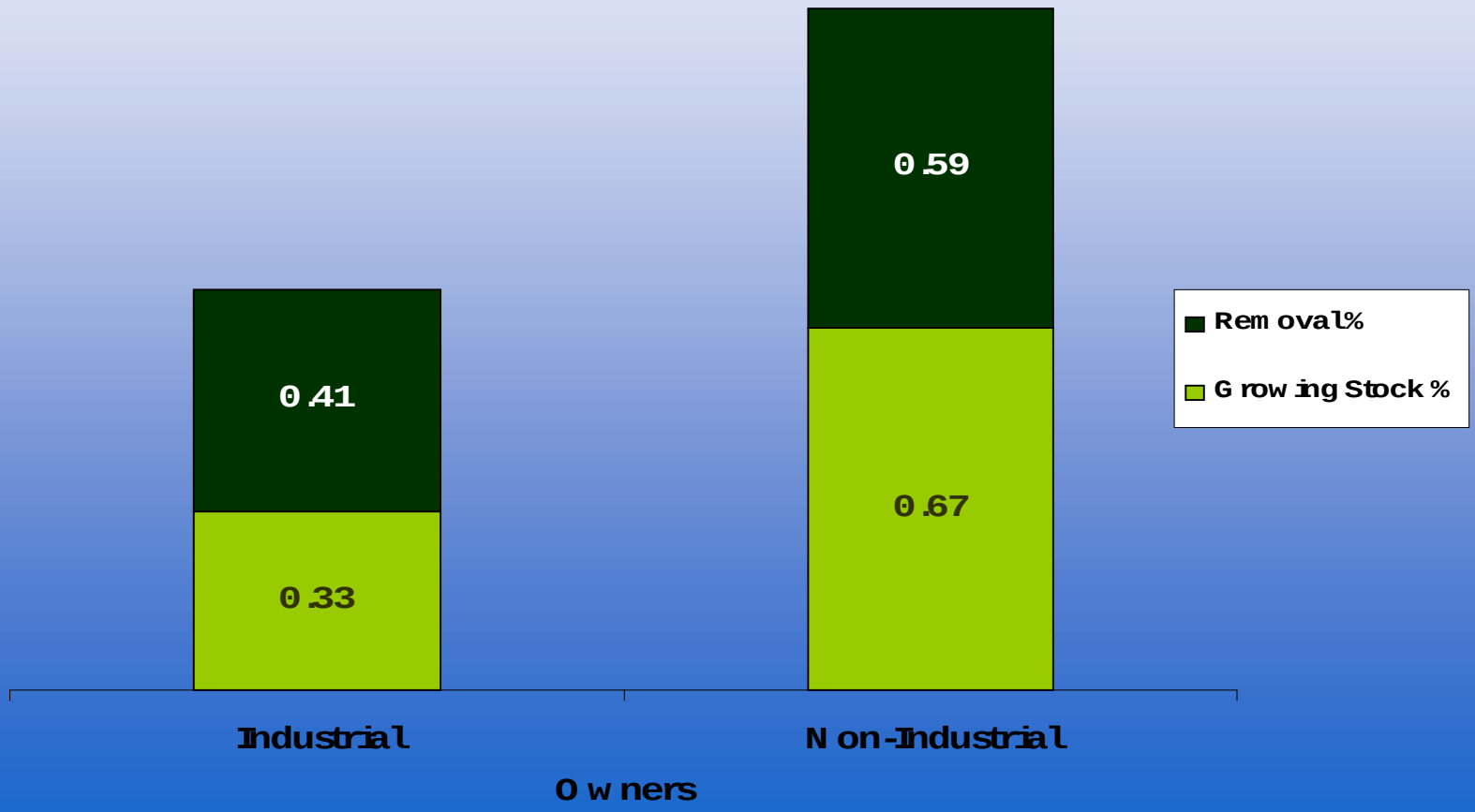
Modeling Timber Harvesting Behavior: II.B.2

- Introduction to Supply Modeling
- Evidence of Timber Supply Heterogeneity and Modeling Impacts
- Proposed Research Tasks

