

## **Ownership and its influence on forest management, a case study in the Bernese Jura region.**

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*Illustration 1*

*Source: <https://www.pexels.com/photo/rustic-path-with-stacked-log-pile-in-autumn-forest-30555900/>*

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# 1 Introduction

Forests are omnipresent in Switzerland's landscape. According to the Forest Report 2025 (WSL & Federal Office for the Environment (FOEN)), almost one third of the national surface is covered by forest. Aside from the aesthetic value, forests provide numerous services to the population. They act as protection against avalanches and landslides; they are home for many wild species; and they are a favoured environments for recreational activities. However, we will turn our attention to two specific functions of forests that are critical in climate change mitigation.

*Wood and carbon capture.* First, forests have the ability to absorb carbon dioxide (CO<sub>2</sub>) through the process of photosynthesis and storing it in woody matter and soil. This is particularly important because forest and therefore wood, act as carbon sinks. Second, forests provide a sustainable resource of wood that can be collected and transformed for multiple uses, especially in construction sector. And because carbon is stocked in wooden elements, building can become carbon sinks, drastically reducing the environmental impact of the construction sector (Churkina et al., 2020). Researchers at the University of Canterbury estimated that approximately 1,500 tonnes of CO<sub>2</sub> emissions are embodied in a mid-rise, steel or concrete building. Whereas 610 tonnes of CO<sub>2</sub> are sequestered in the same building constructed of mass timber (John et al., 2009). As the Swiss government has committed itself to take measures to reduce its net carbon emission to zero by 2050 (The Federal Council, 2019), this is a serious leverage that Switzerland should consider in order to reach that goal. For these reasons, Swiss forests represent a significant asset in the effort to mitigate greenhouse gas emissions.

*Forest expansion.* Furthermore, the Forest Report 2025 shows that the overall forest surface has been expanding over the last 150 years (WSL & Federal Office for the Environment (FOEN)). Although the rate of expansion has slowed in the past decade, forests remain under-exploited. Optimizing forest management is an opportunity to produce more domestic construction materials for local use. However, production cannot be increased easily.

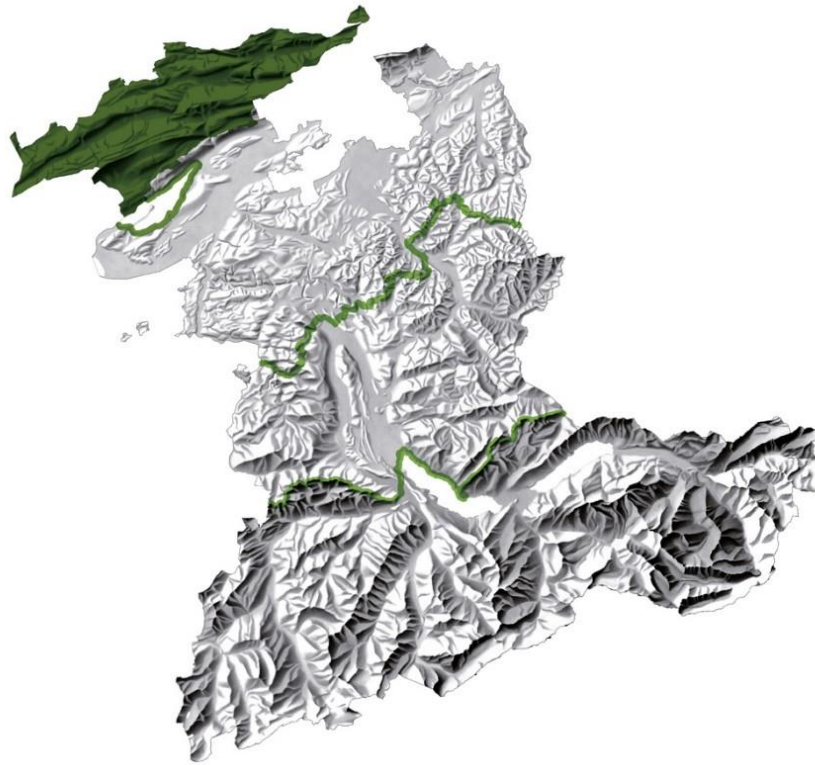
*Limiting factors.* There are multiple reasons for which wood production struggle to increase. First, it is due to the will to maintain the other functions of the forest, such as protection and welfare that must be assured. Second, there are multiple practical obstacles that remain. For example, profitability is still difficult to reach for forestry companies (Federal Statistical Office (FSO), 2025); production capacity is limited, domestic sawmills cannot process the totality of the timber harvested in Switzerland (Odermatt et al., 2022); forest ownership and fragmentation is also a limiting factor (Orazio et al., 2017). In this study, we will further explore the latter obstacle and its influence on management.

*Forest ownership.* In 2021 there were approximately 248,000 forest owners in Switzerland (WSL & Federal Office for the Environment (FOEN), 2025). The vast majority (99%) of them are private owners. But they own in average, very small forests. In term of surface area, 71% of the forest is in public hands. This diversity of owners means a diversity of management situations and goals. To enforce a relevant and efficient forestry policy, it is important to understand these differences. This thesis uses causal loop diagrams (CLD) constructed on interviews with owners from the Bernese Jura to identify and understand the impact of ownership on forest management.

In the next chapter, we will discuss the particular context of ownership in the Bernese Jura region. Then the methods used will be presented in the next section, while the CLDs will be introduced and discussed in the results section.

### 1.1 Bernese Jura ownership

*Geographic scope.* This thesis focusses on the Bernese Jura region in the canton Bern in Switzerland. This region is particularly interesting as its territory is 46% covered with forest – against one third at the national level – (Vieille, 2025). The geographic boundaries of the region studied correspond to the subdivision region determined by the canton for forests management (Ill. 2). There is a total of the four regions, named “Divisions” by the Office for Forests and Natural Hazards of the canton Bern. To understand the organization of the ownership and forest management, we must understand the general organisation of Switzerland’s political organization.



*Illustration 2: Map of Forestry Division Bernese Jura.*

*Source: Presentation booklet of Forestry Division Bernese Jura*

*(<https://www.weu.be.ch/fr/start/ueber-uns/die-organisation/amt-fuer-wald-naturgefahren.html>)*

*Switzerland’s political organisation.* First, the federal government provide the legal framework for forest management (Federal Act on Forest (Forest Act, ForA), 1991). Then the cantons organize their own framework according to their necessities to operationalize national policy (Ordonnance cantonale sur les forêts, 1997). Finally, political communes constitute the smallest political unit of the canton. Although historically, forests were mostly owned by citizens’ communes, the situation of ownership evolved, and we will shortly present it.

*Type of owners.* The categorization of the owners in this work is based on the report on Swiss forest owners (Walker & Artho, 2018). It distinguishes between private and public owners, while public owners are categorized according to the political status. To be representative of the ownership situation in the Bernese Jura region, in this thesis we will consider private owners and three types of public owners: the canton, political and citizens' communes. While the types of owners are mentioned here, they are presented in detail in Chapters 3.2 and 3.3. According to the Forestry Division Bernese Jura (personal communication, 15.12.2025), the 23,886 ha of forests are shared as follows: ~7% owned by the Canton (cantonal forests are called Domanial forests); ~73% owned approximately equally shared by political and citizens' communes; ~20% owned by private owners. Now that we have set the ownership landscape, we will review forestry organizations in the canton Bern to better understand the relation between owners and institutions.

*Cantonal forestry organisation.* First, the Office for Forests and Natural Hazards (OFNH) is responsible for forests in the canton. This office allocates subsidies to forest owners or forestry cooperatives for forestry projects. He provides the cantonal legal framework in accordance with the Swiss legal framework. Then, the OFNH is organized in four regional offices in charge of four different regions. These regional offices are called Forestry Division; the Forestry Division Bernese Jura is responsible for controlling and approving the local forestry projects. Each region is then divided in local forestry units managed by forest rangers. Typically, political and citizens' communes within the same forest units organize themselves in Forestry Cooperatives. By contrast, cantonal forests are independently managed by the Domanial Forest Company. However, private owners are not part of the forestry cooperatives' management, although they are part of the forestry unit supervised by the local forest ranger. Finally, forestry work is carried by private forestry companies for all owners.

In the following map of actors (fig. 1), we can already distinguish the challenges of a multi-level management. There is an effort to rationalize through forestry cooperatives who play a central role in the management of communal forests. However, we also see the difficulty to reach private owners, who are free to actively manage their forests or not. Meanwhile the management of Domanial forest is completely detached from public cooperatives. With this study, we will try to understand the factors influencing each type of owner and how they affect forest management.



## 2 Methods

### 2.1 Qualitative approach

To allow a participatory construction of the causal loop diagrams, a qualitative approach based on interviews was adopted. Using this approach allows the actors to describe their motivation and the challenges they face with more freedom, as compared with survey for example. Data were collected through semi-directed interviews, conducted in two phases: an exploratory phase with forestry professionals, and a second phase focusing on forest owners. All interviews were conducted in French. The elaboration and operationalization of the interviews were carried out with the help of the methodological book *Les outils qualitatifs en géographie* by Morange & Schmoll (2016).

*Exploratory interviews.* During the first phase, two goals were pursued. First, to get familiar with forestry actors, institutions, and companies, and to understand how they are organized. Second, to gather contact information about relevant forest owners to interview, using the snowball sampling. For this purpose, a semi-directed, exploratory interview grid was developed (Appendix Exploratory interview grid). Then the delicate question of the first contact. Indeed, choosing an adequate stakeholder is essential to establish further contacts. The choice was made to contact the local forest ranger first, as a private owner would probably do when seeking guidance on forest management (Interview, forest ranger). His knowledge of the region proved to be valuable and allowed us to deepen our understanding of the local forestry actors. He also suggested potential forest owners to contact and directed us toward the Forestry Division of the Bernese Jura for more insight. The second exploratory interview was then conducted with two forest engineers of the Division. They were able to provide a broader understanding of forest ownership structure and confirmed the selection of relevant owners to interview. Based on professionals' recommendation, interviewing two political communes, two citizens' communes, one private owner and the canton would be representative of regional ownership situation. Additionally, the results of these exploratory interviews helped create the map of actors presented in the previous chapter (fig. 1).

*Interviews with owners.* During the second phase, the goal was to reach owners and collect relevant data. Another semi-directed interview grid was established (Appendices Private owners interview grid & public owners interview grid). We carefully selected owners with significant differences. For instance, the second citizens' commune (labelled as Bourgeoisie 2) interviewed owned forests twice the size of the first (Bourgeoisie 1). The political commune interviewed comprised of more than 4,000 inhabitants (Municipality). Unfortunately, we could not find a second smaller municipality that responded to our requests. For this reason, only five of the six interviews planned were conducted. However, the forest ranger in charge of the local forestry cooperative was present during the political municipality's interview. It allowed to gather additional information about the functioning of the cooperative and the link between it and the various communes. Additionally, one private owner was interviewed along with the Forest Ranger of the Domanial Forests to represent the Canton.

*From interviews to CLD.* Finally, the interviews were transcribed, and the relevant elements were extracted, translated, categorized, and organized into a table. The table then facilitated the construction of the CLD. Once the diagrams were advanced enough, they were sent to the interviewed owners for feedback. The responses allowed us to adjust

further the diagrams. Ideally, with more time, workshops could have been organized to meet with all owners and discuss the diagrams. In this manner, the participatory aspect of this thesis would have been reinforced. The next chapter will present how the CLDs were constructed, and how to read and understand them.

## 2.2 Causal loop diagram

To begin, we will briefly explain how the causal loop diagrams were created; then we will review basic knowledge of CLDs about how to read and understand them. All the diagrams were created with the help of Kumu, a dedicated free-to-use program.

*Diagram construction.* First, the different elements identified in the interviews were added and organized visually to assess the boundaries of the system. This important step determines which subsystems will be modelled and which will be considered as external factors. For instance, forest stages were deemed important enough to model, while it was not considered necessary to model the timber market. Then the CLD was extended through iterative refinement, until the result was satisfactory. This means being simple enough to be readable, and complex enough to illustrate important dynamics with fidelity.

*What is a CLD?* Now that we have gone through the construction process, we will review the basic knowledge necessary to properly read and understand CLDs. The explanations presented in this chapter are drawn from *Causal Loop Diagrams: A Short Handbook*, by Michael Lawrence (2024). CLDs are practical tools to map a system and illustrate influences occurring within it. They consist of elements, connections, and loops. For this reason, they are considered as a “[...] natural stepping-stone to simulation methods such as System Dynamics” (Barbrook-Johnson & Penn, 2022, p.48). We will now review the different components of causal loop diagram.

Elements are the nodes of the system. They represent the variables of the system, such as stocks or other types of factors. However, it must represent something that either increases or decreases. For example, “Trust in the Swiss confederation” would fit as an element, whereas “The Swiss confederation” would not, because it cannot increase or decrease.

**Direction of the connection.** Elements are then linked together with connections. These are illustrated with arrows, they are directed and they are either positive or negative. When the connection is positive (annotated with a "+" symbol) it means that the two elements react in the same manner (fig. 2). If one element increases, the second also increases. Similarly, if one decreases, so does the second. If the relation is negative (annotated with a "-" symbol) it means that the two elements react oppositely (fig. 3). If one increases, the second decreases and vice versa.

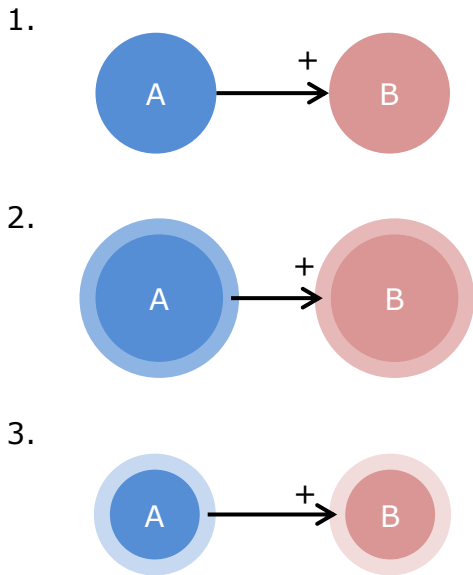


Figure 2: Positive causal relationship – If A increase, B increases. If A decrease, B decrease.

