# Creating the landscape, one stand at a time

The role of timber buyers in landscape-level planning in southern Sweden

*Keeli Jo Curtis*

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**LUCSUS**
Lund University Centre for Sustainability Studies


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Supervisor: Sara Brogaard, LUCSUS, Lund University

## Abstract

A central tension within forestry is balancing timber production and nature. This tradeoff is important when managing individual stands, but also has effects on biodiversity across spatial and temporal scales. In Sweden, private landowners are officially responsible for forest management, and these decisions are mostly taken at the property or stand level. While ecologists increasingly try to encourage conservation planning at the landscape level, practically, biodiversity is 'conserved' with even smaller retention areas within individual properties. By managing forests and subsequently biodiversity at lower spatial levels, largely without regard to surrounding forest properties, the landscape can be degraded through 'the tyranny of small decisions.'

Existing research on forest management focuses on characteristics of landowners, but they do not make management decisions alone. An unexplored factor is the influence of timber buyers on those management decisions. Timber buyers (TBs) are important because they are directly involved in planning and management over long time periods in a given area. In this thesis, I ask, what are the roles of TBs? How do their decisions at the stand level impact the landscape level? How do their spatial competence and technical capabilities relate to other actors, and what does that mean for policy?

To understand their role, I conducted semi-structured interviews with TBs, asking primarily about the data they use, relationships with landowners, and their perception of the forests they work in. With a qualitative content analysis, I first describe their role, then interpret how it relates to the creation of the landscape and effects on biodiversity. I see potential to position TBs as critical leverage points in the implementation of coordinated forest management that creates a diverse, multi-functional landscape.

I use Hägerstrand's nested domains as a conceptual framework to illustrate the spatial competence and technical capabilities of TBs, especially in relation to forest owners and the Swedish Forest Agency. Results suggest that TBs have access to extensive data, but primarily use information about the property level. TBs have greater spatial competence and technical capabilities than landowners, but lack incentives to actively apply a landscape perspective. However, TBs have contributed to successes in forest management in recent years, and they build long-term, trusted relationships with landowners. These characteristics of TBs could be a starting point for conversations about future forest management which contributes to timber production, climate change mitigation, and conservation of biodiversity at the landscape level.

**Keywords:** landscape, forestry, biodiversity, cross-scale interactions, Hägerstrand, conservation

**Word count: 11,960**

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## Preface

I have worked many seasons doing forest inventory myself, but now I find myself questioning, at a deep level, what really counts when evaluating forests. I am not the only one who feels confused- every person I talked to throughout this thesis genuinely loves the forest. However, as climate change looms and we overshoot many of the planetary boundaries, including of course huge losses in biodiversity, the forest industry must find new ways to reconcile increasingly heavy tradeoffs.

Starting in July 2020, standards for FSC certification will change, which will hopefully have positive impacts for conservation in Sweden. Either way, this recent decision by FSC to change their rules makes this thesis much more timely than expected, since timber companies will have to adjust their methods in order to continue benefitting from the new guidelines.

**Abbreviations**

**ES:** Ecosystem services

**FMP:** Forest management plan

**FOT:** Forest owner typology

**PFO:** Private forest owners

**SFA:** Swedish Forest Agency, *Skogsstyrelsen*

**TB:** Timber buyer

**Glossary of select forestry terms**

**Certification**: market-based standards for forest products starting with standards for forest management at the stand level

**Even-age:** forest management strategies where whole stands are uniformly aged, meaning they are regenerated and harvested

**Property:** the total forested land owned by a landowner

**Retention**: groups of or single trees in a stand that are not harvested for conservation and regeneration purposes

**Stand**: a relatively small, uniform forest area within a property where a single management step applies

**Timber buyer:** also referred to as forest inspector, officer, or advisor; updates and facilitates forest management for forest owners

# 1 Introduction

Tradeoffs between nature and production are at the core of forestry. Forest managers globally must handle the increasingly urgent tension between managing forests production of timber and pulp, climate change mitigation, and diverse, climate-adapted forests (Felton et al., 2019). Biodiversity is decreasing rapidly across the world (Rockström et al, 2009), but management strategies suggested for meeting climate change mitigation and even production-oriented 'forest resilience' can be directly at odds with biodiversity goals (Newton, 2016). In Sweden, fragmentation is a primary threat to biodiversity, which is linked to intensive forestry practices in many parts of the country (Gustafsson et al., 2015; Felton et al., 2019). However, forestry is an essential driver of the Swedish economy, employing up to 12% of the Swedish workforce, and forests and forestry are culturally important to Swedes in and beyond those employed in the sector (KSLA, 2015). Even with less than 1% of the planet's forest area, Sweden manages to be the third largest exporter of timber products in the world (KSLA, 2015). However, cross-scale impacts of intensive forest management (Felton et al., 2019) suggest the need to rethink strategies in southern Sweden.

The type, location, and scale of forest management affects biodiversity and other ecosystem services (ES). A primary actor planning forest management is the timber buyer (TB), employed by private timber companies. Sweden is well-known for its even-aged forestry practices (Felton et al., 2010), which means largely using clearcut systems and accounting for biodiversity and other ES primarily with retention areas (Gustafsson et al., 2020). Retention means some trees or patches are left behind, or conserved, in a harvested stand (Gustafsson et al., 2020).

However, as ecological research increasingly addresses biodiversity and forests at the landscape level (Mori et al., 2017), researchers emphasize tradeoffs even between conservation goals. Most biodiversity goals in Sweden focus on protecting individual species separately (Felton et al., 2019), but these efforts can contradict strategies to protect diversity at a higher level, and make it harder to coordinate conservation across large areas. This is especially problematic in southern Sweden, the most diverse region (Gustafsson et al., 2015). To plan for biodiversity at the landscape level, many ecologists call for diverse actors to coordinate across private land ownership and land use types (Felton et al., 2019). Practically implementing planning for biodiversity at a landscape level, however, is complicated, not least because there is disagreement about what 'the landscape' is referring to (Henderson, 2003; Mitchell, 2005).

Since biodiversity in Swedish forests is mostly managed through retention areas, and TBs are involved in deciding their location and extent, it is important to understand TBs' role in forest management. A research gap exists, as TBs are mentioned in forest owner research, but few studies (Kindstrand et al., 2008) focus specifically on TBs or their decision-making. I investigate TBs through their own perspective, and how the effects of their small-scale decisions build up to effects on the biodiversity on the landscape level. I approach this problem with a focus on the cross-scale interactions (Cash et al., 2006), and use Hägerstrand's (2001) nested domains to position TBs in relation to other actors and ecological processes. I ask:

**RQ1:** How do TBs perceive and describe their role?

**RQ2:** How do TBs' stand-level decisions result in landscape-level impacts?

**RQ3:** How do TBs' spatial competence and technical capabilities relate to other actors, and what are the implications for policy?

### *Navigating this thesis*

Chapter 2 provides background on forestry, governance, biodiversity, and actors in southern Sweden. Chapter 3 outlines my theoretical approach. Chapter 4 describes my methods of data collection and analysis. I share my results in Chapter 5, focusing on RQ1. In Chapter 6 I discuss the results as they relate to other literature and sustainability science, answering RQs2 and 3. Chapter 7 summarizes the main points and their relevance for future forest planning.

# 2 Forestry background

Here I briefly describe forestry practices in Southern Sweden and forestry governance and explain how these relate to biodiversity at the landscape level. I then introduce the main actors, including forest owners, authorities, and the forest industry to contextualize TBs.

## 2.1 Dominant forestry practices in southern Sweden

In southern Sweden, forest biomes are temperate and hemi-boreal, and these forests are much more diverse than boreal forests of the north (Gustafsson et al., 2015). Ask & Carlsson (2000) write that over the last century, Swedish forests, especially in the south, have "transformed" in terms of species cover and structure (p.209). Starting in the 1920s, shifts in agricultural and grazing practices contributed to spruce (*Picea abies*) more successfully regenerating across much of southern Sweden, and intensive spruce forestry became widespread in the 1950s due to industrial initiatives (Lindbladh et al. 2014). Most policies, industrial goals, and research remain oriented around spruce monocultures (Felton et al., 2016) (Figure1). As intensive industrial practices like even-aged management became more widespread, previously structurally-diverse forests decreased across the region (Lindbladh et al., 2014). One effect of intensive forestry is the increase in forest density, which is how Sweden is able to produce so much timber in a relatively small area (KSLA, 2015). This combination of "simplified tree species composition… and increased forest density" is linked to reductions in biodiversity (Hedwall & Mikusinski, 2016, p.372). These factors are interconnected and generally related to decreases in biodiversity of the stand, and the wider surroundings (Felton et al., 2019), resulting in extensive fragmentation "with relatively low proportions of habitat types important for many species" (Ask & Carlsson, 2000, p.209). Habitat fragmentation is a global issue that threatens biodiversity and other ES (Haddad et al., 2015), especially relevant at the landscape level (Mori et al., 2017) (Figure2).

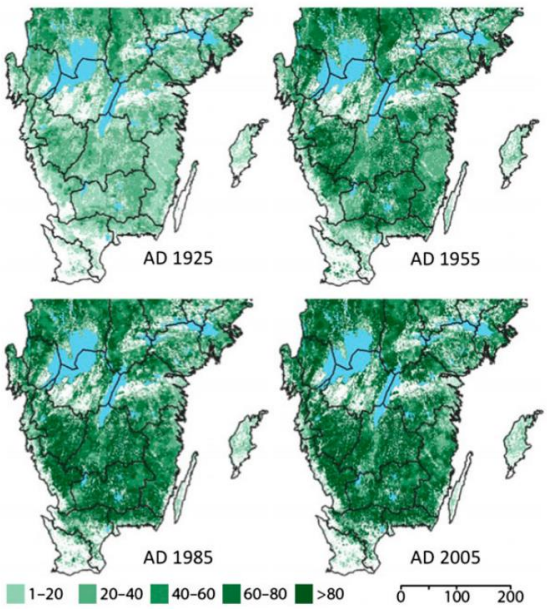


**Figure 1. Spruce Density Map.** This shows the increased density of spruce forests in southern Sweden, the colors show the density of spruce volume per hectare. Although spruce is native to Sweden and has been a part of the forest for thousands of years, this map shows how spruce has 'taken over' the landscape through the decades as the dominant species, which is largely a result of intensively managed production forests that manage for high-density, usually single-species stands (Figure from Lindbladh et al., 2014, p.689).

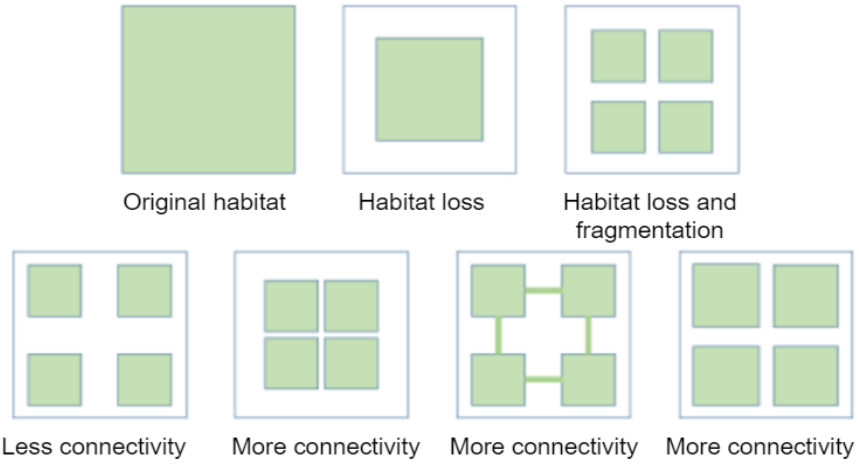


**Figure 2. Fragmentation**. This shows a simplified explanation of fragmentation. Thordarson (2019) writes the size and quality of habitats are important for species richness and population size, so across a fragmented landscape, the density of habitats is meaningful for connectivity and therefore species survival. Fragmentation is important to keep in mind as it applies to the scale of forestry management and retention areas. Retention areas or trees are 'left behind' during harvest to attempt to accommodate habitat requirements of some species and contribute to other ES (Gustafsson et al., 2020), but these are often separated from each other, which contributes to fragmentation. Some retention areas are based on specific habitat types, from single trees to unique ecosystems, or around legally-protected features like streams (Gustafsson et al., 2020), but otherwise they can be areas that are hard for harvesters to reach anyways. (Figure adapted from Thorardson, 2019).

## 2.2 Forest Governance

To begin, I introduce some policies in Swedish forestry and their implications and limitations in regard to biodiversity conservation.

### *2.2.1 The Forestry Act & certification*

Sweden passed the Forestry Act in 1993, which officially gave environmental and industry goals equal weight, and "enforcement softened" (Guillen et al., 2015, p.23). Hoogstra-Klein et al. (2017) explain how the Forestry Act massively deregulated forestry, with few "sharp quantitative thresholds on silvicultural or environmental targets" (p.255). A core element of the Forestry Act is the concept of 'freedom with responsibility,' giving the forest owner great freedom to develop your forest after your own goals (SFA, 2017). The intention was that fewer regulations would allow private forest owners (*PFOs* from now on) to make a wider range of choices in forest management, so that diversity of decisions would result in diverse forests (Felton et al., 2019).

Skogsstyrelsen (SFA) is the primary forest authority in Sweden. SFA is mandated to ensure forest management is follows the Forestry Act, through contributing to sustainable growth and development of the growing bioeconomy (SFA, n.d.). There is also an element of sectoral responsibility, so the industry must contribute to meeting some goals set by the Forestry Act (SFA, 2017). The Act requires SFA and private actors to communicate but does not provide many prescriptive rules or direct support (Hoogstra-Klein et al., 2017), and instead of strict mandates, "relies on soft policy instruments," through providing information and advice (Felton et al., 2019, p.3).

This 'soft' governance and sectoral responsibility trusts the market to conserve biodiversity and other ES, largely through forest certification. Certification is welcomed by industry because products earn a substantial marginal price, through setting standards for forest management at the stand level (Schlycter et al., 2009) (Figure3). With certification, the total conserved forest area has increased greatly across Sweden (Gustafsson et al., 2020). However, concerns about fragmentation linger, since "certification has not halted forest degradation in that it has not improved any of the environmental outcomes" (Villalobos et al., 2018, p.1).