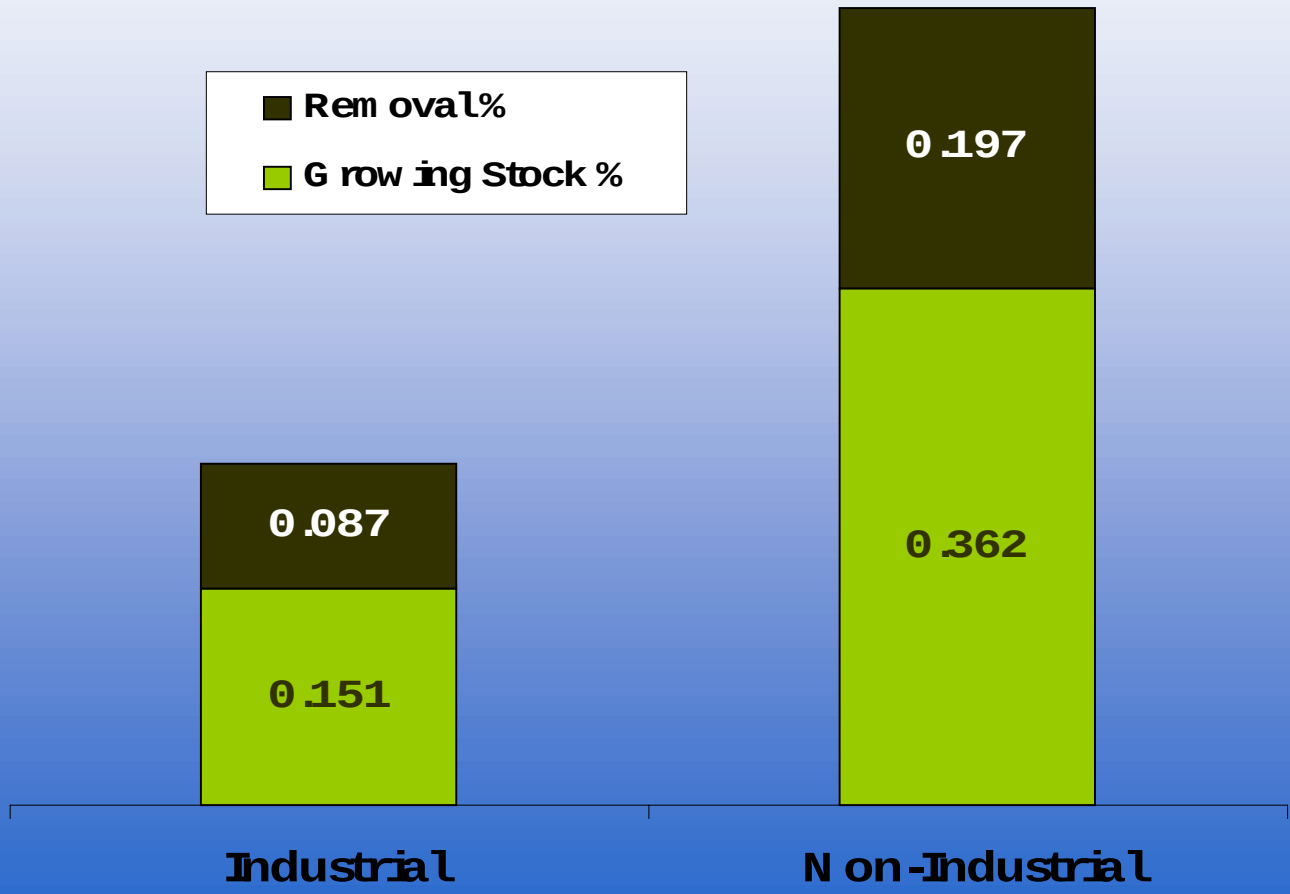
Introduction to Supply Modeling

- Parametric View of the World
  - Elasticity of Price
  - Elasticity of Inventory
  - Elasticity of Plantation Intensity
- Empirical Basis
- Heterogeneity
- Implications for Modeling Strategy
  - ‘Bottom-up’ vs. ‘Top-down’

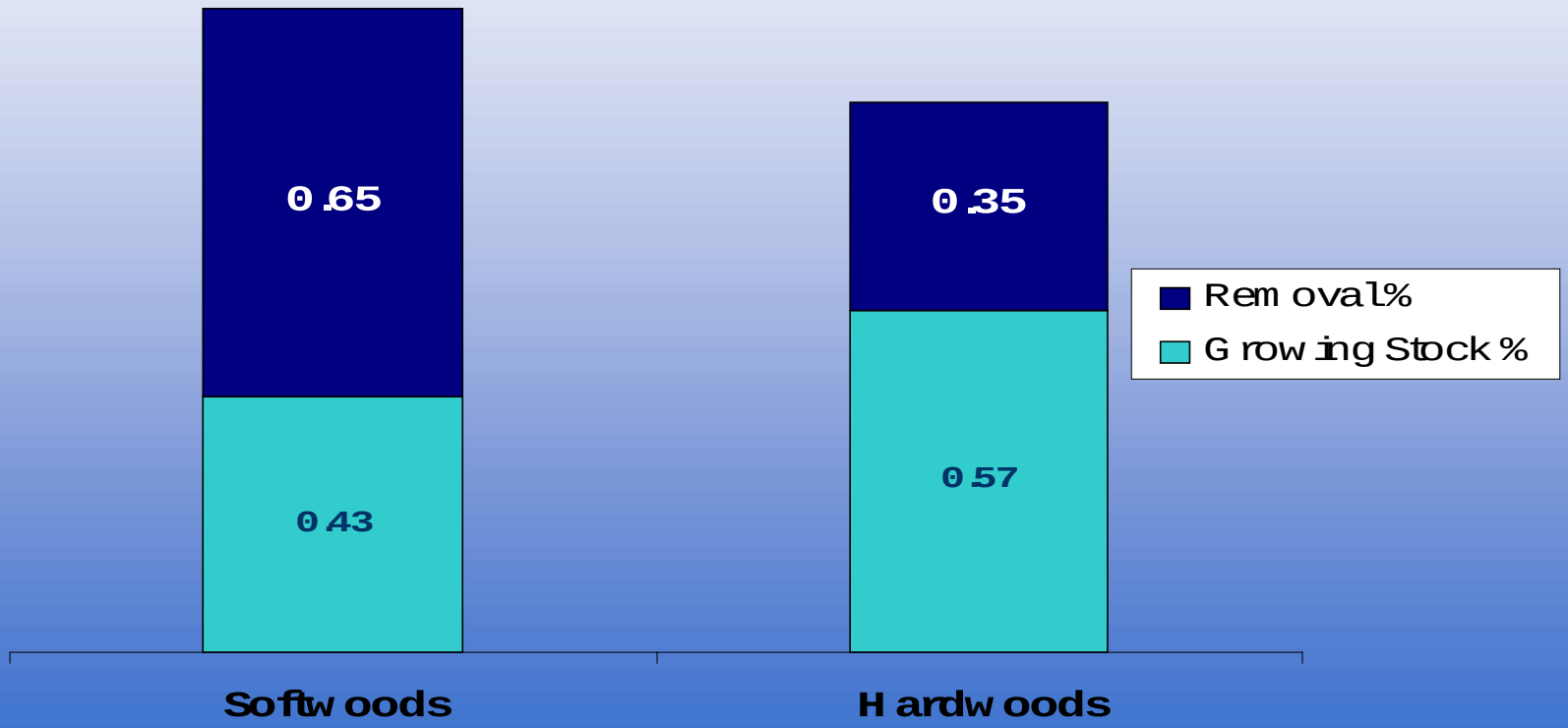
Empirical Evidence:
Removals and Growing Stock by Owners



