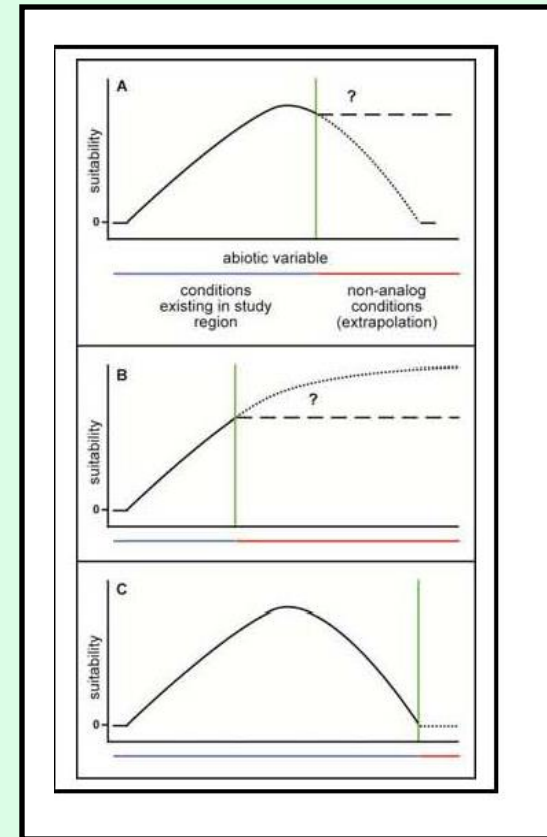


# Transfers and climate change

Robert P. Anderson  
Department of Biology  
City College of CUNY



# Cary Institute of Ecosystem Studies

*Climate change and species interactions: Ways forward*  
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Issue: *Climate Change and Species Interactions: Ways Forward*

## **A framework for using niche models to estimate impacts of climate change on species distributions**

**Robert P. Anderson**

Department of Biology, City College of New York, Graduate Center and Cooperative Remote Sensing Science and Technology (CREST) Center, City University of New York, and Division of Vertebrate Zoology (Mammalogy), American Museum of Natural History, New York, New York

Address for correspondence: Robert P. Anderson, 526 Marshak Science Building, City College of New York, City University of New York, 160 Convent Avenue, New York, NY 10031. [anderson@sci.cuny.cuny.edu](mailto:anderson@sci.cuny.cuny.edu)

# Environmental variables

*Effect of species on predictor variable (Hutchinson 1978)*

Scenopoetic      Not affected by presence of focal species

Non-scenopoetic      Affected by presence of focal species

# Environmental variables

*Relative degree of causality (Austin 2002)*

Proximal                      Determines the organism's response

Distal                         Linked to proximal variable that  
determines response

# Environmental variables

*Physiological effect on species (Austin 2002)*

Indirect	Does not affect focal species physiologically; correlated with distribution via correlations with other factors
Direct	Affects focal species physiologically <i>but is not</i> consumed by it
Resource	Affects focal species physiologically <i>and is</i> consumed by it

# Environmental variables: examples

*Effect of species on predictor variable (Hutchinson 1978)*

Scenopoetic      Temperature or precipitation

Non-  
scenopoetic      Water or nutrients consumed by a  
plant

# Environmental variables: examples

*Relative degree of causality (Austin 2002)*

Proximal                      Available soluble [P] at root hair;

Distal                         Total soil phosphate;

# Environmental variables: examples

*Relative degree of causality (Austin 2002)*

Proximal

Available soluble [P] at root hair;

Freeze durations that affect survival of cacti along poleward range margin

Distal

Total soil phosphate;

Mean temperature of coldest month, or annual mean temperature (relatively more distal than the former)



# Environmental variables: examples

*Physiological effect on species (Austin 2002)*

Indirect                      Elevation; latitude or longitude

Direct                        Temperature; pH

Resource                    Water or nutrients in soil

# Environmental variables: guidelines

*Effect of species on predictor variable (Hutchinson 1978)*

Scenopoetic      Not affected by presence of focal species

**USE!**

Non-  
scenopoetic      Affected by presence of focal species

**AVOID!**

# Environmental variables: guidelines

*Relative degree of causality (Austin 2002)*

Proximal                      Determines the organism's response

**USE!**

Distal

# Environmental variables: guidelines

*Relative degree of causality (Austin 2002)*

Proximal                      Determines the organism's response

**USE!**

Distal                         Linked to proximal variable that  
determines response

**MAYBE: use for transfer only if the  
correlation with the driving variable is  
likely to hold across space/time**

**(see also indirect and direct)**

# Environmental variables: guidelines

*Physiological effect on species (Austin 2002)*

Indirect

Direct

Affects focal species physiologically but not consumed by it: **USE!**

Resource

Affects focal species physiologically and is consumed by it: **MAYBE: Use if scenopoetic**

# Environmental variables: guidelines

*Physiological effect on species (Austin 2002)*

Indirect	Does not affect focal species physiologically; correlated with distribution via correlations with other factors: <b>MAYBE (depends on correl.)</b>
Direct	Affects focal species physiologically but not consumed by it: <b>USE!</b>
Resource	Affects focal species physiologically and is consumed by it: <b>MAYBE: Use if scenopoetic</b>

# Environmental variables: guidelines

*Physiological effect on species (Austin 2002)*

Indirect

**AVOID** if correlated with distribution because of associations with factors related to dispersal/demography or with the distributions of important biotic interactors;

