International Conference on
Mountains and Climate Change

Effects of climate on biodiversity and faunal dynamics in the Alps

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High Summit
Lecco 2013

Our research group focuses on modelling the dynamics and management of terrestrial and marine populations

Case studies here presented

- Alpine marmot
- Black grouse
- Alpine ibex

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Models commonly used for GCC impacts

STATIC
vs.
DYNAMIC

- Static relationship between abiotic factors (including climate) and biotic variables. Biosphere considered at equilibrium.
- Simulate one or more biospheric processes and simulate transient states.

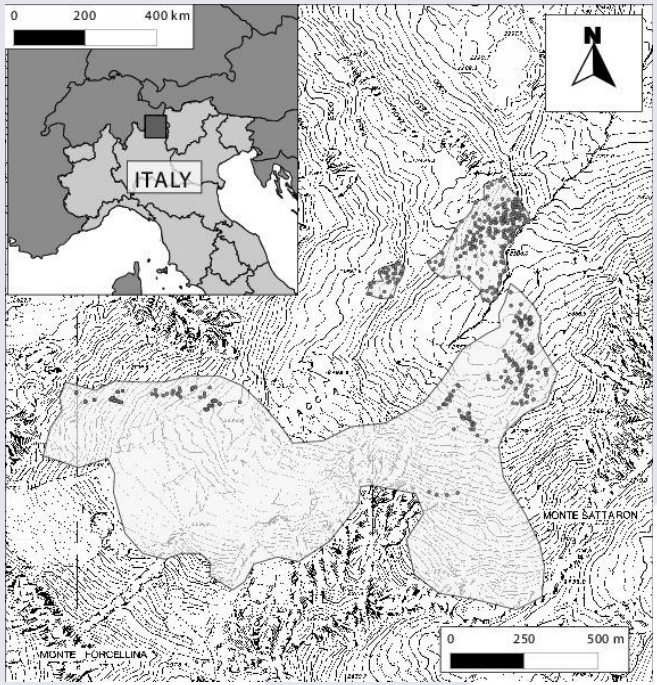
SINGLE SPECIES
vs.
ECOSYSTEM

- Simulate single species isolated from other components of the ecosystem to which they belong.
- Simulate changes in ecosystem/biome function and composition, whether at the level of species or of functional types of organisms.

LOCAL
vs.
GLOBAL
SPATIAL SCALES

- Detailed physiological processes, ecological interactions and species diversity
- Climate envelopes, no or little interaction, functional types

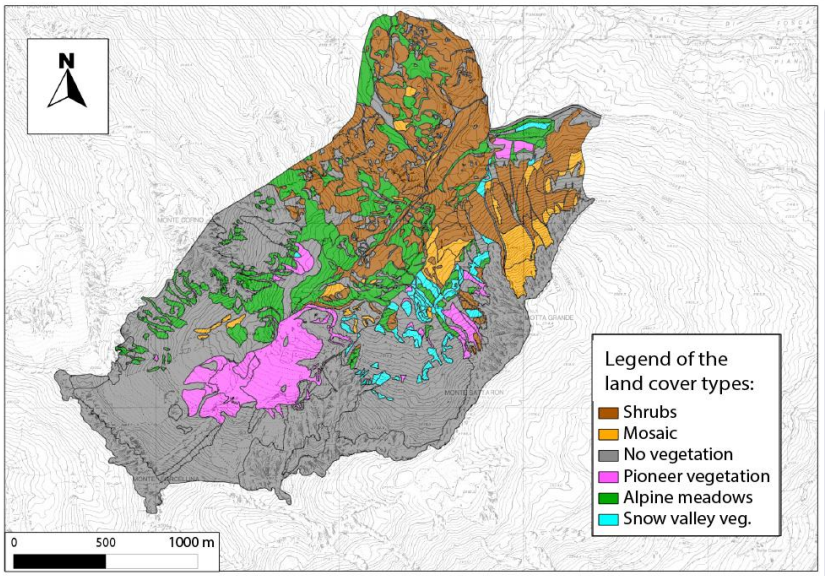
Distribution of Alpine marmot burrows



GOALS

To study the distribution of Alpine marmot burrows in a high altitude valley with respect to:

- The vegetation (available at a fine scale)
- The topography (altitude, slope, …)



Fine scale vegetation map (N. Cannone, Università dell'Insubria)

Method

BMA (Bayesian Model Averaging)

