

Tools and Approaches for Managing Landscapes in an Uncertain World

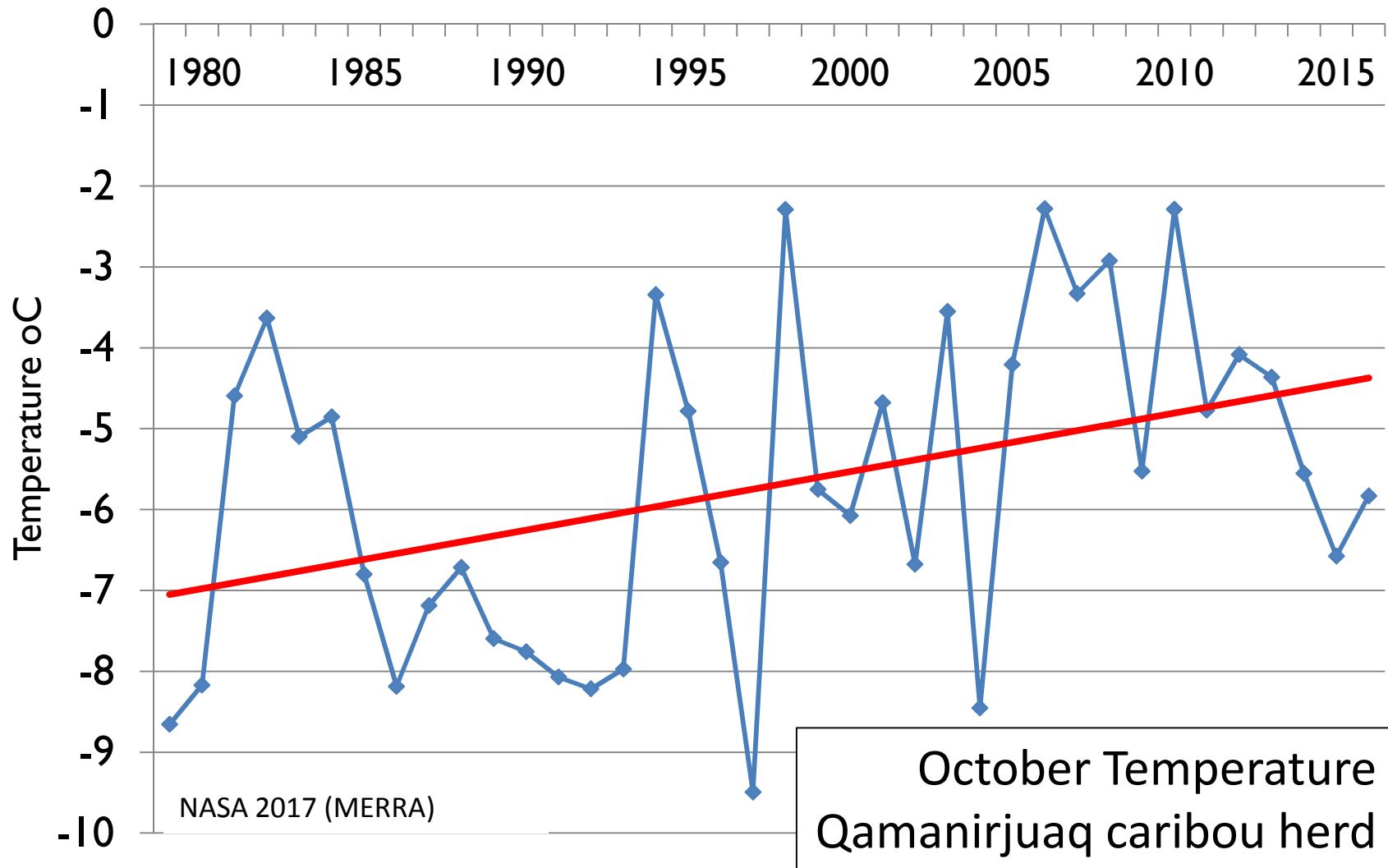
Colin Daniel & Anne Gunn

CARMA 9

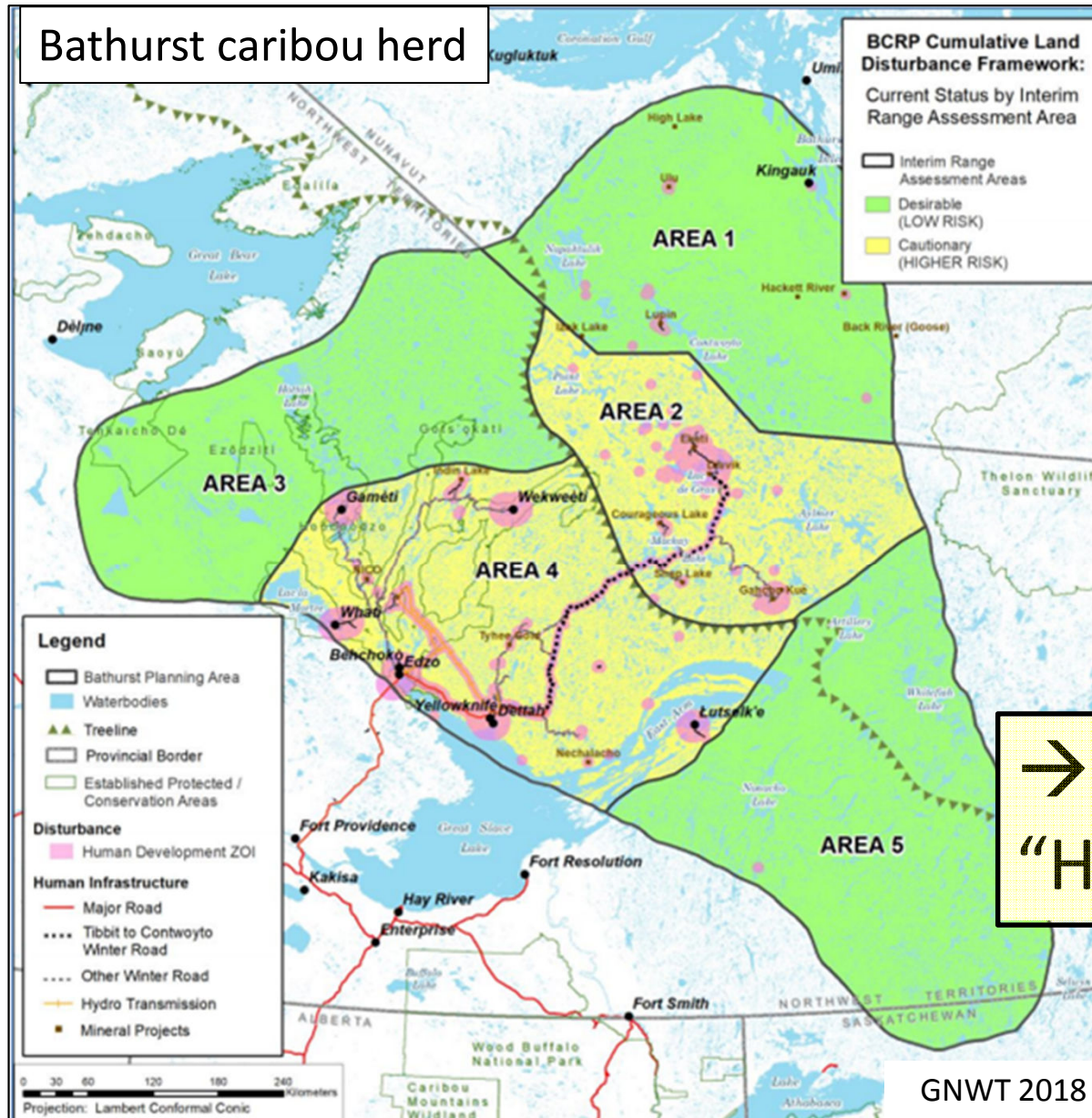
Whitehorse, Yukon

March 7, 2018

Climate Change



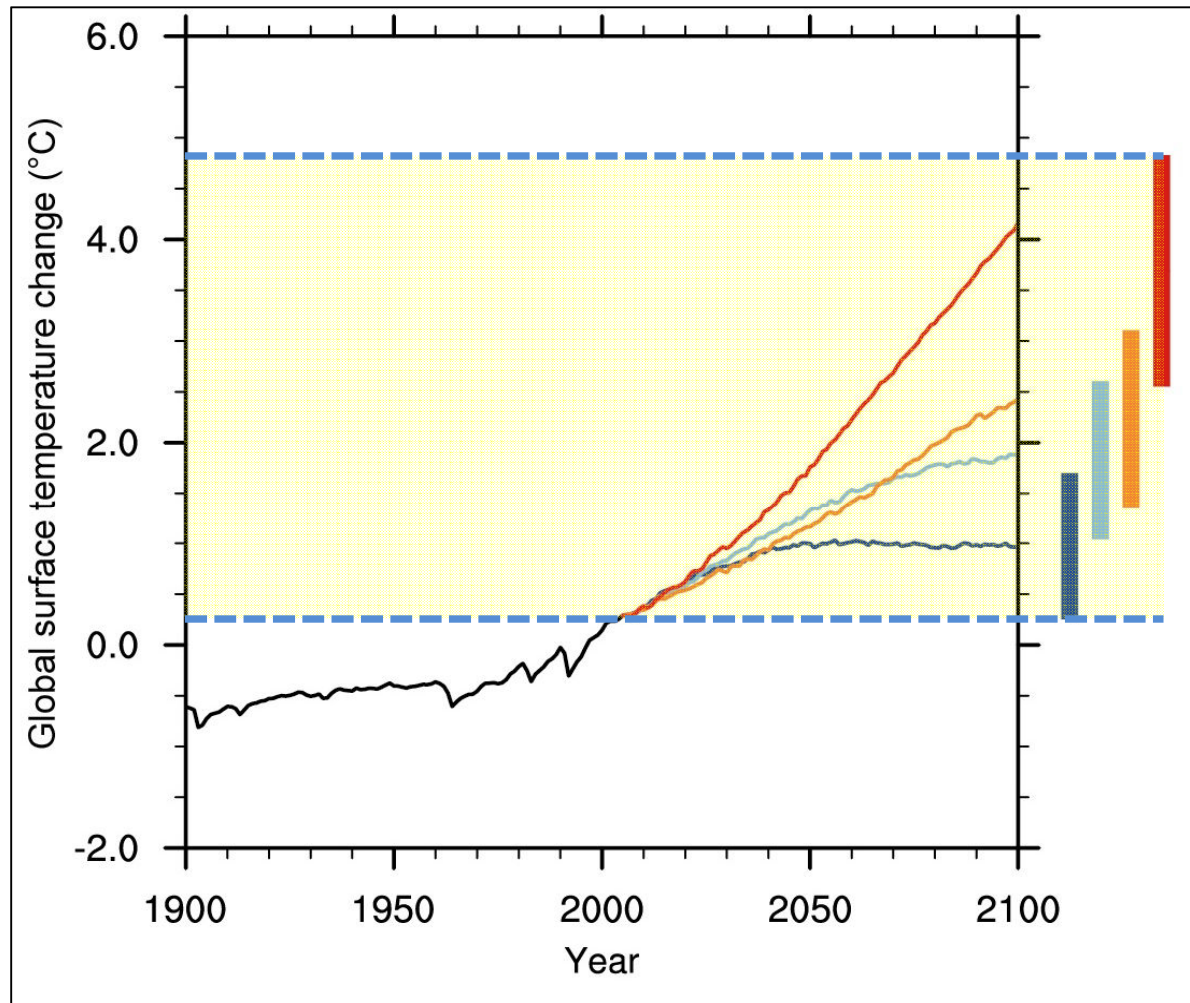
