Overview of Hog Models

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Nell Sedransk, NISS
Emilola Abayomi, NASS-RDD
Seth Riggins, NASS-SD
Gavin Corral, NASS-RDD
Yijun (Frank) Wei, NISS at NASS-RDD
Luca Sartore, NISS at NASS-RDD

Disclaimer

The findings and conclusions in this presentation are those of the author(s) and should not be construed to represent any official USDA or U.S. Government determination or policy.

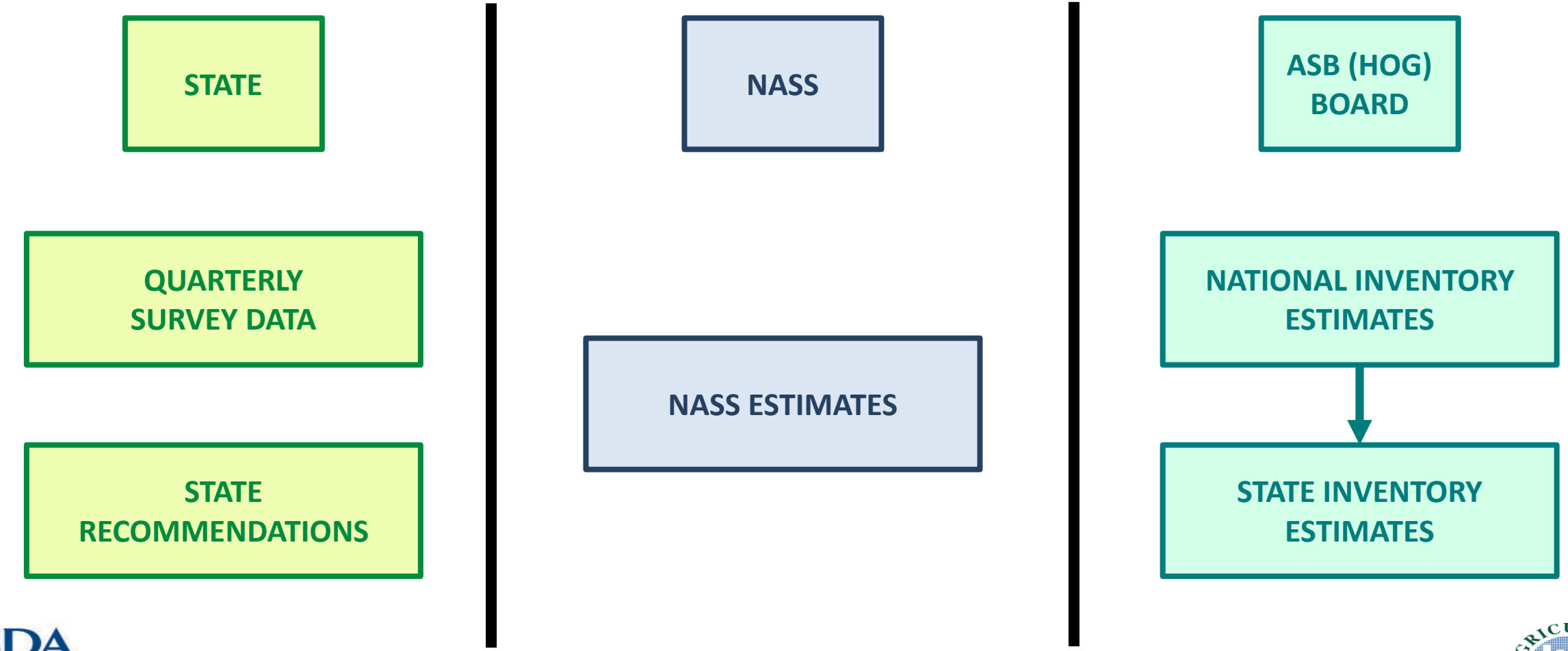
Presentations of Topics and Details

• Overview of Project Goals and Challenges	- Nell Sedransk
• Sample Design and Data Resources	- Emilola Abayomi
• Estimation Process involving Hog Board	- Seth Riggins
• Statistical Approaches – Existing Data Models	- Gavin Corral
• Web Scraping, Natural Language Processing	- Yijun (Frank) Wei
• Proposed New Time Series Model	- Luca Sartore

Clear Requirements – Complex Problem

- Estimates of US Hogs – Quarterly Publication of Hog Inventory
  - National numbers; State numbers (calibrated to national totals)
  - Primary reporting: 7 categories plus 2 derived variables
    - Sows farrowed
    - Pig Crop
    - Litter rate (= pig crop/sows farrowed)
    - Market hogs by 4 weight groups and total
    - Breeding stock
    - Total hogs
  - Minor categories
    - Import / export
    - Death loss

Original Process: From Survey to Published Estimates



Value-added for Hog Inventory Model

- Statistical estimates with standard errors
  - Based on survey data
  - Explicitly reflecting internal relationships in the data both within and between quarters
    - Long-term and seasonal patterns
    - Localized, geographic events or differences
    - Inventory composition based on biology (breeding, growth, death, market)
- Predictive value
  - Diagnostics based on Data-Prediction differences
- Allocation algorithms (e.g., national – to – states)

Model Component: Empirical Time Relationships

- Time Series
  - Seasonal component: peaking in autumn months, decreased in spring
    - Strongest seasonality in northern region
  - Long-term trend: slow increase
    - Local (temporary) cap on production due to slaughterhouse capacity
- Constraints
  - Biologic factors: weight class inventories
    - Conditional upon inventories from earlier quarters
  - Operation accounting: cohort total is constant
    - Total of surviving hogs, death loss, slaughter numbers, (export or sale)
  - External information
    - National slaughter numbers