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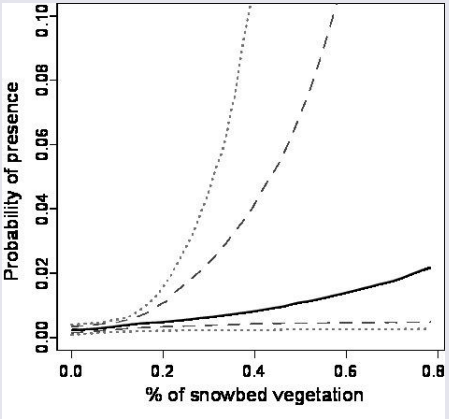
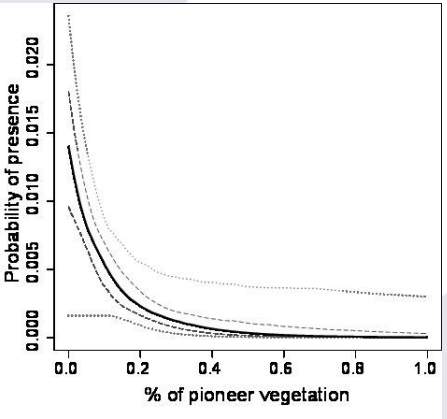
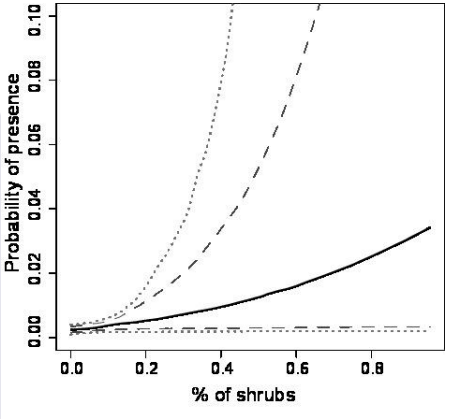
Alpine marmot: most important variables

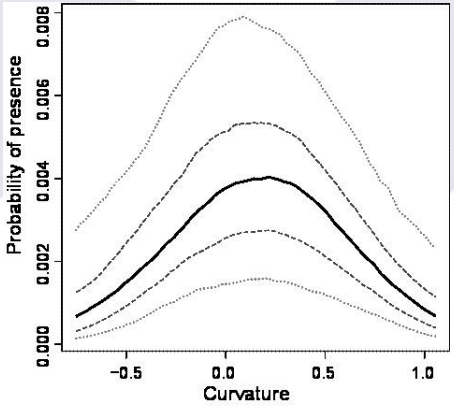
Vegetation

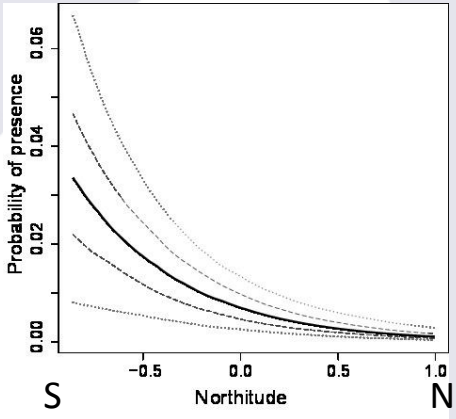


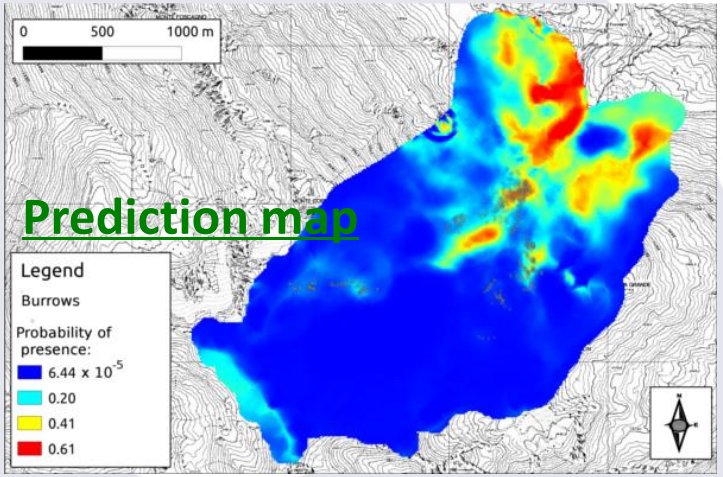




Topography







If fine scale vegetation is used,
altitude is not in the pool of most important variables.

