



A spatial model of elephant, vegetation and fire dynamics for scenario-based adaptive management simulations

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Overview

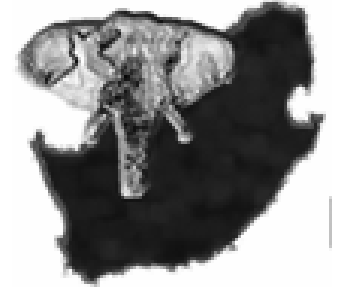


- Challenge: Modeling for Adaptive Management
 - Landscape Scale Elephant/Vegetation Modeling
 - Uncertainty and sensitivity analysis
 - Global sensitivity analysis techniques
 - Decision analysis techniques
- Integration for Scientific and Institutional Learning



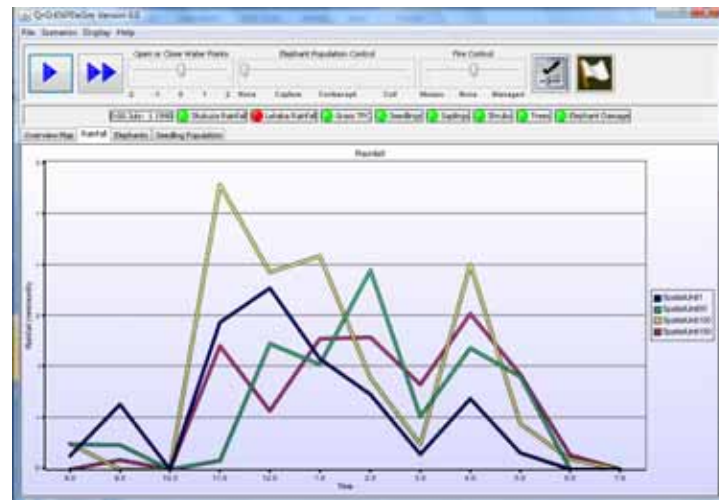


Assessment of South African Elephant Management



- Translates existing scientific information into a form usable by policymakers.
 - **Legitimacy:** the stakeholders have to accept that the process is well-founded
 - **Saliency:** it must be relevant to an expressed need
 - **Credibility:** it must be conducted by experts, to the highest standards
- www.elephantassessment.co.za
- RJ Scholes and KG Mennell (eds) ***Elephant Management: A Scientific Assessment of South Africa***. Witwatersrand University Press, Johannesburg.

QnD:EleSim Model



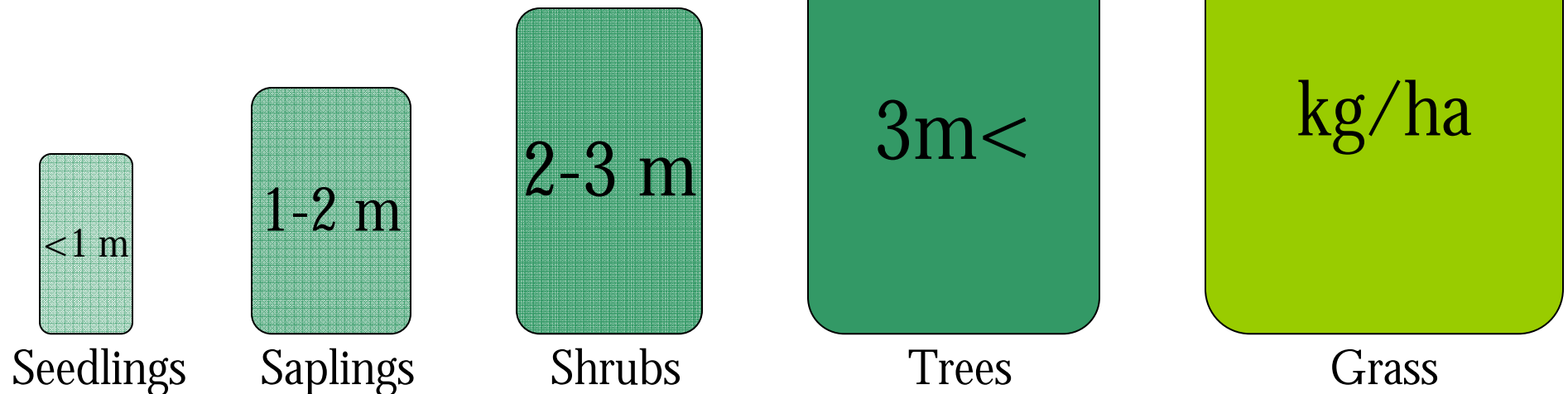
- QnD – “Questions and Decisions” or “Quick n Dirty”
- A fully integrated, open-source, Graphic User Interface (GUI) with a flexible, agent-based modelling engine
- Spatial simulation with GIS linkage
- Multiple maps/graphs/files for output variables
- Elephant /Vegetation/Fire Modelling “inspired” by Baxter 2003; Baxter and Getz 2005
- Modular components with interchangeable XML format

QnD:EleSim Model Assumptions

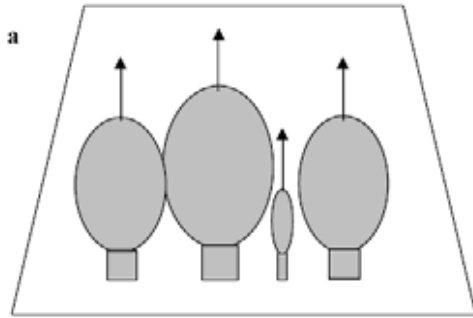
- 10 km² hectare grid resolution (195 grids)
- Monthly time step (with seasons)
- Climatic Data (Historic or Stochastic)
 - Rainfall Ratios (monthly amount/Long term Average)
 - 9 stations currently used
- Vegetation
 - One generic woody plant species (more planned)
 - One generic grass species with base
 - Parameters based on Venter Land System (ongoing)
- Fire
 - Historic map inputs for calibration/validation period
 - van Wilgen/Biggs fire probability - $f(\text{grass biomass})$
- Elephant population movement/interchanges among grid cells
 - Metapopulation
 - Individual-based
- Algorithmic details in Baxter (2003), Baxter & Getz (2005) and Kiker et al (2008), or via email/Skype (gkiker@ufl.edu)

