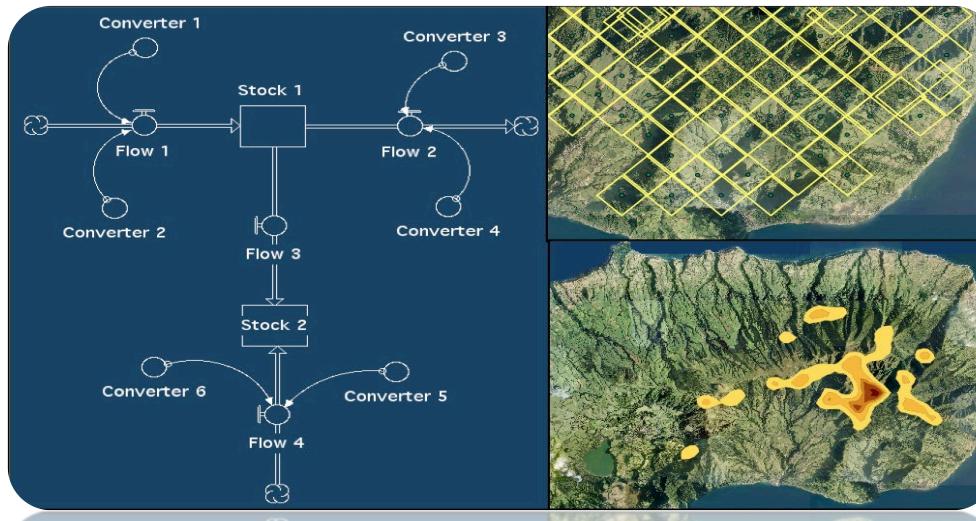


## Workshop

# The Stochastic Dynamic Methodology (StDM)

## Fundamentals and description in practice

### Part II



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Portugal

# Testing a novel spatially-explicit dynamic modelling approach in the scope of the laurel forest management for the endangered Azores bullfinch (*Pyrrhula murina*) conservation



Bastos, R., Santos, M., Ramos, J.A., Vicente, J., Guerra, C., Alonso, J., Honrado, J., Ceia, R., Timóteo, S., Cabral, J.A., 2012. Testing a novel spatially-explicit dynamic modelling approach in the scope of the laurel forest management for the endangered Azores bullfinch (*Pyrrhula murina*) conservation. *Biological Conservation*, 147: 243-254.

## The Azores bullfinch

- *Pyrrhula murina*
- Azores islands (Portugal)

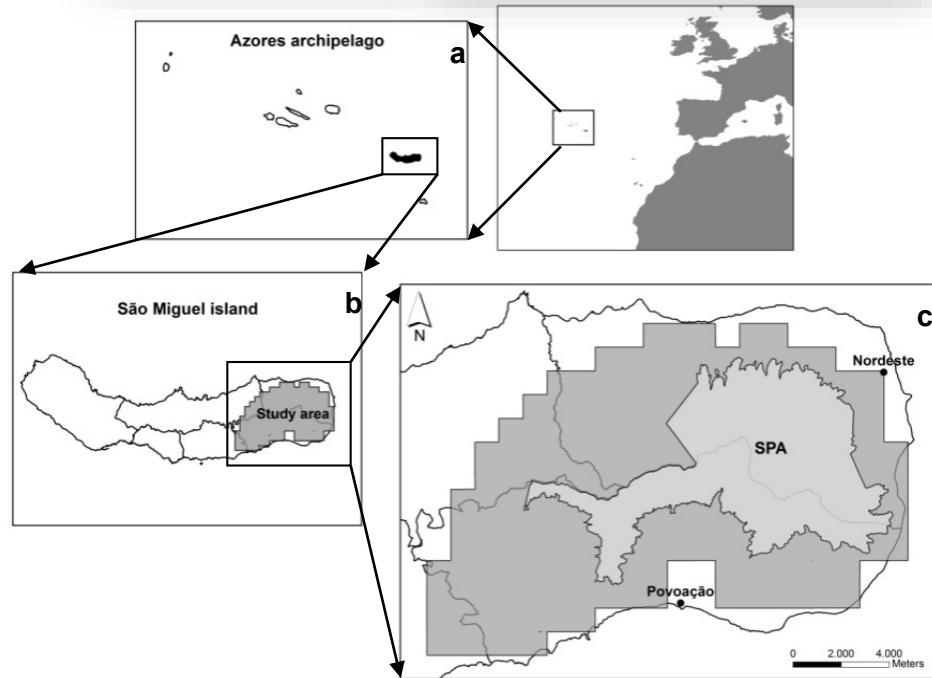


## Distribution

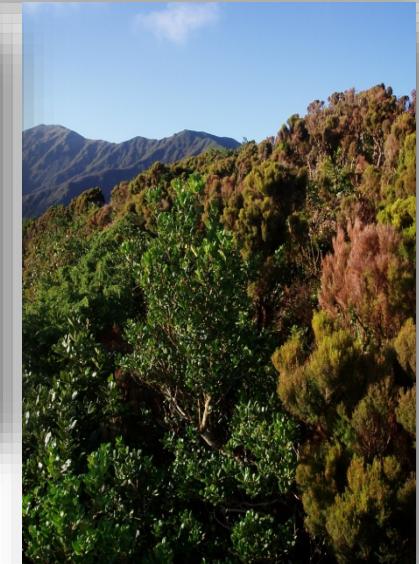
-Serra da Tronqueira

## Habitat constraints

- Land use changes
- Invasive plant species



Conservation status - “Critically endangered” to “Endangered” (BirdLife International)