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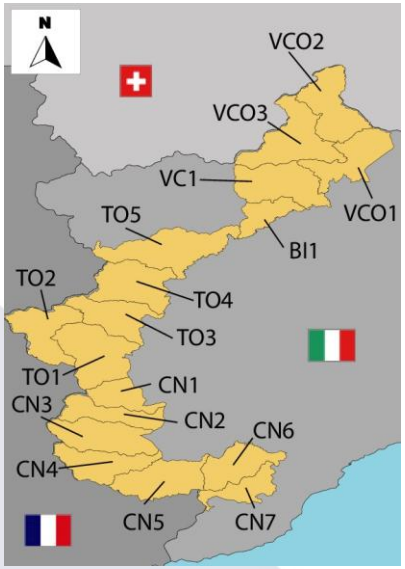
Black grouse in Piedmont (Italy)

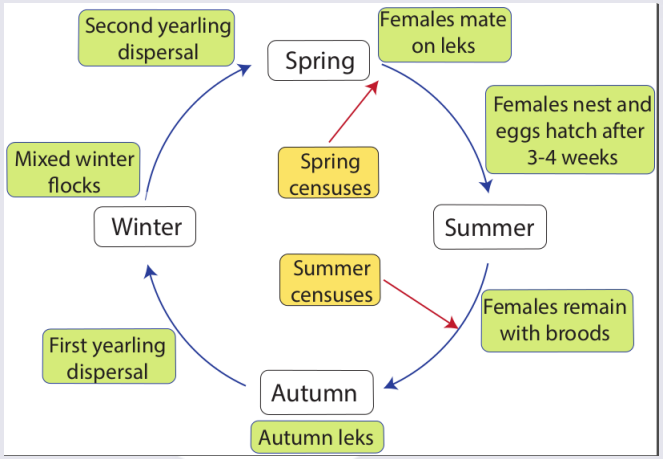


Project ALCOTRA IT-FR

DEMOGRAPHIC RATES (1999-2009)

Juveniles/brooding hen
Juveniles/female
} Summer censuses

Increase rate (male counts) → Spring censuses



GOALS

To study:

- the spatial structure of the population
- the effects of environmental (meteo) variables
- possible density dependence

METHODS

- clustering, BMA

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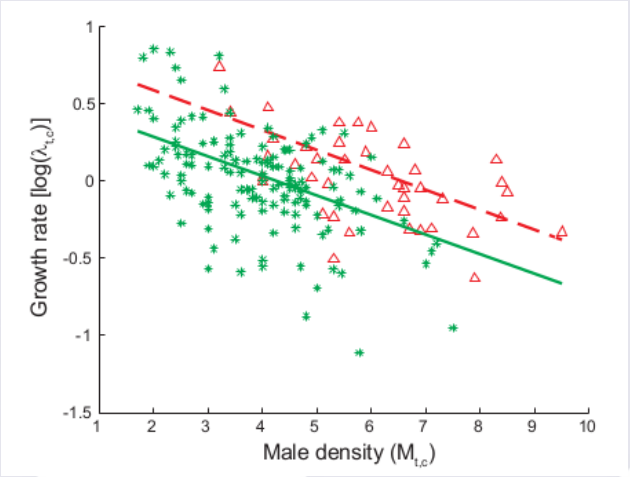
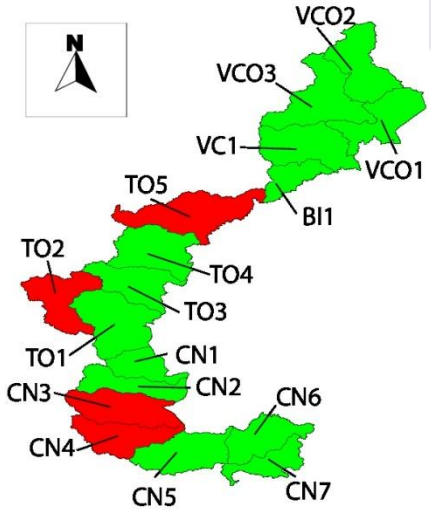
Black grouse: results

The Most important driver of growth rate is density :