QnD:EleSim Vegetation Classes

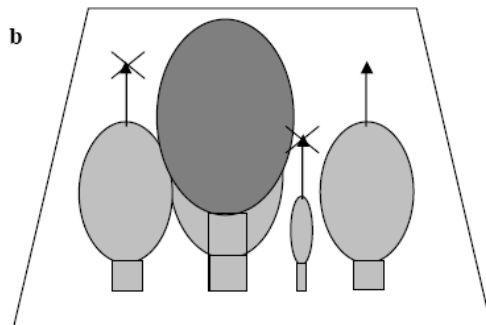
- In each of the 195 spatial areas, a set of vegetation objects exist
- Woody Plants – 4 Woody Population Objects based on height (simplified from Baxter's 9 size classes)
- Grasses – 1 Grass Object based on area and biomass
- Processes
 - Woody Plant Growth and Mortality (Area and Population)
 - Grass Growth and Mortality (Area and Biomass)
 - Elephant Browsing/Grazing Mortality and Transition
 - Fire Mortality and Transition



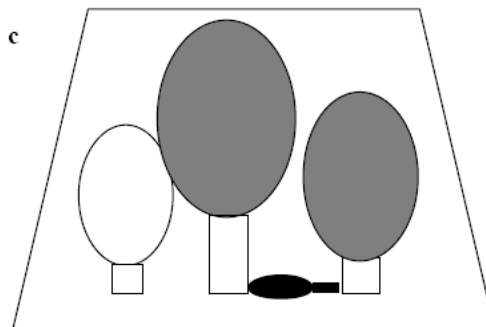
Vegetative Growth Limitations



No vegetation limitations on expansion (rainfall limited only)

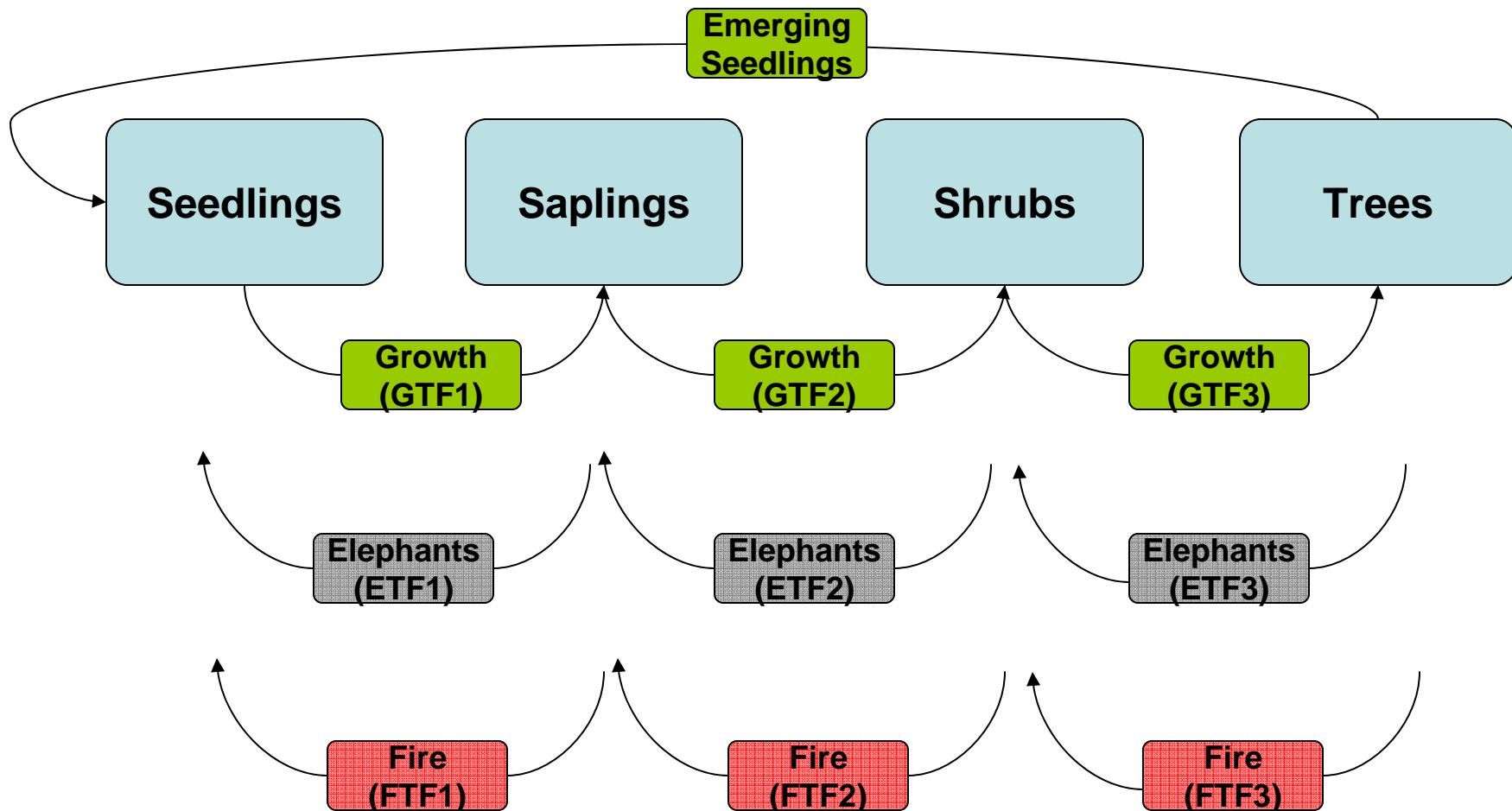


Limitations on expansion by growth (Shrub transition to tree limits other shrubs, saplings and seedlings)



Limitations on expansion by crowding (More mature plants, have priority over smaller plants, self thinning is possible)