# Environmental variables: guidelines

*Physiological effect on species (Austin 2002)*

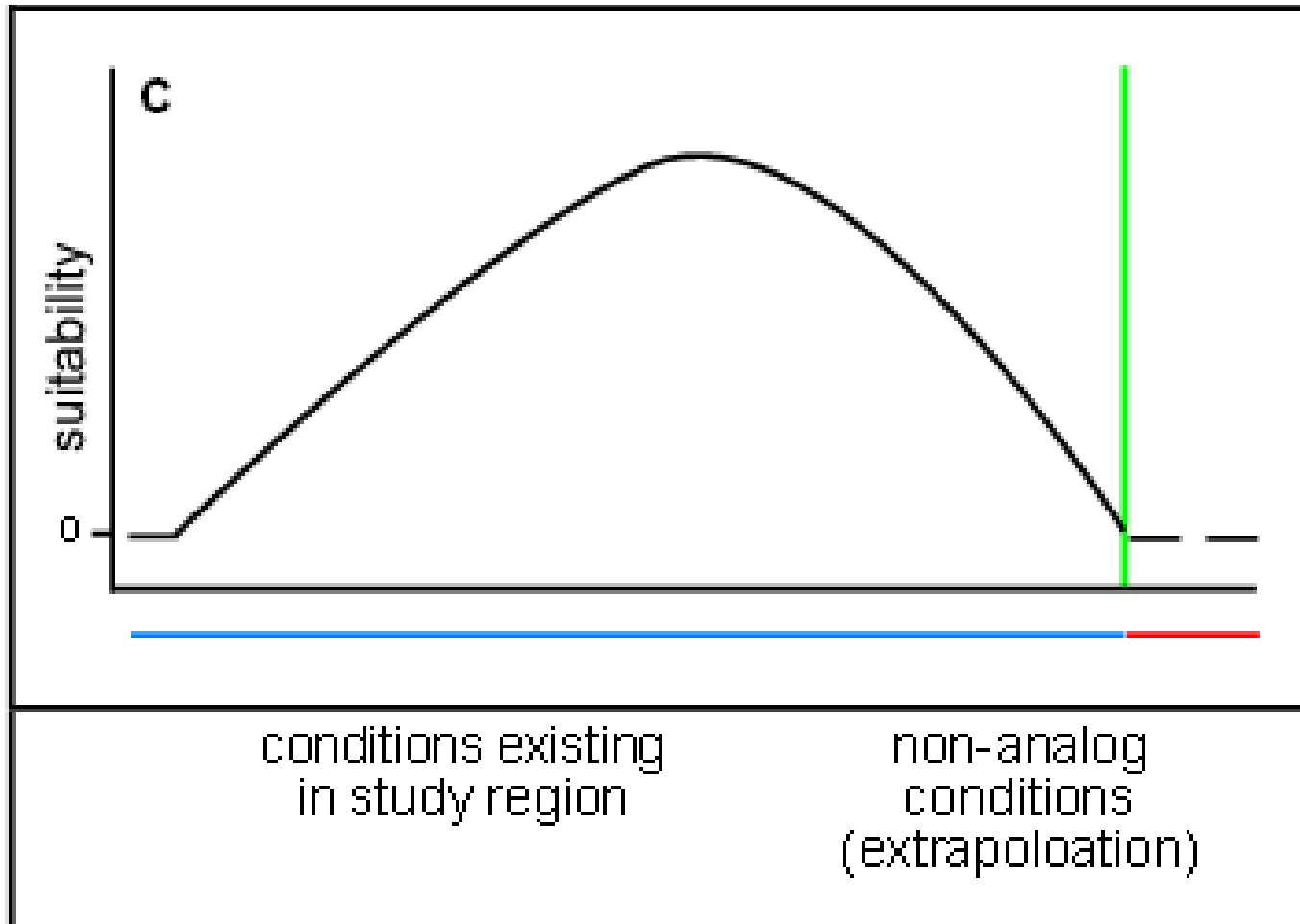
Indirect

**AVOID** if correlated with distribution because of associations with factors related to dispersal/demography or with the distributions of important biotic interactors;

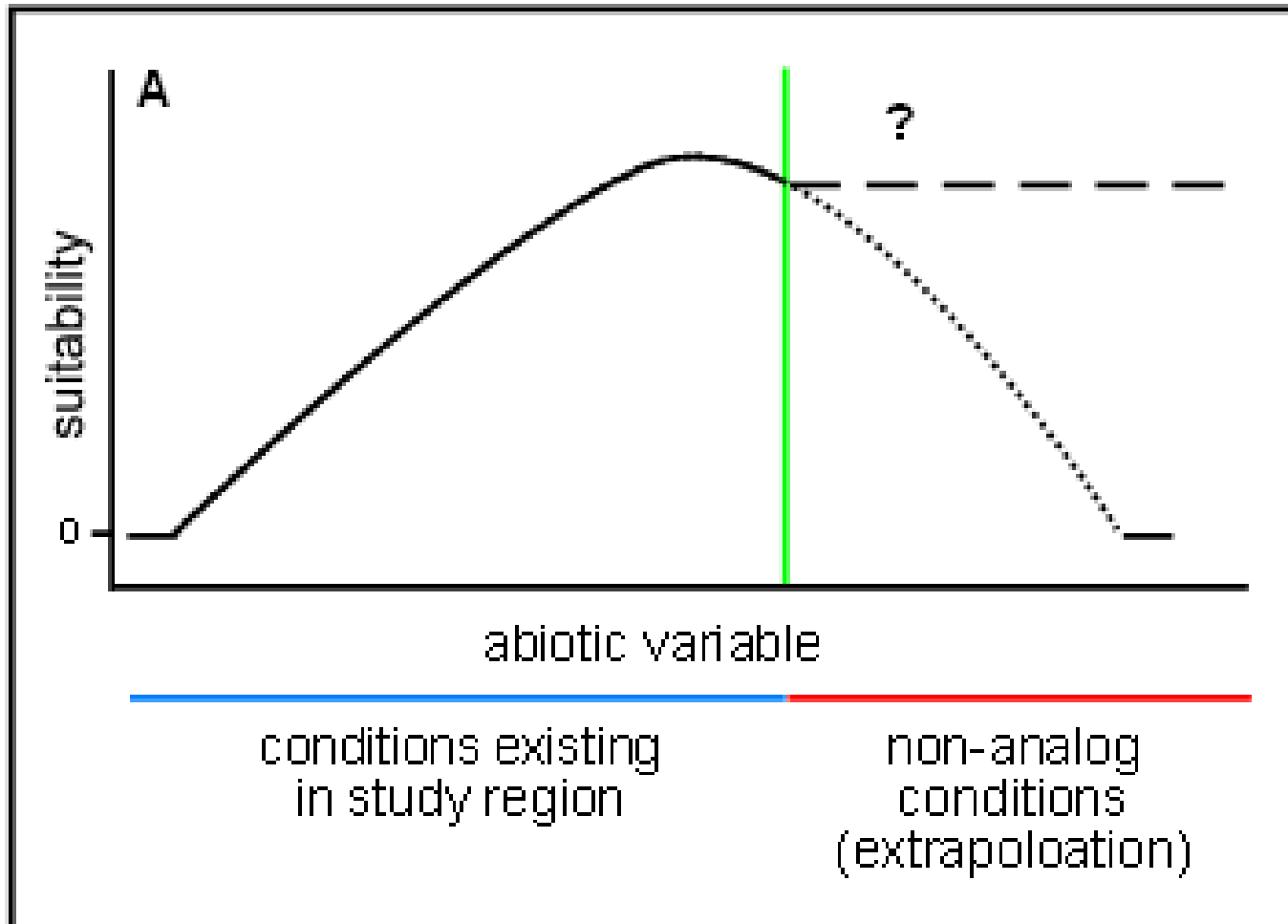
**USE** if correlated with distribution because of correlations with driving abiotic variables; **use for transfer only** if the correlation with the driving variable is likely to hold across space/time



# Extrapolation in environmental space

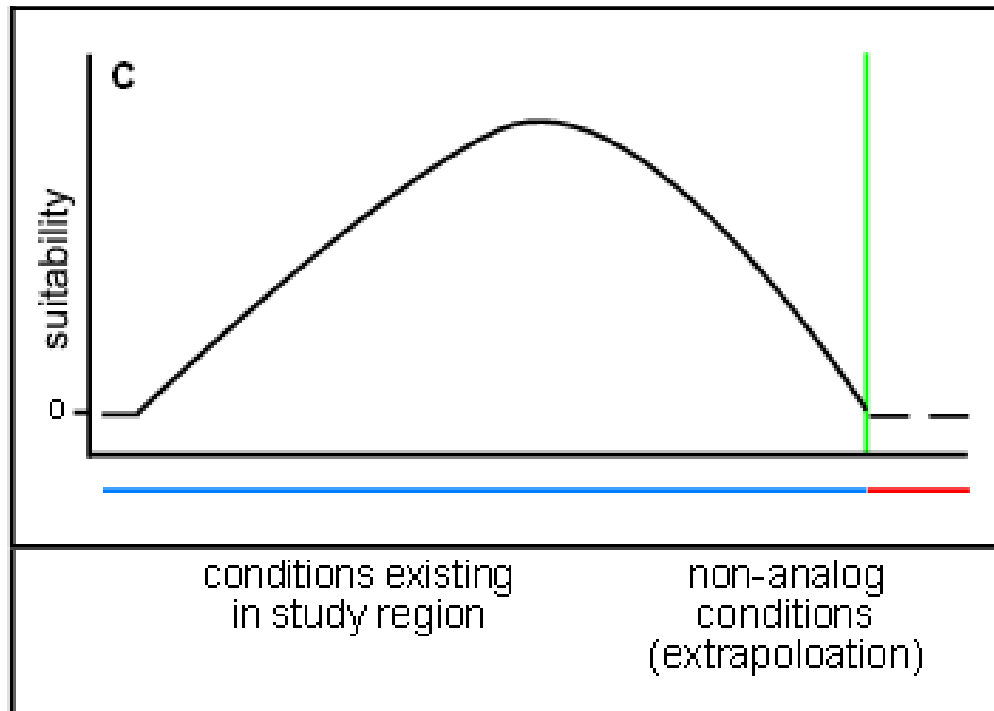


# Extrapolation in environmental space



# Niche Space Assumption

*The study contains the full range of conditions that the species can inhabit (for the examined abiotic variables)*



