Master's Thesis

Impacts of nudging in forest management

Padamraj Pokharel

University of Jyväskylä

Department of Biological and Environmental Science

Ecology and Evolutionary Biology

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UNIVERSITY OF JYVÄSKYLÄ, Faculty of Mathematics and Science
Department of Biological and Environmental Science
Ecology and Evolutionary Biology

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Intense forest exploitation has decreased ecological services and has led to the loss of biodiversity. In Finland, a shift towards Continuous Cover Forestry (CCF) from Rotation Forest Management (RFM) could provide more ecosystem services and conserve the forest's biodiversity. To encourage such a shift, there is the need to find tools that leverage change in management practices in favor of CCF. Nudge is a behavioral change tool that can change people's decision-making unconsciously. Here, I explored the impact of nudging on forest owners and professional's intention to either practice or recommend CCF. I did so by using online experiment survey data from a previous study done by Isoaho *et al.* (2019), where stakeholders had to report the intention of using/recommending CCF after reading one of four texts comparing the two main management regimes. The text had a range of bias from favoring RFM to favoring CCF. I also evaluated how the respondent characteristics (i.e., distance to and area of owned forest, age, gender, education, and specific knowledge about forest management, economics, and the environment) may impact the nudging effect. Professionals were not affected by the nudge text, whereas the forest owner's intention to use CCF was conditional on the text version they read. To promote increased adoption of CCF, forest owners should be provided with text that includes no or a nudging slightly favoring CCF. Distance from residence to owned forest property and, to some extent, owned forest area were related to the effect of the nudge. I conclude that a better understanding of nudges can help to better frame managements options for

forest sustainability. However, a clear challenge is that professionals, that are not positive about increasing CCF and are often consulted by private owners, did not react to nudge.

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TERMS AND ABBREVIATIONS

ABBREVIATIONS

CCF	continuous cover forestry
RFM	rotation forest management
PCA	principal component analysis

1 INTRODUCTION

Forest covers one-third of the land on earth. Forests are an essential component required for human well-being and biodiversity because they provide different ecological services that support the fundamental basis of life and maintain continuity on the world biodiversity. Ecosystem services play a significant role in making various environment management policies (Millennium Ecosystem Assessment 2005). It mainly helps to link the peoples with nature and makes them realize their importance in how humans are both, directly and indirectly, benefitted from them. The concept of ecosystem services was evolved during the 1970s, and currently, it has been popular (Boudell 2018). Despite having significant importance, ecosystem services have not been addressed properly during the making of policies and conservation programs (Millennium Ecosystem Assessment 2005). The Boreal forest holds a significant source of terrestrial carbon stock which helps in climate regulation of the globe (Pan *et al.* 2011; Bradshaw and Warkentin 2015).

Ecological services are the benefits that an individual obtained from the ecosystem (Millennium Ecosystem Assessment 2005). The Ecosystem can be of various categories like the forest, grasslands, mangroves, and other urban areas where ecosystem services are different from others but are equally valuable for human benefits. According to the United Nations Millennium Ecosystem Assessment report, ecological services have been categorized into four services as provisioning services, regulating services, supporting services, and cultural services. Food, clean water, fuel, timber, and other products come under provisioning services whereas climatic regulation, water management, disease regulation, and pollination come under regulating services. The Soil formation process, nutrient

cycles are part of supporting services. Meanwhile, educational, aesthetic, and heritage values, recreation, tourism belongs to the cultural services of the ecosystem (Balloffet *et al.* 2012; Peters *et al.* 2015). Ecosystem services change the people's vision regarding their relationship with nature and guide them in making regulations and policies. Ecosystem services can be visualized on a local, regional, or global range. For example, clean water accessible from the watershed's boundaries are at the regional level, climatic condition regulation comes under either local or a global scale. The Ecosystem maintains the climate globally by balancing the different gases emissions or absorption states, whereas land-use change can affect the climate by influencing temperature and precipitation (Balloffet *et al.* 2012).

Biodiversity is defined as a variety of all the life forms and species within an ecosystem. Forest types determine biodiversity. Any species remains on that ecosystem either by adapting themselves to their environmental conditions, edaphic or other factors or through depending on other species of that ecosystem. The Tropical Forest is the most diverse forest. Biodiversity plays a significant role in ecosystem functioning and the provision of different ecological services. For instance, carbon sequestration, biomass production, habitat, pollination, seed dispersal, and many other ecosystem services are dependent on forest type, structure, and diversity (Brockerhoff *et al.* 2017).

Forest management is a process of planning and implementation of practices to maintain the forest or care for the forest. In another sense, it can be expressed as uses of forest to achieve some environmental, cultural, economic, and social objectives (Wojtkowski 2019). According to United Nations Millennium Ecosystem Assessment (2005) study, it had found that humans were responsible for the change in an ecological system where the ecosystem had destructed for their social welfare. Based on the production of ecosystem services, forest management has

been classified into three categorized: even-aged Rotation Forest Management (RFM), Continuous Cover Forestry (CCF), and Any aged Forestry (AAF) where AAF includes both even-aged and Uneven-aged management policies (Pukkala 2016).

Continuous Cover forestry management is a broader concept compared to uneven-aged management because in CCF stand structure is not compulsory to be continuously uneven-aged (Pukkala 2018). Uneven-aged management is based on the German Plenterwald concept, whereas CCF is related to the German Dauerwald concept (Möller 1922). The main feature of CCF is to cover the forest continuously. Therefore, its main principles are enlisted as to avoid clear-fellings, gap maintenance where gaps should not be more than 0.25 hectares, uses of natural regeneration method and harvesting of only matured financial valuable, senescent, and unhealthy trees (Möller 1922; Schütz *et al.* 2012). RFM causes clear cuts and early successional stages of forest development and focuses more on maximizing the volume of extracted timber resources. Previously, in the boreal forest used for timber production, RFM has been used for several decades as the main forest management alternatives although it has some adverse effects on ecosystem services and biodiversity (Burton *et al.* 2010; Gerasimov *et al.* 2012; Gauthier *et al.* 2015). Biodiversity has been declining while using the RFM alternative which focuses only on timber production (Östlund *et al.* 1997; Siitonen 2001; Bradshaw *et al.* 2009). Additionally, according to Laudon *et al.* (2011), it has been found that RFM reduces the water quality, causes soil erosion, and even affects the nutrient cycling in the boreal forest. Meanwhile, comparing with other optimal management, RFM focusing only on timber production is responsible for reducing the carbon storage in the boreal forest (Triviño *et al.* 2017). Similarly, there can be a disputation while focusing only on timber production because there are other beneficial forest management practices that promote other non-timber values like mushroom picking, berries collection, and recreation (Peura *et al.* 2016).

Previous research highlights the diversification importance because diversification in forest management gives more beneficial ecosystem services and biodiversity (Mönkkönen *et al.* 2014; Triviño *et al.* 2015; Miina *et al.* 2016). This is further supported by (Puettmann *et al.* 2015) and (Felton *et al.* 2016) studies indicating that alternative silviculture practice is essential for getting high multifunctionality from the forest.

Even though CCF has a long history of management, RFM has been the most dominant management for many years (O'Hara 2002; Pommerening and Murphy 2004; Kuuluvainen *et al.* 2012). Nowadays, CCF has been bounced back as an alternative silvicultural practice to RFM (Diaci *et al.* 2011). In CCF practice, trees either small or groups of small trees are being harvested at the period of 15 to 20 years (Pommerening and Murphy 2004; Laiho *et al.* 2011; Kuuluvainen *et al.* 2012).

The conflicts that have arisen between biodiversity conservation, non-timber ecological services, and timber extraction can be lessened or reduced through less intensive forest management and/or through proper planning on the landscape (Eyvindson *et al.* 2018). Recently, different forest management approaches to balance both economic and ecological perspectives have been developed. This alternative mimics the natural disturbance for equalization either by enhancing the forest structure's importance for biodiversity or through reducing forest extraction intensity spatially or temporally (Hanski 2011; Kuuluvainen and Grenfell 2012). These management alternatives are implemented by focusing on avoiding clear cut, limit thinning, selective harvesting, or leaving areas without any management (Äijälä *et al.* 2014). Spatial allocation for resource extraction between intensive and non-intensive resources like land sharing, and land sparing approaches could be utilized in forest planning (Messier *et al.* 2009; Edwards *et al.* 2014). There has been a major conflict between threatened species and other diverse species for resources and habitat where single forest management

alternatives would be effective for high multifunctionality (Haight and Monserud 1990). However, other studies suggest that increased forest management diversification leads to increased diversification of forest structure, and higher multifunctionality of forest can be obtained (Mönkkönen *et al.* 2014; Triviño *et al.* 2017). Since ecosystem services are found on various spatial scales and planning scales should be made either through perfect matching or through making larger than service scale (Raudsepp-Hearne and Peterson 2016; Pohjanmies *et al.* 2019).

There is always a significant controversy on a scientific and political discussion regarding the best methods for planning the forest. In many forests, significant changes have been noticed that forest stakeholders prefer CCF over RFM (Kröger and Raitio, 2017). There is still discussion surrounding these two management alternatives for their effectiveness and relative performance, although CCF is based on promoting sustainability (Pukkala 2016). Likewise, in many cases, CCF provides more ecosystem services and biodiversity, along with recreation and non-timber value, compared to RFM (Peura *et al.* 2018). Similarly, in the boreal forest also CCF dominates RFM regarding the berry production, amenity of the forest landscape, carbon sequestration, and wind resistance (Pukkala *et al.* 2011; Pukkala 2016). Contrary, in another research in the boreal forest and temperate region forest, RFM has been able to overpower CCF for extracting timber (Appelroth *et al.* 1948). For the temperate and boreal forest, CCF has become a centre of attraction as CCF always maintains a forest canopy, and it does not give end in clear cut (Pukkala and Gadow 2012). Moreover, in the case of private forest owners, CCF seems to be more economically profitable than RFM (Tahvonen *et al.* 2010; Pukkala 2016; Tahvonen and Rämö 2016; Tahvonen 2016). More applicable silviculture practice CCF has a similar principle like selective logging where individual trees are harvested only after reaching a certain size or diameter allocated for harvesting. Many recent research compared selective logging with a

clear cut on different forest conditions and found CCF to be more promising for high multifunctionality (Peura *et al.* 2018).