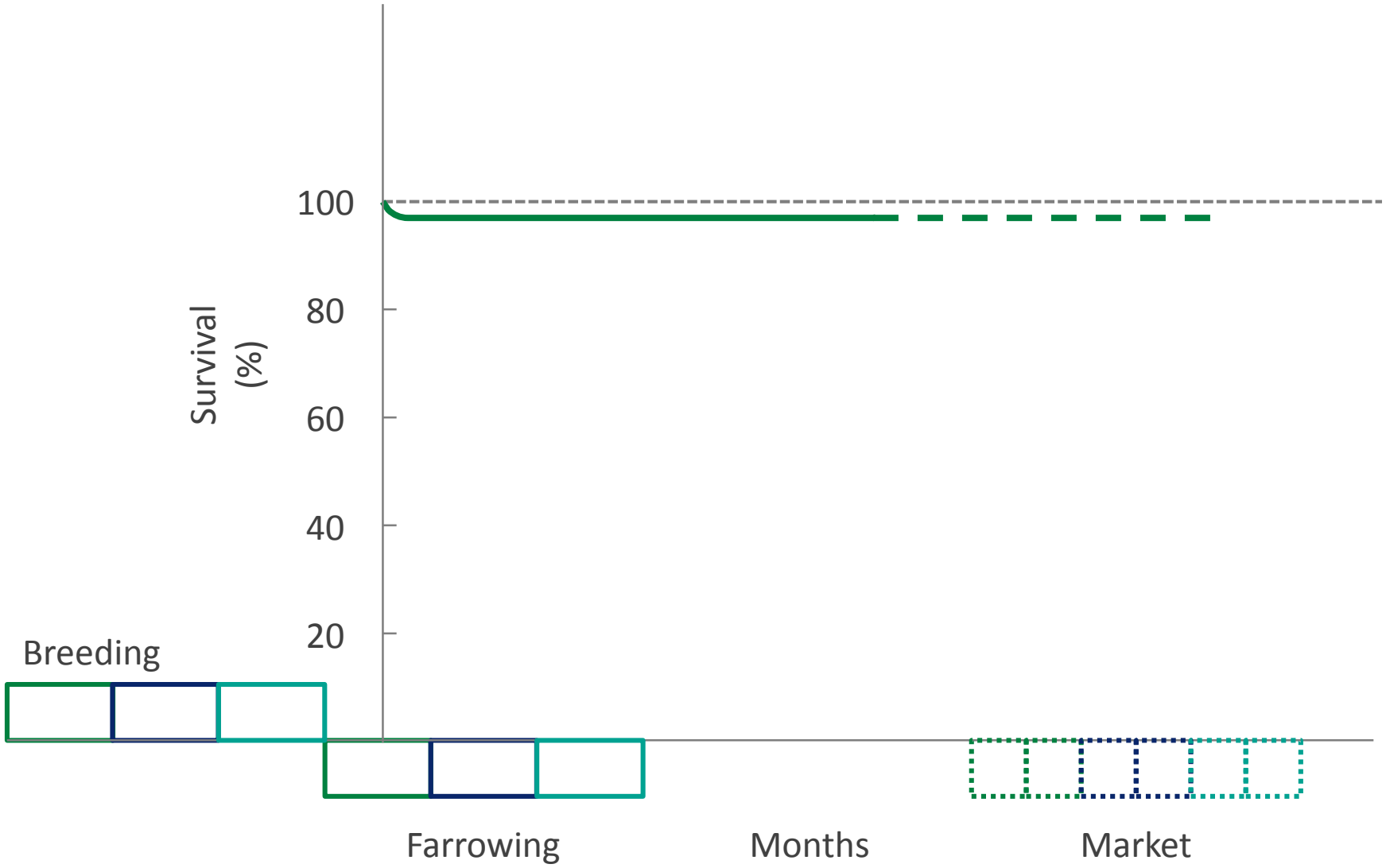
Empirical Time Relationships: Available Data

- Historical Series – quarterly published estimates
  - All reported quantities
  - National and state
  - Initial, revised and final ASB estimates
  - Current form and weight class definitions since 2008
  - Total hogs since 1866 and total market hogs since 1963
- National slaughter numbers – published monthly

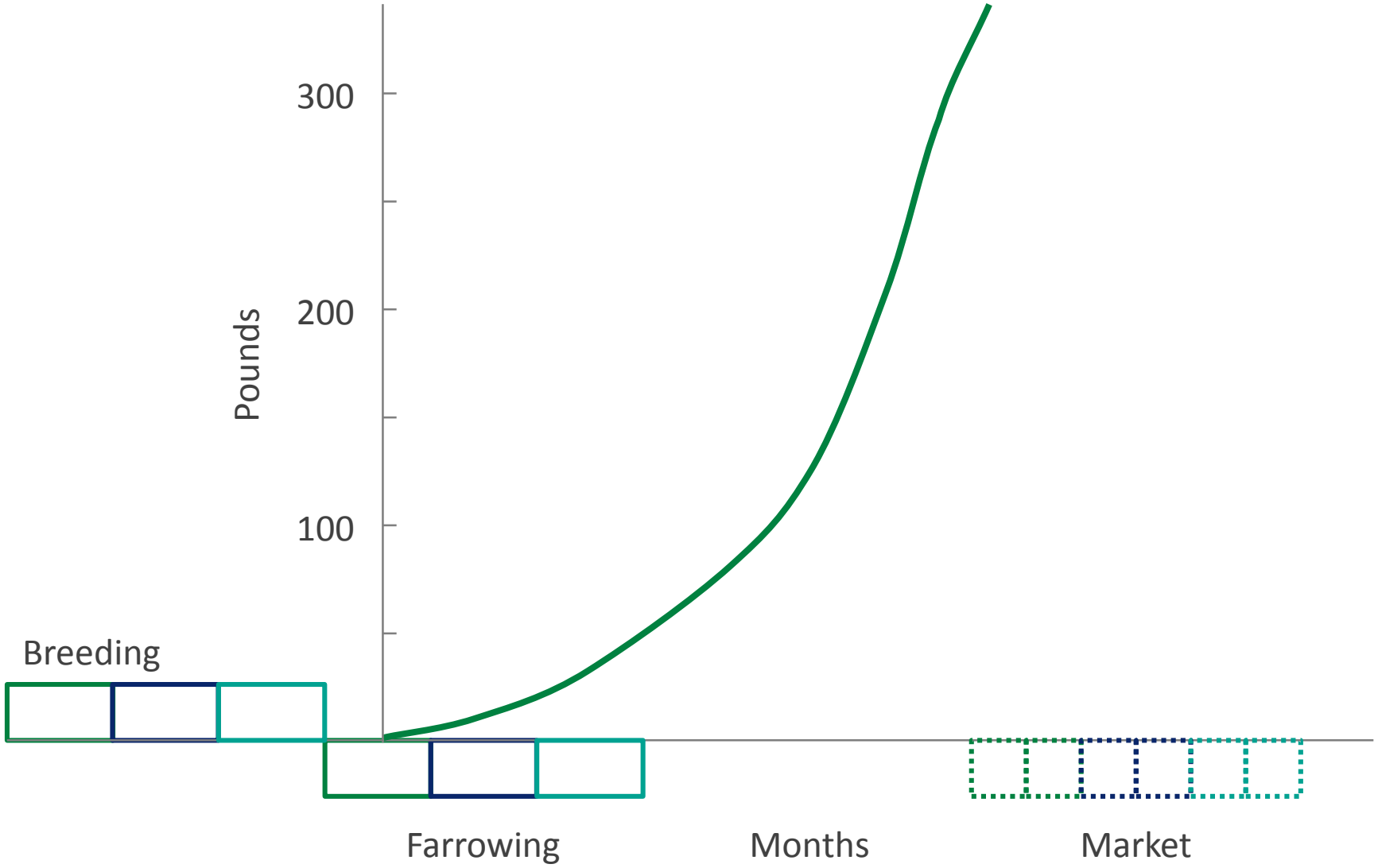
Model Components: Hog level

- Biology: Survival
  - Breeding to Farrowing to Market
  - Survival function (theoretical) in “production equilibrium”
    - i.e., absence of disease, disaster or other modifying event
- Biology: Growth
  - Birth to Weaning to Pig Crop through Weight classes to Market weight
  - Growth function (theoretical) in “production equilibrium”
    - Subject to slight adjustment for seasonality or other factor