**Figure 3. Certification.** This is an image of a retention area in a clearcut, including a small tree group that was left behind for conservation. Forest certification is widespread, within and beyond Sweden, with two main schemes, FSC and PEFC, setting standards for processes and products along the supply chain (Schlycter et al., 2009). For the purposes of this thesis they are very similar. Approximately half of Sweden's production forests use one or both schemes (Villalobos et al, 2018). However, current guidelines require retaining 5% productive forest area on each property (Hoogstra-Klein et al., 2017), which Felton et al. (2019) emphasize is "the smallest scale of conservation" (p.3). Although the industrial actors proudly use certification as a minimum requirement, "in functional terms the demands of the standards are largely arbitrary and can be seen as based on ecological common sense rather than detailed knowledge of ecological demands of different biota" (Schlycter et al., 2009, p.377). Since certification does not correspond to specific habitat requirements in Sweden, it is still contributing to degradation of the forest (Villalobos et al., 2018). (Own photo, taken 4 May 2020 in Kiaby, Sweden).

### *2.2.2 Landscape-level biodiversity*

Hoogstra-Klein et al. (2017) describe that Sweden applies the concept of multiple-use forestry across all forests as one way to achieve the dual goals of production and environment. However, production forests are typically associated with a great ability to maximize a single resource type (Newton, 2016), and biodiversity is often negatively impacted by this (Felton et al., 2016). So, although all forests are officially multiple-use, uses like recreation are easier to couple with production, than biodiversity and some other ES. Further, in many places including Sweden, biodiversity conservation aims to primarily target 'hotspots' or 'key ecoregions' based on the presence of certain species, which often influences where official nature reserves are located (Naturvårdsverket, 2020). On privately owned land, however, the most straightforward way to achieve both timber production and environmental quality is setting some

productive land aside for conservation in retention areas (Gustafsson et al., 2020). This means that conservation and production goals are spatially separated.

Maintaining biodiversity is achieved with "different strategies on multiple spatial scales" (Hoogstra-Klein et al., 2017, p.253). Felton et al. (2019) explain the main point of multi-scale conservation: "since species vary in the spatial scale of their habitat requirements, and capacity to persist in non-protected areas, when used in combination, protected and non-protected areas should more efficiently sustain viable populations of species" (p.2). This means privately-owned land must contribute to conservation, but there are ongoing debates about how well environmental impacts and tradeoffs across scales are balanced in Sweden (SFA, 2017), since not all actors see changes in forest composition as problematic. A main example is how ecologists and industrial actors perceive the amount of birch in production forests: birch regeneration is seen as too low by ecologists and too high by industry actors (Felton et al., 2019). This debate also applies to certification (Villalobos et al., 2018). Some ecologists are critical of perceived successes of certification's total area because they argue *where* biodiversity is conserved in the landscape makes a difference (Gustafsson et al., 2015). Far less relative forest area is protected in southern Sweden, although more species and habitats are at stake there (Gustafsson et al., 2015). So, while the amount of both formally and voluntarily preserved forestland has increased across Sweden, including retention areas (Gustafsson et al., 2020) this issue of fragmentation is problematic at the *landscape* level (Haddad et al., 2015).

Gustafsson et al. (2015) suggests Sweden needs "conservation policy interventions to rectify forest ecosystem degradation and associated species loss" (p.51). Forest regulations are generally soft, and either too broad, primarily at the national level; or too narrow, meaning conservation opportunities in productive forests are limited to fragmented, small retention areas. Götmark et al. (2009) found that although soft policy, including education and advice, has improved conservation of some existing forest elements, like older broadleaved trees, these policies have not been effective for establishing new diverse forests. This would be necessary for addressing existing fragmentation of some habitats. Further, management and monitoring for diversity is only conceptualized practically at the lowest spatial levels (Angelstam & Dönz-Breuss, 2004). Acknowledging tradeoffs across spatial levels reveals contradictions and knowledge gaps about impacts of certain types and levels of forest management (Felton et al., 2019). This division puts additional pressure on the classic forestry tradeoff between production and nature. Landscape-level planning is important because the production forest 'matrix' affects biodiversity and ecological processes at a larger scale than the level at which individual forest stands are managed (Felton

et al., 2019). This means that to meet biodiversity targets at the landscape level, planning must be done at the landscape level, because the priorities are different if only small stands are in focus.

'Green infrastructure' has been increasingly discussed in Sweden and is the only tangible attempt at incorporating a landscape perspective in regional planning (SLU, 2018), organized around ES. Regional maps are designed to provide information about where valuable ecosystems are spread out across in order to improve planning for all actors (Naturvårdsverket, 2019b) (Figure4). There are regional strategies for sustainable development and for the forest industry, which include regional priorities for forestry (Andersson et al., 2013b). However, according to an informant from SFA's Policy Unit, green infrastructure, while full of valuable information, are currently "totally separate and parallel" to regional strategies, not programs integrated into planning (personal communication, 29 Jan 2020).

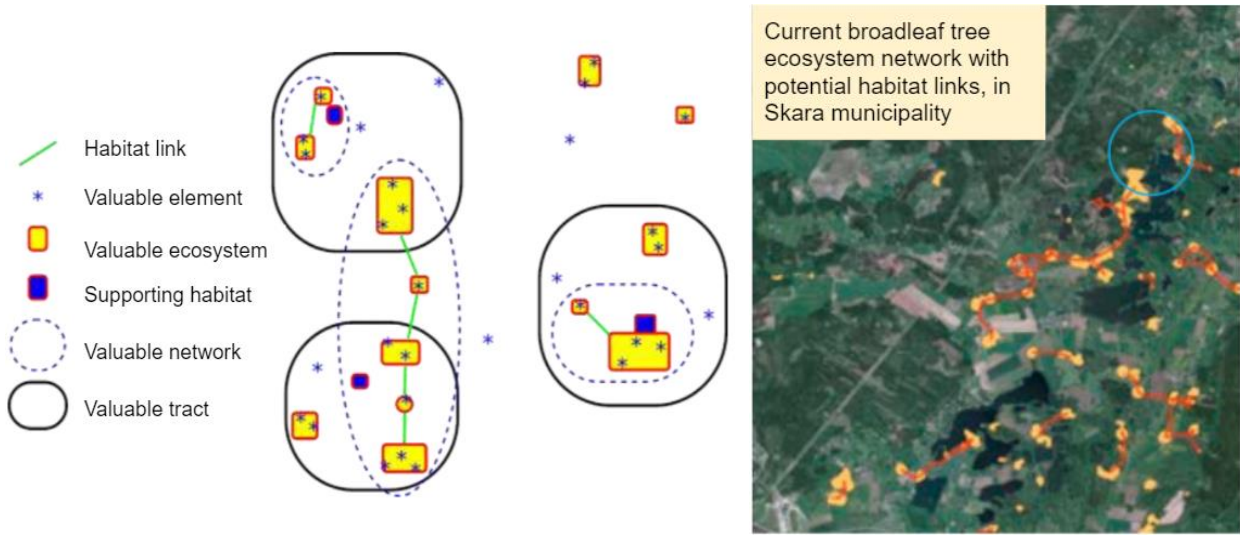


**Figure 4. Green Infrastructure.** Green infrastructure's goal is identifying and connecting high value ecosystems across regions. The sketch shows how fragmented, valuable habitats could be linked through developing habitat corridors, to avoid or remedy fragmentation. The aerial photo shows a real, however, each habitat and land between them could be owned by different landowners, which makes coordination difficult. Naturvårdsverket (2019a) writes that production forests can contribute to building green infrastructure, but there is no requirement for how industry should do so. Green infrastructure has no 'program' and this data remains only as visualizations (Andersson et al., 2013a) (Left adapted from Thorardson, 2019) (Right adapted from Thordarson, 2016).

## 2.3 Relevant actors

Before getting to TBs specifically, I introduce PFOs, authorities, and other industrial actors, since their interactions are key to understanding TBs' unique position. Figure5 illustrates a simplified overview of actors involved in this study.

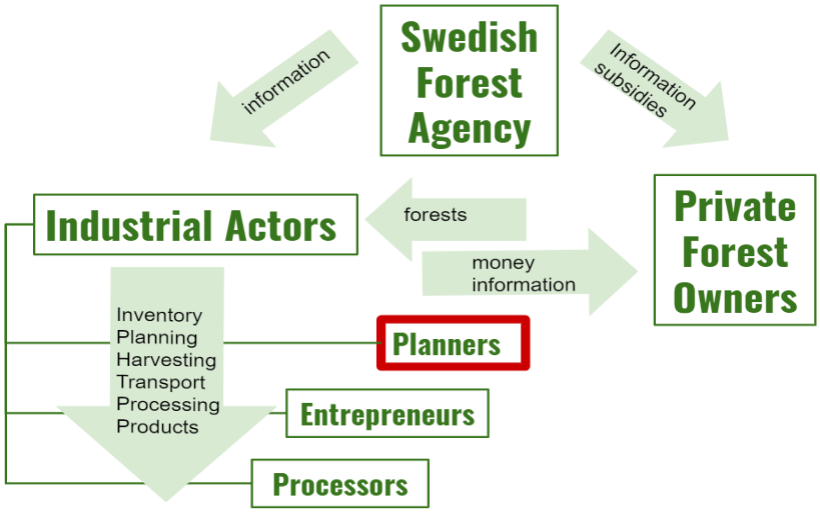


**Figure 5. Actors.** Based on informant interviews, I organized the main actors into landowners, authorities and industry. Industrial actors are divided into planners, entrepreneurs, and processors. SFA providing information and advice to both groups of actors and approves harvests, subsidies, and some other reporting (SFA, n.d.). At the most basic level, planners decide how forests can be managed to provide maximum products and regenerate after harvests, which requires field inventories to measure the state of standing forests and prescribing physical management actions. Entrepreneurs are third-party companies who carry out physical management and logistics. Processors are mills that turn timber into finished products. TBs are a primary actor in the 'planner' group. The companies in my study do not own their own land, so processors rely on planners to manage PFOs' forests to supply timber. PFOs are often members of forest owner associations (FOAs). (Own illustration).

### *2.3.1 Private forest owners*

Land ownership patterns in southern Sweden aggravate the complicated nature of this landscape-level coordination since there are thousands of small landowners (Felton et al., 2019; Eggers et al., 2014). Southern Sweden is more densely populated than the north, has much smaller average land holdings, and is characterized by a 'mosaic' of towns, farms, and forests (Eggers et al., 2014). Most existing research about forest management and priorities in Sweden focuses on PFO characteristics, but since PFOs are often not making forest management decisions alone, and are limited in their ability to carry out management steps themselves (Eggers et al., 2014), information on TBs is often filtered through literature about PFOs.

Various forest owner typologies (FOTs) attempt to categorize PFO decision-making. Eggers et al. (2014) write that "importance of income from the forest, membership in a forest owners' association, certification and an interest in and knowledge of forestry issues" (p.1) are related to forest management. The amount of land owned, however, is the most influential factor, because it relates closely to dependence on forestry income (Eggers et al., 2014). Even though most PFOs earn some income from

their forests, generally PFOs have multiple goals for their land besides only income (Ingemarson et al., 2006; Eriksson, 2016)[1]. Actualizing any forest management goals depends on industrial actors.

### *2.3.2 Interacting with industry*

52,000 PFOs are members of the largest Swedish forest owner association (FOA), Södra Skogsägarna, a democratically-run organization representing 36 regions of southern Sweden (Södra, 2020). Södra is also a timber company, with hundreds of employees including 'planners,' who manage forests, and 'processors,' with large-scale mills (Figure5). I see TBs as a critical part of the "planners," because the process of buying timber is an inherent step in forest management (Brukas & Sallnäs, 2012). Brukas & Sallnäs (2012) emphasize the importance of long-term forest management plans (FMPs) for individual properties, written by forest advisors, usually a step above TBs.

Research about social capital in southern Sweden examines relationships between PFOs, industry, and authorities. Throughout the forest management process, there are multiple social meetings between owners and TBs to update the plans and prepare next steps (Guillen et al., 2015). SFA also offers FMP services, but FOAs can offer significantly discounted prices on FMPs (Brukas & Sallnäs, 2012). 84% of PFOs in the south outsource at least some forestry activities, and 71% have sought out forest advice at least once (Eggers et al., 2014). Especially since 1993, SFA's official responsibilities have been reduced to mostly providing information and subsidies, now the industry gives relatively more advice to PFOs (Guillen et al., 2015).

As of 2015, Södra was considered by PFOs to have primarily industrially-focused priorities, but its members remain loyal, especially after the 2005 disaster Gudrun (Guillen et al., 2015). The storm strengthened relationships between PFOs and Södra, since the FOA guaranteed prices for salvage wood[2] (Lodin et al., 2017). This 'good news' tends to be passed on through TBs (Lodin et al., 2017), since TBs are largely seen as the friendly face of timber companies (Guillen et al., 2015). Even with extensive research on PFOs, there is much to learn about priorities and processes in forest management from other

[1] Numbers differ due to differences in study areas, times, and definitions of goals and even definitions of forest owners. Ingemarsson et al. (2006) found that approximately ⅓ have 'multiple' or 'conservation' goals, but other studies suggest current numbers are higher (Eggers et al., 2014).

[2] fallen or damaged timber, much lower quality than 'healthy' timber

perspectives. My study explores forestry through the perspective of TBs, who have a professional industrial duty to both bring in volume and give forest management advice (Lodin et al., 2017) (Figure6).

**Figure 6. Overview of TBs.** For privacy reasons, I do not include a picture of any timber buyers, so this picture is just an example of timber that has been 'bought,' harvested, and is waiting to be transported to the mill. Depending on the company they work for, timber buyers can be referred to as simply buyers, forest inspectors, forest officers, or forest advisors. I use TB to simplify this because no matter what they are called, buying timber is at the center of their work, and because it the forest office and advisor titles are also sometimes applied to SFA employees. Typically, TBs work with 'the whole chain' from starting conversations with landowners to the final harvest (Sydved, n.d.). TBs decide on a wide range of management decisions, and a key element is marking boundaries between stands and for forest roads, using increasingly more advanced technology (Södra, 2018). Many TBs say the best part of the job is meeting with the landowner, (Södra, 2018). (Own photo, taken 9 May 2020 near Rickarum, Sweden).

# 3 Theoretical background

I explore TBs' roles with blended sustainability science approaches. I begin with some aspects of political ecology, then explore the complexity of cross-scale interactions, primarily using Hägerstrand's nested domains to understand how TBs relate to landscape processes and fragmentation.