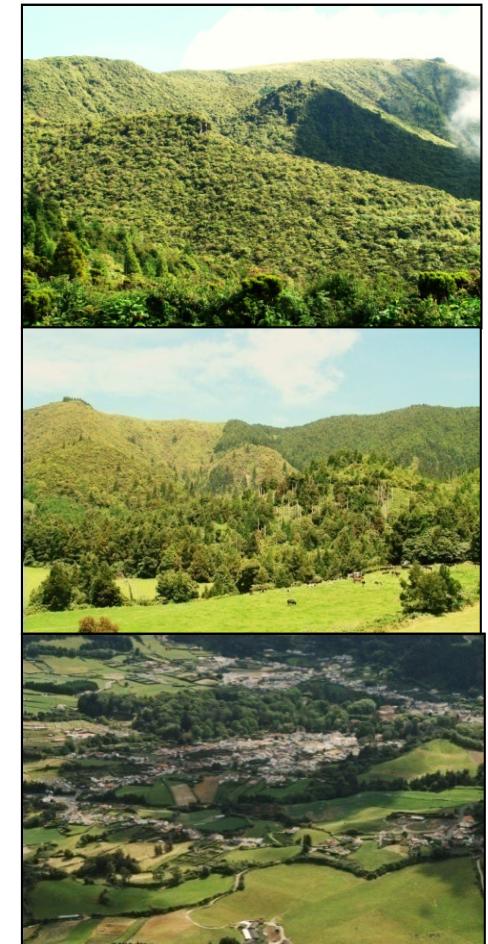
# Stochastic Dynamic Methodology

## Stochastic-dynamic methodology (StDM)

captures the complexity of some ecological consequences

representative gradients of change

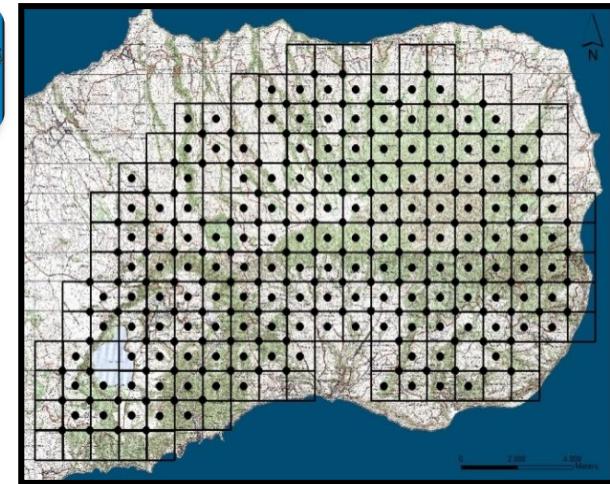
Exotic plants invasion and land use changes  
(*Cryptomeria japonica*, *Clethra arborea* and *Pittosporum undulatum*)



# Sampling Strategy

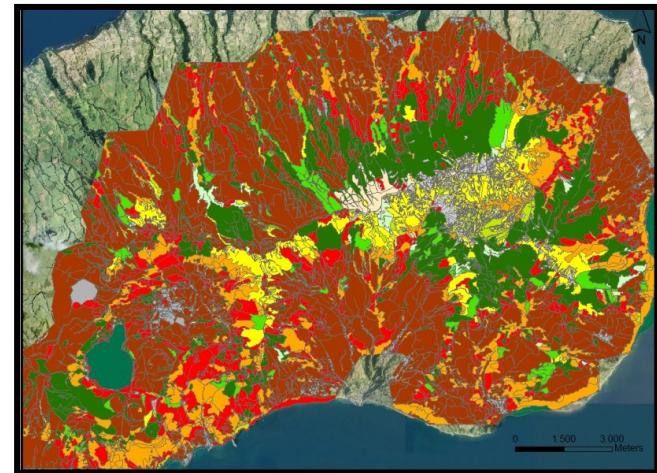
- “Atlas do Priolo” 2008
  - 50 researchers
  - 306 point-counts

90 Azores bullfinch



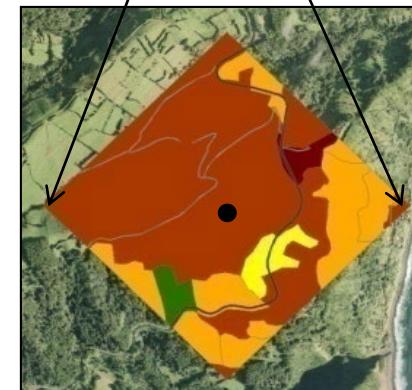
- Vegetation mapping
  - Foto-interpretation and validation in the field

Forestry areas  
Humanized areas  
Natural vegetation



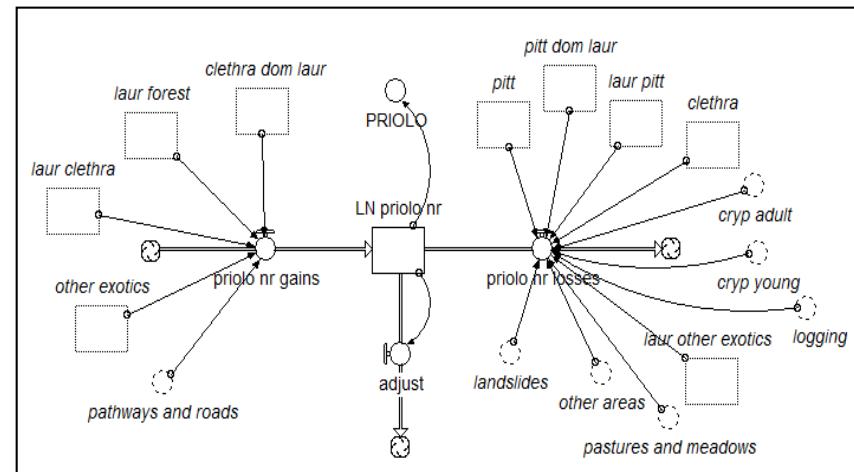
## Habitat classes selection:

- **Pure laurel forest**  
Laurel forest (>75%)
- **Laurel forest – initial invasion process**  
Laurel forest (50%–75%)  
e.g. *C. arborea* (25%–50%)
- **Laurel forest – advanced invasion process**  
Laurel forest (25–50%)  
e.g. *C. arborea* (50–75%)
- **Total invaded areas**  
e.g. *C. arborea* (>75%)



