The production management of hazelnuts in Province of Cuneo, under a system dynamics approach. How the dormice affect its performance.

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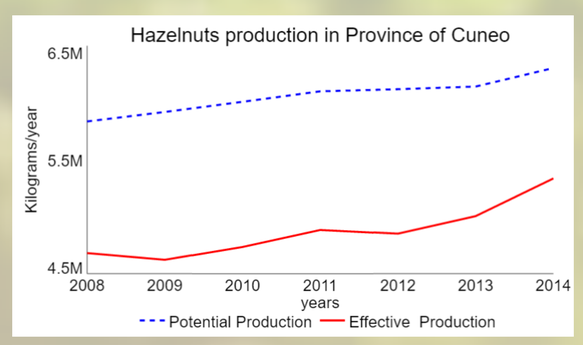
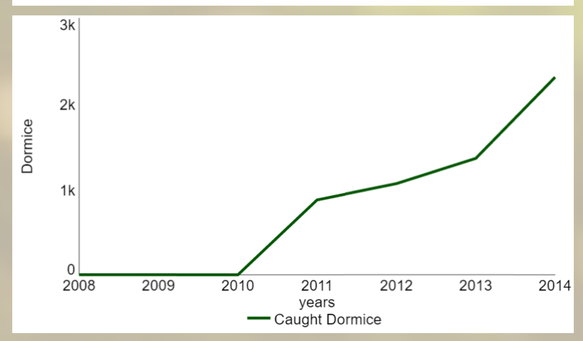
Introduction

The production of hazelnuts represents an important resource in several italian rural areas. Sicily and Piedmont, ones of the most important producers of hazelnuts, are affected by the presence of a rodent (Glis Glis), that has reduced considerably the production of hazelnuts. The study aims to analyze the complexity of dynamic relations between dormice and hazelnuts production in cases of high proliferation by using a system dynamics taking as example the case of province of Cuneo, a local area of Piedmont, where through a project of local Public Governance, the policy makers were able to counteract the damage of the dormice. The analysis of the implemented policies was developed by using System Dynamics (SD) methodology (FORRESTER, 1969; STERMAN, 2000; FORD, 2009; BIANCHI, 2016). A SD microworld was developed to define the conceptual relations between hazelnuts production and dormice, then through the analysis of the results of the simulations, it was been possible to show the effects of reduction policies to the performance of hazelnuts production. This study could help to steer the decision-makers to implement a set of optimal policies to counteract the high proliferation of dormice in other local areas.

The issue of hazelnuts production in Province of Cuneo

In Cuneo, in the mid 70's, the slopes of the areas most affected by the phenomenon (Valli Bormida, Belbo and Alta Langa's Area) were intensively cultivated with cereal crops, meadows and pastures; there were not many hazels. Later, with the gradual depopulation of the hilly areas, the land was gradually abandoned, allowing the development of the forest and its undergrowth which, joined the now reduced consistency of human presence, they have been the ideal habitat for the proliferation of wild animals, besides the introduction of other animals, to promote the practice of hunting (primarily wild boars and roe deer). Since 1990, farmers started to cultivate hazels, in uncultivated land or through the elimination of wooded areas. The development of the hazels, near the wood, has attracted the dormice giving them access to one of their preferred foods (ISPRA, 2016).
In Piedmont, in Province of Cuneo, after finding a high increase of loss production due to the presence of the rodents, local authorities have started to monitor the problem and they have collected some data.
Since 2008, Public Local Authorities have started to monitor the presence of dormouse in Cuneo. Preliminary surveys conducted in the province of Cuneo, have detected that hazelnut trees are easily accessible to the rodents that bring direct damage due to food consumption of hazelnuts (CIMINI, et al. 2016).
Even they have reduced the loss over time (as shown by the charts alongside), there is uncertainty of the sustainability of their implemented policies.

