Universitat de Lleida

Social capital in rural areas and governance of economic instruments for Non-Wood Forest Products: the case of mushrooms in Catalonia

Elena Górriz Mifsud

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Memory presented to opt for the Doctoral degree by the
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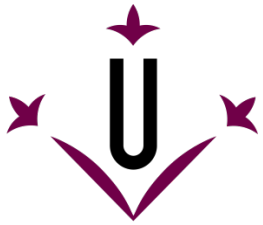

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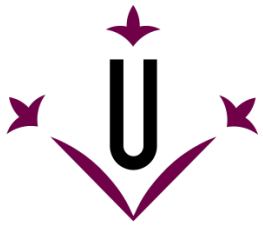

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PhD supervisors

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2017

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How your network helps you in achieving your personal projects has been evident in the attainment of this thesis. Conceptualising the doctoral work as an initiation, I had the pleasure to be embedded in a wide, demanding and heartening "tribe", and I'm grateful to all of them (even if not all listed down below).

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I have to express my gratitude as well to Irina Prokofieva and Elsa Varela for accompanying in the process, and especially for their valuable comments on the first paper. Thanks also to Valentino for putting light in the econometrics world and to Marko Lovric for initial insights on the questionnaire development. Special thanks also to Enrico Vidale for transmitting the passion for the fungal world as well as for pushing always towards the practical side of life. Gràcies also to Sara Sánchez for introducing me to the mushroom picking world. Grazie mille as well to Alessandro Leonardi and to Chiara Carletto for the stimulating talks while hosting me in Padova. And big thank you to the TESAF team, which has nicely adopted me during these years.

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Valbona, Teruel, 2017

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ABSTRACT

The concept of social capital (SC) within the forest governance field encompasses networks, norms and values of local communities that determine cooperation and contribute to their development. The linkages among community characteristics affect the implementation of forest policy instruments, and enlighten on the variables policy-makers and practitioners have to put attention beyond traditional technical factors or individual incentives.

A dynamic, nested model is proposed along the policy cycle, highlighting the relevant forest governance and SC variables related in a context where collective action is desirable. Institutions (i.e. norms) and networks are conceived as elements bridging the SC and governance divides. The case study of a mushroom picking permit introduction in the protected area of Poblet (north-eastern Spain) provides evidence of some relations of the model. The alignment of the traditional ecological knowledge between mushroom pickers and decision-makers seems to indicate a similar perception of the need for a governance reform.

The Social Network Analysis illustrates the structural evolution of the decision-makers from the policy conception to the implementation phases. The structural SC dynamics jointly with the correlation of rather influential connections with local pickers denotes an accurate transmission of pickers' preferences into the policy formulation phase. Moreover, the low trust towards foreign pickers underlies the positive discrimination of locals in the permit, given that outsider pickers are felt out of reach of the informal community enforcement means. Thus, the policy of a permit serves to align foreigners' behaviour with that of the locals –perceived as sustainable. The synergies between the different SC dimensions probably signify the wide acceptance and engagement with the permit in its first years of implementation. Beyond non-wood forest products, this model applies in

forest policies entailing cooperation among open-access resource users, or landowners' coordination for adjacency externalities or upscaling.

In addition, the perception of property (i.e. harvesting) rights and of pickers-caused nuisances (both tangible and intangible) shape the positioning of private forest owners regarding the wild mushroom governance. Forest owners widely advocate for the introduction of a specific regulation at the regional level; most of them support a picking fee that is reinvested in the forest tending; and half of them would like to establish a mushroom reserve with their neighbours. Socio-economic and ecological variables -like farming occupation, proximity to large cities and fungal productivity of the forest- influence their preferences.

RESUMEN

El concepto de capital social (CS) dentro del ámbito de la gobernanza forestal abarca las redes, normas y valores de las comunidades locales que determinan la cooperación entre sus miembros y contribuyen a su desarrollo. La interconexión entre las características de la comunidad afecta a la implementación de los instrumentos de política forestal, e informa a decisores y técnicos sobre las variables en las que han de enfocar su atención, más allá de los factores técnicos tradicionales o los incentivos individuales.

En esta tesis se propone un modelo anidado y dinámico a lo largo del ciclo político, remarcando la relación entre variables de CS y de gobernanza forestal en el contexto de una reforma donde la acción colectiva es deseable. Las instituciones (ej. normas) y redes se conceptualizan como elementos puente entre el CS y la gobernanza. El caso de estudio de la introducción de un permiso de recogida de setas en el área protegida de Poblet (noreste de España) evidencia algunas relaciones del modelo. La alineación del conocimiento ecológico tradicional entre recolectores y decisores parece indicar una percepción similar de la necesidad de una reforma del sistema de gobernanza.

El análisis de redes sociales ilustra la evolución estructural de los decisores desde la fase de concepción de la política hasta su implementación. La dinámica del CS estructural, junto con la correlación de sus conexiones medianamente influyentes con los recolectores locales, denota una transmisión certera de las preferencias de los recolectores en la fase de formulación de la política. Asimismo, la baja confianza hacia los recolectores foráneos subyace en la discriminación positiva de los locales en el permiso, dado que perciben que los recolectores foráneos están fuera del alcance de los medios de control informal de la comunidad rural. Por tanto, la política de un permiso sirve para alinear el comportamiento de los foráneos con el de los locales –percibida como sostenible. Las sinergias entre las diferentes dimensiones del CS probablemente explican la amplia aceptación del

permiso en sus primeros años de implementación. Más allá de los productos forestales no madereros, este modelo es aplicable a otras políticas forestales que requieran cooperación entre los usuarios de recursos de libre acceso, o bien la coordinación de los propietarios para las externalidades de adyacencia o para aumentar la escala de gestión.

Además, la percepción de los derechos de propiedad (ej. recolección) y de los daños causados por los recolectores (tanto tangibles como intangibles) determinan el posicionamiento de los propietarios forestales privados respecto a la gobernanza de las setas silvestres. Los propietarios forestales propugnan de forma mayoritaria la introducción de una regulación específica a nivel regional; la mayoría de ellos apoya una tasa para la recogida de setas que sea reinvertida en el cuidado del bosque; y la mitad de ellos querría participar en un acotado de setas con sus propietarios vecinos. Algunas variables socio-económicas y ecológicas -como la ocupación en el sector primario, la proximidad a las capitales de provincia y la productividad micológica de su bosque- influencian sus preferencias.

RIASSUNTO

La nozione di capitale sociale (CS), nell'ambito della *governance* forestale, comprende tutte quelle reti, norme e valori delle comunità locali fondamentali per generare cooperazione e per contribuire al loro sviluppo. Le differenti norme che le comunità usano per relazionarsi influiscono sul processo d'implementazione di strumenti di politica forestale; inoltre contribuiscono ad esplicitare su quali variabili i decisori politici ed i professionisti di settore debbano focalizzarsi per non limitarsi ad utilizzare i tradizionali fattori tecnici o incentivi individuali.

Per poter meglio concettualizzare tali variabili, é stato proposto un modello dinamico e nidificato lungo il ciclo normativo, che possa evidenziare i modelli rilevanti di *governance* forestale e tutte quelle variabili relative al CS che evidenziano contesti con un'elevata cooperazione locale. Le istituzioni (ovvero le norme) e le reti sono concepite come elementi ponte per ridurre il divario tra CS e *governance* forestale. Tale modello è stato applicato con successo ad un caso studio reale, consistente nell'introduzione di un sistema di permessi per disciplinare la raccolta di funghi nella zona protetta di Poblet (localizzata nella Spagna nordoccidentale). L'allineamento delle conoscenze tradizionali ecologiche tra raccoglitori di funghi e decisori politici sembrerebbe indicare un comune bisogno di una riforma della *governance*.

L'analisi delle reti sociali dei decisori politici riassume l'evoluzione del processo decisionale, dall'ideazione della normativa fino alla sua implementazione. Le dinamiche strutturali del CS, insieme alle influenti connessioni con i raccoglitori locali di funghi, denotano un'accurata trasmissione delle preferenze dei raccoglitori nella fase di formulazione normativa. Inoltre, la scarsa fiducia verso i raccoglitori stranieri (non locali) bene illustra la positiva discriminazione dei locali nel sistema di permessi, poiché i raccoglitori stranieri sono considerati essere fuori dal raggio di azione dei mezzi esecutivi informali della comunità. Questo suggerisce che un sistema di permessi può servire per riallineare il comportamento dei

raccoglitori stranieri con quello dei locali, quest'ultimo generalmente percepito come maggiormente sostenibile. La sinergia tra le varie dimensioni di CS probabilmente può essere tradotta in un'ampia approvazione con il sistema di permessi nei suoi primi anni d'implementazione. Pur essendo applicato nell'ambito di prodotti forestali non legnosi (la raccolta di funghi), questo modello può essere esteso a tutte quelle politiche forestali che esigano una cooperazione tra gli utilizzatori delle risorse o che necessitino di una forte coordinazione dei proprietari forestali per la gestione di esternalità contigue o per aumentarne il valore.