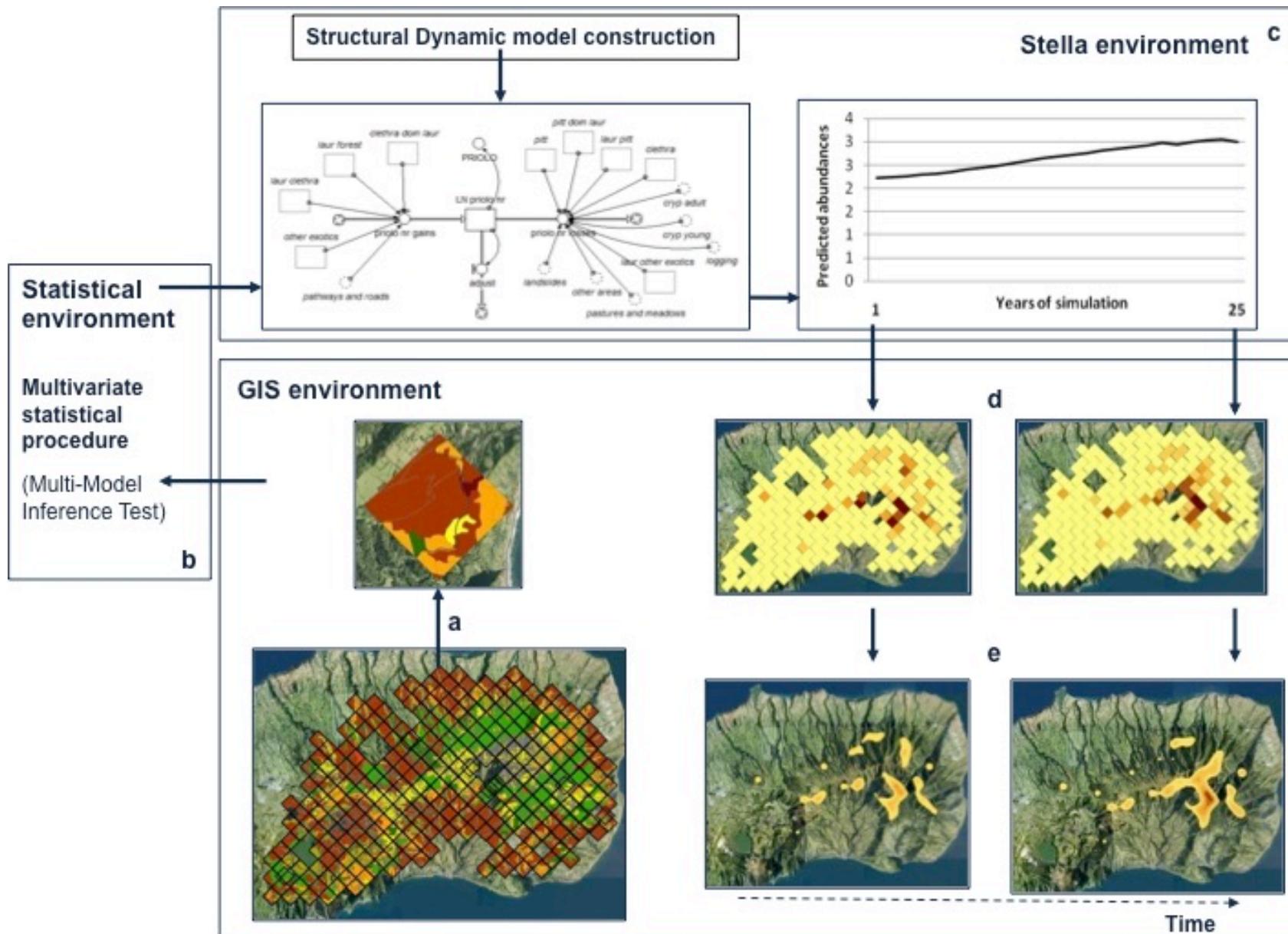
- Data analysis
  - Generalized Linear Models – Multi-model Inference

- Dynamic model construction and StDM unit



- Spatio-temporal projections
  - Since StDM estimations perform individual abundances for each study unit, an interpolation method was applied in order to account for spatial autocorrelation within the overall study area.