Industrial Development



→ Increase in the
“Human Footprint”

The future is uncertain...

Global Temperature Change Projections

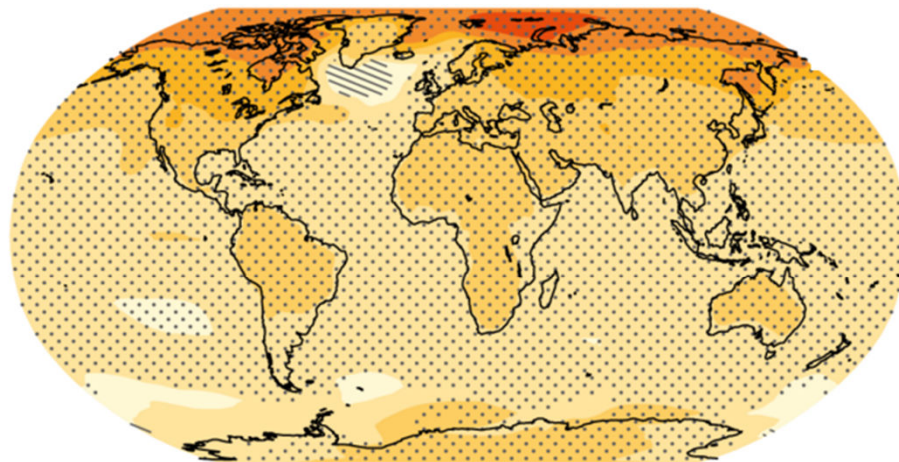


IPCC 2014

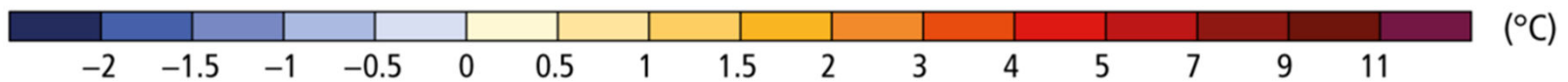
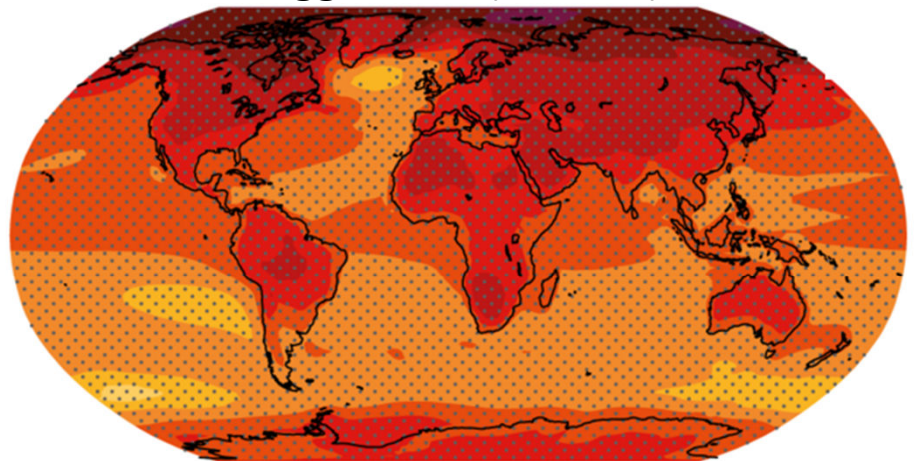
Future climate change projections