In secondo luogo, la percezione di diritti di proprietà sulla raccolta dei funghi e di disturbi legati al comportamento dei raccoglitori (sia intangibili che tangibili), modifica il posizionamento dei proprietari forestali in riguardo alle politiche di gestione della raccolta dei funghi. I proprietari forestali domandano fortemente l'introduzione di una regolamentazione *ad hoc* a livello regionale: la maggioranza di questi é in favore ad una tassa sulla raccolta che sia successivamente reinvestita nella gestione forestale; metà degli intervistati risulta essere in favore alla realizzazione di una zona di riserva micologica con la collaborazione dei proprietari contigui. Variabili socioeconomiche ed ecologiche, come l'occupazione del proprietario nel settore primario, la vicinanza a grossi nuclei urbani e la produttività micologica del bosco, contribuiscono ad influenzare addizionalmente le loro preferenze finali.

RESUM

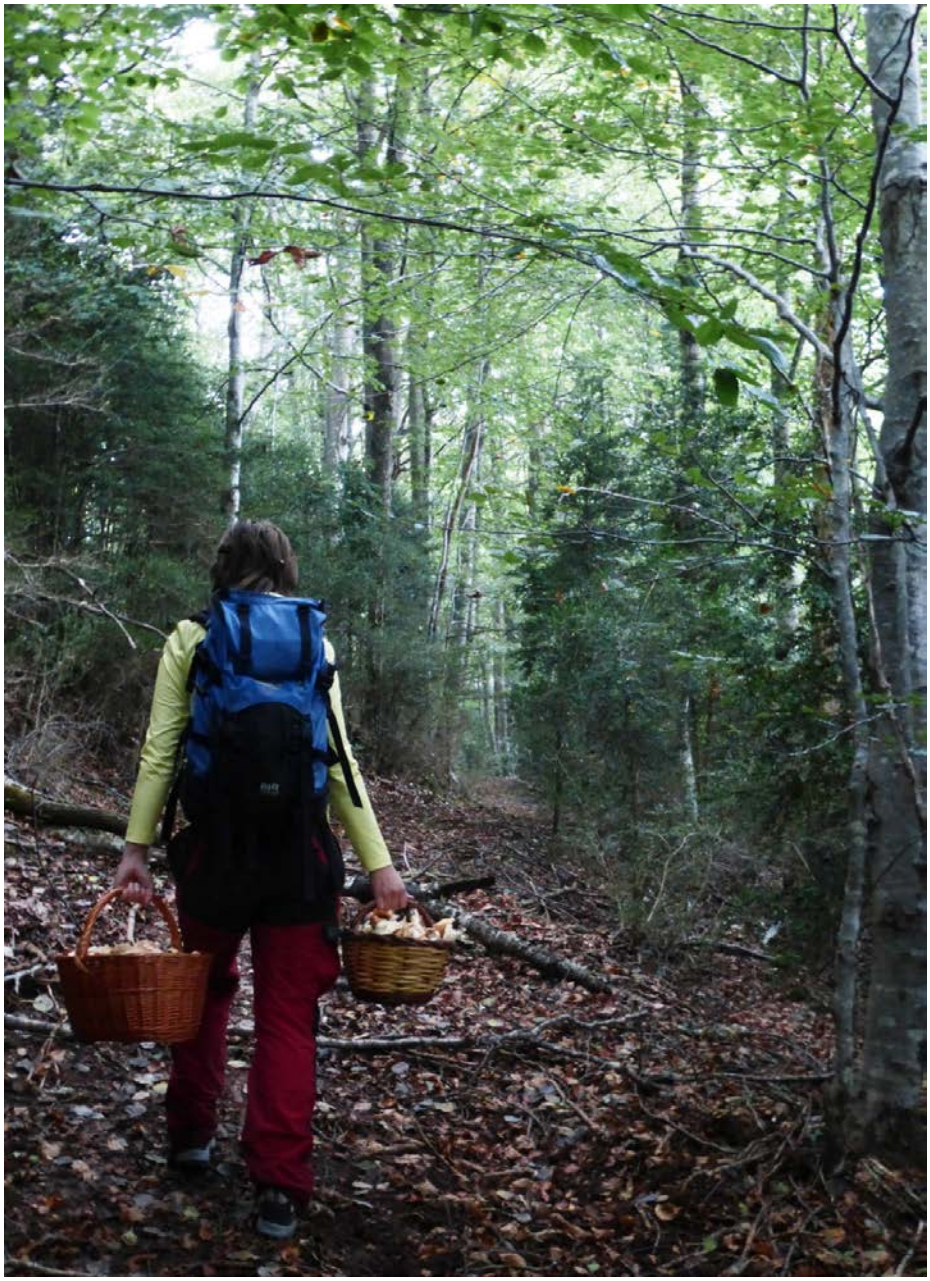
El concepte de capital social (CS) dins de l'àmbit de la governança forestal abasta les xarxes, normes i valors de les comunitats locals que determinen la cooperació entre els seus membres i contribueixen al seu desenvolupament. La interconnexió entre les característiques de la comunitat afecta la implementació dels instruments de política forestal, e informa a decisors i tècnics sobre les variables en que han de focalitzar-se, més enllà dels factors tècnics tradicionals o els incentius individuals.

En aquesta tesi es proposa un model niat i dinàmic al llarg del cicle polític, remarcant la relació entre variables de CS i de governança forestal en el context d'una reforma on l'acció col·lectiva es desitjable. Les institucions (ex. normes) i xarxes es conceptualitzen com a elements pont entre el CS i la governança. El cas d'estudi de la introducció d'un permís de recollida de bolets a l'àrea protegida de Poblet (nord-est d'Espanya) evidencia algunes relacions del model. La alineació del coneixement ecològic tradicional entre boletaires i decisors sembla indicar una percepció similar de la necessitat d'una reforma del sistema de governança.

L'anàlisi de les xarxes socials il·lustra la evolució estructural dels decisors des de la fase de concepció de la política fins a la seua implementació. La dinàmica del CS estructural junt amb la correlació de les seues connexions mitjanament influents amb els boletaires locals denota una transmissió adient de les preferències dels boletaires en la fase de formulació de la política. Així mateix, la baixa confiança cap als boletaires forans subjeu en la discriminació positiva dels locals al permís, donat que perceben que els boletaires forans estan fora de l'abast dels mitjans de control informal de la comunitat rural. Per tant, la política d'un permís serveix per a alinear el comportament dels forans amb el dels locals –percebuda com a sostenible. Les sinèrgies entre les diferents dimensions del CS probablement expliquen la amplia acceptació del permís durant els seus primers anys d'implementació. Més enllà dels productes forestals no fusters, aquest model

és aplicable en polítiques forestals que requereixen cooperació entre els usuaris de recursos d'accés lliure, o bé la coordinació dels propietaris per a les externalitats d'adjacència o per augmentar la escala de gestió.

A més, la percepció dels drets de propietat (ex. recol·lecció) i de les molèsties causades pels boletaires (tant tangibles com intangibles) determinen el posicionament dels propietaris forestals privats respecte a la governança dels bolets silvestres. Els propietaris forestals propugnen de forma majoritària la introducció d'una regulació específica a nivell català; la majoria recolza una taxa per la recollida de bolets que es reinvertisca en el cuidat del bosc; i la meitat d'ells voldria participar en un vedat de bolets amb els seus propietaris veïns. Algunes variables socioeconòmiques i ecològiques -com la ocupació al sector primari, la proximitat a les capitals de província i la productivitat micològica del seu bosc- influencien les seues preferències.