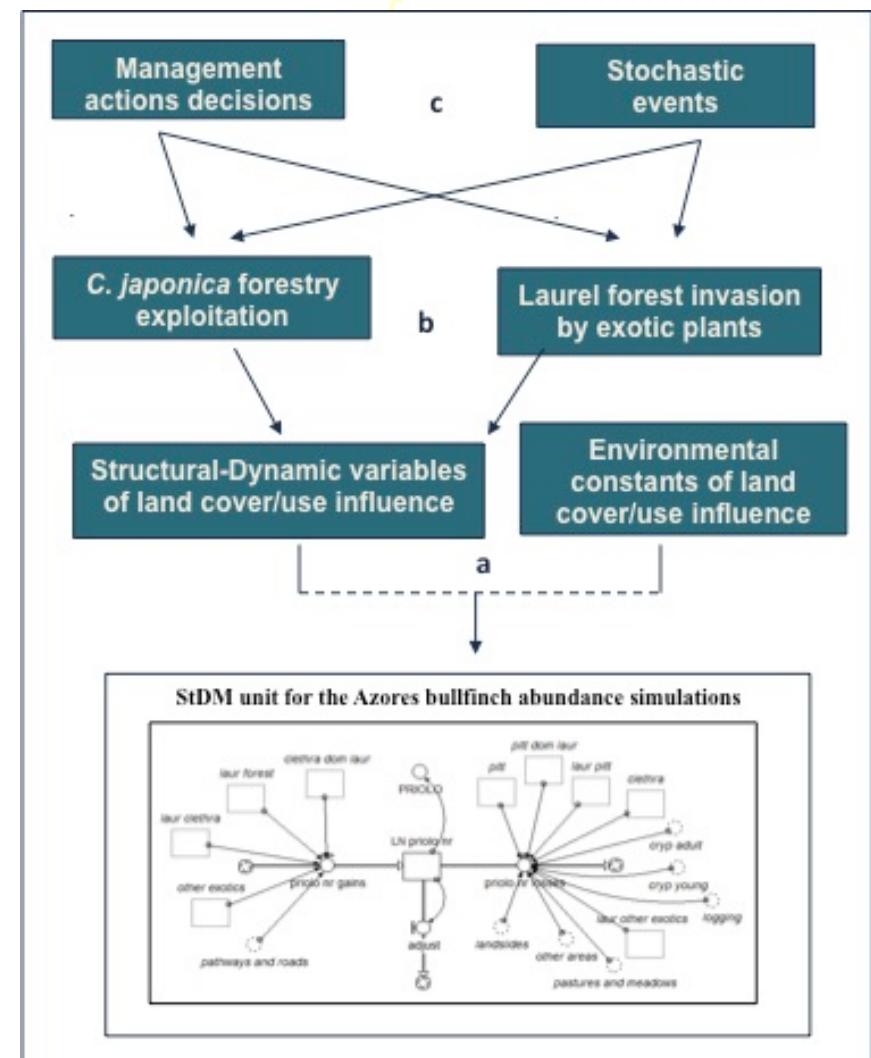


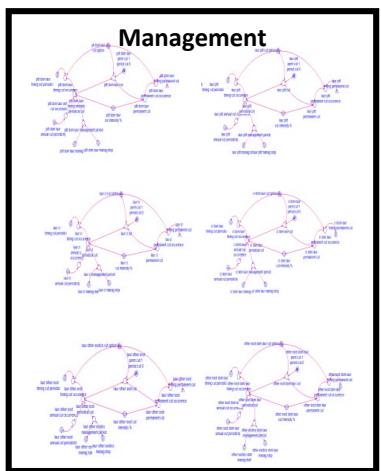
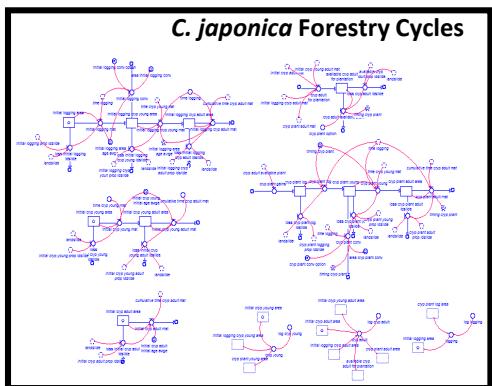
# Stochastic-Dynamic Model

Conceptual diagram of the StDM model used to estimate the Azores bullfinch abundances in São Miguel Island.

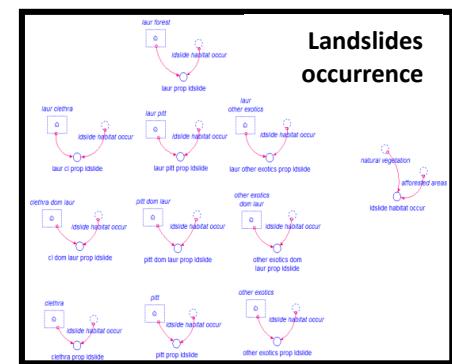
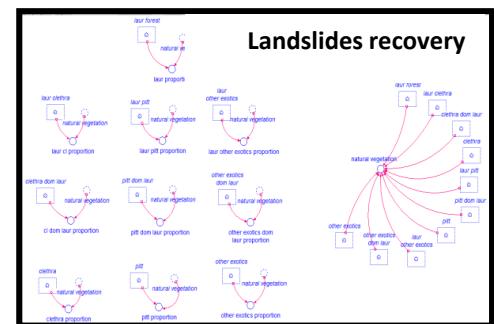
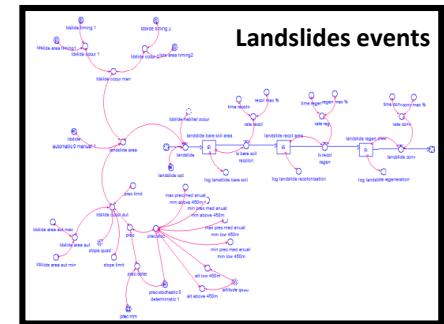
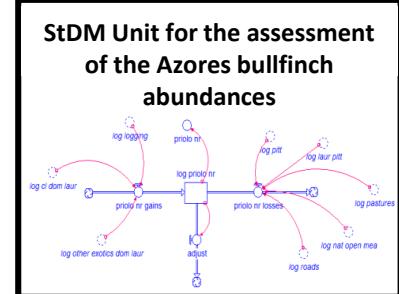
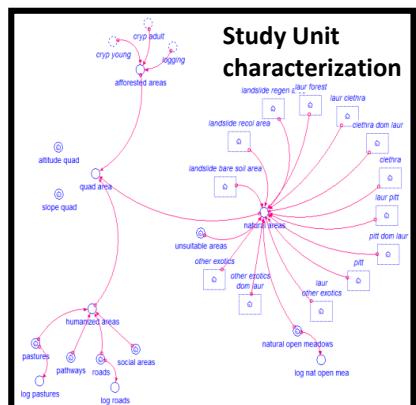
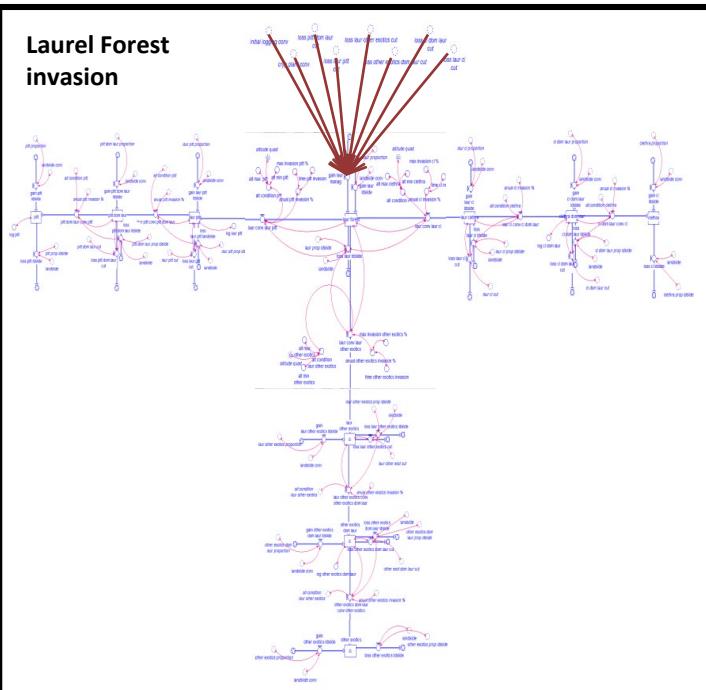
Influences in the StDM simulations of the Azores bullfinch abundances:

- (a) the overall structural-dynamic variables and environmental constants
- (b) influences of the land cover/use dynamics;
- (c) influences of the management options and stochastic events.





## Stella environment



**Study unit portrayal**

Enter data to characterize the study unit in terms of:  
**(A) geomorphology** and  
**(B) land cover type.**

**(A) Geomorphology**

altitude - m  
slope - °

**(B) Land cover characterization**

**Management actions**

There are two different management actions to simulate:  
 (a) Control of exotic plants in target Laurel habitats;  
 (b) Conversion of *C. jacquemontii* plantation in Laurel vegetation.