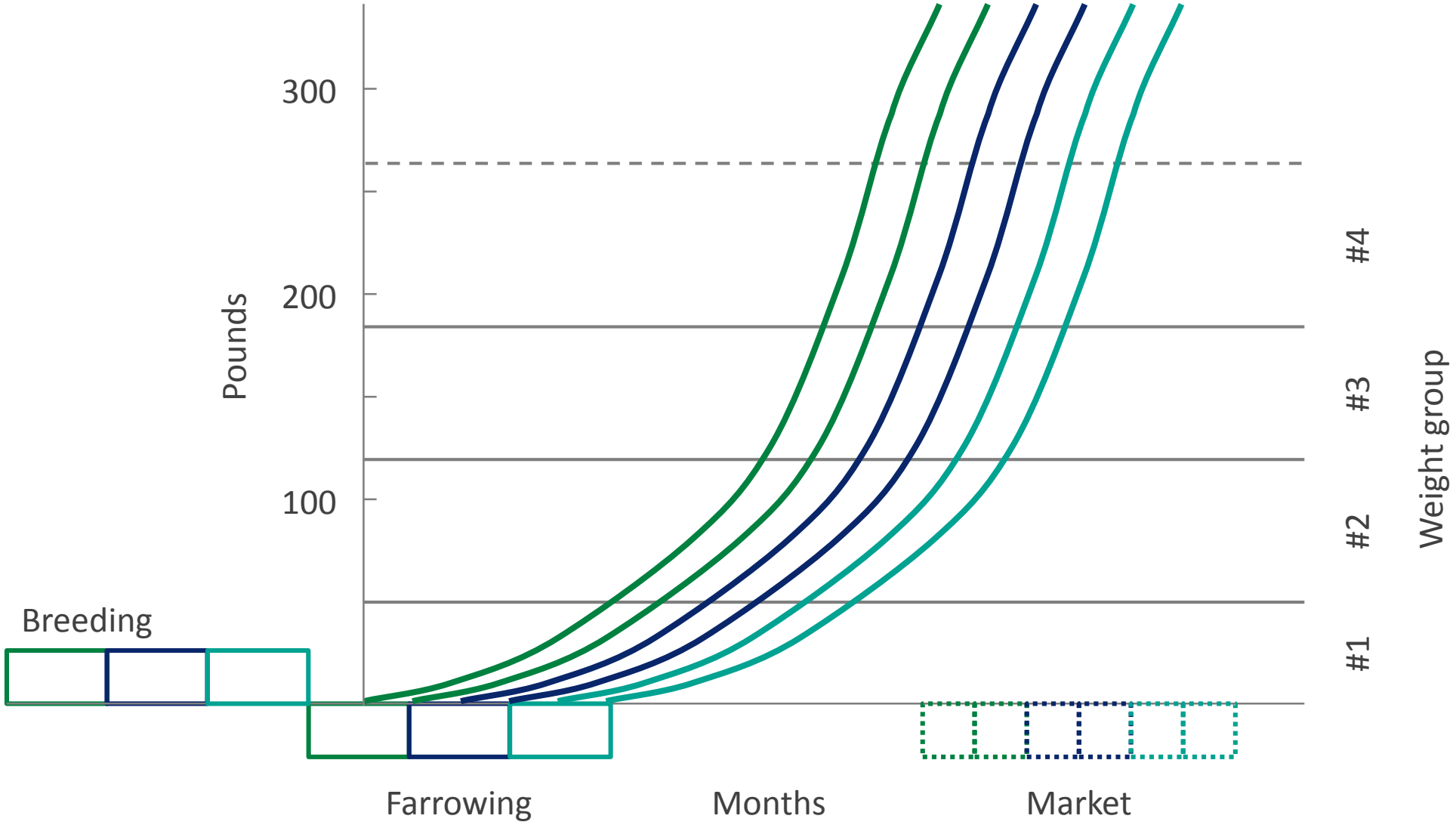
Model Component: Hog – level Survival



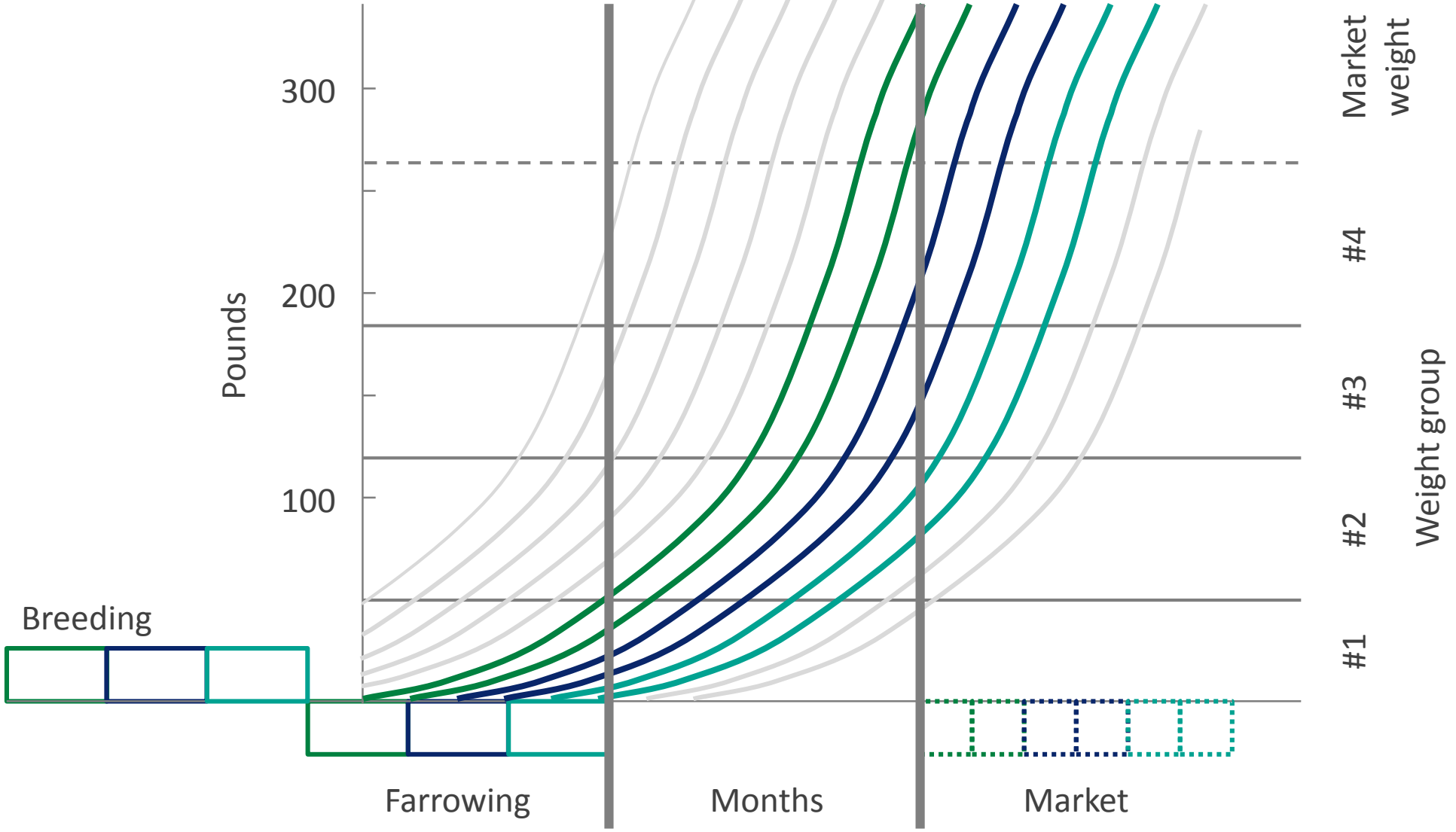
Model Component: Hog – level Growth