1.1 Forest in Finland

In Finland, there is a variation in ownership of forest. According to the Finnish Statistical Yearbook of Forestry, 2014, more than 60% of the productive forest in Finland is owned by non-industrial private owners from which around 80% of wood is supplied for industrial purposes. The remaining portion of the forest, 25% is owned by the government, 10% by the forest industry, and 5% is owned by municipalities and parishes. Based on involvement in forest management almost for past one-decade, non-industrial private owner is classified into two categories as active and passive owners (Haltia *et al.* 2017). Among the private owners, 10% of them who owned their forest for industrial uses are almost of the older generation and there is a high chance of shifting this ownership to the young generation after certain years (Hujala *et al.* 2007). According to 2010s data, the gender ratio of forest owners was 38% female and 62% male excluding co-operatives, but this ratio would be changed after including co-operatives and the ratio was found to be 44% female and 56%, male. This condition gave us a generalization that women own less forest area compared to men (Karppinen and Hänninen 2017). If we see the Employment data of 2017, it clearly showed that around 59000 people in Finland were benefited from the forest sector (Luonnonvarakeskus 2018).

In this study, stakeholders are categorized into two groups of people: Owners and Professionals. In Finland, while implementing forest management policies, there is close interaction between professionals and private forest owners. Where in many cases, professional provides more information and valuable suggestions to the private owner regarding the forest management alternatives. During the

preparation of forest management plans and policies, all new private owners are taken into consideration along with professionals. While making the final implementing policies, in some cases, both (Private owner and Professional) interests do not match, and no agreement condition occurs on the management plan (Hujala and Tikkanen 2008). In the history of Finland especially during the mid to late 1900s, even-aged rotation forest management was dominant over all other alternative management. The reason behind this situation was to produce cheap raw materials for Pulp and Paper industries (Kröger and Raitio 2017). However, later Finnish forest manager starts to change their policies due to the ongoing global paradigm shift on different forest management practices. There were no other options for the Finnish government except to bring a new forest act. So, in 2014 Finnish government released the new Forest Act, that provides more liberty to forest owner to use their forest accordingly to their own choice. These new policies cause more diversity in different forest management practices. The new Forest Act was focusing more on CCF however, shifting to new management was too slow until these days (Finnish Statistical Yearbook of forestry 2014). In 2018, for measuring the effectiveness of CCF, a survey was done between January and May. The survey shows a shocking result, only 3.7 % forest owner uses their forest under CCF practice (Metäkeskus 2018).

1.2 Attitudes of stakeholder towards CCF and RFM

Recently, specific literature examining the effects on stakeholder perceptions regarding forest management has delivered that stakeholder holds different perceptions regarding the forest management and their reaction to informational intervention is based on how the information is adapted to their existing internal representation (Kearney 2001; Ribe 2006; Ford *et al.* 2009; Smith *et al.* 2012; Matthies *et al.* 2018). The stakeholder perceptions of the ecosystem closely 'relate to different personal objectives, concerns, and priorities for ecosystem

management' and have an emotional attachment to these services (Kearney 2001; Lamarque *et al.* 2011; Asah *et al.* 2012). Similarly, dissonance theory also illustrates that when stakeholders are exposed to informational nudge, their (stakeholder) personal objectives, concerns, and effects will play an influencing role in selecting different dissonance reduction strategies. In informational interventions, changes in attitude can be achieved by providing accurate information in a strategic fashion. This strategy reduces belief-based cognitive elements and contains the removal method of dissonant beliefs (Festinger 1962; Steele 1988; Aronson 2012). It has been observed that if newly obtained information is not more significant than previous existing information regarding the topic, there is a chance of the receiver to deny or reduce the dissonant importance. Likewise, the addition of more consonant beliefs and changes on dissonant beliefs causes the outweigh of dissonant beliefs (Festinger 1962). Thus, in this research, we are investigating the impacts of nudging on stakeholder intentions regarding forest management. The stakeholders are Finnish forest owners and professionals whose decisions on the management of forests can be altered by the nudging effect. Mainly in the Finland forest context, for nudging linguistic nudging has accomplished. While comparing forest owners with professionals regarding the CCF practice, it has observed that Forest professionals have negative attitudes towards CCF (Haltia *et al.* 2017) because Professionals favor more economics that goes with RFM practices. Conversely, forest owner's attitudes favor more on ecosystem services and biodiversity conservation rather than economics.

1.3 Nudge: behavior tool

A nudge is a powerful tool that helps in changing people's perceptions and making their choice of interest or preference. It can guide society towards the sustainable management and conservation of biodiversity. It is a theory that can changes people's behavior or attitude unconsciously. Beyond the forest

management sector, it can be used in other different fields like economics, public health, and food, education, and so on. This theory or policy can be used in influencing people's behavior and making a good choice of context. In the marketing field, nudge theory has been used as a go-to strategy that helps in explaining the consumers purchasing decisions (Nudge Theory: Definition & Influence on Consumer behavior 2018). Nudge theory has become a centre of attraction on managing household energy waste (Dotti 2020). It has been used as a strategy in controlling the pandemic of COVID 19 particularly in Denmark and the UK government had applied a nudge for controlling the spread of the virus (Tripathi 2021).

From the behavioral economic aspect, the nudging can create a woodland that fulfills the objectives of climate change mitigation and adaptation (Valatin *et al.* 2016). Similarly, nudge can be used as a tool for increasing social acceptability and to transfer the information of ash recycling in a forest (Ouvrard *et al.* 2020). In the southern United States, the government and their programs were not able to meet forest owner goals that is maintaining the ecosystem services. The Public of Southern US were more focused on the maintenance of ecosystem services than timber production, and their attitudes were positive towards new initiative policies using nudge strategies (Kreye *et al.* 2019). Nudge has been successfully used to encourage people to create woodland for climate change mitigation. However, there were some misconceptions and fatalistic attitudes that affect woodland creation and climate change mitigation where these problems can be overcome by the use of different nudge approaches (Moseley *et al.* 2014). In more related boreal conditions, CCF had become one of the suitable forest management alternatives for reindeer husbandry in northern Sweden forest where CCF helps to improve the decreasing state of reindeer pasture area and increase the chance of more pasture area in the future (Korosuo *et al.* 2014). In Irish forests, CCF was popular, and people were more interested in using CCF because they promoted a

mixture of tree species in their forests. However, they used it only for less than 15 years and have become an aspiration rather than reality. So, there was the necessity of more awareness of CCF, and forestry managers should know more aspects of CCF to convert it from an aspiration to reality (Vítková *et al.* 2013)

Nudging is a shrewd intervention designed to help people making decisions according to their choices without any limitation (Thaler and Sunstein 2008). It is a powerful tool that links the information interventions with individuals' perceptions concerning forest-based ecosystem services. Nudge can be defined as 'any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives'(Thaler and Sunstein 2008). Nudge theories affirm while designing the context of choice which matters because in many cases the chooser may be clueless about the context and can give irrelevant decisions that may be harmful as well as may not be of the chooser's best interest (Thaler and Sunstein 2008). Nudging is a policy instrument that has the capacity to change people´s optimal behavior and attitude unconsciously (Stoknes 2014). Thaler and Sunstein (2008) nudge theory is based on framing nudge, and they gave different opinions on the process where people can adjust the implications of their choices through the various way of presenting the information. Here, we are focusing more on linguistic nudging through metaphorical framing where stakeholder decision impacts on forest management alternatives can be seen. Many studies on cognitive linguistics and social psychology give an idea that people's behavior can be changed through changing the metaphorical context of text regardless of how the information is exposed to them (Lakoff 2004; Thibodeau and Boroditsky 2011).

At the organization level, nudge can be categorized into three types namely: perception nudge; motivation nudge; and ability and simplicity nudge. Nudging can be done through various techniques and some popular ones can be listed as

define change; analyzing stakeholders; work plan and timelines; inclusive decision making; receptive to feedback; removing bottlenecks; and consistency (Tahir 2020).

The critics of the nudging approach highlight the patriarchal framing and see connections to manipulative marketing such as propaganda. propaganda is defined as 'dissemination of information (information can be facts, rumours, arguments or maybe half-truth) or lies to influence the people'(Smith 2021). Propaganda is a manipulation technique where people's beliefs, attitudes, and actions are being manipulated through symbols in the form of words, gestures, banners, monuments, music, clothing, insignia, hairstyles, designs on coins, and postage stamps, and so forth (Smith 2021). People covering these propagandas have specific or targeted goals and for achieving these goals propagandists use facts, arguments, and displays of symbol which can impact on people mind. In some cases, even they lie or makes false narration. Meanwhile, nudging mainly focuses on realistic things, and they guide people in choosing the right choices that are beneficial. However, while there may be controversial aspects associated with nudging, there are nudge virtuous effects which can lead to encouragement for the donation of an organ, reduction in energy consumption to save more money. These types of cases can be observed basically on commercial nudging (Dholakia 2016).

1.4 Aims of the study

The previous research of Isoaho *et al.* (2019) showed that perception had been changed through linguistic nudging. Here in this thesis, I am focusing on whether nudging affects stakeholder intention to practice or recommend CCF.

Based on the previous pilot study regarding changing in forest stakeholder perception through linguistic nudging by Isoaho *et al.* (2019) and different

theoretical perspectives and finding above mentioned helps us in delivering the hypothesis that nudging can change the forest owner decision regarding the selection of forest management alternatives (CCF over RFM). Additionally, professionals have more knowledge about forest management, and they are expected to be less affected by nudge text. We expect that nudging changes the intention of forest owners towards forest management. I am also investigating whether the stakeholder's different characteristics model the reaction to the nudge.

2 MATERIALS AND METHODS

2.1 Data and methods

For testing our hypothesis, I used data obtained from an online nationwide survey directed to forest stakeholders (Finnish private forest owners and professionals) conducted by Isoaho *et al.* (2019). The survey was sent to 5000 private forest owners and 1099 forest professionals. I discarded responses where the survey was not complete or that took less than 8 minutes to complete. The resulting survey data for the analyses was 749 professionals and 733 private owners. The survey consists of four main parts: first, collection of background information of respondents with their different characteristics like age, gender, level of education; and how much they know forest management, economy, and environmental issues, second, what proportion of CCF they were willing to practice in their forest (for the owners) or they intend to recommend (for professionals). The third, set of the questionnaire consists of different nudged text written by experts, comparing RFM and CCF practices. Finally, in the fourth part is the respondents were asked again after reading the nudge text, what proportion of CCF they are willing to do in their forest (owner) or planning to recommend (professionals).

The nudge text on the questionnaires consisted of four different versions with a different emphasis towards either RFM, neutral (NEUTRAL), minor emphasis towards CCF (MINOR), and major emphasis towards CCF (MAJOR). On MINOR nudging, the texts were favoring CCF by prioritizing economic factors whereas on MAJOR nudging the texts were more emphasized with both ecological and economic factors. The original text selected from Forestry Development Centre Tapio was already leaning towards RFM. The Tapio guidelines were specifically taken into account for nudging because Tapio provides the latest scientific

information along with benefitted advice for both stakeholders. More detailed information on four different nudge texts is illustrated below.