## 3.1 Creation of the landscape

Political ecology often deals with narratives of degradation, through how economic and political conditions lead to unsustainable practices and changes to environmental conditions (Robbins, 2012). My understanding of landscape creation comes from the production of nature through socially-constructed framings of what the forest is and should be (Robbins, 2012). Production systems like forestry require framing natural resources in 'market-friendly' terms (Boyd et al., 2001; Robertson, 2006), and this framing results in material changes on the physical landscape. Expecting consistent outputs of ES from natural systems leads to degrading effects over time, where the production system eventually undermines itself (Robbins, 2012). Since focusing on only timber production has impacts on other ES' functioning across multiple scales, but timber production requires the other ES to function properly, it could lead to reduced timber output in the long-term without additional inputs (Rist et al., 2014; Newton, 2016).

### *3.1.1 Simplifying natural systems*

Production ecosystems are designed to maximize specific ES, like timber, but this output requires other ES to function as well (Rist et al., 2014). Defining ecosystems depends on how the 'natural' qualities can be defined in social or economic terms, "in the logic of capital" (Robertson, 2006, p369). The ES concept attempts to capture the wide range of benefits nature provides, from provisioning, regulating, supporting, and cultural services (Mori et al., 2017). However, even ES are defined so that ecosystems can be quantified and compared by function (Thorén & Stålhammar, 2018; Robertson, 2006). To evaluate value, particularly economic value of ecosystems, they must be simplified to be quantified (Robertson, 2006), commodified (Castree, 2003) and controlled (Boyd et al., 2001). However, this means their natural complexity cannot be captured, and some important system elements can go unnoticed over time, like fragmentation, or create externalities that show up elsewhere (Rist et al., 2014). Production ecosystems can be seen as held in 'coerced resilience,' since production forests would not have the same function without human interference (Rist et al., 2014).

### *3.1.2 Tyranny & tragedy*

As described, PFOs have freedom to decide on individual goals for their forests. Odum (1982) explains that the sum of many small decisions can add up to unexpected, often negative effects at a higher level, applying economist Kahn's concept of "the tyranny of small decisions" to environmental issues. Choices made with one priority or spatial level in mind, might unintentionally disregard other considerations like ES that are important at other scales (Odum, 1982). This is analogous to Hardin's application of the 'tragedy of the commons' to environmental issues (1968), since each actor's 'selfish' decision can end up in an arguably degraded, less diverse landscape (Hedwall & Mikusinski, 2016). I see landscape-level biodiversity as a form of the commons, but biodiversity, or lack thereof, is largely seen as an externality of forest management, instead of a prerequisite to productive forests (Newton, 2016). The main contrast to the commons is that landscape-level biodiversity is not seen as a *resource*, so it is not commodified in the same way timber can be (Castree, 2003). Further, biodiversity in this system is managed across the landscape by PFOs separately, which makes the 'tyranny' a better fit in some ways. Either way, no single actor can effectively address fragmentation without looking up to landscape-level priorities.

## 3.2 Cross-level interactions

Considering social and ecological interactions across multiple scales is a fundamental aspect of sustainability science (Cash et al., 2006). Multi-faceted social-ecological issues cannot be fixed nor governed simply, and there are various tradeoffs and synergies between processes at different levels (Hägerstrand, 2001). While Hägerstrand writes that the highest levels should coordinate the sectors and issues at each level (2001), Gustafsson et al. (2015) write, coordination, or appropriate boundaries for managing ecological units are lacking in Sweden. Without clear goals or rules for landscape priorities, the "tyranny of small decisions" can arise without individuals recognizing a problem at all, because implications for ES at other scales are 'masked' by the ongoing productivity of forests at the stand level (Rist et al., 2014). This means ecosystems 'underneath' the socially-defined property boundaries are affected by choices we make according to social boundaries, which might not coincide with the 'natural' boundaries (Hägerstrand, 2001). It can be complicated to draw the line between the "natural" and social processes, because they are interacting in endless and complicated ways (Hägerstrand, 2001). Without ecologically-meaningful plans, natural gradients in environmental conditions are sharply, and essentially randomly, divided by social boundaries, with degrading effects for the landscape.

Hägerstrand (2001) writes that managing ecosystems depends on not only understanding these cross-scale interactions, but also "how abstract knowledge can be turned into action on the ground" (p. 36). I later discuss potential leverage points in this process (Meadows, 2009), and the importance of boundary agents, who can move between sectors and levels to translate information and priorities appropriately (Cash et al., 2003).

### *3.2.1 Nested domains*

To explore discrepancies between managing production forests and other ecological processes, I use Hägerstrand's nested domains as a conceptual framework. Dividing land between owners is a fundamentally basic part of how society interacts with and uses land (Hägerstrand, 2001). These divisions last centuries, and within these socially-defined boundaries, certain actors are responsible for decisions regarding that "domain" (Hägerstrand, 2001). This is the basis for private property. Hägerstrand (2001) referred to this territorial, or *spatial competence*, a "combination of freedom and limitation" (p.38) of an actor to change or act upon a spatial area within that actor's domain. Each PFO is responsible for forest management decisions, and their private property is their domain. By dividing up land for use in our social systems, social boundaries are "placed directly upon" (p.38) natural processes happening on that land, and then the social divisions can further result in changes to those natural processes within those social boundaries (Hägerstrand, 2001)

Decisions in society are made by different actors at various levels, and decisions made at the top, often the highest level of government, affect those that can be made below (Odum, 1982), down to individual landowners. There can be great distances, literally and figuratively, between actors in charge of planning and actors tasked with on-the-ground environmental management, and these actors can have different interpretations of goals and priorities (Hägerstrand, 2001). Each governance level has increasingly strict or specific constraints, which can be divided into different sectors, "each with its own limited pocket of responsibility, each staffed by professionals with scientific or technical expertise," (Hägerstrand, 2001, p.39). The spatial areas are "nested," so authorities at higher levels have oversight over the most land, but each parcel is subsequently subjected to increasing levels of governance (Hägerstrand, 2001) (Figure7). However, rules from various levels and sectors are not always straightforward or clearly explained, leaving lower levels to interpret how and to what degree rules are followed and enforced (Hägerstrand, 2001).

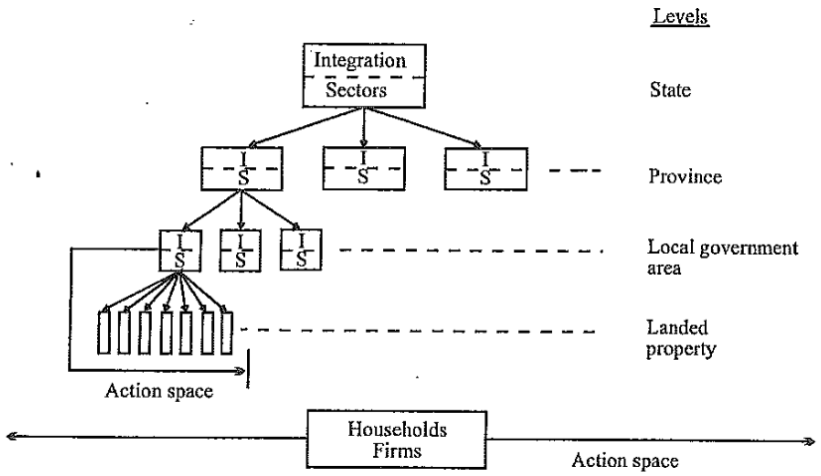


**Figure 7. Nested Domains.** Hägerstrand's simple diagram is densely packed with information. This shows there is a range of spatial and administrative levels that are divided into sectors. For example, national forestry regulations are made in central policy offices, but forest management decisions are made on-site. Some governance is driven by SFA, while some comes from the Environmental Agency or County Board. Private actors also play a role in governance, especially industrial companies that plan forest management and process forest products. The domains reach down to individual landowners at the lowest level. The groups and individuals at each level have their own priorities and knowledge, which might not always cover all the 'necessary' information or accommodate priorities of other levels or sectors. This highlights the 'fixed reach' between levels and sectors. Since divisions of responsibility are not always neatly explained or clearly defined, problems can arise when some planning is done at lower levels versus higher up. (Figure from Hägerstrand, 2001).

Hägerstrand writes 'relations between policy- and decision makers having spatial competence with various fixed reaches, and the actors in the landscape endowed with territorial competence and mobility" (p.41). This 'fixed reach' of governance between levels and sectors, and between authorities and PFOs, is fundamental for understanding TBs' role in the larger system. At the core of nested domains, Hägerstrand favors understanding human action in relation to environmental processes through "...try[ing] to identify constraints of various kinds which define the limits of the potential choices of the actor" (Hägerstrand, 2001, p.37). Hägerstrand considers both technological and legal constraints, which he defines as "1) actors' territorial and spatial competence, and 2) actors' technical capability" (Hägerstrand, 2001, p.37).

I use nested domains to explore TBs' roles and what 'constrains' their decisions. I then examine how their decisions at the lowest spatial levels are linked to effects on landscape. I apply Hägerstrand's terms to understand TBs' roles in forestry decision-making. To rephrase my RQs, I ask, first of all, what do TBs do? How does their role link to changes at the landscape level? And, what are TBs' spatial competence and technical capabilities in relation to other actors, and why is that important for policy?

# 4 Methods

I focus on southern Sweden because the land ownership and ecosystems create unique challenges for landscape governance. I met with academic and government informants early in the research process to discuss relevant issues (Figure8). I limited my scope to large companies that buy from relatively high numbers of PFOs, since I assumed they had more potential for applying a landscape perspective. This perception was supported by informants from SLU and Skogsstyrelsen. Also, I limited the scope to TBs whose clients are primarily small-scale, non-industrial PFOs, since they are the majority in southern Sweden (Eggers et al., 2014). Limited by practicalities of time and access, TBs in this research were only Skåne and Småland, from two companies, Södra and Sydved, and how they relate to PFOs and SFA.

| FALL 2019 & JAN 2020 | FEB 2020 | MAR 2020 |
|---|---|---|
| Initial informants | Industry informants & TB interviews | |
| Attended SFA's hardwood forestry event in Höör (Sept 21), met 4 SFA Skåne representatives (early Nov), who led me to 1 SFA policy representative (Jan)<br><br>Met 3 SLU forest ecology researchers (Nov, Dec, Jan), who led me to 3 SLU forest policy researchers (Nov, Dec) | Went to Småland's forestry and wood industry strategy day in Viserum (Feb 4), met<br>1 LRF project leader<br>1 Södra policy representative<br>2 Södra landowner representatives<br><br>Event & SLU forest ecologists led to<br>1 Södra hardwood forestry expert<br>1 Södra ecologist<br><br>Södra contacts led me to<br>**Södra 1A TB interviews Feb 24** | Södra and event contacts led to<br>**Södra 1B half day meeting and TB interviews March 2**<br><br>**Sydved 2A TB interviews March 5** |

**Figure 8. Timeline.** The initial contacts at SLU are authors on many of the early papers I read about forestry and ecology, leading up to deciding on my final topic, since they were interested in how industrial actors consider some of the ecological issues they study. These researchers encouraged me to attend events and contact as many as possible in SFA and at the companies. Based on advice from academic and government informants plus my early research, I went to the event in Småland, ready for purposive sampling. The private sector informants, many associated with Company 1, put me put me in contact with TBs who were ultimately the focus of this study. Field notes were taken at all events and informant interviews, and interviews on or after 24 Feb were recorded. I attended a half-day meeting at Office 1B where all TBs were present in addition to the one-on-one interviews.

## 4.1 Sampling

In February 2020 I attended Småland's Regional Forestry and Wood Industry Strategy Day to meet potential participants in my study. Småland is a heavily forested region where many industrial actors and SFA have their head offices, so I knew relevant stakeholders would be present. I started my sampling

purposively at that event, and those contacts in turn shared names of further individuals to meet, and so on, so my informants and TBs were found through this snowballing technique. Snowballing was necessary because Södra alone employs over 200 TBs spread out across 19 work areas (Södra, 2020), and it can be difficult to find individual TBs' contact information without asking another employee of the company. I ultimately interviewed nine TBs from two companies (Figure9).

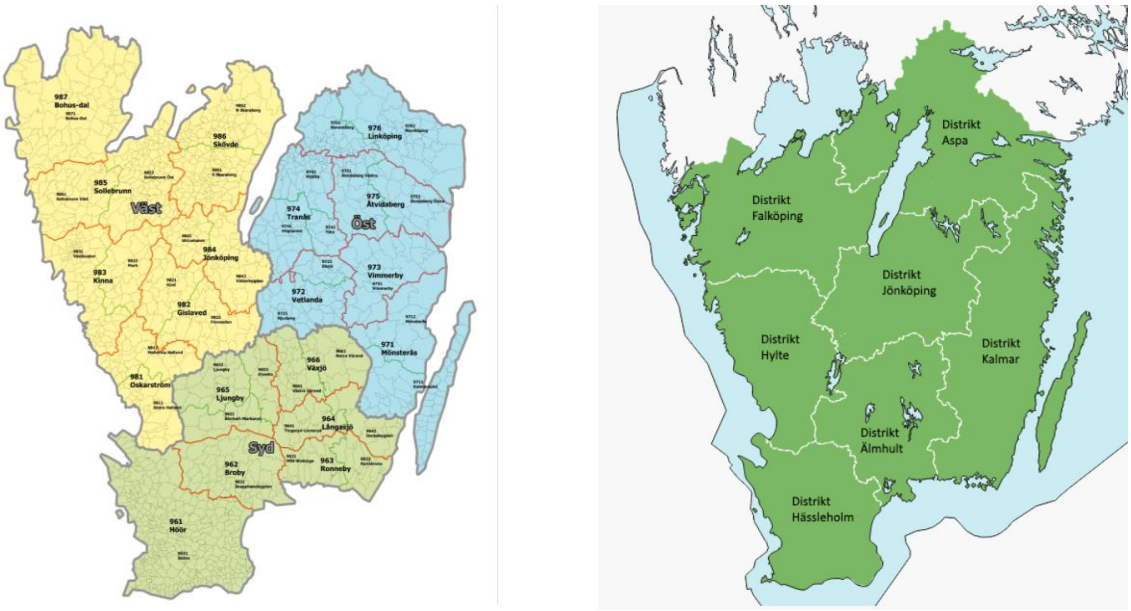


**Figure 9. Companies in the study.** Södra is the leading industrial actor in the south, with many of its own processing facilities. It is also Sweden's largest FOA with 52,000 members who are entitled to a small percentage of the company's earnings every year. These 19 areas are the timber buyer working areas, which are further split into individual TB buying areas, with about 8-15 TBs in each. Sydved is one of Södras most widespread regional competitors, although far smaller than Södra. They do not own any processing facilities and employ about 70 TBs across 7 districts in southern Sweden. (On the left, from Södra, 2020) (On the right, from Sydved, nd).