To activate option buttons click the lever:  
 Option 1 - lever down  
 Option 2 - lever up

**A**

**Management action - Out of *Clethra* arborea**

**Target habitat - Laurel Forest (20-70% with *Clethra* arborea (25-50%)**

**Permanent cut**  
Lev. 01: long permanent cut  
Lev. 02: long periodical cut (annual cut periodicity)  
Lev. 03: short periodical cut (annual cut periodicity)  
Lev. 04: short intensity %  
Lev. 05: short managed start  
Lev. 06: short managed stop

**Periodical cut**  
Lev. 01: dom laur out option  
Lev. 02: dom laur out 1 period cut 0  
Lev. 03: dom laur out 1 period cut 1  
Lev. 04: dom laur out annual cut periodicity  
Lev. 05: dom laur out managed start  
Lev. 06: dom laur out managed stop

**B**

**Target habitat dom laur (*Clethra* arborea (20-70% dominating Laurel Forest (25-50%)**

**Permanent cut**  
Lev. 01: dom laur out option  
Lev. 02: dom laur out 1 period cut 0  
Lev. 03: dom laur out 1 period cut 1  
Lev. 04: dom laur out annual cut periodicity  
Lev. 05: dom laur out managed start  
Lev. 06: dom laur out managed stop

**Periodical cut**  
Lev. 01: dom laur out option  
Lev. 02: dom laur out 1 period cut 0  
Lev. 03: dom laur out 1 period cut 1  
Lev. 04: dom laur out annual cut periodicity  
Lev. 05: dom laur out managed start  
Lev. 06: dom laur out managed stop

**A**

If during simulation you want to initiate a new forestry cycle, you must click crop plant option and choose the time for the new plantation.

Time to crop plant include a 4 years logging period that precedes the timing you define for the new plantation.

By the time chosen to the new plantation you can choose to revert a certain amount of the selected area, into Laurel Forest. You must activate crop plant conv option and define the amount of area that, after logging, will revert to Laurel Forest.

**B**

**Initial logging conv option**  
**area initial logging conv**

**C**

**Management action - Out of *Pittonia undulatum***

**Target habitat pitt Laurel Forest (20-70% with *Pittonia* (25-50%)**

**Permanent cut**  
Lev. 01: long permanent cut  
Lev. 02: long periodical cut (annual cut periodicity)  
Lev. 03: short periodical cut (annual cut periodicity)  
Lev. 04: short intensity %  
Lev. 05: short managed start  
Lev. 06: short managed stop

**Periodical cut**  
Lev. 01: pit dom laur out option  
Lev. 02: pit dom laur out 1 period cut 0  
Lev. 03: pit dom laur out 1 period cut 1  
Lev. 04: pit dom laur out annual cut periodicity  
Lev. 05: pit dom laur out managed start  
Lev. 06: pit dom laur out managed stop

**D**

**Management action - Out of Other exotics**

**Target habitat other exot Laurel Forest (20-70% with Other exotics (25-50%)**

**Permanent cut**  
Lev. 01: other exot out option  
Lev. 02: other exot out 1 period cut 0  
Lev. 03: other exot out 1 period cut 1  
Lev. 04: other exot out annual cut periodicity  
Lev. 05: other exot out managed start  
Lev. 06: other exot out managed stop

**Periodical cut**  
Lev. 01: other exot dom laur out option  
Lev. 02: other exot dom laur out 1 period cut 0  
Lev. 03: other exot dom laur out 1 period cut 1  
Lev. 04: other exot dom laur out annual cut periodicity  
Lev. 05: other exot dom laur out managed start  
Lev. 06: other exot dom laur out managed stop

**A**

This management action assume cut of (a) *C. arborea*, (b) *P. undulatum* (b) and (c) Other exotics, in two target habitats of Laurel Forest, different in degree of invasion by each of the invaders.

Each management action presumes the choice of a cut type that differs in time scale:

a permanent cut - which is a singular cut, along the simulation. You must choose the year of simulation when cut will occur;

a periodical cut - which is a repeated cut along the simulation, according to an annual periodicity. You must choose the time interval between cuts (annual cut periodicity), and the timing (year), within time interval, when cut happens (timing periodical cut). You must choose the starting and finishing year of management, by defining manag start and manag stop (years of simulation);

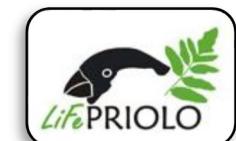
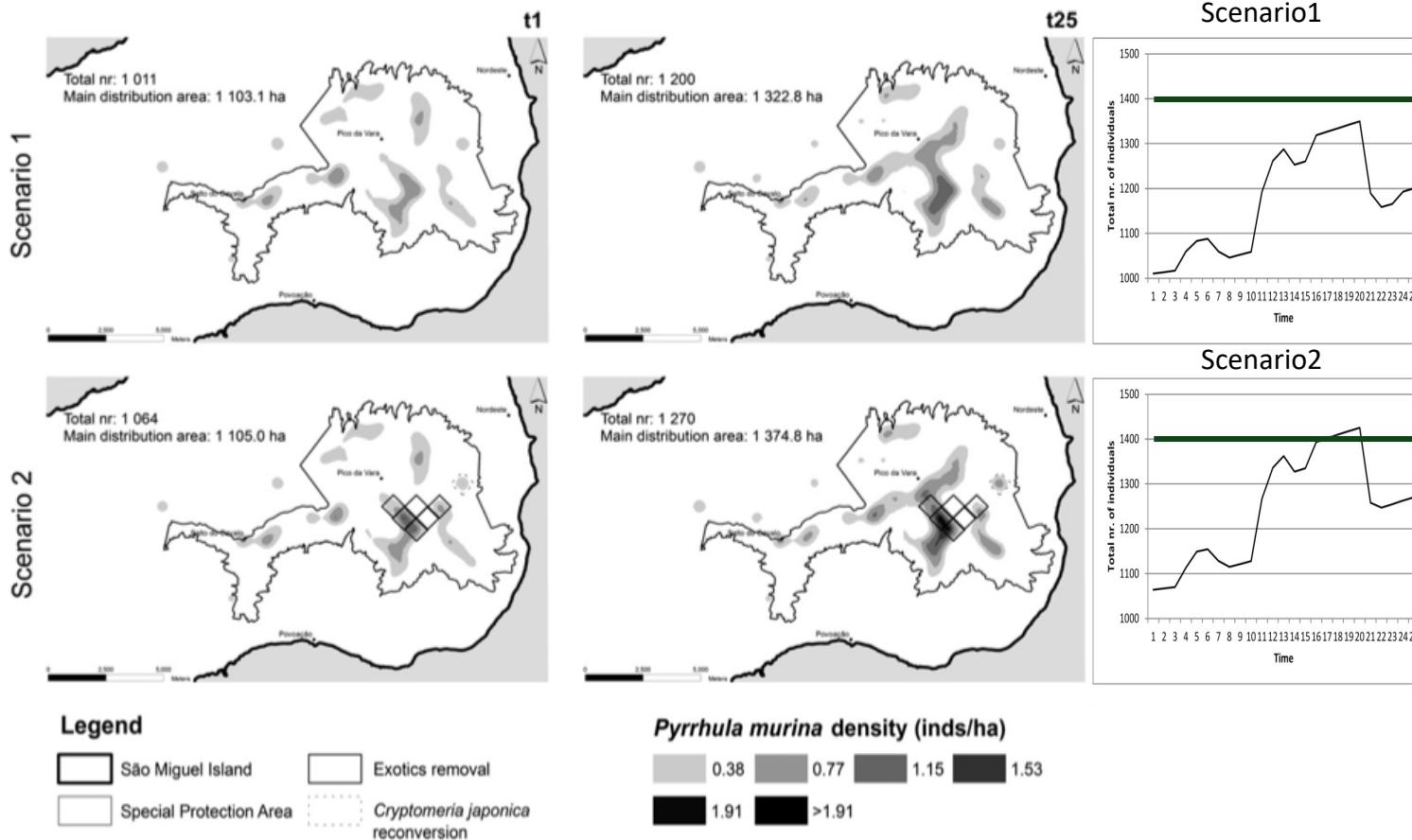
The intensity of cut is the percentage of target habitat that will be converted into Laurel restored vegetation. In the case of periodical cut, intensity is the percentage of target habitat that will be converted into Laurel Forest, each year chosen to cut periodicity.