2.2 The nudge

Metaphorical framing is an approach that changes people's attitudes and perception's where metaphors activate the emotional side and patterns of thought and these, helps to guide people in certain directions (Thibodeau and Boroditsky 2011; Hukkinen 2012). This study is based on linguistic nudging, where text is adjusted with wording and dispositional perceptions of the recipients (Thaler and Sunstein 2008; Ferraro and Price 2013; Bao and Ho 2015). According to Slovic *et al.* (2007) study, reflective judgments were responsible for activating emotion-based evaluation. The texts that are produced for nudging are designed according to the metaphor identification procedure. This procedure identifies linguistic metaphors in the text and their reliability were tested according to the Pragglejaz group (Steen et al., 2010). The original Tapio text used in the metaphorical framing procedure are modified by finding a lexical item that works as a metaphor. The lexical item on the text is identified through the process described by Steen *et al.* (2010). The metaphors were changed to the desired version of the nudge type by changing the wording or information. For instance, for a MINOR nudge, the costs of forest management were characterized in terms of "flows" of money and for a MAJOR nudge, CCF was characterized in terms of "denser networks of habitats" and "richness" of forests with respect to biodiversity and human health benefits. Meanwhile, for changing the wordings, the shifting of terms were focusing mainly on primary and secondary metaphors as by Lakoff and Johnson (1999). Therefore, the first nudge made in metaphorical assumption is like MONEY IS A LIQUID (which is able to "flow"), whereas the other nudge made on metaphorical assumption was like WELL-BEING IS WEALTH (where "density" represent as whole part for "richness" and "richness" is applicable for both environmental and

human well-being). More details with an example can be seen in (**Appendix B and C).**

Furthermore, while finding a metaphorical content in lexical items, it was found that the original Tapio text was favoring the business perspectives. This situation is quite similar with the RFM text, so these texts were considered as RFM nudge text. All the biased facts in between RFM and CCF were balanced to get a NEUTRAL nudge type text. Practically, the original Tapio text that compares even-aged and uneven-aged forestry were shortened for modifying the text to nudge type. During the modification process, both content and wordings were considered which ultimately gives RFM nudge text. After this, the informational content of the original text of uneven-aged forestry was changed through the discussion with experts to balance the prevalence biasness. This discussion changes gives the neutral text and becomes NEUTRAL nudge text. The original Tapio text was informationally biased towards RFM. Additionally, for the third nudge type, MINOR, the changes were made on wordings with reference to economic aspects of CCF forest management that can follow "flow", as explained above. Finally, for MAJOR nudge type text, they were changed by focusing on ecological and economical aspects of CCF. In summary, it can be observed that RFM, and NEUTRAL nudge were made by changing informational content whereas for MINOR and MAJOR nudges changes were made by linguistic nudging. Through the above-mentioned strategies, we received a way to test both the informational contents as well as the effects of linguistic nudging (Isoaho *et al.* 2019). More detailed and explanations with examples are listed on supplementary data **(Appendix A, B, and C).**

2.3 Statistical analyses

To analyse the nudge effects on CCF according to respondent characteristics, a linear regression model was used. As the dependent variable, the stakeholder change in percentage in intent to use CCF after reading the text was calculated using the below-mentioned formula:

Increment of willingness to do CCF = CCF after reading the text − CCF before reading the text

After this, the variation in the increment in intent to do CCF was modelled with a linear regression by including the nudge type with interaction with all other respondent characteristics following the formula:

Increment in intent to use CCF ~ nudge * stakeholder * age +

nudge * stakeholder * gender +

nudge * stakeholder * knowledge * knowledge bias

$$\text{Increment in intent to use CCF} \sim \mathrm{N}(\mu, \sigma^2)$$

where knowledge refers to how much stakeholders know about the knowledge of forest management, forest economics, and the environment. Similarly, knowledge bias indicates that they do not know much more about forest management, economics, and the environment. It has been observed that stakeholder self-reporting knowledge variables (i.e., forest management, economics, or environment) were highly correlated with each other. This would violate the assumption of no multicollinearity of explanatory variables and could affect the model reliability. To solve these issues, an independent variable was created through running PCA (Principal Component Analysis) on these three-knowledge components (management, economics, and environment). After successfully

running PCA, three principal components were yielded. The principal components are knowledge level which explains 91.4% of the variance when compared to three knowledge, second is knowledge bias between ecological aspects vs bias towards economic and management which explains 6.4% of the variance. It has a low value when they say they know much more about forest management and economics than the environment. The remaining third component actually represents the bias between knowledge management and economics which explains 2.2% of the variance. On the model, only the two first principal components were used.

The variable nudge which represents the stakeholder attitude on using CCF was expected to be changed from RFM nudge text to MAJOR nudge. The respondent different characteristics like their age, gender, and level of education, all were expected to affect the stakeholder attitude towards using CCF.

Additionally, as some characteristics were only present in forest owners, but not on professionals. To see whether there is any significance with the owner distance between residence and the owned forests, and owned forest area, we used the linear model formula below where professionals were excluded from the modelled data.

Increment in willingness to use CCF ~ nudge * age +

nudge * gender +

nudge * knowledge * knowledge. bias +

nudge * log.owned.distance+

nudge * log.owned.area

Increment in intent to use $\mathrm{CCF} \sim \mathrm{N}(\mu, \sigma^2)$

where all the criteria are defined similarly to the above-mentioned model description. Owned distance (in kilometres) and area (in hectares) were transformed with the natural logarithm. Statistical analyses were run using R software version 4.0.3 (2020-10-10) (R Core Team 2020).

3 RESULTS

This study found that the change in intent to practice or recommend CCF after reading the text comparing RFM and CCF was significantly correlated to stakeholder identity, what nudge was read and the interaction between the stakeholder and what nudged text was reads (Table 1). For the model including both stakeholders, other respondent characteristics (age, gender, education, knowledge, and knowledge bias) were not significant (Table 1).

More specifically, the nudge was successful to influence the owner's intention (Figure 1). Private forest owners that read NEUTRAL and MINOR nudge text showed approximately 11% increment in intent use of CCF as compared to the intention before reading the text. The owners reading the RFM text had an average increased intention of 7%, while readers of the MAJOR text showed merely approximately a 1% increase. On the other side, for the professionals, there was no significant changes in intend to recommend CCF after reading the nudge text. (Figure 1).

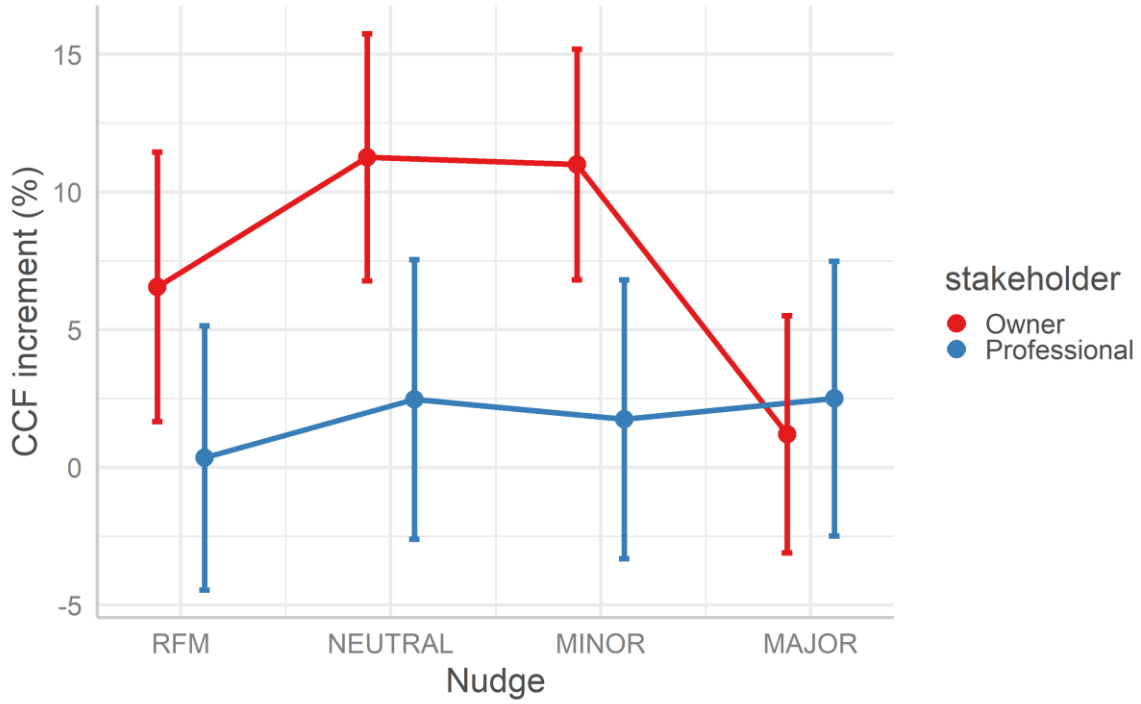

Figure 1. Model fit for estimated increment on willingness to use CCF as forest management after reading different nudge text by the two stakeholder types.

Table 1. F-tests on whether the added variables or interactions significantly reduced the residual sum of squares in the model. In bold: the variables or interactions that contributed significantly to explaining the variance in the data.

