



UNIVERSITÉ
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The mission of the celebration of Ecology Day is to increase societal awareness that Ecology, as a science, has a central role in identifying sustainability problems and finding solutions to tackle them. This is why the sustainable development committee of the Institute of Integrative and Systems Biology (IBIS) at Université Laval joined this initiative with the aim to create an educational resource that focuses on the interconnectivity that is characteristic of ecosystems.

Our objective is that, by reading these texts, readers will ask themselves about the environmental impacts of their actions from a systematic point of view, such that they can better understand the place of their actions in a global context.

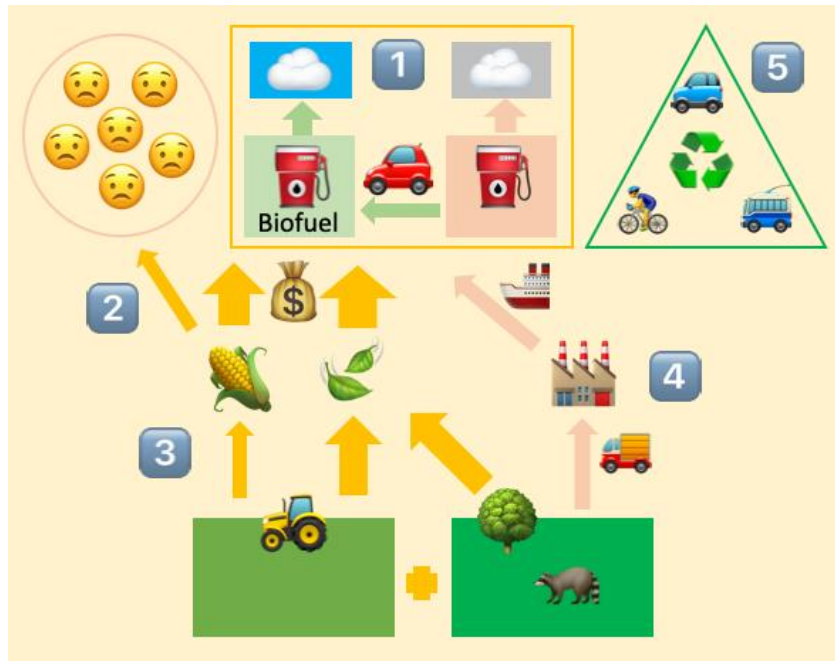
Ecological concepts will be communicated with the help of specific examples. First, we will discuss the impact of biofuel usage and the pollination by bees on agriculture. Finally, we will elaborate on speciation in urban zones and the proliferation of invasive species, two phenomena that are largely caused due to human economic activities.

The interdependence of the elements that is so central to ecosystems makes ecology complex, but also fascinating! Enjoy your reading!



Biofuels: the “green” picture...