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## *Consequences of violation:*

Existing fundamental niche smaller than fundamental niche;  
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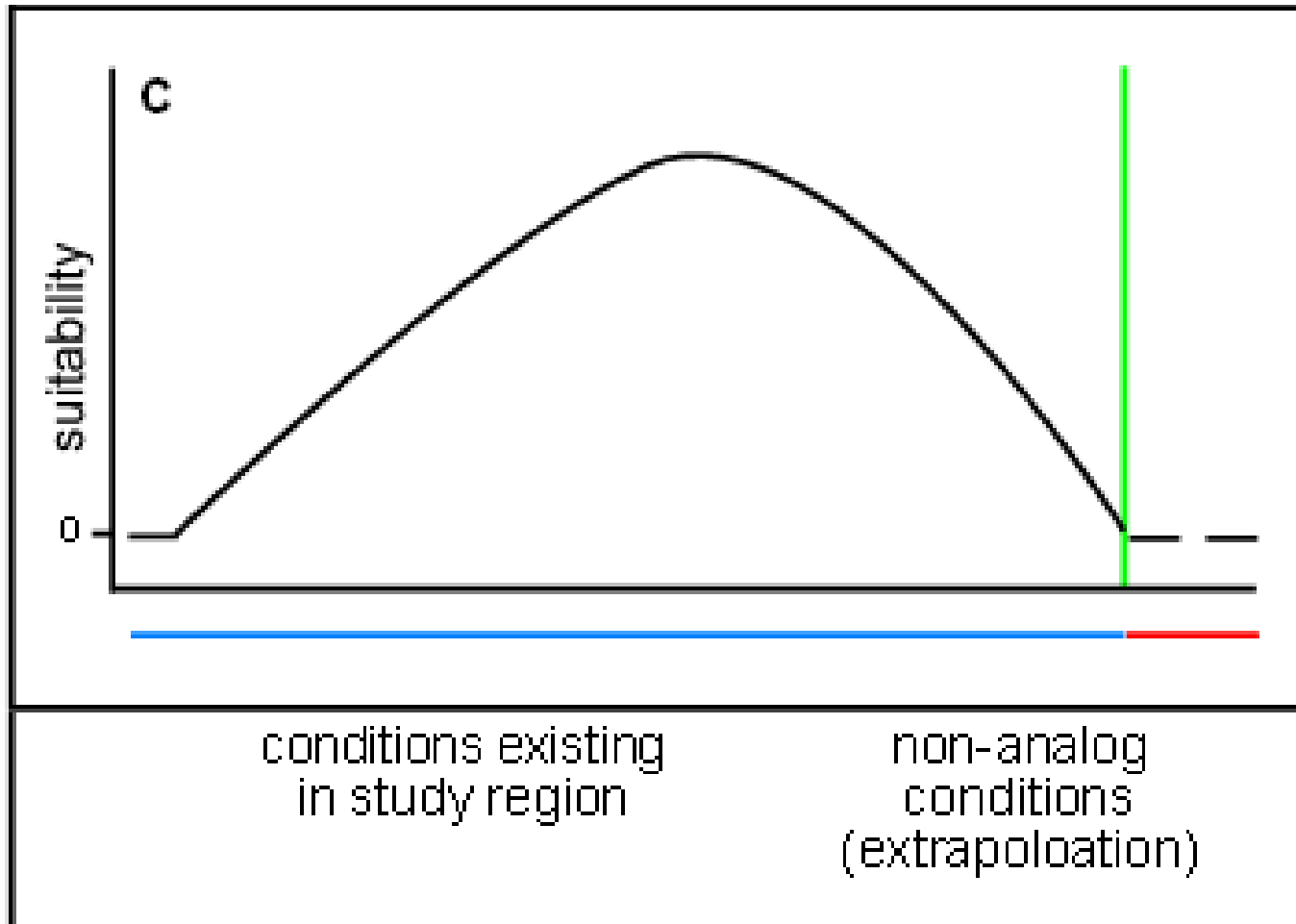
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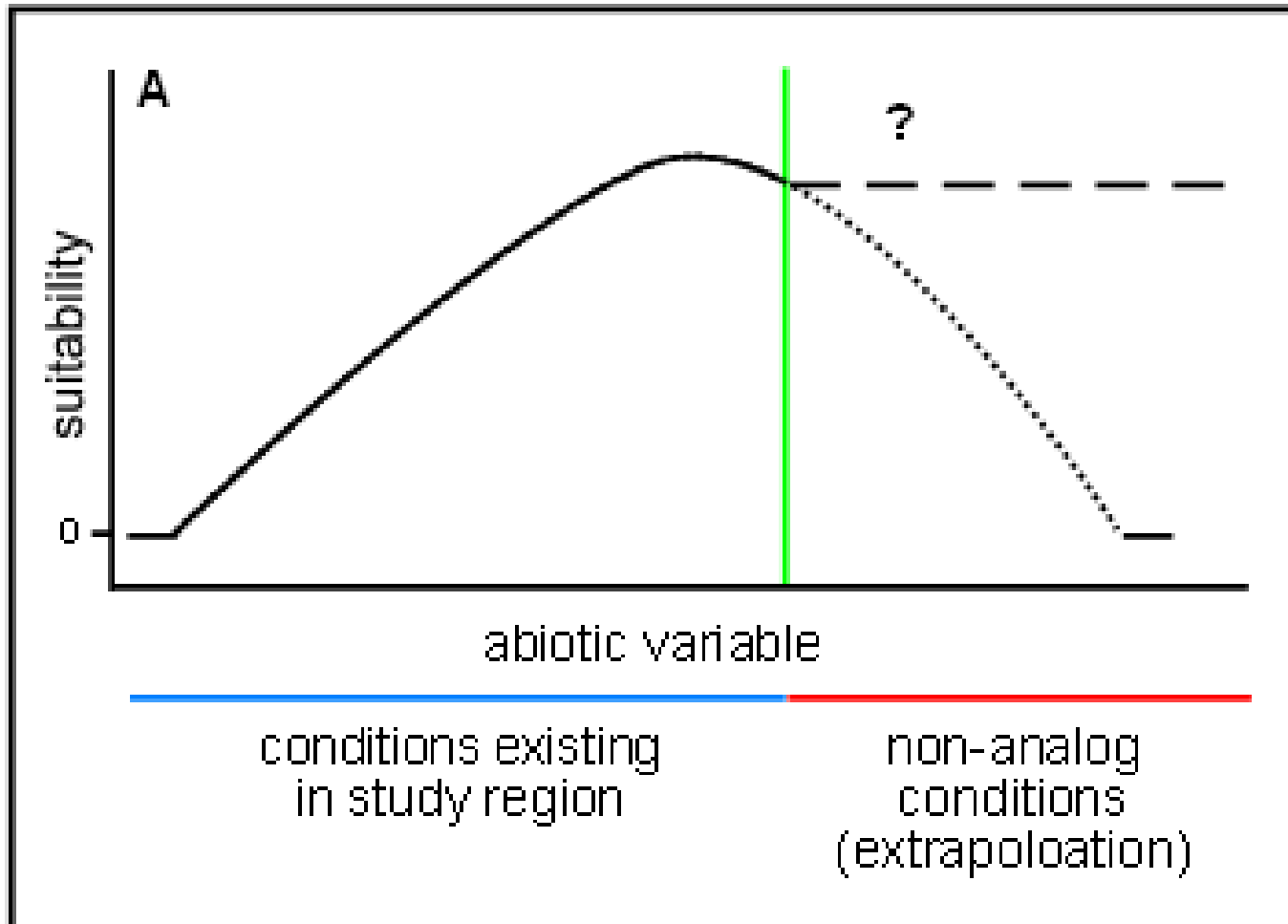
## *Recommendation:*