Model term	**df**	**Sum of Squares**	**Mean Square**	**F**	**P-value**
Nudge	**3**	**9313**	**3104,4**	**5,618**	**0,001**
Stakeholder	**1**	**8071**	**8070,7**	**14,605**	**< 0,001**
Age	**1**	394	393,9	0,713	0,399
Gender	1	1005	1004,7	61,818	0,178
Knowledge	**1**	408	407,7	0,738	0,391
Knowledge bias	**1**	1883	1883,4	3,408	0,065
Nudge : Stakeholder	**3**	**7630**	**2543,3**	**4,603**	**0,003**
Nudge : Age	3	1187	395,7	0,716	0,542
Stakeholder : Age	1	275	274,9	0,497	0,481
Nudge : Gender	3	928	309,5	0,560	0,641
Stakeholder : Gender	1	106	106,3	0,192	0,661
Nudge : Knowledge	3	2239	746,4	1,351	0,256
Stakeholder : Knowledge	1	104	103,8	0,188	0,665
Nudge : Knowledge bias	3	1082	360,8	0,653	0,581
Stakeholder : Knowledge bias	1	378	378,0	0,684	0,408
Knowledge : Knowledge bias	1	1997	1997,3	3,614	0,057
Nudge : Stakeholder : Age	3	1276	425,5	0,770	0,511
Nudge : Stakeholder : Gender	3	651	217,0	0,393	0,758
Nudge : Stakeholder : Knowledge	3	357	119,1	0,216	0,886
Nudge : Stakeholder : Knowledge bias	3	3913	1304,4	2,360	0,070
Nudge : Knowledge : Knowledge bias	3	1376	458,8	0,830	0,477
Stakeholder : Knowledge : Knowledge bias	1	1114	1114,0	2,016	0,156
Nudge : Stakeholder : Knowledge : Knowledge bias	3	1227	409,0	0,740	0,528
Residuals	1380	762586	552,6		

The second linear regression model evaluated change in intention to do CCF with all the same characteristics which I had taken on the first model but here I added characteristics owned distance, and owned area, that are applicable only for private owners and not for professionals. The model showed that the difference in change was significantly related to nudge and that this reaction to the nudge was conditional with the distance to the owned forest and, to a lesser extent, with the area of the forest owned (Table 2, Figure 2 and 3).

Specifically, owners whose forests are located near their residence were most negative towards CCF when they read MAJOR nudge text, and equally positive when reading RFM or NEUTRAL (Figure 2). On the contrary, when they reside far away from their forests, their change in intent to use CCF was at its highest after reading the MINOR nudge text (Figure 2).

The interaction of owned area and nudge was nearly significant. Owners that owned small areas of the forest showed an increment in intent to use CCF particularly after reading MINOR texts (16% mean increase). But after reading RFM or MAJOR nudge texts, they no change in intent to use CCF (Figure 3). Instead, when the respondent owned a large area of forest, that was more positive towards CCF after reading the NEUTRAL nudge text. Among large owners, the change in intent to use CCF was the lowest when they read the MAJOR text. The difference in change of intent between nudge versions were higher among small forest owners than among the large forest owners (Figure 3).

Table 2. F-tests on whether the added variables or interactions significantly reduced the residual sum of squares in the model. In bold: the variables or interactions that contributed significantly to explaining the variance in the data.

Model term	**df**	**Sum of Squares**	**Mean Square**	**F**	**P-value**
Nudge	**3**	**16646**	**5548,6**	**5,998**	**< 0,001**
Age	**1**	522	522,1	0,564	0,453
Gender	1	1296	1296,3	1,401	0,237
Knowledge	**1**	556	566,5	0,612	0,434
Knowledge bias	**1**	2222	2221,7	2,402	0,122
Owned distance	1	2938	2938,5	3,176	0,075
Owned area	1	12	12,5	0,014	0,908
Nudge : Age	3	1653	551,0	0,596	0,618
Nudge : Gender	3	1449	482,9	0,522	0,667
Nudge : Knowledge	3	1511	503,6	0,544	0,652
Nudge : Knowledge bias	3	4509	1503,1	1,625	0,182
Nudge : Owned distance	**3**	**7655**	**2551,7**	**2,758**	**0,041**
Nudge : Owned area	**3**	**6135**	**2045,0**	**2,211**	**0,086**
Residuals	682	630934	925,1		

Figure 2. . Model fit for estimated increment on willingness to use CCF as forest management after reading different nudge text by owner with respect to the distance of forest from their residence. The distance of the forests was measured in kilometers.

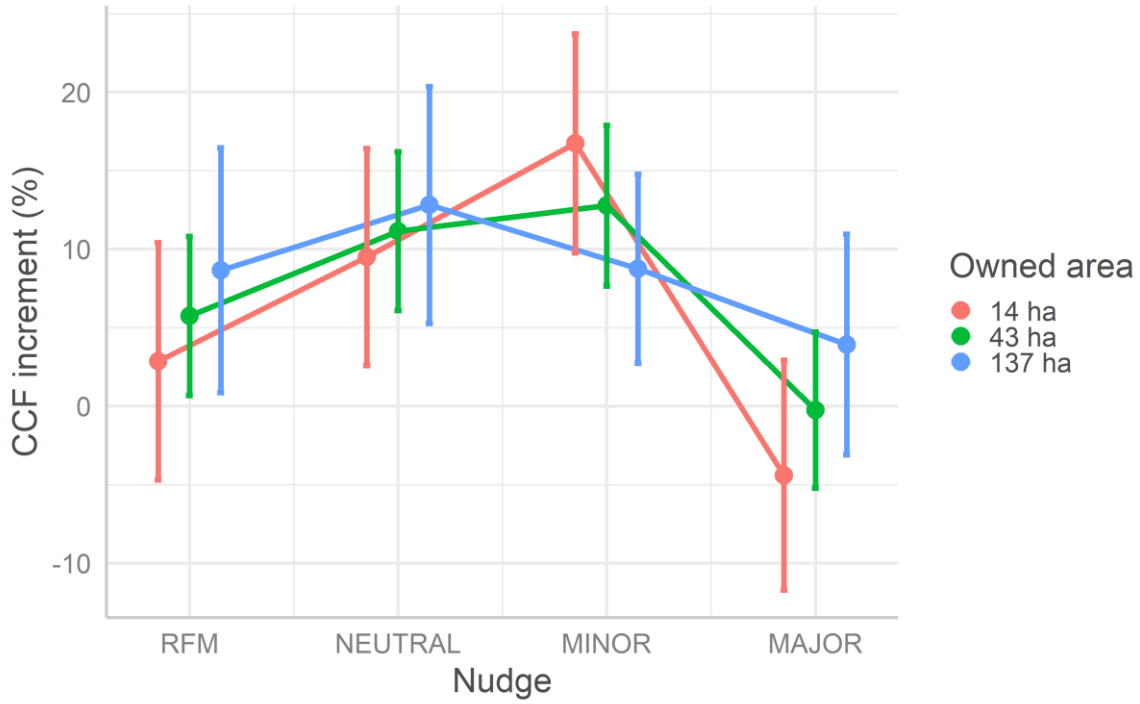

Figure 3. . Model fit for estimated increment on willingness to use CCF as forest management after reading different nudge text by owners. The area of the forests was measured in hectares.

4 DISCUSSION

These results showed that the stakeholders were influenced by different nudge text versions regarding the forest management alternatives. Especially forest private owners were hypothesised to be affected by nudges and they were affected on results.Professionals were not influenced by the nudge texts. Potentially as they know more about forest management practices and a similar result was seen in our study that proved our predicted hypothesis true.

In general, forest owners were more positive towards CCF when they read NEUTRAL and MINOR texts. The NEUTRAL text is the unbiased text between RFM and CCF. Besides this, MINOR nudge had similar impact than the NEUTRAL nudge text but here minor changes was done in economic aspects. In general terms, for forest owners the simple provision of unbiased information on CCF as a valid forest management alternative is already a potentially relevant tool to increase intention of use of CCF among forest owners. Notoriously, the increment as compared to NEUTRAL or MINOR nudge appeared smaller if reading RFM, or even had no increment if reading the MAJOR text. The reason can be that they are not convinced with both the ecological and economics perspectives of CCF because they do not have more knowledge on CCF. According to cognitive dissonance theory, if we push an individual forcefully to an extreme level then results may not be in the favor of what we wanted or there will have a negative effect (Festinger 1962). In our study also pushing owners towards using CCF by providing all the positive aspects of CCF without any flaws may not be effective as owners may not believe or trust all positive things only. The results proved the statement highlighting the decrease in owner's willingness to use CCF after reading MAJOR nudge text. However, there can be some

shortcoming regarding the study design. MINOR nudge text enhances the economic aspect of CCF, and MAJOR adds on top of the MINOR the enhancement of ecological aspects. It would have been interesting to have another version of MINOR where instead of enhancing the economic aspect it only enhanced the ecological aspect. Forest owners when provided with both aspects (MAJOR) were not satisfied with the nudge text and there was a negative response in our results too. Thus, we can expect that they would show the same response as MAJOR nudge showed when MINOR focus only on the ecological aspects of the forest.

When studying the impact of nudging, I have taken into account respondent's different characteristics age, gender, and specific knowledge on management, economics, and environment. The stakeholder responses were not correlated with all these characteristics. Furthermore, I also tested the importance of the owned forest location and owned forest area and how distance to the forest owner's home and size of the forest impacts management decision with the nudge. The distance variable was significant, and area was nearly significant. These results became a surprising point of our study because all the other variables which was expected to be significant were not significant, but these were significant. Forest owner who owned their forest near to residence were negative to use CCF while for far distance, they were positive. Similarly, for the area, owners that owned large area of forest tend to more positive with CCF while the differences in reaction to different nudge texts in the intention to use CCF was larger when they owned small area of forest.

However, my study did not show significance of nudge with the prior knowledge of owners where they said they know more about forest management and economics. A similar result was found with the owners who said they do not have much knowledge of the management and economics of forests. This is contrast with the previous research by Isoaho *et al.* (2019) showed that the nudge texts were

significant with both variables. The reason for outcomes of positive significance might be that they analysed the stance towards CCF. Meanwhile, my study is the study of willingness to use CCF which might be difficult to change the respondent intention after reading a single nudged text.

In Finland, the dominant ownership is private owner, where most of the owner are of old generation. Mostly, the owned forest is shifted from one generation to other. As the ownership age structure shifts, there may be increased discussions on the uses of different forest management alternatives. So, there can be chances of changing decision regarding the uses of CCF. It means that preferences are a social construct, as social systems change, preferences will also change. Practically, private owners had chances of changing their decision or thought nudging because they do not have profound knowledge about the forest management and they were found to be skeptical, pragmatic, uncertain, and having a fatalistic orientation. They request to have some guidance for pro-climate and climate-responsive forest management where professionals could be a better options for guiding them in decision-making (Laakkonen *et al.* 2018). Professionals are dominant in decision-making even though private forest owners participated during the forest management decision-making. In many cases, professionals give information and suggestions to owners.

This study highlights the practical implication nudging can have on forestry and its role as a tool in enhancing or deteriorating prospects for forest sustainability. CCF may help to conserve biodiversity and provides more ecological services from the forest. These studies could be a pioneer for forestry as it provides enormous information for policymakers of the forest like how nudging influences the people's behavior and which nudge text plays a significant role in influencing.