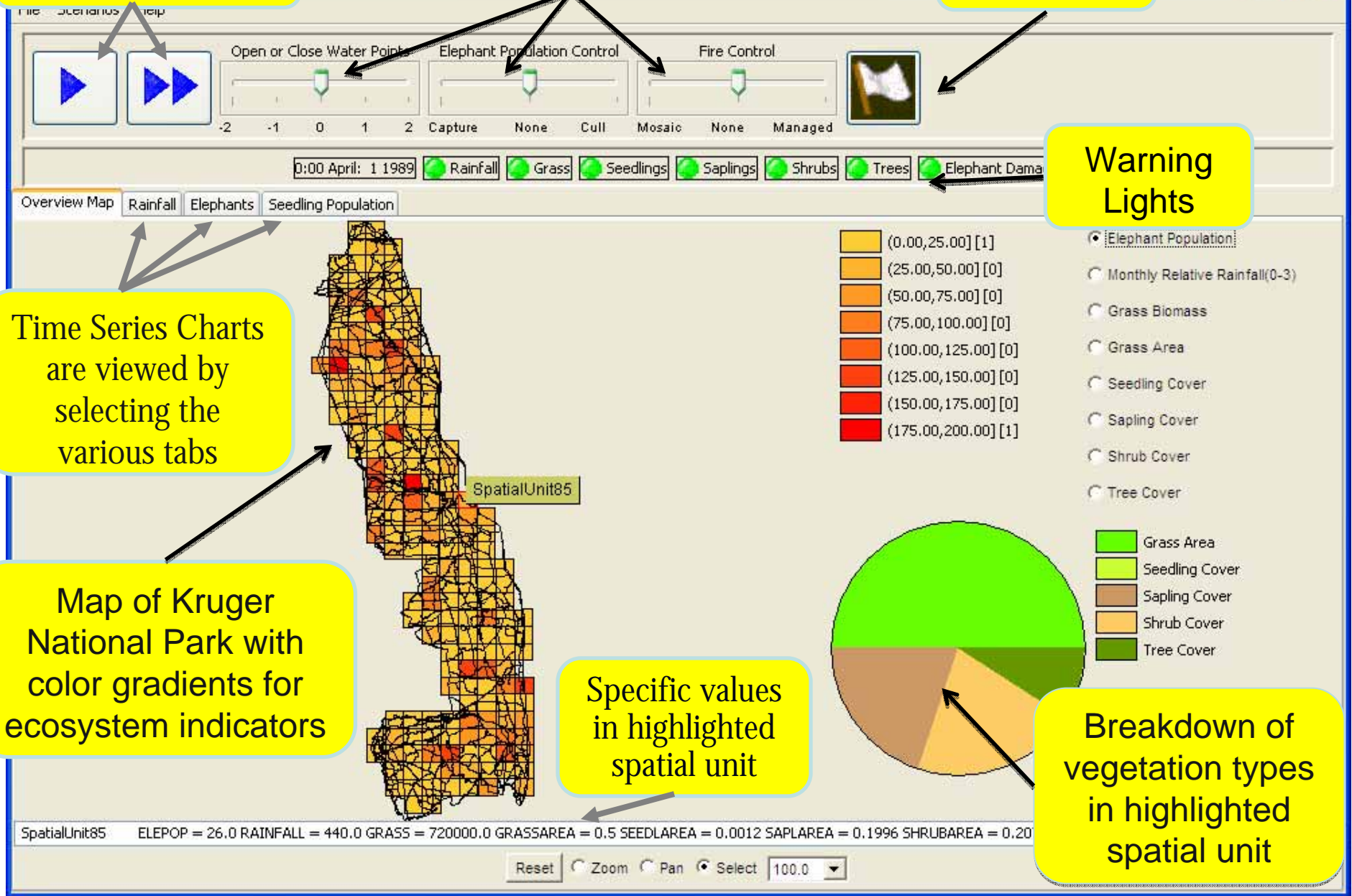
Woody Structure in Each Spatial Unit



1 month and 6 month timesteps

Management Decisions

Reset Time Series



Warning Lights

Time Series Charts are viewed by selecting the various tabs

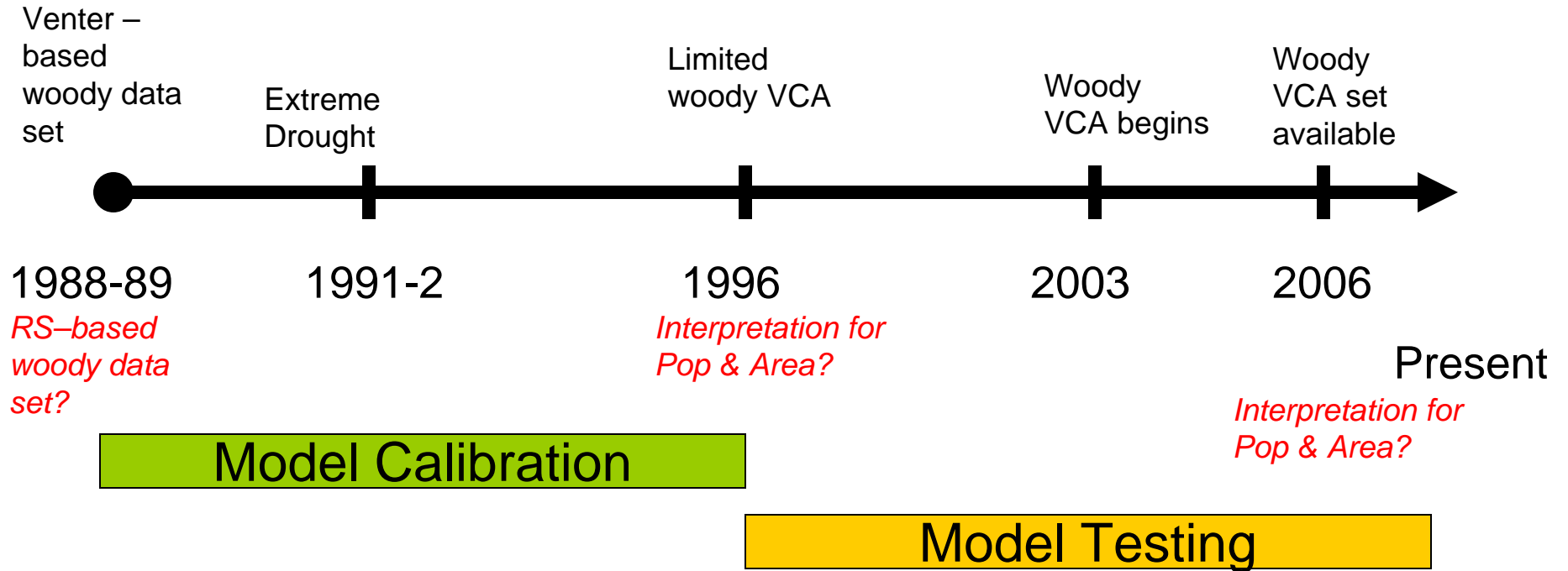
Map of Kruger National Park with color gradients for ecosystem indicators

