Dissertation Chapter Outline

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# Chapter 1: White-tailed Deer Management in the 21st Century

## Chapter Objective

* Conduct a conceptual synthesis of white-tailed deer (WTD) population modeling and monitoring tools as they relate to management decision-making in the 21st century.
* Evaluate the evolution of analytical approaches, identify persistent limitations, and synthesize a pluralistic, reproducible framework for state agency decision-making.

Produce a generalizable **decision-making framework** that integrates multiple modeling approaches to address contemporary management challenges.

### Introduction and Rationale

* Turning point in management: shifting from restoration and harvest regulation to disease control, hunter recruitment/retention, climate change adaptation, and sociopolitical considerations.
* Current decision-making often shaped by legacy approaches from the 20th century, despite changing ecological and social contexts.

Absence of a standardized, transparent, and reproducible framework hinders agency capacity to make defensible, adaptive decisions.

## ### Historical Foundations

* Major management eras:
  + *Exploitation and near-extirpation* (pre-1900s)
  + *Restoration and recovery* (1910s–1950s)
  + *Population expansion and Quality Deer Management* (1970s–2000s)
  + *Contemporary era* (2010s–present) — marked by disease emergence, declining hunter participation, and broader environmental change.
* Role of the North American Model of Wildlife Conservation in shaping funding structures, public trust mandates, and harvest regulation.

Legacy effects: how past successes and institutional frameworks constrain modern adaptation.

### Contemporary Management Challenges

* **Ecological and epidemiological drivers**: CWD, EHD, bovine TB, Lyme disease, climate-driven range shifts.
* **Sociocultural pressures**: declining hunter numbers, shifting demographics, urbanization, changing stakeholder expectations.
* **Political and institutional constraints**: policy inertia, mistrust in agencies, stakeholder polarization.
* **Private–public land management tensions**: DMAP programs, cooperative data sharing, and regulatory consistency.

### Current Decision-Support Practices

* Dominance of harvest-based monitoring: Statistical Population Reconstruction (SPR), Sex–Age–Kill (SAK) models — data needs, assumptions, scalability.
* Supplementary and alternative data sources:
  + Camera trap surveys, including citizen science integration
  + Roadkill/incidental mortality reports
  + Telemetry and GPS collar data
  + Hunter effort and satisfaction surveys

Integration potential: double-sampling designs, linking low-resolution extensive data with intensive localized datasets.

### Evolution of Population Modeling Approaches

* **Traditional approaches**: SAK, SPR, matrix models — strengths and weaknesses in informing harvest policy.
* **Modern approaches**:
  + Bayesian hierarchical/state-space models
  + Spatially explicit agent-based models (ABMs)
  + Hybrid and modular models combining elements of both
* **Evaluation criteria**:
  + Data requirements and availability
  + Interpretability for managers/stakeholders
  + Cost/logistical feasibility
  + Flexibility to evaluate alternative scenarios
* Reproducibility and transparency

### Toward a Pluralistic “Bouquet of Tools”

* Rationale for modular frameworks over single-model dependence.
* Ani’s “Rule of 3”: no model can answer all questions; multiple complementary tools are needed to address the full decision space.

Mapping model types to decision needs (e.g., harvest optimization, disease risk assessment, habitat change impacts).

### Gaps and Opportunities

* Lack of reproducible workflows and standardization across agencies.
* Underuse of citizen science and participatory monitoring in formal frameworks.
* Limited cross-jurisdictional data integration and sharing.

Opportunities for cloud-based, interactive decision-support tools (e.g., Shiny, GitHub-hosted workflows) to democratize access and facilitate adaptive management.

### Final Synthesis: Proposed Decision-Making Framework

* Core principles: generalizability, precision, reproducibility, transparency, and adaptability.
* Integration of multiple data streams with complementary modeling approaches.
* Explicit documentation of assumptions, uncertainty, and trade-offs in decision outcomes.
* Framework designed for scalability across spatial (property, zone, state) and temporal (annual, decadal) scales.
* Intended as a **decision-support blueprint** for state wildlife agencies to guide defensible and adaptive WTD management in the 21st century.

## Chapter 2: Building a Modeling Framework for Deer Management

**Objective**:

* Build an adaptable population modeling framework using Alabama as the initial focus, centered around an ABM and designed for eventual transferability to other states or contexts.

**Main Points**:

* Outline of available harvest data, cooperator check station records, and decision workflows currently used by Alabama DWFF.
* ABM built using ODD protocol as the foundation using available data in AL representing spatial harvest dynamics, deer life-history, and hunter behavior.
* Integrate other modeling and methods (e.g., spreadsheet deterministic models can help initialize or calibrate the ABM)
* Scenario-based evaluation: simulate the impact of regulatory changes (e.g., season length, bag limits, spatial scale, demographic ratios) on deer population structure and harvest outcomes.
* Use trade-off analysis to visualize how decisions might perform across multiple agency objectives (e.g., age structure, harvest numbers, effort).

**Alternatives and Additions**:

* Demonstrate generalizability by applying model structure to a second southeastern state using their data templates. (motivation for participatory effort from DWFF)
* Include scenarios with a decline in hunting participation and explore alternative approaches (e.g., landowner incentives, recruitment-focused efforts).

## Chapter 3

## Option A: Integrating Evaluating Nontraditional Data for Modeling and Monitoring

**Objective**:

* Assess the potential to incorporate and validate wildlife population models using existing data sources that are publicly available

**Main Points**:

* Categorize data by structure: traditional (cooperator harvest), semi-structured (camera projects), and unstructured (e.g., social media, opportunistic sightings).
* Test how these data could validate model predictions or refine parameter estimates.
* Build feedback loops where outputs from simulations inform priorities for new data collection, and vice versa.
* Consider implementation challenges such as standardization, storage, legal concerns.
* Highlight automation opportunities (e.g., ML image classification), and future surveillance systems that enable more responsive management.

**Alternatives and Additions**:

* Focus in on trail cameras as a case study—building off recent applications in avian monitoring (e.g., Jonathon’s bird point work).

## Option B: Designing Modeling Tools and Data Systems with State Agencies and Stakeholders

**Objective**:

* Work directly with Alabama DWFF and other stakeholders to co-develop usable, trusted, and streamlined data systems and modeling interfaces.

**Main Points**:

* Identify what data is already collected (e.g., antler points, age estimates) and evaluate how it could feed into a modeling workflow.
* Propose centralized workflows to reduce archived or inconsistent data collection (e.g., digital entry from the field, real-time dashboards).
* Conduct interviews or surveys with hunters, landowners, and agency staff to understand trust in models, desired outputs, and transparency needs.

## Option C: Modeling Stressor Interactions and Regulatory Trade-Offs in Southeastern Deer Populations

**Objective**:

* Extend the ABM to simulate how interacting population stressors such as disease outbreaks, habitat degradation, and invasive species—could shape management outcomes and risk-based decision-making.

**Main Points**:

* Overview of stressors: CWD, EHD, tick-borne burdens, drought effects, competition with pigs.
* Link stressor events to modeled dynamics (e.g., how reduced forage + high density = higher disease prevalence).
* Simulate compounding scenarios (e.g., drought year + reduced hunter effort + EHD outbreak).
* Evaluate cross-boundary impacts from local disturbances.
* Model surveillance strategies and adaptive regulation
* Include uncertainty analysis: how risk tolerance and unknowns could shift decision thresholds.