Use presence records from many portions of species' range and over multiple time periods;  
examine response curves and detect truncations

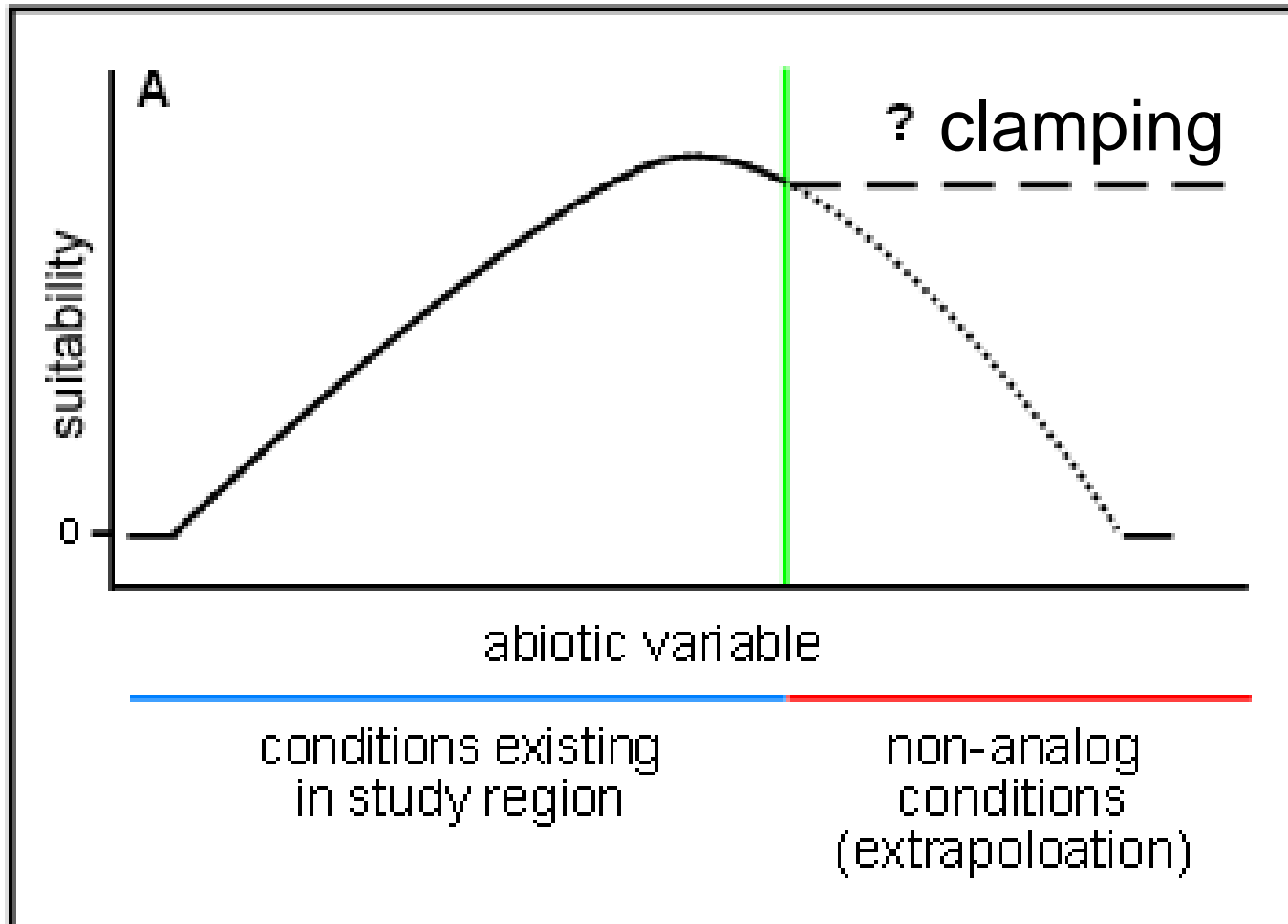
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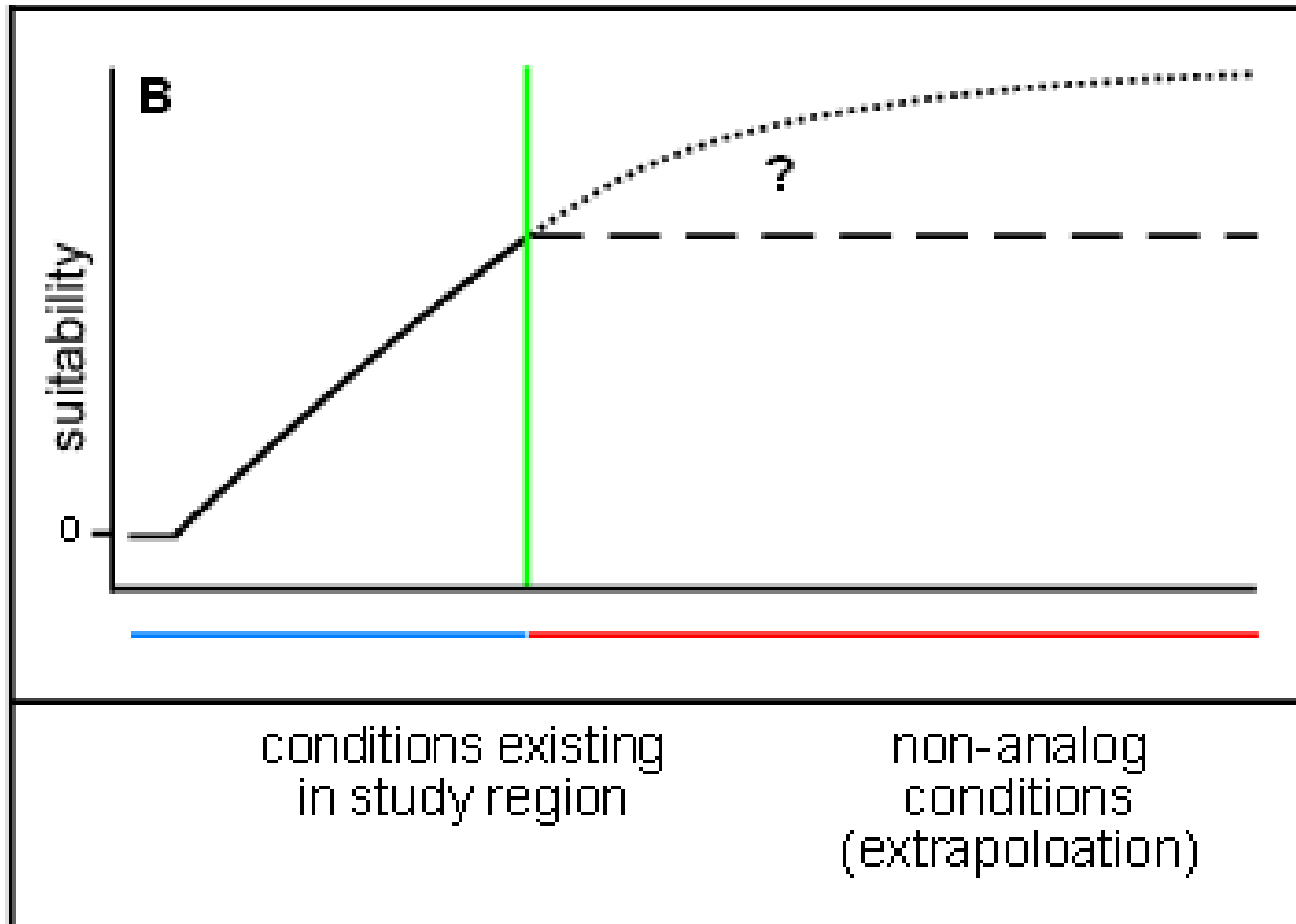