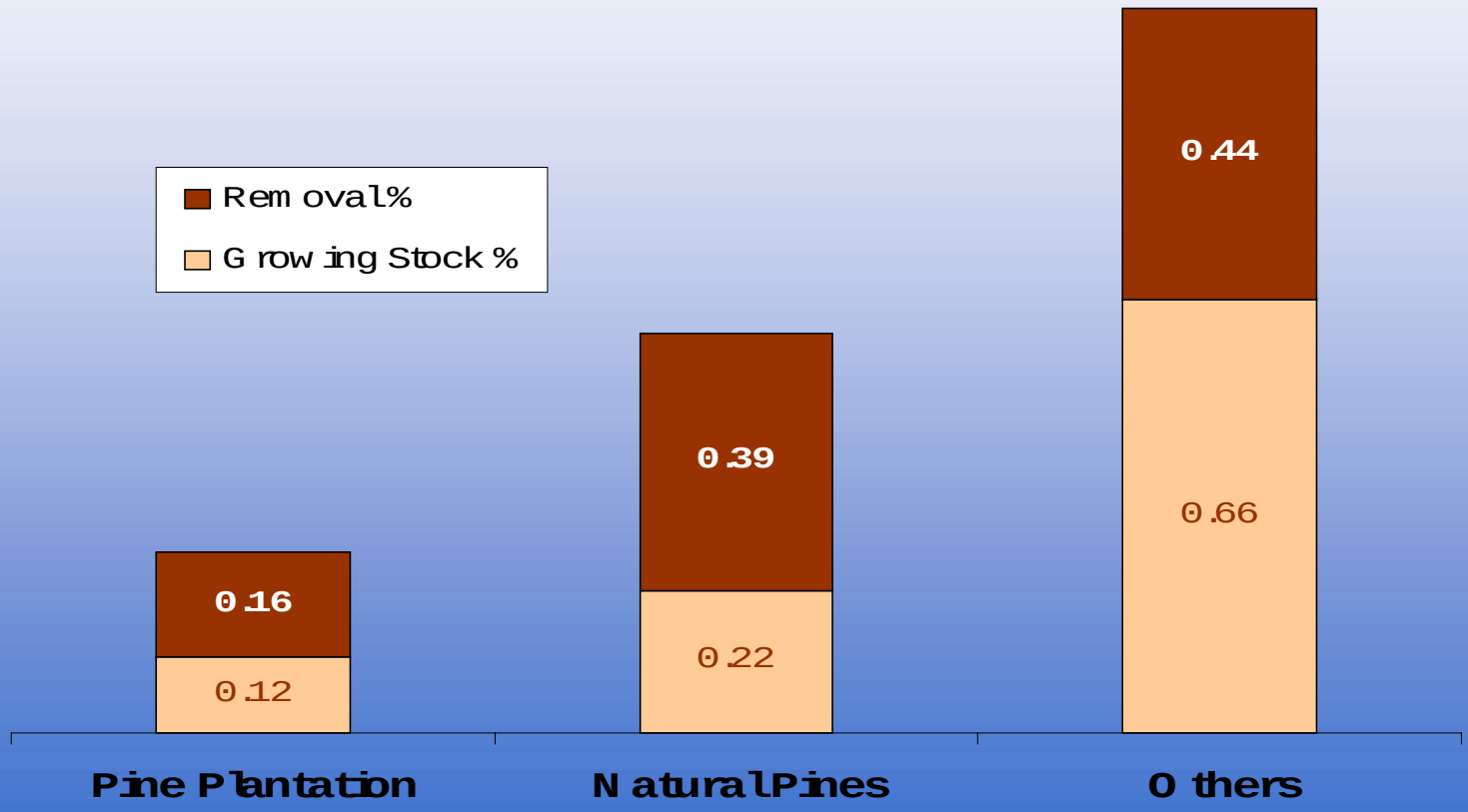
Empirical Evidence:
Removals and Growing Stock by Owners for Age-class >50



Empirical Evidence:
Removals and Growing Stock by Species



Empirical Evidence:
Removals and Growing Stock by Management Type



Exploratory Data Analysis

- Exploratory regression modeling of FIA data, Southeastern U.S.
- Age structure, Species, Ownership and Management on Harvest