## 4.2 Interview process

I visited two district offices of Södra and one of Sydved for interviews (Table1). I conducted interviews instead of sending surveys to a potentially larger number of TBs because I wanted them to be reflective. The one-on-one, semi-structured format allowed me to be flexible with the order of questions and follow up on potentially new directions during the interview (Bryman, 2012). Since there is little research on TBs, this was an exploratory process, and I considered it important to allow for potentially unexpected themes to come up (Bryman, 2012). I interviewed six who currently work as TBs and three former timber buyers (FTBs). FTBs had spent the majority of their career as TBs and still work alongside TBs, but now have leadership or logistics-focused roles.

**Table 1. TB Offices.** Those interviewed were based on who was available the day I visited.

| | |
|---|---|
| Södra (Office 1A) | TB1, TB2 |
| Södra (Office 1B) | TB3, (F)TB4, TB5, (F)TB6 |
| Sydved (Office 2A) | (F)TB7, TB8, TB9 |
| F = former. All were male so any uses of 'he/his/him' are deliberate and maintain their confidentiality. | |

A semi-structured interview guide was used in all TB interviews (Appendix1). The questions were designed to learn what TBs actually do, how they describe and perceive their own role, who they are in contact with, and the range of their decision-making capabilities. I wanted to explore to what degree they use, or are incentivized to use, ecological information from beyond the property they are working in, basically asking them to describe their spatial competence in their own words. Some questions were slightly adjusted for Office 1B and 2A since some standard information was addressed before the recordings.

Interviews were conducted in Swedish and lasted between 25 and 75 minutes depending on the level of engagement with questions and time available, most were about 50 minutes. Swedish is not my first language, but I spoke Swedish to make the interviewees more comfortable and allow their responses to be more free. An unexpected benefit of speaking Swedish was that interviewees explained some thoughts and concepts in great detail to ensure I understood. I was deliberate in my wording because Swedish is not my first language, I did not want to bring in political topics, and I did not want to influence their choice of wording when talking about the landscape in particular.

### 4.3 Analysis methods

The recorded interviews were transcribed in Swedish using NScribe. I used open coding to organize their responses in a qualitative, thematic content analysis using the software ATLASti based on the main categories of data, landscape, and landowner relations. I further conducted an interpretive analysis, linking my interview questions to deeper analysis by exploring patterns in their relation to the landscape. Select passages were translated to include in this thesis.

I organized their responses related to the interview questions, then iteratively returned to the transcripts to allow other or deeper themes to emerge. Therefore, my results include a combination of text-based analysis and further interpretive analysis. For example, although some questions touched on this, I was interested in their assumptions about spatial and administrative levels at which decisions are taken, and

at which forests are conceptualized. The primary focus of the analysis was to understand the TBs' perception of their role in relation to the greater landscape.

### 4.4 Limitations

I initially wanted to focus solely on Södra, since its position as FOA and timber company is unique, and interview more TBs. Since I could only reach a small number of representatives, I also reached out to other large timber companies in southern Sweden but did not receive responses. Even without additional responses from within Södra, and risking potential differences in procedures and perspectives by adding Sydved, I feel that I was still able to reach saturation in the responses. It is not my intention to directly compare TBs across companies, only to find patterns in TBs generally, and any differences between companies that came up in the interviews are not quantitatively comparable, since only nine TB interviews were conducted. Further, since a main point of this thesis is that southern Sweden has diverse habitats, so differences in forests between Skåne and Småland might mean that TBs working in different regions cannot be fairly compared either. Since few studies have TBs in the spotlight, however, my study is merely an early exploration of their role. I cannot make sweeping generalizations about how TBs work, I can only interpret what their responses might suggest in relation to effects on the landscape and how they could be incorporated in future policy. I also only focus on TBs in relation to PFOs and SFA, not other authorities or organizations that could also be relevant, but most literature and informants focused on only SFA and PFOs as well.

Another point is that in the interviews, I specifically did not mention some topics, like climate change, instead asking repeatedly about future or expected challenges in their job, the industry, and questions from landowners, or 'the landscape,' instead asking what information is important; which elements they pay attention to before and during site visits or landowner meetings; and if or how they use information about the surroundings, which would indicate which spatial or temporal levels are most relevant for them in their daily work. However, if I had mentioned these keywords, they might have responded differently. Finally, throughout, I focused mostly on the spatial elements, but temporal aspects are also important for cross-scale interactions, especially in forestry, and could be examined more closely in the future.

# 5 Results

Here I provide descriptive summaries and examples of TB responses, including what their role entails, the data they use, how they see the landscape, and relationships with PFOs and other actors. In this section I focus on answering RQ1 and end the results with a short interpretation of how they perceive their role, which forms the base for the following RQs, by further interpreting their responses in relation nested domains and the landscape in the discussion.

## 5.1 Role Description: what does a TB do?

To answer RQ1, a primary goal was to obtain a self-described role definition, including their social network and range of tasks and decisions. All explained the main aspects of their role in similar terms. Each TB has a buying area of a few hundred square kilometers, which includes hundreds of PFOs. The average property size that each TB works with is around 30-40 hectares, but management activities are carried out at a smaller scale, typically 1-3ha for final harvests up to dozens for thinning or cleaning. The main practical steps of contracting a timber sale their role are summarized in Figure10.

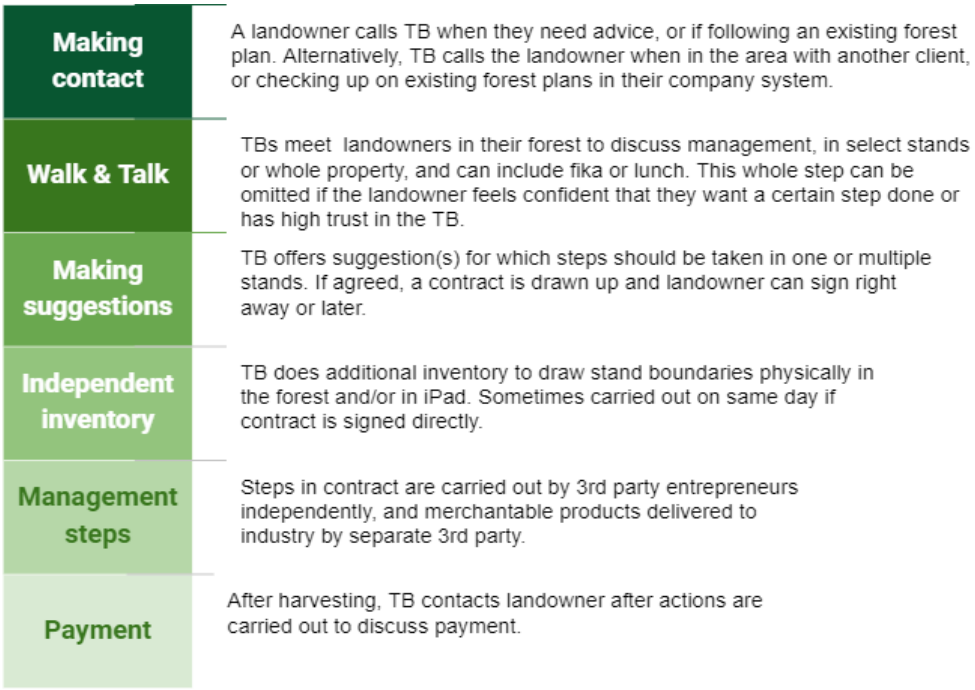


**Figure 10. Steps in buying timber based on interviews.** TBs did not always tell these steps in the same order, but all 9 described steps similarly. The time between contract signing and payment can be from a matter of days to nearly 2 years, depending on weather or entrepreneur availability, and harvesting, for example, takes longer because SFA must approve requests to harvest. The steps they plan include cleaning, thinning, harvesting, soil preparation, replanting, road building. (Own illustration).

They described dual roles of advice-givers and buyers of timber (Table2.). TB1,2,3,8 emphasized the role of advice-giver to the PFO as the most important part of their job, or simply that the relationship with PFOs is most important (TB5,6,7). TB4,6,9 emphasized performing a service for the PFOs. Some described financial stability, or profitability, of the PFO as their primary task (TB5,6,8,9) some referring instead to the 'property,' not the PFO as a person (TB2,3). TB1,2,7,8 saw their roles as necessary parts of the community and economy in the long-term.

TB3,4,5,6 gave examples of coworker teamwork, where teams of 3-4 share some large buying areas with up to 1,000 PFOs. TB1,2 further discussed that planning for some tasks is done as a group, with all TBs in the office working together to coordinate logistics and goals. Many described how the industry has changed over time, as all agreed that there has been an industry-wide increased focus on 'nature' or 'environment' over the past few decades. All emphasized in detail that certification is an important part of their planning, and said or implied that basically all properties use certification guidelines as the minimum requirement. They spoke of certification success as a clear example of how forestry has become more environmentally-friendly, as well as efforts to reduce soil damage from heavy machinery.

**Table 2. Dual Roles of Timber Buyers.**
Here are some select examples of TBs nicely summing up the two main parts of their job. Most put emphasis on the advice-giving and contact with landowners.

| | |
|---|---|
| TB5 | *"I do what all the others do in this office. I work for the forest owner, giving advice. That is part: going over their forest, looking at what is going on. The other role is the buyer, buying in timber to Södra's industry. So, two roles. One giving advice and one buying timber. It goes in waves, right now it is a lot of advice."* |
| TB2 | *"I am of course the contact man for a number of forest owners. The geographic area that I have is 20 by 20 kilometers, approximately. And I have maybe 200 members who have me as a contact man. And that is for all forest-related questions. All that applies to forests, they can call me. And sometimes they call more, and I have a full job to just take care of those conversations that come in, and sometimes they call less. Then I call them instead, and give support, do visits, write contracts for timer, and then when I visit a property, I look at all the actions that need to be done, cleaning, planting, soil preparation, thinning, and harvesting"* |
| TB1 | *"My job is to keep contact with a number of forest owners within the area where I work independently, or together with some colleagues. I am of course a forest advice-giver, really, for all forest-related questions. We also sometimes help support those who carry out the job, the production leader and forest improvement leaders.... That is largely how it is. A lot of contact with landowners and carrying out different services."* |

### *5.1.1 Data & decision-making*

What kind of information they use is relevant to understand how they measure and interpret the forests they work in, as well as how they stay updated on forestry research.

***Ecological & economic data important***

TBs use iPads in the field with detailed, company-specific GIS programs containing various data types. TBs add to this when they do their field visits. Their programs provide information on property boundaries and PFOs and some ecological data (tableDATA). TBs described that nearly all properties have existing FMPs, which help them propose suggestions for management. Most use some combination of data types to prepare before field visits, often relying heavily on existing FMPs.

Information they have access to in forest plans and iPads include "*... the economic picture of the forest owner, how long they've been a member, and how much he has harvested, and what they have invested…. Then I have of course the forest plan and all I need of course in the iPad*," TB2. When I rephrased to emphasize that I was also interested in specifically ecological data, TB2 continued, *"It is the forest plan!*" This "all I need" was a central theme. Most were very open about the data they use, and TB3,6,7 showed in great detail what the map layers contain, including 'official' inventories provided by government agencies with specific valuable ecosystems (Figure11). TB7 explained that while they do not have details on all elements of the properties, they have access to a wide variety of information.

They described metrics they must record in their field inventories, starting with timber volume evaluation, as well as certification, the law, or PFO requests. They have individual working styles and independent decision-making processes, but generally focus field inventories on metrics specific to the management steps they recommend. They take further qualitative considerations into account to some degree, especially TB1,8,9, in terms of which areas should be harvested versus conserved, which is actualized into a plan primarily by drawing stand borders or other boundaries for management in the iPad. TB1,2,5,7 clarified that retention areas are typically separated from the areas harvested. A main element of their inventory is marking boundaries, physically or digitally, around features they think should be protected or simply different stands. TB1,3,6,7,8 emphasized the importance of clear boundaries, because this information is sent to third-party entrepreneurs, who then carry out the steps.

I intended to ask mostly about ecological data TBs use, but they emphasized economic characteristics of PFOs are also important for management decisions. Timing of management steps can be shifted for PFOs

to strategically plan income or taxation, or ensure family members will have future income (TB3,6,7). Further, the state of the market can affect when PFOs want to harvest, so if prices change due to external factors, it influences conversations and choices about management (TB2,5,9).

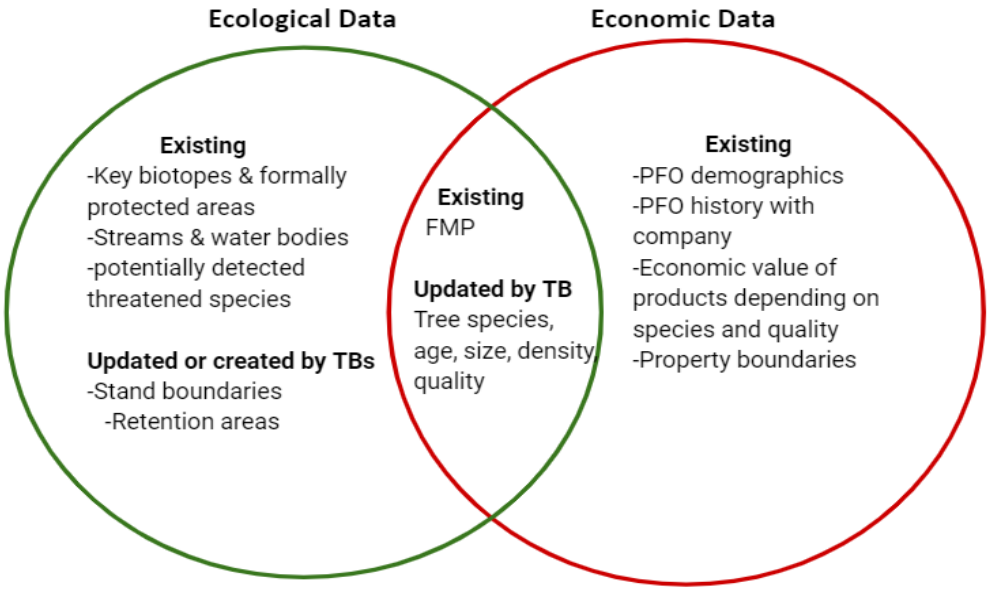


**Figure 11. Data.** Data TBs have access to or create. In the middle is FMPs and TBs' inventories, which can be combined with the market price of different wood products to give PFOs an estimate of the stand's value. TBs described that economic information about PFOs is very important for influencing management and harvesting times. Most of the ecological data comes from authorities. TBs draw in boundaries between stands and retention areas, which becomes very important for the discussion. (Own illustration).