1. Introduction

Non-wood forest products (NWFPs) from Mediterranean forests have an important role in the rural economies for their edible, medicinal, construction or industrial material, or decoration uses (Merlo and Croitoru, 2005). The wide variety of edible NWFPs includes i.a. chestnuts, mushrooms, truffles, pine seeds, wild asparagus, arbutus fruit or lentisc. Many NWFPs are by economic nature a common-pool resource, as they are individually consumable (rival) and accessible to anyone (non-excludable) as far as forests are not fenced (Merlo and Rojas Briales, 2000; Ostrom and Ostrom, 1977). However, their official property rights depend on the formal institutions in each location (Bouriaud and Schmithüsen, 2005). *De jure* rights of NWFPs assign NWFP ownership either to landowners, tenants, to anyone, to authorised pickers, etc. Nevertheless, there may be informal perceptions of to whom NWFPs belong, which overlook the legislation, and are rather based on tradition or recurrent interactions with the resource. On the one side, people periodically visiting a forest area often develop feelings of attachment, i.e. psychological ownership (Pierce et al., 2003). On the other side, traditions linked to certain forests constitute cultural symbols that relate current with past generations and contribute to build group values and identities (Swidler, 1986). Both phenomena shape actual patterns of understanding of the resource at the local level, and its related behaviour (e.g. picking practices). Therefore, in the absence of strong enforcement, informal norms may emerge and prevail over formal rights. These norms can also count with some sort of informal or social control and punishment (Bowles and Gintis, 2002).

Ostrom (1990) puts forward that in close community systems with clear resource usage norms, such "informal" setting of harvesting rights could in principle be sustainable. However, the improved transport options permit

that our society increasingly displaces. This means that forests are receiving now NWFP pickers from farther away. These pickers may not necessarily share the local community norms and add pressure over the resource. This may be more explicit in forests located in rural areas receiving pickers from urban districts as occurring in Spain (Górriz-Mifsud et al., 2015), or immigrant pickers as it happens in USA (e.g. McLain, 2008) or in Finland (e.g. Richards and Saastamoinen, 2010).

Moreover, informal settings remain statistically invisible, which precludes from proper sustainability analysis and from rational resource usage planning (Vantomme, 2003). Enforced permit systems, for example, allow recording this activity (Wilsey and Nelson, 2008). Only a few attempts to account the value of NWFP exist, often based on estimations and reflecting only the formal market. Yet, they show their relevance in the Mediterranean context (Masiero et al., 2016; Merlo and Croitoru, 2005). NWFP picking emerges as an interesting activity given their attractive market price, and frequently also recreational value (Díaz Balteiro, 2015; Martínez de Aragón et al., 2011). Indeed, NWFP are increasingly becoming more fashionable as wild food and recreation by people coming from outside the forest area (Reyes-García et al., 2015), augmenting the value of the activity. The crucial question is how to internalise such values into a cash flow that remains in the local area, given that most NWFP are externalities of forestry interventions (Merlo and Rojas Briales, 2000). As long as the forest owner or manager does not obtain any revenue, NWFPs-improving forestry interventions are likely not implemented. Such a market failure to internalise costs and benefits among beneficiaries (demand) and forest owners (providers), leading to three possible conflicts:

a. ecological harms on the resource sustainability: the lack of connection between pickers and the daily forest management may lead to overharvesting or damages in the NWFP productivity factors;
b. economic harms to forest managers: due to tangible impacts, such as direct costs to their management as well as loss of potential

economic revenues, and intangible nuisances, in terms of the social pressure; and

c. social harms to traditional communities of pickers, by additional competence, and challenging their traditional usage.

Among the NWFP, it was decided to focus on wild mushroom picking given its worldwide importance (and hence potential transferability of the results) and its changing institutional framework in many European regions. Exemplifying such relevance and governance reforms, Catalonia (North-eastern Spain) is a mycophilic region with a long-lasting debate on the appropriateness of establishing a regulation and a possible picking permit fee. Yet, only punctual and sparse initiatives are in place.

Related to this fungal subsector, the European Council adopted the recommendations of introducing governance mechanisms that dissipate conflicts and create synergies with local communities and landowners (European Council, 2013). Different governance mechanisms are being applied in some areas with the aim of capturing part of this value and translating it into incentives for forest managers (Prokofieva et al., 2016; Vidale, 2012). These are policies reformulating property rights on who can gather, how and where, which are often combined with economic instruments. Empirical observations show:

- different instrument design characteristics (ex. payment amount, maximum quantity allowed, picking norms, geographical or administrative scope, intermediary actors, differentiation between commercial/recreational, local/foreigner, daily/seasonal pickers);
- variable degree of implementation success;
- fluctuating degrees of a priori acceptance.

Our background proposition is that the perceptions and interests of decision-makers shape the design of any governance reform, and their alignment with the opinions of pickers and landowners set the basis for the

acceptance such a reform, with its consequent adherence. For studying perceptions, transmission of knowledge, norms, collective action, or connections with decision-makers, the concept of local networks emerge as crucial.

Networks at the local community level are likely a key factor of the implementation of any new mechanism through information and collaboration flows, resulting in value sharing, power relationships, trust, and mainstream discourses. These ties, trust relationships and shared knowledge are key elements of Social Capital (SC) dimensions, respectively structural SC, relational SC and cognitive SC (Nahapiet and Ghoshal, 1998). These features are likely to constitute the identity for a local group. Social psychology also notes that sometimes SC features –e.g. ingroup effect, fear to unknown people (Brewer, 1999)- may exclude outsiders (e.g. pickers of urban origin) in some degree. Additionally, beliefs and values are likely to conform their views on legitimacy of any governance reform and therefore on the preferences for certain typology of instruments and their design features. Outcomes from social capital may be supportive for the introduction of an instrument or, conversely, can constitute a bottleneck for its implementation. For example, if the community becomes worse-off for not taking part due to their SC (e.g. mistrust, exclusion, elite capture), this is called the "dark side of SC" (Portes and Landolt, 2000). On the reverse, depending on the type of policy intervention and its design it may affect SC. In addition, SC relates to the configuration of the NWFP-related value chain, which is likely to be influenced by the introduction of any policy reform, and therefore its economic performance (Brooks, 2010; Secco et al., 2009; Shumsky et al., 2014).

Other stakeholders accrue in the acceptance of a NWFP policy instruments, such as the forest owners, conservationists or rural tourism. The role of conservationists in mushroom policy has been studied, especially in the USA (Arora, 2008; McLain et al., 1998). Mycotourism is being incipiently studied (de Frutos Madrazo et al., 2009). And there has been also little research on

the views of landowners –especially non-industrial private forest owners- in this field.

Taking mushrooms as an example of NWFP, through my PhD I wanted: (i) to explore the possible relationship between social capital and the forest governance variables, (ii) to develop a serial of indicators to analyse Social Capital of communities of pickers in rural areas; (iii) to quantify forest owners' opinions on the governance reform.

This information is of relevance for (regional) policy makers, given that it may help explaining the challenges and opportunities to coordinate actors related to diffuse uses of the forest (e.g. NWFPs), to value chain reorganisation (Secco et al., 2009), spatial coordination for upscaling forest management (e.g. forest owner cooperatives) or for tackling adjacency externalities -e.g. wildfire prevention (Agrawal and Monroe, 2006), green habitat corridors (Parkhurst and Shogren, 2007). Decision-makers can then better understand the offer of mushroom picking locations (i.e. forest owners) and its demand (i.e. pickers), the possible mismatch between formal and *de facto* perceived mushroom-related discourses, rights and norms, and consequently design more tailor-made policy interventions. The results are also significant for local authorities, to better defend the interests of their communities while also analysing the possibilities of retaining added value in their municipalities.

To find empirical evidence of the theoretical model on SC relations, the case study of the forest of Poblet was used. Poblet is a protected area (*Paratge Natural d'Interès Nacional*) located in the southern province of Tarragona. A mushroom picking permit system was established in 2012, as a pilot permit which has been prolonged in order to gather enough data. A positive predisposition of the park decision-makers and the large number of permits issued provides the intuition that the policy tool was felt appropriate by the affected population. Yet, the differential engagement across towns might indicate social differences, which set the basis for our study.

Objectives of the thesis and structure

The objectives of this PhD have been:

1. To identify and analyse the evolution of the key elements of the governance system connected with the conception, design and implementation of the governance reform of wild mushroom picking by means of a policy mechanism (a picking permit).

2. To identify and analyse the changes between community relationships before and after the introduction of the governance reform for mushroom picking in selected rural areas.

3. To identify and explore the relationships between social capital of selected rural communities and the policy process of introducing a mushroom permit.

4. To quantitatively analyse the policy design preferences of private forest owners as factor for the acceptance and engagement in the forest governance reform.

The objectives have been tackled through the review of the literature, the development of a theoretical model, the empirical analysis of parts of it, and the analysis of a specific stakeholder. The different analyses have lead to the development of the following scientific articles:

Chapter	**Article**
2	Górriz-Mifsud E, Secco L, Pisani E. 2016. Exploring the interlinkages between Governance and Social Capital: a dynamic model for forestry. Forest Policy and Economics 65:25-36.
3	Górriz-Mifsud E, Secco L, Da Re R, Pisani E, Bonet JA. 2017. Structural social capital and local-level forest governance: do

they inter-relate? A mushroom permit case in Catalonia. Journal of Environmental Management 188 (1): 364–378.