Projected change in temperature over 100 years

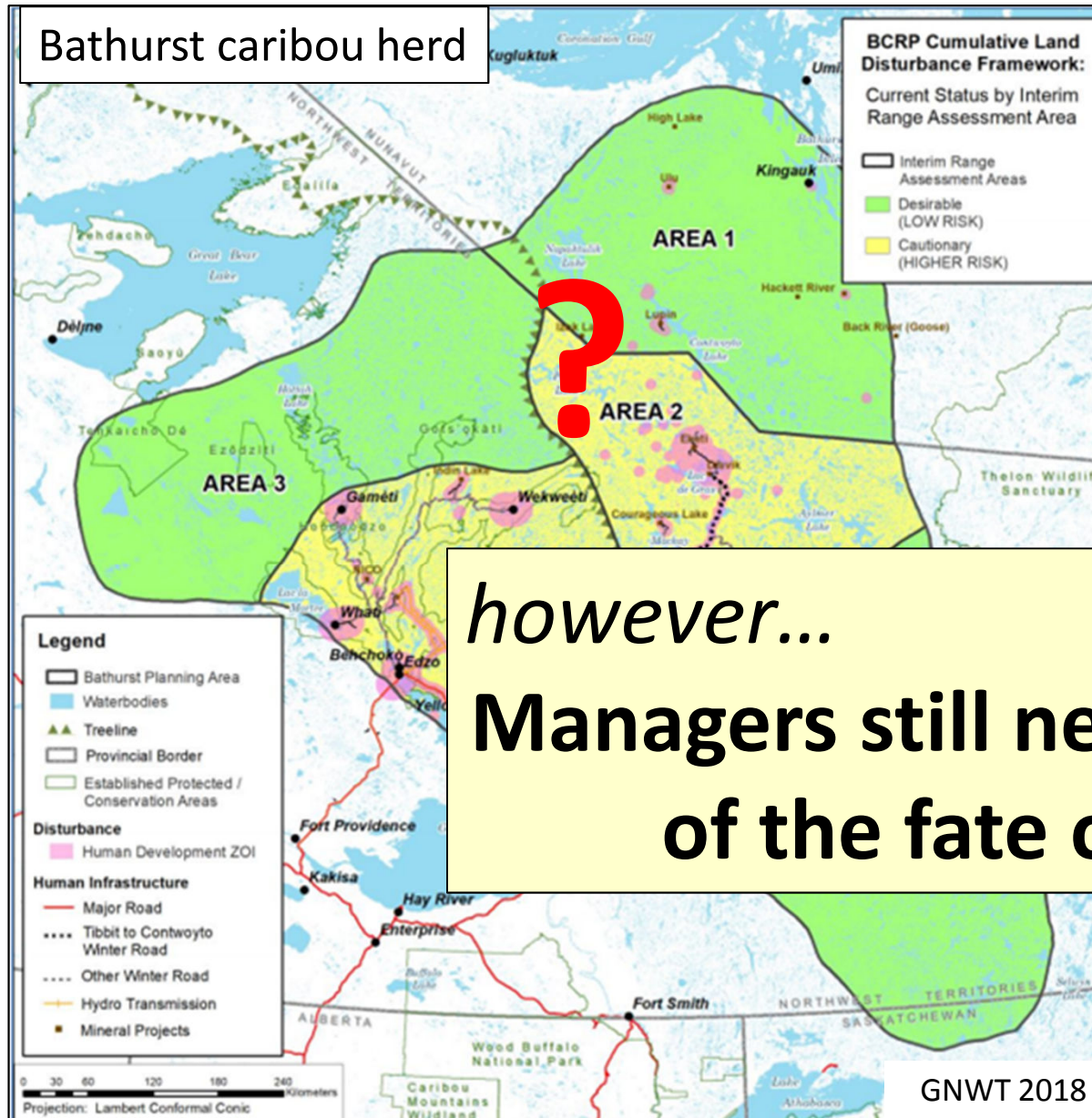
Conservative (RCP 2.6)



Aggressive (RCP 8.5)



The future is uncertain...



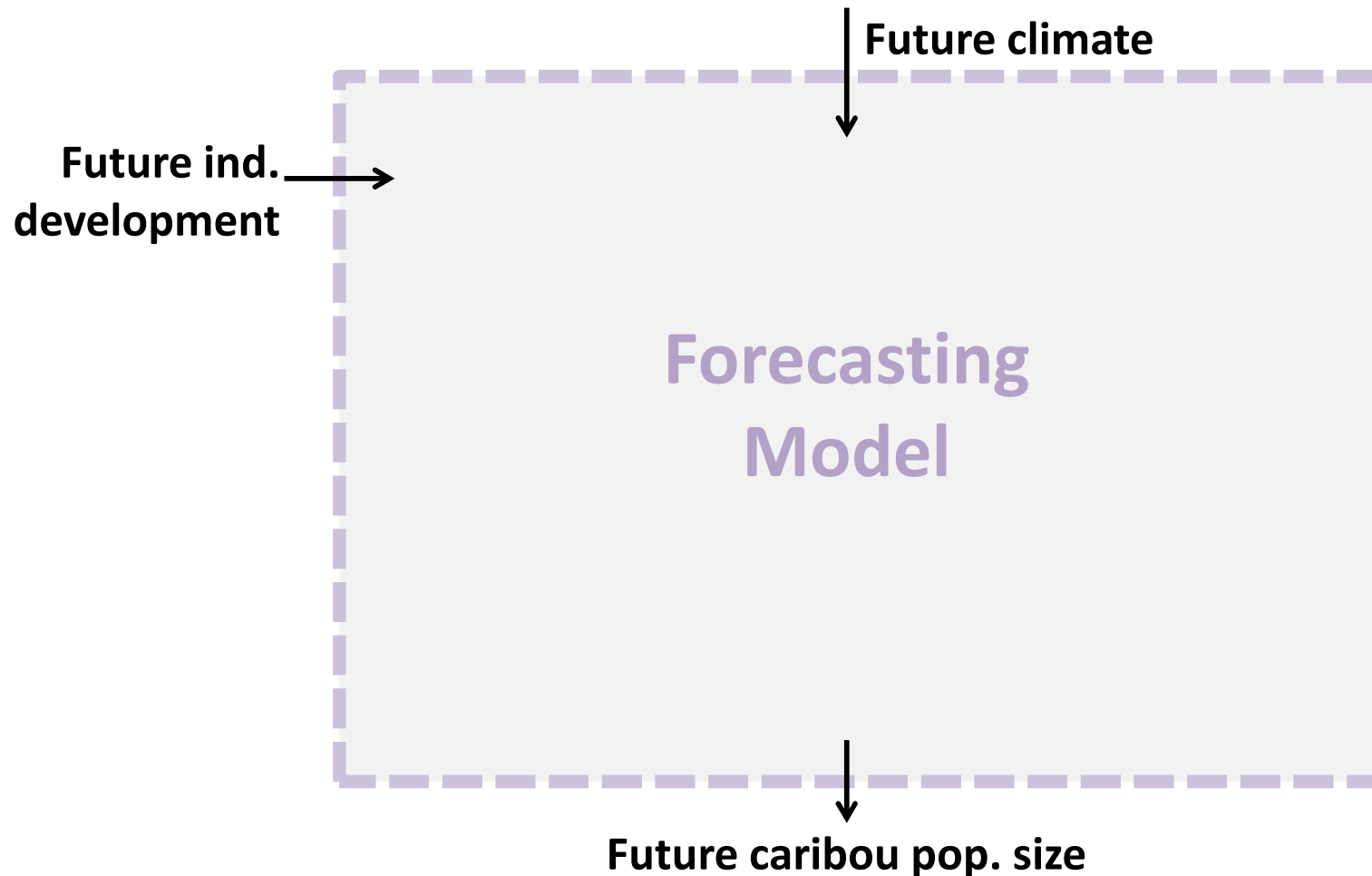
however...