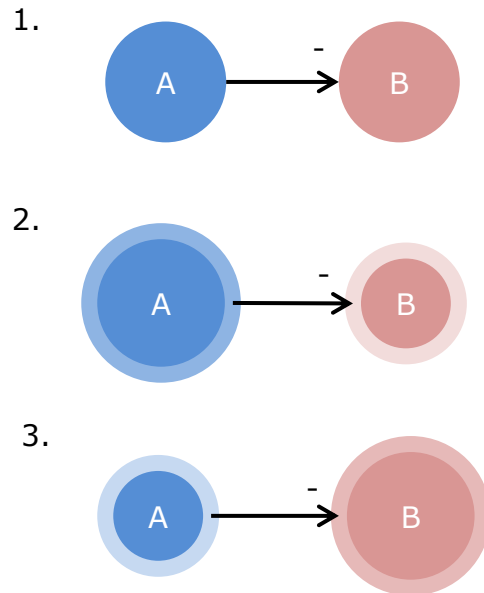


Figure 3: Negative causal relationship – If A increase, B decreases. If A decrease, B increase.

**Feedback loop.** Finally, the particularity of CLDs is the presence of feedback loop. A loop is created when two or more elements are linked with connections that allow the effect of an element to loop back onto itself. The loop can either be reinforcing or balancing. A reinforcing loop occurs when the initial effect is amplified (figs. 4 & 5). The easiest way to understand this, is to think of the example of interest. In a bank account, the bigger the balance, the greater interest. The balance therefore reinforces itself.

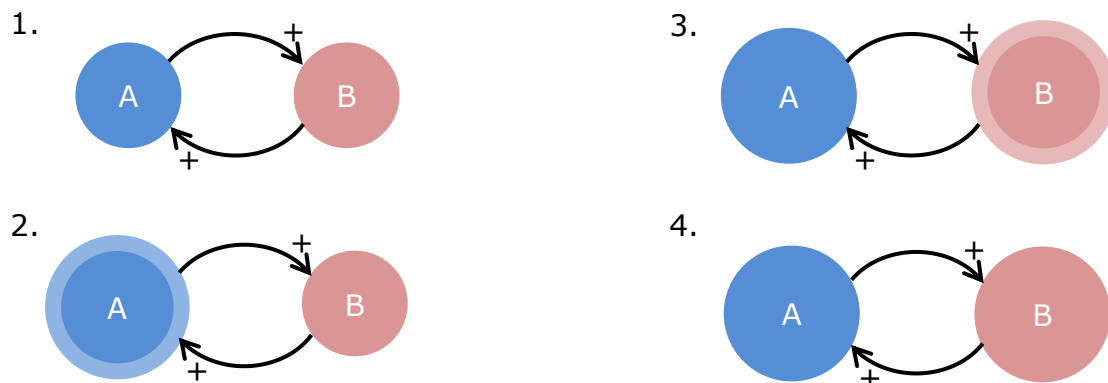


Figure 4: Reinforcing feedback loop working in an increasing direction.

Methods

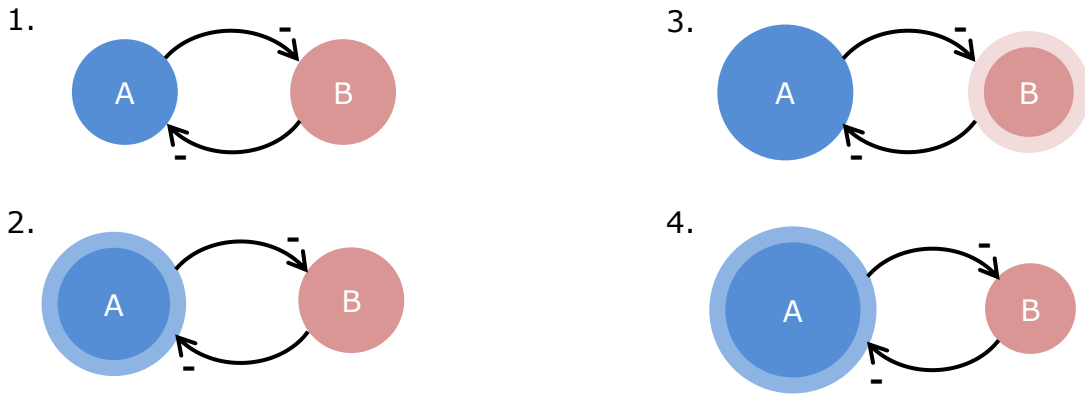


Figure 5: Reinforcing feedback loop working in a decreasing direction.

**Balancing loop.** Operating in the opposite way, in balancing loop the initial effect is counteracted (fig. 6). One can think of the example of a thermostat and room temperature. If the temperature rises, the thermostat triggers the air conditioning, thereby reducing the temperature.

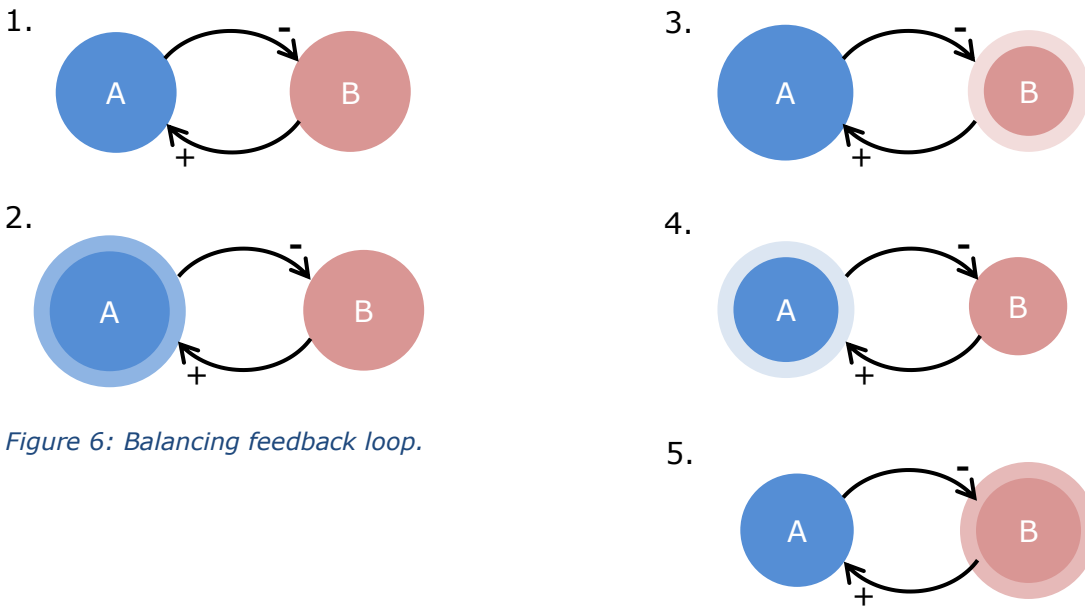
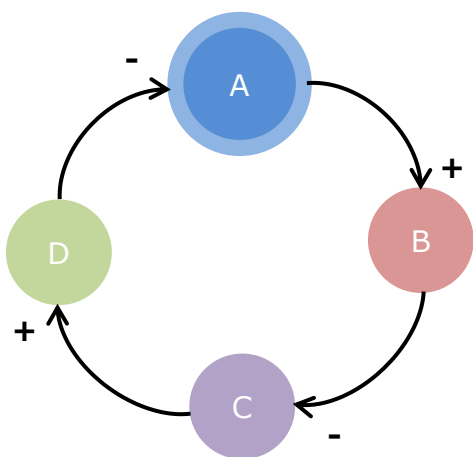


Figure 6: Balancing feedback loop.



**Multiple connections loop.** Loops with more than two connections are also either reinforcing or balancing (fig. 7). A quick way to determine this, is to multiply the positive and negative symbols within the loop. If the product is positive, it is a reinforcing loop, if it is negative, it is a balancing loop.

Figure 7: Feedback loop with four causal factors and an initial increase. Here, the loop is reinforcing, increasing back A.

*Technical vs. judgmental naming.* A common source of confusion comes from the naming of connections and loops. A positive connection does not mean a positive impact. It means that the two elements react similarly. In the same way, a reinforcing loop does not necessarily mean that it is virtuous.

Four causal loop diagrams were produced with the material collected during the interviews: One for private owners, one for the canton, one for citizens' communes, and one for political communes. They will be introduced in the next chapter.

## 3 Results

### 3.1 General causal loop diagram

Before discussing the differences between the different type of owners, the general causal loop diagram will be presented. The important loops will be introduced and described step by steps to allow for a better understanding. Once the full diagram is presented, owner-specific elements and connection intensity will be introduced in the following chapter.<sup>1</sup>

*Elements categorization.* By default, the elements constituting the causal loop diagram are considered as factors affecting other elements. However, to increase readability, we decided to create two categories for specific elements. First, "Resource" including the central product of the forest "Standing wood volume". Second, "Action" regrouping the forestry activities conducted by forest owners. These activities will be introduced in the Chapter 3.1.2.

#### 3.1.1 Unmanaged forest

*Representation of the natural forest cycle.* To begin, natural and unmanaged forest dynamics are illustrated in a simple model (fig. 8). The reinforcing loop (R1) represents tree growth, increasing wood volume and leading to more tree mortality. The death of old trees clears the canopy and allows for more light in the forest, thereby enabling younger trees to grow faster. The balancing loop (B1) represents the natural limitation of growth. Here, more standing wood volume means higher tree density, which reduces light availability for shorter young trees. This in turn decreases the growth rate and limits the standing wood volume (Ryan et al., 1997). Naturally, it is a simplified representation of much more complex dynamics. External factors such as temperature and precipitation are excluded from the model. While light availability is included, because is the main dynamic endogenously controlled.

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<sup>1</sup> Link to the diagram directly accessible on Kumu : <https://kumu.io/canovii/ownership-and-its-influence-on-forest-management>

For instance, all owners interviewed explain that harvesting is a means to maintain the forest, as old trees are removed allowing young and vigorous trees to grow. In the next step forest management will be introduced into the diagram.

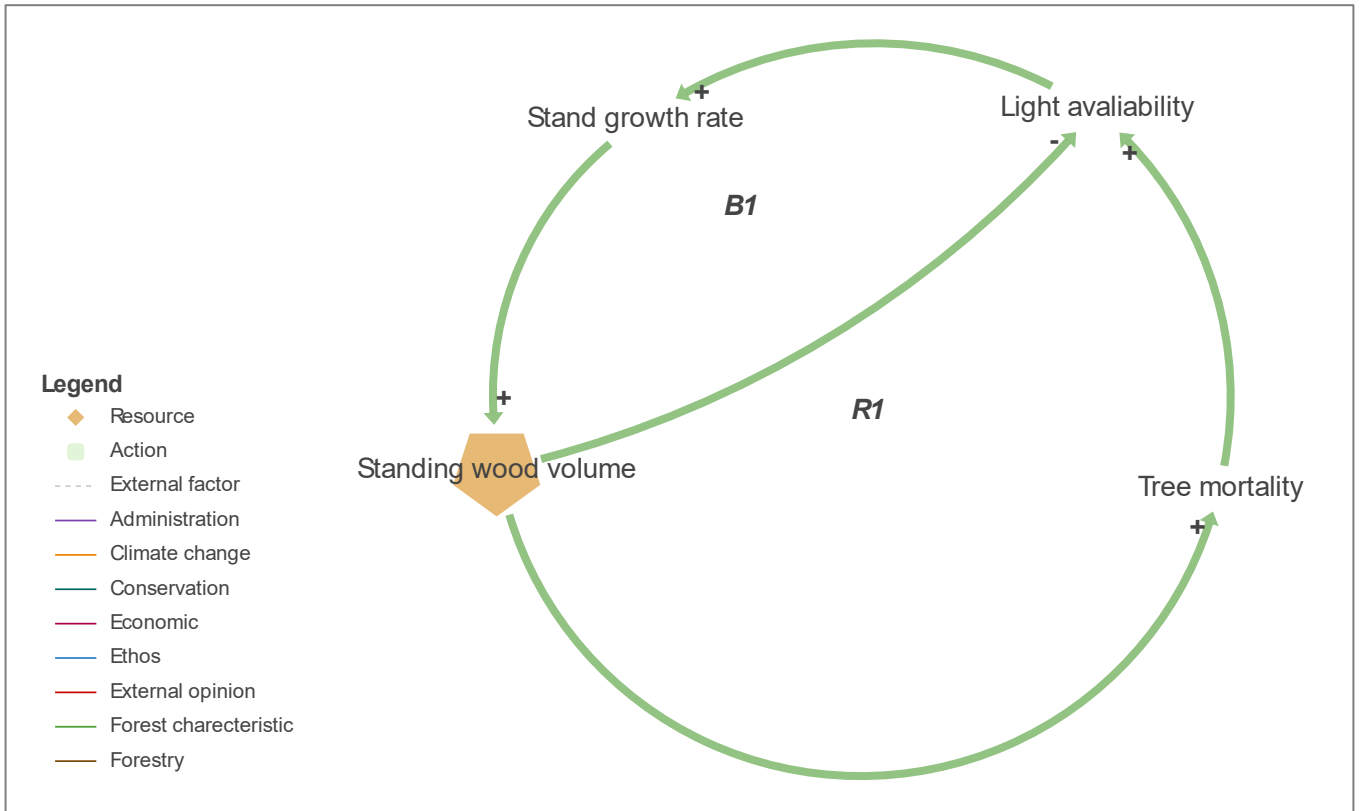


Figure 8: The two loops representing the natural forest cycle.

### 3.1.2 Managed forest

**Basic forestry activities.** There are several operations that foresters can conduct in the forest to reach the desired goal they are pursuing. To simplify the range of these operations, they were broken down into three basic activities (fig. 9). First, harvesting, which occurs whenever wood is extracted from the forest. Then replanting, which takes place when young trees are planted in the forest after a cut. The delay symbolizes the time needed for young trees to grow. Finally, conservation measures. In this study, we decided to consider two conservation measures: the creation of forest reserve and the marking of habitat trees. These measures are realised in acknowledgment with the Forestry Division Bernese Jura through a written contract. This contract set the conditions and allow the owners to perceive cantonal subsidy. The conditions include the prohibition of logging in the forest reserve; the interdiction to fell habitat trees as well as periodical controls by cantonal employees. Conceptually, it acts as an inhibitor for harvesting activities.