Model Component: Operation – level Growth



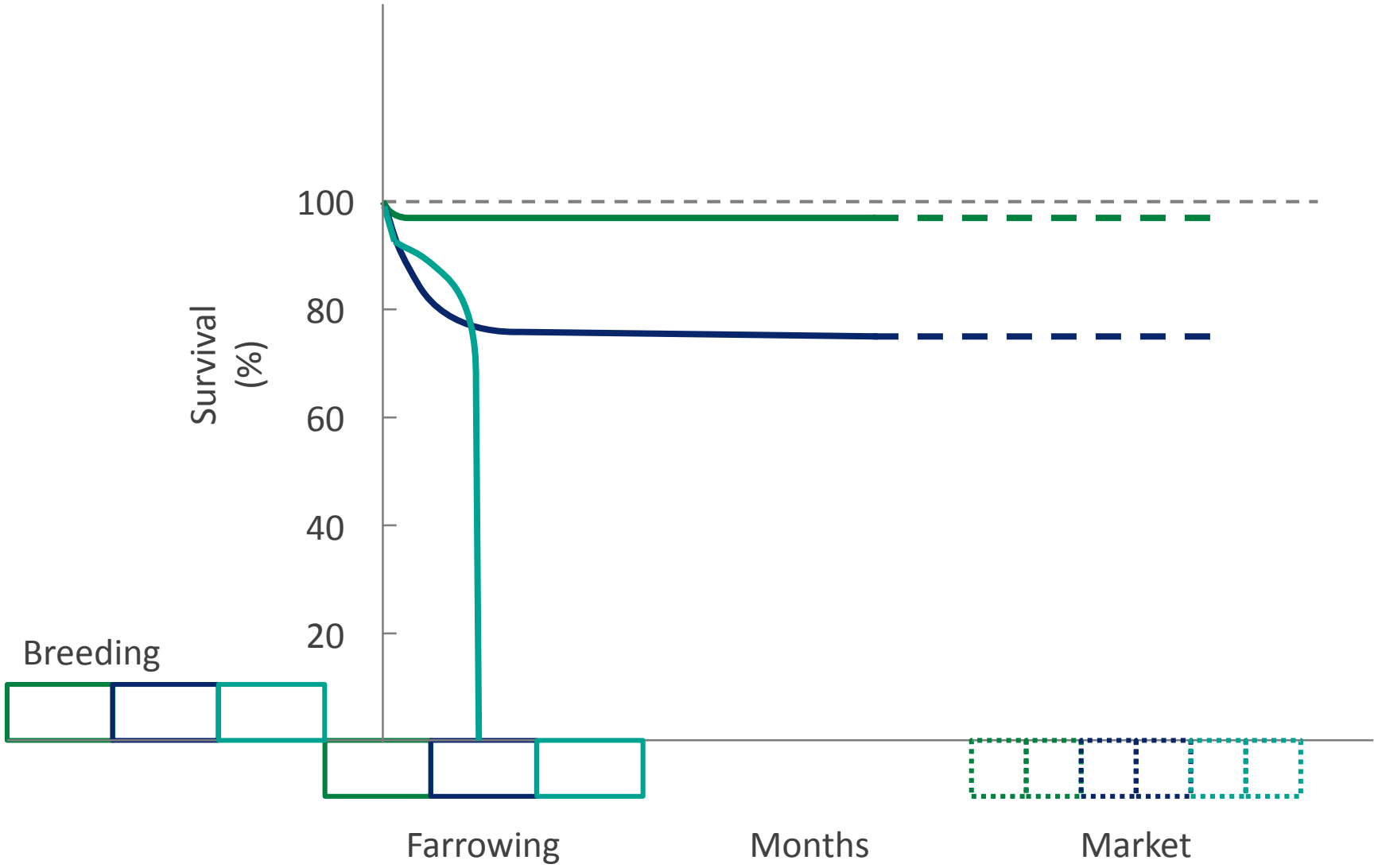
Model Component: Operation – level Weight Classes



