Memòria justificativa de recerca de les convocatòries BE, PIV, BCC, NANOS i BP

La memòria justificativa consta de les dues parts que venen a continuació:
1.- Dades bàsiques i resums
2.- Memòria del treball (informe científic)

Tots els camps són obligatoris

1.- Dades bàsiques i resums

Nom de la convocatòria

BE

Llegenda per a les convocatòries:

BCC	Convocatòria de beques per a joves membres de comunitats catalanes a l'exterior (BCC)
BE	Beques per a estades per a la recerca fora de Catalunya (BE)
BP	Convocatòria d'ajuts postdoctorals dins del programa Beatriu de Pinós (BP)
NANOS	Beques de recerca per a la formació en el camp de les nanotecnologies (NANOS)
PIV	Beques de recerca per a professors i investigadors visitants a Catalunya (PIV)

Títol del projecte: ha de sintetitzar la temàtica científica del vostre document.
MODELLING OF BIRD DISTRIBUTION UNDER COMPLEX MEDITERRANEAN LANDSCAPE DYNAMICS: OPEN HABITAT BIRDS AND FIRE (MEDFIRE)

Dades de l'investigador

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Número d'expedient
2006 BE-2 52

Paraules clau: cal que esmenteu cinc conceptes que defineixin el contingut de la vostra memòria.
modelització del paisatge, incendis, dispersió, canvi global, models poblacionals

Data de presentació de la justificació
21/11/2007

Generalitat de Catalunya
Departament d'Innovació, Universitats i Empresa

Resum del projecte: cal adjuntar dos resums del document, l'un en anglès i l'altre en la llengua del document, on s'esmenti la durada de l'acció

Resum en la llengua del projecte (màxim 300 paraules)
General context

Landscape change during the last years is having significant impacts on biodiversity in many Mediterranean areas. Land abandonment, urbanisation and specially fire are profoundly transforming large areas in the Western Mediterranean basin and we know little on how these changes influence species distribution and in particular how these species will respond to further change in a context of global change including climate.

General objectives

Integrate landscape and population dynamics models in a platform allowing capturing species distribution responses to landscape changes and assessing impact on species distribution of different scenarios of further change.

Specific objective 1

Develop a landscape dynamic model capturing fire and forest succession dynamics in Catalonia and linked to a stochastic landscape occupancy (SLOM) (or spatially explicit population, SEPM) model for the Ortolan bunting, a species strongly linked to fire related habitat in the region.

Predictions from the occupancy or spatially explicit population Ortolan bunting model (SEPM) should be evaluated using data from the DINDIS database. This database tracks bird colonisation of recently burnt big areas (>50 ha). Through a number of different SEPM scenarios with different values for a number of parameter, we should be able to assess different hypothesis in factors driving bird colonisation in new burnt patches. These factors to be mainly, landscape context (i.e. difficulty to reach the patch, and potential presence of coloniser sources), dispersal constraints, type of regenerating vegetation after fire, and species characteristics (niche breadth, etc).

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2.- Memòria del treball (informe científic sense limitació de paraules). Pot incloure altres fitxers de qualsevol mena, no més grans de 10 MB cadascun d'ells.