**Forestry activity's loops.** Three new loops are introduced. First, the mature harvest balancing loop (B2). As the standing wood volume grows, so do the perceived maturity of the stand. The more the stand is perceived as mature, the more it is likely to trigger harvesting activities. Harvesting then reduces the standing wood volume in the forest. This last connection is shared with the second balancing loop introduced (B3). Here the reduced standing wood volume also reduces tree mortality, simply because harvested trees are not part of the natural cycle of the forest anymore. As tree mortality drops, the salvage or

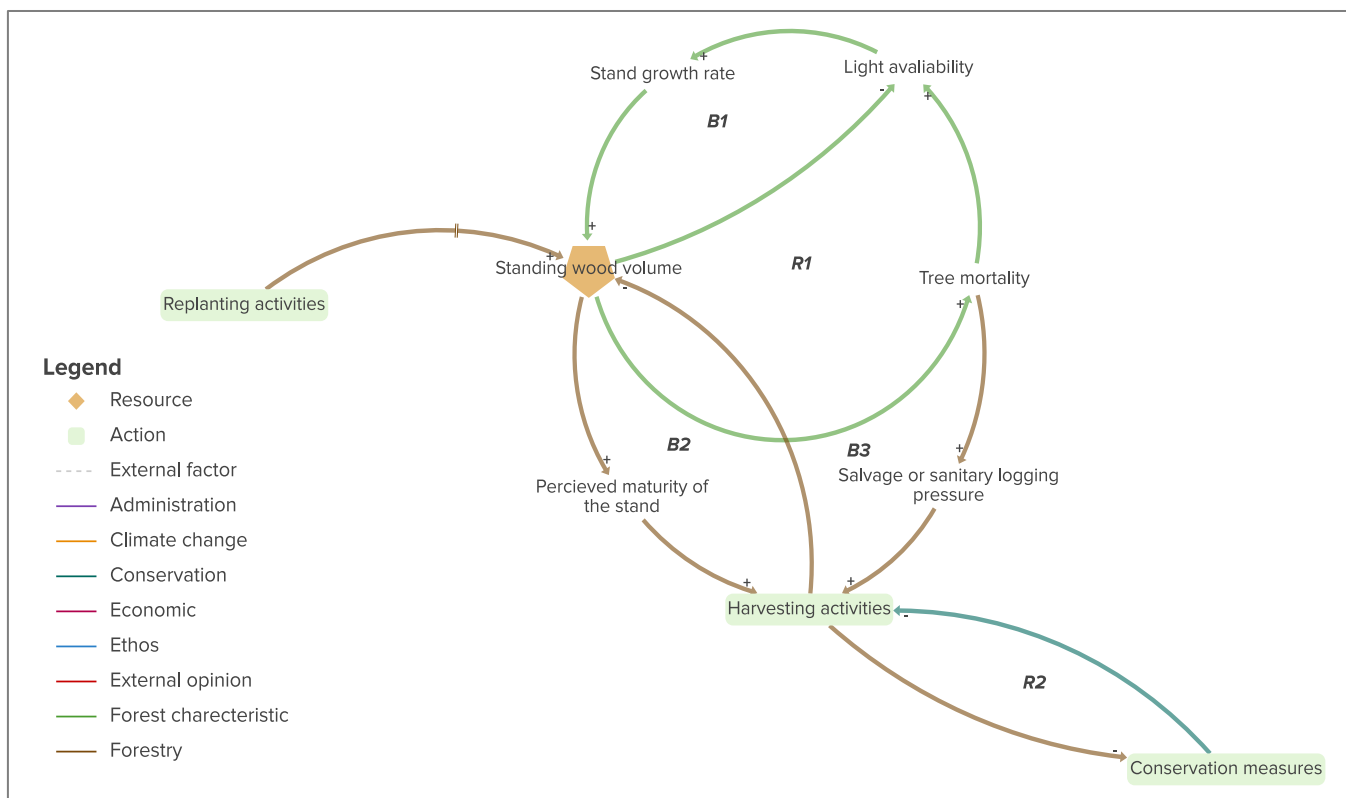


Figure 9: Forestry activities added to the natural forest cycle.

sanitary logging pressure drops too. This reduces the overall harvesting activities in the forest. The third loop is reinforcing (R2). If more harvesting activities occur, it reduces conservation measures possibilities. If conservation measures are reduced, meaning less protected habitat trees or smaller forest reserve area, it allows for more harvesting activities in the forest. Inversely, more conservation measures reduce harvesting activities. This reflects the fact that logging is prohibited in forest reserves.

This was expressed for instance by one of the citizens' communes when asked about discouraging factors for harvesting:

*"[...] And what is discouraging, is the fact to let nature do. To leave small area untouched, as wild as possible." (Interview Bourgeoisie 2)*

There are of course other elements that encourage or discourage engagement in different forestry activities. These will be presented in the next step.

### 3.1.3 Motivations

Multiple motivation or factors can influence the action taken in the forest. Here, three main motivations were identified (fig. 10). First, the active management motivation that pushes owners to engage in harvesting activities. Second, the economic motivation that also pushes toward more logging. Furthermore, replanting activities are stimulated by the interest in fast growing tree species with the perspective of future profit. Third, a rising conservation motivation increases conservation measures.

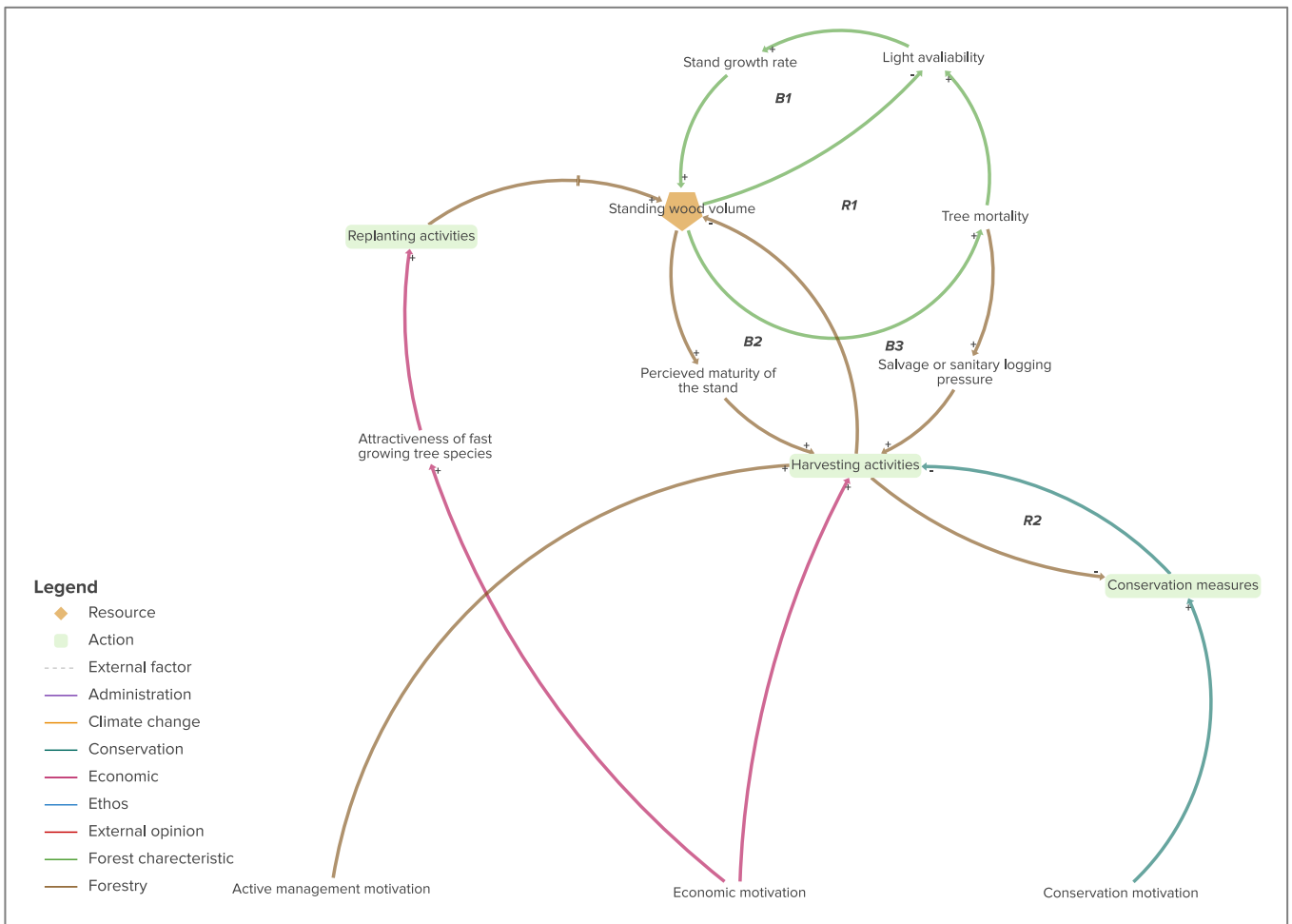


Figure 10: Motivations driving the forestry actions.

### 3.1.4 Consequences

The forestry activities also generate consequences that influence the activity itself or the motivation driving it (fig. 11). For instance, cost is generated by replanting (B4). This balancing loop limits the intensity of replanting activities.

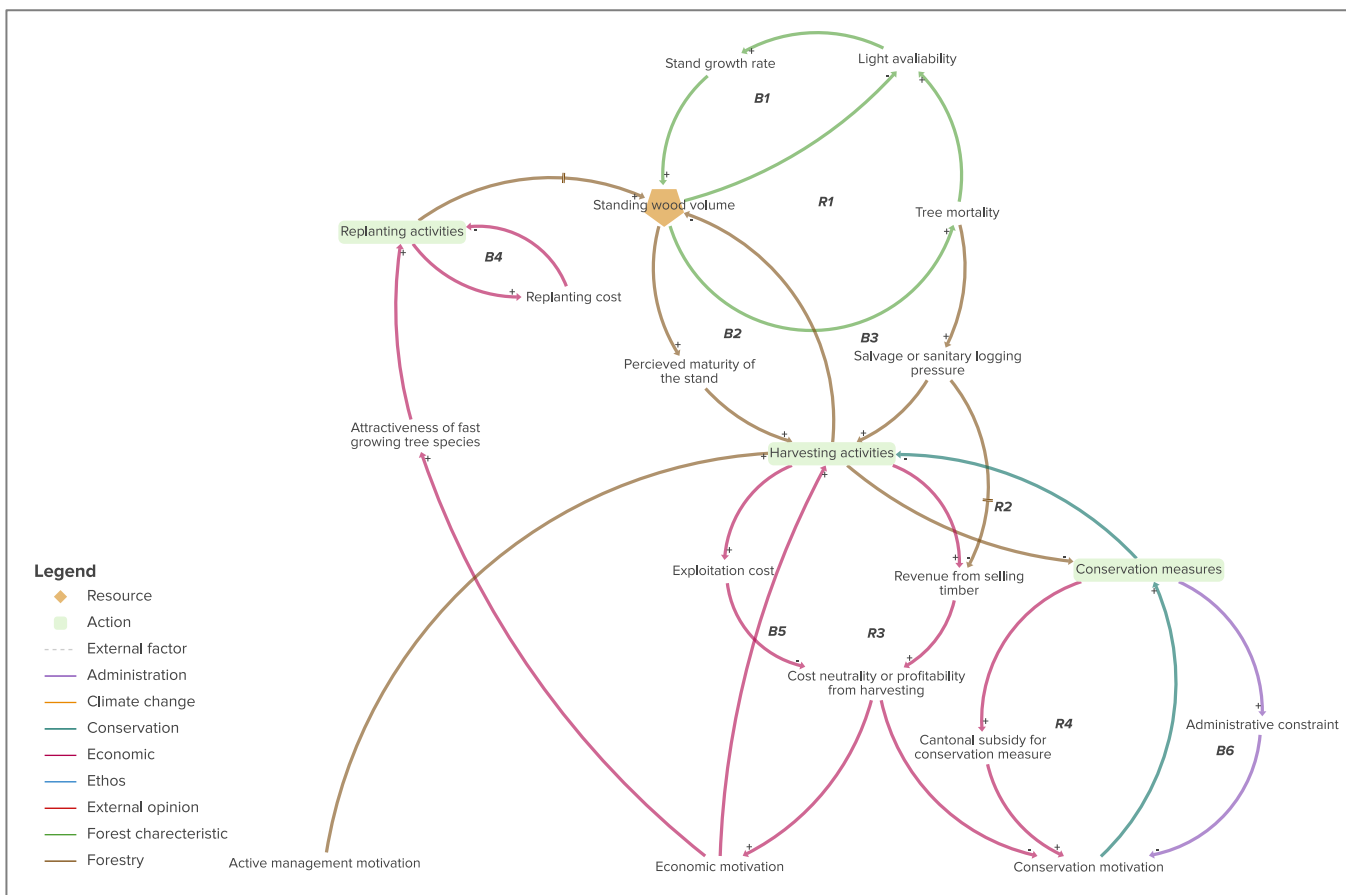


Figure 11: Consequences resulting of forestry actions.

**Importance of cost neutrality or profitability.** Harvesting activities generate both exploitation cost and revenue through the sale of timber. This leads to one important element for both public and private owners: the cost neutrality or profitability from harvesting. As it was clearly explained by a forester when asked about the motivation for harvesting:

*"[...] We live in a region where it is awaited that forests don't cost money. In principle, they generate money." (Interview Municipality)*

The more logging leads to profitability or at least cost neutrality, the more it increases economic motivation and stimulates harvesting activities. This balance between profit and cost is depicted by the reinforcing loop of revenue (R3) and the balancing loop of cost (B5).

**Profitability, a break to conservation.** The more profitable a forest is, the less motivation there is to conserve it. This is illustrated by the negative connection from the profitability element to the conservation motivation in the causal loop diagram. When asked about motivation for conservation measures, the forester in charge of the cantonal forests put it in these words:

## Results

*"You have to look at what kind of forests they are. Whether they can be exploited or not. Take the example of the Court gorges: they've been turned into a reserve. They can't be logged. So, it's easy to put them under protection, and then you can get a bit of compensation for your forest. "(Interview Canton)*

*Conservation, between subsidy and constraint.* Finally, conservation measures generate subsidy allocated by the canton. On the other hand, to receive the subsidy, a project must be prepared and presented to the regional Forestry Division for approval. Then it must be enacted and follow up controls are expected. This constitutes the administrative constraint occasioned by conservation measures. These elements both influence conservation motivation positively and negatively. This is depicted by the reinforcing loop of the subsidy incentive (R4) and the balancing loop of the administrative hurdle (B6).