***Digitalization & education***

All talked about significant developments in technology on the job. They agreed digitalization drastically affects their work, mostly positively, by simplifying inventory and information-sharing. However, TB2,3,6,9 described constantly needing to do more in the same time, which puts pressure on fieldwork. TB2: "*One is watched over more now… what one does, or doesn't do! Everything in our work is measured, of course. What we do, how much timber we buy, and how many hectares cleaning, how many forest plans we have ordered… so everything is compared*." TB3,6,7,9 were also critical of the double-edged sword of technology and efficiency.

They talked about getting information from within the company, from peers or from some ongoing company education (TB1,2,3,5). TBs1,5,7 emphasized additional training is added when mistakes are made, and TB7,9 described mistakes as helpful learning experiences. Although all but TB3 in this study

had at least two years of forest technician education or higher, TB5 explained that "*You can get this job without some kind of forest education…*" TB3,5 agreed openly that it was more important to have strong communication and relationships than specific knowledge about ecological processes. TB1,3,7 commented on trying to weigh scientific data and their field experiences.

### *5.1.2 Landscape considerations*

TBs described a few examples of incorporating information beyond single properties into their work and interesting perspectives on the landscape, which are relevant for both RQs2 and 3 in the discussion.

#### ***Practical management beyond property lines***

Some particular qualities of surrounding areas can lead TBs to take some extra steps. TB2,3,5,7,8,9 mentioned contacting neighboring property owners, if for example, they planned to harvest a mature spruce stand (Table3). If the neighbor also had a mature spruce stand, they would at least alert the neighbor, if not also try to contract the neighbor to harvest.

Another example (TB1,5,7,8) was if a neighboring property was under some specific protection, extra steps or caution might be taken to leave additional retention areas or elements. TB5,8 gave specific examples of contacting SFA preemptively to ensure their plans around certain areas are adequate. TB1,7,9 referred to hypothetical examples of planning around unique features, or trying to conserve a 'special' ecosystem that is rare in that area.

**Table 3. Spruce across property lines.** Since there is high windfall risk in spruce stands, TBs felt it was their duty to reach out to landowners across property lines to alert them about plans to harvest. These select examples show that TBs can and to an extent do actively look at surroundings when they make decisions, but their primary influence is economic, through convincing the neighbor to also sell their timber.

| | |
|---|---|
| TB5 | *"It can be that we want to harvest an old forest, and the neighbor has his old forest in the west wind, and if we take this forest, the other will blow down. Then we take contact with the neighbor there and say that if we harvest this here, it will affect your forest! Do you want us to harvest your forest now, or do you want to wait until it blows down?* [laughs] *It's usually a good argument!"* |
| TB3 | *"[if] I'm going to do a final harvest in this area, and it blows here from the lake, if we harvest this, and that landowner also has an old forest, so maybe I come and tell the landowner that we are going to harvest, don't you also want to take yours down now, since it risks blowing down? 'No, I don't think I want to do that, because I won't want to take mine down yet.' No, no, just so you know that we are harvesting this. But it doesn't affect this landowner's decision or my decision to take it down, but I will ask him, don't you want to take that too?... I'm going to give him the possibility or chance to talk about it before it happens, that i can do. But I will not hinder this person's thought if that other person doesn't want to harvest!"* |
| TB8 | *"It could be, [if we do] an action on this one, … then [I] can take contact with the others, and especially if you take down, clearcut a spruce forest, maybe the spruce forest next to it, so maybe it will blow down. So I always want to call the property now, in some months we are taking down the spruce, so you know about it. And [I] see if they are interested in taking it down, or going in to thin, do* some *action. I always do that, actually. When it's something like this, to just go in and thin, maybe they use [another company], so yes, but if it is a final harvest, and something comes down, and you have the wind direct...* [shakes head] *And of course, it would always be wrong if the government-owned forests did not contact the private landowners. And they became a little sad, ah so, 'why the hell didn't you say anything before? Then I of course also could have taken mine down…'"* |
| TB9 | *"If a neighbor does a final harvest that opens up a southern edge, and one sees, oh! There is also a stand that is ready, or almost ready, so I take contact with them, and ask if they are interested in, or if another actor, maybe they don't use Sydved, but then, then it feels better to talk, if we are going to take this down, I try to do that."* |

### *'Seeing' the landscape*

TBs described a fair amount of qualitative consideration weighting the accessible data with their own inventories, goals of the PFO, and personal opinions. TB7 was straightforward that he sees 'modern' forestry as just plantations, not 'natural' forests. TB1,5 mentioned similar but less passionate remarks. Others described forest aesthetics in a different way, talking about seeing the forest in terms of specific tasks that stage would require (TB2,3,5,9). Further, TB6 talked about outcomes of management, including, "it should look nice and tidy when thinned," and "you should do a nice-looking job." TB5, 8, less specifically 1,7,9, reflected on how they affect the landscape as part of why they see their work as important. TB8 was fully aware of his influence on the landscape, but said he plans management not based on his own preferences, but so that the PFO will appreciate the result. TB1,2,3,9 mentioned the ability to be somewhat creative in their planning, but TB5,7,8 were explained that creativity comes through just in

finding ways to balance PFO goals. However, TB1,2,3,8,9 also brought up that they might not see the same thing as PFOs when they look at the forest. TB1 explains, "*If [someone] comes from Kalmar, … they might say clearly that juniper should be removed because juniper is a problem on Öland. Meanwhile, if someone comes from around here, they save it as much as possible. So there are differences, I can give my opinion, the landowner can also give his opinion... very differently*." This shows that there can be very different perspectives depending on past experiences and perspectives of some aspects of forest management.

TB3,7 supported 'variety' in management across the landscape, where each forest owner does management differently. TB3 saw this as very positive (Table4). TB7 had a similar understanding of this, but he and TB1 were slightly more critical. This is particularly relevant as it directly relates to goals and limitations of the Forestry Act.

**Table 4. Variety in forest management across the landscape.** TB7 here captures aspects of what TB1, 3 mention in their comments: the pendulum of priorities and management in forestry as well as the benefits of variety or diversity across the landscape, which they describe as being achieved through each PFO making different choices. The tension between these ideas will be explored in the discussion in relation to the Forestry Act.

| | |
|---|---|
| TB3 | "*It's better that you do so on your hectares, and another does it an a totally different way. All shouldn't go with the same plants, all shouldn't do the same… the most important is that everyone does [forestry] a little differently, because it won't be as vulnerable, so I believe in… variety.*" |
| TB7 | "*I think that in Swedish forestry we have a very strong tendency that everyone runs this way, then we all run that way, … so I like to say that the trends in Swedish forestry swing very powerfully, so everybody runs the same way. It is really good if one does something else. Because it becomes, one calls it diverse, so different things get done ... here in southern Sweden, it is much more varied. And I think that is good. Because if everyone does things a little differently, and maybe some do it wrong, but many have done it right, and those that did it wrong 10 years ago, maybe they're doing it the right way in today's perspective."* |
| TB1 | *"I think of course that the trends in forestry... what we have worked with, nothing is new, it just goes in cycles. How I understand it, it is the same in conservation also!"* |

### *5.1.3 Relationships with other actors*

TBs repeatedly emphasized the importance and spoke fondly of landowner relations. TBs commonly work in the same area for decades and feel confident in their knowledge about PFO preferences and local forest conditions (TB1,2,3,5,6,7,9). TB1,2,3,5,7,8,9 described their advice-giving strategy comes from their personal perspective, as in, "what I would do" if this were my land.

All described working with a 'wide spectrum' of PFOs, and there were differences in how TBs interpret PFO goals and knowledge. Some TBs (4,5,6,9) had the assumption about primary goals of PFOs that simply,

"*the forest should be taken care of,*" TB2. TB5,8,9, and particularly TB1, were empathetic to nuanced, mixed, goals of PFOs. TB5,7,8 said they will try to do anything the PFO wants as long as it is legal, but they try to share as much information as possible about weighing tradeoffs. I call this, "the customer is always right," since these TBs emphasized the importance of meeting PFO expectations to keep them as a client.

In many cases, there is a strong element that TBs "convince" PFOs to make certain decisions (Table5). TB2, 9 were particularly confident that their long-term field experience should be trusted. They described actively convincing PFOs toward decisions, when, they say, the PFO does not adequately understand the future impacts of certain choices. TB3,5 made similar comments, repeatedly mentioning using 'psychology' on the job. 'Convincing,' however, also takes the form of subtle "*planting a seed*" of ideas TB8, "*acting as a sounding board"* TB3, or simply encouraging PFOs to be more actively engaged in their forest management (TB2,3,6,7). TB7 expanded that he simply tries to give PFOs more realistic expectations of management impacts. Some also compared their experience and expertise in a given area to the PFO, saying that they see more of the big picture, since the PFO can have 'tunnel vision' about his/her own property (TB2,3,5,7). This also came up in relation to Gudrun, where TB5,6,7,9 mentioned that PFOs forgot about the impacts of the disaster after just a few years.

All answered that they "take care of" reporting to or contact with SFA for the PFO. TB1,4,7,8 suggested, or said outright (2,3,5,9), they considered this a favor to PFOs. FTBs (4,6) who now have specific, logistics-focused tasks, seemed relieved to no longer have that responsibility. TB5,7,8 spoke particularly positively about SFA contact. In most cases the contact with SFA is limited to simply submitting an intention to final harvest in a stand, typically online, and SFA has 6 weeks to accept or challenge it, or occasional subsidy applications.

**Table 5. Convincing PFOs.** Here are some select examples of how TBs convince PFOs to make certain decisions, which can be contrasted in some ways to the 'customer is always right' theme. Instead of only following landowners goals, TBs encourage, sometimes strongly, that PFOs should make another choice, sometimes in line with an attitude of "I know better." There are also examples of when TBs convince PFOs to be simply more active in learning about forest management.

| | |
|---|---|
| TB2 | *"They know I have experience, and can give advice for their questions. So it is not always that we have the same thought when we meet, but if I know that I am right with my ideas, I try to convince the forest owner. I see a little longer than what the forest owner sees of course"* |
| TB3 | *"I want to come with ideas, I want to be on the same page… I want to make a relationship, so that we can discuss the forest. I do not want to stand up and point at you, 'you shall do it like this, all else is wrong!" No, I want to be on the same level and have a dialogue, and lead the person in to say what I said! Like that. So it really is, it's more psychology than being good with insects or forestry. It's more psychology. Because if I get them to sign the contract, I'm not going to take their hand and make them sign it! I'm going to say, here is a suggestion, how do you want to do it? 'Okay, we'll do that,' and they sign themselves!"* |

## 5.2 Interpretation of their role

To summarize TBs' perception of their role, TBs consider themselves trusted by PFOs and industry to make management decisions that serve interests on both sides. They also largely carry the burden of the nature versus production tradeoff, since they draw the borders that separate areas to be harvested or left behind. FigureNESTED shows an illustration of how to conceptualize the nested domains of private industry. Two simple key messages build the foundation for the discussion:

1) TBs have financial and social incentives and use certain data types that keep their focus at the individual property level.
2) TBs have greater spatial competence and technical capabilities than the PFOs, but there are no appropriate incentives for them to apply a landscape perspective in their everyday work.

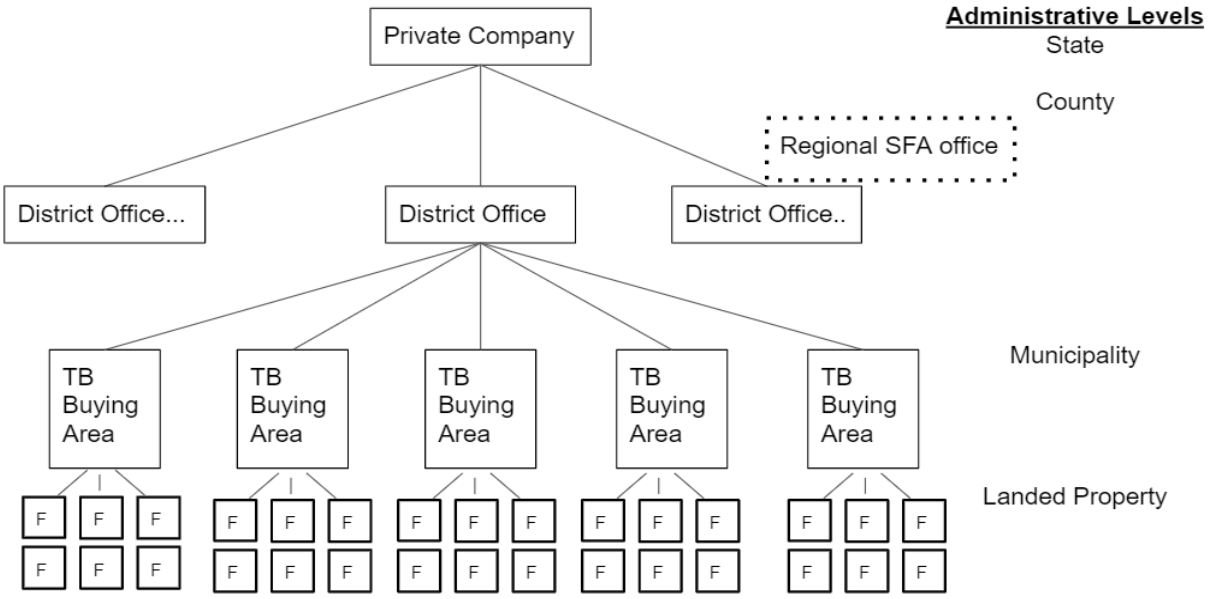


**Figure 12. Private domains.** To compare to Hägerstrand's nested domains, this is one way to conceptualize spatial competence of the TB, focusing on their role within a company. The size of the company and its various offices are not exactly 1:1 to the administrative levels, and the exact size of the TB's buying area can change. Each TB has a buying area of a few hundred square kilometers (between 200-1,000 $km^2$), including hundreds (~100-400) of existing and potential forest owners (F), often for many decades. This to me suggests that they have a significant spatial competence in terms of actual land area and technical capability since they can 'prescribe' management across much of that area. (Own illustration).

# 6 Discussion

Adding in perspectives of other literature, I discuss implications of TBs' spatial competence and technical capabilities, explain how TBs affect the creation of the landscape, then explore how TBs relate to potential leverage points in landscape-level planning and the future of Swedish forestry.