- Effectiveness of previous habitat management actions:
  - Scenario 1: the lack of the “LIFE Priolo” management actions.
  - Scenario 2: the “Life Priolo” interventions in the study area.
- Effects of future (periodic) management actions:
  - Scenario 3: located in the previously managed areas.
  - Scenario 4: dispersed throughout new potential areas in the western part of the species distribution.



# Outcomes from management scenario

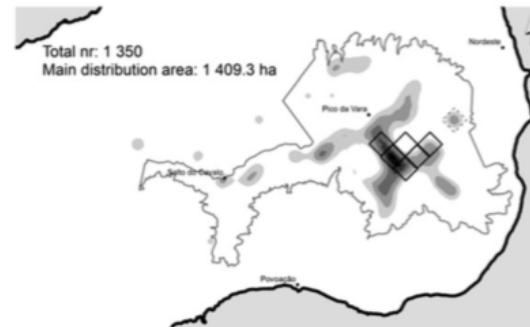
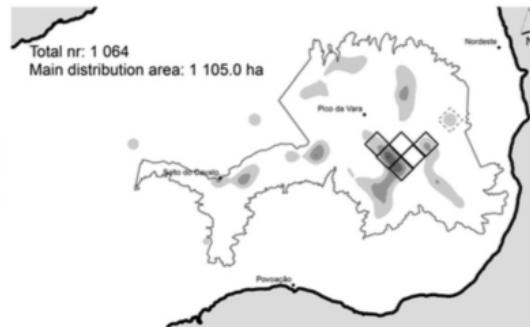
- Scenario 1 vs Scenario 2: Effectiveness of previous habitat management actions



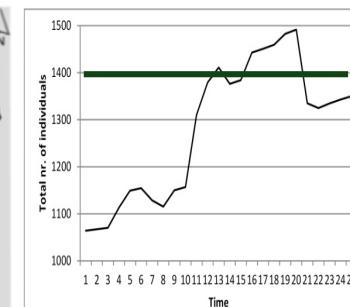
# Outcomes from management scenarios

- Scenario 3 vs Scenario 4: Effects of future (periodic) habitat management actions

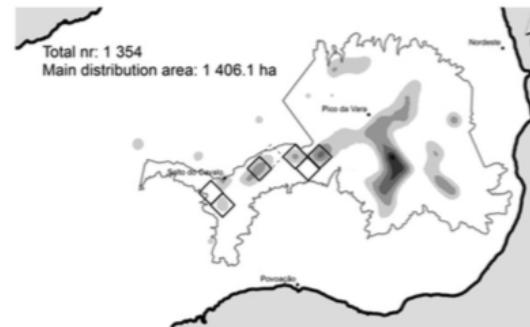
Scenario 3



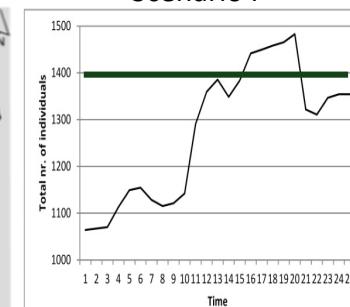
Scenario3



Scenario 4



Scenario4

**Legend**

São Miguel Island

Exotics removal

Special Protection Area

Cryptomeria japonica  
reconversion

**Pyrrhula murina density (inds/ha)**

0.38 0.77 1.15 1.53

1.91 >1.91





# Exploring the Azores bullfinch case study

- Groups of 4 students



# Exploring the Azores bullfinch case study

- Groups of 4 students
- Goal: Predict the Azores bullfinch response to *Clethra arborea* invasion and habitat management actions.



# Exploring the Azores bullfinch case study

- Groups of 4 students
- Goal: Predict the Azores bullfinch response to *Clethra arborea* invasion and habitat management actions.
- **Modelled Response:** Azores bullfinch abundance (Data-driven)