*Understanding of larger loops.* The basic loops constituting the causal loop diagram are covered; they are summarized in the table at the end of this chapter (table 1). These basic loops then help us to understand the broader consequences of a variation within larger loops. For example, increasing replanting activities indirectly increase future harvesting activities. Which in turn will increase revenue and profitability, further stimulating economic motivation. It then bolsters the attractiveness of fast-growing tree species, stimulating back the replanting activities. This loop is of course balanced by the cost in a similar fashion.

Now that we presented the loops of the diagram, we can now introduce elements that lie outside of the system's boundaries.

Table 1: Feedback loops

<b>Label</b>	<b>Name</b>	<b>Category</b>	<b>Description</b>
<b>B1</b>	Limit of growth	Forest characteristic	Represent the natural limits to the growth of trees in a forest.
<b>B2</b>	Mature stand harvest	Forestry; Forest characteristic	As the stand grow forester perceive it as more mature and ready for harvest.
<b>B3</b>	Salvage and sanitary logging pressure	Forestry; Forest characteristic	A raising tree mortality raises the pressure of sanitary and harvesting logging. Increasing harvesting activities intensity.
<b>B4</b>	Replanting cost	Economic	Replanting generate cost that hold replanting activities intensity.
<b>B5</b>	Harvesting cost	Economic	Cost generated by harvesting activities is discouraging.
<b>B6</b>	Conservation administrative hurdle	Conservation; Administration	Conservation measures mean administrative constraints. These are reducing conservation motivation.
<b>R1</b>	Forest growth	Forest characteristic	Depict the natural unmanaged cycle of a forest.
<b>R2</b>	Mutual exclusivity	Conservation; Forestry	Conservation measures prohibit harvesting. And conservation measures are not taken if trees are harvested.
<b>R3</b>	Harvesting revenue	Economic	More harvesting means more timber to sell. It increases economic motivation to harvest.
<b>R4</b>	Conservation incentive	Conservation; Economic	Conservation measures allow for cantonal subsidies. It is a motivation for more conservation measures.

### 3.1.5 Climate Change

The first and most influential external factor to be introduced is climate change, particularly the stress it induces on forests. It has two major consequences, as depicted in the diagram below (fig. 12).

**Forced cuts and pressure on the timber market.** First, tree mortality is increased as trees are more prone to drought, disease and parasite attacks. It then increases salvage or sanitary logging pressure. Note how the revenue from harvesting is negatively influenced with a delay. This represents diverse mechanisms by which timber prices drop due to forced cuts. We can take for example the overflow of wood in the market and the deteriorated quality of the timber after a bark beetle attack (Zürcher, 2024).

**Prepare future forests.** Second, concern about climate-driven forest change rises as the consequences on forests are more palpable. Then attractiveness of more resilient tree species is also increased. Which in turn, stimulates replanting activities. But most importantly, the more this concern grows, the more owners feel the need to act in their forest. This aspect is shared widely among all owner types.

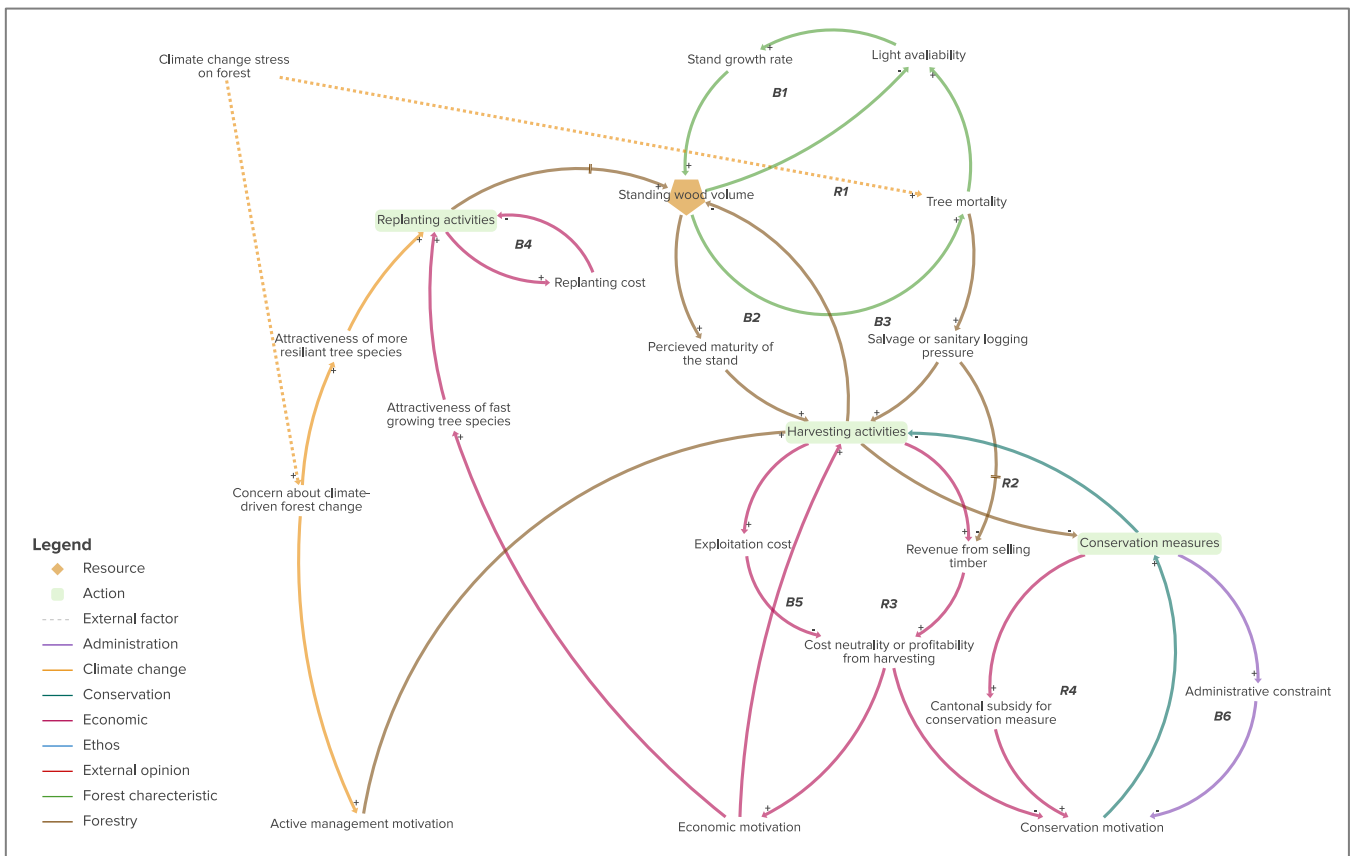


Figure 12: The influence of climate change on forest cycle and decision making.

### 3.1.6 External factors

Finally, the model is completed with other external factors influencing different parts of it. But not every external factor is shared by every type of owner, and not all of them prevail to the same degree. Here, the full diagram is presented in a neutral stance (fig. 13). The complete list of factors can be found in the table at the end of the current chapter, along with a concise description (table 2). While in the following chapters, two separate tables with external factors affecting specifically private and public owners respectively will be presented (table 3 & 4). Beforehand, the intensity of the connections in relation to their perceived importance will be introduced.

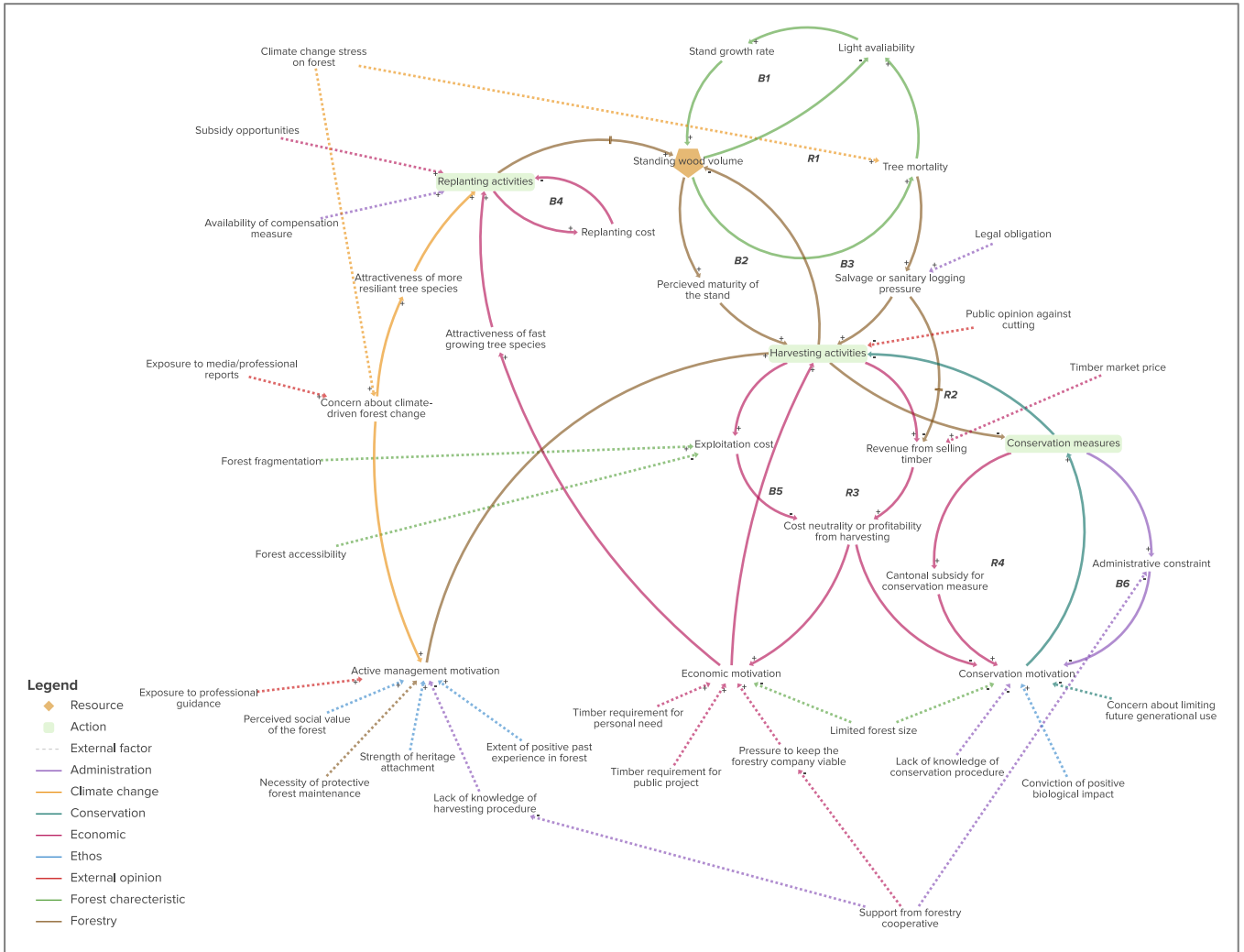


Figure 13: Complete causal loop diagram with external factors (in dashed arrows).

Table 2: External factors

<b>Label</b>	<b>Category</b>	<b>Owner-type</b>	<b>Description</b>
<b>Availability of compensation measure</b>	Administration	Bourgeoisie   Canton   Municipality   Private	Some large projects require deforestation. But compensation measures are compulsory. Trees must be replanted elsewhere
<b>Climate change stress on forest</b>	Climate change	Bourgeoisie   Canton   Municipality   Private	Trees are suffering due to climate change, and are more prone to disease, parasite attacks and drought
<b>Concern about limiting future generational use</b>	Conservation	Bourgeoisie   Canton	A forest linked to a conservation contract for a reserve project; it is forbidden to exploit it for 50 years
<b>Conviction of positive biological impact</b>	Ethos	Bourgeoisie   Canton   Municipality	The more the owner is convinced of the benefits of the measure, the more he is motivated
<b>Exposure to media/professional reports</b>	External opinion	Bourgeoisie   Canton   Municipality   Private	Media or professional reporting about the stress on forest caused by climate change raise concern
<b>Exposure to professional guidance</b>	External opinion	Bourgeoisie   Municipality   Private	Owner in contact with forestry professionals are more motivated to manage their forests
<b>Extent of positive past experience in forest</b>	Ethos	Private	Positive memories in forests encourage owners to take care of their forests
<b>Forest accessibility</b>	Forest characteristic	Bourgeoisie   Canton   Municipality   Private	Good quality of service roads assures a better accessibility; it reduces transportation cost
<b>Forest fragmentation</b>	Forest characteristic	Bourgeoisie   Canton   Municipality   Private	Owned forests can be fragmented in small disparate parcels. Transportation costs are higher when harvesting
<b>Lack of knowledge of conservation procedure</b>	Administration	Private	Not being aware or informed about conservation procedure reduce conservation motivation

<b>Lack of knowledge of harvesting procedure</b>	Administration	Bourgeoisie   Municipality   Private	Not being aware or informed about harvesting procedure reduce active management motivation
<b>Legal obligation</b>	Administration	Bourgeoisie   Canton   Municipality   Private	If the health of the forest is endangered, sanitary of salvage logging can be enforced
<b>Limited forest size</b>	Forest characteristic	Private	Owned forest being of limited size generally reduces motivation to manage it
<b>Necessity of protective forest maintenance</b>	Forestry	Bourgeoisie   Canton   Municipality	Forests with a protective role, against landslide or rock felling, must be maintained to make sure they fulfil their role
<b>Perceived social value of the forest</b>	Ethos	Bourgeoisie   Canton   Municipality	If the owner value, the social role of the forests he is more interested in making it safe for users
<b>Pressure to keep the forestry company viable</b>	Economic	Bourgeoisie   Canton   Municipality	Owning a forestry company means costs and salaries. These must be covered by harvesting activities
<b>Public opinion against cutting</b>	External opinion	Bourgeoisie   Canton   Municipality	The pressure of the public opinion against the felling of trees discourage harvesting
<b>Strength of heritage attachment</b>	Ethos	Bourgeoisie   Municipality   Private	How strongly the owner is attached to the forest past and future ownership.
<b>Subsidy opportunities</b>	Economic	Bourgeoisie   Canton   Municipality   Private	Canton, private or public entities can finance replanting operation
<b>Support from forestry cooperative</b>	Administration	Bourgeoisie   Municipality	Involvement of the members of the forestry cooperative motivate forest management
<b>Timber market price</b>	Economic	Bourgeoisie   Canton   Municipality   Private	High timber price is favourable and increase revenue

## Results

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<b>Timber requirement for personal need</b>	Economic	Private	Private owner can use wood for heating or small construction projects
<b>Timber requirement for public project</b>	Economic	Bourgeoisie   Municipality	Public projects such as constructions or district heating stimulate economic motivation

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### 3.1.7 Connection intensities

*Perception differences.* Owners are pushed to manage their forest in a particular manner due to different factors. Some are unique to a particular type of owner while others are shared. However, not all the shared elements are perceived as equivalently important regarding their impact on management decisions by every owner. For this reason, the intensity of the connections is depicted on the diagram with three different arrow thicknesses. This represents how much an element is perceived to prevail from the point of view of the different type of owners. This categorisation is based on the words of the owners, but also on how frequently an element is mentioned across the owners.