$$
\begin{aligned}
\%H_{ijkl} = {} & \alpha_0 + \alpha_1 \bullet AG_i + \alpha_2 \bullet SP_j + \alpha_3 \bullet OW_k + \alpha_4 \bullet MT_l \\
& + \alpha_5 \bullet AG_i \bullet OW_k + \alpha_6 \bullet AG_i \bullet SP_j + \alpha_7 \bullet AG_i \bullet MT_l \\
& + \alpha_8 \bullet SP_j \bullet OW_k + \alpha_9 \bullet SP_j \bullet MT_l + \alpha_{10} \bullet OW_k \bullet MT_l \\
& + \alpha_{11} \bullet AG_i \bullet SP_j \bullet MT_l + \alpha_{12} \bullet AG_i \bullet SP_j \bullet OW_k + \alpha_{13} \bullet AG_i \bullet MT_l \bullet OW_k \\
& + \alpha_{14} \bullet AG_i \bullet SP_j \bullet MT_l \bullet OW_k \\
& + \%GS \bullet [\beta_0 + \beta_1 \bullet AG_i + \beta_2 \bullet SP_j + \beta_3 \bullet OW_k + \beta_4 \bullet MT_l \\
& + \beta_5 \bullet AG_i \bullet OW_k + \beta_6 \bullet AG_i \bullet SP_j + \beta_7 \bullet AG_i \bullet MT_l \\
& + \beta_8 \bullet SP_j \bullet OW_k + \beta_9 \bullet SP_j \bullet MT_l + \beta_{10} \bullet OW_k \bullet MT_l \\
& + \beta_{11} \bullet AG_i \bullet SP_j \bullet MT_l + \beta_{12} \bullet AG_i \bullet SP_j \bullet OW_k \\
& + \beta_{13} \bullet AG_i \bullet MT_l \bullet OW_k + \beta_{14} \bullet AG_i \bullet SP_j \bullet MT_l \bullet OW_k] \\
& + \varepsilon
\end{aligned}
$$

Hypothesis Test

- H_{01}: Ownership effect - joint significance of ownership dummy

  F 50, 587 = 7.1 p-value (F) = 0.0000

- H_{02}: Species effect - joint significance of species dummy

  F 49, 587 = 14.82 p-value (F) = 0.0000

- H_{03}: Management (PP) effect - joint significance of management

  F 26, 587 = 3.55 p-value (F) = 0.0000

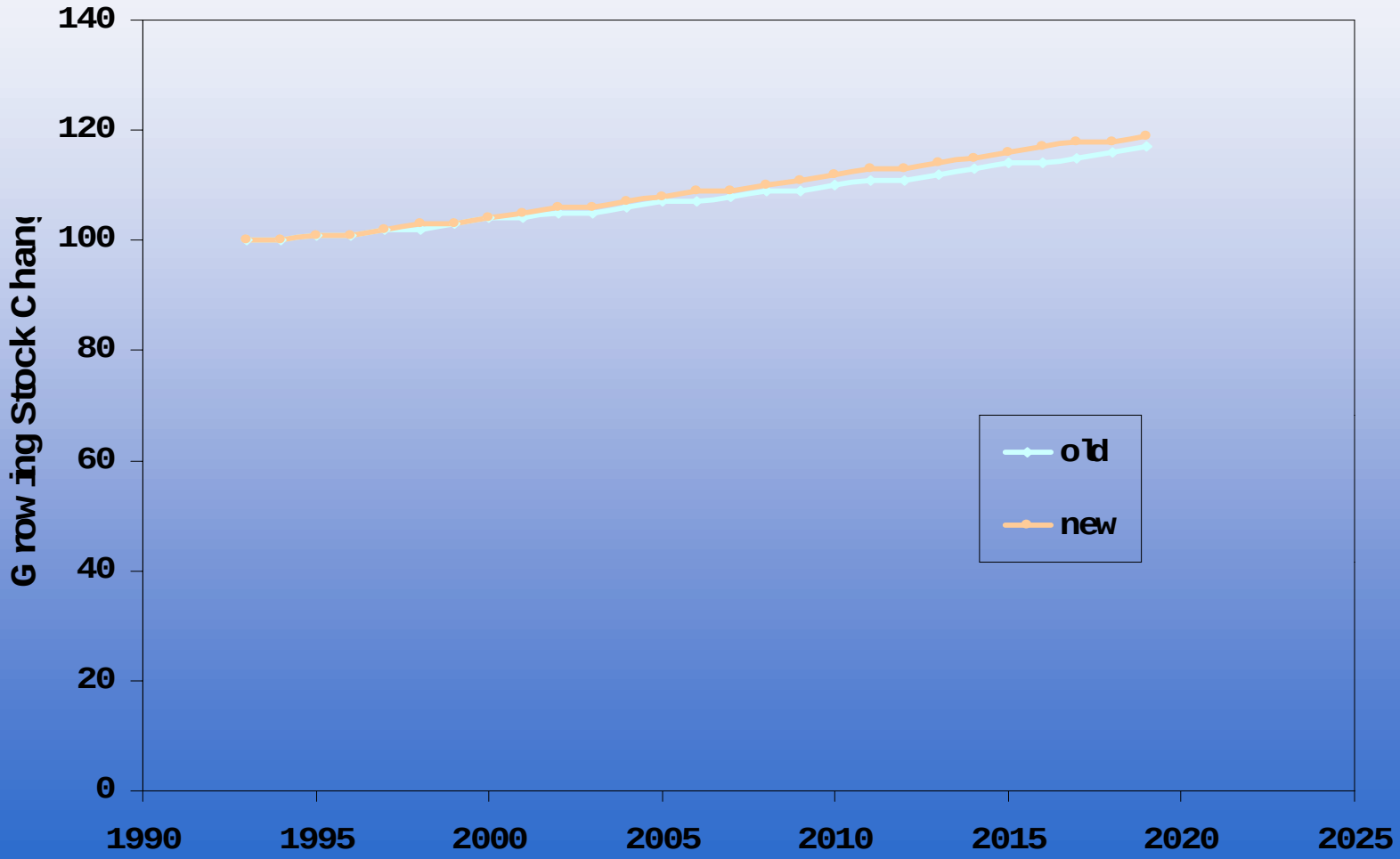
- H_{04}: Management (NP) effect - joint significance of management

