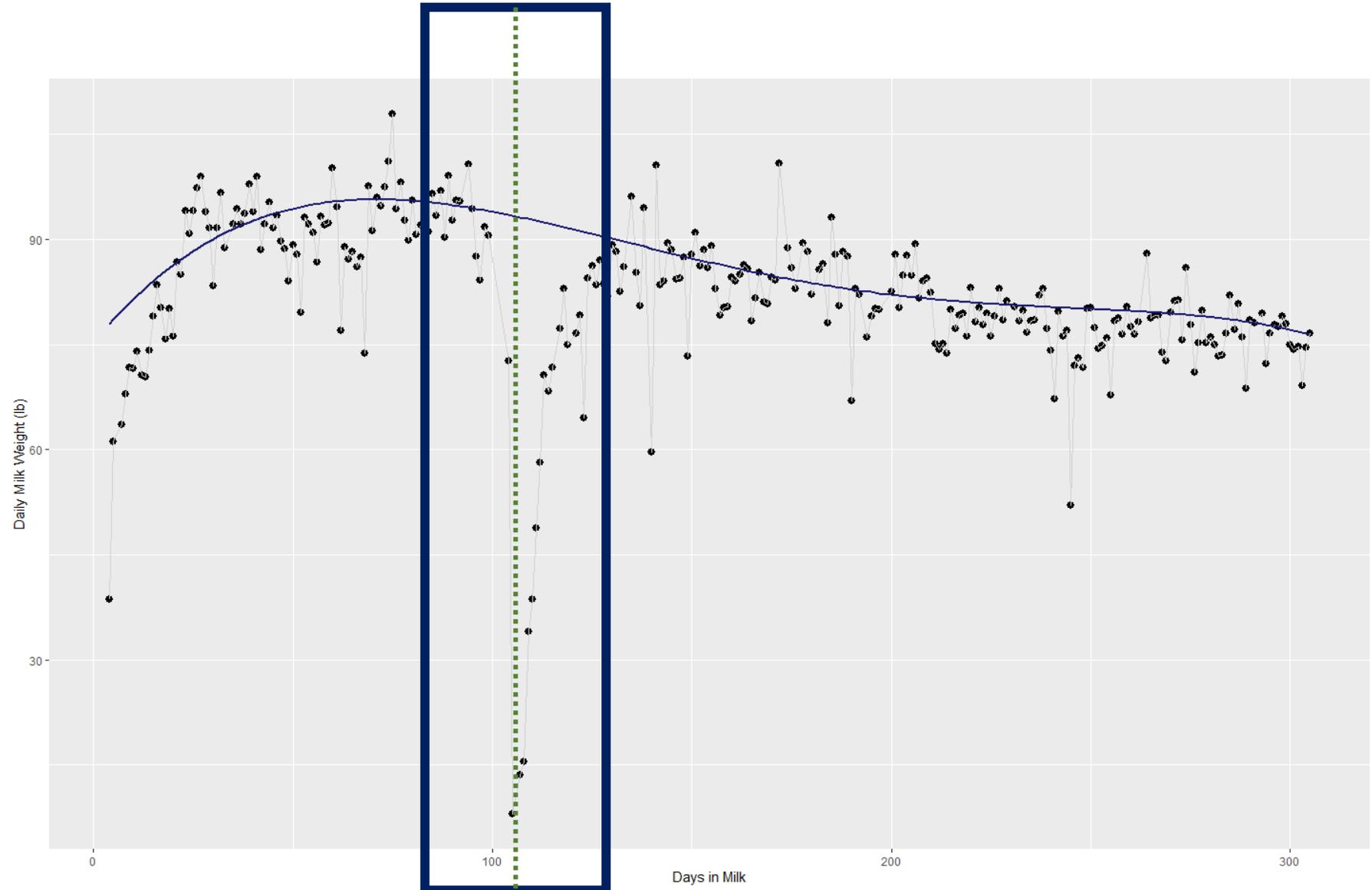
“The capacity to bounce back to normal functioning after a perturbation or maintain specific functions in the face of change or stress”