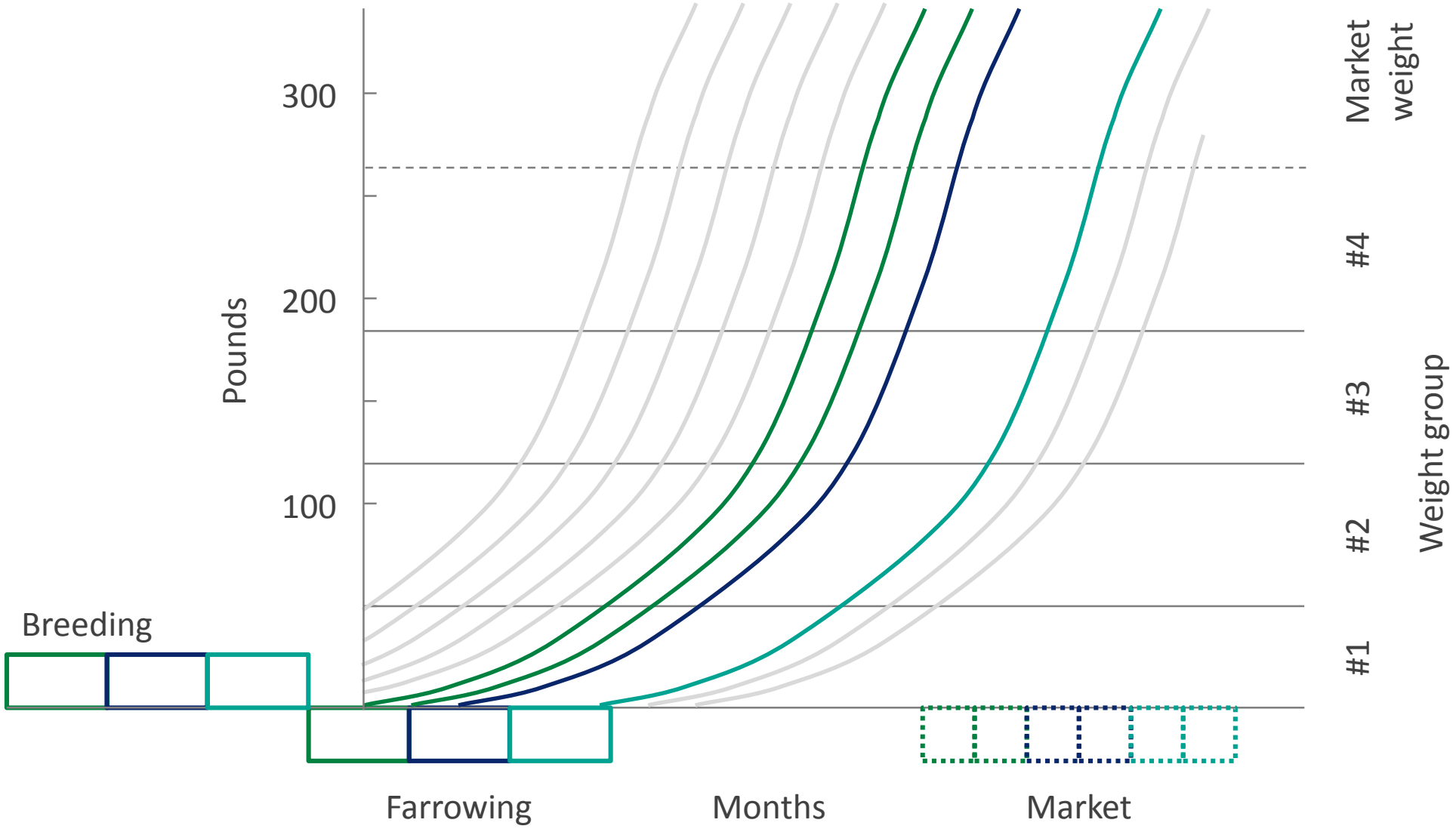
Model Components in Disequilibrium

- Sources of Perturbation
  - Disease coupled with operation's response: localized but dynamic
  - Natural disaster: localized
  - Slaughterhouse capacity: regional
  - Market forces: national, regional or localized
- Biologic Impact – Survival
  - Survival function (family of theoretical functions)
    - Dependent upon source of perturbation
- Inventory Composition
  - Dynamic with respect to duration of perturbation

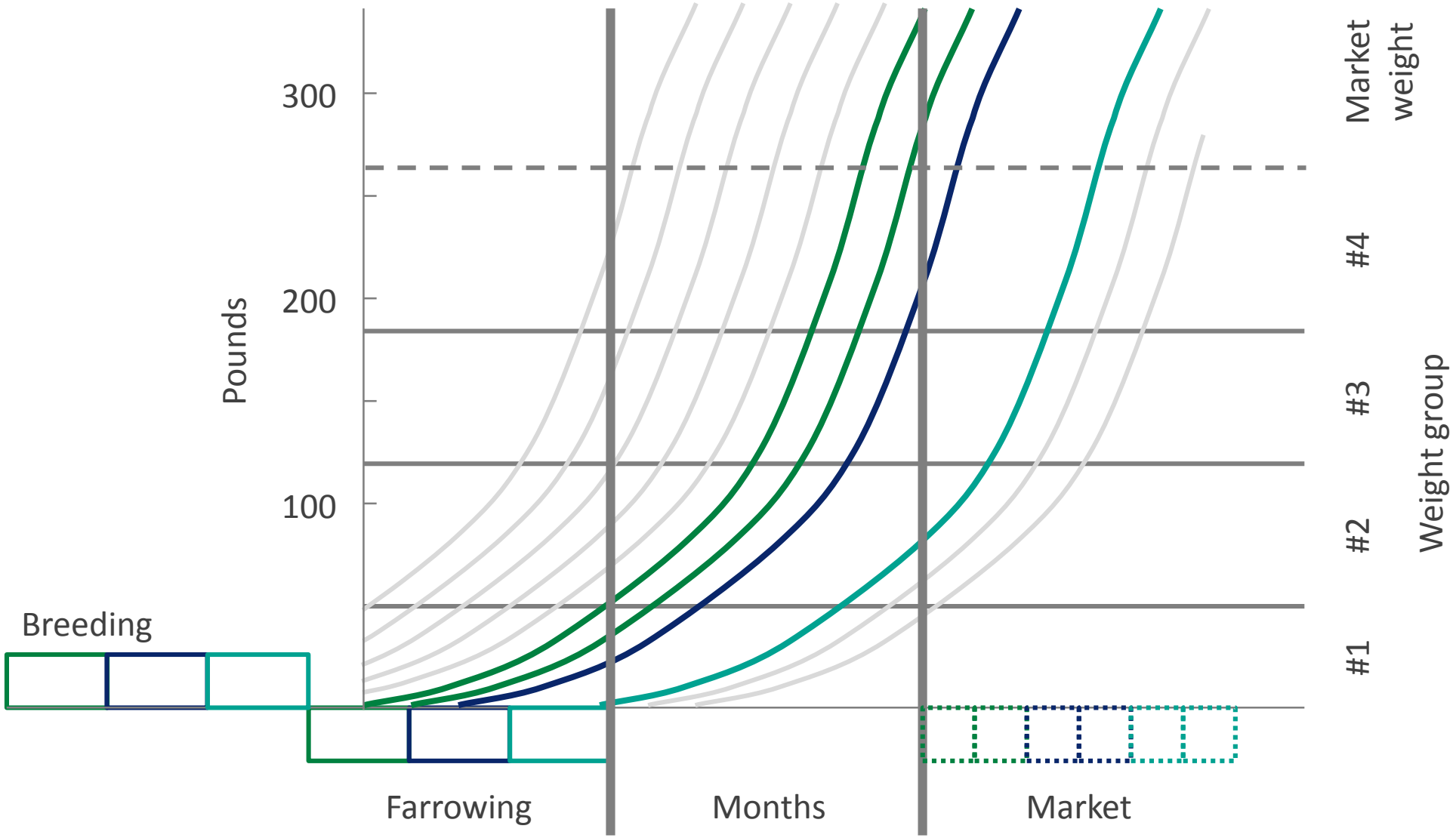
Disequilibrium Component: Hog – level Survival