## 6.1 Comparing competence & capabilities

Here I partially address RQ3, illustrating the domains of TBs in relation to PFOs and SFA. I see TBs' entire buying areas as the total extent of their spatial competence, usually hundreds of square kilometers (Figure13). Some TBs directly compared their expertise about their buying area to the relatively limited perspective of individual PFOs who focus only on their own land, saying that they see the 'big picture' compared to PFOs. This is basically acknowledging their greater spatial competence in their own words. However, plans are made entirely within property lines of PFOs separately, which I see as 'shrinking' their spatial competence, for practical purposes, but perhaps more importantly, to show their loyalty to that PFO. TBs saw this as a favor, by prioritizing that particular property individually. Encouraging neighbors to harvest (Table3) show that TBs are able and willing to reach out beyond property lines, and do indeed understand impacts of one stand on another. However, they do this often in the form of making an additional sale, or where additional nature protection already exists.

I focus more on the spatial competence than the technical capabilities, but industrial actors as a group clearly have greater technical capabilities than individual PFOs. PFOs depend on outside companies to carry out management steps (Eggers et al., 2014), and although TBs do not personally carry out physical management, TBs are crucial for translating goals into management steps and communicating those steps to entrepreneurs, who have practical skills and machinery.

Adding to Hägerstrand's nested spatial domains, the understanding of time differs between actors. TBs especially mentioned that they can 'see' the impacts of certain management steps on a much longer timeline than their average PFO. I see this time element as a further element of TB competence, but in this case also greater *temporal* competence, which is especially important for the long timescales that make forestry decision-making unique.

Since SFA has regional offices (SFA, n.d.), and TBs have buying areas within these regions, SFA is officially operating at a higher domain than TBs. Because SFA's official capacity has decreased over the years, (Brukas & Sallnäs, 2012), and SFA is unable to provide as much direct advice or contact with PFOs, TBs are

in many cases the sole ambassadors for updates about forest management and knowledge, largely replacing SFA's advice-giving role. So, while SFA's official status and spatial competence is greater than that of TBs, it seems that technical capabilities of TBs, and certainly their companies as a whole, are greater than those of SFA, particularly in terms of accessible funding and manpower.

I was genuinely surprised that TBs take over contact with authorities in place of the PFOs in most cases. This could mean that many PFOs have no contact with SFA at all, with major implications for social capital between PFOs and authorities, social capital depends on regular contact and trust-building (Guillen et al., 2014). Although it has the potential to be problematic, the information they share is not necessarily one-sided, since TBs often give genuine, personal advice. However, economic incentives, for both TBs and PFOs, remain primarily in line with industrial goals. Basically, this questions if PFOs are really 'free,' if they are only getting advice from a single actor who has clear economic incentives.

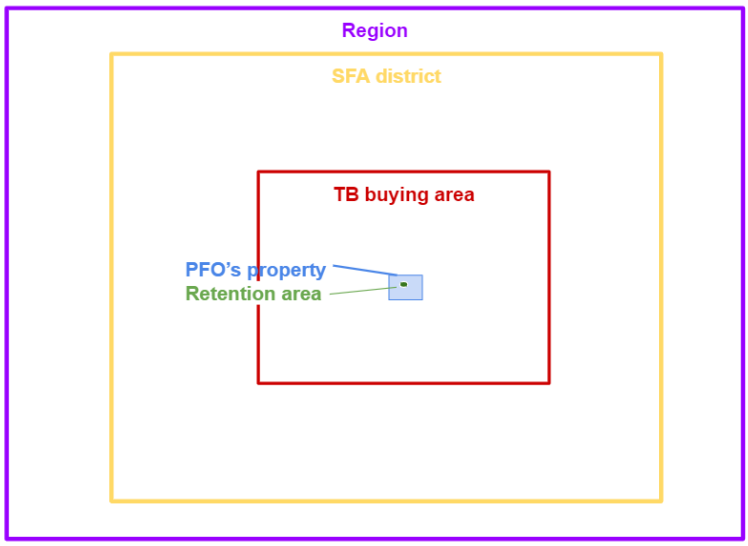


**Figure 13. Nested domains.** A very simplified, and not to scale visualization of nested domains in this system. Few TBs could say the exact area of their buying area, but TB2 said his is approximately 20 by 20 kilometers (about 400 km²), and others seemed to range from about 100 to 1,000 square kilometers, depending on the area. SFA districts are of course bigger than a TB's buying area, but SFA's ability to directly influence management is not as strong as the TBs. This is important for policy because now, green infrastructure provides information at the regional level (Thorardson, 2019). If SFA cannot effectively coordination landowner decisions, maybe a TB's buying area is the next biggest, yet still reasonable domain, which can be hundreds of square kilometers and include hundreds of PFOs. (Own illustration).

## 6.2 TBs & creation of the landscape

Here I focus on RQ2, examining how TBs contribute to the creation of the landscape. I begin by discussing how TBs measure forests and perceive forests as a part of the landscape. As Hägerstrand defined (2001),

actors at various levels might conceptualize goals or system boundaries differently, depending on their perspective. I see that TBs, as a part of the industrial actor group, professionally define forestry systems in a way that is fundamentally oriented around production of timber.

### *6.2.1 "All I need"*

The problem with the "all I need" theme begins with the pressure towards efficiency on the job. Although increased technology makes some parts of their job easier, TBs suggested it is part of a corporate 'time is money' attitude, and that they have less time out in the field. Without a convenient way to record information that corresponds to 'landscape' features, it remains impractical to try to incorporate those features into their planning. Further, if "all they need" is either already uploaded onto the iPad, or they have checklists to add in particular data types, it suggests there is no incentive or reason that TBs *must* think beyond a single property. By assuming all information they "need" can be quantified and recorded by others or themselves, this suggests a problematic oversimplification of forests to select quantifiable elements (Robertson, 2006). As efficiency is increasingly expected of TBs, it could risk the exclusion of the 'qualitative' aspects of the forest that they pay attention to individually, if these factors cannot be easily recorded in their iPads.

TB7's memorable quote, "*we cannot take special consideration to things that we don't know exist!*" reveals a fundamental problem with the 'all I need' theme. TB7's comment[3], and similar reflections, suggests TBs are well aware that they cannot have access to nor record *all* important information, and that some environmental or other qualitative features cannot be accommodated in their iPads. This implies without relevant data or clear landscape-related goals from authorities or employers, TBs are unable to incorporate some factors into management.

While some did describe trying to capture qualitative factors they notice in forests, like a feeling for nice areas or special elements they individually notice, but since TBs work relatively independently, some might be better at or more creative with finding ways to record additional factors in their iPads. TBs seem to generally utilize quantitatively-oriented guidelines. Without an incentive to think beyond the 'checklist,' I see this as clearly underutilizing their spatial competence, because it keeps their focus on easily quantifiable elements in that stand. Further, focusing inventories on property- or stand-specific data

[3] Even more interesting, TB7's quote was referring to 'cultural heritage sites,' *kulturlämningar*, which can easily be hidden under plant cover, but are much more tangible sites than potential ecological factors.

could falsely suggest that decisions made for an individual property result in outcomes for only that immediate area.

### *6.2.2 Production-oriented perspectives & landscape degradation*

TBs and industrial actors see certification as 'enough' for meeting the dual goals of production and nature set by the Forestry Act. TBs feel proud of what they contribute to conservation, but it is important for TBs to see forests as complex adaptive systems (CAS) (Messier et al., 2015), not only timber-producing systems with biodiversity on the side. Society's view on 'naturalness' influences 'what kind' of biodiversity is recognized as locally important, connected to historical human impact on ecosystems (Angelstam & Dönz-Breuss, 2004), so continuing to simplify forests to merely production skews how wider society sees the landscape. Since the Forestry Act officially gives timber and environment equal weight, the long-term, gradual degradation might set an artificially low standard for how much biodiversity is expected in southern Sweden.

The Forestry Act is interpreted as a classically neoliberal policy (Nichiforel et al., 2020) that assumed allowing more freedom would translate to more biodiversity. However, this assumes forest owners have distinctly unique goals which they are able to carry out themselves. The link to the pendulum of, or cycles in, Swedish forestry (Table4) is an important point that highlights this flaw in the logic of the Forestry Act. First of all, as mentioned, PFOs largely do not plan forest alone and require other actors to carry out most management steps (Eggers et al., 2014). Also, there is a clear economic incentive for PFOs to supply what the market demands, and industrial actors necessary for management also have economic incentives. This combination of PFO dependence on industry for advice and physical work, alongside economic incentives, means waves of landowners pursue the same production-oriented goals simultaneously (Lindbladh et al., 2014). In this way, economic framings of forests drive the creation of the landscape (Robbins, 2012).

This economic framing of forests becomes obvious in some examples. TBs can decide when to harvest based on when PFOs want to receive payment, not just when a stand reaches an ecologically-defined stage. TBs' definitions of trees or stands as 'old' or 'ready,' is in many cases 'old' only in production terms (Felton et al., 2019). This shows that even though TBs describe personal connections to nature, their view of forests is still influenced by economic framings. Another example is TBs' descriptions of ideal forest aesthetics as 'neat,' 'tidy,' 'nice,' linking to production-oriented opinions on forest aesthetics. Linne & Sellerberg (2018) wrote about 'clean,' and 'neat' forest management specifically in Småland, so some PFOs may indeed also have this production-oriented view of their forest. However, as mentioned, other

studies show that many PFOs do have a variety of goals in addition to production (Eggers et al., 2014; Ingemarson et al., 2006).

TBs had a range of views of PFO knowledge and abilities, and some described, sometimes passionately, an "I know better' attitude, arguing that their years of experience outweigh PFO's goals or expectations. If Kindstrand et al.'s (2008) findings hold true, and TBs do underestimate the range and importance of PFOs' goals, this could create power imbalances where PFOs do not end up with the forests they hoped for, especially in the cases where TBs 'convince' or 'use psychology' on PFOs. Further, if TBs do indeed underestimate or oversimplify landowner perspectives and values (Kindstrand et al., 2008), I see it is problematic for biodiversity for two main reasons:

1) Within the neoliberal logic of the Forestry Act, PFOs should be fully free to make decisions, and that 'freedom' should result in a diverse landscape, since PFOs and their goals are assumed to be unique. This is problematic because even if PFO goals were distinctly unique, PFOs rely on industrial actors to carry out management, and PFOs are influenced and potentially limited by TBs' advice, whether intentional or not.

2) No matter which actor chooses the management, intensive, production-oriented management is more likely to result in negative impacts on biodiversity and ES of that stand and the surroundings (Rist et al., 2014). The Forestry Act simply cannot account for landscape priorities if responsibility lies with actors at the property level. When timber is prioritized at the stand level and certification makes it *seem* like environmental goals are given equal attention, negative effects at another scale can be discounted as irrelevant (Newton, 2016). So, to contrast with 'convincing,' if TBs 'shrink' their spatial competence as a favor to PFOs, as with the 'customer is always right' theme, TBs could be accommodating potentially 'degrading' wishes.

This is problematic when combined with how TBs access or interpret scientific data. This was not a main focus of my interviews, but some mentioned that it is difficult or unnecessary to keep up with new research. Returning to Felton et al.'s (2019) example about birch regeneration from the background, disagreements about 'how much is too much' depends on each actor's interpretation of the purpose of forest management. Differing perceptions of data can affect how management is carried out. Many TBs described a main element part of advice-giving as 'translating' or explaining all sides of tradeoffs of management decisions. Without a good way for companies to inform TBs on well-rounded research that incorporates broader ecological science across multiple levels, the advice TBs give PFOs is at worst, biased towards production, and at best, not fully informed. This is extremely important because many forestry

methods that might be taken for granted in southern Sweden will have to change significantly to adapt forests to climate change (Subramanian et al., 2016).

TBs' influence also affects how scientists should research PFOs, since Eggers et al. (2014) wrote most FOTs cannot effectively predict forest management behavior. I argue this is because FOTs exclude relationships with and influence of TBs. PFOs are supposed to exercise "freedom with responsibility," but the influence of TBs suggests that landowners are neither *free* nor *responsible* for forest management on their land! Especially for landowners who exclusively receive information and advice from TBs. Eggers et al. (2014) continued that 12% of PFOs in the south are not aware if their land is certified or not, complicating the TBs' description of the strong, open relationships between PFO and TB.

Although an imbalance of power between TB and PFO can be problematic, TBs' influence, or 'convincing,' is not necessarily negative. Many TBs described 'convincing' as trying to increase forest owner engagement, actually encouraging PFOs to be more active in their goal-setting. 'Convincing' could also be linked to encouraging certification or participation in other positive actions, but it is hard to say if their motivations are at all environmental, or purely economic, even in terms of advice based on 'what I would do.' Also, PFOs are not totally passive either, and of course PFOs are unique in many ways, including that some are harder to convince than others (Guillen et al., 2015). The TBs *do* know the laws, norms, and environmental characteristics of their buying area, and potentially add a necessary element of checks and balances on PFO decisions.

### *6.2.3 Tyranny & tragedy, revisited*

The main way TBs contribute to conservation is how and where they plan retention areas. Forest certification and retention areas are designed around the idea that *leaving behind* a minimum percentage of productive forest *within a stand* is enough to support biodiversity (Villalobos et al., 2018; Gustafsson et al., 2020), but this is an extremely small-scale focus in relation to the landscape. The greater ecological issues arise at the landscape level because it is difficult to conceptualize biodiversity effects beyond an individual's property lines, when private property norms are so strong (Nichiforel et al., 2020). This a primary limitation to applying the 'commons' to biodiversity, because it cannot be measured in a straightforward way (Robertson, 2006; Newton, 2016). By seeing production and conservation as inherently at odds in forestry systems, it seems as though nature is 'getting in the way' of production (Boyd et al., 2001). If the only way TBs can work with nature is 'leaving it behind,' in retention areas, that oversimplifies the complexity of nature.

Limiting planning to single forest properties could mean future impacts are largely considered only within those property lines, even if TBs are aware of environmental tradeoffs to some degree. Considering that many species require larger areas or specific forest structures (Felton et al., 2019), it is not enough to plan retention areas without regard to the surroundings. This exemplifies the tyranny of small decisions. Results suggest that TBs can use their own judgement in drawing lines between stands and retention areas. However, exactly where retention areas are left makes a difference for survival of many species that retention areas are intended to protect, for example in terms of slope direction, proximity to water and other forest areas (Gustafsson et al., 2020). I see this as potential for incorporating a "landscape perspective" in their work, by actively planning retention areas in a way that could create corridors across property ownership.

To address the 'tyranny,' planning biodiversity conservation could be considered a form of the commons, which would require many actors to actively acknowledge each other's forest management decisions in order to conserve or facilitate habitats. I think it would be appropriate for the TB to inform surrounding PFOs about how their properties *could be* coordinated, and then it would be their choice to do so or not. However, there is currently no carrot or stick for TBs or PFOs to adjust the spatial level of forest management.