Scheffer et al., 2018



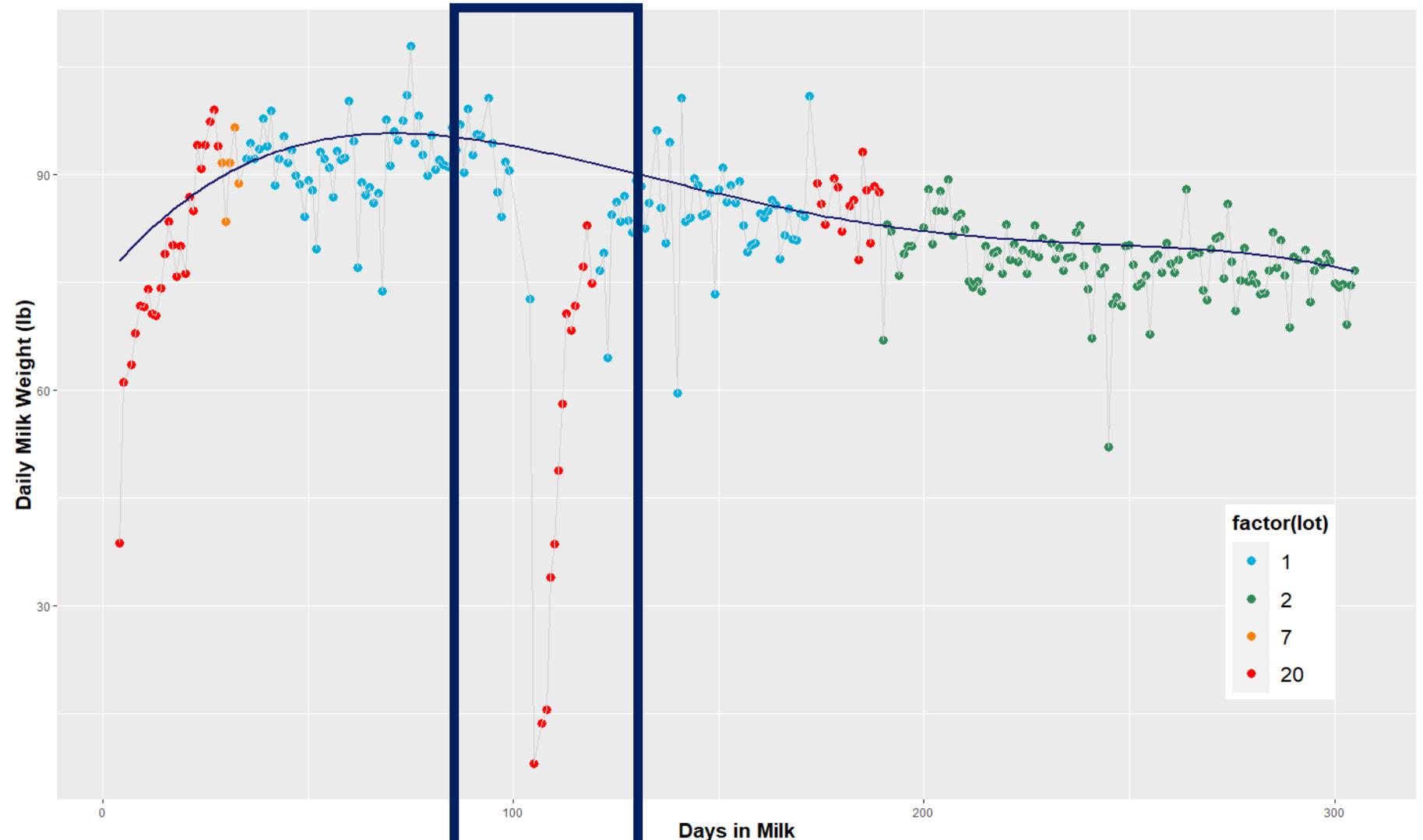
2. Resilience indicators

- How many consecutive days below expected curve?
- Do we measure response or recovery rate as a resilience indicator? (Le et al., 2022)
- How do we define contemporary groups to calculate resilience indicators?