**Managers still need projections
of the fate of caribou**

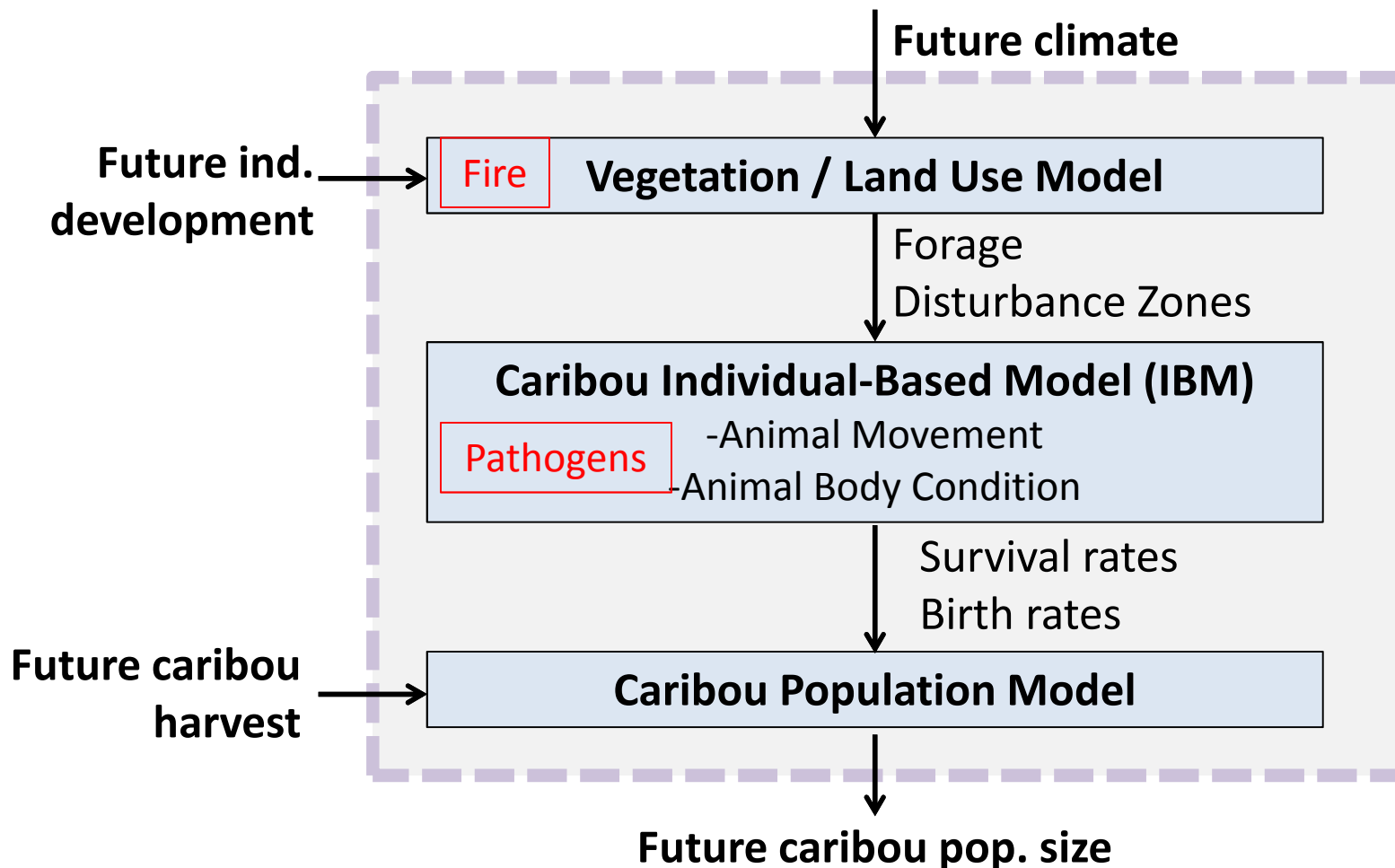
Consequences for caribou?



Integrated forecasting model for cumulative effects



Integrated forecasting model for cumulative effects



But what about all the uncertainties?