Specific values in highlighted spatial unit

Breakdown of vegetation types in highlighted spatial unit

SpatialUnit85 ELEPOP = 26.0 RAINFALL = 440.0 GRASS = 720000.0 GRASSAREA = 0.5 SEEDLAREA = 0.0012 SAPLAREA = 0.1996 SHRUBAREA = 0.20

Model Testing Strategy

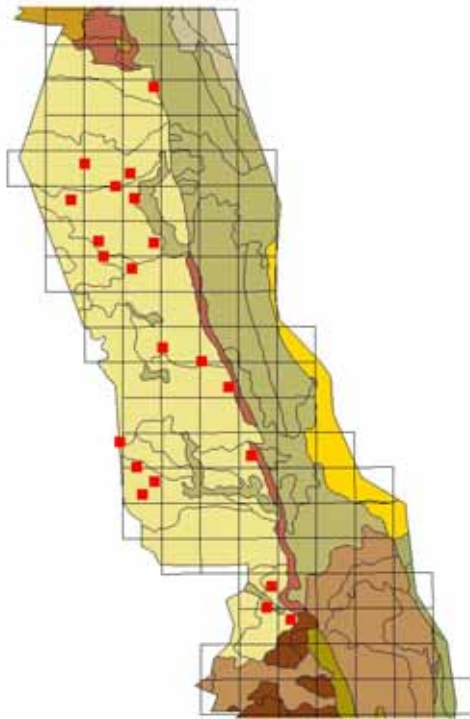


Historical Data as inputs: Rainfall, Fire, Elephant Populations

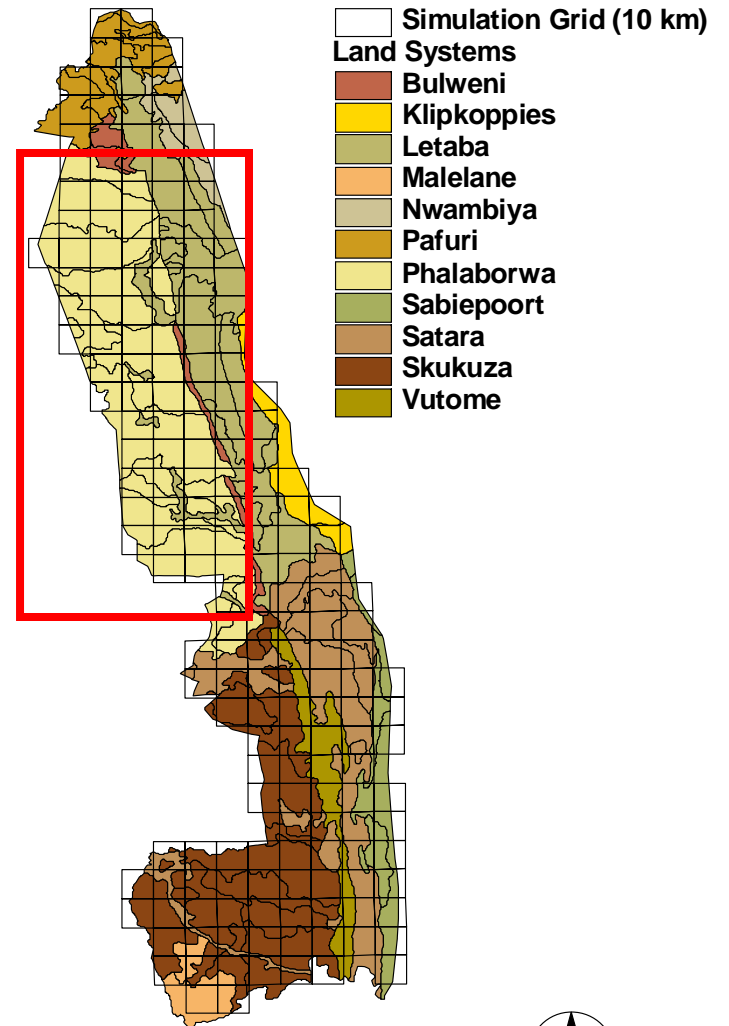
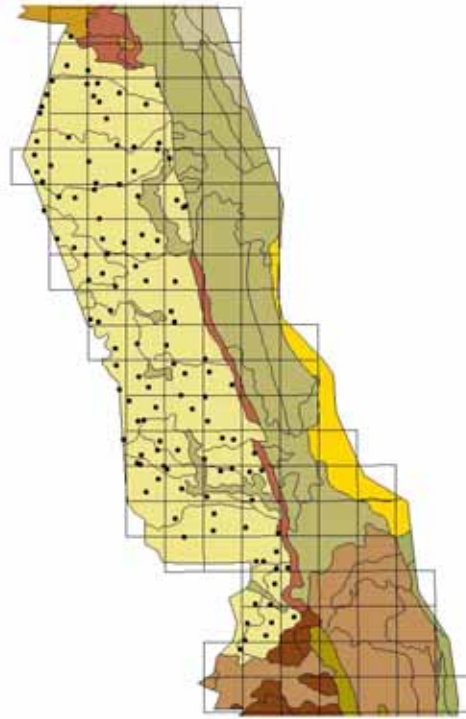
Scenario runs : Projected rainfall, stochastic fire, moving elephants!