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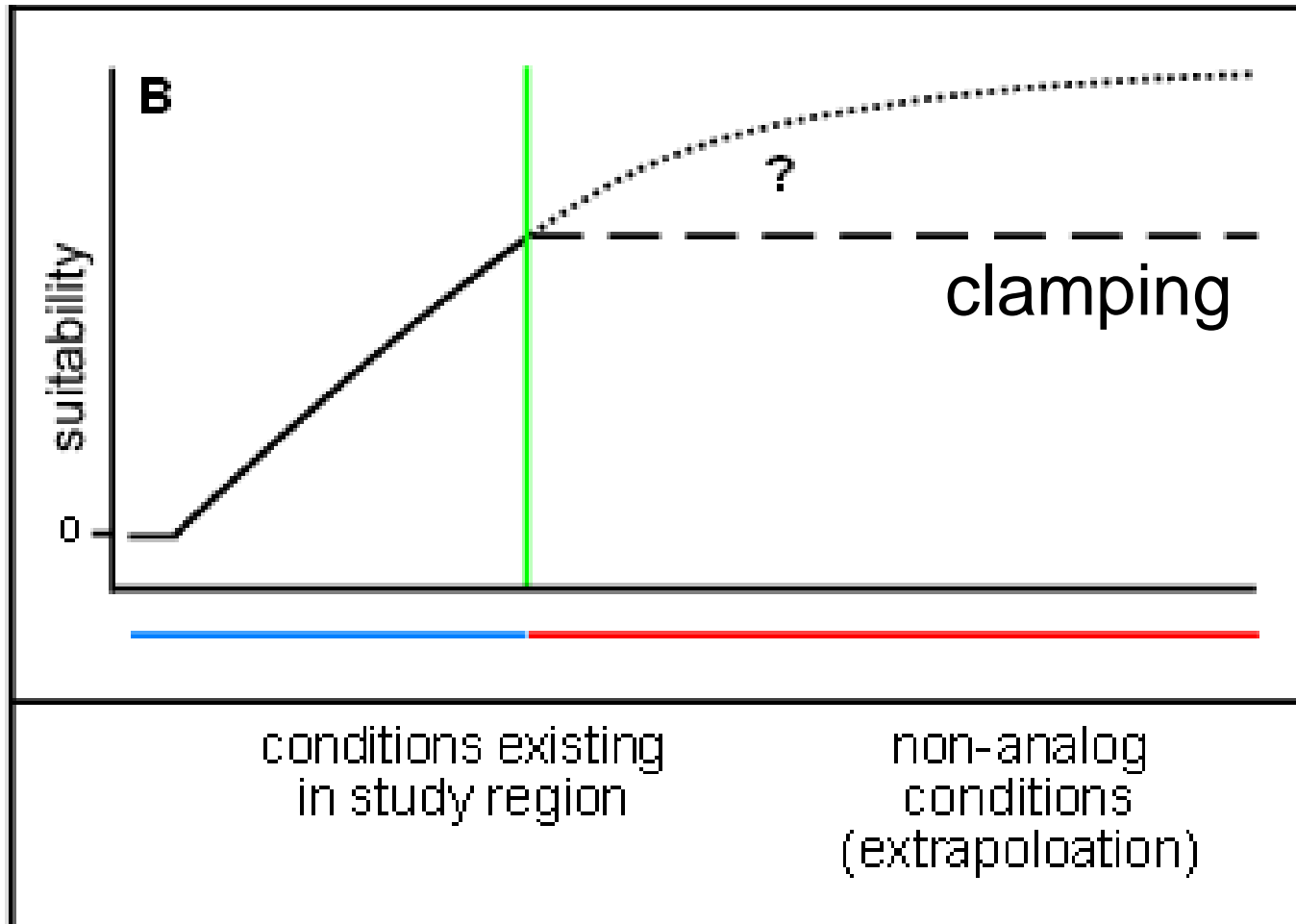




# Extrapolation in environmental space



# Extrapolation in environmental space



# Dispersal/demographic Noise Assumption

*Factors related to dispersal, establishment, and persistence do not cause the species to occupy an environmentally biased subset of the abiotically suitable areas*

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# Dispersal/demographic Noise Assumption

*Factors related to dispersal, establishment, and persistence do not cause the species to occupy an environmentally biased subset of the abiotically suitable areas*

# Biotic Noise Assumption

*Biotic interactions do not cause the species to occupy an environmentally biased subset of the abiotically suitable areas*

# Human Noise Assumption

*Human modifications of the environment do not cause the species to occupy an environmentally biased subset of the abiotically suitable areas*

# Noise Assumptions

*These factors do not cause the species to occupy an environmentally biased subset of the abiotically suitable areas*

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*These factors do not cause the species to occupy an environmentally biased subset of the abiotically suitable areas*

## *Consequences of violation:*

Occupied niche space is smaller than existing fundamental niche; species' response is truncated and/or distorted for one or more abiotic variables

# Noise Assumptions

*These factors do not cause the species to occupy an environmentally biased subset of the abiotically suitable areas*

## *Consequences of violation:*

Occupied niche space is smaller than existing fundamental niche; species' response is truncated and/or distorted for one or more abiotic variables

## *Recommendation:*

Use data (presence and comparison) only from regions where species is at equilibrium or where limitations do not cause it to inhabit environmentally biased subset of abiotically suitable areas



# Conflicts between assumptions

*Which is more important?*

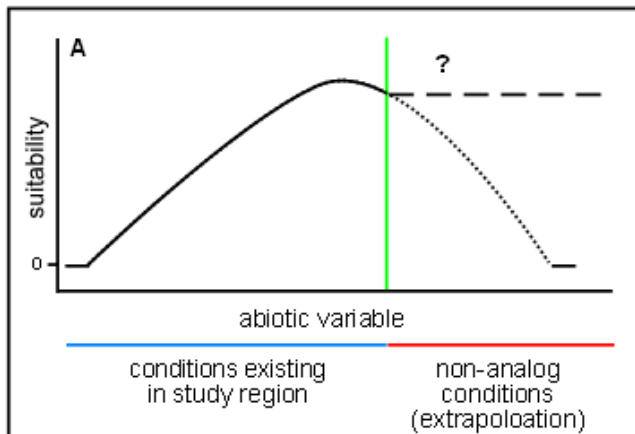
## Niche Space Assumption

*The study contains the full range of conditions that the species can inhabit (for the examined abiotic variables)*