### 6.3 TBs & leverage points

The status quo of forestry in southern Sweden is managing small units of land, and even smaller retention areas. Although this seems practical to respect private property norms (Nichiforel et al., 2020), it limits conservation options in productive forestland, making it difficult to effectively prioritize landscape-level goals. It seems counterintuitive to attempt to coordinate the largest, most diverse group of actors with the smallest domain. I see the need for leverage points higher up the chain.

Green infrastructure at the regional level attempts to prioritize landscape-level biodiversity (Naturvårdsverket, 2019b), but 'visualization' proposed by Andersson et al. (2013a) is not enough, because its remains too abstract and impractical for PFOs to use directly. This suggests the Region is *too high* on the chain for a leverage point. Neither regional green infrastructure nor management on private property can appropriately address biodiversity concerns. I see that there is a fundamental gap between the "fixed reaches" of biodiversity and forestry governance. Responsibilities for conservation may overlap in name, but not in practice, so it becomes impossible to account for fragmentation. So, even though TBs'

buying areas might not quite be 'the landscape,' it is perhaps an appropriate level for conceptualizing biodiversity management (Figure13).

Incorporating coordinated goals into TBs' work could make a difference for landscape-level biodiversity. Cash et al. (2003) explained the importance of clearly defining shared goals and responsibilities in transferring knowledge. Leverage points are "places to intervene in a system" ((Meadows, 2009, p.1), which could apply to a variety of system elements. In this case, I see that redefining TBs goals and data collection methods could be an essential leverage point for better meeting multiple goals in forest management and actively addressing tradeoffs across scales. TBs are well-positioned to achieve these goals because as members of private companies, they are certainly better funded and arguably more flexible than SFA. Perhaps most importantly is that TBs have existing relationships across relatively large buying areas that could be a convenient size for coordinating conservation priorities across PFOs.

TBs now balance goals of PFOs and industry, acting as mediators in some ways. It should be part of the Forestry Act's sectoral responsibility that industrial actors account for and inform PFOs about cross-scale impacts of forest management. Since TBs have largely taken over SFA's information-sharing and advice-giving role, they are in some ways already de facto boundary agents. TBs embody some necessary elements outlined by Cash et al. (2003) for effective boundary management, including regular two-way communication with PFOs and mediating the potentially conflicting goals of a PFO, or conflicts between industrial and PFO goals. A fundamental element of their advice-giving is translating abstract goals into material management based on their field experience; both Cash et al. (2003) and Hägerstrand (2001) emphasized the importance of 'translation' between groups. It is important that they are seen as credible, salient, and legitimate by PFOs, which are key for effective knowledge transfer between groups (Cash et al., 2003).

If TBs are actively encouraged and incentivized to apply a landscape perspective, I see that they could effectively meet at least some conservation goals. For example, goals could relate to planning retention areas differently (Gustafsson et al., 2020) or expanding education about uneven-aged management (Felton et al., 2016), which could both address fragmentation issues (Figure14). TBs' credibility, in terms of the scientific accuracy of the information they share (Cash et al., 2003), could improve through updated training that incorporates broader scientific perspectives.

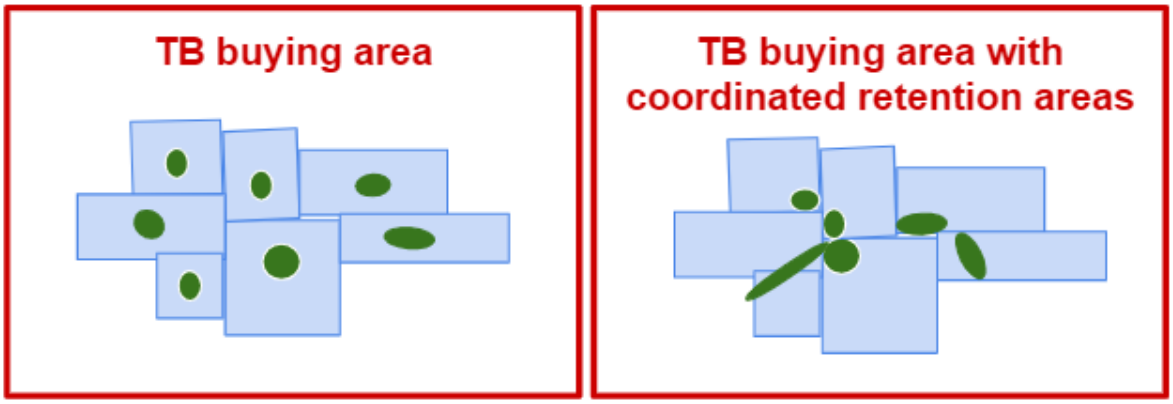


**Figure 14. Potential new planning.** This is a simplified visualization of how TBs could draw retention areas differently. Even if the same area is left behind in a harvest, it could make a difference to some species that retention areas are connected across property lines so that the area left behind is bigger and less edge habitat is created (Haddad et al., 2015). Using their buying area is still not quite landscape-level, but it would be a significant step up from individual properties in terms of spatial planning. (Own illustration).

### *6.3.1 Evidence of success*

TBs are proud of notable, ongoing successes they have helped facilitate. Criticism of certification aside, TBs have played a role in increasing certification rates, leading to total increases in retention trees and areas in productive forestland (Gustafsson et al., 2015). Since TBs tend to be the industry's 'friendly face,' TBs directly and effectively communicate information and planning to PFOs (Lodin et al., 2017; Guillen et al., 2015). TBs explained success with specific programs beyond certification, for example, Södra implemented a sort of tax on timber to avoid soil damage, which FOA members enthusiastically agreed to pay. Success with teamwork and sharing large buying areas suggests even greater spatial competence and potentially an added level of checks and balances in management. Even if only for purposes of logistics, planning certain steps together is a step toward coordinated planning. These successes suggest when there is a clear goal for TBs to meet, they are excellent at communicating and actualizing goals. If elements relevant for landscape planning were a clearly defined requirement for their everyday work, I see that TBs would be able to accommodate them, and could facilitate planning across hundreds of PFOs.

### *6.3.2 Need for appropriate incentives*

The point of landscape-level planning for forestry is to alleviate the tradeoff between production and nature (Felton et al., 2019), but limitations with adequate compensation for nature remain problematic. Literature about ES and arguments for conservation struggle with this, because it is hard to quantify ecological quality and agree on appropriate compensation (Robertson, 2006; Newton, 2016). It is also

important to consider who should receive incentives for this kind of conservation: landowners, TBs and industrial actors generally, or both groups?

Economic incentives for all actors have worked to increase certification rates (Villalobos et al., 2018), but fails to address the main problem of fragmentation. So, is there a way to develop economic incentives, or otherwise, for expanding management to incorporate green infrastructure? TB5,7,8 brought up instances where they came up with deals with neighbors or authorities about how to manage certain areas or be compensated for certain choices, so I think the charisma, networking capabilities, long-term commitment, and spatial competence of TBs is extremely important for reaching coordinated solutions across actors.

### *6.3.3 Policy directions beyond TBs*

There are many methods for measuring biodiversity at various scales, and existing metrics are chosen largely due to practical limitations (Angelstam & Dönz-Breuss, 2004). Hedblom et al. (2020) write that to measure changes to the landscape, more than only ecological data can be used. Actually recording the perceptions of PFOs and other actors could be a new way to account for changes to an area (Hedblom et al., 2020), and that could revolutionize how priorities are set for a region, if local actors can better visualize and understand cross-scale impacts. It can be confusing or expensive to re-educate actors with new biodiversity metrics (Angelstam & Dönz-Breuss, 2004), and it is important to educate not just TBs, but a broad group of actors working with coordinated, landscape level goals.

Of course, unknowns remain, in terms of the practicality of multi-scale conservation efforts, but many negative impacts of intensive production forestry are certain (Felton et al., 2019). Felton et al. (2019) continue, some of these impacts on biodiversity and other ES can be addressed by adjusting the type, spatial level, and intensity of forest production, and many alternative strategies are also linked to better climate-adapted forests (Subramanian et al., 2016). Coordination of forest management at the landscape level is fundamentally necessary to address these tradeoffs, even more important than reducing the intensity of management at the stand level, because some seemingly pro-diversity management decisions, like extended rotation periods, can actually end up in worse effects for some biodiversity metrics in some cases (Roberge et al., 2018).

It is possible to follow Gustafsson et al.'s (2015) advice to adjust social and administrative boundaries to fit natural boundaries, since Hägerstrand (2001) writes, the social boundaries and rules that apply to them can change. These changes could positively affect how society frames landscape processes and changes

(Hedblom et al., 2020). Gustafsson et al. (2015) write that leaders must decide: what are the priorities for managing biodiversity, then, which spatial level is appropriate for managing that? I see that the next decision should be: which *actor* is best situated to carry out that management at that spatial level? This is particularly important as it applies to the 'fixed reach' of different levels and sectors (Hägerstrand, 2001). By using information provided by green infrastructure, identifying local conservation priorities (Andersson et al., 2013b), TBs could potentially balance management to reflect them in a manner that respects local ecological conditions and landownership. I see that TBs could do this at a more appropriate spatial level than PFOs alone, as well as fill in the gap between the 'fixed reach' of current governance.

### 6.4 New directions

There are hundreds of studies about Swedish forests in relation to climate change and ecology, but future research must challenge some basic ideas in forestry. The fundamental assumption that biodiversity and production *must* be at odds and must be separated spatially is not necessarily true (Felton et al., 2016; Newton, 2016), but requires a new and in some ways more complicated forest management. In Sweden, where particularly even-aged forestry, has deep cultural and economic importance (KSLA, 2015), it will take time to reeducate large numbers of industrial actors to view forests in a different way. There will be cross-scale tradeoffs no matter which elements are prioritized, but forest managers need both education and confidence to manage forests that are both productive and diverse (Felton et al., 2016). Examining forestry as a sustainability scientist helps reframe the possibilities for what the industry can achieve. As the world's forests change, sustainability science can encourage existing actors to be more reflexive and approach problems from a transdisciplinary perspective (Spangenberg, 2011) to meet goals in addition to timber production, from diverse forests to rural job creation.

Future research could dig deeper into education and training of TBs, as well as agency and power between actors, especially in terms of the diminished role of SFA. This angle could help build stronger dialogues and foundations for polycentric (Folke, 2016) and interdisciplinary governance. Future policies must coordinate goals in space and time and address that biodiversity and other ES are prerequisites to productive forests (Newton, 2016) at the landscape scale (Felton et al., 2019; Gustafsson et al., 2015), not an externality.

# 7 Conclusion

Since the spatial level necessary for conserving biodiversity is greater than the spatial level at which private properties are managed, this mismatch combined with intensive production forestry practices has negative impacts for biodiversity and other ES at the landscape-level. Sweden's 'soft' forest policies cannot effectively address this, since there is a governance gap that leaves landscape-level biodiversity and other ES unaccounted for. TBs play a central role in actualizing forest management goals into material changes to forests, and they primarily relate to biodiversity through leaving retention areas. I see potential for TBs to contribute to coordination of landscape-level planning due to the extent of their spatial competence in relation to PFOs and authorities.

This thesis is not a criticism of TBs, I see that they are doing their job and doing it well. This thesis is far more a criticism of Sweden's Forestry act and the structural scale mismatch between governance and ecological processes that make it difficult to effectively conserve biodiversity. Without coordinated obligations or incentives for TBs to incorporate landscape-relevant targets in their work, segmented decision-making that prioritizes intensively-managed production forestry will perpetuate the degradation of the landscape, especially as TBs are pushed toward efficiency-maximization and simplification of nature on the job. TBs are trusted with the responsibility to balance potentially conflicting wishes of PFOs and industry. TBs' spatial competence in combination with their ability to effectively communicate with vast networks of PFOs position them in a uniquely important role. Implementing clearly-defined goals for TBs to achieve could be leverage points for improving the coordination of landscape-level biodiversity management. While it is not the responsibility of the TBs themselves to revolutionize the forest industry, TBs act as messengers to vast, trusted social networks, and could widely share forest management practices that acknowledge landscape-level goals. Their position in the forestry system could be pave the way for implementing coordinated policies that address cross-scale tradeoffs and better achieve both biodiversity and production goals.

## References


Andersson, K., Angelstam, P., Axelsson, R., Elbakidze, M., & Törnblom, J. (2013a). Connecting Municipal and Regional Level Planning: Analysis and Visualization of Sustainability Indicators in Bergslagen, Sweden. *European Planning Studies, 21*(8), 1210-1234. doi:10.1080/09654313.2012.722943

Andersson, K., Angelstam, P., Elbakidze, M., Axelsson, R., & Degerman, E. (2013b). Green infrastructures and intensive forestry: Need and opportunity for spatial planning in a Swedish rural–urban gradient. *Scandinavian Journal of Forest Research, 28*(2), 143-165. doi:10.1080/02827581.2012.723740

Angelstam, P., & Dönz-Breuss, M. (2004). Measuring forest biodiversity at the stand scale: an evaluation of indicators in European Forest History Gradients. *Ecological Bulletins, 51*, 305-332. https://www-jstor-org.ludwig.lub.lu.se/stable/20113319

Ask, P., & Carlsson, M. (2000). Nature conservation and timber production in areas with fragmented ownership patterns. *Forest Policy and Economics, 1*, 209-223. https://doi-org.ludwig.lub.lu.se/10.1016/S1389-9341(00)00016-2

Boyd, W., Prudham, W. S., & Schurman, R. A. (2001). Industrial Dynamics and the Problem of Nature. *Society & Natural Resources, 14*(7), 555-570. doi:10.1080/08941920120686

Brukas, V., & Sallnäs, O. (2012). Forest management plan as a policy instrument: Carrot, stick or sermon? *Land Use Policy, 29*(3), 605-613. doi:10.1016/j.landusepol.2011.10.003

Bryman, A. (2012). *Social research methods* (4. ed.). Oxford University Press.