Martine Jean



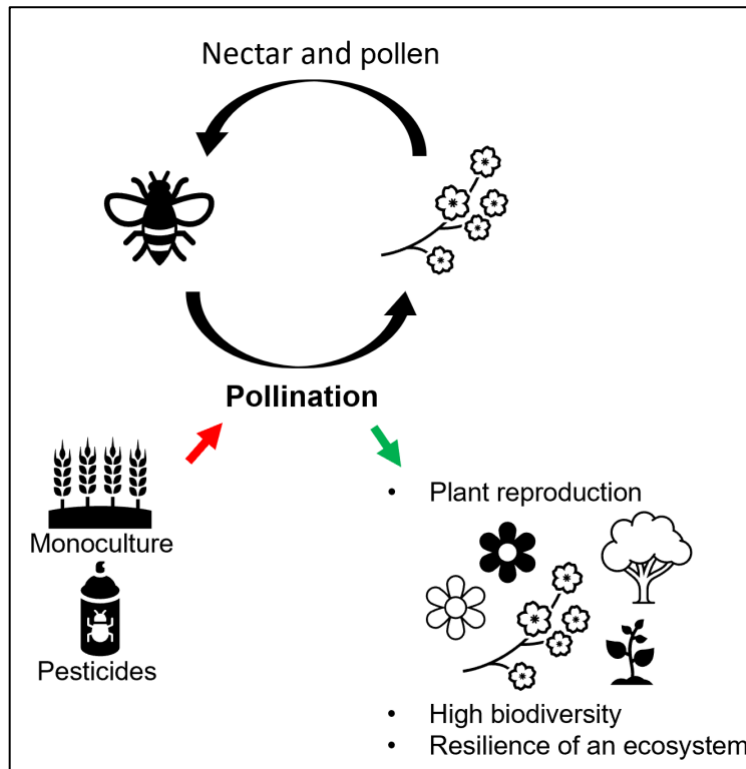
1. Using biofuel may seem like a green option as your car will emit less pollution and run on renewable energy. However, asking these four questions may help you learn how truly green this option really is:
2. **What crop was used to produce it?** The easiest way to produce biofuel starts from grains like corn. Since crops are sold at a higher price for biofuel production, this means less grains are available for human consumption. Using biofuel produced from non-food biomass crops is thus a greener option.
3. **Where was the crop grown?** There are only so many farmlands available. This means that when growing crops for biofuel production, there will be less land available to grow crops for human consumption. Growing biomass crops on marginal lands may seem like a greener option but wildlands will have to be destroyed to create these new fields.
4. **Where was the crop processed?** Crops are usually grown far from factories. Furthermore, many countries import biofuels for their internal consumption. Too much traveling may in fact negate the environmental benefits achieved by running your car on biofuel. Buying a locally produced biofuel is thus a greener option.
5. **Do I really need to use my car to go there?** Indeed, the only truly green option is to use your car less frequently. So be “green” today by using public transports, share rides, bicycles or even walking!

Did you know...

- In 2013, [280 million people](#) could have been fed by the crop used to produce biofuel. However, such biofuel provides only [4% of the total energy needed](#) by the transport sector.
- Biofuel production relies only on [2-3% of the available farmlands](#). However, the amount of food that could be grown on these lands could feed about [30% of the malnourished population](#) if it was actually distributed where it is most needed.
- As can be seen in the following example, making “green” choices is never as straightforward as expected because of the complexity of the intricacy of international trade and economy:
 - Bioethanol production [tripled in the US between 2005 and 2010](#) while at the same time, maize price increased from 106\$ to 277\$ per ton. It would therefore be easy to link these two facts and think that bioethanol production is a threat to food security of low-income people. However, the truth is that a worldwide severe drought destroyed many crops during those years and created a shortage that also contributed to the price increase of maize. Furthermore, because this higher price increased the appeal of this crop, new fields were created to cultivate more of it and, in fact, the amount of maize produced worldwide [increased by 19%](#). Finally, producing bioethanol from maize can potentially have beneficial effects on other food availability. Indeed, for each ton of maize used in bioethanol production, [300 kg of a byproduct](#) that can be used as animal feed is generated.

The importance of pollinators

Marika Drouin



What do bees, bumblebees, and butterflies have in common? They are pollinators! They forage flowers in search of nectar and pollen, which are sources of carbohydrates and proteins, respectively. Pollination – the transportation of pollen from a flower’s male organ to the female organ of another flower – allows the sexual reproduction of plants. It is often carried out by the wind or pollinators. Around [90% of flowering plants](#) are pollinated by animals, mostly insects. Honeybees were shown to play an important pollinating role in agriculture, which is why they have been domesticated and thoroughly studied.

In Québec, blueberry and cranberry producers sign contracts with beekeepers so that their bees pollinate their fields in early summer. [Domestic bees](#) can forage on average 10 times farther than indigenous insects. This is the reason why farmers have looked for the services of these bees to pollinate their monocultures. [Thanks to commercial pollination](#), the production of fruits increases by 70% in blueberry fields and 50% in cranberry fields.