## Noise Assumptions

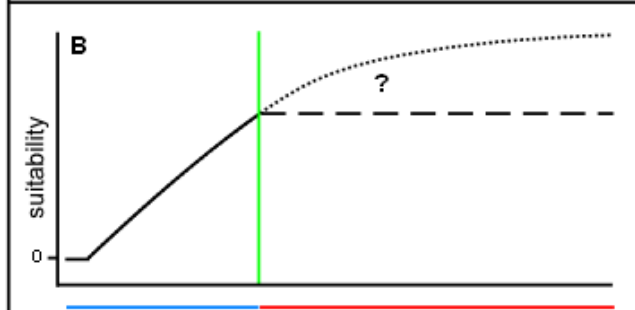
*These factors do not cause the species to occupy an environmentally biased subset of the abiotically suitable areas*

# Summary of assumptions



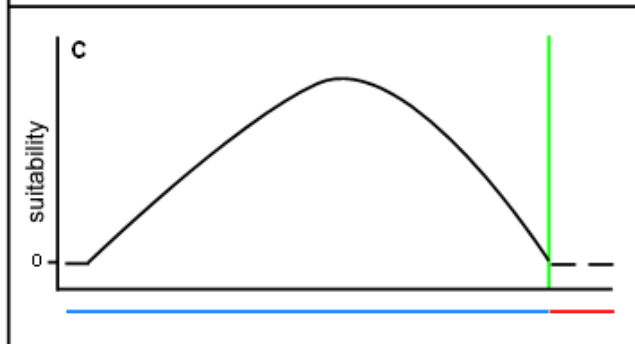
**Danger!**

Try to fulfill Noise Assumptions, even if that means violating Niche Space Assumption,



**More danger!**

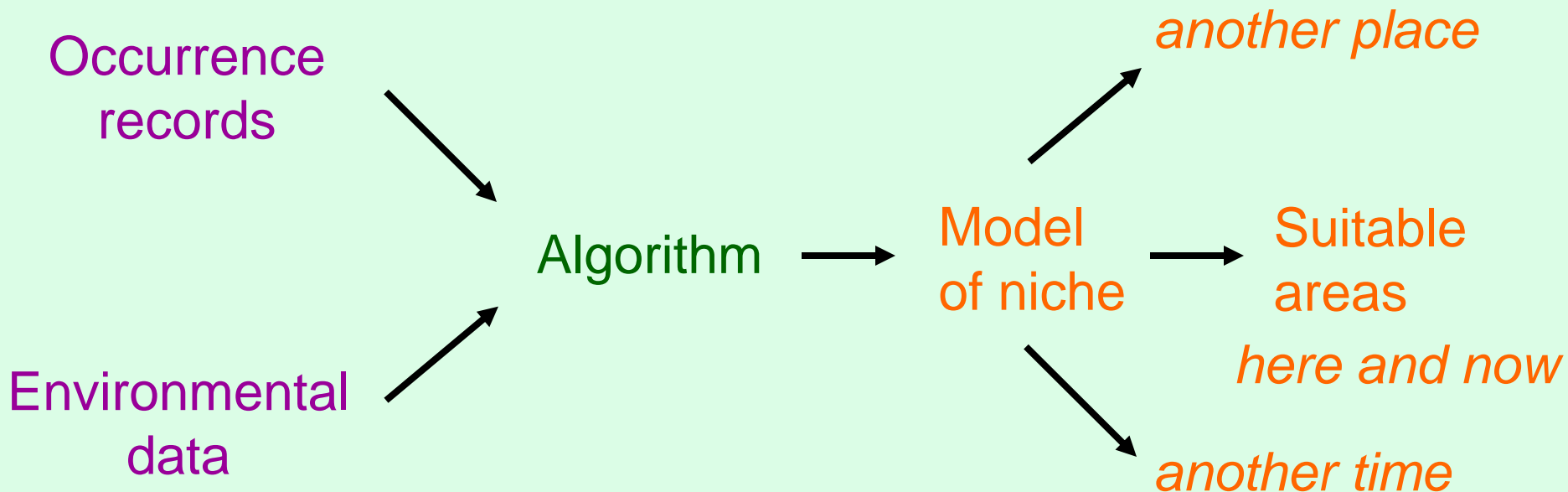
then be cautious when extrapolating in environmental space



**Safe**

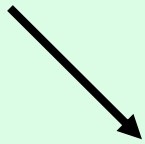
Niche-based models are critical ...

but must be coupled with Dispersal simulations



# Niche models coupled with Dispersal simulations

Model  
of niche



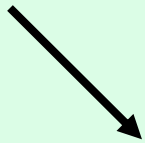
Future  
suitable  
areas



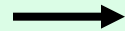
Future variables (climate)