# Exploring the Azores bullfinch case study

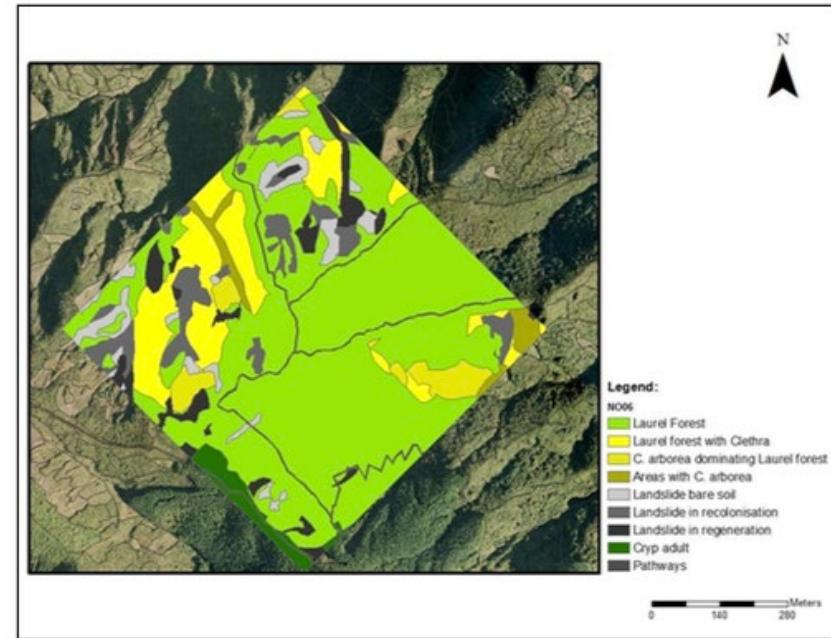
- Groups of 4 students
- Goal: Predict the Azores bullfinch response to *Clethra arborea* invasion and habitat management actions.
- **Modelled Response:** Azores bullfinch abundance (Data-driven)
- **Modelled Process 1:** Effect of *Clethra arborea* invasion on laurel vegetation (Vegetation classes succession)
- **Modelled Process 2:** Removal of *Clethra arborea* from laurel habitats.



# Exploring the Azores bullfinch case study

- Model settings:

- Study unit of 500000 m<sup>2</sup> (50 ha)
- Time unit – year
- Length of simulation 50 years



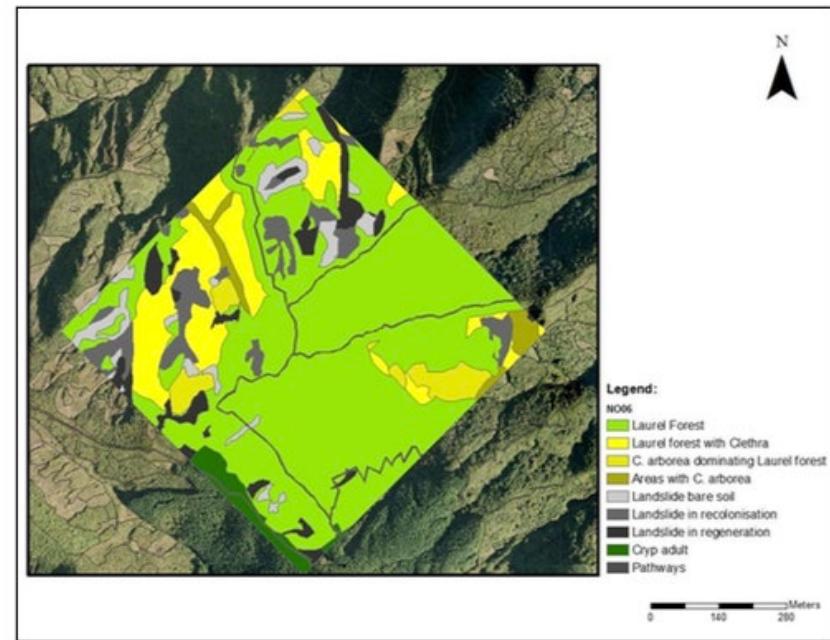
# Exploring the Azores bullfinch case study

- Model settings:

- Study unit of 500000 m<sup>2</sup> (50 ha)
- Time unit – year
- Length of simulation 50 years

- Habitat features characterization:

Vegetation classes	% of occupation
Pure laurel forest	Laurel forest (>75%)
Initially invaded laurel forest	Laurel forest (50%–75%) <i>C. arborea</i> (25%–50%)
Moderately invaded laurel forest	Laurel forest (25–50%) <i>C. arborea</i> (50–75%)
Totally invaded laurel forest	<i>C. arborea</i> (>75%)



# Constructing an StDM model

- Create File: Azores\_bullfinch.STMX



# Constructing an StDM model

- Create File: Azores\_bullfinch.STMX
- **Modelled Response: Azores bullfinch abundance (Data-driven)**



# Constructing an StDM model

- Create File: Azores\_bullfinch.STMX
- Modelled Response: Azores bullfinch abundance (Data-driven)
- Variables:
  - $\text{LN PRIOLO} = 0.37E-01 + (2.00E-06 * \text{laur}) + (1.89E-07 * \text{laur\_cl}) + (1.29E-06 * \text{cl\_laur}) - (4.2E-08 * \text{cl})$
  - $\text{PRIOLO} = \text{EXP}(\text{LN\_Priolo})$  note: IF LN\_Priolo=0 then 0 else EXP(LN\_Priolo)

Environmental predictor	Description	Coefficient
Constant	-	0.637
Laurel	Pure laurel forest	0.000002
Laurel_clethra	Laurel forest with Clethra	0.000000189
Clethra_laurel	Clethra dominating laurel forest	0.00000129
Clethra	Pure Clethra	-0.0000000642



# Constructing an StDM model

- Modelled Process: Effect of *Clethra arborea* invasion on laurel vegetation (Vegetation classes succession)

Vegetation classes	Variables	Rate of invasion per year
Pure laurel forest	laur	-
Initially invaded laurel forest	Laur cl	0.001
Moderately invaded laurel forest	Cl laur	0.002
Totally invaded laurel forest	Cl	0.004



# Constructing an StDM model

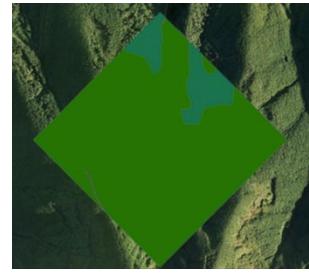
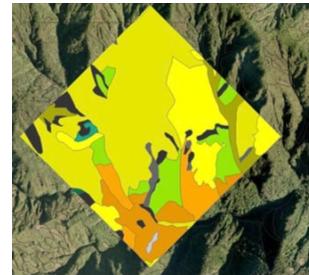
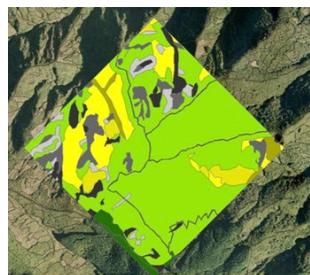
- **Modelled Process:** Recreate the removal of *Clethra arborea* from laurel habitats.
- Variables:
  - Management option (switch on/off)
  - Management timing (timing when management take place along simulation)
  - Management effort (in proportion of target vegetation classes)

Suggestion: Create an Interface in accordance!