The decline of honeybees is truly worrying due to their importance for the pollination of cultivated plants. However, indigenous pollinator species such as wild bees, solitary bees, and bumblebees have a greater impact on their environment than honeybees. The number and variety of [pollinators have a strong influence on the vegetal biodiversity](#), and vice versa. The production of fruits and grains increases in the ecosystems that present a great diversity of plants and

pollinators. It is thus important to preserve a variety of indigenous pollinators and to evaluate the impact of human activities on them.

Many human actions have negative consequences on these pollinators. By cultivating intensively a single plant, humans deprive pollinators of a balanced food supply. For example, cranberries produce little nectar and the floral diversity around cranberry trees is low. Bees foraging these fields have a limited access to nectar, their main source of energy. Pollen is on its own a protein source for pollinators and contains essential nutrients for their physiological development. [The quality of pollen](#) can influence the number of eggs laid by the queen, the development of larvae, and the tolerance of bees to the parasite *Nosema ceranae*. Nevertheless, providing food supplements to bees could allow them to overcome the lack of proteins or sugars associated with the pollination of monocultures.

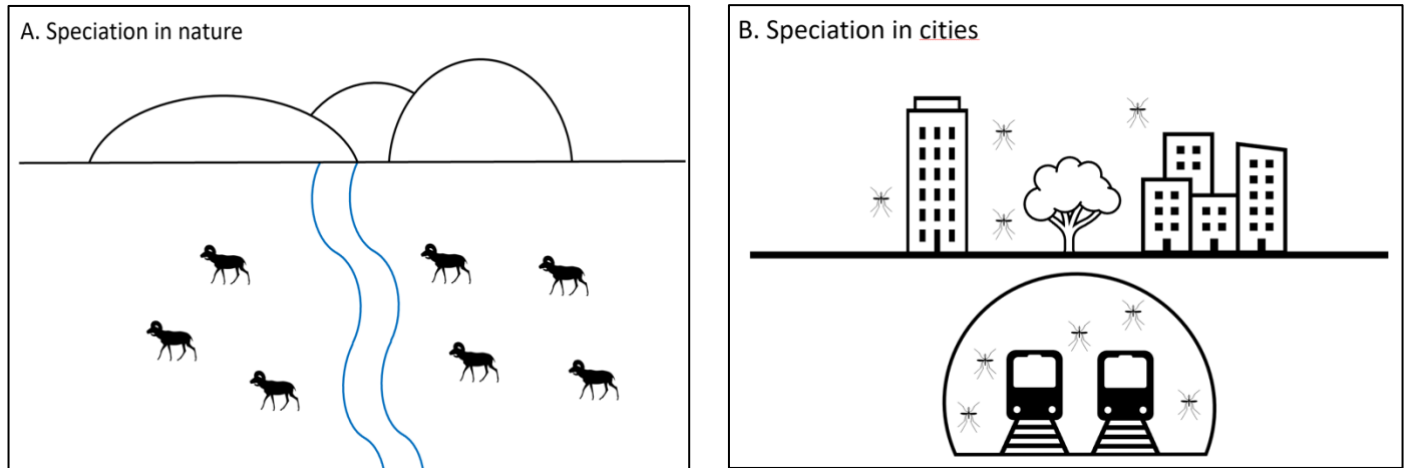
Moreover, [the use of pesticides](#) in the fields from which bees are exported has harmful effects on bees. Indeed, the mortality of domestic bees quadruples when their hives are located next to corn fields treated with neonicotinoids. This class of insecticide increases dramatically the sensitivity of bees to varroa, a mite that decimates hives.

Furthermore, the sexual reproduction of plants, which depends on pollinators for many flowering plants, is important for the health of an ecosystem. Indeed, it ensures the maintenance of the genetic diversity of a species, which increases the probabilities that it can adapt to environmental changes. Ecosystems that harbor more species are more resistant to ecological changes. Plant diversity is particularly important for the health of an ecosystem because they are at the base of the food chain. Many animal species cannot adapt to changes in their environment if their habitat or other levels of the food chain are highly perturbed.