  F 38, 587 = 7.16 p-value (F) = 0.0000

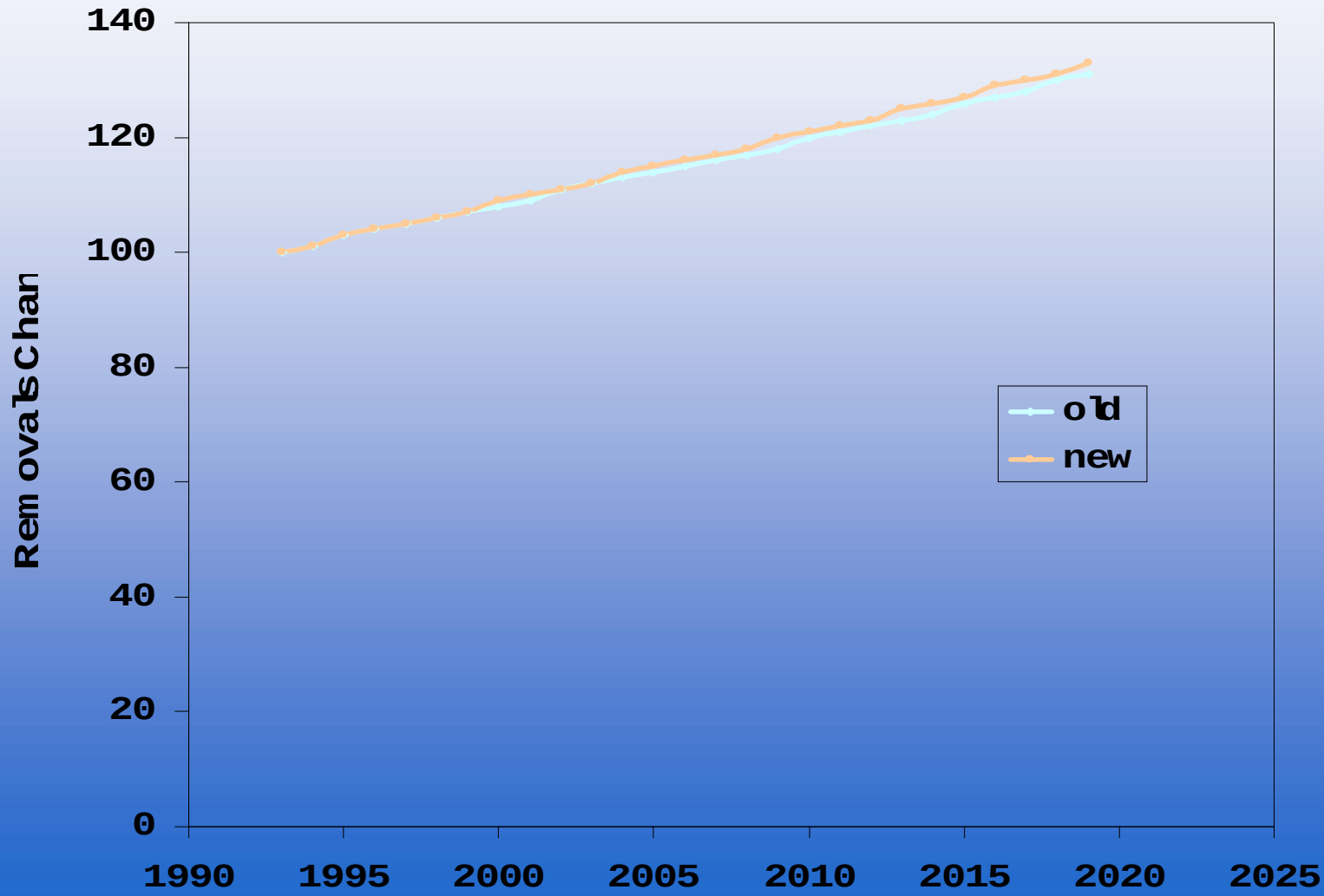
Effects of new modeling approach on projected outcomes

- Economic
  - growing stock
  - removals
  - prices
- Ecological (for North Carolina)
  - age class distribution
  - seral stages
  - wildlife suitability habitat