# Niche models coupled with Dispersal simulations

Model  
of niche

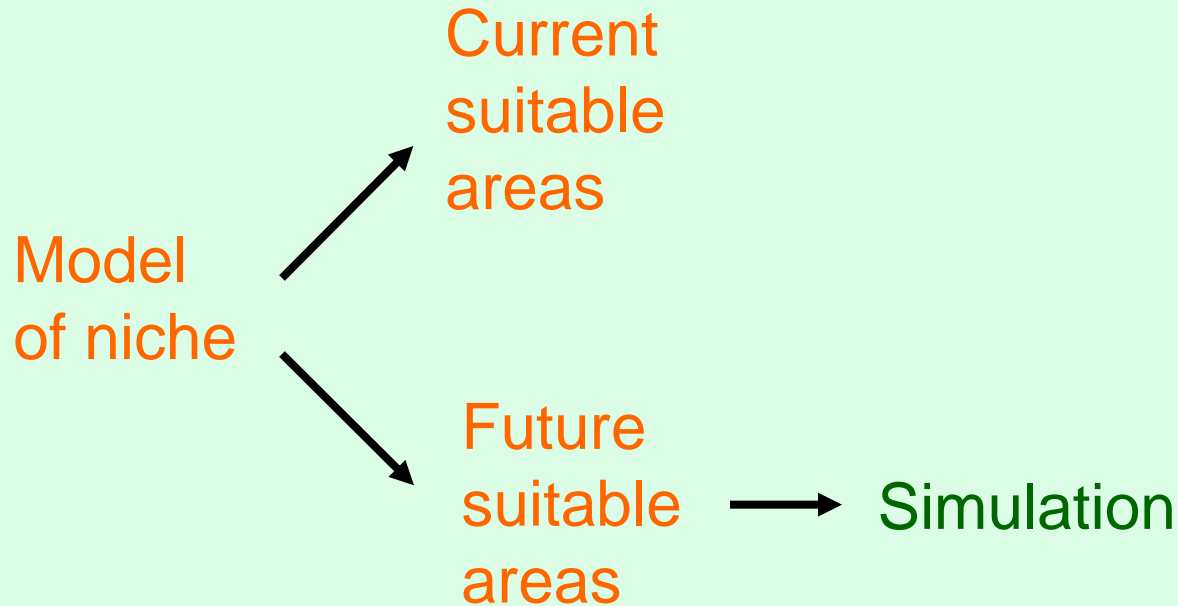


Future  
suitable  
areas



Simulation

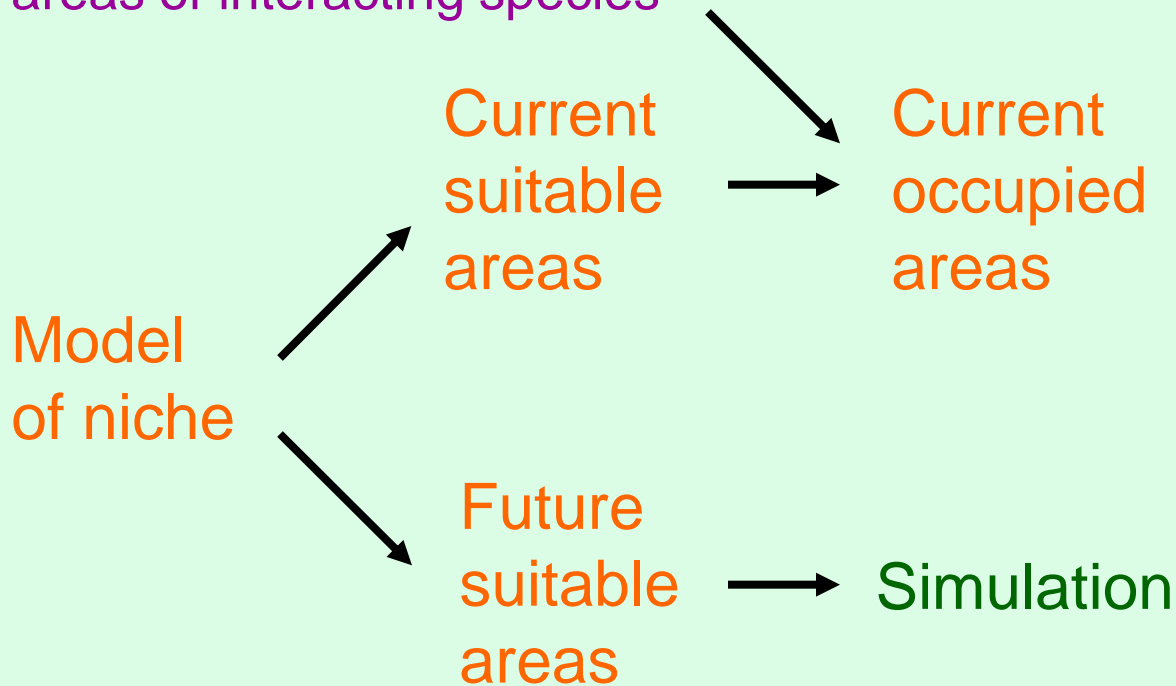
# Niche models coupled with Dispersal simulations



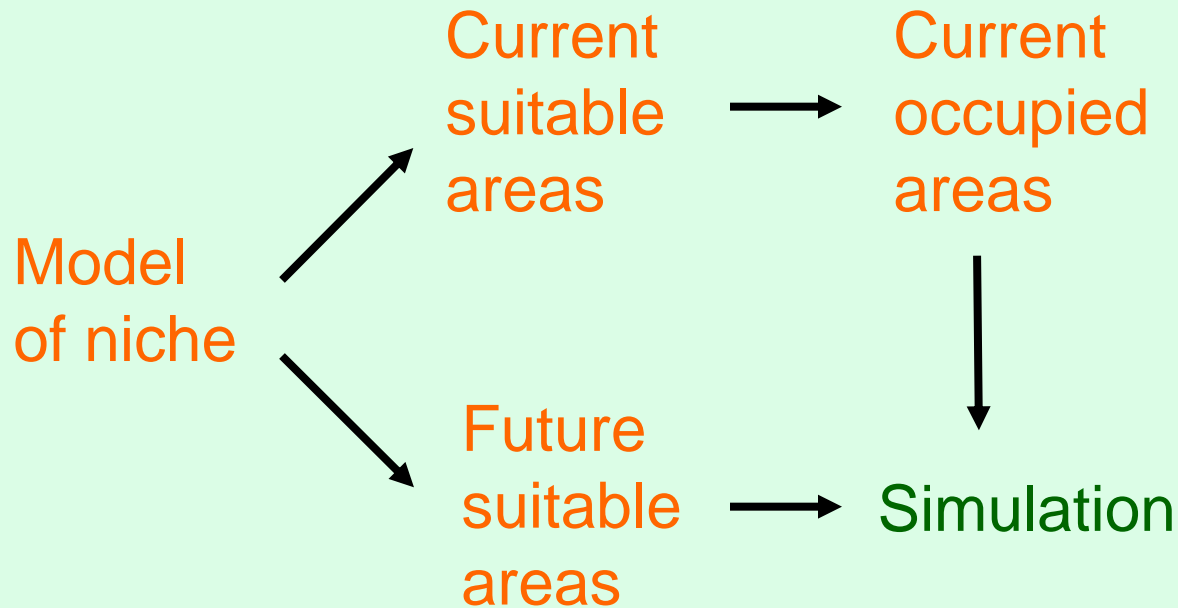
# Niche models coupled with Dispersal simulations