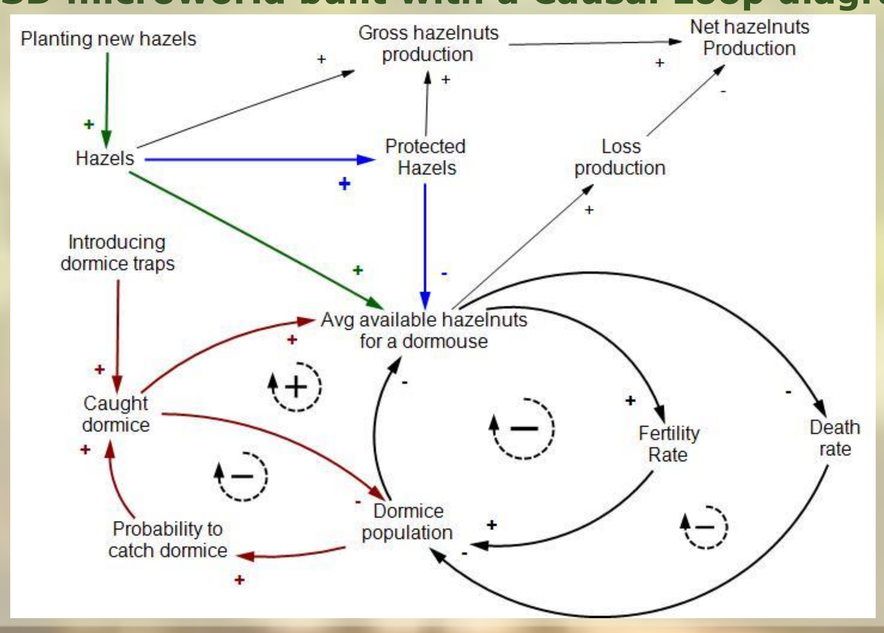




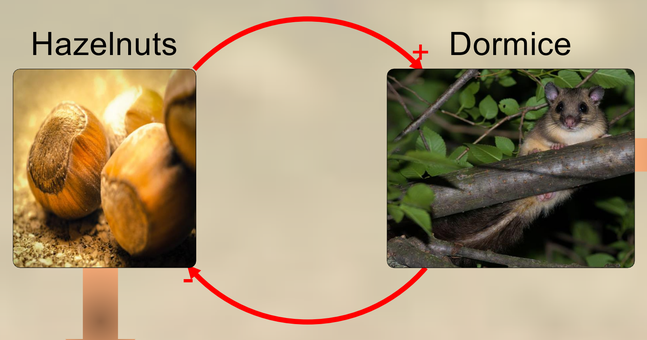
Material and Methods

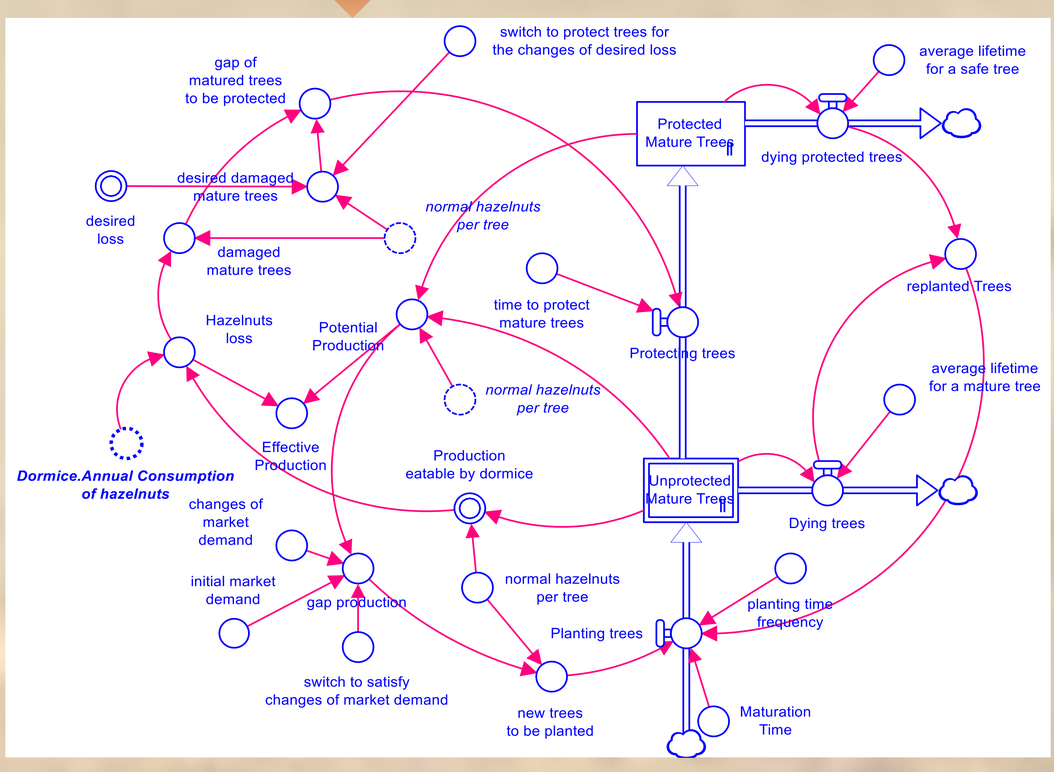
The model was developed through two different source information: interviews with experts in the agricultural sector and literature searches. Initial values and the parameters were estimated from the primary and secondary data collected from different research reports, in the case of absence of quantitative data, some assumptions have been made, consistent with the qualitative information.
The SD microworld was been developed through a Stock and Flow diagram, using 72 variables, organized in two interdependent subsystems (hazelnuts and dormice). In nature, hazelnuts and hazels are susceptible to be attacked by several predators; this model considers as a predator, only the dormouse. An increase of hazelnuts will increase the dormice until a stable ratio. An increase of dormice, will decrease the effective production that will cause a reduction of dormice population for lack of food. Therefore, this ecosystem will be stable until the farmers will not introduce a shock to the environment.
The system is dominated by several balancing loops because the ecosystem will always try to reach new equilibria, after some exogenous shocks.