*Important shared connections.* To illustrate this, every connection with the same intensity for the four types of owners is highlighted in the diagram (fig. 14). A thicker arrow means that the factor is perceived as more influential. It is the case for four connections. First, concern about climate-driven forest change, motivating owners to manage forest actively. Second, cost neutrality or profitability from harvesting, decreasing conservation motivation. Third, Availability of compensation measure that stimulates replanting. And fourth, the price of timber, allowing for more revenue when high. We can consider these elements as the most prevalent factors explaining motivation to replant, harvest or conserve among all types of owners. It is particularly true for conservation motivation, if a forest is profitable, it is very unlikely that a forest reserve will be created within it. On the contrary, unprofitable forest are more likely to be conserved by creating a reserve if the owner is willing to go through the administrative process.

*Shared normality.* The other connections share the normal intensity. This is because they represent a shared reality for every ownership. Therefore, it was decided to depict them as normal connections. Law, subsidy, cost and forest dynamics are all the same for everyone.

## Results

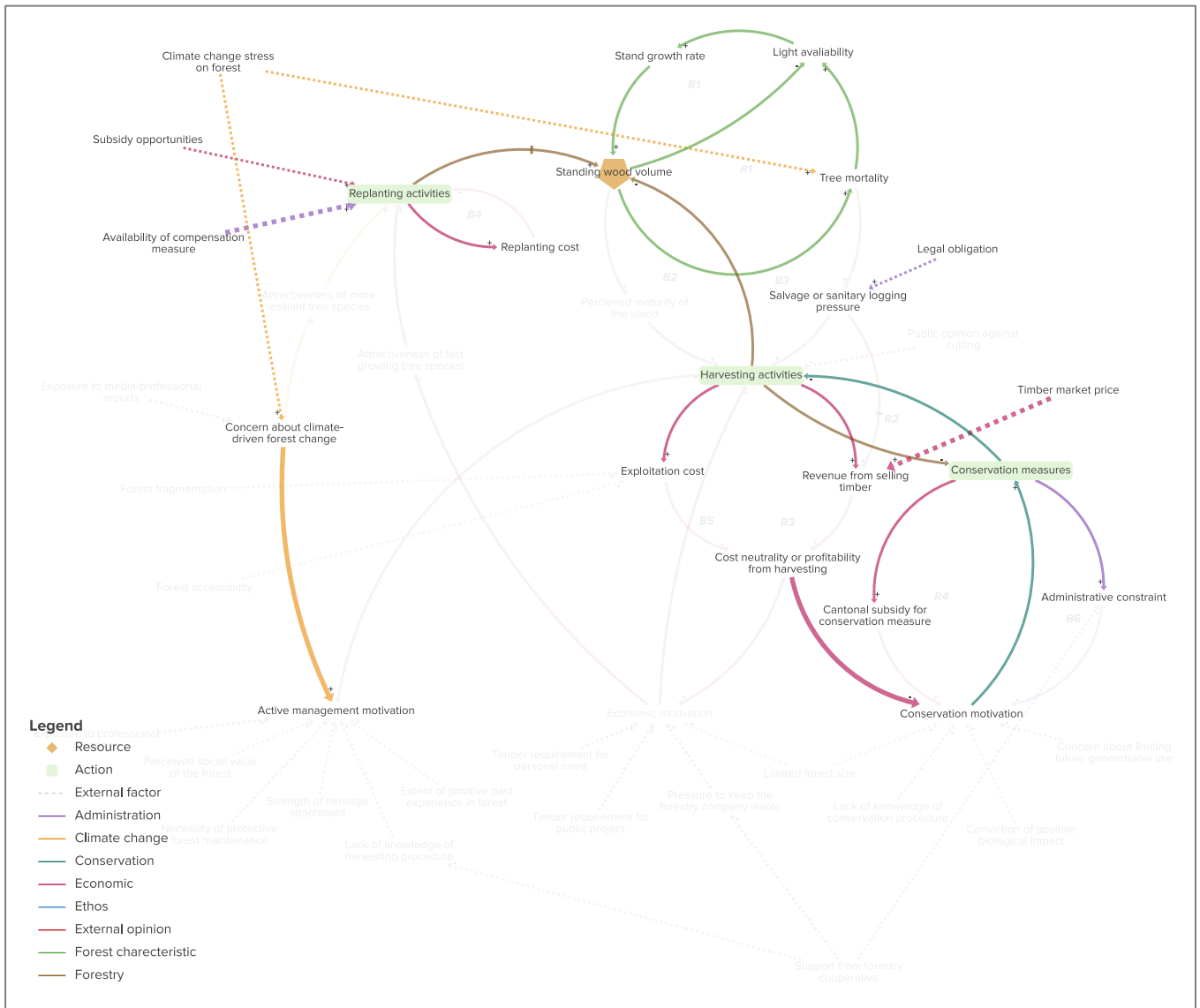


Figure 14: Highlighted connections with identical intensity shared by all owner types.

### 3.2 Private owners causal loop diagram

In this chapter, we will present the results along with the CLD (fig. 15) for private owners. The table with the external factors relevant to this type of owner can be found at the end of this chapter (table 3).

**Limiting forest size.** Private owners possess comparatively smaller forests than public owners (Interview Forest ranger). And this aspect has a determining influence on the decision-making process in their forest management. Profitability is lower and cost weigh more in the balance the private owner interviewed starts by explaining the situation of his own forest:

*"They were never really exploited. Because it is really small and really disparate, it isn't profitable."* (Interview Private owner)

The limited size of the forest also enhances the impacts of a difficult forest accessibility or fragmentation. It reduces economic and to a lesser extent conservation motivation due to the lack of prospect.

*Unfamiliarity with forestry.* However, this is not the only obstacle for private owners. The lack of knowledge in forestry procedures reduces the motivation to manage forest actively or engage in conservation procedure. The administrative procedure generated by conservation measures also feel more complicated and discouraging for them:

*"I think it can quickly be complicated because you need to mandate a company, you need to establish quotes, you must run after subsidy because they aren't going to do it for you. [...] So, there is all these elements, elements of assurance, that you need to control to make sure it work. I think that it is strongly complicated. And it can discourage more than one." (Interview Private owner)*

*External motivation.* On the other hand, contact with professional strongly stimulates the motivation for active management along with the raising concern about climate driven forest change. In this extract, the private owner explains how he was approached by a forestry company organizing a logging operation with multiple owners:

*"So, the deal is that they maintain the forest. Because we know the problematic of dying spruce, especially in dense forest. Everything is dying, there is bark beetle attack everywhere, everything is getting out of control. So, the idea is to maintain it and give more life to the young broadleaves trees who comes after. And for us, what's super interesting is that our forest is maintained this way. By professionals, at every level." (Interview Private owner)*

Economic and forestry elements are not the primary motivation for private owners. For instance, fast-growing tree species are not mentioned as something relevant for replanting choice. For this reason, arrows pointing to harvesting activities are thinner for forest and economic influences as shown in the CLD. To them, the maintenance of the forest is their main concern.

*Heritage and experience.* Furthermore, Forest ranger 1 shares that in his experience, forests are mostly inherited among private owners (Interview Forest ranger). He also explains that some private owners are close to their forests, while other are not even aware that they own a forest. We can deduce that the more they feel attached to their heritage and have had positive experience within forest, the more they are likely to be motivated to manage it. It could also be linked to the size of the forest they own. The smaller the forest, the less likely it is that they are motivated to manage it.

*Self-sufficiency.* Finally, the personal need for timber is a factor significantly increasing economic motivation to harvest. It may be for heating or construction projects. Here is again forest ranger 1 describing this fact:

*"[Private] Owners are not very motivated to exploit. Except for a specific reason. For instance, [Farmer owner] he exploited his forest for the construction of a stable." (Interview Forest ranger)*

# Results

Overall, it appears that private owners appear to be more opportunistic regarding the management of their forests. We can see in the diagram, the strong influence of external factors. Public owners in the contrary are more structured.

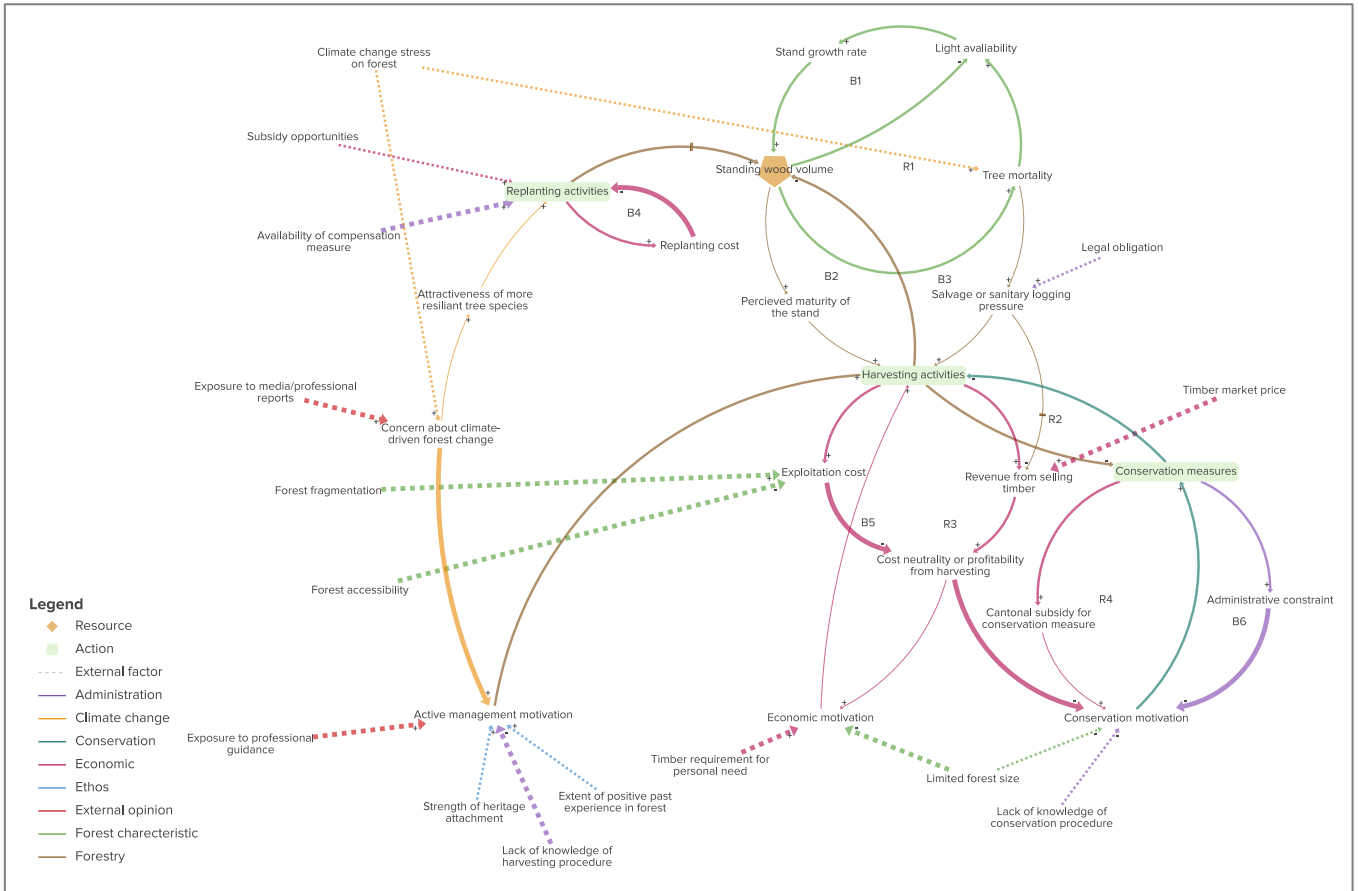


Figure 15: Causal loop diagram with connection intensity and external factors proper to private owners.

Table 3: External factors affecting private owners

<b>Label</b>	<b>Category</b>	<b>Owner-type</b>	<b>Description</b>
<b>Availability of compensation measure</b>	Administration	Bourgeoisie   Canton   Municipality   Private	Some large projects require deforestation. But compensation measures are compulsory. Trees must be replanted elsewhere
<b>Climate change stress on forest</b>	Climate change	Bourgeoisie   Canton   Municipality   Private	Trees are suffering due to climate change, and are more prone to disease, parasite attacks and drought
<b>Exposure to media/professional reports</b>	External opinion	Bourgeoisie   Canton   Municipality   Private	Media or professional reporting about the stress on forest caused by climate change raise concern
<b>Exposure to professional guidance</b>	External opinion	Bourgeoisie   Municipality   Private	Owner in contact with forestry professionals are more motivated to manage their forests
<b>Extent of positive past experience in forest</b>	Ethos	Private	Positive memories in forests encourage owners to take care of their forests
<b>Forest accessibility</b>	Forest characteristic	Bourgeoisie   Canton   Municipality   Private	Good quality of service roads assures a better accessibility; it reduces transportation cost
<b>Forest fragmentation</b>	Forest characteristic	Bourgeoisie   Canton   Municipality   Private	Owned forests can be fragmented in small disparate parcels. Transportation costs are higher when harvesting
<b>Lack of knowledge of conservation procedure</b>	Administration	Private	Not being aware or informed about conservation procedure reduce conservation motivation
<b>Lack of knowledge of harvesting procedure</b>	Administration	Bourgeoisie   Municipality   Private	Not being aware or informed about harvesting procedure reduce active management motivation

<b>Legal obligation</b>	Administration	Bourgeoisie   Canton   Municipality   Private	If the health of the forest is endangered, sanitary of salvage logging can be enforced
<b>Limited forest size</b>	Forest characteristic	Private	Owned forest being of limited size generally reduces motivation to manage it
<b>Strength of heritage attachment</b>	Ethos	Bourgeoisie   Municipality   Private	How strongly the owner is attached to the forest past and future ownership.
<b>Subsidy opportunities</b>	Economic	Bourgeoisie   Canton   Municipality   Private	Canton, private or public entities can finance replanting operation
<b>Timber market price</b>	Economic	Bourgeoisie   Canton   Municipality   Private	High timber price is favourable and increase revenue
<b>Timber requirement for personal need</b>	Economic	Private	Private owner can use wood for heating or small construction projects

### 3.3 Public owners causal loop diagrams

Before proceeding with detailing each of the public owners and presenting their respective CLD, we will go through the few elements and connections they share. The table of the external factors they have in common can be found at the end of this chapter (table 4).