CCF has emerged as one of the better options to manage the forest in ecological and social aspects but can be worst for economic factors compared to RFM

(Nordström *et al.* 2013). CCF is more profitable when compared to even-aged forestry, and forest owners can get more profit from CCF even with a high discount rate and poor growing areas. CCF is more suitable in the northern part of Finland (Pukkala *et al.* 2012). In contrast to the advantages of CCF, CCF may affect the growing bioeconomy of the Finnish forest as there is a low supply of timber with the more uses of CCF. This situation highlights the need for awareness among the forest owners about the alternative silviculture practice to maintain the bioeconomy of Finland (Heinonen *et al.* 2020).

Previous research by Eyvindson *et al.* (2021), Peura *et al.* (2018), and Pukkala (2016), all highlighted the importance of CCF and its multifunctionality in the forest. However, in reality, we cannot force the owners to use CCF only as they might have different priorities and may own their forests with some specific motives. Some have their forest for economic profit, and they might prefer RFM as they thought RFM is the best for economical benefits even though CCF provides good economical values. My result supports the prediction that nudge has a significant role in changing or influencing the stakeholder decision towards the selection of forest management alternatives. Our result also suggests that there will be a negative response when people read the MAJOR nudge text which focuses both on economic and ecological perspective of CCF. This study is all about the possibilities of changing the intention of people not about what exactly people do in the real context. This means that we expect that people can change their decisions after reading nudge text. We can influence them and changes their decision through a nudge but when it comes to use in their real forest, we can not strongly conform that they will act according to the results that we obtained. The implication of the nudge on actual terms of ecosystem services provision and biodiversity conservation could be further studied.

5 CONCLUSIONS

This study is about the implications of using nudging approaches to affect forest management embracement. Our result is applicable for policymakers as it brings understanding on how we can promote that more people use CCF in the forest. Interestingly, the results point that only by presenting the owner with a discussion putting CCF at the same level than RFM, can positively affect predisposition to practice CCF. Text that are very biased towards RFM or CCF can result with less embracement of CCF than text with no bias. Nudge can be beneficial tool that alters people's behaviour and attitude unknowingly, but it should be used with care. Many stakeholders still regard CCF as consistently less beneficial than RFM with respect to economic aspects. There is need of more information and awareness for them to understand that CCF is beneficial equally with RFM. This study is only looking at the intention of stakeholder, not what is the actual decision made in the real world. The fact that professionals did not react to nudge sets limitations to the applicability of nudge.

In the context of a Finnish forest, there is a variation in the ownership of forest. More than 60% of the forest are own by private owners. For this case, nudge can be a successful tool for influencing the owner's attitudes towards using various management alternatives, majorly towards CCF that maintains the sustainability of the forest. A single style of forest management cannot meet the objectives of every forest owner, so professional adapt and reflect the needs of the individual owner. Additionally, to meet the varied demands of the forest owner there will be an increased requirement to use different alternative silviculture practices in the forest.

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APPENDIX A: THE FOUR NUDGES

The originals are from Isoaho *et al.* (2019) supplementary data.

RFM

Even- or unevenaged forestry. The starting points for choosing forestry management are the aims of the foresters and the preconditions given by the site type and the existing trees. Changing from even-aged stands to unevenaged stands usually requires a long transition phase. In contrast, an uneven-aged stand can be turned into an even-aged one quickly with regeneration felling and subsequent regeneration duties. With even-aged forestry, you can distinguish between the regeneration and growth phases. With continuous-cover forestry, the forest remains mainly covered. Forest regeneration is usually based singularly on naturally grown undergrowth and the further development of this. For even-aged forestry, there are established and well-researched silvicultural and felling methods, of which there is also practical experience. Knowledge of methods pertaining to uneven-aged forestry still rest on a narrow research base and there is relatively little long-term experience.

Economic effects. Even-aged forestry presupposes investments into the regeneration of forests, especially if the area is regenerated artificially. Income focuses on regeneration felling. With uneven-aged forest management, the aim is mainly to harvest logs. In even-aged forestry, regeneration and tending of seedling stands are a significant cost. With uneven-aged forestry, the regeneration of forests when successful does not imply costs and the need for tending of seedling stands

is smaller. With even-aged forestry, you can collect logging residues and stumps for energy wood from regeneration felling.

Environmental and multifunctionality effects. In even-aged forestry, the cultivated forest area forms a mosaic of forest stands. Different forest stands in different developmental stages provide different habitats, the diversity of which are promoted by nature management. The variability of uneven-aged forests is beneficial for biodiversity but does not in itself guarantee the preservation or formation of structural features.

Damage risks. With the selection cutting of uneven-aged tree stands the risk for harvesting damage is especially high, when large trees are picked out among smaller trees which are left to grow. The risks for damage from moose, voles and wind depend on forest management practices and local conditions for both even- and uneven-aged tree stands. There are possibly differences between the two differing forest management practices when it comes to these kinds of risk, but there is little proven knowledge on the topic. In even-aged forests the risk for root-rot is smaller.

NEUTRAL

Even- or unevenaged forestry. The starting points for choosing forestry management are the aims of the foresters and the preconditions given by the place of growth and the existing tree stands. Changing from even-aged stands to

unevenaged stands usually requires a long transition phase. In contrast, an uneven-aged stand can be turned into an even-aged on quickly with regeneration felling and subsequent regeneration measures. Current growth models show that both can be economically profitable. With even-aged forestry, you can distinguish between the regeneration and growth phases. With continuous-cover forestry, the forest remains mainly covered. Forest regeneration is usually based singularly on naturally grown undergrowth and the further development of this. For even-aged forestry, there are established and well-researched silvicultural and felling methods, of which there is also practical experience. Internationally there is much knowledge on uneven-aged forestry, and also in Finland there are experts on continuous-cover forestry.

Economic effects. Even-aged forestry presupposes investments into the regeneration of forests. Income focuses on regeneration felling. With even-aged forestry, you can collect logging residue and stumps for energy for forest energy wood from regeneration felling. With uneven-aged forest management, the aim is mainly to harvest logs, which is far more valuable than forest energy wood. In even-aged forestry, regeneration and tending of seedling stands are a significant cost. In uneven-aged forestry forest regeneration usually does not imply costs.

Environmental and multifunctionality effects. In even-aged forestry, the cultivated forest area forms a mosaic of forest compartments. Different forest compartments in different developmental stages provide different habitats, the diversity of which are promoted by nature care. It is probable that a combination of uneven- and even-aged forestry management produces the greatest benefits for biodiversity.

Damage risks. In both even- and uneven-aged forestry, there are risks of harvesting damage from fellings. The risks for damage from moose, voles and wind depend on forest management practices and local conditions for both even-

and uneven-aged tree stands. There are possibly differences between the two differing forest management practices when it comes to these kinds of risk, but there is little tested knowledge on the topic. With uneven-aged forestry the risk for root-rot can be lessened with winter fellings, because snow and ice protect the trees left standing.

MINOR

Even- or unevenaged forestry. The starting points for choosing forestry management are the aims of the foresters and the preconditions given by the place of growth and the existing tree stands. Changing from even-aged stands to unevenaged stands usually requires a long transition phase. In contrast, an uneven-aged stand can be turned into an even-aged on quickly with regeneration felling and subsequent regeneration measures. Current growth models show that both can be economically profitable. With even-aged forestry, you can distinguish between the regeneration and growth phases. With continuous-cover forestry, the forest remains mainly covered. Forest regeneration is usually based singularly on naturally grown undergrowth and the further development of this. For even-aged forestry, there are established and well-researched silvicultural and felling methods, of which there is also practical experience. Internationally there is much knowledge on uneven-aged forestry, and also in Finland there are experts on continuous-cover forestry.

Economic effects. Even-aged forestry presupposes investments into the regeneration of forests Income focuses on regeneration felling. With even-aged forestry, you can collect logging residue and stumps for energy for forest energy

wood from regeneration felling. With uneven-aged forest management, the aim is mainly to harvest logs, wherefore income flows are significantly higher than in the case of e.g., harvesting of energy wood. In even-aged forestry, regeneration and tending to seedling stands cause significant cost flows. In uneven-aged forestry forest regeneration usually does not imply costs. The saved cost is freed for other use. In even-aged forestry regeneration fellings give rise to small income flows by harvesting logging residue and stumps into energy wood.

Environmental and multifunctionality effects. In even-aged forestry, the cultivated forest area forms a mosaic of forest compartments. Different forest compartments in different developmental stages provide different habitats, the diversity of which are promoted by nature care. It is probable that a combination of uneven- and even-aged forestry management produces the greatest benefits for biodiversity.

Damage risks. In light of recent Finnish research, forest management practices impact the risk of wind damage. Uneven-aged forests have been observed to lessen the risk for wind damage. With uneven-aged forestry the risk for root-rot can be lessened with winter fellings, because snow and ice protect the trees left standing. Root-rot also does not spread under temperatures below zero.

MAJOR

Even- or unevenaged forestry. The starting points for choosing forestry management are the aims of the foresters and the preconditions given by the place of growth and the existing tree stands. Changing from even-aged stands to unevenaged stands usually requires a long transition phase. In contrast, an uneven-aged stand can be turned into an even-aged on quickly with regeneration felling and subsequent regeneration measures. Current growth models show that both can be economically profitable. With even-aged forestry, you can distinguish between the regeneration and growth phases. With continuous-cover forestry, the forest remains mainly covered. Forest regeneration is usually based singularly on naturally grown undergrowth and the further development of this. For even-aged forestry, there are established and well-researched silvicultural and felling methods, of which there is also practical experience. Internationally there is much knowledge on uneven-aged forestry, and also in Finland there are experts on continuous-cover forestry.

Economic effects. Even-aged forestry presupposes investments into the regeneration of forests Income focuses on regeneration felling. With even-aged forestry, you can collect logging residue and stumps for energy for forest energy wood from regeneration felling. With uneven-aged forest management, the aim is mainly to harvest logs, wherefore income flows are significantly higher than in the case of e.g., harvesting of energy wood. In even-aged forestry, regeneration and tending to seedling stands cause significant cost flows. In uneven-aged forestry forest regeneration usually does not imply costs. The saved cost is freed for other use. In even-aged forestry regeneration fellings give rise to small income flows by harvesting logging residue and stumps into energy wood.

Environmental and multifunctionality effects. In even-aged forestry, the cultivated forest area forms a mosaic of forest compartments. Different forest compartments in different developmental stages provide different habitats, the diversity of which are promoted by nature care. An area with uneven-aged forest compartments enables a more unified end dense network of forest habitats, which according to modern research is beneficial for biodiversity. Uneven-aged forestry brings with it environmental and multifunctionality benefits also when combined with traditional even-aged forestry. The more rich forest in terms of biodiversity, the more numerous are also the health benefits provided to humans.