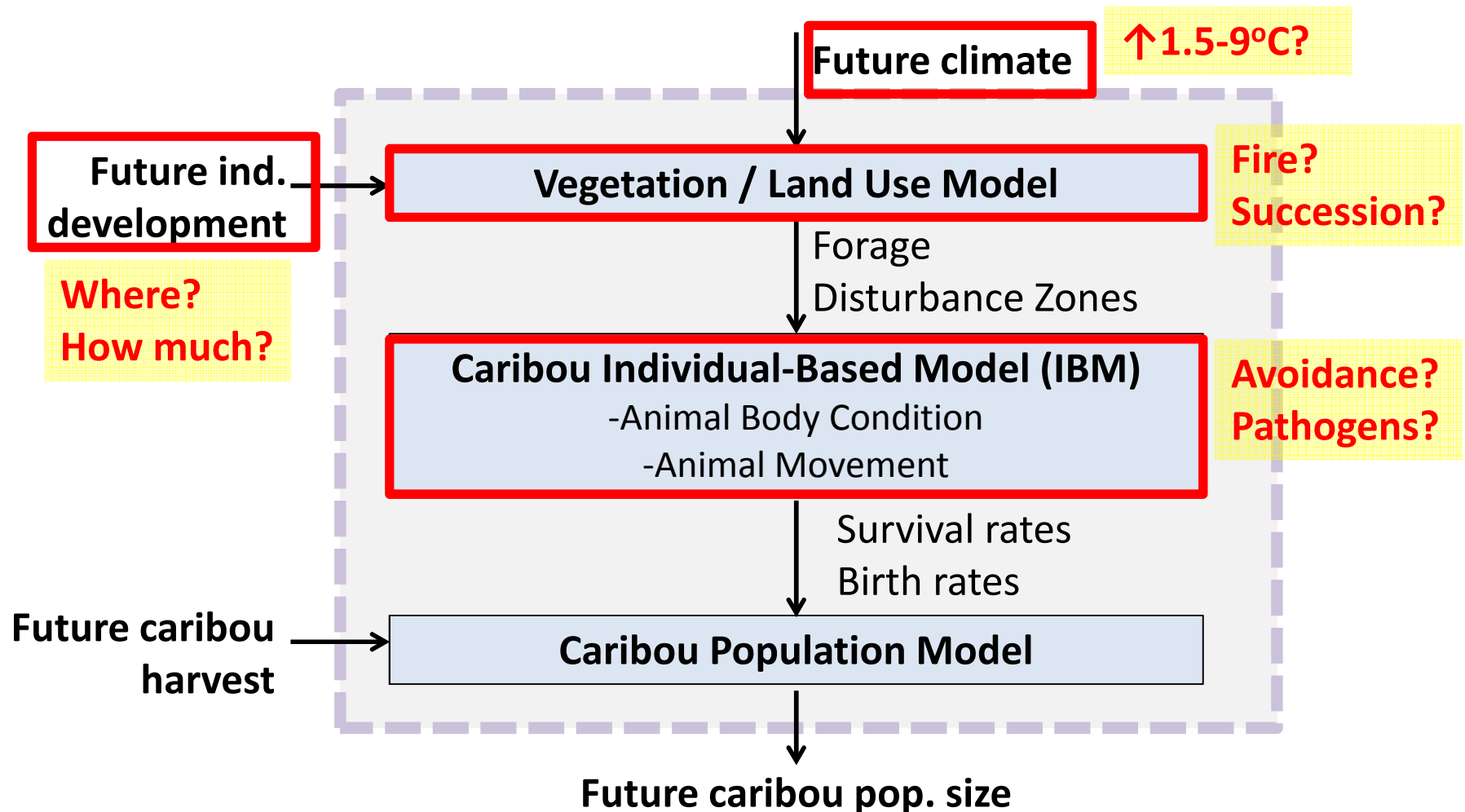


Uncertainties can be due to...

- **Insufficient understanding** → *model structure*
- **Insufficient data** → *estimation error*
- **Unknown unknowns**

Clark et al 2001. Science.
Ecological forecasts: an emerging imperative.

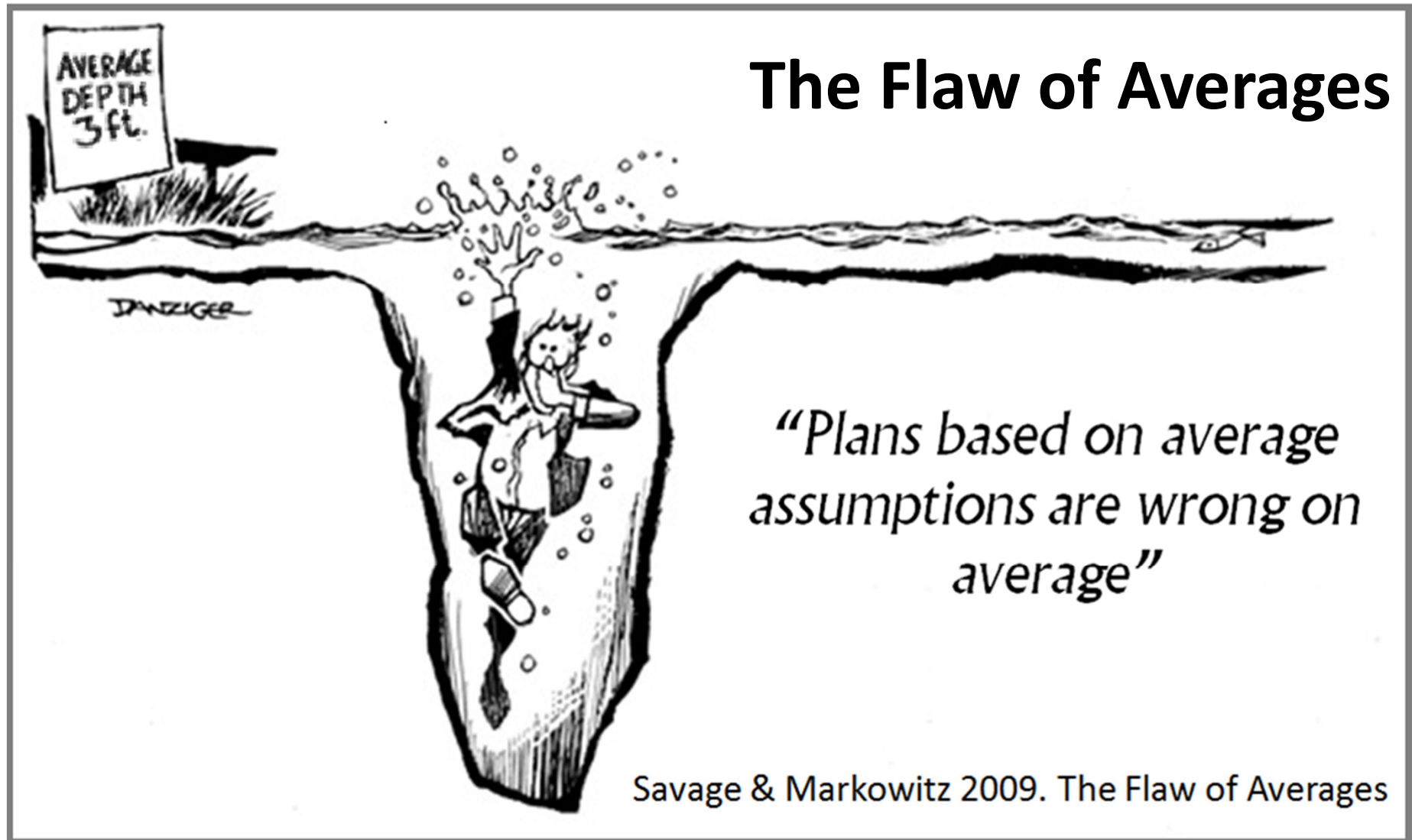
Key uncertainties in forecasting cumulative effects



Why are most uncertainties ignored?

- Most models try to **explain, not forecast**
- Uncertainty is **challenging to characterize**
- Techniques can be **computationally demanding**

The problem with ignoring uncertainties...



So what to do?