Disequilibrium Component: Operation – level Growth



Disequilibrium Component: Weight Classes



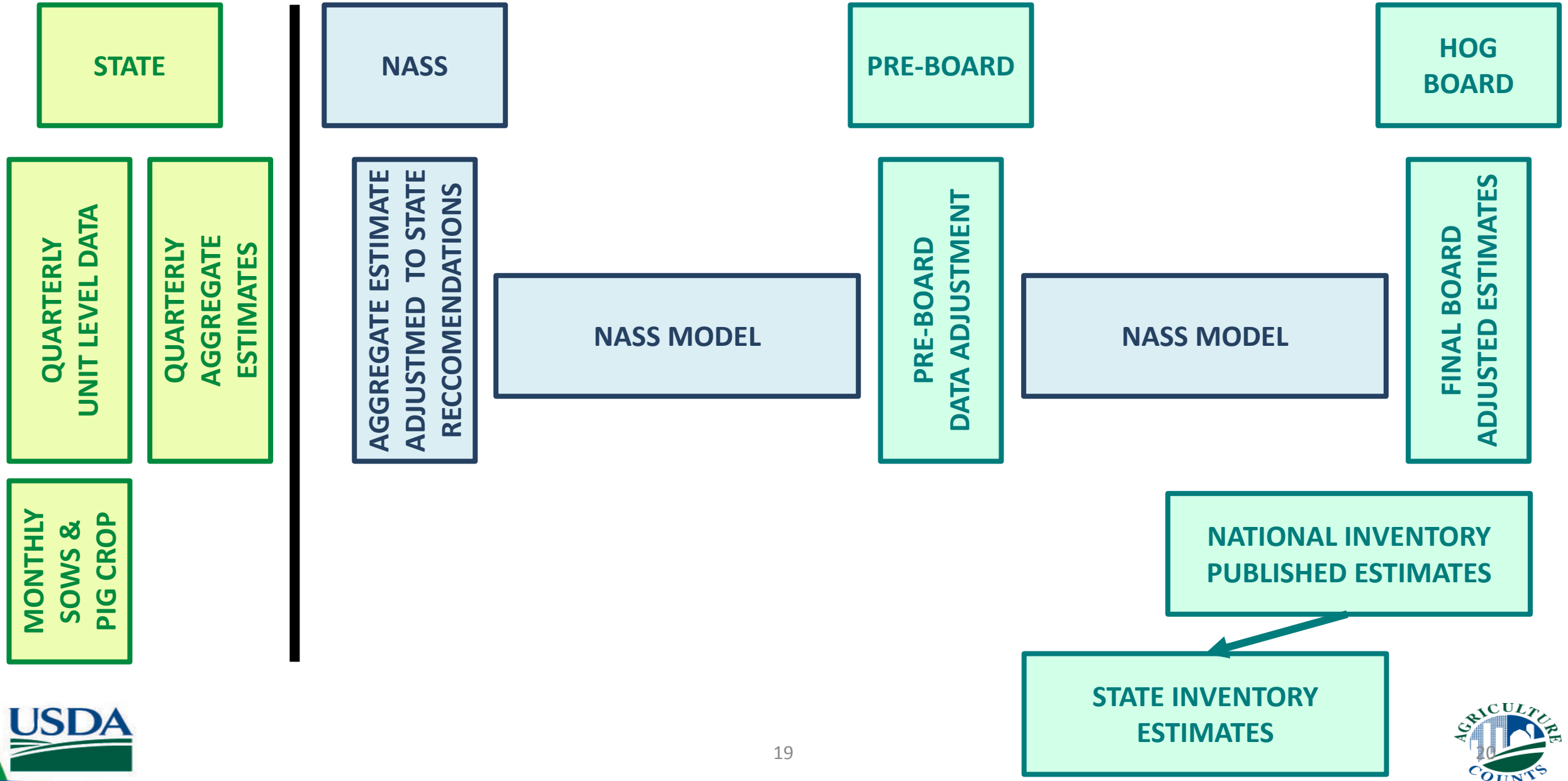
Hog Inventory: Data Available

- Sampled operations quarterly information
  - Aggregated to state level
  - Weighted estimators adjusted for non-response, undercoverage
  - All estimated quantities
  - State source recommendations
  - Monthly (past quarter) sows farrowed, pig crop
- Operation level data
  - Used subsequently in model validation
- Auxiliary (external) information
  - National slaughter numbers

Model Estimates – Context and Constraints

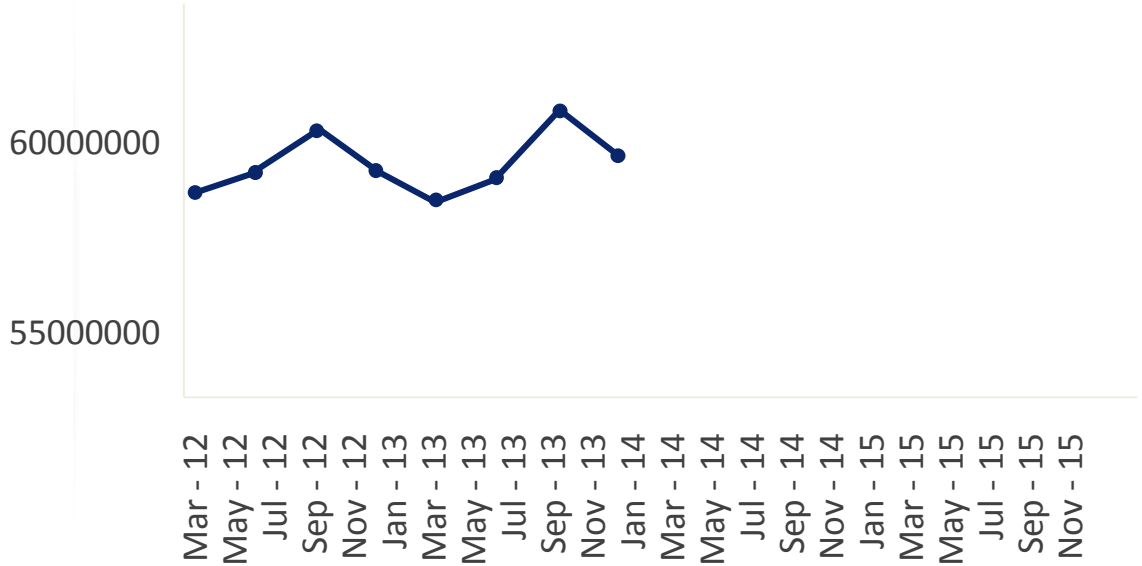
- Timeline
  - Survey Data available to NASS
  - Model-based estimates to Pre-Board Panel and to ASB (Hog Board)
  - National numbers released; state numbers calibrated to national numbers
- Revised and final numbers
  - Quarterly revision, with final revision one year later
- Pre-Board Panel
  - USDA HQ – NASS-Statistics Division livestock specialists
- Hog Board
  - USDA Regional Office representatives – hog specialists

From Survey to Published Estimates

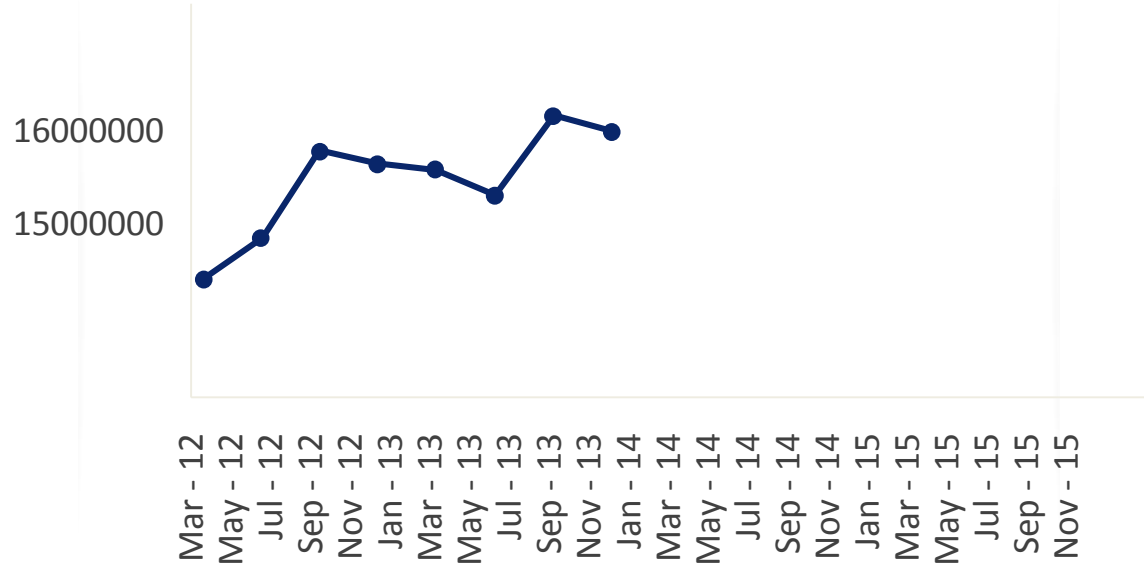


Emerging Disequilibrium OR Not?