Damage risks. In light of recent Finnish research, forest management practices impact the risk of wind damage. With uneven-aged forestry the risk for root-rot can be lessened with winter fellings, because snow and ice protect the trees left standing. Root-rot also does not spread under temperatures below zero.

APPENDIX B: COMPARISION BETWEEN THE FOUR NUDGES

The originals are from Isoaho *et al.* (2019) supplementary data.

Below, we present the translations of the four nudges and their original Finnish versions (in brackets).

Reading instructions

GREY HIGHLIGHT: indicates that an information change has been made.

~~STRIKE THROUGH~~: indicates that a removal has been made.

GREY HIGHLIGHT IN BOLD: indicates that a linguistic nudge has been made.

RFM

EN-RFM1. Even- or unevenaged forestry. The starting points for choosing forestry management are the aims of the foresters and the preconditions given by the site type and the existing trees. Changing from even-aged stands to unevenaged stands usually requires a long transition phase. In contrast, an uneven-aged stand can be turned into an even-aged one quickly with regeneration felling and subsequent regeneration duties. With even-aged forestry, you can distinguish between the regeneration and growth phases. With continuous-cover forestry, the forest remains mainly covered. Forest regeneration is usually based singularly on naturally grown undergrowth and the further development of this. For even-aged forestry, there are established and well-researched silvicultural and felling methods, of which there is also practical experience. Knowledge of methods

pertaining to uneven-aged forestry still rest on a narrow research base and there is relatively little long-term experience.

(RFM1. Kasvatus tasa- tai eri-ikäisrakenteisena. Kasvatustavan valinnan lähtökohtana ovat metsänomistajan tavoitteet sekä kasvupaikan ja olemassa olevan puuston luomat edellytykset. Tasaikäisrakenteisen metsän kehittäminen eri-ikäisrakenteiseksi vaatii useimmiten pitkän siirtymävaiheen. Eri-ikäisrakenteinen metsä voidaan sen sijaan muuttaa nopeasti tasaikäisrakenteiseksi uudistushakkuulla ja sen jälkeisillä uudistamistöillä. Tasaikäisrakenteisen metsän kasvatuksessa on erotettavissa metsiköiden uudistamis- ja kasvatusvaihe. Eri-ikäisrakenteisena kasvatettaessa metsä säilyy pääosin peitteisenä. Metsän uudistuminen perustuu yleensä yksinomaan luontaisesti syntyneeseen alikasvokseen ja sen jatkokehittämiseen. Tasaikäisrakenteisen metsän kasvatuksessa käytettävissä ovat vakiintuneet ja hyvin tutkitut hoito- ja hakkuumenetelmät, joista on myös käytännön kokemusta. Tiedot eri-ikäisrakenteisen metsän kasvatuksessa käytettävistä menetelmistä ovat vielä kapean tutkimustiedon varassa ja pitkäaikaiset kokemukset ovat suhteellisen vähäiset.)

EN-RFM2. Economic effects. Even-aged forestry presupposes investments into the regeneration of forests, especially if the area is regenerated artificially. Income focuses on regeneration felling. With uneven-aged forest management, the aim is mainly to harvest logs. In even-aged forestry, regeneration and tending of seedling stands are a significant cost. With uneven-aged forestry, the regeneration of forests when successful does not imply costs and the need for tending of seedling stands

is smaller. With even-aged forestry, you can collect logging residues and stumps for energy wood from regeneration felling.

(RFM2. Talousvaikutuksia. Tasaikäiskasvatus edellyttää investointeja metsän uudistamiseen erityisesti, jos alue uudistetaan viljellen. Tulot painottuvat uudistushakkuuseen. Eri-ikäiskasvatuksessa tavoitteena on korjata hakkuissa pääasiassa tukkipuuta. Tasaikäiskasvatuksessa uudistaminen ja taimikonhoito ovat merkittävä kustannuserä. Eri-ikäisrakenteisen metsän kasvatuksessa metsän uudistaminen ei onnistuessaan aiheuta kustannuksia ja tarve taimikonhoidolle on vähäisempi. Tasaikäisrakenteisen metsän uudistushakkuualoilta voidaan korjata hakkuutähdettä ja kantoja energiapuuksi.)

EN-RFM3. Environmental and multifunctionality effects. In even-aged forestry, the cultivated forest area forms a mosaic of forest stands. Different forest stands in different developmental stages provide different habitats, the diversity of which are promoted by nature management. The variability of uneven-aged forests is beneficial for biodiversity but does not in itself guarantee the preservation or formation of structural features.

(RFM3. Ympäristö- ja monikäyttövaikutuksia. Tasaikäisrakenteisena kasvatettava metsäalue muodostaa metsikkökuvioiden mosaiikin. Eri kehitysvaiheissa olevat metsikkökuviot tarjoavat toisistaan poikkeavia elinympäristöjä, joiden monipuolisuutta edistetään luonnonhoidolla. Eri-ikäisrakenteiseen metsään liittyvä vaihtelevuus on eduksi luonnon

monimuotoisuudelle, mutta se ei sinällään vielä takaa rakennepiirteiden säilymistä tai muodostumista.)

EN-RFM4. Damage risks. With the selection cutting of uneven-aged tree stands the risk for harvesting damage is especially high, when large trees are picked out among smaller trees which are left to grow. The risks for damage from moose, voles and wind depend on forest management practices and local conditions for both even- and uneven-aged tree stands. There are possibly differences between the two differing forest management practices when it comes to these kinds of risk, but there is little proven knowledge on the topic. In even-aged forests the risk for root-rot is smaller.

(RFM4. Tuhoriskit. Eri-ikäisrakenteisen puuston poimintahakkuussa korjuuvaurioiden riski on erityisen suuri, kun suuria puita poimitaan kasvamaan jätettävien pienempien puiden seasta. Tasa- ja eri-ikäisrakenteisen puuston hirvi-, myyrä- ja tuulituhoriskit vaihtelevat puuston käsittelystä ja paikallisista oloista riippuen. Kasvatusmenetelmien välillä on mahdollisesti eroja näiden tuhojen riskissä, mutta todennettua tietoa tästä on niukasti. Tasaikäismetsässä juurikäävän riski on pienempi.)

NEUTRAL

EN-NEU1. *Even- or unevenaged forestry*. The starting points for choosing forestry management are the aims of the foresters and the preconditions given by the place of growth and the existing tree stands. Changing from even-aged stands to unevenaged stands usually requires a long transition phase. In contrast, an uneven-aged stand can be turned into an even-aged on quickly with regeneration felling and subsequent regeneration measures. ADDED: Current growth models show that both can be economically profitable. With even-aged forestry, you can distinguish between the regeneration and growth phases. With continuous-cover forestry, the forest remains mainly covered. Forest regeneration is usually based singularly on naturally grown undergrowth and the further development of this. For even-aged forestry, there are established and well-researched silvicultural and felling methods, of which there is also practical experience. ADDED: Internationally there is much knowledge on uneven-aged forestry, and also in Finland there are experts on continuous-cover forestry. ~~REMOVED: Knowledge of methods pertaining to uneven-aged forestry still rest on a narrow research base and there is relatively little long-term experience.~~

(NEU1. Kasvatus tasa- tai eri-ikäisrakenteisena. Kasvatustavan valinnan lähtökohtana ovat metsänomistajan tavoitteet sekä kasvupaikan ja olemassa olevan puuston luomat edellytykset. Tasaikäisrakenteisen metsän kehittäminen eri-ikäisrakenteiseksi vaatii useimmiten pitkän siirtymävaiheen. Eri-

ikäisrakenteinen metsä voidaan sen sijaan muuttaa nopeasti tasaikäisrakenteiseksi uudistushakkuulla ja sen jälkeisillä uudistamistöillä. Nykyiset kasvumallit osoittavat, että molemmat voivat olla taloudellisesti kannattavia. Tasaikäisrakenteisen metsän kasvatuksessa on erotettavissa metsiköiden uudistamis- ja kasvatusvaihe. Eri-ikäisrakenteisena kasvatettaessa metsä säilyy pääosin peitteisenä. Metsän uudistuminen perustuu yleensä yksinomaan luontaisesti syntyneeseen alikasvokseen ja sen jatkokehittämiseen. Tasaikäisrakenteisen metsän kasvatuksessa käytettävissä ovat vakiintuneet ja hyvin tutkitut hoito- ja hakkuumenetelmät, joista on myös käytännön kokemusta. Eri-ikäisrakenteisen metsän kasvatuksesta on kansainvälisesti paljon tietoa ja Suomessakin löytyy jo jatkuvan kasvatuksen osaavia toimijoita.**)**

EN-NEU2. Economic effects. Even-aged forestry presupposes investments into the regeneration of forests ~~REMOVED: especially if the area is grown artificially.~~ Income focuses on regeneration felling. ~~REMOVED: With uneven-aged forest management, the aim is mainly to harvest logs. In even-aged forestry, regeneration and tending of seedling stands are a significant cost. With uneven-aged forestry, the regeneration of forests when successful does not imply costs and the need for tending of seedling stands is smaller. With~~ even-aged forestry, you can collect logging residue and stumps for energy for forest energy wood from regeneration felling. ADDED: With uneven-aged forest management, the aim is mainly to harvest logs, which is far more valuable than forest energy wood. In even-aged forestry, regeneration and tending of seedling stands are a significant cost. ADDED: In uneven-aged forestry forest regeneration usually does not imply costs.

(NEU2. Talousvaikutuksia. Tasaikäiskasvatus edellyttää investointeja metsän uudistamiseen. Tulot painottuvat uudistushakkuuseen. Tasaikäisrakenteisen metsän uudistushakkuualoilta voidaan korjata hakkuutähdettä ja kantoja energiapuuksi. Eri-ikäiskasvatuksessa tavoitteena on korjata hakkuissa pääasiassa tukkipuuta, joka on paljon arvokkaampaa kuin energiapuu. Tasaikäiskasvatuksessa uudistaminen ja taimikonhoito ovat merkittävä kustannuserä. Eri-ikäisrakenteisen metsän kasvatuksessa metsän uudistaminen ei yleensä aiheuta kustannuksia. **)**

EN-NEU3. Environmental and multifunctionality effects. In even-aged forestry, the cultivated forest area forms a mosaic of forest compartments. Different forest compartments in different developmental stages provide different habitats, the diversity of which are promoted by nature care. ~~REMOVED: The variability of uneven-aged forests is beneficial for biodiversity but does not in itself guarantee the preservation or formation of structural traits.~~ ADDED: It is probable that a combination of uneven- and even-aged forestry management produces the greatest benefits for biodiversity.