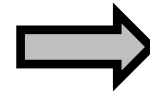
“Sufficiently thorough **understanding** of ecosystems needed to reduce deep uncertainties is **probably not achievable**”

“We should identify the range of alternative plausible futures and **develop strategies that are robust** across these scenarios and **responsive to unpredictable ecosystem dynamics**”

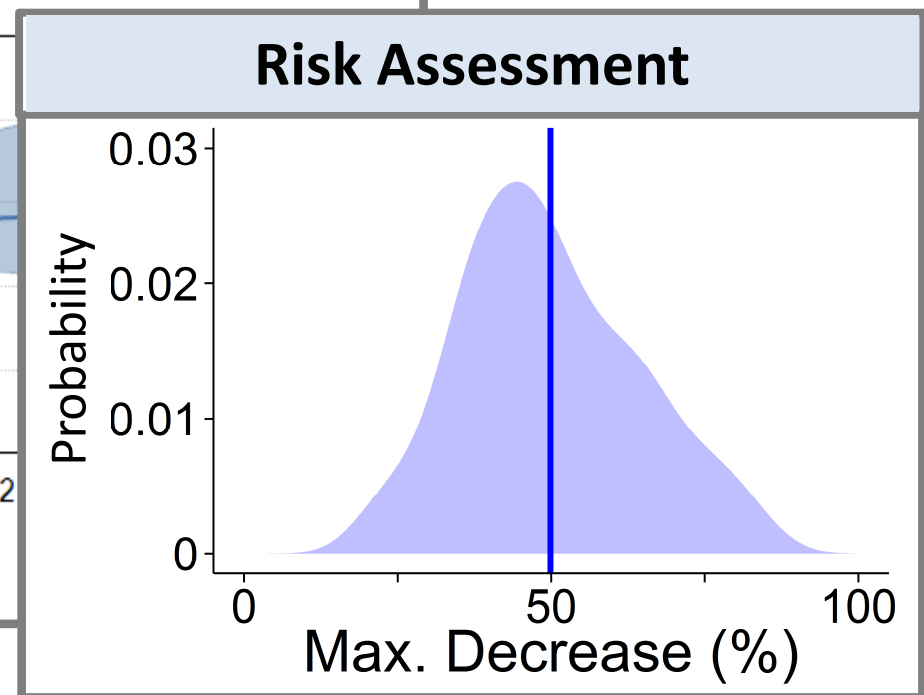
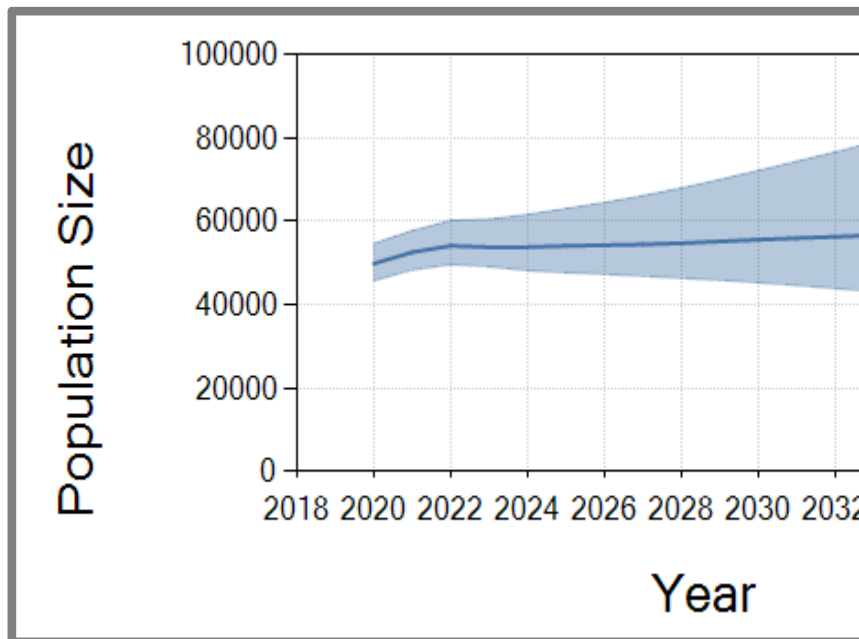
Schindler & Hilborn 2015. Science.
Prediction, precaution, and policy under global change

The solution?

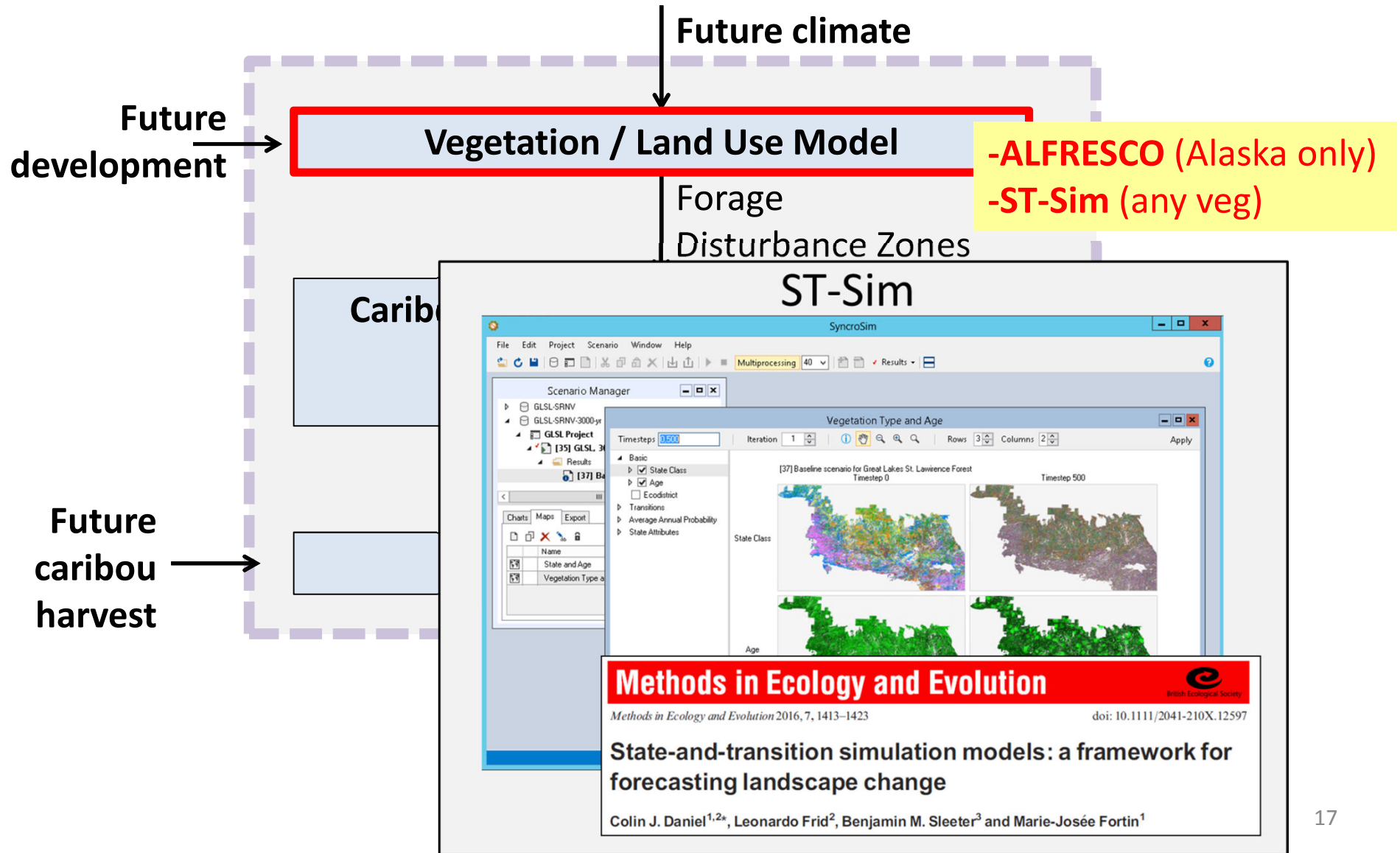
Develop **forecasts** for
caribou
that acknowledge key
uncertainties



Better inform
**management
decisions**
in the face of
global change



Where are we at today?