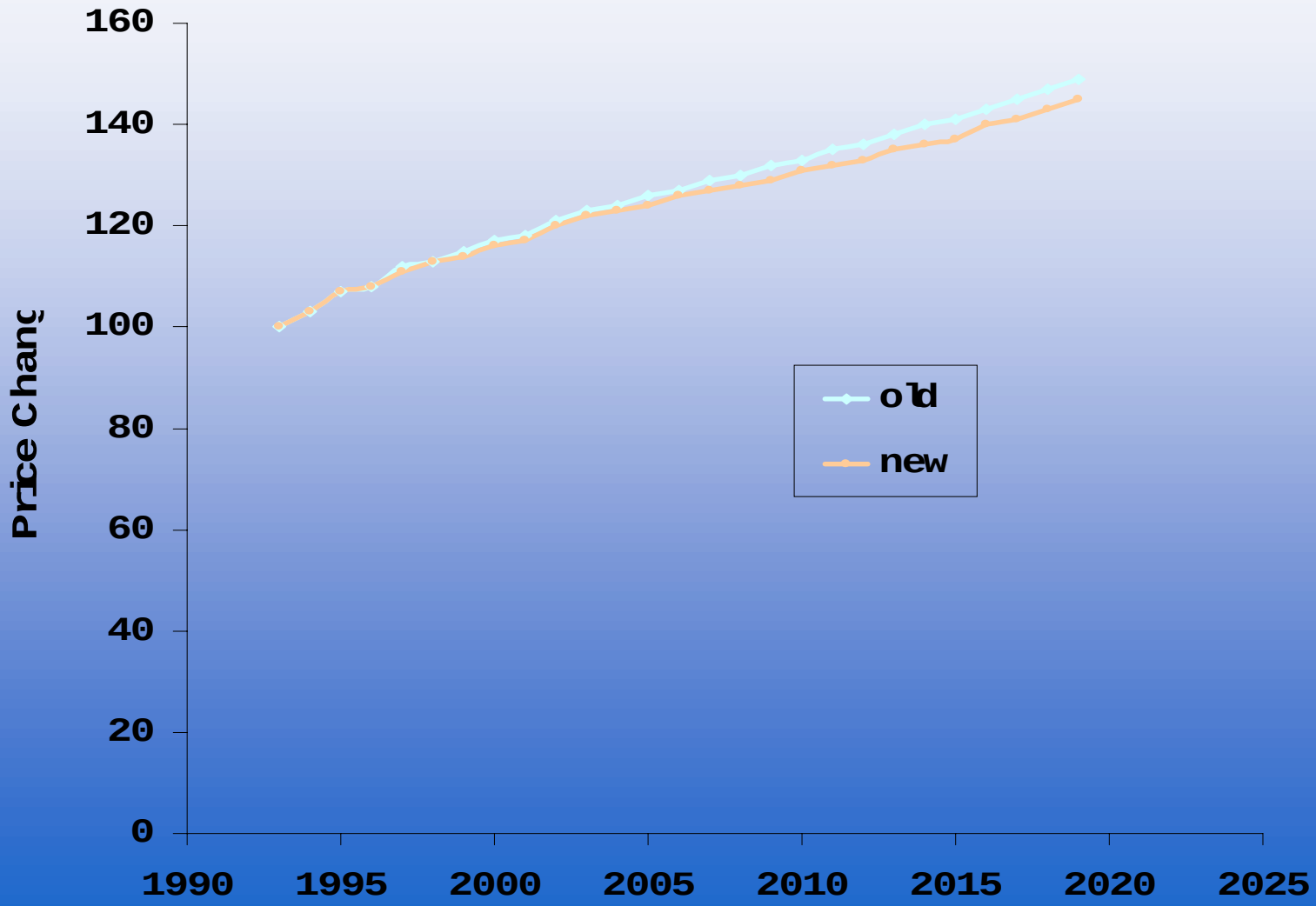
Growing Stock Projections (1994-2020) under two modeling approaches



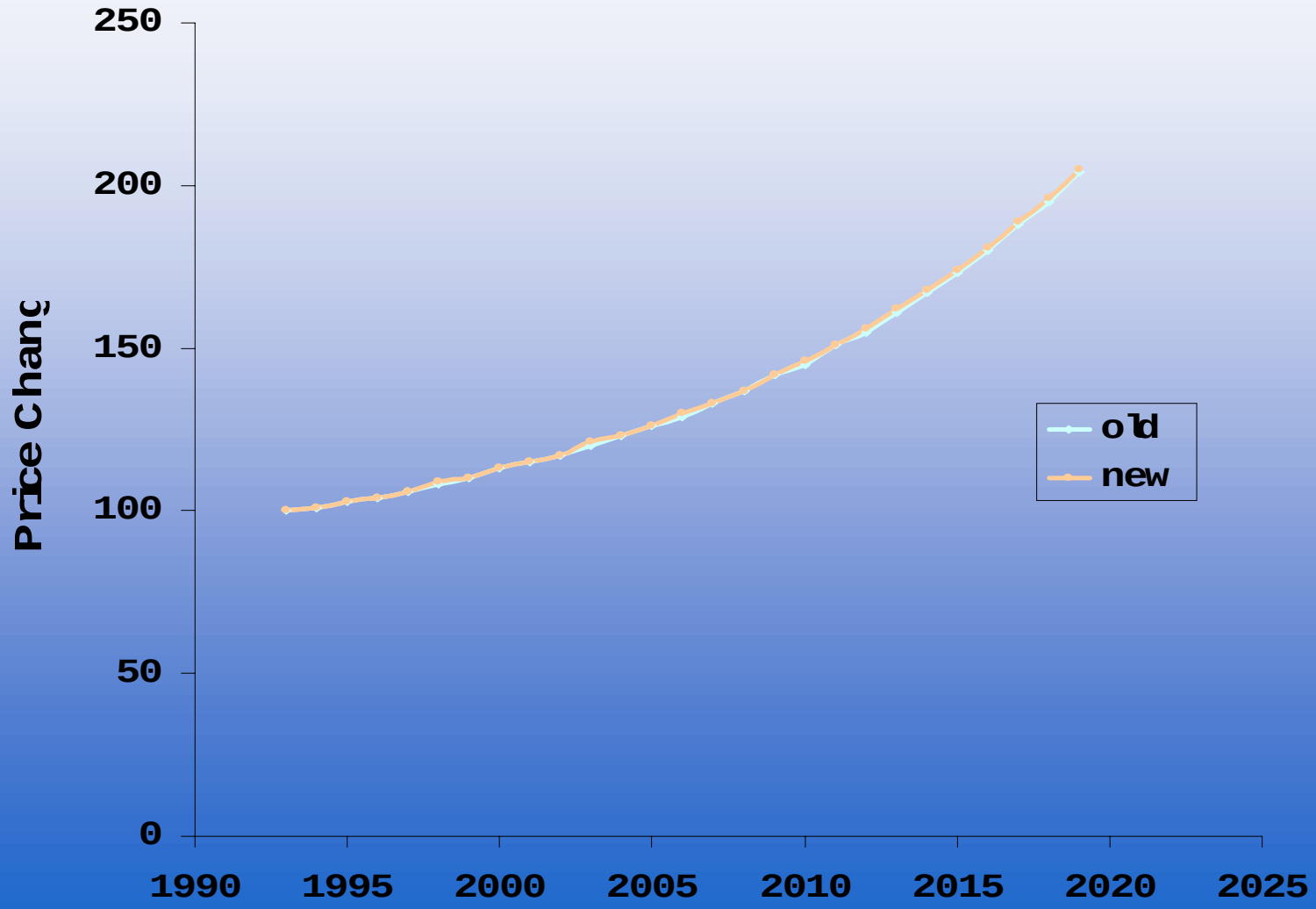
Removals Projections (1994-2020) under two modeling approaches