US Total Hogs



Iowa Total Hogs



Emerging Disequilibrium OR Not?

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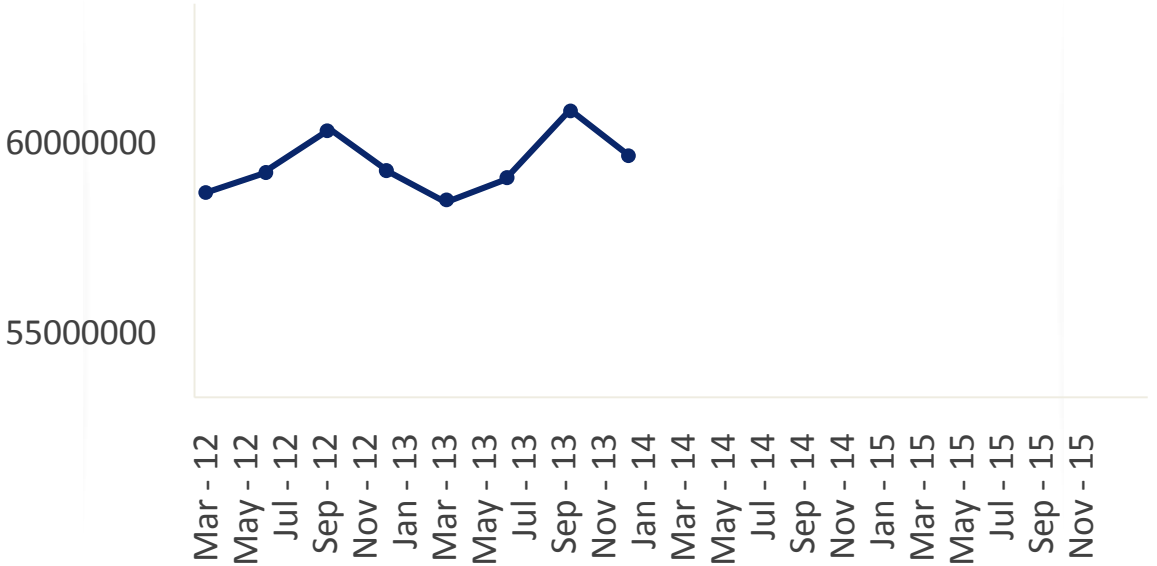
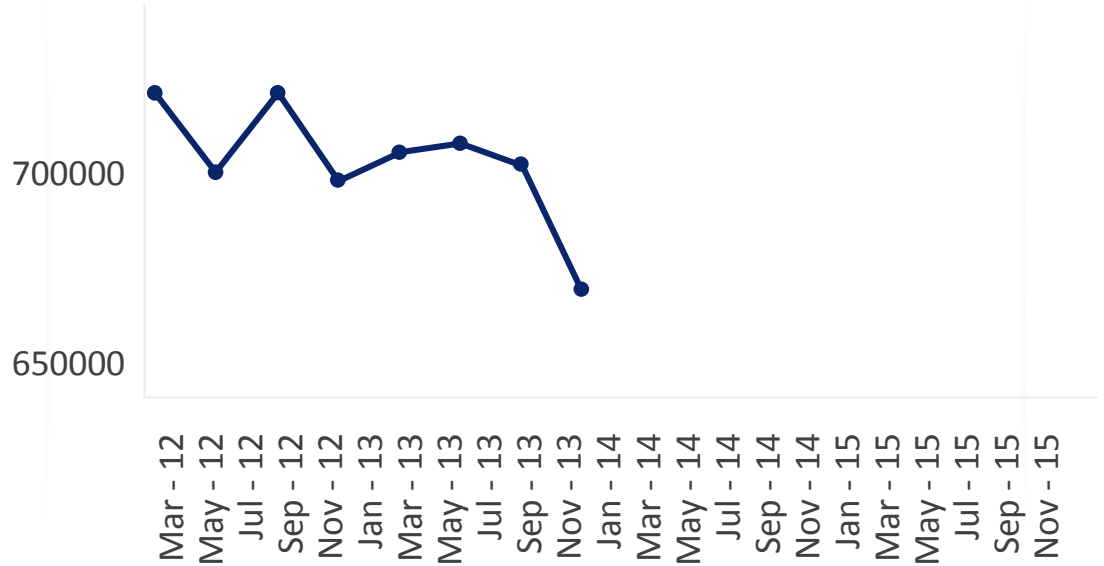


Colorado Total Hogs



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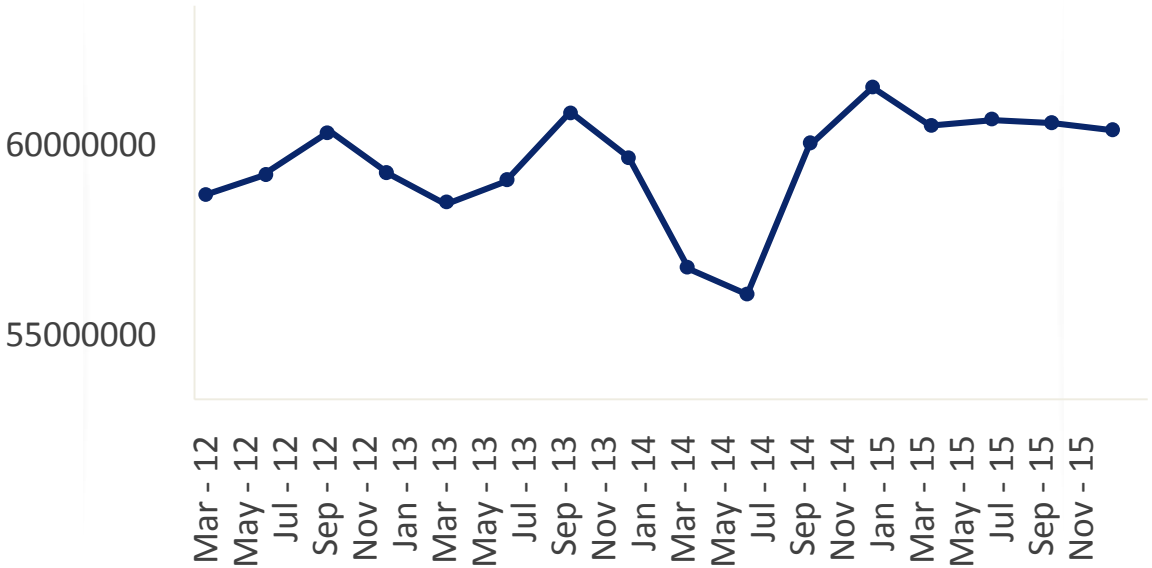
Equilibrium and Disequilibrium