4 Górriz-Mifsud E, Secco L, Pisani E, Bonet JA. (in review). Building on relational social capital for governing mushroom resources: community enforcement and trust among pickers. Society and Natural Resources.

5 Górriz-Mifsud E, Secco L, Da Re R, Bonet JA. (in review). Cognitive social capital and local forest governance: community ethnomycology grounding a picking permit. Human Ecology.

6 Górriz-Mifsud E, Marini Govigli V, Bonet JA. 2017. What to do with mushroom pickers in my forest? Policy tools from the landowners' perspective. Land Use Policy 63:450-460.

The following paragraphs present the articles where I have acted as leading author, and the objectives in each. Figure 1 represents the different analytical aspects and units tackled in each chapter. At the moment, chapter 2, 3 and 6 have been published in scientific journals. Chapters 4 and 5 are in review process.

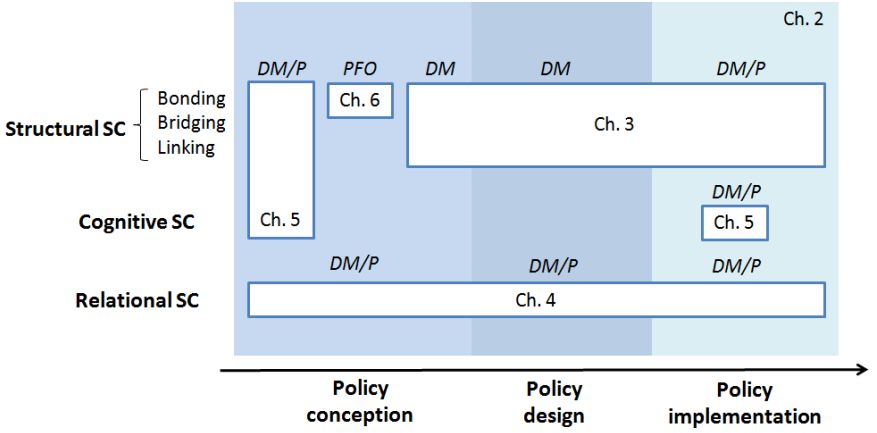


Figure 1 - Chapter structure according to the Social capital dimensions analysed (Y axis) and the policy process stages (X axis). Italics indicate the stakeholders analysed: DM: decision-makers, P: pickers, PFO: private forest owners.

In Chapter 2 we reviewed the existing literature on social capital theory and its dimensions, on forest governance and policy processes, and the empirical analyses of social capital within the field of governance of natural resources - and specifically, on forest governance. My role in this paper was to conduct the literature review, and draft the paper. The analysis of the results and the model building was jointly performed with Laura Secco, in collaboration with Elena Pisani.

The empirical analyses have mainly focused on the case study of the forest of Poblet. I conducted face-to-face in-depth interviews to park decision-makers and local pickers in order to measure some of the relations emerging from the literature review (full questionnaires available in the final appendix). A review of secondary data jointly with the interviews to decision-makers allowed an initial institutional analysis to study key governance variables in each policy phase (objective 1).

Chapter 3 presents the aspects of the social structure of rural communities related to forest governance (objective 3), and the evolution of such structure along a forest governance reform (objective 2). Social Network Analysis was employed for the decision-makers, while average ego-networks were used for pickers.

Chapter 4 focuses on the relational aspects of the social communities which underpin the forest institutional change, namely the governance reform (objective 3). In it we checked how trust was before and after the permit introduction, peer control, social sanctioning and reputation (objective 2).

In a similar pace, Chapter 5 analyses the cognitive social capital of local communities and decision-makers, mainly concentrated on the conception phase. We checked whether the perceptions are shared among pickers and decision-makers (objective 2). We analyse whether such mental models shape informal norms, which are now formalised through the permit (objective 3).

My role in Chapters 3 to 5 was to conduct the analyses with the support of Riccardo da Re in the SNA and statistical sections. Moreover, the results were discussed with Laura Secco, Elena Pisani and José Antonio Bonet. I drafted the manuscripts with their contributions.

In Chapter 6 we shift to other type of stakeholders: private forest owners. Through a survey we analysed the factors behind the acceptance of a forest governance reform. Specifically, we studied the mushroom picking policy design preferences by private landowners. My role in this paper was the design of the survey with support of José Antonio Bonet, building the database with help of Pablo Montiel, the design and implementation of the statistical analyses with Valentino M. Govigli, and to draft the paper.

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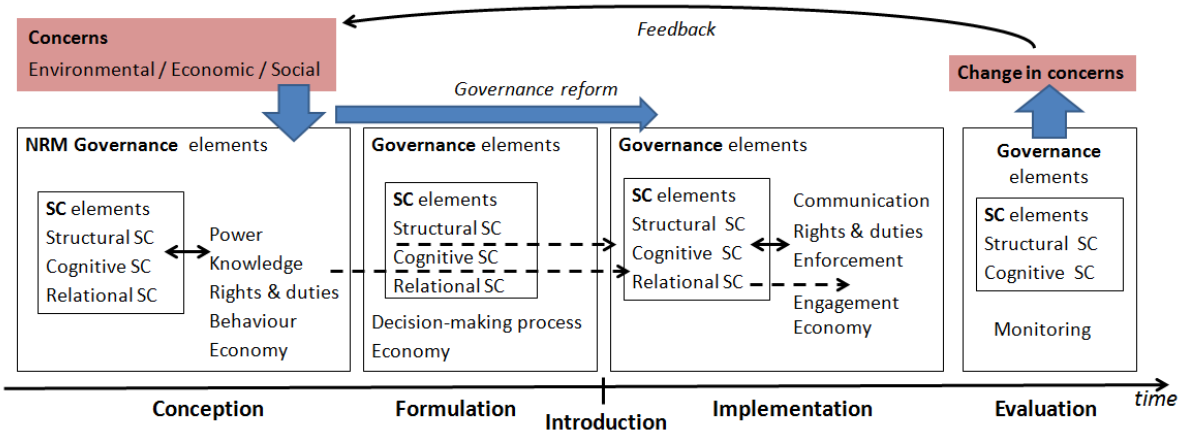
2. Exploring the interlinkages between Governance and Social Capital: a dynamic model for forestry



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2. Exploring the interlinkages between Governance and Social Capital: a dynamic model for forestry

Abstract

The concept of social capital within the forest governance field encompasses networks, norms and values of local communities that determine cooperation and contribute to their development. Interlinkages among community characteristics affecting the implementation of governance arrangements, forest policy instruments or traditional social norms are untangled, which enlighten on the variables policy-makers and practitioners have to put attention beyond traditional technical factors or individual incentives. Through the review of social capital (SC) and forest governance literature, we find network structure and institutions as their common core aspects. Theoretical relationships and feedbacks are first identified, and then checked in published forestry case studies.

We propose hence a dynamic, nested model comprehensively illustrating the co-evolution of SC and forest governance elements along a policy process. The model uncovers the interrelation between different factors underlying natural resources' and rural development challenges based on cooperative behaviour. This model identifies cognitive dimensions of SC as triggers of local-level governance reforms. Network structure shapes information flows, power relationships, trust among actors and innovation spread.

Trust and social sanctioning impinge on the enforcement of (in)formal norms and rules. The model applies in forest policies entailing cooperation among open-access resource users, or landowners' coordination for adjacency externalities or upscaling.

Keywords

networks; rural development; forest management; natural resources; socio-ecological systems; institutions

2.1. Introduction

Our paper aims at increasing the conceptual and theoretical understanding of the relationships between social capital and forest governance in rural areas, delving into their cause-effect interlinkages. We put special emphasis on those linkages conducive to better economic performance of rural communities, suggesting a process-based model for understanding their interactions as applied in the forestry sphere.

Societal dilemmas concerning access to or use of natural resources (NR) are shaped by diverse actors' interactions[1] (Bodin and Crona, 2009). Depending on the research perspective adopted, these interactions can be analysed in different ways. The two prominent ones are linked to political and social sciences as follows.