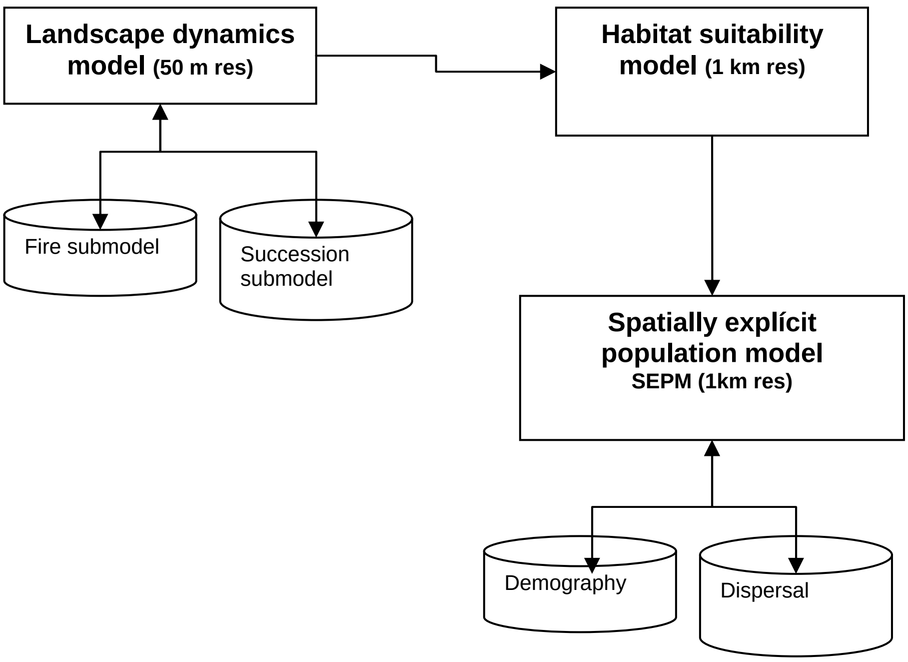
MODELLING OF BIRD DISTRIBUTION UNDER COMPLEX MEDITERRANEAN LANDSCAPE DYNAMICS: OPEN HABITAT BIRDS AND FIRE (MEDFIRE)

SELES application- Vancouver-Victoria, summer (June-set 2007). Collaboration with Andrew Fall and the Simon Fraser University

The objective of the stay of Lluís Brotons at the Simon Fraser Unviersity has been the development of an integrated modelling platform allowing the simulation of the responses of biodiversity to changes in fire regimes in a global change scenario. In the following pages, we describe the main components of the structure of the MEDFIRE model dveloped by Lluís Brotons and Andrew Fall during the stay at the SFU. The next step to follow after the development of the model will be to calibrate the different parameters involved in the model and proceed with the publication of at least one first article with the aim at evaluating the effects of fire on the distribution of a model species the Ortolan bunting (Emberiza hortulana).

Modelling structure

The MEDFIRE fire is a complex model combining landscape, habitat and spatially explicit population model in an integrated attempt to assess bird species response to fire impact in Catalonia.



Landscape dynamics model

This modelling module is responsible of mimicking changes in landscape composition derived from succession and fire dynamics and it is therefore composed of two separate sub modules each dealing with a different landscape event. The main purpose of the landscape dynamics model is to update the forest map with different forest classes (i.e. each corresponding to a dominant species of set of species) and land use classes. Forest types had seral stage (from 1 to 4) as determined by the Spanish forest map, whereas other categories including shrub did not have seral stage and maturation was only related to time since last fire.

- ***SUCCESSION SUB-MODEL:***

This sub-model is responsible for the simulation of time related changes in forest composition. This submodel determines the characteristics of the potential transitions in terms of dominant tree species that affect each cell each year according to the event affecting it. Two main types of changes are included in the model.

A- *Post-fire changes* in forest composition: including all changes in dominant tree forest species after fire event affects a given cell.
B- *Forest maturation and*
C- *Succession*: including changes in seral stage and transitions of shrub to forest structures.

A- Post-fire changes in forest composition account for direct and non-direct (i.e. changes in dominant tree species) forest regeneration dynamics after the impact of fire in a given area. Transition changes were not located spatially at random but were forced to be aggregated. This was implemented by forcing transition to be based on neighbours with a predetermined probability. Neighbours available to define the transition were only available if being the same species before fire and having the same time since last fire.

a. Base transition probabilities of dominant tree species after a fire are based on Rodrigo et al. (2004). Given that post-fire transition probabilities are based on data from different fires located in different regions, we included different transitions probabilities for a given tree species in different region by including region as a varying factor in the model (Base transition probabilities for each region were loaded into the model via a table).

b. Regeneration patterns are known to be strongly linked to aspect value. In order to mimic this pattern, non-direct regeneration patterns where modified in order to increase the amount of shrub (.i.e. non tree regeneration after fire) in southern slopes. This was loaded into the model by means of a table. Final parametrisation of slope weights should take into account not to bias base transition probabilities obtained through Rodrigo et al. (2004) models.

c. Given than transition probabilities after fire are known to depend on time since the previous last fire, we used a new table with modified transition probabilities for recent re-burns in which those for species with non-direct regeneration after repeated fires were modified according to the literature (i.e. *Pinus halepensis* starts producing cones 15-20 years after a fire).