US Total Hogs



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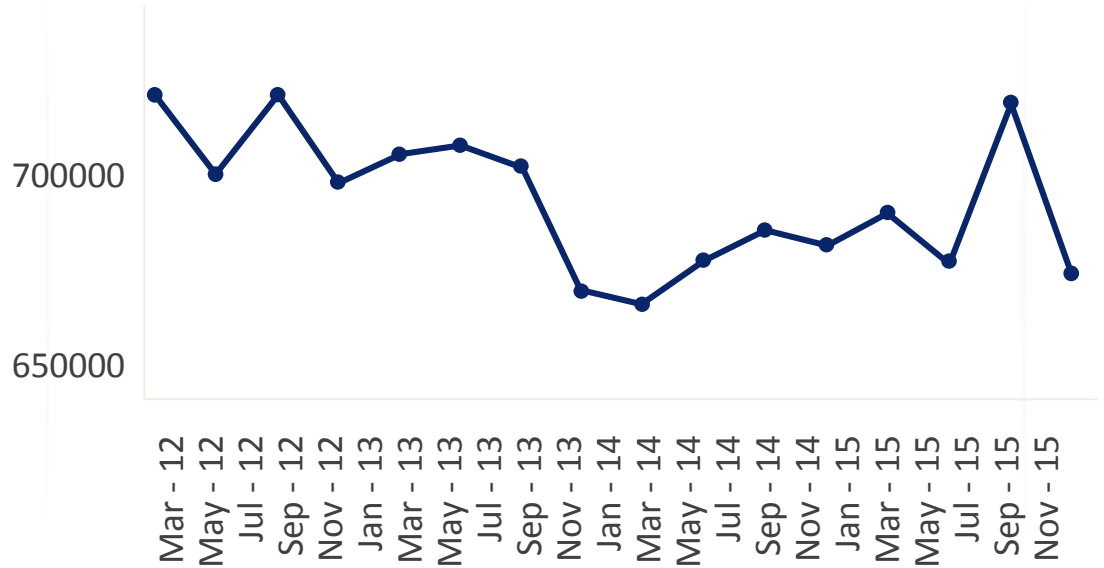
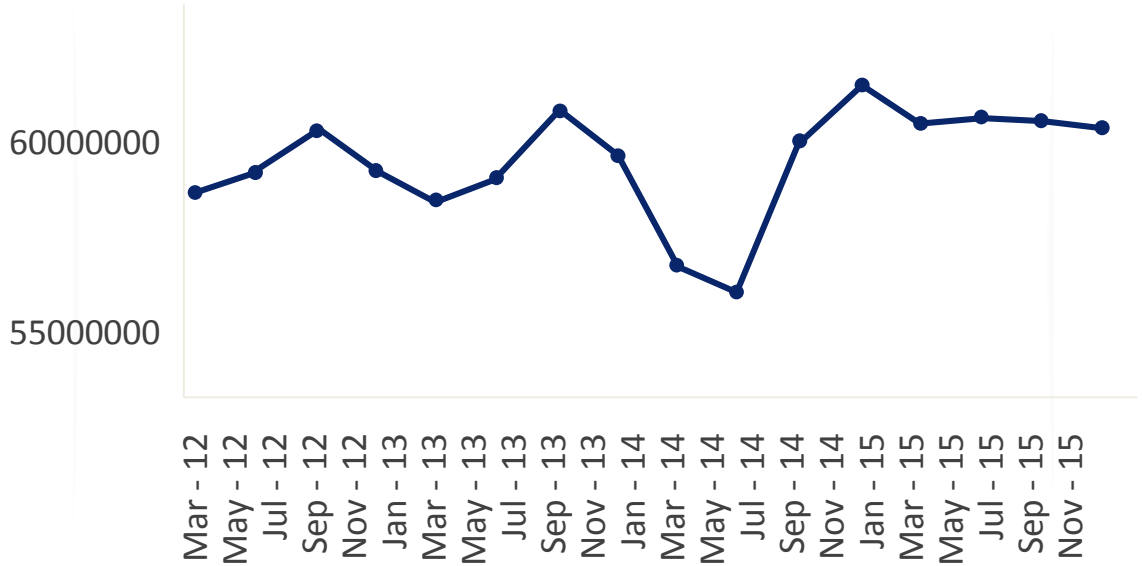
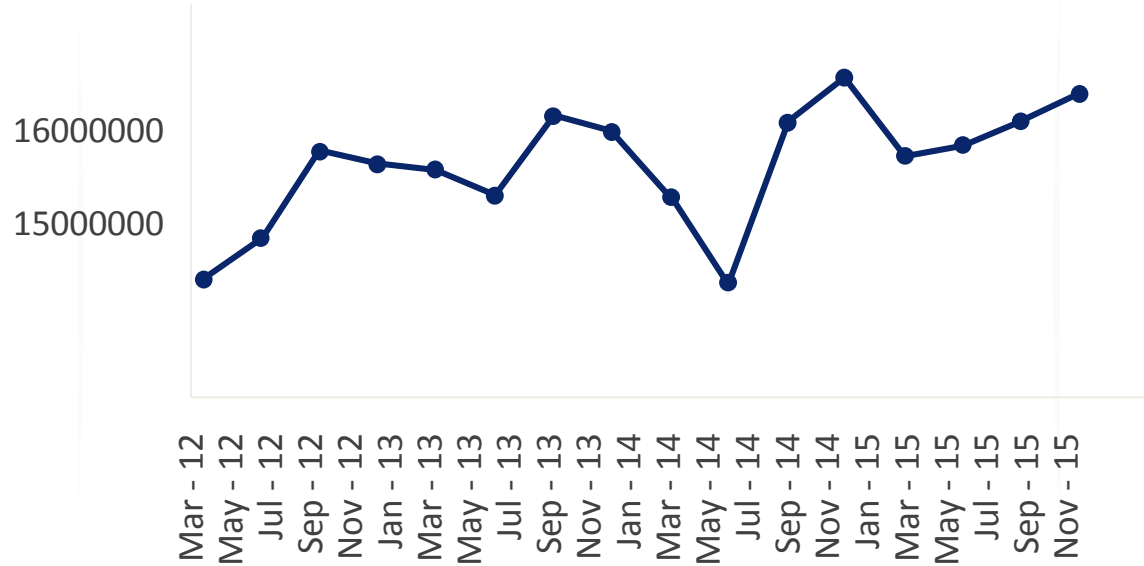


Equilibrium and Disequilibrium

US Total Hogs



Iowa Total Hogs



Emerging Disequilibrium

- Spatial Component
  - Localized or National
  - Dynamic or limited geographical
  - Mapping and scale
- Detection Sensitivity
  - Data diagnostics
  - Web scraping
- Other Factors
  - Operation size

Model Decisions

- Fundamental Decisions
  - One comprehensive model OR Several models (linked or switched)
  - Equilibrium model PLUS Diagnostics
  - Operation – level / State – level / National – level primary model
  - Resolution and level of detail
- Technical Issues
  - Inference for non-sample operations under disequilibrium conditions
  - Uncertainty estimates for hybrid model with mixed kinds of components / data
  - Computation requirements

Details and Specifics

- How estimation process works
- Sample design and data sources
- How two implemented models work
  - When each succeeds
  - When and why each fails
  - Potential for successful modification and extension
- New model
  - Incorporating lessons learned
  - Moving ahead – future directions