From the viewpoint of political scientists, interactions among government, market and civil society actors[2] in the pursuit of common goals are changing, determining a shift from hierarchical-based to network-based governance modes (e.g. Kjaer, 2004; Rhodes, 1997). This approach is also consolidated in NR management (NRM): the way in which the public administration, market and civil society deal with environmental challenges determine the establishment of co-management initiatives, private-public partnerships or social-private agreements (e.g. Lemos and Agrawal, 2006). Networked governance sets the stage for the analysis of (partially) decentralised actors' coordination, representing a mode of governing where the public administration is *"dependent upon the cooperation and joint resource mobilization of policy actors outside their hierarchical control*" (Börzel, 1998:260). In the last decade, on the one hand, networked governance has become a salient approach in NR management, as several policy instruments have been applied based on local networks for the co-production of benefits, especially in rural communities (i.e. Nath et al., 2009; Ribot, 2002). On the

[1] "Interactions" is used interchangeably with the terms "connections", "relations", "flows" or "exchanges".
[2] In this paper we use "actors" as (rural) community members, and hence as social agents.

other, different sets of "good governance" principles have been used as yardsticks to evaluate the integrity of governing processes, typically at national level. In relation to NR management, these include efficiency, participation, transparency, accountability, effectiveness, equity and capacity (e.g. Conley and Moote, 2003; Cashore, 2009a, 2009b; Rametsteiner, 2009; Kaufmann et al., 2010; Cowling et al., 2014; Secco et al., 2014).

From the point of view of social scientists, the same actors' interactions constitute an asset for each society, labelled as social capital (SC) in parallel with other forms of capital[3] (financial, human, natural or built) (Castle, 2002; Scoones, 1998). Social capital has been defined as the features of social organizations that facilitate coordination and cooperation for the mutual benefit of both individual members and the society as a whole (Putnam, 1993, Coleman, 1988; Bourdieu, 1986). These features include networks, reciprocity, norms and trust (Bowles and Gintis, 2002) which, if used in a positive manner, encourage collective action to achieve sustainable development (Pretty and Ward, 2001; Woolcock, 2001). At community level[4], the SC catalyses flows (e.g. information and collaboration exchange) among community members in building or consolidating institutions ("rules of the game" according to North, 1990) that shape collective action related to NR.

Different theoretical models use SC, interacting with other types of capital, as an explanatory factor for community economic and social performance[5]. Generally, the analysis of SC as an enabling intangible factor for sustainable NR management has found positive connections between local-level network-based relationships and successful joint management practices (Bodin et al., 2006; Pretty and Smith, 2004). Some scholars hypothesised

[3] The term "capital" is used in a stock-flow context insofar as the fluxes of interactions "*are accumulated –invested- and hereby become a stock*" (Paldam and Svendsen, 2000:345)

[4] SC can be analysed at individual (micro-) or community (meso-) levels. For details, see Section 3.

[5] Bourdieu's theory of practice (1986), Castle's model of rural capital (2002), or DFID livelihood asset pentagon (1999).

that a strong SC contributes to better community outcomes (Coleman, 1988; Putnam, 1993). Nevertheless, local relations linked with strong SC[6] are sometimes reported to block governance processes (e.g. Kamoto et al., 2013; Zuka, 2013) and the community development itself (Adler and Kwon, 2002).

It is thus clear that the two concepts (governance and SC) are strictly interconnected: network governance deals with societal challenges entailing institutional changes by increasing agents' coordination, collaboration and participation in multiple facets (multi-actor, multi-sector, and multi-level), which constitute core SC elements.

The relationships between SC and NRM governance have so far been explored only in relation to specific fields of analysis (e.g. community-based NR management, participatory processes), and their nature and intensity are not entirely clear. Our guiding idea is that community interactions are relevant for NRM governance in a broader sense: being neither restricted to the narrow property rights' system (community ownership), nor formally setting participation processes. Moreover, within a socio-ecological system framework, the linkages connecting SC and NRM governance go beyond the simplification of the former as an input to the latter, given the likely endogeneity - the "chicken-and-egg" dilemma (Plummer and FitzGibbon, 2007:43). In particular, Luthe et al. (2012) noted the need for further research on the role of networks in the mechanisms and practices of switching between governance modes.

There is a need for a throughout analysis of SC and governance relations in the forestry realm, where the causal link between SC and collective action is not fully understood (Borg et al., 2015; Rico García-Amado et al., 2012), and which lack theoretical models of the relationship between forest-dependent communities and forest policy changes (Akamani and Hall, 2015). Taking a policy network analysis approach (Arts, 2012), we consider the bi-

[6] SC critics indeed pinpoint the potential inequalities strong networks may imply, such as perpetuation of power relationships (Bourdieu, 1986; Ishihara and Pascual, 2009).

directional effects among networks and institutions, framing them within a policy cycle model. We thus adopt the definition of forest governance that encompasses these key elements: "*a) all formal and informal, public and private regulatory structures, i.e. institutions consisting of rules, norms, principles, decision procedures, concerning forests, their utilisation and their conservation, b) the interactions between public and private actors therein, and c) the effects of either on forests*" (Giessen and Buttoud, 2014:1).

After the Introduction and Methodology (sections 1 and 2), the paper presents a review of governance and SC concepts and dimensions from a general perspective (section 3). This is followed by a theoretical analysis of the bridging elements between the two concepts, highlighting cause-effect relationships and illustrated - when available - by specific insights into the forestry realm (section 4). Section 5 attempts to re-conceptualise SC and governance elements and their inter-linkages, proposing a model of their co-evolution along a policy reform process. We discuss the model and suggest its application in forestry, followed by the conclusions.

2.2. Methodology

This paper focuses on unfolding potential linkages between SC and forest governance, by taking a descriptive (positive) approach. We do not make inferences about governance assessment based on good governance principles (i.e. we do not take a normative approach). However, we provide some insights on possible connections between these principles and the SC-governance interactions as described in our model (see section 5).

We took a deductive approach in this study. First, through a literature review, we explored the key dimensions of SC and governance concepts, and their compounding elements. The literature review was conducted in two steps. Six keywords were searched in SCOPUS appearing either in the title, abstract or keywords: "social capital", "governance", "natural resource", "forest*", "rural development" and "network". Three terms were combined simultaneously, following the criteria of being as targeted and

comprehensive as possible[7]. The search was done in February 2015 and produced 129 scientific papers. Although SCOPUS may not be an exhaustive database for scientific literature, we used it as it indexes most common journals on forest and NR policy and economics. The term "governance" being relatively new may hamper the detection of previous studies conducting similar analyses but using other wording; however, we chose it as "policy making" or "management" would have been less meaningful. Papers were filtered according to the coherence between keywords and content, as well as their focus on SC aspects of local-level forest governance, resulting in 60 papers. Papers were either fully theoretical (7), presenting an analytical model checked in forestry case studies (5) or purely empirical (48). An additional 52 papers regularly cited as basic literature on governance, SC and environment completed the list.

In particular, two core elements were identified as bridging the governance and SC divides (namely, "networks" and "institutions"), around which we explored the possible cause-effects relationships. These relationships were classified by adopting a result-chain approach (Virtanen and Uusikylä, 2004), inspired by the input-output policy model of Easton (1957). We consequently outlined a comprehensive new conceptual model putting together theoretical and empirical evidence reported in the literature, structured within a forest policy process.

2.3. Governance and social capital links: state of the art in forestry

How SC influences NR governance, forestry and rural development is a recent scientific field, as revealed by our SCOPUS search (Figure 1 - additional material), with an increasing number of scientific publications. In this section, the first insights into the SC concept applied to the NR and

[7] The combinations used were: Forest* AND "social capital" AND network; Forest* AND governance AND network; "Natural resources" AND governance AND "social capital"; Forest* AND governance AND "social capital"; "social capital" AND governance AND "rural development".

forestry realm are reported (3.1), followed by an overview of current knowledge on SC and forest governance (3.2).

2.3.1. Social capital in forest resources management

SC has traditionally been analysed according to three dimensions: structural, cognitive and relational (Nahapiet and Ghoshal, 1998). The structural dimension includes the presence, direction, content and intensity of relational flows among community members; depending on with whom the relations take place SC can be split into bonding (flows within the community), bridging (with other communities) and linking (with higher level members). The cognitive dimension includes shared values, attitudes and beliefs, and predisposes people towards mutually beneficial collective action. Relational SC focuses on norms, trust and trustworthiness.

Rural communities[8] show a propensity towards SC features with a potential for either community development or marginalization processes (Wiesinger, 2007), namely: geographical rootedness, close helping ties (strong bonding SC), but also social exclusion for non-followers of local norms (i.e. left out from clusters), or hostility towards newcomers (little bridging SC). Moreover, the primary sector - and hence NRM – is a substantial source of employment, in contrast with urban or industrial areas.