*Economically driven decisions.* First, regarding economic motivation, the element of "Attractiveness of fast-growing tree species" is unique to public owners. The idea to replant fast-growing tree species -such as Douglas fir- can be a motivation for replanting. However, forest managers' main preoccupation is the future composition of forest regarding climate change. Therefore, the influence of fast-growing tree species is weaker than the attractiveness for resilient tree species (figs. 16-18). The pressure to keep the forestry company viable is also an important factor increasing the economic motivation. It is interesting to note that political and citizens' communes do not own their own forest companies anymore. But they mention the effect it had in the past and explain that now they are grouped in forestry cooperative, which removes the pressure of viability (figs. 16-18).

*No conservation without conviction?* Second, regarding conservation activities, public owners insisted that money should not be the main motivation to engage in such procedures (Interview Canton). There needs to be a deep conviction that it will be beneficial for the forest and its biodiversity (Interview Municipality). The strength of this conviction increases conservation motivation; this is illustrated with the external factor "Conviction of positive biological impact" (figs. 16-18). However, we can note that cantonal subsidy also constitutes a strong intensive.

*Public opinion.* Finally, regarding active forest management motivation, public actors evoke the social value of forest and the necessity of protective forest maintenance as being important to them. Furthermore, every public actor mentioned public opinion against cutting as a discouraging factor for harvesting activities. However, it is difficult to assess to which extent logging is reduced as opposition rises. The exception being for the canton Bern, where its influence is illustrated as having a stronger impact for reasons covered in the next chapter.

Table 4: External factors affecting public owners

<b>Label</b>	<b>Category</b>	<b>Owner-type</b>	<b>Description</b>
<b>Availability of compensation measure</b>	Administration	Bourgeoisie   Canton   Municipality   Private	Some large projects require deforestation. But compensation measures are compulsory. Trees must be replanted elsewhere
<b>Climate change stress on forest</b>	Climate change	Bourgeoisie   Canton   Municipality   Private	Trees are suffering due to climate change, and are more prone to disease, parasite attacks and drought
<b>Concern about limiting future generational use</b>	Conservation	Bourgeoisie   Canton	A forest linked to a conservation contract for a reserve project; it is forbidden to exploit it for 50 years
<b>Conviction of positive biological impact</b>	Ethos	Bourgeoisie   Canton   Municipality	The more the owner is convinced of the benefits of the measure, the more he is motivated
<b>Exposure to media/professional reports</b>	External opinion	Bourgeoisie   Canton   Municipality   Private	Media or professional reporting about the stress on forest caused by climate change raise concern
<b>Exposure to professional guidance</b>	External opinion	Bourgeoisie   Municipality   Private	Owner in contact with forestry professionals are more motivated to manage their forests
<b>Forest accessibility</b>	Forest characteristic	Bourgeoisie   Canton   Municipality   Private	Good quality of service roads assures a better accessibility; it reduces transportation cost
<b>Forest fragmentation</b>	Forest characteristic	Bourgeoisie   Canton   Municipality   Private	Owned forests can be fragmented in small disparate parcels. Transportation costs are higher when harvesting

<b>Lack of knowledge of harvesting procedure</b>	Administration	Bourgeoisie   Municipality   Private	Not being aware or informed about harvesting procedure reduce active management motivation
<b>Legal obligation</b>	Administration	Bourgeoisie   Canton   Municipality   Private	If the health of the forest is endangered, sanitary of salvage logging can be enforced
<b>Necessity of protective forest maintenance</b>	Forestry	Bourgeoisie   Canton   Municipality	Forests with a protective role, against landslide or rock felling, must be maintained to make sure they fulfil their role
<b>Perceived social value of the forest</b>	Ethos	Bourgeoisie   Canton   Municipality	If the owner value, the social role of the forests he is more interested in making it safe for users
<b>Pressure to keep the forestry company viable</b>	Economic	Bourgeoisie   Canton   Municipality	Owning a forestry company means costs and salaries. These must be covered by harvesting activities
<b>Public opinion against cutting</b>	External opinion	Bourgeoisie   Canton   Municipality	The pressure of the public opinion against the felling of trees discourage harvesting
<b>Strength of heritage attachment</b>	Ethos	Bourgeoisie   Municipality   Private	How strongly the owner is attached to the forest past and future ownership.
<b>Subsidy opportunities</b>	Economic	Bourgeoisie   Canton   Municipality   Private	Canton, private or public entities can finance replanting operation
<b>Support from forestry cooperative</b>	Administration	Bourgeoisie   Municipality	Involvement of the members of the forestry cooperative motivate forest management
<b>Timber market price</b>	Economic	Bourgeoisie   Canton   Municipality   Private	High timber price is favourable and increase revenue
<b>Timber requirement for public project</b>	Economic	Bourgeoisie   Municipality	Public projects such as constructions or district heating stimulate economic motivation

### 3.3.1 Canton

Canton Bern represents the biggest single owner in the Bernese Jura region. With 1900 ha of forest, it makes up around 7% of public forest (Personal correspondence, 15.12.2025). The forest ranger of the Canton explained (Interview Canton) that until 2005, every parcel of cantonal forest was attached to a forestry district. There, the local forest ranger was paid by the canton to manage that part of cantonal forest. Consequently, this organisation led to a large deficit, and it was then decided to create the Domaniel forest company. It is composed of forest engineers and forest rangers who manage the forest and a small team of lumberjacks for emergency intervention. The main work is delegated to private companies. These particularities have an undeniable influence on forest's management, where profitability is central (fig. 16).

*Guarantee protection.* During the interview, three main aspects are mentioned to motivate the exploitation of cantonal forests. The first is the duty to maintain protective forest. As the bigger forest owner, the canton is responsible of a large quantity of protective forests, preventing landslide and rockfall to damage construction and infrastructure:

*"If you don't maintain those [protective forest], after a while it starts to act like a house of cards — it can all collapse at once." (Interview Canton)*

*Maintain profitability.* The second main aspect is the economic motivation. It is important that profitability is reached. As cantonal forests were costing a lot, it is awaited from the canton that forests are profitable with the company they decided to create in 2005.

*"I mean, if we function like a company, we're required to have positive figures at the end of the year." (Interview Canton)*

The cantonal employee also mentioned that as a large timber provider, it is important to supply local and national wood industries.

*Act as a leader in forest preparation.* The third important aspect mentioned is to act as an example for other owners by replacing aging and ill adapted trees in the face of climate change, leading the way by replanting more resilient tree species. For instance, an experimental plantation was set within cantonal forests and is conducted in partnership with WSL to test resilience of several exotic tree species.

## Results

**Opposition to intense harvesting.** Finally, there is a particular relation with public opinion. There has been a cut in the neighbouring region of Seeland conducted by the regional division of the Domonial forest company. And the cut was highly mediatized and critiqued by public opinion, opposing the plan for further logging (Bertholet, 2023). Such opposition has not yet occurred in the region so far, but the forest ranger dreads it. For this reason, public opinion against cutting is shown to have a greater impact on harvesting in the diagram for cantonal forests (fig. 16).

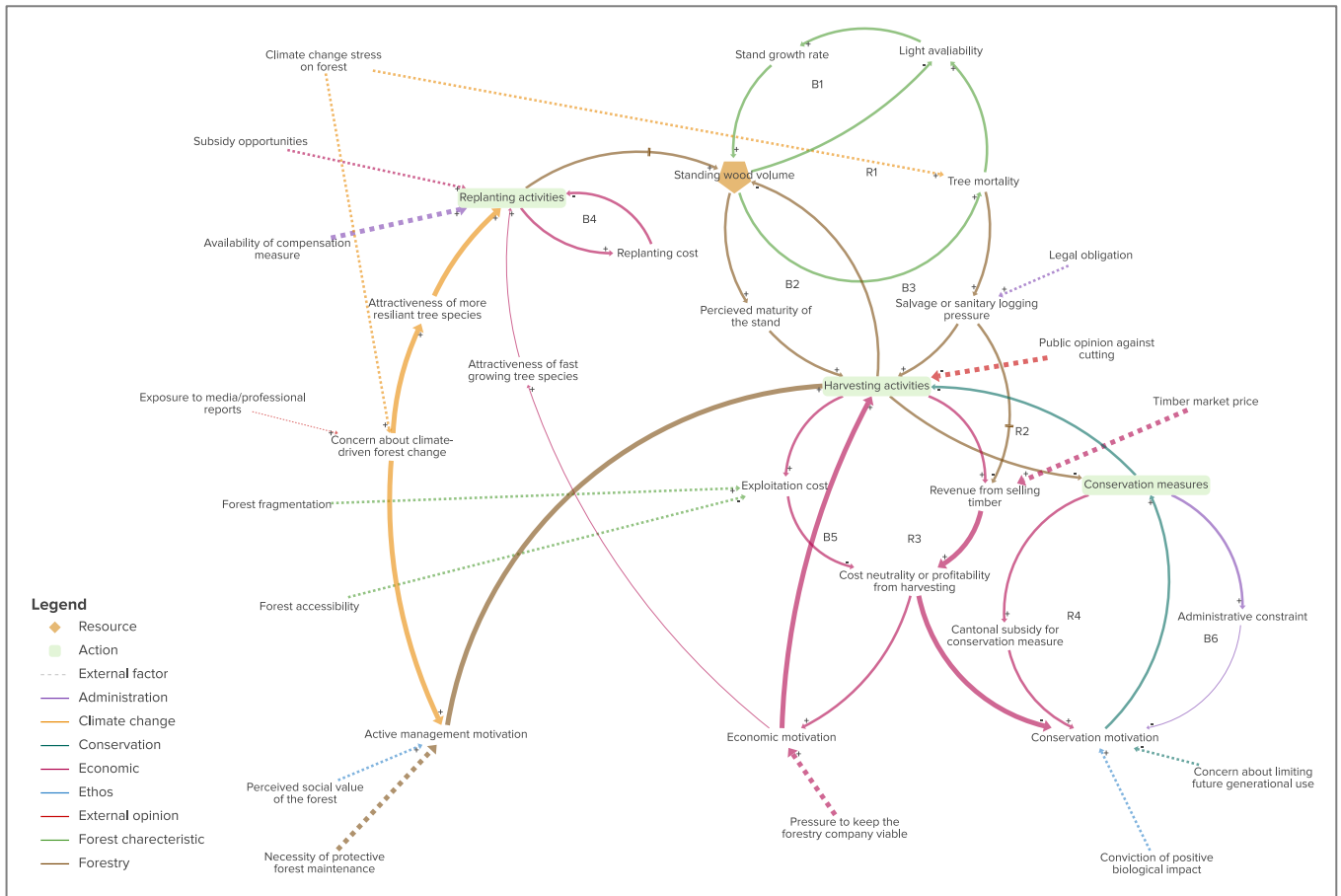


Figure 16: Causal loop diagram with connection intensity and external factors proper to the canton Bern.

### 3.3.2 Citizens' communes

**Cultural heritage.** Citizens' communes are called bourgeoisies in French, they are public-law bodies composed of families with citizenship rights of the corresponding locality (Sieber, 2005). They share half of the forests in public hands along with political municipalities – canton excluded. In the Bernese Jura region, bourgeoisies are culturally known for their role in forest and meadow management, as Bourgeoisie 1 points out:

*"As you know bourgeoisies, it is an historical heritage on its own. And it is the role of bourgeoisies in the region to maintain meadows and forests."  
(Interview Bourgeoisie 1)*

This is illustrated on the diagram below with a strengthened arrow for the element of heritage attachment (fig. 17). Additionally, it is important for citizens' communes to take care of the forest inherited from their ancestors with the aim to pass it along to the next generation. The answer of Bourgeoisie 2 when asked about the importance of their forests to them, illustrate the matter well:

*"Inheritance, really. I realized it across several answers—it keeps coming back, actually. That's what a bourgeoisie is. [...] But I think that this inheritance, for me, for us, is important. That is to say, it's a property that we have received to manage." And then we are keen to pass it on to those who come next, in the best possible condition."  
(Interview Bourgeoisie 2)*

**Public service.** Moreover, it is important that the forest and its benefits are shared with the population. For instance, Bourgeoisie 1 (Interview Bourgeoisie 1) mentions the securitisation and maintenance of forest paths to make sure everyone can wander freely. Or more trivially, provide Christmas trees at the end of the year. Hence, the greater is the perceived social value of the forest, the more is the motivation to actively manage it.

**Local timber supplier.** Another element increasing the economic motivation is the timber requirement for public project. If we leave aside the Christmas trees, some projects in the locality require large quantities of wood. Bourgeoisie 1 mention the construction of a public school with a large part of local wood (Interview Bourgeoisie 1). But it could also be district heating, requiring wood chips.