Where are we at today?

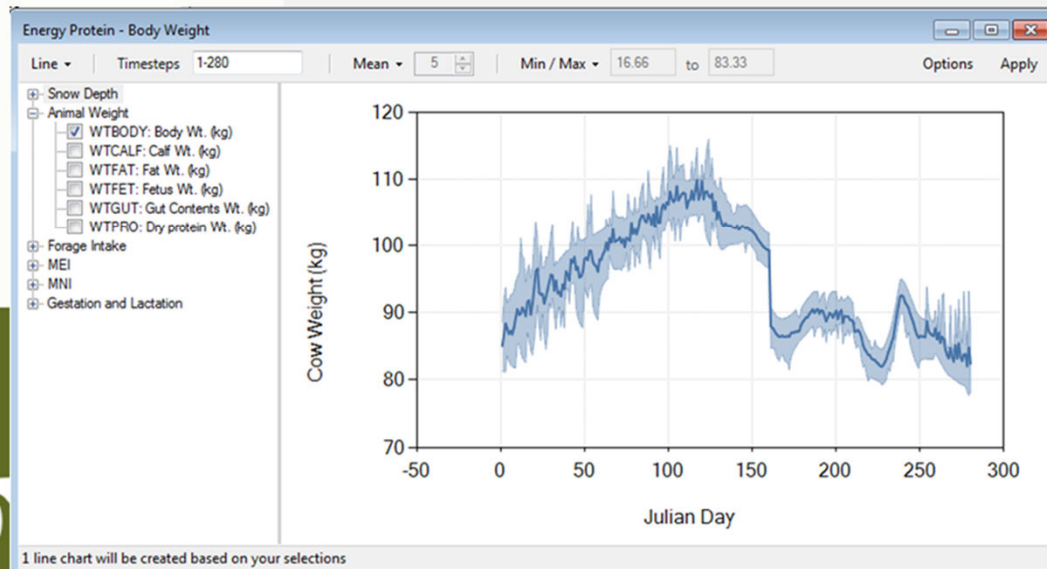
Energy/Protein Model

Simulation of maintenance, growth and reproduction of caribou and reindeer as influenced by ecological aspects of nutrition, climate change and industrial development using an energy-protein model

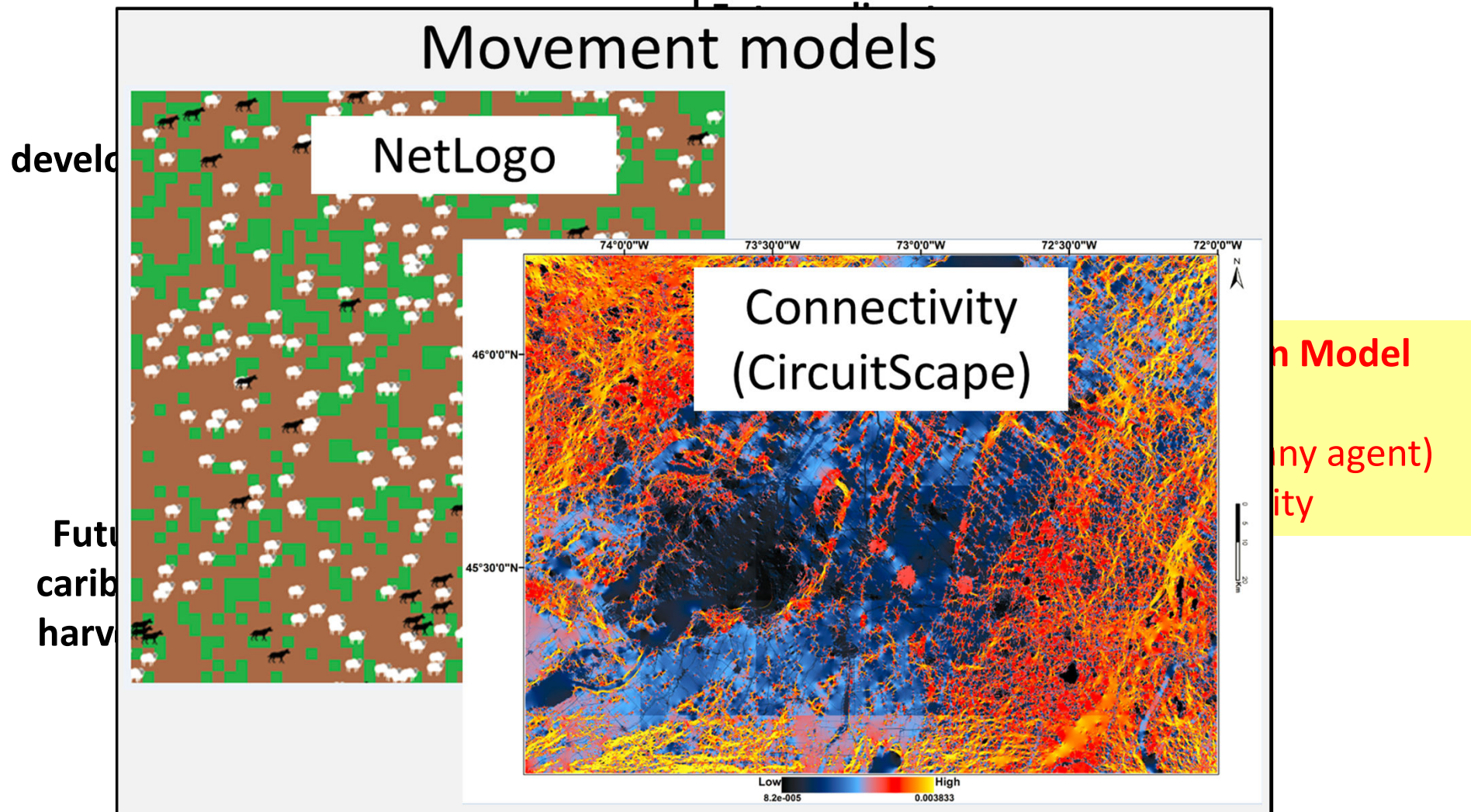
**Robert G. White
Don E. Russell
Colin J. Daniel**



odel



Where are we at today?