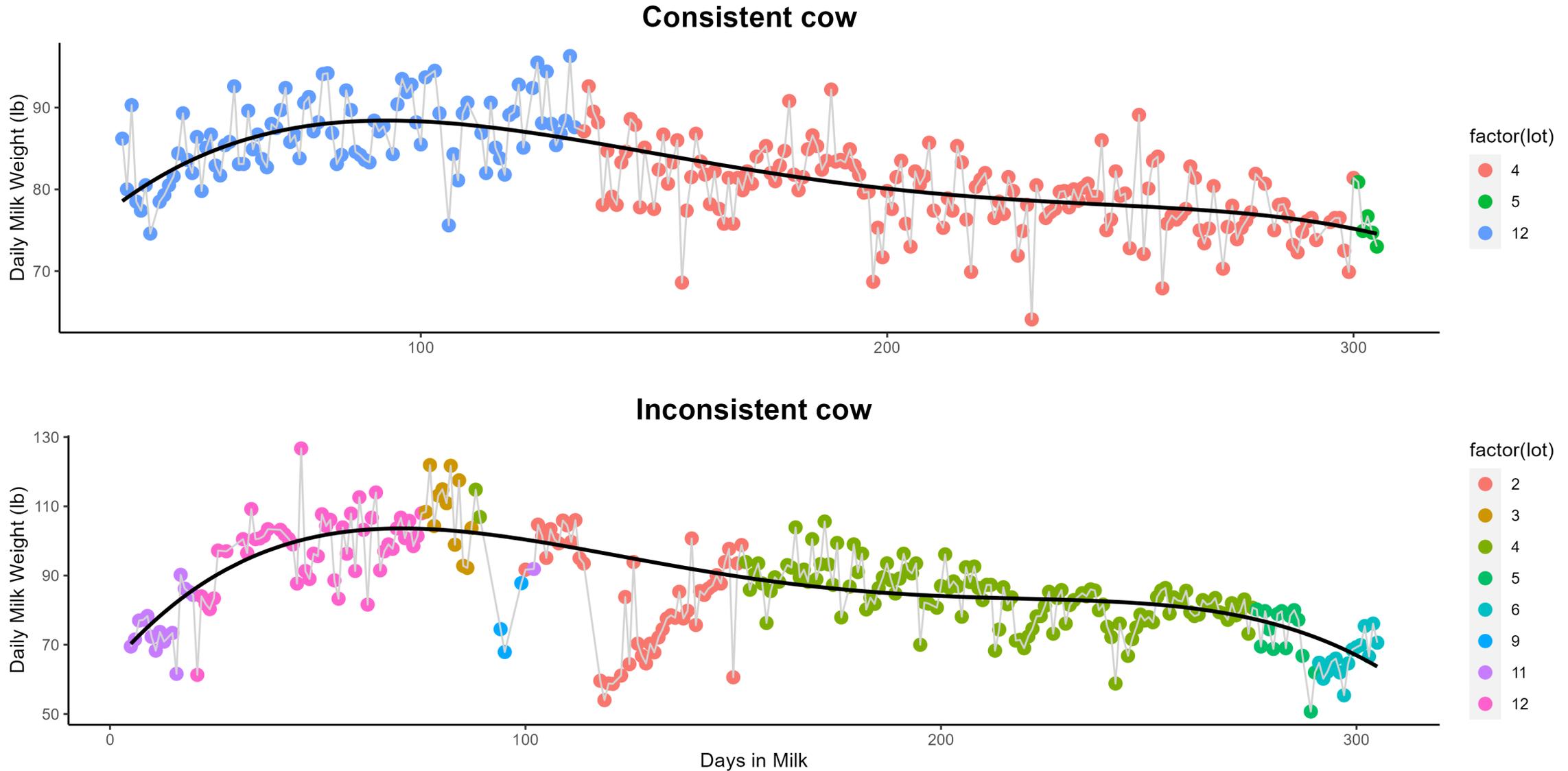


3. Including pen demographics in resilience indicators

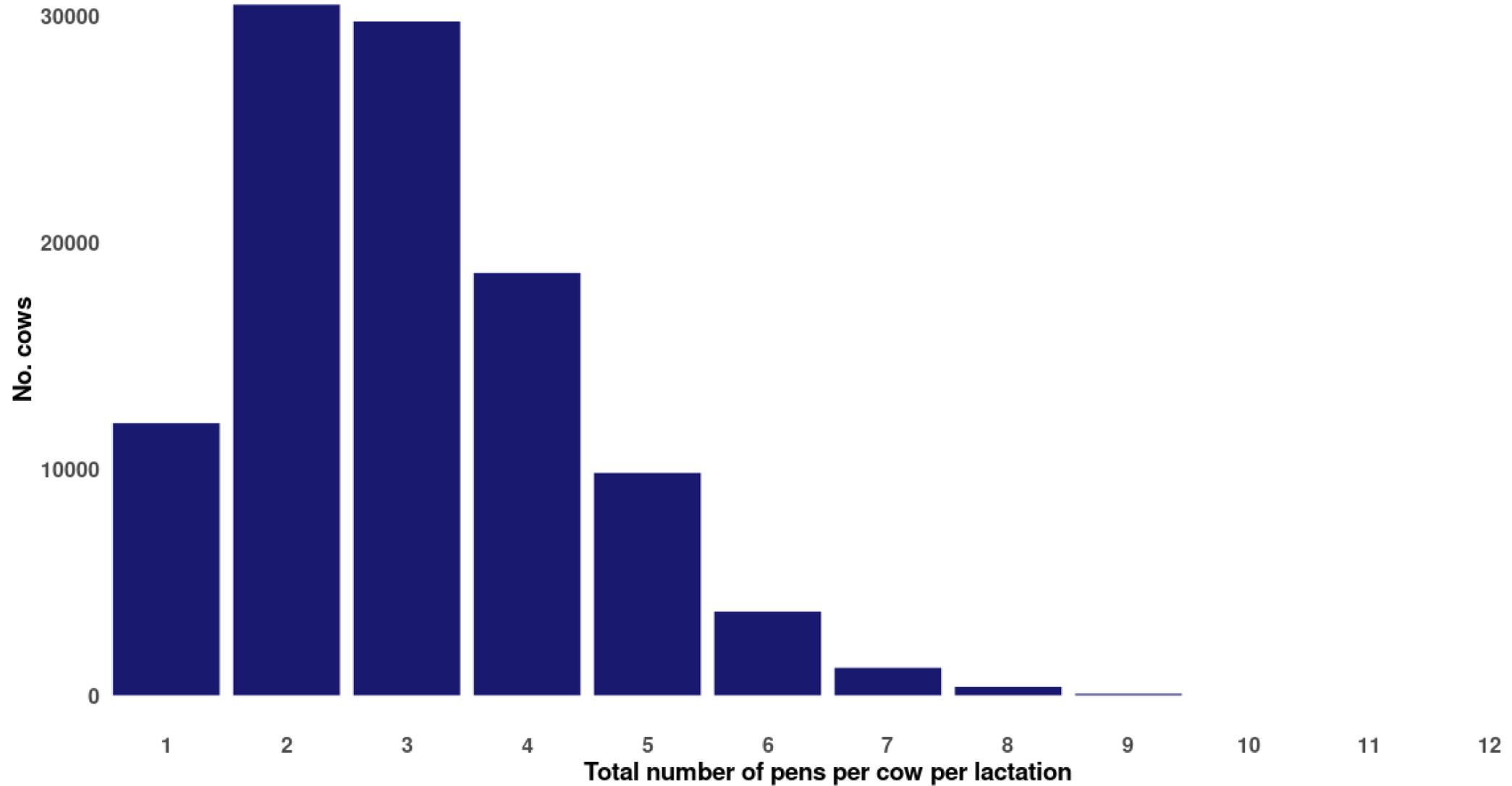
- Can group demographics provide additional information for resilience indicators?
- Were all cows in the pen affected by the perturbation (feed, weather, system changes)?
- How are cows moved based on changes in production? i.e., sick pen