Insofar as NR are simultaneously influenced by multiple actors, community interactions influence how people approach NR (Bodin and Crona, 2009:367). The way people perceive NR problems, share values, and legitimate chosen strategies (Kobayashi et al., 2013) results in institutional solutions governing NR management.

From the micro-level analytical perspective (see footnote 4), SC implies that there are aspects of social structures that act as resources for individuals,

[8] Characteristics of rural communities include their sparse populations very dependent on urban and global systems (Castle, 2002), and, especially in remote areas, people's greater dependence on each other for their livelihoods (Nath et al., 2010).

both in terms of economic productivity (Schmid and Robison, 1995), and achieving individual interests (Coleman, 1988:101). This is relevant for the business model of forestry actors as value chain links.

From a community analytical perspective, SC catalyses members' flows in co-constructing institutions that structure collective action related to NR. From this standpoint, the contribution of SC to NRM governance and economic development can be driven by different processes (Bowles and Gintis, 2002; Narayan and Pritchett, 1999; Pretty and Ward, 2001; Woodhouse, 2006), including: (i) "peer monitoring", which reduces incentives to free-ride; (ii) "strong reciprocators", which enforce legally non-binding rules thereby increasing government effectiveness (Putnam, 1993), and (iii) "risk pooling" among community members, which facilitates the spread of, and engagement in, innovations.

Process (i) is relevant insofar as different NR managers, users or harvesters may concurrently have different expectations for the same open-access resources - those without physical barriers, which is often the case for forests and their products (Merlo and Rojas Briales, 2000b). Within the framework of common-pool resources and/or public goods, the absence of appropriate governance arrangements allows individualistic motivations (free-riding), contributing to the famous "tragedy of the commons"[9] (Hardin, 1968). Repeated interactions between agents build networks, whose relationships reflect flows of information, formal or informal collaboration. Recurrent interactions among forest users facilitate higher levels of reciprocity and trust; this reduces free-riding incentives, thereby alleviating the "commons' tragedy", and leads to lowered transaction costs and to risk-sharing among community members (Bowles and Gintis, 2002).

In relation to processes (ii) and (iii), we refer to those governance reforms entailing changes in community "rules of the game", which could be conceptualized as the introduction of a social innovation, such as adaptation

[9] Forest products depletion, CO_2 emissions, recreational congestion in some forests often derive from such "tragedy".

to environmental changes (Adger et al., 2005). In this framework, innovation diffusion models incorporate SC as a facilitating factor (Adam and Westlund, 2013:5). Applied for forest harvesting norms, Brooks (2010) proposed a model explaining the role of community networks in the endogenous creation of informal rules, their spread and evolution into formal rules, as follows: when some community subgroup attains awareness of a forestry-related problem, they start implementing good practices and informal sanctioning modes; if those applying such behaviour reach a critical mass, these practices eventually become formalised.

2.3.2. Current knowledge on SC-governance link in forest resources management

Papers analysing SC as a component of NRM governance present a wide spectrum of theoretical models (deductive- or game theory-based), often integrated with empirical evidence. Socio-Ecological Systems (SES) showing large ratios of collective challenges, such as fisheries' management (e.g. Sekhar, 2007), irrigation systems (e.g. López-Gunn, 2012) or community forestry, concern most case studies exploring SC and governance interlinkages. Thematic clustering of papers results in three major fields where networks play a role in NRM:

- value chains related to NR (e.g. Chand et al., 2015), and the way networks facilitate sustainable economic revenue flows, and consequently rural development (e.g. Vennesland, 2004; Engel and Palmer, 2006);
- community-based resilience of socio-ecological systems, and the introduction of innovations tackling risks (e.g. Cundill and Fabricius, 2010);
- assessment of NRM policy instruments (e.g. Pretty and Smith, 2004). Zooming in to forest policy tools, scholars focussed their attention on participatory processes (e.g. Nath et al., 2009), collaborative forest management (e.g. Akamani and Hall, 2015; Conley and Moote, 2003), co-management (e.g. Ros-Tonen et al., 2014), community forestry (e.g.

Brown et al., 2007; Baynes et al., 2015; Tole, 2010), forest owners' coordination (e.g. Borg et al., 2014; Rickenbach, 2009), and collective action (e.g. García-Amado et al., 2012). Insights from their findings are presented in the next sections.

Most SC and forest governance papers focus on the local level, as this is the usual sphere of forest policy implementation (Secco et al., 2014). At this scale SC elements such as agents' flows (e.g. information, collaboration), duration of relationships, or incentives for coordination become keystones for good forest governance assessment (see e.g. Da Re, 2011; Secco et al., 2014).

2.4. Two core concepts for bridging forest governance and SC

The two core concepts in common to both SC and governance are: i) networks, including connectedness and exchanges; and ii) institutions, including norms and trust. In this section, we present and discuss them in detail. Table 1 summarises the common elements across governance and SC dimensions with an insight into forest resources management issues.

Table 1 - Common elements linking forest governance and SC dimensions

Dimensions		**Social Capital**	
		Structural	**Relational**
Forest governance dimensions	**Multi-actor** (usually, local or lower administrative levels, focus on implementation)	• Bonding SC: horizontal relations and networks. Actors belong to the same community or sector, holding similar interests. They belong to the same analytical (scale) level. • Logic of inter-firm network for local rural development.	• Formal and informal norms regulating cooperation and interchange at the (lowest) implementation level. • Functioning and control mechanisms, informal and contractual agreements for establishment and procedures of associations
	Multi-sector (usually, local to national)	• Bridging SC: inter-community networks, multi-disciplinary platforms, stakeholder dialogues.	• Similar to above, but with actors belonging to different sectors. Examples: multi-sector

		• Logic of territorial network for integrated development.	policies, multi-disciplinary projects.
	Multi-level (usually, national to EU/global, focus on top-down decision-making or legal frame)	• Linking SC: vertical interactions and networks. • Logic of integration or of respect to vertical hierarchies. • Focus on congruence in goals and interventions.	• Formal and informal norms regulating interactions between administrational and policy levels, competence distribution and subsidiarity principle

2.4.1. Networks

In these subsections we explore in detail the actors' connections as bridging point between SC and governance, first the structure of exchanges, and then the informational content of exchanges.

2.4.1.1. Actors' constellations

When analysing networks' configuration, actors' interactions are usually categorised by their frequency as either strong (very frequent) or weak (less frequent) ties (Granovetter, 1973). Strong ties delineate rather homogeneous groups (Granovetter, 1973) that tend to share similar interests and challenges. These relationships constitute the bonding SC, which increases with the number of links among neighbours, i.e. community cohesiveness (Bodin and Crona, 2008:2767). Bonding SC is relevant for collaboration, information sharing (Coleman, 1990) and social control - reputation (Bowles and Gintis, 2002). The denser the network, i.e. the ratio between existing links in a network and the maximum number of possible links, the greater the potential for collective action (Bodin and Crona, 2009), which may mean social innovation.

The aspects of intra-community relationships are observed in the multi-actor perspective of governance processes (Table 1), through:

- local participation, such as increased wildfire risk prevention actions among more cohesive communities of residents in the wildland-urban interface (Bihari and Ryan, 2012);
- interest groups' formation, such as forest management information flows among landowner associations' members and technical staff (Rickenbach, 2009); or
- intra-sector organisation, such as horizontal integration in forest value chains to improve bargaining power (Secco et al., 2009) or market access (Cosyns et al., 2014). However, some forest development policies maintaining existing ties evidence the permanence of social and trade inequalities (Chen et al., 2012; Wilshusen, 2009; Zuka, 2013).

Inter-community relationships are depicted as the bridging SC. Granovetter (1973) stressed the "strength of these weak ties" for their potential to introduce knowledge and innovation from other groups. Actors with these connections act as (latent) brokers or gatekeepers among the network nodes (Bodin and Crona, 2009). From the multi-sector governance standpoint, platforms uniting different business fields or multi-disciplinary teams form these relationships, whose common interests lie in integrating expected benefits at a territorial/landscape scale (Table 1). Extension officers or NGOs often play this role, especially relevant in contexts of new forest owners originating from e.g. land devolution policies, or newly established community forests (Nath et al., 2010), or engaging landowners in a new forest policy tool (Borg et al., 2014).

Linking SC corresponds to relations across hierarchies, and hence with external actors and decision-making structures. Vertical interactions connect different administrative, and thus competence levels, also encompassing vertical integration of the value chain (Table 1). This multi-level governance aims at coordination among administrative and trade spheres, especially important in contexts of decentralisation and subsidiarity principles. For example, brokers' role across different scales emerged as crucial in a model

forest establishment in Sweden (Keskitalo et al., 2014), as well as government support in community forestry groups (Baynes et al., 2015).