Land System Based Comparisons for Vegetation

1996 Woody VCA Sites



Herbaceous VCA Sites



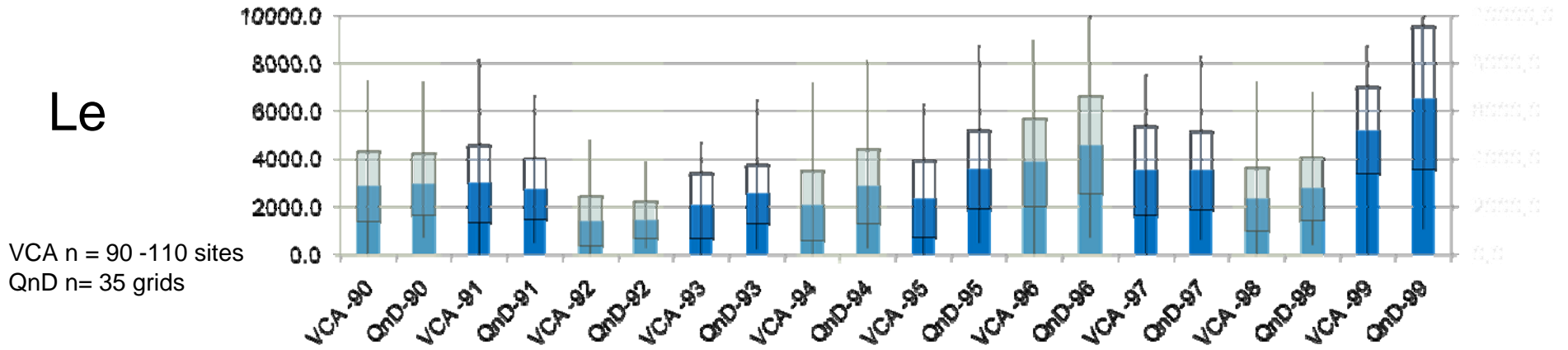
0 30 60 Kilometers



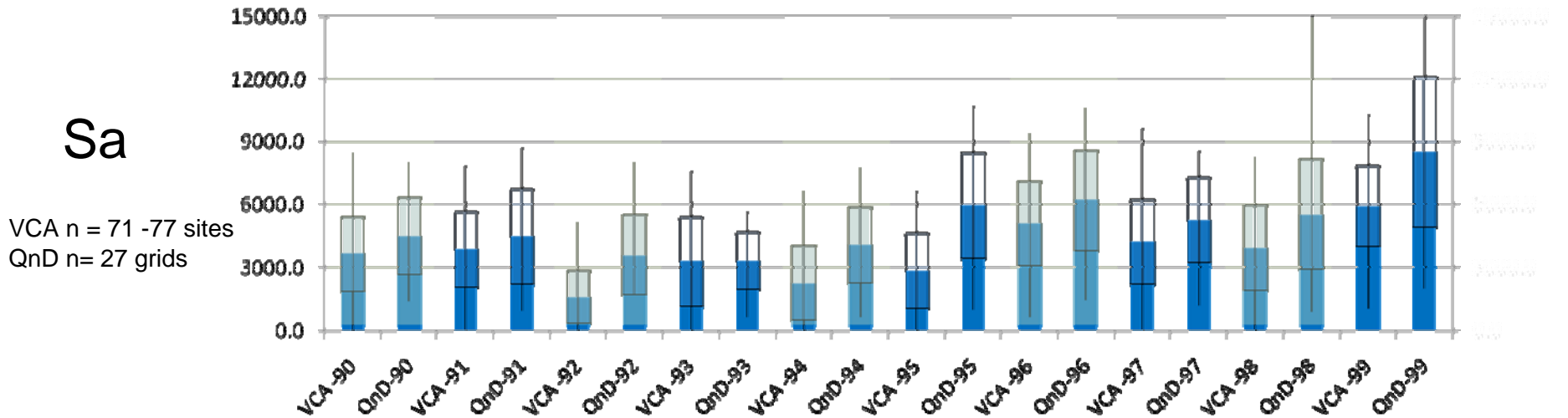
Peak Herbaceous Biomass (kg/ha) Comparisons

Observed (VCA) vs Simulated (QnD)