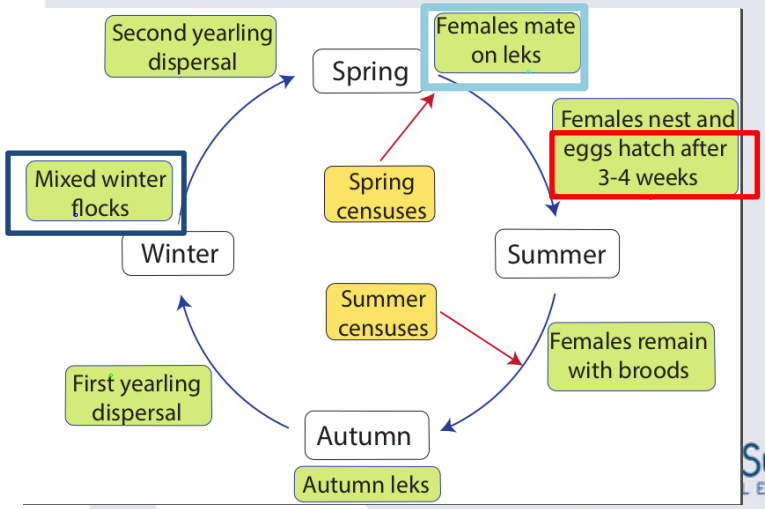




HIGH VS **LOW** carrying capacity districts

Most important meteorological drivers:

- **Growth rate:**
  - (-)temperature in late April — Too early mating
  - (-) rainfall in early January — Food availability
- **Juveniles/brooding hen**
  - (-) rainfall in May-June — Chick survival after hatching
  - (-) rainfall in late January — Food availability
- **Juveniles/female**
  - (-) rainfall in early June — Chick survival after hatching



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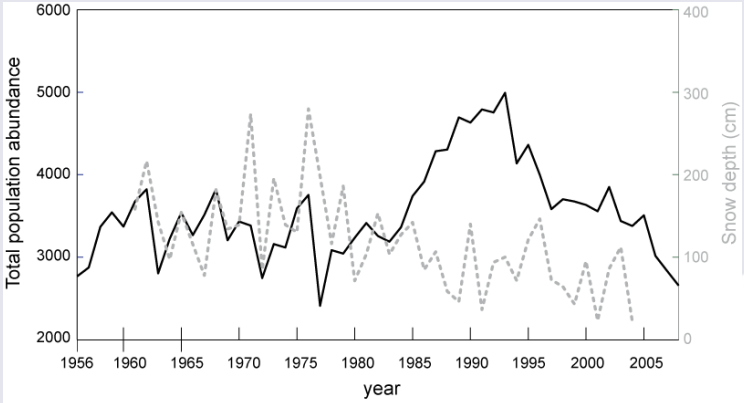
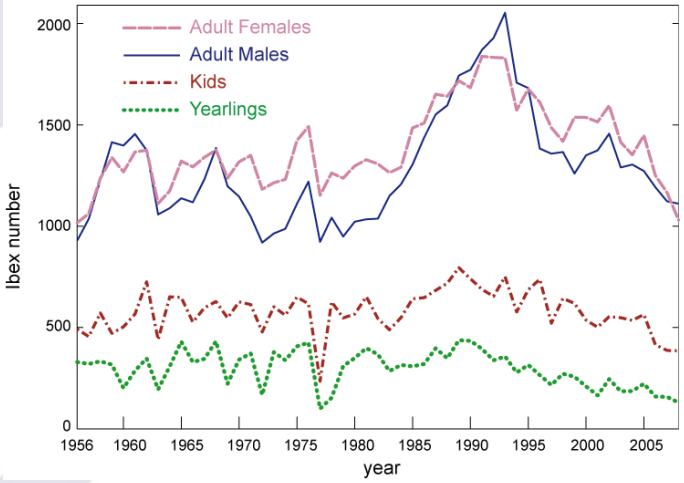
Alpine ibex in the Gran Paradiso National Park