2.4.1.2. Information and power

Personal ties function as communication channels, which are conducive to social learning processes (Reed et al., 2010). The cognitive aspects of SC as defined by Nahapiet and Ghoshal (1998) include the communication means –languages and codes– and the contents –shared narratives–. Shared narratives could build upon conventional wisdom[10] or common perceptions, originating from a shared belief system (Sabatier, 1993).

Two types of information emerge as leading collective environmental action: community members' information, and community understanding of the SES. The first stems from recurrent community relationships, where members develop a reputation, hence reducing information asymmetry and consequent strategic behaviour (Bowles and Gintis, 2002; Ostrom and Ahn, 2009). The second largely relies on the traditional ecological knowledge (TEK) held by rural communities (Berkes, 2000), which for forestry often entails a long- to medium-term memory (e.g. recall of last wildfire, Bihari and Ryan (2012)).

Rural people's perception of socio-economic and environmental phenomena determines their being considered as problems (Wiesinger, 2007). Given the complexity of SES, community capacity-building may be required so that their members engage in collective action (Pretty and Smith, 2004). In this context, the relationship of forest owners within association/cooperatives with their technical staff and other members has been reported as crucial for peer-to-peer learning: through information flows among strong ties –see Rickenbach (2009), rapid learning on biodiversity conservation based on informal interchanges –see Primmer (2011), or building mental models and discourses based on trust –see Schlüter and Koch (2009).

[10] Conventional wisdom is "*social constructs stemming from stories or experiences*" (Patriotta, 2003).

Another type of information interchange refers to innovations in forest product, process or value chain. Pettenella and Maso (2011) highlight the relevance of the engagement of small- and medium-size forest enterprises in networks for their strategic value chain positioning and performance.

Given that the structural network aspects affect common knowledge creation and diffusion, Ishihara and Pascual (2009) warned about elites' dominating discourse through their symbolic power, while relegating marginalised groups. McDougall and Banjade (2015:44) provided evidence of Nepal village elites dominating forest community committees and linking ties: their alignment with the conservationist discourse by state bureaucrats precluded marginalised subgroups thriving, and a change in the development paradigm disentangled the elite from the project and reduced marginalization. Designing inclusive participatory processes can improve SC of marginalised subgroups, as Bizikova et al. (2012) showed for Roma minorities in Carpathian forest management planning.

2.4.2. Institutions

2.4.2.1. Norms

Informal norms and formal rules are considered as cornerstone institutions by governance scholars. Social norms "*specify what actions are regarded by a set of persons as proper or correct, or improper and incorrect*" (Coleman, 1990:243). Norms and obligations could be assimilated to the "working rules" –following Ostrom and Ahn (2009) terminology– that fulfil the exigencies of the daily life and may complement formal rules. The congruence level between those institutions with shared beliefs determines their social legitimacy (Kobayashi et al., 2013).

The wide institutional understanding of the SC approach is partially captured by typical good governance assessments, where only formal rules are considered under the regulatory quality principle (e.g. Kaufmann et al., 2010). Overlooking such idiosyncrasies may lead to poorly designed institutions crowding-out community governance (Bowles and Gintis, 2002).

For example, payments for ecosystem services and other economic instruments for NRM have been criticized for their potential to crowd-out intrinsic landowners' incentives for collective action (Vatn, 2010).

Internal norms governing associations or contractual agreements among community members exemplify multi-actor governance, while arrangements bridging communities or business fields exemplify multi-sector governance (Table 1). For instance, customary rules governing Non-Wood Forest Products (NWFP) were conducive to effective local forest management in Laos (Hyakumura and Inoue, 2006). SC has been found as enabler but also as a result from informal norms: on the one hand Ros-Tonen et al. (2014) reported SC enabling the introduction of institutional changes in forest management in Ghana; on the other, Szulecka and Secco (2014:188) found local institutions played an anchoring role for SC in Paraguayan villages. Furthermore, the distribution of rules and responsibilities across different administrative levels, based on decentralization and subsidiarity principles, determine multi-level governance (Table 1).

2.4.2.2. Enforcement of the norms and trust

Once norms determine "good" behaviour, control is needed to ensure abidance by community members. *De-jure* rules include enforcement mechanisms, which in NRM imply field or aerial surveillance, and infractions' categorisation with their corresponding sanctions. Peer-control and social sanctioning (Bowles and Gintis, 2002; Coleman, 1990) are the fundamental for *de-facto* rules and complement formal enforcement. In forest contexts with dispersed agents, local enforcement affects the overall effectiveness of norms and consequent forest conditions (Gibson et al., 2005). However, even communities with strong SC have shown low monitoring levels when interacting with competing external forest users (Van Laerhoven, 2010).

The need for enforcement efforts depends on members' trust that others will abide by the norms (Bowles and Gintis, 2002). Trust has been defined as the subjective assessment of the probability of another agent performing a

particular action (Gambetta, 2000). Given that repetitive games reduce self-regarding, non-cooperative choices within the traditional prisoner's dilemma (Ostrom and Ahn, 2009), frequency of relationships determines mutual trust and reciprocity (Bowles and Gintis, 2002), which can be reinforced through institutions rewarding honest behaviour (Ostrom and Ahn, 2009). Decision-makers perform reciprocity through the good governance principle of accountability, which shows the liability for their decisions to society (e.g. Cashore, 2009a; Cowling et al., 2014). Jedd and Bixler (2015) confirmed that interactions among members of a forest conservation platform developed norms which in turn strengthened accountability.

Uslaner (2001) distinguished between generalised and particularised trust – i.e. confidence towards the society in general and towards known people -, which contributes to analysing Wiesinger's (2007) detected rural propensity of hostility towards outsiders. Brooks (2010) confirmed that lower trust among NWFP-collectors to follow good picking practices explains stronger enforcement. Trustful environments requiring less control reduce costs, which increases the overall efficiency (Bowles and Gintis, 2002) as objectives are met using fewer resources. Efficiency constitutes one of the good governance principles (e.g. Cowling et al., 2014) and a guiding criterion for rural businesses.

Several empirical studies confirm trust as an ingredient for collective action in forestry (Baral, 2012; Guillén et al., 2015; Jones et al., 2012). Borg et al. (2014) ascertained trust playing a crucial role in Finnish collaborative networks for biodiversity conservation, where cooperation still takes place even among actors with different goals. Furthermore, collective action can also improve trust, as membership in informal labour-sharing networks in Cameroon was found to be a significant proxy for trust and solidarity among forest community members (Brown et al., 2007).

Moreover, agents are more prone to share risk within trustful contexts, favouring economic interchanges and hence business development. Risk

pooling favours riskier transactions (Bowles and Gintis, 2002), such as the long-term investments typical in forestry. In this sense, trust was found to explain Brazil nuts' value chain development (Cunha, 2014). Szulecka and Secco (2014) report community trust constituting the backbone for Paraguayan plantation cooperatives (value chain structure), with effects on wood quality and prices. Trust is an important aspect in the creation of small forest owners' organisations addressing joint timber mobilisation: confidence among members and staff is generally high, whereas business-oriented agents -with perceived opportunistic behaviour- are considered less trustworthy (Guillén et al., 2015; Schlüter and Koch, 2009). Trust and reputation is also found to be relevant for every step of sawmills' activities (Toppinen et al., 2011).

2.5. A dynamic model representing the interlinkages between governance and social capital in forestry

How SC is created and modified is a debated question among scholars (Adler and Kwon, 2002; Paldam and Svendsen, 2000). Such cause-effect relations are crucial when considering networks in policy analysis and economic modelling. In this section we propose a dynamic model to explore the interlinkages between SC and forest governance in a process of governance change, such as policy reform, social innovation, or reshaping the value chain.

Inspired by models and key relationships put forward by previous researchers -see section 3-, and the nested logic of policy subsystems (Sabatier and Jenkins-Smith, 1999:137) we hypothesise a nested structure that conceptualises SC elements as intrinsic components of the governance system, with networks and norms – see section 4 - as common elements (figure 1). Next, we conceptualise a co-evolution where the way community members interrelate in the face of NR challenges affects the institutional strategies considered, and those strategies conversely influence community SC. We adopt a result-chain approach for analysing causes and effects between SC and governance elements with a temporal perspective. Taking

the benchmark policy cycle of conception, formulation, implementation and evaluation phases (Krott, 2005), this approach conceives interlinkages as inputs-activities-outputs-outcomes, fitting with the problem-solving model. Intra-phase, the inter-relations among different SC dimensions put forward that, rather than isolated blocks, cause-effects are found among their elements. Finally, the model also acknowledges SC interactions with other types of capital.