B- Forest maturation (i.e. change in seral stage) is charged of changing the seral stage category for a given forest cell. Changes in forest stage are at present fixes after a number of years. After 35 years final change to seral stage 4 is set.

C- Succession (i.e. changes in species as time goes) is only modelled for shrub (i.e. forest are assumed to be in a relatively stable state, once forest is present it does not change). Shrub is allowed to have a yearly probability to change to forest after the age of 20 years. In case that transition from shrub to forest is possible, the transition probabilities are obtained from the distribution of mature forest types in the surroundings of the cell (150 m radius). Not all tree species have the same probability of shrub colonisation. Therefore, we use aspect and tree species (i.e. mimicking differences among species in seed pressure) to weight the relative contribution of each species to distribution of tree species neighbour. New forests originated from shrub maturation are set to seral stage 3. Changes from shrub to forest could be evaluated by comparing temporal changes in shrub state in land use maps.

- ***FIRE SUB-MODEL:***

This submodel is intended to simulate fire regime in the study area. At the moment, the model is stochastic based on data on current fire regime and fire extent.

2- The sub-model sets each year the amount of area to be burnt from a given distribution of burnt area per year. This distribution is estimated from data on current fire regime in Catalonia (Diaz-Delgado et al. 2004). Then the model sets a number of ignitions that burn area until the annual extent is reached (only forest and shrub count in the objective of final burnt extent). One an ignition starts a fire; a fire size is obtained from a fire size distribution aimed at mimicking the one obtained from real data from the period 1960-1999 (see below).

3-

A- Ignitions are not at random, but decrease in areas with high summer precipitation and increase near roads. Ignitions have also a much higher probability in high risk areas of forest fire (Generalitat de Catalunya).

4- Fires do not burnt at random:

A- Two kinds of general burning (set to different proportions in different regions):

a- Topographic: upslope burning. This is modelled by calculating differences in altitude between cells about to be burnt and increase spread time in those spreading upslope.

b- Wind-mediated: main wind in different regions. A similar method to the one used in topographic fires is used here but, here spread time is increased in spreading cells in line with predominant wind directions in a given region.

B- Fire spread depends on species by setting different combinations of fire spread time and a different propensity to burnt (i.e. transition probability).

a- Fire spread (relative probability): determine how fast a cell spreads fire to the neighbours (slow cells remain in the event queue).

b- Fire transition probability (absolute probability): determine the probability that a cell that received fire spread changes indeed to a burnt condition (transition probability). Fire fighting probability can be argued to be integrated in this parameter.

Time since last previous fire is maintained indirectly by tracking *lastFireInterval* in years and time since last fire.

HABITAT SUITABILITY MODEL

Habitat suitability is a main determinant of species distribution. It calculates environmental variables at 1km resolution by aggregating data at 50 m from the current year forest map.

At present three main environmental variables drive HSI:

1- Shrub <8 years and forest sage 1-2 same <3 years since fire.
2- Shrub 8-25 years.
3- Stable shrub >25 years.

SPATIALLY EXPLICIT POPULATION MODEL (SEPM)

Species distribution is dynamic and depends on different factors including habitat suitability and dispersal. The SEPM module incorporates realistic population processes specially dispersal in order to model changes in species distribution more accurately.

The model is based on the male population and determines site occupancy and abundance in each 1 km cell.

Initial step:

At the initial step, the current species population is distributed according to the Atlas distribution map and occurrence and abundance monitoring data (SOCC). A number of cells are set to be occupied according to their initial distribution model $Dist_{initial}$ (relation obtained from $Dist_{initial}$- $SOCC_{occurrence\ relationship}$). For each occupied cell, a density is set also from data obtained through monitoring data (minimum than, max carrying capacity…). Carrying capacity is set from the density obtained from each given cell and multiplied by a $K_{multiplier}$ (i.e. when $K_{multiplier}$ is equal to 1, then K is set by initial density in the cell).