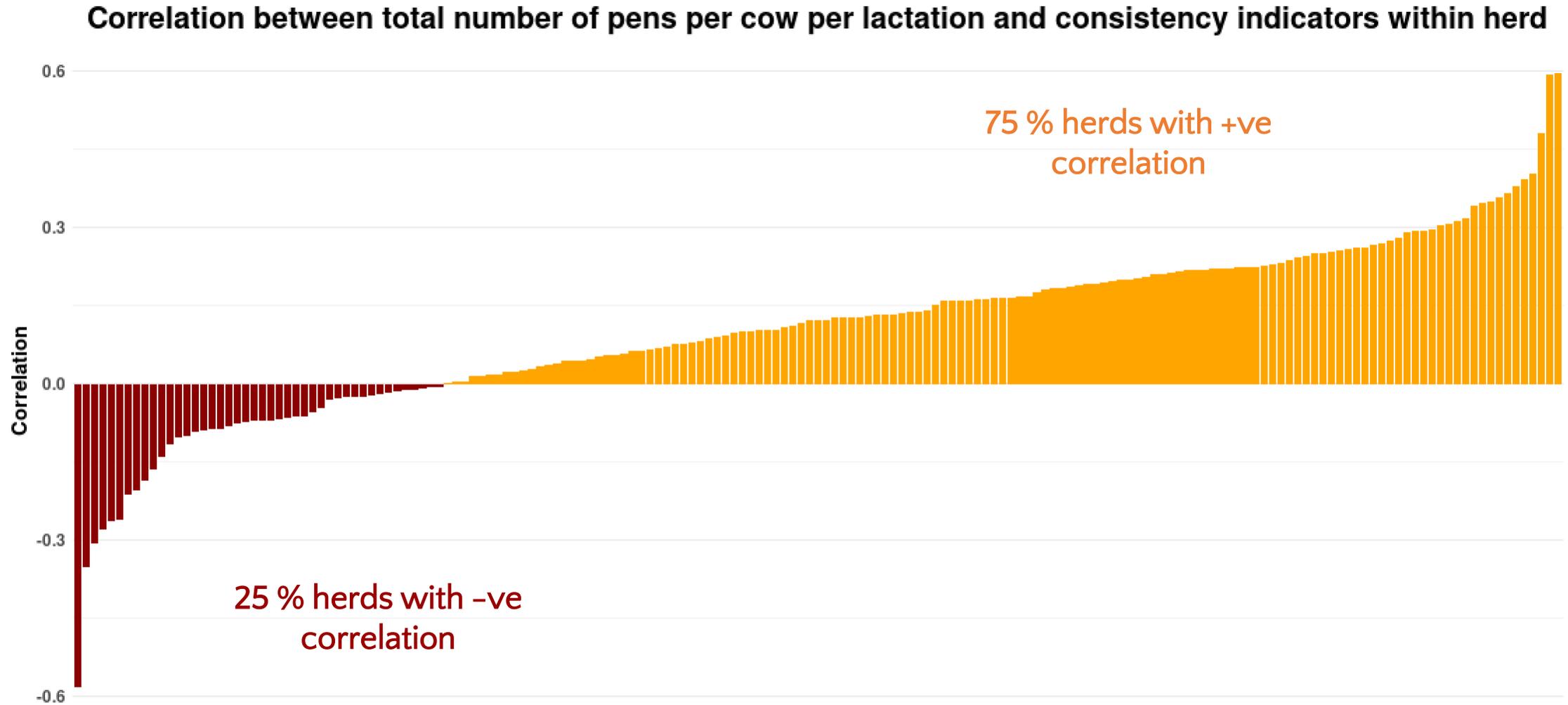
3. Including pen demographics in resilience indicators



4. Pen movements – frequencies



4. Relationship between no. pen movements within herd & consistency indicator



Next steps/Conclusions

- Include pen movements as a parameter in prediction model for calculating resilience indicators
- Phenotypic measure → management decisions
- Genetic evaluation for consistency/resilience
- Consistency indicators could be used to select cows with lower milk loss, that require less labor, and can inform management decisions!



Consistency
is key!



Thank you!
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