In conclusion, pollinators favor plant diversity which, in turn, influences the resilience of an ecosystem. As citizens, we can help protect pollinators by stopping the use of chemical products in our gardens, by planting flowers, and by allowing indigenous species to grow in our fields!

Town mouse and country mouse: how cities give birth to new species

Angel Cisneros



Our planet is teeming with life. Just like there are a wide variety of environments, there is a great diversity of living organisms that thrive in them. [Throughout the Earth's history](#), changes in the environment have led to the birth and extinction of species. Recent years have seen the appearance of a new type of environment - cities - that can [alter the behavior](#) of some species or even [endanger others](#). However, cities also have the potential to [drive the birth of new species](#).

A species is defined as a group of individuals that are capable of mating with one another and produce fertile offspring. However, offspring are not exact copies of their ancestors, just like you are not identical to your parents. As time goes by, small changes accumulate with each generation. Under the right conditions, the new generations might become so different that they cannot mate anymore with their former kin, in which case they just [became a new species!](#) A traditional example of speciation requires changes in the geographical landscape, such as the [emergence of a new river](#) might split a group of individuals from the same species (a population) into two different groups that cannot reunite anymore. Because of the physical separation, they can only mate within their groups, so the two groups can accumulate different mutations. By the time individuals from the two different groups meet again, they might be unable to mate. Rivers are not the only barrier that can split a population: other examples are [mountain ranges](#) and the [separation of continents](#).

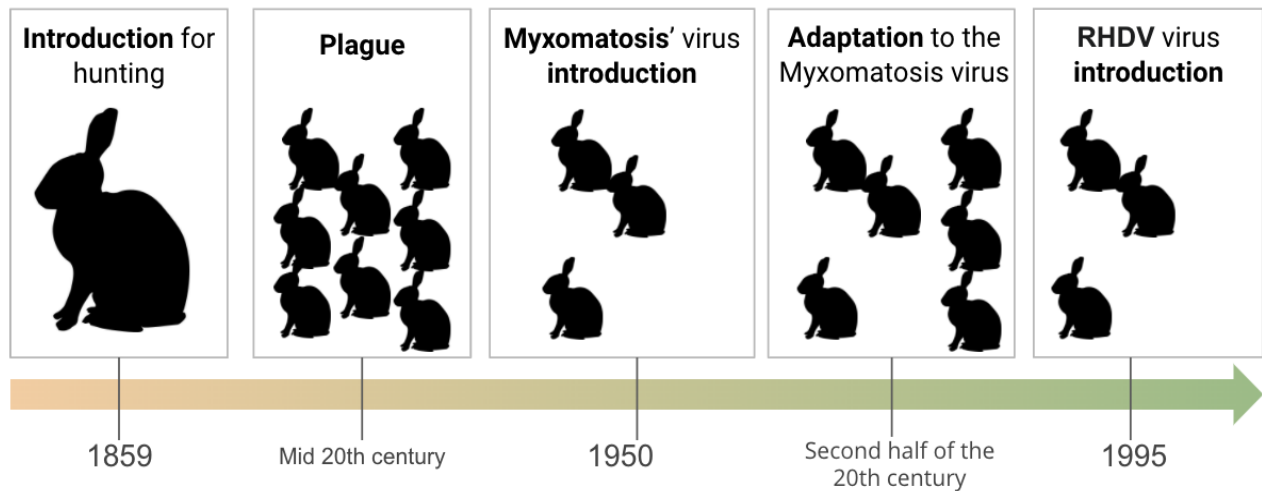
[Human activities](#) can lead to the birth of new species. In London, a [new species of mosquitoes](#) emerged in the underground railway system. Although the underground mosquitoes are similar in appearance to their surface counterparts, researchers noticed differences in the mosquitoes' behavior. For example, they have different life cycles and mating habits and, importantly, the underground mosquitoes bite people whereas the surface ones bite birds. The two populations were also shown to be different at the genetic level and attempts to mate individuals from different populations were unsuccessful. The incompatibility between the two groups of mosquitoes makes them different species and is remarkable, especially considering that the London underground has only existed for around 150 years.