Le



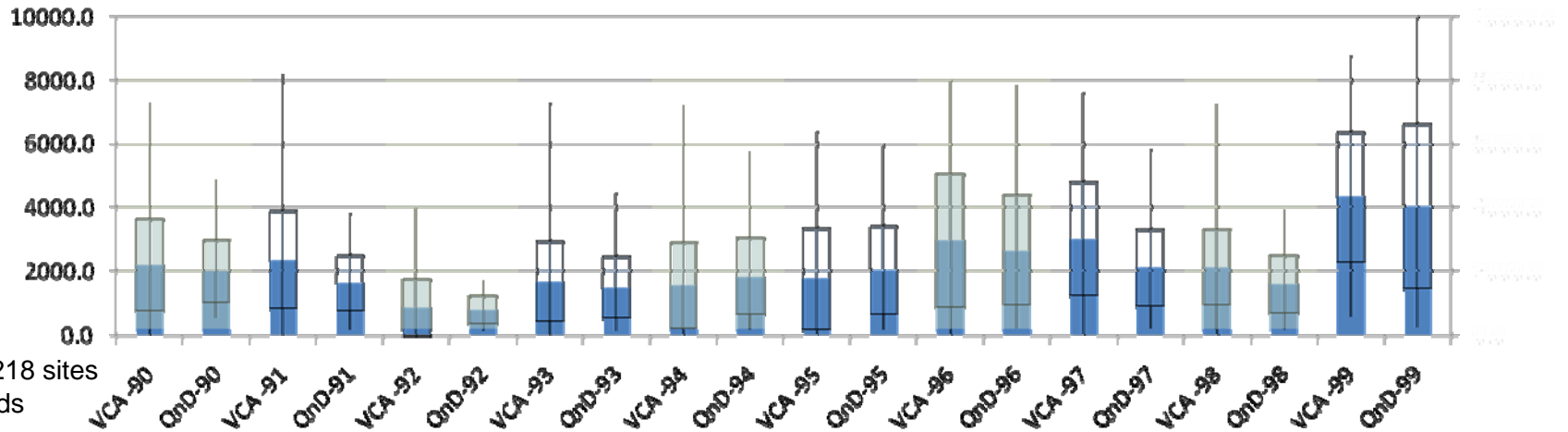
Sa



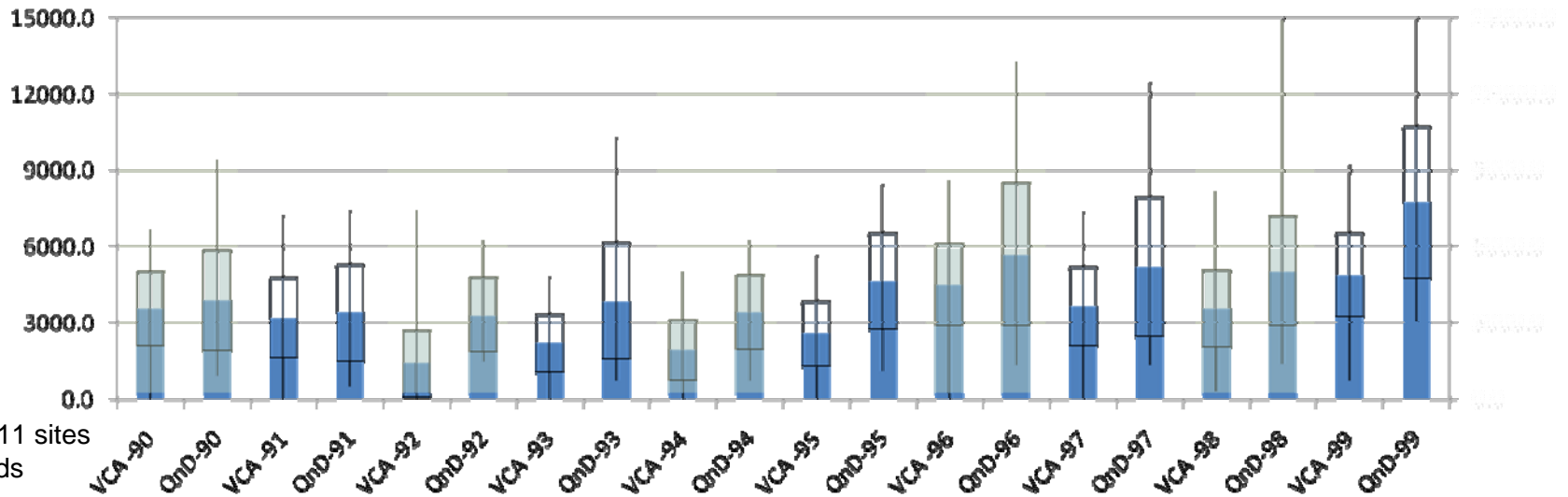
Peak Herbaceous Biomass (kg/ha) Comparisons

Observed (VCA) vs Simulated (QnD)

Ph



Sk



Example Results:

Initial comparison with Woody VCA 1996

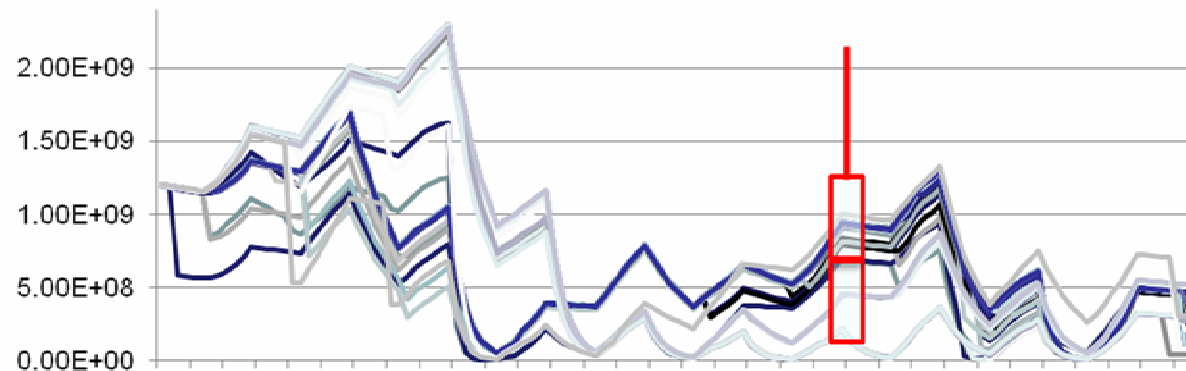
Ph Land System

WVCA n=21

Seedling Population
(#/grid)

QnD n=52

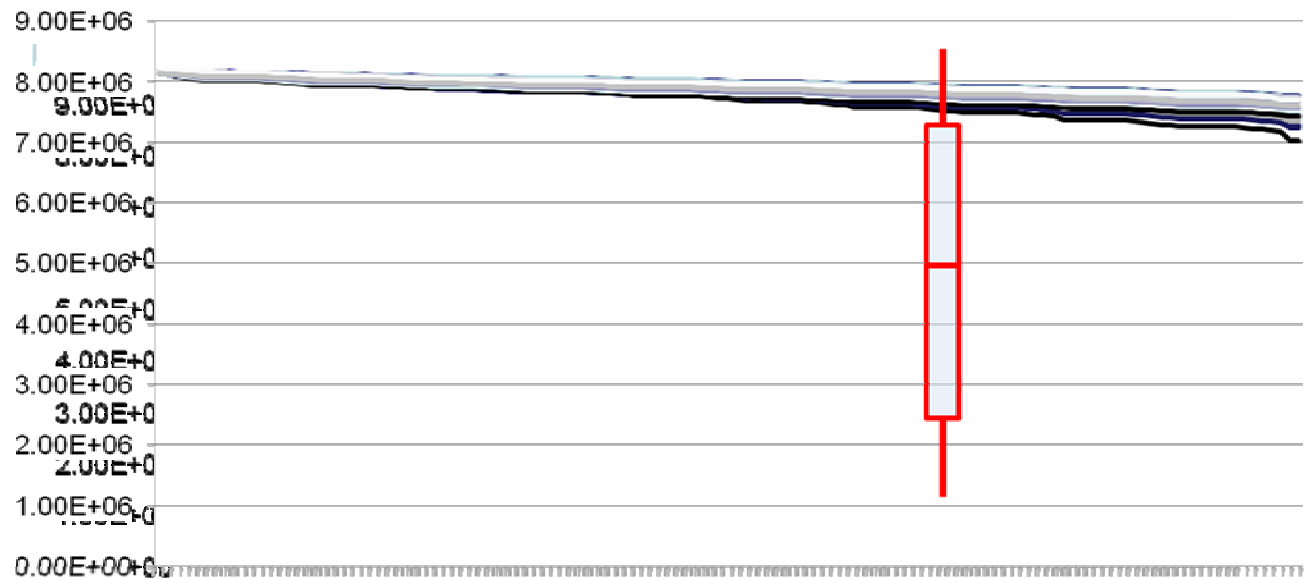
Late 1980s Initial
Conditions Correct?