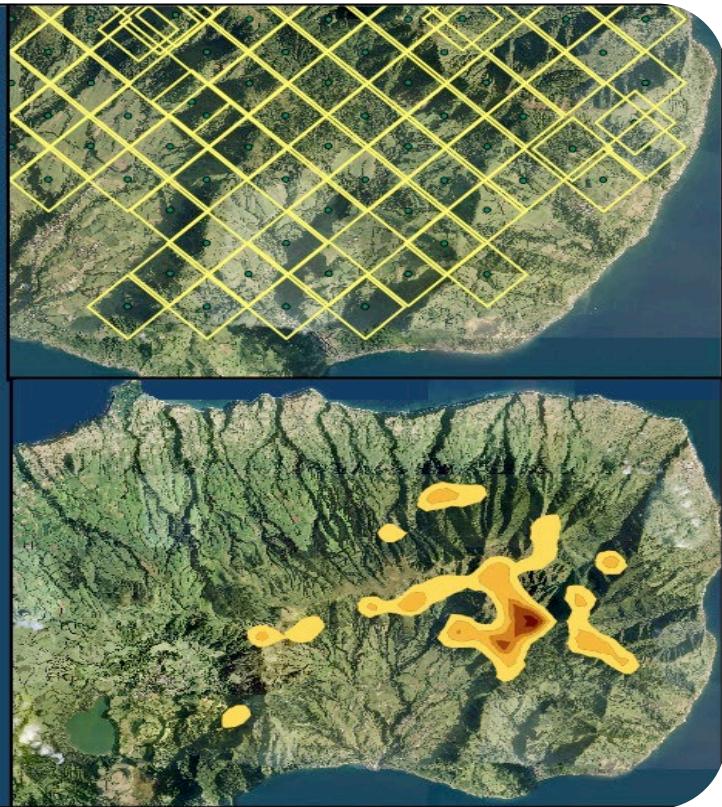
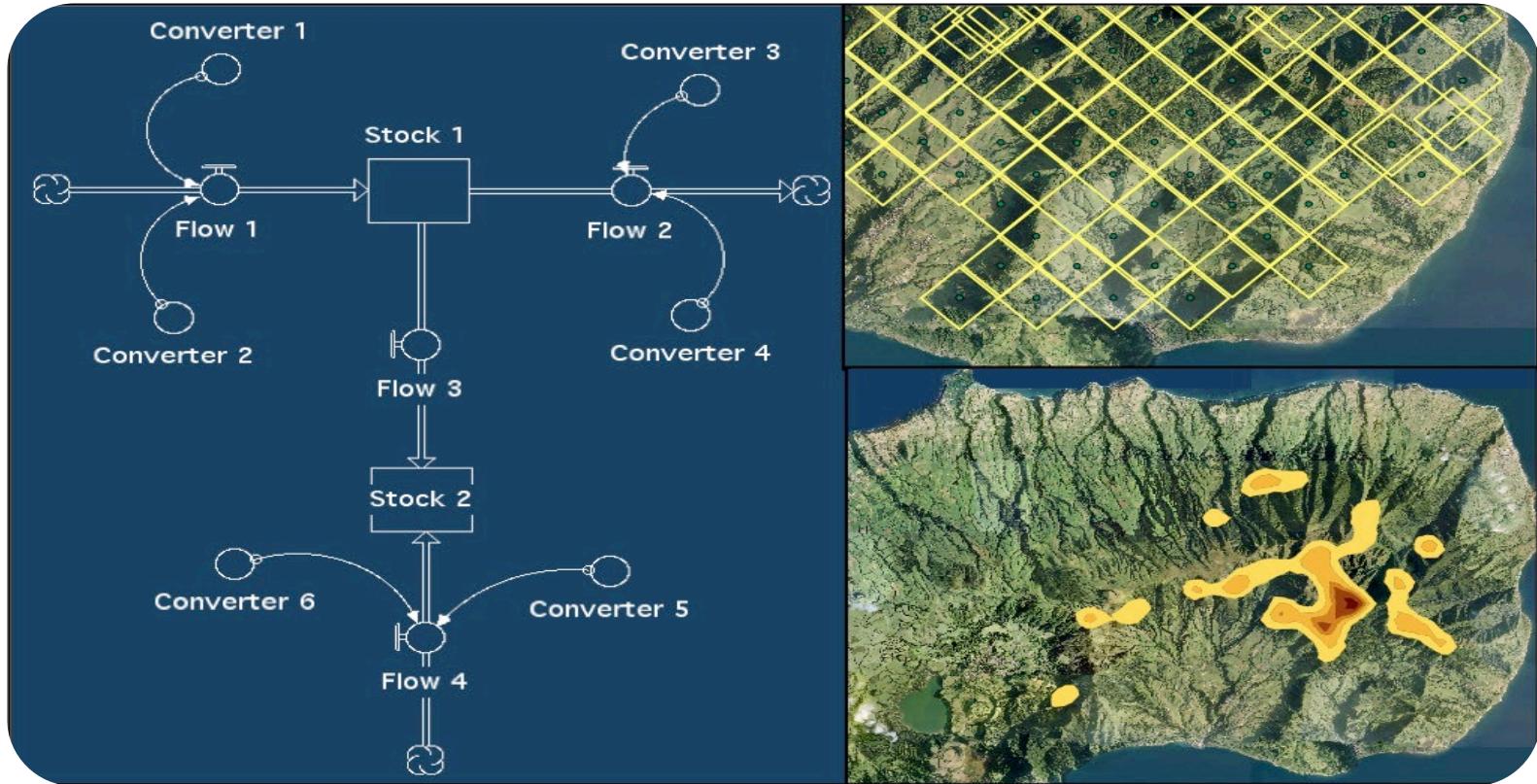
# Exploring the Azores bullfinch case study

- Study units characterization:



	1 - Barely invaded	2 - Moderately invaded	3 - Highly invaded	4 - Totally invaded
Laur (m <sup>2</sup> )	450000	250000	50000	0
Laur cl (m <sup>2</sup> )	50000	150000	100000	0
Cl laur (m <sup>2</sup> )	0	50000	150000	100000
Cl (m <sup>2</sup> )	0	50000	200000	400000





Thanks for your participation!!!

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[mgsantos@utad.pt](mailto:mgsantos@utad.pt)  
[ritabastos@utad.pt](mailto:ritabastos@utad.pt)