(NEU3. Ympäristö- ja monikäyttövaikutuksia. Tasaikäisrakenteisena kasvatettava metsäalue muodostaa metsikkökuvioiden mosaiikin. Eri kehitysvaiheissa olevat metsikkökuviot tarjoavat toisistaan poikkeavia elinympäristöjä, joiden monipuolisuutta edistetään luonnonhoidolla. Eri-ikäisrakenteiseen metsään liittyvä vaihtelevuus on nykytutkimuksen mukaan eduksi luonnon monimuotoisuudelle. Yhdistelmä eri-ikäis- ja tasaikäisrakenteista

kasvatusta tuottaa todennäköisimmin suurimmat hyödyt luonnon monimuotoisuudelle.)

EN-NEU4. Damage risks. ~~REMOVED: With the selection cutting of uneven-aged tree stands the risk for harvesting damage is especially high, when large trees are picked out among smaller trees which are left to grow.~~ ADDED: In both even- and uneven-aged forestry, there are risks of harvesting damage from fellings. The risks for damage from moose, voles and wind depend on forest management practices and local conditions for both even- and uneven-aged tree stands. There are possibly differences between the two differing forest management practices when it comes to these kinds of risk, but there is little tested knowledge on the topic. ~~REMOVED: In even-aged forests the risk for root-rot is smaller.~~ ADDED: With uneven-aged forestry the risk for root-rot can be lessened with winter fellings, because snow and ice protect the trees left standing.

(NEU4. Tuhoriskit. Sekä tasa- että eri-ikäisrakenteisen puuston poimintahakkuussa syntyy korjuuvaurioiden riski. Tasa- ja eri-ikäisrakenteisen puuston hirvi-, myyrä- ja tuulituhoriskit vaihtelevat puuston käsittelystä ja paikallisista oloista riippuen. Kasvatusmenetelmien välillä on mahdollisesti eroja näiden tuhojen riskissä, mutta todennettua tietoa tästä on niukasti. Eri-ikäisrakenteisen kasvatusmenetelmän osalta juurikäävän riskiä voidaan pienentää talvihakkuilla, sillä lumi ja jää suojaavat jäljellejääneitä puita.)

MINOR

EN-MIN1. Even- or unevenaged forestry. The starting points for choosing forestry management are the aims of the foresters and the preconditions given by the place of growth and the existing tree stands. Changing from even-aged stands to unevenaged stands usually requires a long transition phase. In contrast, an uneven-aged stand can be turned into an even-aged on quickly with regeneration felling and subsequent regeneration measures. ADDED: Current growth models show that both can be economically profitable. With even-aged forestry, you can distinguish between the regeneration and growth phases. With continuous-cover forestry, the forest remains mainly covered. Forest regeneration is usually based singularly on naturally grown undergrowth and the further development of this. For even-aged forestry, there are established and well-researched silvicultural and felling methods, of which there is also practical experience. ADDED: Internationally there is much knowledge on uneven-aged forestry, and also in Finland there are experts on continuous-cover forestry. ~~REMOVED: Knowledge of methods pertaining to uneven-aged forestry still rest on a narrow research base and there is relatively little long-term experience.~~

(MIN1. Kasvatus tasa- tai eri-ikäisrakenteisena. Kasvatustavan valinnan lähtökohtana ovat metsänomistajan tavoitteet sekä kasvupaikan ja olemassa olevan puuston luomat edellytykset. Tasaikäisrakenteisen metsän kehittäminen eri-ikäisrakenteiseksi vaatii useimmiten pitkän siirtymävaiheen. Eri-

ikäisrakenteinen metsä voidaan sen sijaan muuttaa nopeasti tasaikäisrakenteiseksi uudistushakkuulla ja sen jälkeisillä uudistamistöillä. Nykyiset kasvumallit osoittavat, että molemmat voivat olla taloudellisesti kannattavia. Tasaikäisrakenteisen metsän kasvatuksessa on erotettavissa metsiköiden uudistamis- ja kasvatusvaihe. Eri-ikäisrakenteisena kasvatettaessa metsä säilyy pääosin peitteisenä. Metsän uudistuminen perustuu yleensä yksinomaan luontaisesti syntyneeseen alikasvokseen ja sen jatkokehittämiseen. Tasaikäisrakenteisen metsän kasvatuksessa käytettävissä ovat vakiintuneet ja hyvin tutkitut hoito- ja hakkuumenetelmät, joista on myös käytännön kokemusta. Eri-ikäisrakenteisen metsän kasvatuksesta on kansainvälisesti paljon tietoa ja Suomessakin löytyy jo jatkuvan kasvatuksen osaavia toimijoita.)

EN-MIN2. Economic effects. Even-aged forestry presupposes investments into the regeneration of forests ~~REMOVED: especially if the area is grown artificially.~~ Income focuses on regeneration felling. ~~REMOVED: With uneven-aged forest management, the aim is mainly to harvest logs. In even-aged forestry, regeneration and tending of seedling stands are a significant cost. With uneven-aged forestry, the regeneration of forests when successful does not imply costs and the need for tending of seedling stands is smaller.~~ With even-aged forestry, you can collect logging residue and stumps for energy for forest energy wood from regeneration felling. ADDED: With uneven-aged forest management, the aim is mainly to harvest logs, ~~REMOVED: which is far more valuable than forest energy wood~~ **ADDED: wherefore income flows are significantly higher than in the case of e.g. harvesting of energy wood.** ~~REMOVED: In even-aged forestry, regeneration and tending of seedling stands are a significant cost.~~ **ADDED: In even-aged forestry, regeneration and tending to seedling stands cause significant cost flows.** ADDED: In uneven-aged forestry forest regeneration usually does not imply costs. **ADDED: The saved cost is freed for other use.**

ADDED: In even-aged forestry regeneration fellings give rise to small income flows by harvesting logging residue and stumps into energy wood.

(MIN2. Talousvaikutuksia. Tasaikäiskasvatus edellyttää investointeja metsän uudistamiseen. Tulot painottuvat uudistushakkuuseen. Eri-ikäiskasvatuksessa tavoitteena on korjata hakkuissa pääasiassa tukkipuuta, mistä syystä tulovirrat ovat huomattavasti runsaammat kuin esim. energiapuun korjuussa. Tasaikäiskasvatuksessa uudistaminen ja taimikonhoito aiheuttavat merkittäviä menovirtoja. Eri-ikäisrakenteisen metsän kasvatuksessa metsän uudistaminen ei yleensä aiheuta menovirtoja. Säästetty kustannus vapautuu muuhun käyttöön. Tasaikäisrakenteisen metsän uudistushakkuualoilta saadaan pieniä tulovirtoja korjaamalla hakkuutähdettä ja kantoja energiapuuksi.)

EN-MIN3. Environmental and multifunctionality effects. In even-aged forestry, the cultivated forest area forms a mosaic of forest compartments. Different forest compartments in different developmental stages provide different habitats, the diversity of which are promoted by nature care. ~~REMOVED: The variability of uneven-aged forests is beneficial for biodiversity but does not in itself guarantee the preservation or formation of structural traits.~~ ADDED: It is probable that a combination of uneven- and even-aged forestry management produces the greatest benefits for biodiversity.

(MIN3. Ympäristö- ja monikäyttövaikutuksia. Tasaikäisrakenteisena kasvatettava metsäalue muodostaa metsikkökuvioiden mosaiikin. Eri

kehitysvaiheissa olevat metsikkökuviot tarjoavat toisistaan poikkeavia elinympäristöjä, joiden monipuolisuutta edistetään luonnonhoidolla. Eri-ikäisrakenteiseen metsään liittyvä vaihtelevuus on nykytutkimuksen mukaan eduksi luonnon monimuotoisuudelle. Yhdistelmä eri-ikäis- ja tasaikäisrakenteista kasvatusta tuottaa todennäköisimmin suurimmat hyödyt luonnon monimuotoisuudelle.)

EN-MIN4. Damage risks. ~~REMOVED: With the selection cutting of uneven-aged tree stands the risk for harvesting damage is especially high, when large trees are picked out among smaller trees which are left to grow.~~ ADDED: In light of recent Finnish research, forest management practices impact the risk of wind damage. ~~REMOVED: In both even- and uneven-aged forestry, there are risks of harvesting damage from fellings. REMOVED: The risks for damage from moose, voles and wind depend on forest management practices and local conditions for both even- and uneven-aged tree stands. There are possibly differences between the two differing forest management practices when it comes to these kinds of risk, but there is little tested knowledge on the topic.~~ ADDED: Uneven-aged forests have been observed to lessen the risk for wind damage. ~~REMOVED: In even-aged forests the risk for root-rot is smaller.~~ ADDED: With uneven-aged forestry the risk for root-rot can be lessened with winter fellings, because snow and ice protect the trees left standing. ADDED: Root-rot also does not spread under temperatures below zero.

(MIN4. Tuhoriskit. Sekä tasa- että eri-ikäisrakenteisen puuston poimintahakkuussa syntyy korjuuvaurioiden riski. Tuoreen suomalaisen tutkimustiedon valossa metsän käsittely vaikuttaa tuulituhoriskiin. Eri-

ikäisrakenteisen metsän on havaittu vähentävän tuulituhoriskiä. Eri-ikäisrakenteisen kasvatusmenetelmän osalta juurikäävän riskiä voidaan pienentää talvihakkuilla, sillä lumi ja jää suojaavat jäljellejääneitä puita. Juurikääpä ei myöskään leviä nollan asteen alapuolella.)