**Conserving, at what cost?** Regarding conservation, citizens' communes tend to be more interested in cantonal subsidy. We can explain that because forest and meadow represent their principal sources of outcome. For instance, the marking of habitat-trees is described as an interesting source of revenue for Bourgeoisie 1. Nevertheless, Bourgeoisie 2 was about to create a forest reserve, but ended up aborting the project. It is important to know that in order to officially create a forest reserve and obtain subsidy, a contract must be signed with the canton. This contract defines the forest area and forbids any logging activities for a period of 50 years. The reason invoked by the citizens' commune to turn down the contract was the concern that in the future the situation may change and future generations could exploit the forest that is currently regarded as unprofitable:

*"Still with the idea of leaving something for those who come after us. Is it really a good idea that in 20 or 30 years, we won't know what will happen here around this place? Our children won't have the possibility to intervene in this forest because we've blocked it."  
(Interview Bourgeoisie 2)*

## Results

In this specific case, concern about limiting future generational use outweighed subsidy opportunity and the conservation project was abandoned.

*The influence of forestry cooperatives.* Finally, citizens' communes along with political communes are part of forestry cooperative. Because over the years, administrative and exploitation costs have grown. Maintaining a forestry company at the scale of a bourgeoisie or a municipality is no longer profitable. Bourgeoisie 2 explained that having its own forestry company had two negative side-effects. It pushed toward over-exploitation to assure salary for the employee, while the employers are not professionals, lacking the experience for a sustainable and profitable management of forest (Interview Bourgeoisie 2). For these reasons, forestry cooperatives emerged and allowed for more professional management as well as cost reduction. The positive impact of the cooperation is depicted in the diagram, with the factor "Support from forestry cooperative" reducing the lack of knowledge in harvesting procedure, the pressure to keep the forestry company viable and the administrative constraints for conservation procedures (fig. 17).

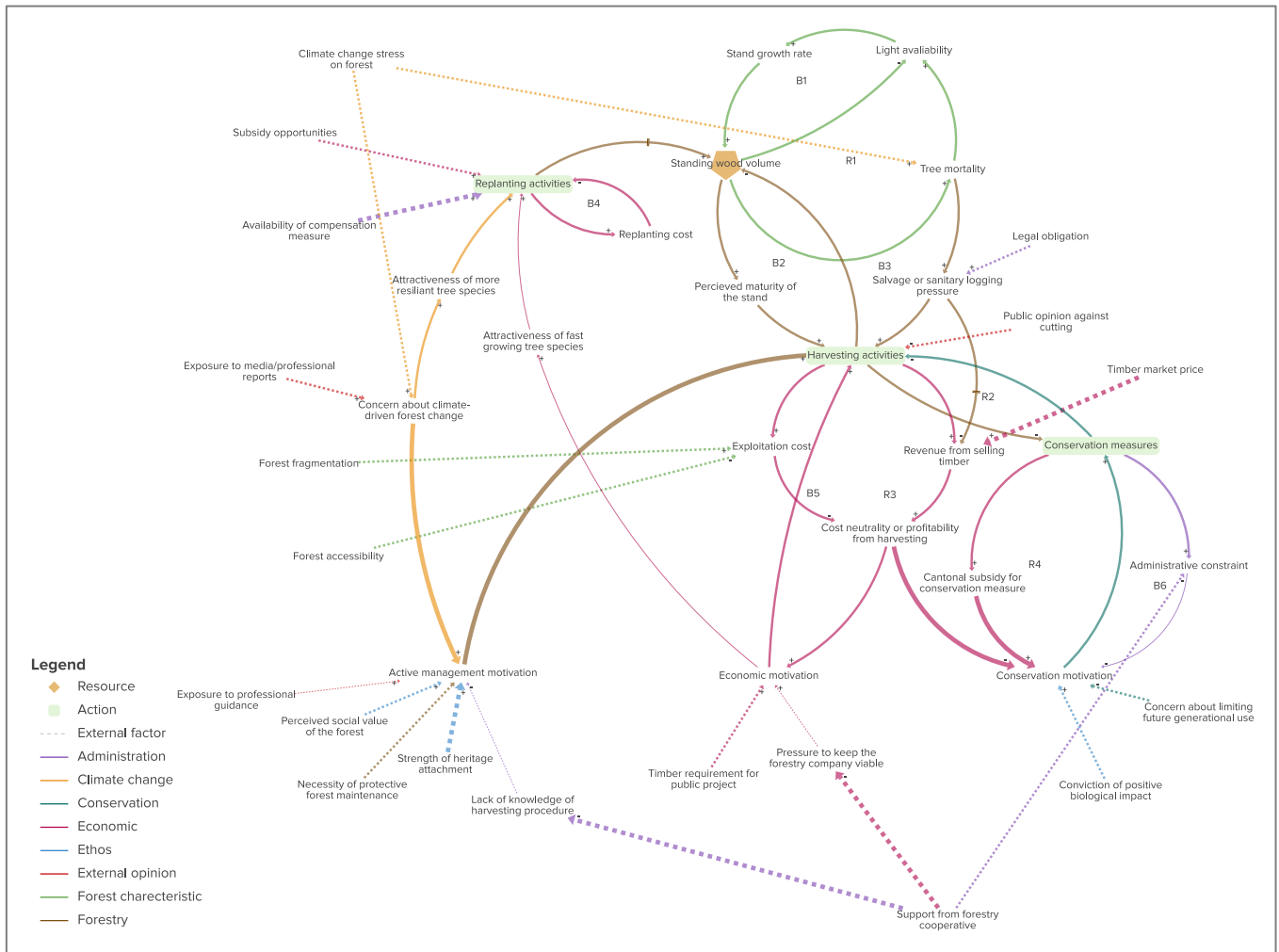


Figure 17: Causal loop diagram with connection intensity and external factors proper to citizens' communes.

### 3.3.3 Political communes

Political communes, also called municipalities, share the second half of the public forest surface (canton excluded). But political communes do not necessarily possess forests. For the ones who do, at the first glance at the CLD (fig. 18), they seem to act very similarly to citizen's communes.

*Prevalence of the social value of forest.* The main difference with respect to forest management would be regarding the strength of heritage attachment. It exists, but to a lesser extent than for bourgeoisies where forests are the property of the families with citizenship rights. Here forest is more seen as common property under the supervision of the municipality. As mentioned by the municipal councillor in charge of the forest, the social value of the forest is important for the locality:

*"It contributes... well, also to our space in a way, a tourist space too. That's also important. So, whether it's for people from the village or people from outside, they move around a lot in our forests, it's very much appreciated. And then in the end, well, it's our landscape. We take care of it; it's part of our values here too."* (Interview Municipality)

Therefore, the influence of perceived social value of the forest is stronger and the strength of heritage attachment is weaker for political commune. Also, the concern about limiting future generational use is not mentioned regarding conservation motivation. This can be linked to the weaker heritage attachment too.

*Political dynamic.* Another particularity of political communes is the nature of its political structure. Councillors are citizen elected for a given period. So, the person in charge of forests may change if he or she is not re-elected. This impacts the long-term vision of forest management and the launching of large forestry projects. Added to this is the fact that elected councillors are not necessarily forestry professionals or experts, and their level of interest in forestry varies. The forest ranger in charge of the forestry cooperative for explains:

*"Then, as you mentioned, there are a lot of citizen-politicians, so that can actually change quickly in politics. And then it's clear that for us, who manage this over the long term, as foresters, we try to think in the very long term. And then the fact that every four years it can jump from one person to another — that's a big challenge. We have people who are very involved, and we have people who are not involved at all."* (Interview Municipality)

To conclude, political municipalities appear to strongly rely on forestry cooperatives for forest management, due to their political organization and the more distant relationship with their forests.

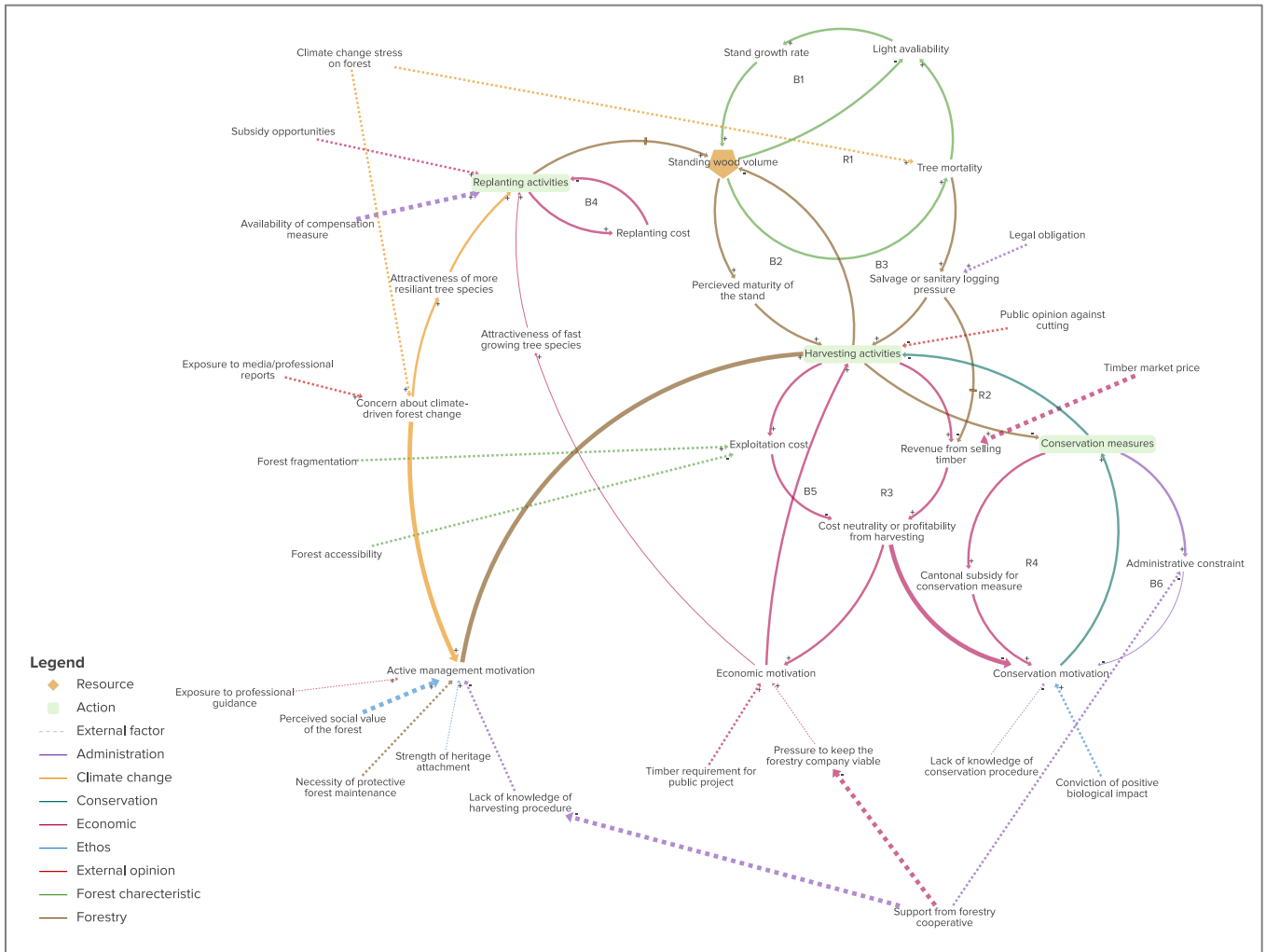


Figure 18: Causal loop diagram with connection intensity and external factors proper to political communes.

## 4 Discussion

### 4.1 Concern about climate-driven forest change

*A growing preoccupation.* We will begin by discussing the most striking factor revealed by the CLDs, by its constancy and prevalence across every type of owner. Indeed, concern about climate-driven forest change was mentioned in every interview. When asked what the ideal forest management situation from their point of view would be, all answered for either the suppression of climate change consequences or a renewed and resilient forest. Owners observe and grow in awareness of the consequences of climate change on their forests every day. Coupled to this fact is the uncertainty about what should be done about it. What specific tree species should be replanted and favoured? The forest ranger at the Domanial forest company summarizes the situation in these words:

*"But now we have to make a transition, with climate warming, from conifers to broadleaf species. [...] After that, it will take fifty years, maybe a hundred, before the broadleaf trees establish themselves. And in between there's a transition—a gap—which, personally, scares me a little." (Interview Canton)*

*Threatened tree species.* The owners' observations support the predictions of the Swiss federal Institute for Forest, Snow and Landscape Research WSL. In 2017, they modelled different climate scenarios. The populations of Spruce and Beech, who are the most common tree species in the region, are predicted to shrink as the temperature increases (Allgaier Leuch et al., p.8).

*A national preoccupation also reaching private owners.* The preoccupation of owners of the Bernese Jura region is also shared by their compatriots. As the study published by the Federal Office of Environment on relationship between forests and owners shows, having a stable and healthy forest is mentioned the most important objective (Walker & Artho, 2018). This is true for both private and public owners who thought about the objective they were pursuing with their forest. The study also mentions that 22% of the private owners of the broader Jura region do not manage their forests. However, as mentioned by the Forest ranger in charge of the forestry association, the rising concern has the effect to motivate more private owners to harvest, even if the cut ends up not being profitable (Interview Municipality).

## 4.2 Public opposition and harvesting

*Misconception and raising concern.* As illustrated in the models, this growing concern increases the active management motivation, which in turn increases harvesting activities. The fact that climate change consequences push owners to cut more trees can be counterintuitive for the general population. Such incomprehension leads to more opposition as seen in the case of the Längholz forest (Bertholet, 2023). However, although the proportion of the population who thought that forests were overexploited grew in 2020 compared to 2010, the majority of the population thinks that forest is exploited as much as necessary (Hegetschweiler et al., 2022). As we saw, public opinion against cutting is mostly determinant for the canton. It could be because of the relative intensity of harvesting activities pushed by the necessity of maintaining viability, exacerbated by the fact that the canton should be regarded as an example in forest management. This is underlined by the Citizens' commune 1:

*"The way the Canton of Bern exploits its forests is shocking, and it bothers me a bit to see that, in the end, a landowner like that—who ought to be setting an example—doesn't really do so, because they're trying to make their forestry business profitable."*  
(Interview Bourgeoisie 2)

*Private owners spared.* On the other hand, public opinion does not seem to have any impact on private owners. It may be explained by the fact that they own relatively small forests (Walker & Artho, 2018). And thus, the result of the logging operation is less shocking for the public opinion.

*Supply and demand.* Aside from the pressure of climate change consequences and public opinion, the CLD demonstrate the influence of two opposing loops on harvesting decision. On one hand is the generated cost, mainly affected by transportation. And on the other hand, the generated revenue, governed by the timber market. This underlines the two main axes on which it is possible to act in order to stimulate harvesting activities. For example, through an increase of subsidies for the creation of service road, or a reinforced regulation of the market.