Softwood Price Projections (1994-2020) under two modeling approaches



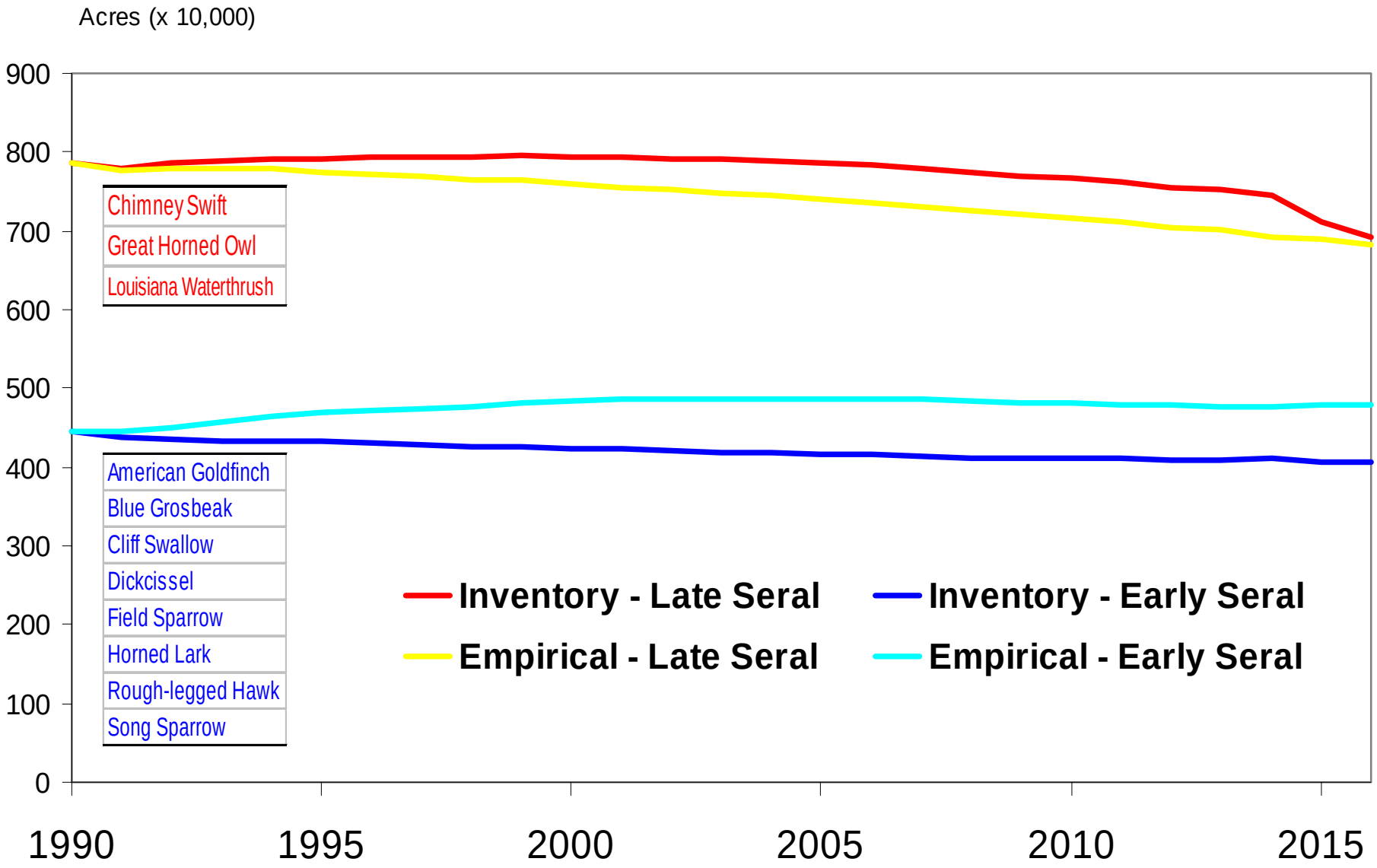
Hardwood Price Projections (1994-2020) under two modeling approaches