Cash, D. W., Adger, W., F. Berkes, Garden, P., L. Lebel, Olsson, P., . . . Young, O. (2006). Scale and cross-scale dynamics: governance and information in a multilevel world. *Ecology and Society 11(2)*. http://www.ecologyandsociety.org/vol11/iss2/art8/

Cash, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Guston, D. H., . . . Mitchell, R. B. (2003). Knowledge systems for sustainable development. *PNAS, 100*(14). https://www-jstor-org.ludwig.lub.lu.se/stable/3139884

Castree, N. (2003). Commodifying what nature? Progress in Human Geography, 27(3), 273-297. doi:10.1191/0309132503ph428oa

Eggers, J., Lämås, T., Lind, T., & Öhman, K. (2014). Factors Influencing the Choice of Management Strategy among Small-Scale Private Forest Owners in Sweden. *Forests, 5*(7), 1695-1716. doi:10.3390/f5071695

Eriksson, L. (2016). The importance of threat, strategy, and resource appraisals for long-term proactive risk management among forest owners in Sweden. *Journal of Risk Research, 20*(7), 868-886. doi:10.1080/13669877.2015.1121905

Felton, A., Lindbladh, M., Brunet, J., & Fritz, Ö. (2010). Replacing coniferous monocultures with mixed-species production stands: An assessment of the potential benefits for forest biodiversity in

northern Europe. *Forest Ecology and Management, 260*(6), 939-947. doi:10.1016/j.foreco.2010.06.011

Felton, A., Lofroth, T., Angelstam, P., Gustafsson, L., Hjalten, J., Felton, A. M., . . . Ranius, T. (2019). Keeping pace with forestry: Multi-scale conservation in a changing production forest matrix. *Ambio*. doi:10.1007/s13280-019-01248-0

Felton, A., Nilsson, U., Sonesson, J., Felton, A. M., Roberge, J. M., Ranius, T., . . . Wallertz, K. (2016). Replacing monocultures with mixed-species stands: Ecosystem service implications of two production forest alternatives in Sweden. *Ambio, 45 Suppl 2*, 124-139. doi:10.1007/s13280-015-0749-2

Folke, C. (2016). Resilience (Republished). *Ecology and Society, 21*(4). doi:10.5751/es-09088-210444

Götmark, F., Fridman, J., & Kempe, G. (2009). Education and advice contribute to increased density of broadleaved conservation trees, but not saplings, in young forest in Sweden. *J Environ Manage, 90*(2), 1081-1088. doi:10.1016/j.jenvman.2008.04.002

Guillén, L. A., Wallin, I., & Brukas, V. (2015). Social capital in small-scale forestry: A local case study in Southern Sweden. *Forest Policy and Economics, 53*, 21-28. doi:10.1016/j.forpol.2014.12.006

Gustafsson, L., Felton, A., Felton, A. M., Brunet, J., Caruso, A., Hjältén, J., . . . Weslien, J. (2015). Natural Versus National Boundaries: the Importance of Considering Biogeographical Patterns in Forest Conservation Policy. *Conservation Letters, 8*(1), 50-57. doi:10.1111/conl.12087

Gustafsson, L., Hannerz, M., Koivula, M., Shorohova, E., Vanha-Majamaa, I., & Weslien, J. (2020). Research on retention forestry in Northern Europe. *Ecological Processes, 9*(1). doi:10.1186/s13717-019-0208-2

Haddad, N.M., Brudvig, L.A., Clobert, J., Davies, K. F., Gonzalez, A., Holt, R.D., . . . Townshend, J. R. (2015). Habitat fragmentation and its lasting impact on Earth's ecosystems. *Science Advances, 1*, 1-9. doi:doi: 10.1126/sciadv.1500052

Hägerstrand, T. (2001). A Look at the Political Geography of Environmental Management. In A. Buttimer, (Ed.), *Sustainable Landscapes and Lifeways: Scale and Appropriateness* (pp.35-58). Cork University Press.

Hardin, G. (1968). The Tragedy of the Commons. Science, 162(3859), 1243-1248.

Hedblom, M., Hedenås, H., Blicharska, M., Adler, S., Knez, I., Mikusiński, G., . . . Wardle, D. A. (2019). Landscape perception: linking physical monitoring data to perceived landscape properties. *Landscape Research, 45*(2), 179-192. doi:10.1080/01426397.2019.1611751

Hedwall, P. O., & Mikusinski, G. (2016). Sprucification in protected forests: myth or veracity? *Applied Vegetation Science, 19*, 371-380. doi:DOI: 10.1111/avsc.12233

Henderson, G.L. (2003) What (else) we talk about when we talk about the landscape. In Wilson, C. & Groth, P. (Eds). *Everyday America : cultural landscape studies after J.B. Jackson* (pp. 178-198). University of California Press.

Hoogstra-Klein, M. A., Brukas, V., & Wallin, I. (2017). Multiple-use forestry as a boundary object: From a shared ideal to multiple realities. *Land Use Policy, 69*, 247-258. doi:10.1016/j.landusepol.2017.08.029

Ingemarson, F., Lindhagen, A., & Eriksson, L. (2006). A typology of small-scale private forest owners in Sweden. *Scandinavian Journal of Forest Research, 21*(3), 249-259. doi:10.1080/02827580600662256

Kindstrand, C., Norman, J., Boman, M., & Mattsson, L. (2008). Attitudes towards various forest functions: A comparison between private forest owners and forest officers. *Scandinavian Journal of Forest Research, 23*(2), 133-136. doi:10.1080/02827580801944842

Lindbladh, M., Axelsson, A.-L., Hultberg, T., Brunet, J., & Felton, A. (2014). From broadleaves to spruce – the borealization of southern Sweden. *Scandinavian Journal of Forest Research, 29*(7), 686-696. doi:10.1080/02827581.2014.960893

Linné, T., & Sellerberg, A.-M. (2017). The forest as a taskscape: seeing through the good forest owner's eyes. *Scandinavian Journal of Forest Research, 33*(1), 91-97. doi:10.1080/02827581.2017.1327613

Lodin, I., Brukas, V., & Wallin, I. (2017). Spruce or not? Contextual and attitudinal drivers behind the choice of tree species in southern Sweden. *Forest Policy and Economics, 83*, 191-198. doi:10.1016/j.forpol.2016.11.010

Meadows, D. H. (2009). *Thinking in systems: a primer.* Leverage points- Places to intervene in a system (pp. 145-165). Earthscan.

Messier, C., Puettmann, K., Chazdon, R., Andersson, K. P., Angers, V. A., Brotons, L., . . . Levin, S. A. (2015). From Management to Stewardship: Viewing Forests As Complex Adaptive Systems in an Uncertain World. *Conservation Letters, 8*(5), 368-377. doi:10.1111/conl.12156

Mitchell, D. (2005). Landscape. In Atkinson, D. (Ed). *Cultural geography : a critical dictionary of key concepts* (pp. 49-56). I.B. Tauris.

Mori, A. S., Lertzman, K. P., Gustafsson, L., & Cadotte, M. (2017). Biodiversity and ecosystem services in forest ecosystems: a research agenda for applied forest ecology. *Journal of Applied Ecology, 54*(1), 12-27. doi:10.1111/1365-2664.12669

Naturvårdsverket (2020). Ett rikt växt- och djurliv. [A rich plant and animal community.] Retrieved 30 April from http://www.Naturvårdsverket.se/Miljoarbete-i-samhallet/Sveriges-miljomal/Miljokvalitetsmalen/Ett-rikt-vaxt--och-djurliv/

Naturvårdsverket. (2019a). *Grön infrastruktur i skogen.* [Green infrastructure in the forest.] Retrieved 23 Jan 2020 from http://www.naturvardsverket.se/Om-Naturvardsverket/Publikationer/ISBN/8800/978-91-620-8833-0/

Naturvårdsverket. (2019b) *Om grön infrastruktur.* [About green infrastructure.] Retrieved 23 January 2020 from http://www.Naturvårdsverket.se/Miljoarbete-i-samhallet/Miljoarbete-i-Sverige/Uppdelat-efter-omrade/Gron-infrastruktur/

Newton, A. C. (2016). Biodiversity Risks of Adopting Resilience as a Policy Goal. *Conservation Letters, 9*(5), 369-376. doi:10.1111/conl.12227

Nichiforel, L., Deuffic, P., Thorsen, B. J., Weiss, G., Hujala, T., Keary, K., . . . Bouriaud, L. (2020). Two decades of forest-related legislation changes in European countries analysed from a property rights perspective. *Forest Policy and Economics, 115*. doi:10.1016/j.forpol.2020.102146

Odum, W. E. (1982). Environmental degradation and the tyranny of small decisions. BioScience, 32, 728–729.

Rist, L., Felton, A., Nyström, M., Troell, M., Sponseller, R. A., Bengtsson, J., . . . Moen, J. (2014). Applying resilience thinking to production ecosystems. *Ecosphere, 5*(6). doi:10.1890/es13-00330.1

Robbins, P. (2012). *Political Ecology: A critical introduction* (2. ed.). J. Wiley & Sons.

Roberge, J. M., Ohman, K., Lamas, T., Felton, A., Ranius, T., Lundmark, T., & Nordin, A. (2018). Modified forest rotation lengths: Long-term effects on landscape-scale habitat availability for specialized species. *J Environ Manage, 210*, 1-9. doi:10.1016/j.jenvman.2017.12.022

Robertson, M. M. (2006). The Nature That Capital Can See: Science, State, and Market in the Commodification of Ecosystem Services. *Environment and Planning D: Society and Space, 24*(3), 367-387. doi:10.1068/d3304

Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin, F. S., 3rd, Lambin, E. F., . . . Foley, J. A. (2009). A safe operating space for humanity. *Nature, 461*(7263), 472-475. doi:10.1038/461472a

Royal Swedish Academy of Agriculture and Forestry (KSLA) (2015). F*orests and Forestry in Sweden*. Royal Swedish Academy of Agriculture and Forestry.

Schlyter, P., Stjernquist, I., & Bäckstrand, K. (2009). Not seeing the forest for the trees? The environmental effectiveness of forest certification in Sweden. *Forest Policy and Economics, 11*(5-6), 375-382. doi:10.1016/j.forpol.2008.11.005

SLU. (2018). Vad ar grön infrastruktur? [What is green infrastructure?]. Artdatabanken. Retrieved May 1 2020 from https://www.artdatabanken.se/arter-och-natur/biologisk-mangfald/vad-ar-gron-infrastruktur/

Södra. (2018). Jobbet som skogsinspektorn. [The job of a forest inspector]. Retrieved 28 April 2020 from https://www.sodra.com/sv/se/sodrahistorien/manniskorna/jobbet-som-skogsinspektor/?_t_id=eYRIIKONCYiWHZ6uGsDz0g%3d%3d&_t_q=lediga+jobb&_t_tags=language%3asv%2csiteid%3a90d18358-2bdc-454e-bb45-24bcd7ace532&_t_ip=81.235.48.15&_t_hit.id=Sodra_EK_WebSite_Domain_Models_Pages_History_HistoryArticlePage%2f_960edcf4-1bfe-4a57-8df2-fc6a2a27ee27_sv&_t_hit.pos=3

Södra. (2020). Södras Uppdrag. [Södras Mission]. Retrieved May 2 2020 from https://www.sodra.com/sv/se/skog/medlem-i-sodra/uppdrag-och-organisation/

Spangenberg, J. H. (2011). Sustainability science: a review, an analysis and some empirical lessons. Environmental Conservation, 38(3). doi:10.1017/S0376892911000270

Subramanian, N., Bergh, J., Johansson, U., Nilsson, U., & Sallnäs, O. (2015). Adaptation of Forest Management Regimes in Southern Sweden to Increased Risks Associated with Climate Change. *Forests, 7*(12). doi:10.3390/f7010008

Swedish Forest Agency (SFA). (2017) *Frihet Under Ansvar*. [Freedom with Responsibility]. Retrieved 28 April 2020 from https://www.skogsstyrelsen.se/aga-skog/du-och-din-skog/frihet-under-ansvar/

Swedish Forest Agency (SFA). (n.d.) *Om oss*. [About us].]Retrieved 30 April 2020 from https://www.skogsstyrelsen.se/om-oss/

Sydved. (n.d.). Kontakta oss. [Contact us]. Retrieved May 5 2020 from https://www.sydved.se/kontakta-oss

Thordarson, M. (2016). Regeringens uppdrag om grön infrastruktur. [The government's mission with green infrastructure]. Länsstyrelsen Västra Götalands Län. Retrieved January 23 2020 from http://www.Naturvårdsverket.se/upload/kalendarium/2016/gr%c3%b6n%20infrastruktur%20f%c3%b6r%20alla%202016/gron-infrastruktur-for-alla.pdf

Thordarson, M. (2019). Regional handlingsplan för grön infrastruktur Västra Götalands Län. [Regional plan for green infrastructure: Västra Götaland]. Länsstyrelsen Västra Götalands Län. Report 2019: 21. Retrieved May 1 2020 from https://www.Länsstyrelsen.se/download/18.4dc15f2816a53b76de76508/1556785668566/2019-21.pdf

Thorén, H., & Stålhammar, S. (2018). Ecosystem services between integration and economics imperialism. *Ecology and Society, 23*(4). doi:10.5751/es-10520-230444

Villalobos, L., Coria, J., & Nordén, A. (2018). Has Forest Certification Reduced Forest Degradation in Sweden? *Land Economics, 94*(2), 220-238. doi:10.3368/le.94.2.220

## Appendix

**Appendix 1. Interview Guide.**
This guide was used in all interviews with TBs. Since it was semi-structured, the questions were not always asked in the same order to maintain the flow in the conversation. Some additional questions were asked for clarification or to follow up on new directions. Before all interviews, I spent some time building rapport by sharing information about my background and experience with forestry, especially because I was concerned about any political connotations of my study.

| Purpose of Question | Interview Questions |
|---|---|
| Introduction & general description | What is your name and your title here?<br>Can you describe your education and work history? |
| Role Description | Can you describe your role?<br>About how many forest owners are you in contact with?<br>What is the average property size you work with?<br>Walk me through the steps of contracting a sale.<br>Who is involved?<br>Who initiates the process? |
| Understanding data and methods available to and used by TB | What kind of information do you have about each property before you go there?<br>What do you focus on in your own inventory in the field?<br>What kind of information do you have about the area surrounding the property you're working in?<br>Are you able to be creative with how you plan forest management and/or meet landowner's goals? |
| Changes in the Industry and the Job | What are your main priorities on the job?<br>What are the main challenges with your work?<br>During your career, do you think that priorities of the industry have changed? How?<br>Has your role as a TB changed during your career? How?<br>Do you see that your work is important? Why? |
| Relationships with the Landowners | Has your role as a TB changed during your career? How?<br>Have the priorities or concerns of the landowners changed throughout your career? How?<br>Do you feel prepared to answer new types of questions from the landowners?<br>Do you think you and the landowner see the same thing when you look at the forest? |

"*The last word in ignorance is the man who says of an animal or plant, "What good is it?" If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of eons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.*" - Aldo Leopold