## 4.3 Conservation and replanting

*Motivation and obstacles.* The report on biodiversity in forests by the Federal institute of environment describes that it is difficult to convince owners to engage in conservation measures (Imesch et al., 2015). We assessed, with help of the models, backed by the interviews, that conservation measures are indeed competing with the profitability of harvesting activities. If a forest is exploitable –meaning that it is at least cost neutral– conservation motivation is low. This is true for every type of ownership. However, private owners are mostly discouraged by the limited size of their forest and the lack of knowledge in conservation procedures rather than by the lack of profitability. Additionally, we noted that citizens' communes are more motivated by subsidies than other owners. This could be explained by the fact that forest is often their primary source of revenue.

*The strength of scattered multi-owned forest parcels.* If private owners are rarely engaging recognized conservation measures, the small and disparate parcels they own are an advantage for biodiversity. Here it is underlined by the Forest Engineer from the Forestry Division, when discussing about the practicality of having larger management units such as public owners:

*"I would say that on the organizational side, it's clear, it's much easier, and we've talked about that quite a bit by now. Then, if I put on the biodiversity lens, it's clear that having several owners who manage things a bit differently is actually a fairly significant advantage for biodiversity, because it creates that mosaic which is interesting. Whereas having a large aggregation often also meant having more or less the same type of forest management."* (Interview Forestry Division)

This aspect is mentioned in a comparative study between the organisation property rights and the implementation of integrative nature conservation (Schulz et al., 2014). It is explained that Switzerland's ownership structure allowed to integrate multiple and competing objectives in forest management, such as conservation and harvesting.

*Prominence of compensation measure in replanting.* Finally, clear-cuts are prohibited in Switzerland, with exceptions for constructions and installations of public interest. If clear-cut is inevitable, compensation measures must be taken, often in the form of replanting (Walther et al., 2014). And owners replant when such opportunities occur. Or in the context of special projects to plant more resilient tree species such as KliWa (Interview Bourgeoisie 2); or in the case of the experimental forest of the canton (Interview Canton). It is not customary to systematically replant trees after harvesting, and the main concern when replanting is the resilience of tree species.

## 4.4 Forestry cooperatives

*A rationalized management unit.* The map of actors helped us to clearly identify the central role of the forestry cooperative for the regional forest management. However, it is therefore particularly difficult to assess clearly the impact of political and citizens' commune ownership on forest management. Because the management of their forests is delegated to the forest ranger in charge of the cooperative, and the management style, motivations, and goals may differ from one forestry cooperative to another. As explained, both by the bourgeoisies and the municipality, regrouping allows for a more rational forest management and reduces the administrative hurdles and costs. It is further acknowledged in the Forest Report (WSL & Federal Office for the Environment (FOEN), 2025), which recommends that forestry cooperatives merge into larger management units to remain economically viable.

It is added that it would be beneficial for forestry and biodiversity conservation if smaller owners organized themselves into forestry cooperatives; acknowledging our findings, as we saw the importance of professional stimulation for the private owners interviewed.

## 4.5 Limits and insights

*Sample size.* If the interviews helped to construct the diagrams and allowed to identify management specificities proper to different types of ownership; their limited number does not allow for a precise assessment of the importance of the factors evoked. We must keep in mind that the strength of the connections depicted in the diagrams is strongly based on interpretation. With more interviews, the number of occurrences in answers could be used to scale more precisely the connections' strength.

*Categorization choices.* Moreover, categorisation and choices that must be made to construct the diagrams have the effect of simplifying complex phenomena. For instance, conservation measures are limited to the creation of forest reserves and marking of habitat trees, but some conservation measures are conducted by owner without being officially recognized. Public owners often claimed to conduct conservation actions while harvesting. For example, they mention intentionally leaving deadwood in the forest.

*Further steps.* Additionally, with more resources and time, the CLDs could be fine-tuned, and the strength of each element could be more precisely established. Therefore, an additional step would be to meet owners in workshops to present and discuss the diagrams with them. The resulting CLDs could then be the stepping stone for the construction of a system dynamic model.

## 5 Conclusions

To conclude, the CLDs based on the data collected through interviews, allowed us to compare four different types of ownership typical of the Bernese Jura region. It appeared that even if they share similar motivations to manage their forests, the management differs from one to another. It is due to differences in perception of factors, heritages and internal organisation. We will now shortly review the main findings for each type of owners.

*Cantonal forests.* We noted that profitability is a strong driver for relatively intensive harvesting activities. This can be explained the company managing the Domanial forest was created in a context of economic deficit for the Canton. However, the large size and uniformity of the managed forests allow the company to conduct large replanting operations and to create large natural forest reserves.

*Political and citizens' communes.* We discovered that they act quite similarly. The actual management of their forests is delegated to the forestry cooperative they are attached to. Maintenance and production are important motivations for both. But citizens' communes are strongly attached to their heritage, while the social value of the forest is more important to political communes. Another important difference regarding long-term management is linked to the political organization of these communes. Bourgeoisies are more stable; it allows for projects to be conducted over longer periods of time and provides a more continuous long-term vision of the forest. Also, there is a higher chance that people involved are more interested in forestry due to the nature of citizens' communes. While political communes are limited by the nature of the citizen-politician system. The responsible of the forest department may change every four years and the commitment and knowledge of the people in charge may greatly differ.

*Private owners.* It was underlined that they are likewise mainly concerned about climate-driven forest change. But the management of their forest is more opportunistic. This is due to the relatively smaller forest size they own, limiting profitability and increasing the impact of costs. Therefore, exposure to professional guidance is more determining for the forest management of private owners. However, it is important to note that it is the most inconsistent type of ownership. Some may be extremely involved in the management of their forests while others do not even know they own a forest. Their interest can be linked to two elements: The size of the forest and the strength of the heritage attachment they have to it.

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## 8 Appendices

### 8.1 Exploratory interview grid

- 1.** Pour commencer, peux-tu décrire la structure de la propriété forestière de la région ?  
→ Qu'en penses-tu ? Cela présente des avantages ou des défis pour la gestion de la forêt ?
- 2.** En tant que professionnel, as-tu déjà un avis sur la question des probables facteurs qui influencent les choix de gestion des propriétaires concernant la production de bois et la conservation de la biodiversité ?  
→ Ces facteurs sont-ils particuliers à la région du Jura Bernois ?  
→ Y-a-t-il des facteurs qui freinent la production de bois ? Y en a-t-il d'autres qui l'encouragent ?  
→ Quel est la place de la nature, de la biodiversité en forêt pour les propriétaires d'après ton expérience ? Qu'est-ce qui pousse les propriétaires à s'y intéresser ou non dans la gestion de leur forêt ?
- 3.** Dans la région du Jura Bernois, existe-t-il des données sur la production de bois ? Où puis-je les trouver ?
- 4.** Je dois réfléchir à un moyen de « quantifier » la biodiversité pour mon modèle. Existe-t-il un indice qui mesure la biodiversité en forêt ? Où un autre type de donnée qui pourrait être utilisable ?
- 5.** Dans le cadre de mes lectures, j'ai identifié plusieurs "types" de propriétaires. Notamment les catégories décrites dans le rapport sur les propriétaires forestiers de l'office fédérale de l'environnement. Pour déterminer les facteurs qui influencent les décisions de gestion de forêt, j'ai choisi d'interviewer directement plusieurs propriétaires. Mon idée serait d'interviewer :
  - 2 propriétaires privés
  - 2 communes
  - 2 bourgeoisies
  - 1 le canton
  - 2 associations / autres→ Est-ce représentatif de la propriété dans la région ?  
→ Y-a-t-il des acteurs auxquels je n'ai pas pensé ?  
→ Quels autres acteurs "invisibles" sont à l'œuvre dans le monde des propriétaires de forêts (associations, communautés, etc.) ?
- 6.** As-tu des contacts à me partager ? Comment contacter ces personnes ?
- 7.** Je souhaite aussi faire appel aux conseils d'un second professionnel de la branche, un ingénieur forestier par exemple. Chez qui pourrais-je prendre contact ?
- 8.** Pour terminer, si tu avais le pouvoir de changer quelque chose dans la foresterie pour l'améliorer. Que changerais-tu ?

## 8.2 Private owners interview grid

## GRILLE D'ENTRETIEN – PRIVÉ

Numéro d'entretien :

Date de l'entretien :

## Histoire, contexte de la forêt

1. Combien de forêt possédez-vous ?

1.1 Quel superficie ?

2. Cette forêt est-elle importante pour vous ?

Pour quelles raisons ?

Quelle en est l'utilité

2.1 Vous y passez beaucoup de temps ?

Combien en moyenne ?

## Exploitation et biodiversité en forêt

3. Exploitez-vous cette forêt ?

Noter : que comprend l'acteur par "exploiter"

3.1 Pour quelles raisons ?

3.2 Comment se passe l'exploitation de la forêt ? Décrivez le processus.

3.3 Quels sont les facteurs qui vous encouragent à exploiter ?

3.4 Au contraire pouvez-vous penser à des facteurs qui vous décourage à exploiter votre forêt ?

4. Prenez-vous des mesures spécifiques pour favoriser la nature en forêt ?

4.1 Notamment des mesures subventionnées. Par exemple des parties de votre forêt protégées ? Sous contrat d'exploitation ? Ou y-a-t-il des arbres inventoriés (monument ou habitat) ? Ou des lisières revitalisées ?

4.2 Quelle importance ces mesures ont pour vous ?

4.3 Qu'est-ce qui vous motive à prendre ces mesures ?	
4.4 Au contraire qu'est-ce qui vous décourage à mettre en place de telles mesures ? Pourquoi ne pas mettre en place de telles mesures ?	
<b>Réflexion sur la gestion</b>	
5. Comment voyez-vous votre forêt à long terme ? Avez-vous un objectif spécifique ?	
5.1 Comment y parvenez-vous ? Quelles mesures avez-vous prises spécifiquement ?	
6. Avez-vous considéré des changements à apporter dans la gestion de votre forêt ? Lesquelles ?	Note : Demander un exemple concret
6.1 Quand cela s'est produit et qu'est-ce qui était la cause de cette réflexion ?	
7. Qu'est-ce qui vous aide, vous encourage dans la réalisation de ces buts/objectifs ?	
8. Au contraire quels sont les éléments qui vous empêche de les réaliser ?	
<b>Question de conclusion</b>	
9. Imaginons que vous puissiez réaliser l'exploitation parfaite de votre forêt, sans contrainte.	
9.1 Quel serait cette exploitation parfaite à vos yeux ?	
9.2 Quels obstacles devraient disparaître ?	

## 8.3 Public owners interview grid

## GRILLE D'ENTRETIEN – PUBLIC

Numéro d'entretien :

Date de l'entretien :

## Histoire, contexte de la forêt

1. Combien de forêt [acteur public] possède ?	
1.1 Quel superficie ?	
2. Pour quelles raisons cette forêt est importante aux yeux de [acteur public] ?	
2.1 Quelle est l'utilité de cette forêt pour [acteur public] finalement ?	
2.2 Pensez-vous que cette forêt est importante pour le publique ? Pourquoi ?	
2.2.1 À votre avis, quel est l'opinion du public sur ces forêt ?	
2.2.2 Est-ce que cela influence [acteur public] ? De quelle manière ?	

## Exploitation et biodiversité en forêt

3. Est-ce que votre forêt est exploitée ?	Noter : que comprend l'acteur par "exploiter"
3.1 Pour quelles raisons ?	
3.2 [Acteur public] exploite elle-même cette forêt ?	
3.2.1 Pourquoi exploiter/ne pas exploiter soi-même ?	

## Appendices

3.2.2 Quel influence a [acteur public] sur les décisions de gestion de la forêt par l'exploitant actuel ? (Demander exemples concrets)	
3.3 Quels sont les facteurs qui vous encouragent à exploiter ?	
3.4 Au contraire pouvez-vous penser à des facteurs qui vous décourage à exploiter votre forêt ?	
4. Des arbres sont-ils plantés/replanté ?	
4.1 Dans quels cas et de quelle manière ?	
4.2 Quelles essences sont plantés et pour quelle raisons ?	
4.2.1 Y-a-t-il une volonté de favoriser la production de bois dur ou de bois tendre ?	
5. [acteur public] prend des mesures spécifiques pour favoriser la nature en forêt ? <b>Développer avec les questions suivantes.</b>	
5.1 Notamment des mesures subventionnées. Forêt protégée ? Contrat d'exploitation ? Arbres inventorié (monument ou habitat) ? Ou des lisières revitalisées ?	
5.1.1 Quelle importance ces mesures ont pour vous ?	

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5.1.2 Qu'est-ce qui vous motive à prendre ces mesures ?	
5.1.2 Au contraire qu'est-ce qui vous décourage à mettre en place de telles mesures ?	
5.2 Y a-t-il aussi de mesures non-subsventionnées qui sont prises en forêt ?	
5.2.1 Quelle importance ces mesures ont pour vous ?	
5.2.2 Qu'est-ce qui vous motive à prendre ces mesures ?	
5.2.2 Au contraire qu'est-ce qui vous décourage à mettre en place de telles mesures ?	
6. D'autres actions sont faites en dehors de la forêt par [acteur public] pour promouvoir la forêt ?	Noter si ces actions promeuvent le bois ou la nature en forêt.
<b>Réflexion sur la gestion</b>	
7. Quelle est la vision à long terme de [acteur public] pour sa forêt ? Avez-vous un objectif spécifique ?	
7.1 Comment y parvenez-vous ? Quelles mesures avez-vous prises spécifiquement ?	
7.2 Avez-vous considéré des changements à apporter dans la gestion de votre forêt ? Lesquelles ?	Note : Demander un exemple concret

7.2.1 Quand cela s'est produit et qu'est-ce qui était la cause de cette réflexion ?	
7.3 Qu'est-ce qui vous aide, vous encourage dans la réalisation de ces buts/objectifs ?	
7.4 Au contraire quels sont les éléments qui vous empêche de les réaliser ?	

**Question de conclusion**

8. Imaginons que vous puissiez réaliser l'exploitation parfaite de votre forêt, sans contrainte.	
8.1 Quel serait cette exploitation parfaite à vos yeux ?	
8.2 Quels obstacles devraient disparaître ?	

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