[Rats in New York City](#) have also been separated as a result of urbanization. Researchers sampled rats from all over Manhattan and analyzed them at the genetic level. They identified two clearly distinct groups: one in the South and one in the North. They attributed this to the greater prevalence of households in the North and South ends of the island, which create more favorable conditions for the rats to eat than in midtown. Since rats do not tend to travel over very long distances, most of the rats stayed on the ends of the island with little contact between groups. It has not yet been determined if these rats are incompatible, but monitoring these separated populations will help us learn more about how new species are born.

Cities are very recent environments that our planet had never seen before. Thus, their construction has had important ecological impacts on local species. While they can certainly endanger some species, cities can also lead to the emergence of new species from previously existing ones. Studying these cases allows us to learn about how species are born and the timescales required. Moreover, it makes us reflect upon the ecological impact of human activities. Only time will tell what the future holds for these new urban species.

Invasive species through the lens of introduced rabbits in Australia

Carla Bautista Rodríguez



Silhouettes from PhyloPic.

Introduced and invasive species

Before starting, we must be clear about the concept of [invasive species](#). This concept involves a population of organisms that thrives outside its geographic area or habitat. Eventually, such organisms could become very abundant and become harmful for indigenous biodiversity. Not all introduced species are invasive since the capacity to populate new areas depends on the ability of the species to survive in the new environment and to have a rapid population growth. But invaded ecosystems also influence this capacity, for example, if there are no natural enemies of the invasive species. But how do these species get into other ecosystems? Humans often introduce them whether it is accidentally (say, if they sneak into a boat) or deliberately (for commercial purposes, food production, hunting or fishing).

Consequences of invasive species

Invasive species produce [imbalances in endemic ecosystems](#) as the native species are not adapted to the presence of these new species. These invasive species can displace native species causing the loss of native diversity. Additionally, the introduction of these species can also have unexpected negative consequences in human activities since many of these species become pests that [destroy crops](#), as well as in the forestry and fishing sectors, or even posing a threat to [public health](#).

Australia, a continent invaded

Invasive species [are very problematic in Australia](#) because, as an isolated continent, most of its flora and fauna is endemic. Around 80% of mammals and reptiles, and more than 90% of fish, amphibians, and insects are only found in Australia. The variety of ecosystems, as well as the absence of predators, has meant that many of the introduced species have flourished rapidly.

The rabbit, the greatest enemy of Australia's biodiversity

The history of Australia is [linked to invasions](#). The most problematic species has been the European rabbit (*Oryctolagus cuniculus*) not only because of its great proliferation but also because of its devastating effects. [It was introduced in 1859 for hunting](#), but no one could imagine the ability of this mammal to adapt to these climatic conditions. The great abundance of grassy and sandy areas where to build their burrows as well as the lack of predators coupled with their high reproductive capacity made them proliferate rapidly, becoming a pest. In the middle of the 20th century, the plague got out of control, occupying two thirds of the territory. The rabbit decimated the native grasses, leaving the native species without food. Many measures were activated to prevent their proliferation: incentivized hunting, poison traps, etc. but they did not work. The most striking was the introduction of another species, the red fox because it is a natural predator of rabbits. This measure resulted in disaster as it preferred to hunt other endemic species of birds and slower marsupials. In the 1950s, the [myxomatosis virus](#), which had devastated the rabbit populations of Europe, was introduced in Australia to try to control rabbits. This measure produced a drastic reduction in populations, but resistance to the virus caused populations to recover over time. Finally, the introduction of the virus that causes rabbit hemorrhagic disease (RHDV) in 1995 seriously affected populations that are [now stabilized and promoting the recovery of numerous native species](#), especially small mammals.

In conclusion, it is important to consider all the possible ecological consequences of introducing a new species into an environment before doing it. Monitoring introduced species and detecting invasive species is also essential to maintain the balance of our ecosystems.