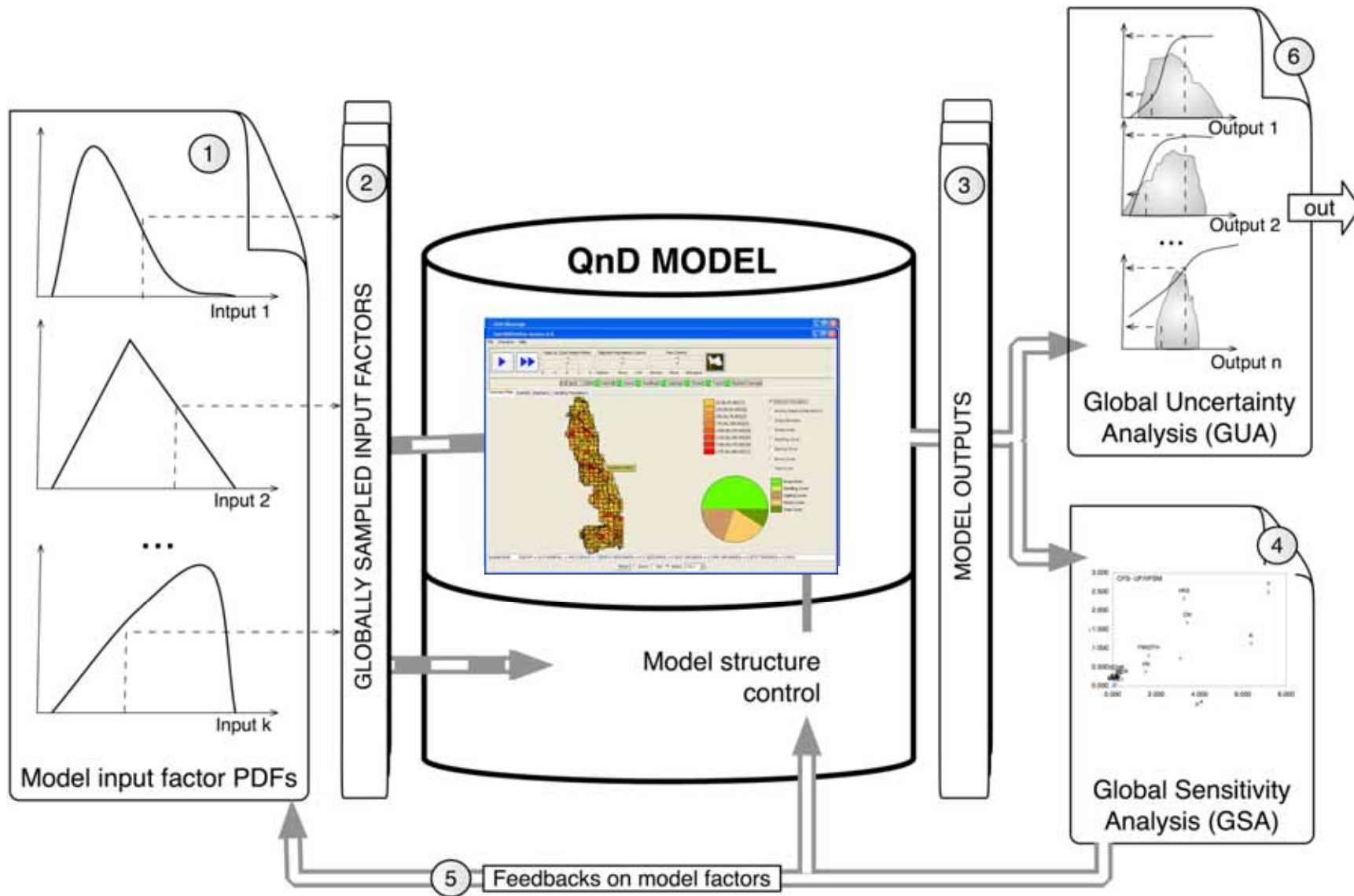
Interpretation issues
on the 1996 WVCA?

Tree Population
(#/grid)