MAJOR

EN-MAJ1. Even- or unevenaged forestry. The starting points for choosing forestry management are the aims of the foresters and the preconditions given by the place of growth and the existing tree stands. Changing from even-aged stands to unevenaged stands usually requires a long transition phase. In contrast, an uneven-aged stand can be turned into an even-aged on quickly with regeneration felling and subsequent regeneration measures. ADDED: Current growth models show that both can be economically profitable. With even-aged forestry, you can distinguish between the regeneration and growth phases. With continuous-cover forestry, the forest remains mainly covered. Forest regeneration is usually based singularly on naturally grown undergrowth and the further development of this. For even-aged forestry, there are established and well-researched silvicultural and felling methods, of which there is also practical experience. ADDED: Internationally there is much knowledge on uneven-aged forestry, and also in Finland there are experts on continuous-cover forestry. ~~REMOVED: Knowledge of methods pertaining to uneven-aged forestry still rest on a narrow research base and there is relatively little long-term experience.~~

(MAJ1. Kasvatus tasa- tai eri-ikäisrakenteisena. Kasvatustavan valinnan lähtökohtana ovat metsänomistajan tavoitteet sekä kasvupaikan ja olemassa

olevan puuston rakenteen luomat edellytykset. Tasaikäisrakenteisen metsän kehittäminen eri-ikäisrakenteiseksi vaatii useimmiten pitkän siirtymävaiheen. Eri-ikäisrakenteinen metsä voidaan sen sijaan muuttaa nopeasti tasaikäisrakenteiseksi uudistushakkuulla ja sen jälkeisillä uudistamistöillä. Nykyiset kasvumallit osoittavat, että molemmat voivat olla taloudellisesti kannattavia mutta useimmiten eri-ikäisrakenteinen kasvatus tuottaa metsänomistajalle suuremmat tulot. Tasaikäisrakenteisen metsän kasvatuksessa on erotettavissa metsiköiden uudistamis- ja kasvatusvaihe. Eri-ikäisrakenteisena kasvatettaessa metsä säilyy pääosin peitteisenä. Metsän uudistuminen perustuu luontaisesti syntyneeseen alikasvokseen ja sen jatkokehittämiseen. Tasaikäisrakenteisen metsän kasvatuksessa käytettävissä ovat vakiintuneet ja hyvin tutkitut hoito- ja hakkuumenetelmät, joista on myös käytännön kokemusta. Eri-ikäisrakenteisen metsän kasvatuksesta on kansainvälisesti paljon tietoa ja Suomessakin löytyy jo jatkuvan kasvatuksen osaavia toimijoita.)

EN-MAJ2. Economic effects. Even-aged forestry presupposes investments into the regeneration of forests ~~REMOVED: especially if the area is grown artificially. Income~~ focuses on regeneration felling. ~~REMOVED: With uneven-aged forest management, the aim is mainly to harvest logs. In even-aged forestry, regeneration and tending of seedling stands are a significant cost. With uneven-aged forestry, the regeneration of forests when successful does not imply costs and the need for tending of seedling stands is smaller.~~ With even-aged forestry, you can collect logging residue and stumps for energy for forest energy wood from regeneration felling. ADDED: With uneven-aged forest management, the aim is mainly to harvest logs, ~~REMOVED: which is far more valuable than forest energy wood~~ **ADDED: wherefore income flows are significantly higher than in the case of e.g. harvesting of energy wood.** ~~REMOVED: In even-aged forestry,~~

~~regeneration and tending of seedling stands are a significant cost.~~ ADDED: In even-aged forestry, regeneration and tending to seedling stands cause significant cost flows. ADDED: In uneven-aged forestry forest regeneration usually does not imply costs. **ADDED: The saved cost is freed for other use. ADDED: In even-aged forestry regeneration fellings give rise to small income flows by harvesting logging residue and stumps into energy wood.**

(MAJ2. Talousvaikutuksia. Tasaikäiskasvatus edellyttää investointeja metsän uudistamiseen. Tulot painottuvat uudistushakkuuseen. Eri-ikäiskasvatuksessa tavoitteena on korjata hakkuissa pääasiassa tukkipuuta, mistä syystä tulovirrat ovat huomattavasti runsaammat kuin esim. energiapuun korjuussa. Tasaikäiskasvatuksessa uudistaminen ja taimikonhoito aiheuttavat merkittäviä menovirtoja. Eri-ikäisrakenteisen metsän kasvatuksessa metsän uudistaminen ei aiheuta menovirtoja. Säästetty kustannus vapautuu muuhun käyttöön. Tasaikäisrakenteisen metsän uudistushakkuualoilta voidaan saada pieniä tulovirtoja korjaamalla hakkuutähdettä ja kantoja energiapuuksi.)

EN-MAJ3. Environmental and multifunctionality effects. In even-aged forestry, the cultivated forest area forms a mosaic of forest compartments. Different forest compartments in different developmental stages provide different habitats, the diversity of which are promoted by nature care. ~~REMOVED: The variability of uneven-aged forests is beneficial for biodiversity but does not in itself guarantee the preservation or formation of structural traits. REMOVED: It is probable that a combination of uneven- and even-aged forestry management produces the greatest benefits for biodiversity.~~ **ADDED: An area with uneven-aged forest compartments enables a more unified end dense network of forest habitats,**

which according to modern research is beneficial for biodiversity. Uneven-aged forestry brings with it environmental and multifunctionality benefits also when combined with traditional even-aged forestry. The more rich forest in terms of biodiversity, the more numerous are also the health benefits provided to humans.

(MAJ3. Ympäristö- ja monikäyttövaikutuksia. Tasaikäisrakenteisena kasvatettava metsäalue muodostaa metsikkökuvioiden mosaiikin. Eri kehitysvaiheissa olevat metsikkökuviot tarjoavat toisistaan poikkeavia elinympäristöjä, joiden monipuolisuutta edistetään luonnonhoidolla. Eri-ikäisrakenteisten metsikkökuvioiden alue mahdollistaa yhtenäisemmän ja tiheämmän metsäisten elinympäristöjen verkoston, joka on nykytutkimuksen mukaan eduksi luonnon monimuotoisuudelle. Eri-ikäisrakenteisen metsän kasvatus tuo ympäristö- ja monikäyttöhyötyjä myös yhdistettynä perinteiseen tasaikäisrakenteiseen kasvatustapaan. Mitä monimuotoisuudeltaan rikkaampi metsä, sitä runsaammat ovat myös sen ihmiselle tarjoamat terveyshyödyt.)

EN-MAJ4. Damage risks. ~~REMOVED: With the selection cutting of uneven-aged tree stands the risk for harvesting damage is especially high, when large trees are picked out among smaller trees which are left to grow.~~ ADDED: In light of recent Finnish research, forest management practices impact the risk of wind damage. ~~REMOVED: In both even- and uneven-aged forestry, there are risks of harvesting damage from fellings. REMOVED: The risks for damage from moose, voles and wind depend on forest management practices and local conditions for both even- and uneven-aged tree stands. There are possibly differences between the two differing forest management practices when it comes to these kinds of risk, but~~

~~there is little tested knowledge on the topic.~~ ADDED: Uneven-aged forests have been observed to lessen the risk for wind damage. ~~REMOVED: In even-aged forests the risk for root-rot is smaller.~~ ADDED: With uneven-aged forestry the risk for root-rot can be lessened with winter fellings, because snow and ice protect the trees left standing. ADDED: Root-rot also does not spread under temperatures below zero.

(MAJ4. Tuhoriskit. Sekä tasa- että eri-ikäisrakenteisen puuston poimintahakkuussa syntyy korjuuvaurioiden riski. Tuoreen suomalaisen tutkimustiedon valossa metsän käsittely vaikuttaa tuulituhoriskiin. Eri-ikäisrakenteisen metsän on havaittu vähentävän tuulituhoriskiä. Eri-ikäisrakenteisen kasvatusmenetelmän osalta juurikäävän riskiä voidaan pienentää talvihakkuilla, sillä lumi ja jää suojaavat jäljellejääneitä puita. Juurikääpä ei myöskään leviä nollan asteen alapuolella.)

APPENDIX C: DESIGN OF NUDGES

The originals are from Isoaho *et al.* (2019) supplementary data.

In the design of our four different versions of the same extract from the Tapio guidelines, we changed both the informational content and the wording of the texts. We did this in a logical and consecutive order and in a way that does not confuse the two. Here is a detailed explanation of the process:

First, we abbreviated the existing text comparing even-aged and uneven-aged forestry, keeping both the content and the wordings (this is the RFM). Then, in close collaboration with experts on uneven-aged forestry, we changed the informational content of this original text to place the two forestry management practices on a par (this became the NEUTRAL; the RFM was informationally biased towards even-aged management).

However, only after having made these informational changes did, we proceed with the nudge in the second sense mentioned, that is, only changing the wording but not the contents of the text. In the third and next version of the NEUTRAL – that is, the MINOR – we changed the wordings pertaining to economic aspects of the two forestry management practices so that they emphasize" flows". The relevant extracts for NEUTRAL and MINOR are as follows (with the modified sentences highlighted in **bold**):

EN-NEU2: ADDED: With uneven-aged forest management, the aim is mainly to harvest logs, which is far more valuable than forest energy wood. In even-aged forestry, regeneration and tending of seedling stands are a significant cost. ADDED: In uneven-aged forestry forest regeneration usually does not imply costs.

EN-MIN2: ADDED: With uneven-aged forest management, the aim is mainly to harvest logs, ~~REMOVED: which is far more valuable than forest energy wood~~ **ADDED: wherefore income flows are significantly higher than in the case of e.g. harvesting of energy wood.** ~~REMOVED: In even-aged forestry, regeneration and tending of seedling stands are a significant cost.~~ **ADDED: In even-aged forestry, regeneration and tending to seedling stands cause significant cost flows.** ADDED: In uneven-aged forestry forest regeneration usually does not imply costs. **ADDED: The saved cost is freed for other use. ADDED: In even-aged forestry regeneration fellings give rise to small income flows by harvesting logging residue and stumps into energy wood.**

Finally, to this MINOR text we added – in the fourth and final MAJOR text – the following modification (**bolded**):

EN-MIN3: ***Environmental and multifunctionality effects***. In even-aged forestry, the cultivated forest area forms a mosaic of forest compartments. Different forest compartments in different developmental stages provide different habitats, the diversity of which are promoted by nature care. ~~REMOVED: The variability of uneven-aged forests is beneficial for biodiversity but does not in itself guarantee the preservation or formation of structural traits.~~ ADDED: It is probable that a combination of uneven- and even-aged forestry management produces the greatest benefits for biodiversity.

EN-MAJ3. Environmental and multifunctionality effects. In even-aged forestry, the cultivated forest area forms a mosaic of forest compartments. Different forest compartments in different developmental stages provide different habitats, the diversity of which are promoted by nature care. ~~REMOVED: The variability of uneven-aged forests is beneficial for biodiversity but does not in itself guarantee the preservation or formation of structural traits. REMOVED: It is probable that a combination of uneven- and even-aged forestry management produces the greatest benefits for biodiversity.~~ **ADDED: An area with uneven-aged forest compartments enables a more unified end dense network of forest habitats, which according to modern research is beneficial for biodiversity. Uneven-aged forestry brings with it environmental and multifunctionality benefits also when combined with traditional even-aged forestry. The more rich forest in terms of biodiversity, the more numerous are also the health benefits provided to humans.**

In sum, thus, RFM and NEUTRAL are on a par (with informational changes) and MINOR and MAJOR are on a par (with linguistic nudge changes). With this strategy, we achieved a way of testing for both the change in informational contents only as well as, additionally, for effects of linguistic nudging.