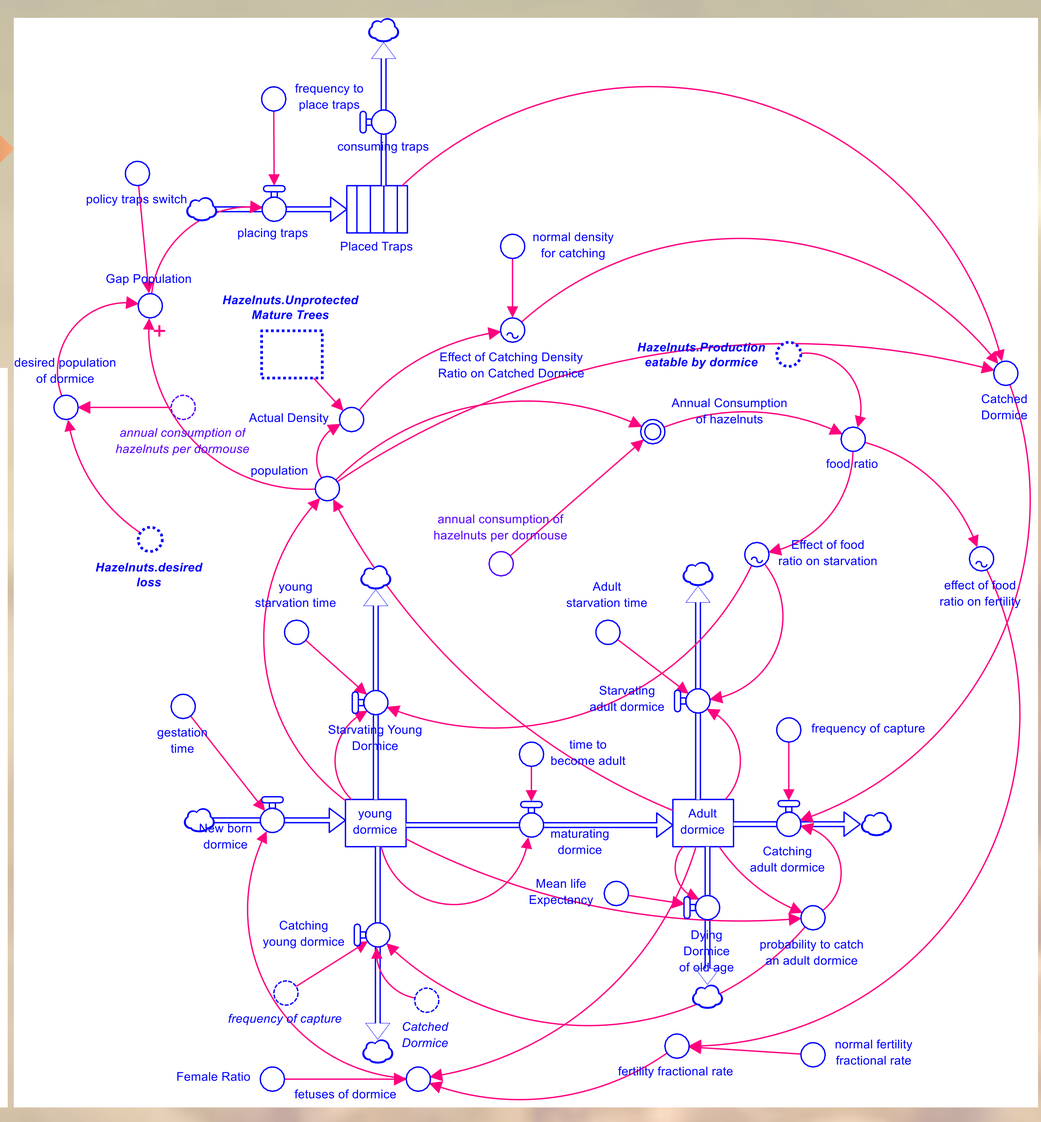
The SD microworld built with a Causal Loop diagram