The model tracks two different states for each cell: occupancy and potential occupancy (carrying capacity, $K > 0$). And occupied cell is a cell which is potentially occupiable and either at initial state or through dispersal has been populated. Occupied cells are set to be potentially occupied during the rest of the simulation (other are set later according to a probability *pPotentialOcc* and initial distribution).

Model steps

- Step 1: Mortality before dispersal. It is applied differently for adults and juveniles and sets the number of individuals finally present in each occupied cell. Surviving juveniles will become adults at the end of step 3.

    - This step also updates potentially occupiable ied cells according to changes in HSI (generated by HSI submodel). In cases in which $HSI_t < HSI_{t-1}$ then the model will set new potentially occupiable cells according to the occurrence distributions used in the initial conditions. In these new potentially occupiable cells, the carrying capacity is set, but the number of individuals is 0.

    - At each time step, the carrying capacity of a given cell is updated in order to account for changes in habitat quality related to maturation (i.e. decreases) or new fires (i.e. new habitat). Initial carrying capacity $K_{initial}$, is multiplied by a ratio HSI_t/HSI_{t-1}. (i.e. is HSI increases K will increase, in HSI decreases, it will decrease and so the maximum number of individuals in a cell).

    - In case in which population in t-1 was very low (i.e. $N<3$), HSI has been decreasing and population in time t is 0, the cell is considered to be no longer capable of supporting the species and then is no longer considered potentially occupiable (i.e. should undergo an increase in HSI, before it has the opportunity to become available for colonisation again).

    - HSI reference for a cell corresponds to HSI at which the cell becomes potentially occupiable.

- Step 2: Dispersal. It is devolved for adults and juveniles since each of these to classes of individuals show a different dispersal kernel. According to the available data, the proportion of individuals dispersing from each cell is calculated and these individuals are then distributed among available receiver cells according to the respective dispersal kernel function (*spreadprob*). The way this is finally accomplished is using a two step process:

        - First, using the selected dispersal kernel and the number of dispersers from a given cell, the maximum distance dispersed is selected.

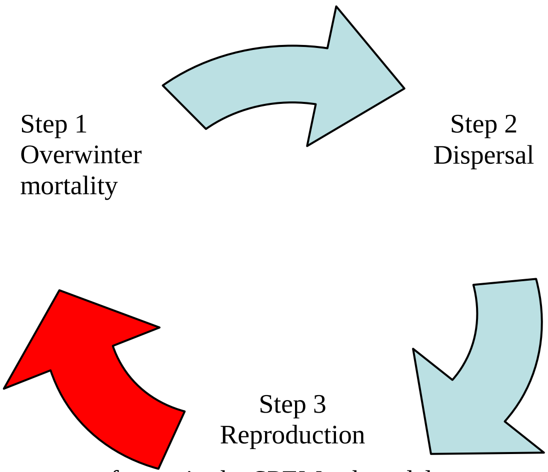
        - Second, a cost distance function is calculated from that cell (i.e. cost 1 is the default no cost, linear distances), and a function is generated. Final dispersal distance is chosen from a second distribution (see problems and calibration of kernel distribution).

    - Dispersal is modelled different from adult and juvenile males.
    - Dispersal can only take place to cell with individual under K.
    - This step also sets evaluation variables (eval File for the cells, *NumEvalId* previously set).

- o Dispersal distances distribution can be based on linear (default) or cost distance based on HSI or forest abundance (i.e. dispersal in bad habitat or forested areas more difficult).

- Step 3: Reproduction. Here, and according to available data and local data, number of offspring according to the current population in each cell is calculated from prevailing reproductive data. This updates abundance for each cell.

  - o The number of individual males in a given cell may be higher than *K* after reproduction (i.e. first mortality and then dispersal will later deal with this).



Time sequence of steps in the SPEM submodel.

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