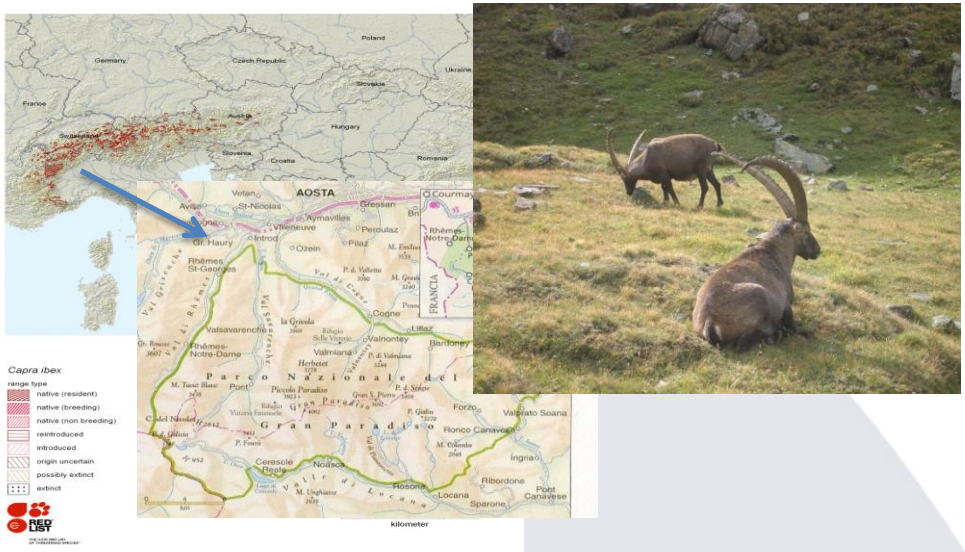
The longest continuous data series of mountain ungulates (censuses from 1956)

The snow depth (a climatic variable) is crucial for the dynamics of the species

(Jacobson, 2004)







Past studies concentrated on the dynamics of total population density only.

GOALS

To study the dynamics of the GPNP population considering

- the age and sex population structure
- nonlinear effects of climate

METHODS

Model selection (AIC)

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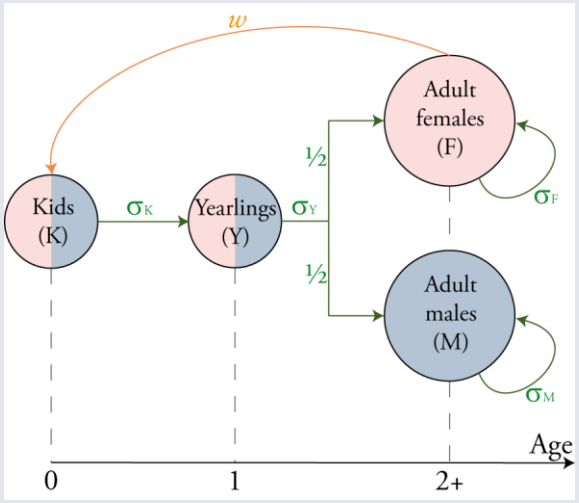
Alpine ibex in the Gran Paradiso National Park

Stage-structured models

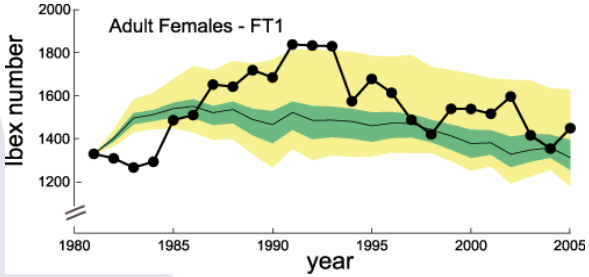
Parameters are calibrated using data from 1961 to 1980

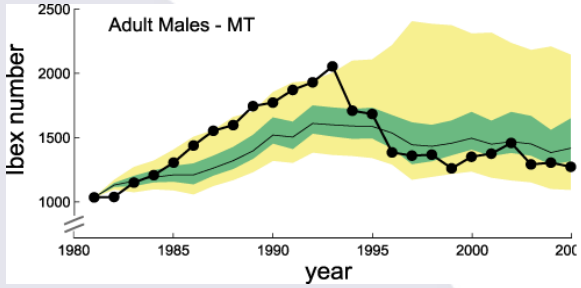
Validation starting from 1981

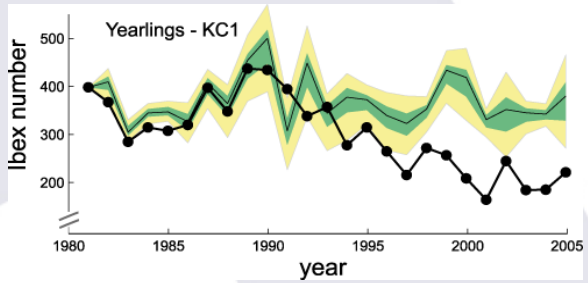


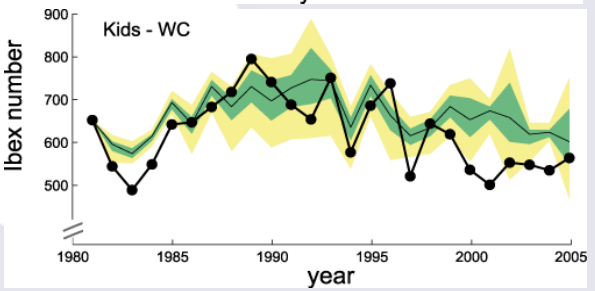
Our results show the importance of considering:

- Snow (in diversified non-linear ways)
- Interaction between snow and density
- Spatial segregation

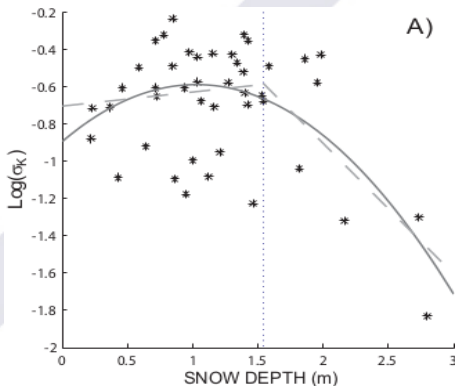


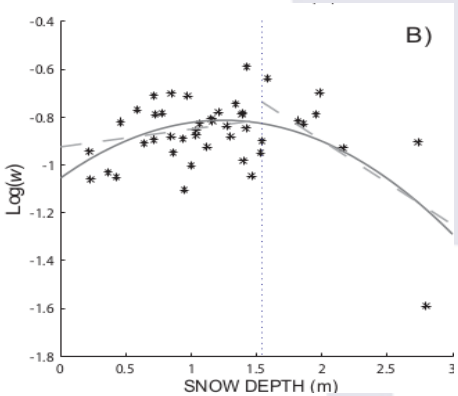






Non linear effects of snow depth on juvenile compartments:





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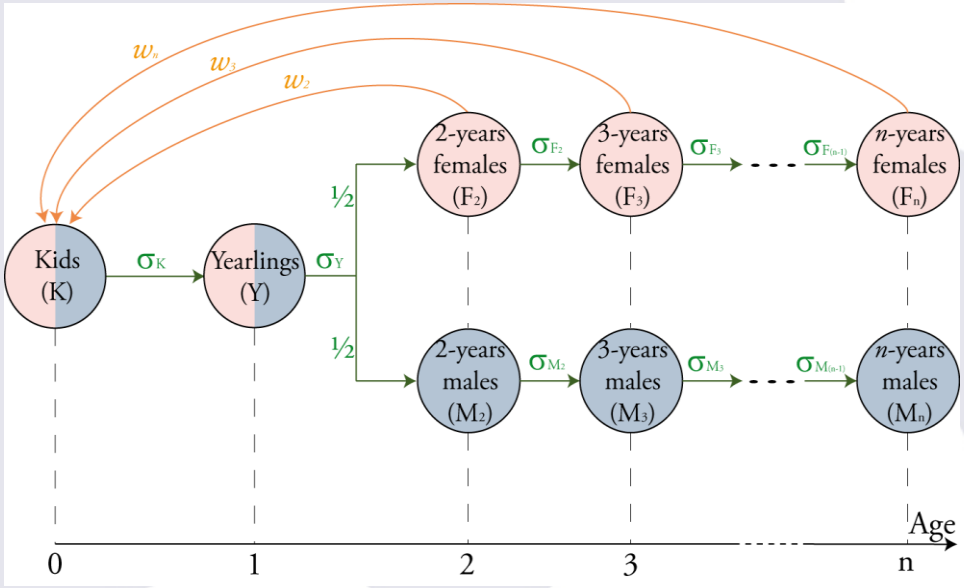
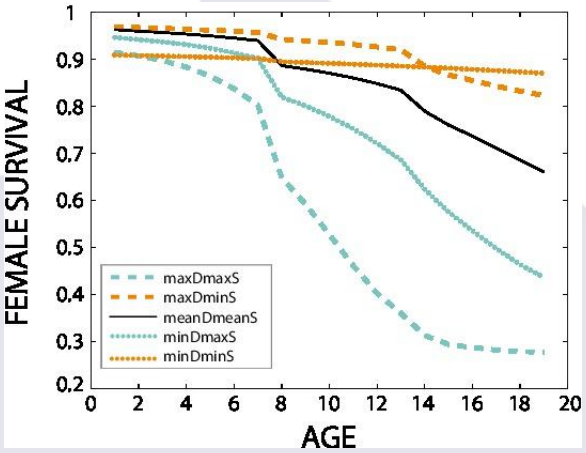
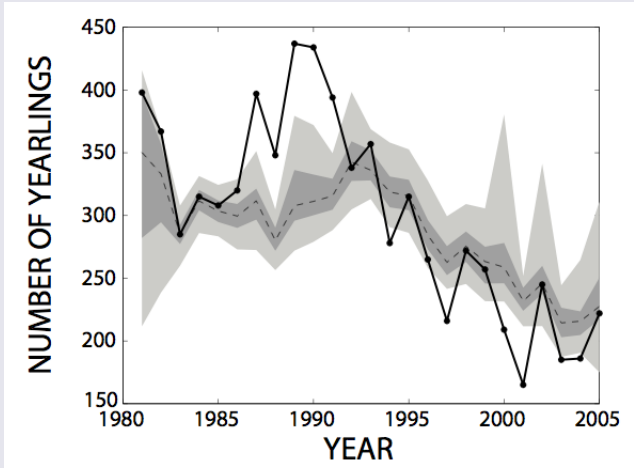
Mignatti, A., et al (2012). Wildlife Biology, 18(3), 318–332.