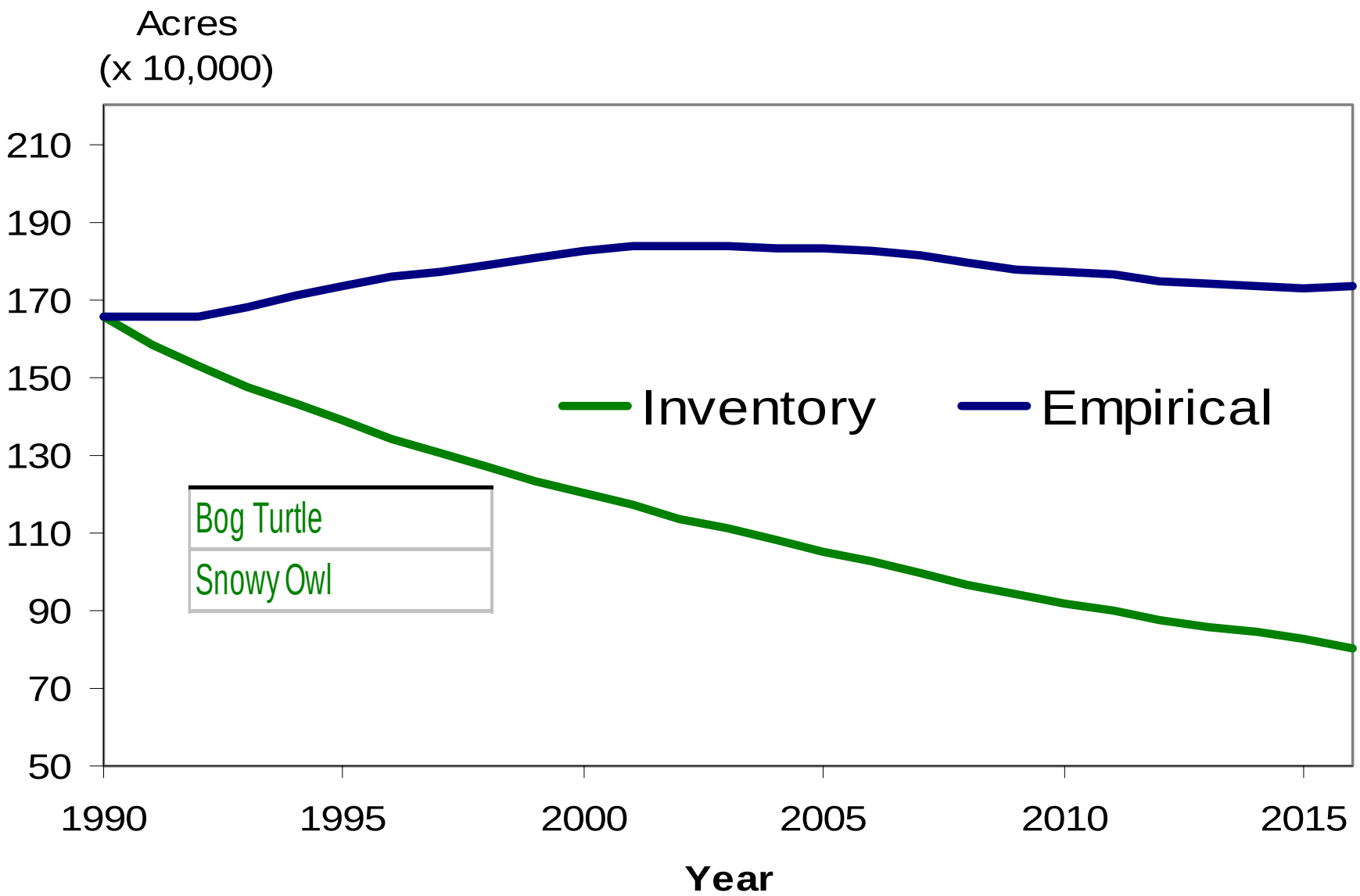
Harvesting Patterns and Wildlife Habitat (implications for product modeling)

- Link Age class distributions from SERTS to wildlife habitat model
- Evaluate effects of evolving forest structure (from SERTS) on habitat abundance for different wildlife species groups
- Evaluate whether modeling approach affects wildlife habitat projections
- Case study: North Carolina

NC All Mgt Types All Regions
Early vs Late Seral Stage



NC Piedmont/Mountain
All Mgt Types - Early Seral Stage



Task II.B.2.1: Consistently Aggregate Supply

- Move disaggregation down from unit-owner to type-age class level
- Estimate cell-level parameters

Task II.B.2.2 Collect Data

- Literature review (benchmark)
- Quantity data from FIA tables
  - physical volumes if measured at region scale
  - discrete variable (1 = cut, 0 = not cut) at plot level
- FIA tables will also provide disaggregated data on timber inventories
  - better biometric descriptions of forest growth,
  - influence of age-class distribution on timber supply
- Price data from TMS
  - accurate mapping of FIA and TMS measurement zones
  - using GIS coverage to crosswalk FIA and TMS
- Census data - characterize the different owners of forestlands

Task II.B.2.3: Identify Spatial Scale

- Little *a priori* justification for choosing a particular regional scale
  - FIA ‘plot’ supply (area expansion factor)
  - FIA unit supply (ST, Eco Region, SP, OW, MT)

- Patterns in the existing data to determine the scale of heterogeneity

- Purely empirical criterion to choose the appropriate spatial scale
  - compatibility of our price (TMS) and quantity (FIA) data.

Task II.B.2.4: Estimate Supply Parameters

- Timber Supply = Function (Market Prices, Timber Inventory, Socio-Economic Factors, Biophysical Characteristics)
  - Discrete choice version of harvesting
  - Continuous version of quantity of timber supply
- Three established statistical methods to determine the extent of heterogeneity
  - fixed effects,
  - random effects,
  - random coefficients
- Choose among these models based on the predictive power

Task II.B.2.5: Verify Model Parameters

- Statistical criteria for predictability (*e.g. A*dj R^2)
- Internal Statistical Verification
  - estimation data subset (A), validation data subset (B)
  - compare predicted for B, using estimates from A, with actual timber supply for B
- External Economic Verification
  - use model parameters in MP-SRTS for validation runs
  - compare the simulated prices, timber inventory, and timber harvests to historical trends and future projections available in the literature