QnD n=52

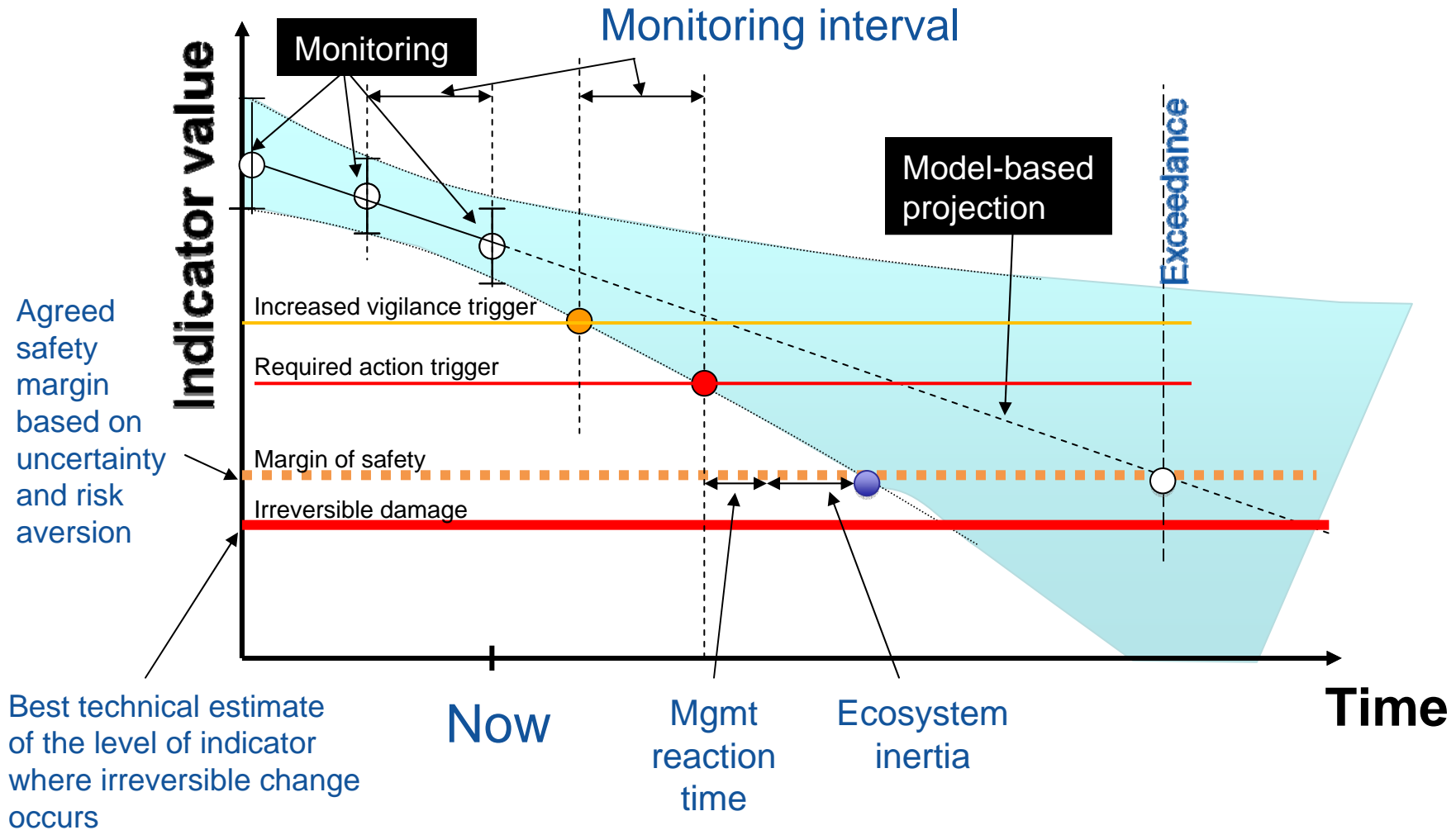


In Process: QnD:EleSim simulations for Global Sensitivity Analysis and Global Uncertainty Analysis





Integrating Monitoring, Modeling and Uncertainty into Decisions





Discussion



- Calibration/Validation: Sensitive dependence on initial conditions
 - Monthly rainfall dynamics are more intense than annual totals
 - Grass biomass manageable
 - Tree groups still problematic, especially in estimating functional groups representing specific Land Systems

- Elephant parameters are going to be critical
 - Movement algorithms with respect to water, vegetation and density dependence
 - How to build in specific tree groups and elephant choice

- Modeling towards TPCs
 - Establishing benchmarks are critical (Venter 1990)
 - A set of test runs that all modelers should attempt (for inter-model comparison and improvement)
 - Uncertainty will be significant and must be systematically addressed

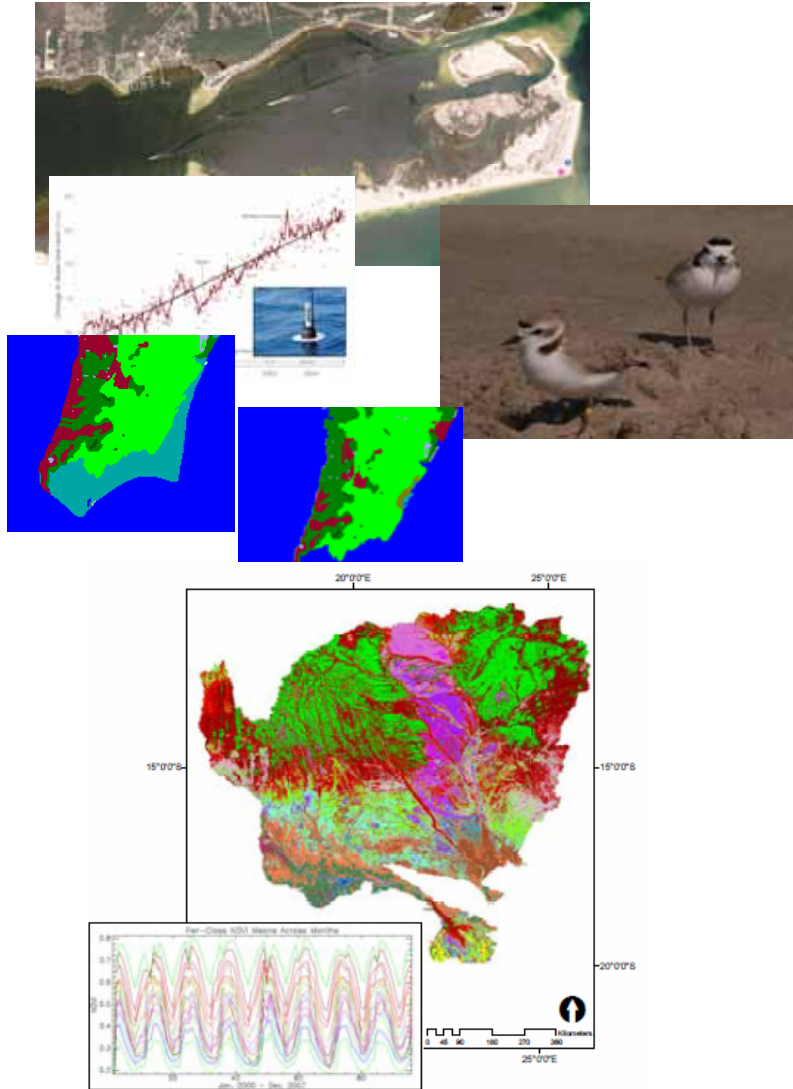


Discussion Continued



- How to build in landscape differences without over-calibrating the model
- Iterations are continuing with GSA and model complexity levels
- Management implications
 - Which management policies are under consideration?
 - “Whack a mole” (or elephant), *ad hoc* population management
 - “Gentle Persuasion”/ “Dry County “
 - Mixtures?
 - Are you ready to trade-off TPCs?
 - Active or passive adaptive management?
 - Uncertainty is no fun for managers ...
 - When are you ever going to know for certain?
 - Transparency (how much and for whom?)
- Models (and Modelers) run best in packs (building a culture of simulation)
- Coming soon – decision analysis, after that dealing with uncertainty, after that being adaptive

Simulation Opportunities at UF



- Simulation of endangered shorebirds under climate change and hurricanes on Florida coastal military bases (3 year Post Doc funded by the DoD:SERDP)
- Simulation of savanna processes and land use change in the Okavango, Kwandu and Zambezi Catchments(PhD funding from NASA)
- Available immediately
- gkiker@ufl.edu

Thank you!



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Seed Grant

QnD Model: Further Information

- General QnD information

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- Baxter Vegetation Impact Model Information

- Baxter, P.W.J. (2003). Modeling the Impact of the African Elephant, *Loxodonta Africana*, on Woody Vegetation in Semi-Arid Savannas. PhD Dissertation, University of California, Berkeley.
- Baxter, P.W.J. & Getz, W.M. (2005). A Model-Framed Evaluation of Elephant Effects on Tree and Fire Dynamics in African Savannas. *Ecological Applications*, 15, 1331-1341.