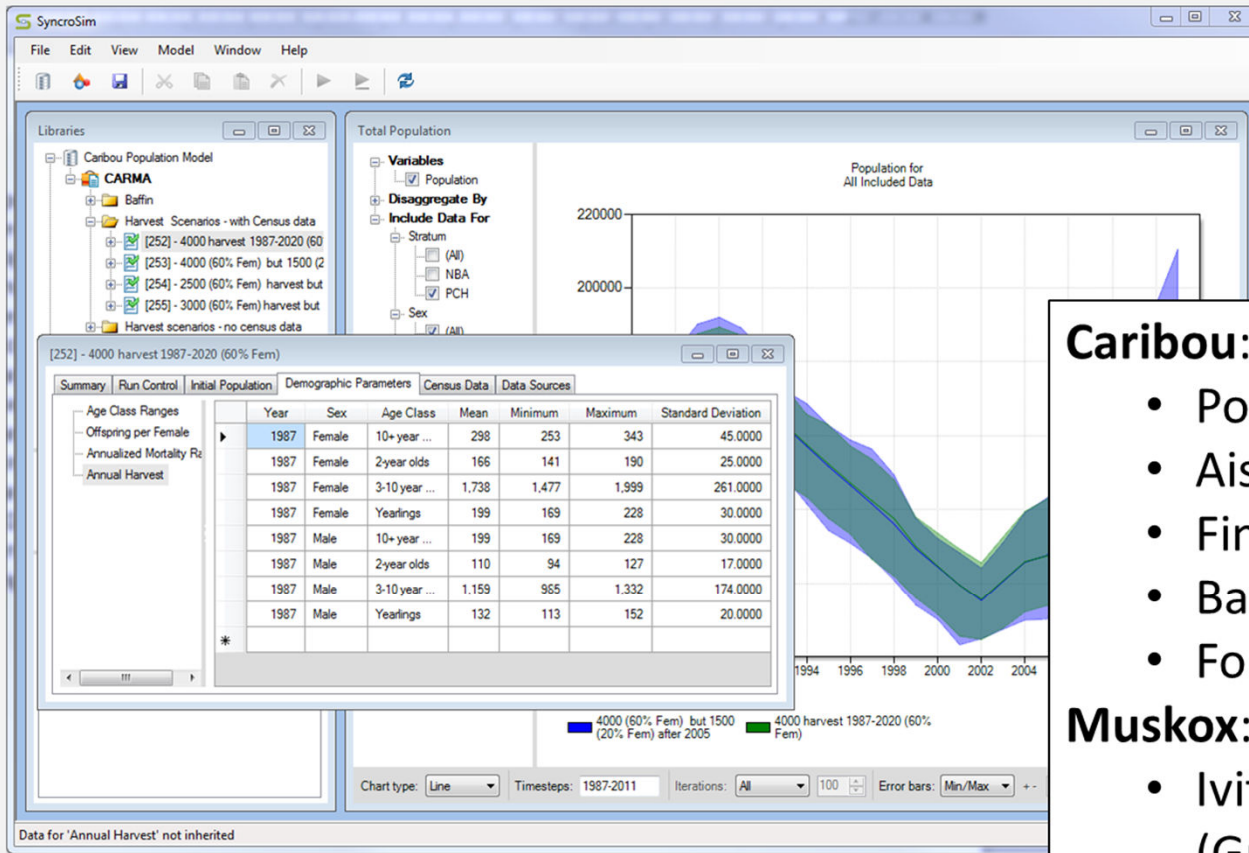


Where are we at today?

Population models: DG-Sim

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h



Caribou:

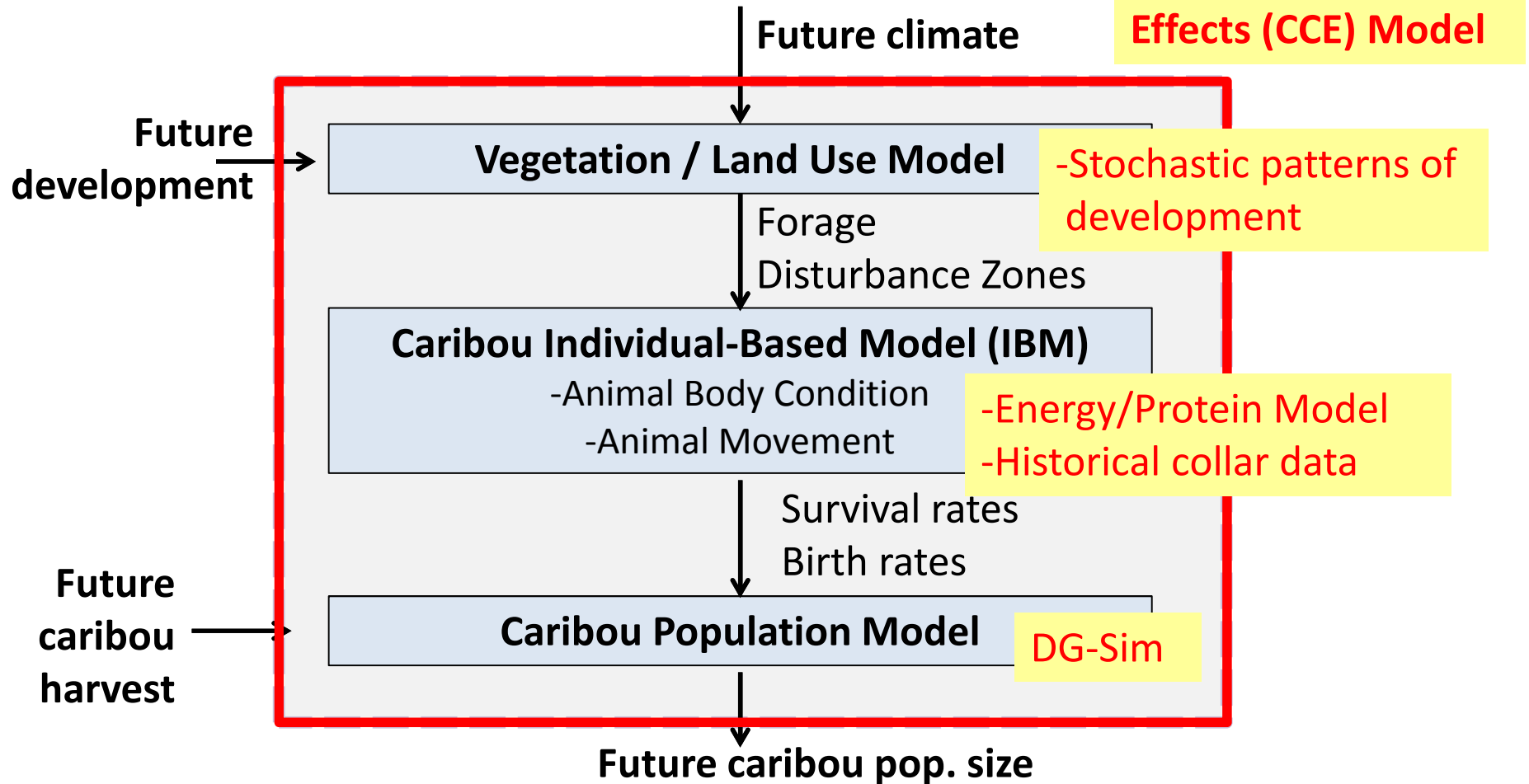
- Porcupine
- Aishihik
- Finlayson
- Bathurst
- Fortymile

Muskox:

- Ivittuut (Greenland)

Multiple herds)

Where are we at today?



- Initial prototype for Bathurst herd
- Full accounting of uncertainties → risk assessment

To summarize...

Forecasting cumulative effects requires:

- **Integrating** multiple models
- Accounting for **uncertainty**
- **Relevance** for decision makers

Collaboration is key

- Brings research & stakeholders together
- However... requires **overall framework**