Alpine ibex: accounting for senescence

From STAGE to AGE structure: one state variable for each age to deal with senescence (i.e., age-decreasing survival and fertility) and maturation







- Several senescence functions tested
- Best models selected using AIC.

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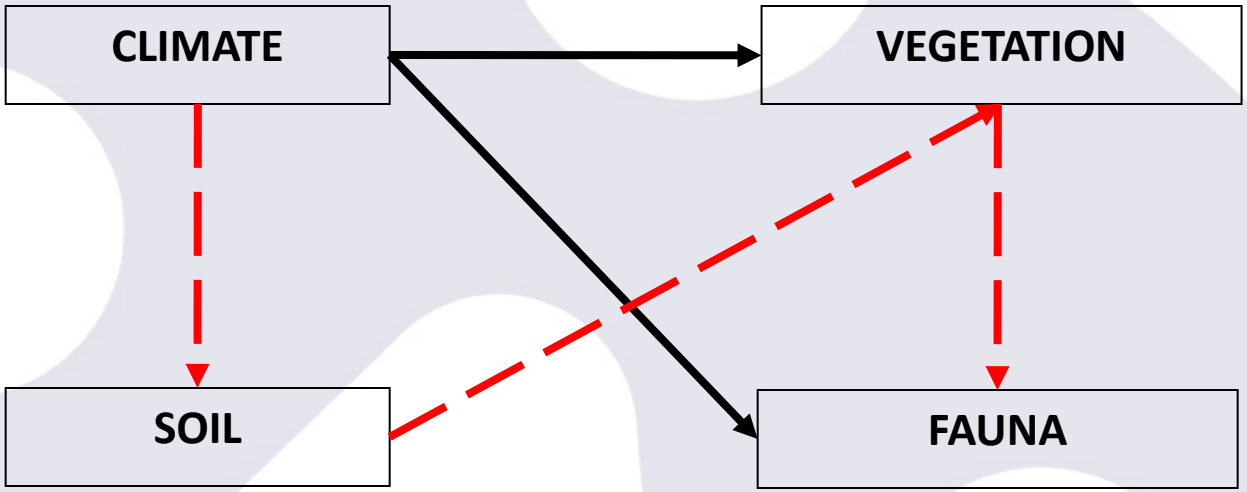
Critical point

Indirect and synergistic impacts



Even if indirect pathways do exist, current models focus on individual responses of species to exogenous factors.

Synergisms and interactions are often neglected.

Conclusions

- GCC does influence the distribution of animal and plants and the functioning of Alpine ecosystems
- However, finding the impact pathways is not at all simple
- There is need for experimental work in the lab and the field to understand
  - the basic physiological and ecological processes
  - the organismic response to climatic variables, hence to climate change
  - the synergism of various factors
- More sophisticated models with greater predictive power are necessary, however they crucially depend on good data which are still lacking
- Downscaling of GCM's is fundamental to understand impacts on ecological communities but is a challenging task