Sampling data

Land cover and current occupied  
areas of interacting species

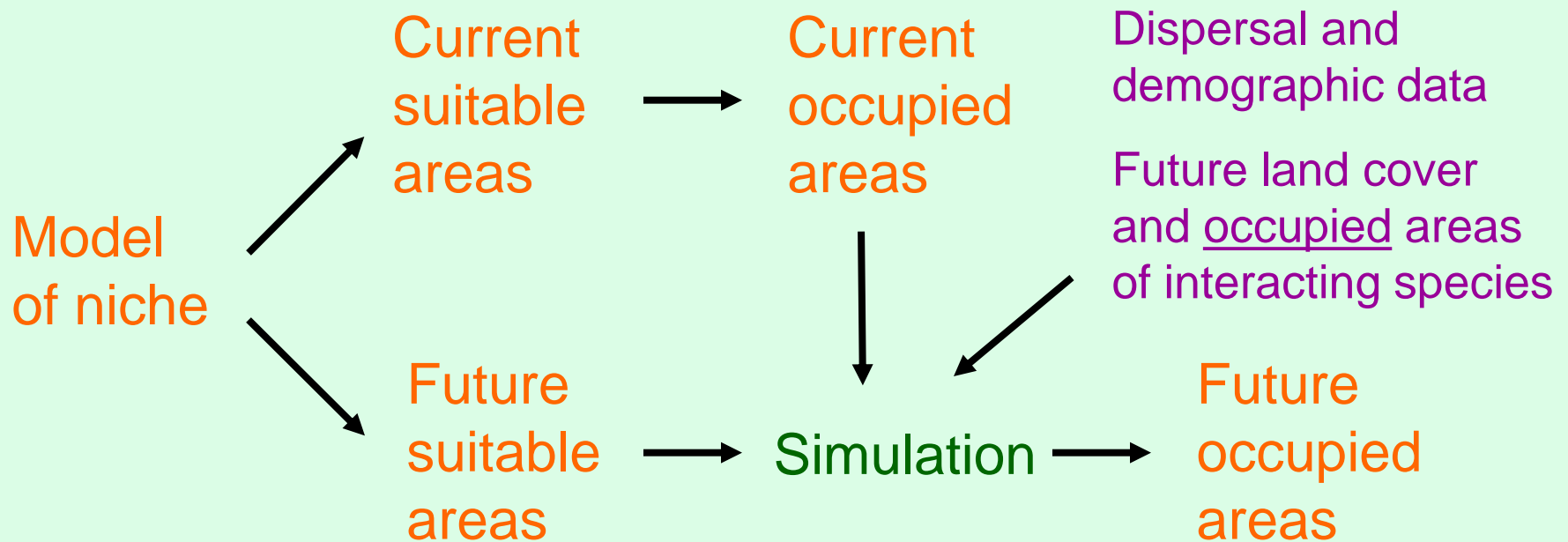


# Niche models coupled with Dispersal simulations





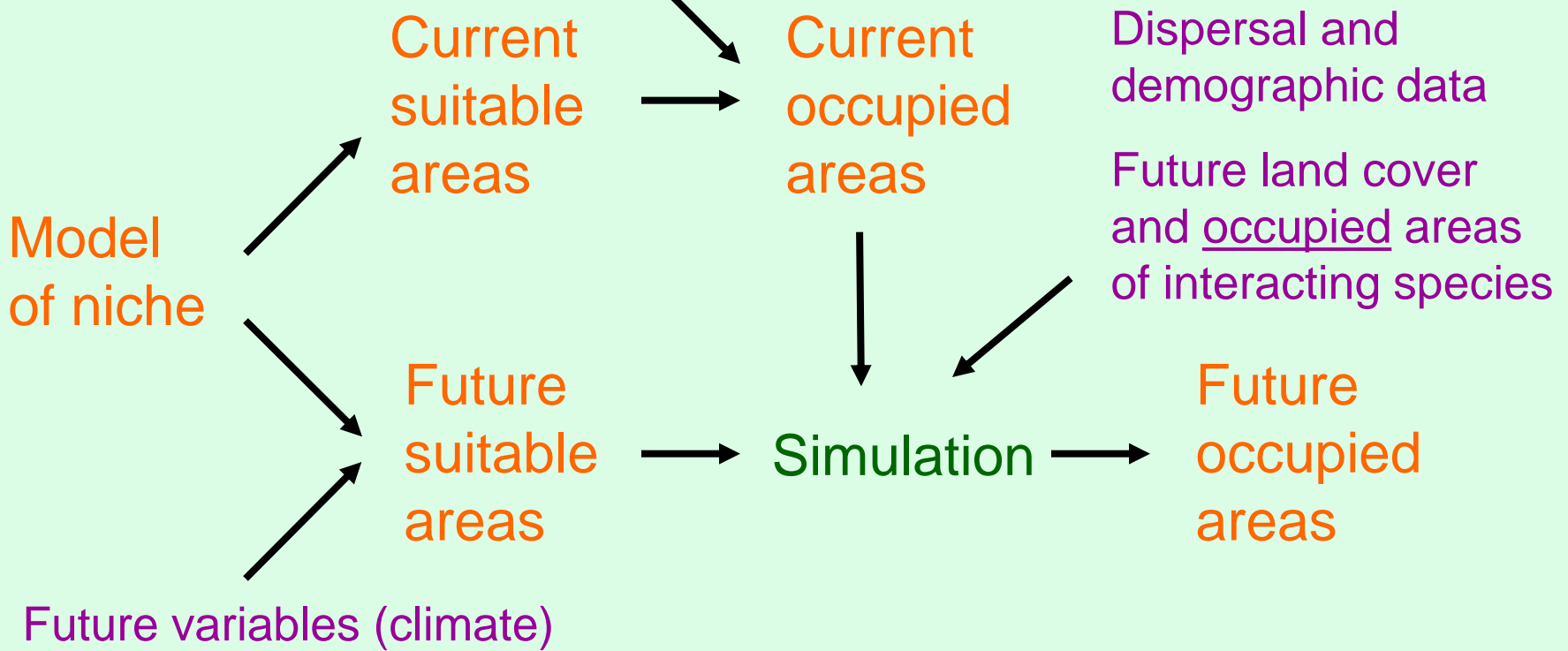
# Niche models coupled with Dispersal simulations



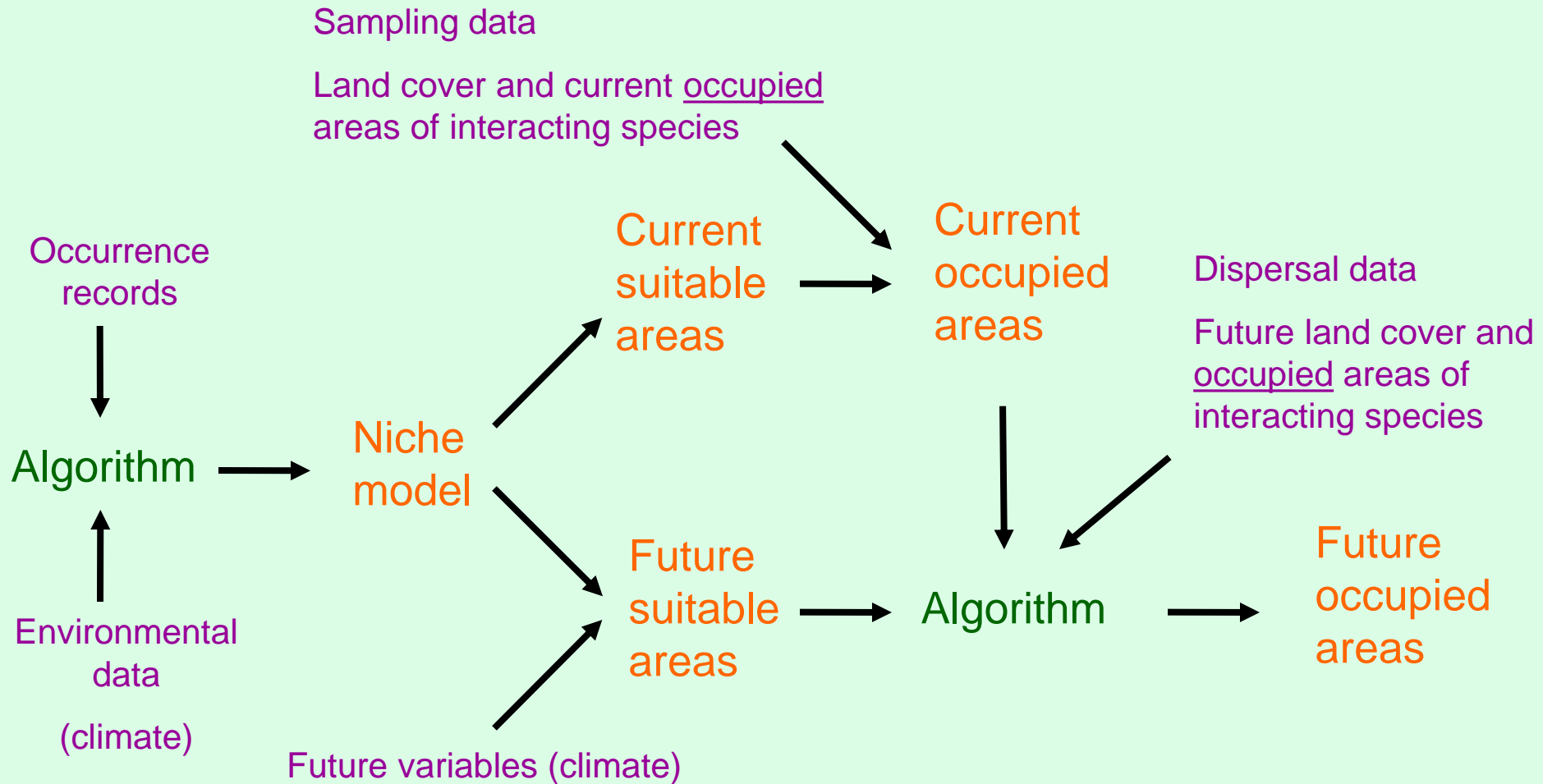
# Niche models coupled with Dispersal simulations

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Land cover and current occupied areas of interacting species



# Niche models coupled with Dispersal simulations



# Thank you

NSF DEB-1119915

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<http://web.sci.cny.cuny.edu/~anderson>