The SD microworld built with a Stock and Flow diagram

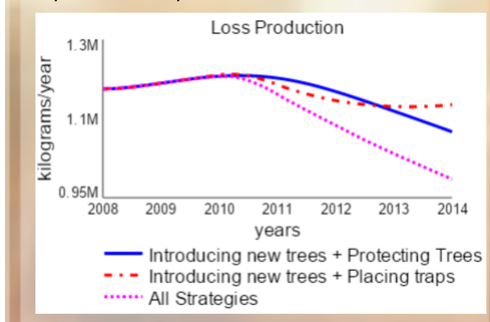


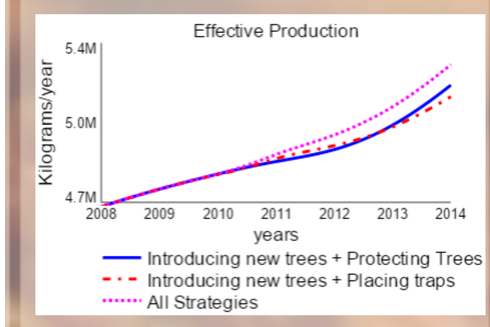




Results and Discussions

The model shows different scenarios, by applying different implemented policies: *planting new trees to satisfy the market demand*, *protecting trees from dormice* and *placing traps to catch dormice*.
The following charts shows these scenarios, changing the set of the implemented policies.





The model agrees with a recent study (CIMINI, et al. 2016) that suggests that an individual policy cannot prevent the damage caused by the dormouse; however, it seems that the concomitant use of other management actions may be able to reduce the damage done.
The capture of dormice has only a benefit in the short run, because an increase of "Captured dormice", will be balanced by a decrease of the starvation outflows (less competition for the food) and by an increase of "New dormice". Indeed, a reduction of the population means a greater food availability that affects dormice's fertility rate.
The policy "Protecting Trees" will reduce the dormice population under an exponential decay; this policy should consider that a reduction of the available trees will be effective to limit the reproductive capacity only if it's energy content exceeds a certain threshold (FIETZ, et al. 2005). A combined set of policies may show a lesser shock to the ecosystem, causing minor damage to the dormice and a more sustainable production of hazelnuts.

Conclusions

Because of the organizational and temporal complexity of ecosystems, human intervention may have different effects at different times; these effects may also depend on which ecosystem components are impacted. More complex institutions may be necessary to maintain ecosystem functions in the face of human use, and they may govern not just the level and intensity but the timing, spatial pattern, and specific form of resource use. In principle, there is an inherent unawareness, as well as unpredictability, concerning these evolving managed ecosystems and the societies with which they are linked. The essential point is that evolving systems require policies and actions that not only satisfy social objectives but also achieve a continually modified understanding of the evolving conditions and provide flexibility for adaptation to surprises (FOLKE, 2007).

Hazelnuts production is affected by the presence of its predators, this study explains its performance in relation with the presence of dormice. Using a SD Model, it is possible to explain operational relationships between the variables. This model can represent an instrument of interactive learning showing some scenarios with alternative policies. The impact of several balancing loops shows that the presence of this animal is so inherent in the territory that only by changing the distinctive characteristics of the local area (as for example protecting all the trees), it's possible to find a sustainable solution. This means several costs for the communities and it's not clear if a drastic reduction can cause effects on the ecosystem, because of the boundaries of the model.

Even this study clears the effects of two macro-strategies (trapping and protecting trees), a deeper study should be considered to analyze the dynamic effectiveness of different kinds of "Protecting trees" micro-strategies as a buffer zone around hazel orchards ("no-tree zone"), physical barriers, and chemical deterrents that differ in cost, arrangement time and maintenance (GHIRARDI et al, 2011). As the implementation of successful policies requires the involvement of different stakeholders and uncertainties are likely to remain high, this work could represent a tool to develop a facilitation strategy in which stakeholders elaborate shared ambitions and directions for solutions, and ecological scientists extend their participation in scientifically assessing policy alternatives (Hansenn et al., 2009).

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