The peculiarity of our model relies on (i) the nested conceptualisation between SC and governance systems; (ii) the dynamic relationship between governance and SC elements, allowing for feedbacks during the policy process; (iii) the acknowledgement of inter-relations among SC dimensions; and (iv) its comprehensiveness for framing societal challenges such as rural development, resilience, and governance changes.

The model holds for SC as positively or negatively affecting the governance reform: i.e. facilitating decision-making and agents' engagement, or conversely, hindering social changes towards collective action. The model also holds for policy instruments influencing the creation as well as the weakening or destruction of SC (Wiesinger, 2007).

Given the complexity of the model, we first present an overview (2.5.1); the different stages are then described in their respective subsections: conception (2.5.2), formulation (2.5.3), implementation (2.5.4), and evaluation (2.5.5). While acknowledging the cyclical nature of a policy process (Jann and Wegrich, 2007), the evaluation stage is not analysed in detail due to the limited references of linkages between SC and governance elements in this phase.

2.5.1. General overview

The model departs from a local socio-ecological system embedded in an overarching governance system at larger administrative scales, which is assumed as constant. This regional and national context constitutes external factors that play three types of roles:

- Drivers of change, i.e. technological or economic changes, or natural disasters (Akamani and Hall, 2015; Bihari and Ryan, 2012).
- Setting the boundaries where collective action can occur: establishing responsibilities of local actors (Lowndes and Wilson, 2001), mainly decision-making (Wiesinger, 2007) and market patterns affecting local trade. For instance, Rametsteiner (2009:145) notes that while successful sustainable forest management largely depends on local factors, most policies and developmental actions are planned and evaluated at national level.
- Pre-existing institutions determining trust at the local-level, which influences collective action (Ostrom and Ahn, 2008).

The model hypothesises local SES relying on four types of capital (financial, natural, human and social) that are brought into play through a governance system of NRM (e.g. forest) (Figure 1). Social capital, power, agents' behaviour and knowledge, rules and rights, the local economy and trade make up the governance elements. Local SES interrelates with the NRM governance system through its natural capital, and through networks and norms with the SC subsystem. The structure of economic agents around NRs determines their access to financial capital, hence moulding trade patterns and community economy. Knowledge and power drive the debates about the need for and design of a governance reform; hence human capital plays a crucial role in perception of the problem and of the diverse institutional alternatives.

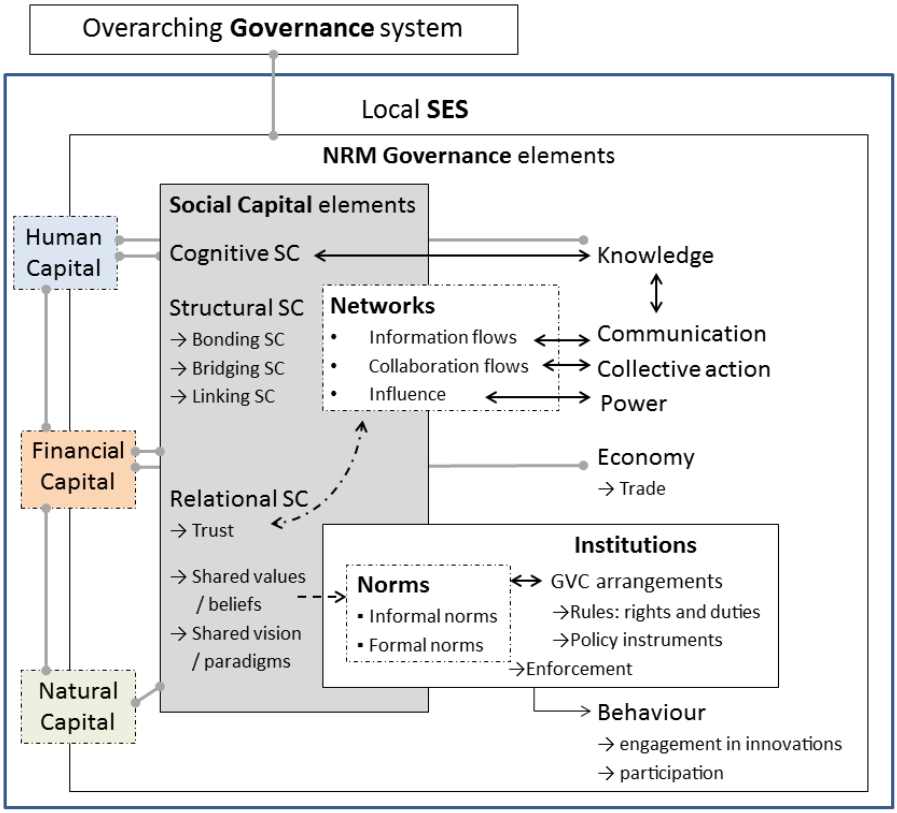

Figure 1. Overview of the intra-phase model. Grey lines: relations not in focus. The location of natural, human and financial capitals is only approximate. GVC: governance.

At each policy stage, the SC elements play a role so that community members (i) structurally, interrelate in more or less formalised networks, (ii) cognitively, tackle NR concerns more or less explicitly, and (iii) normatively, deliberate on the alternative solutions and take part to different coordination degrees in implementing the chosen option (see 2.3.1).

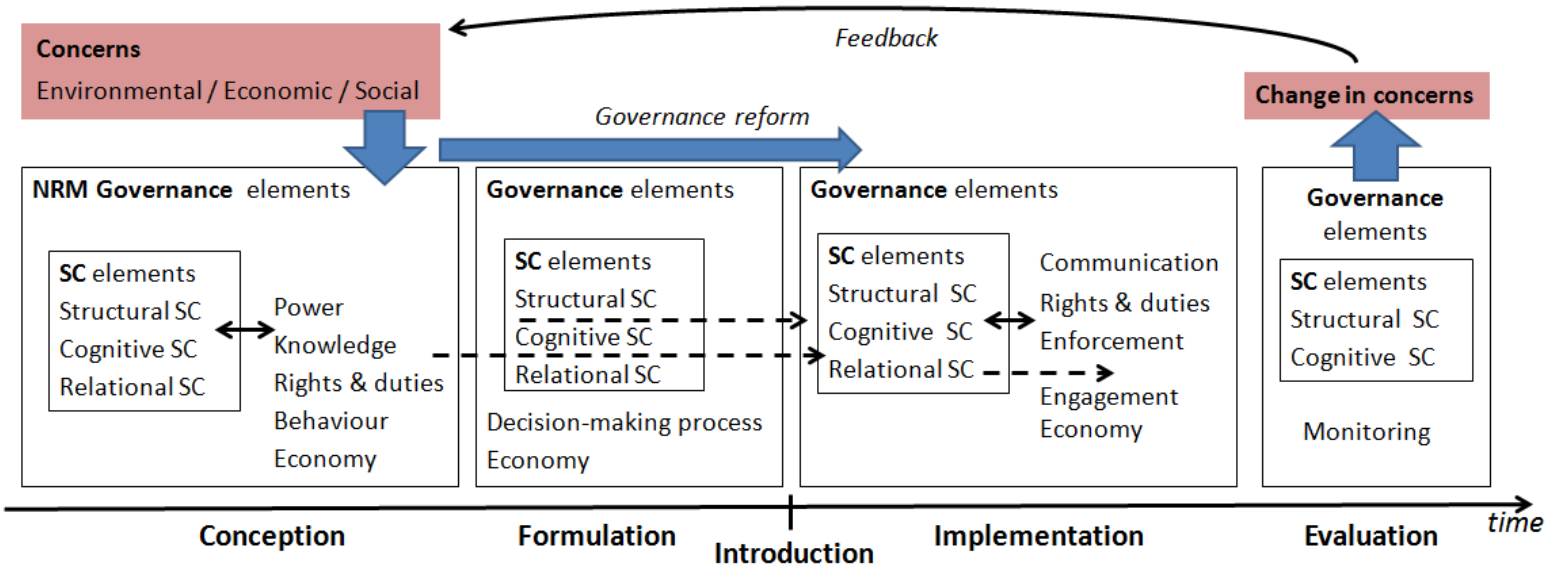

Figure 2. Overview of the general model with the key elements in each policy process phase. Dotted lines = those we hypothesise as key drivers.

Figure 2 shows the temporal development. The conception phase illustrates a snapshot of the collective action situation previous to a reform, depicting the ground on which debates take place about the need to change the status quo. When the community widely perceives an environmental, economic or social problem, the internal relationships drive the collective action process towards its resolution (Bodin and Crona, 2009; Wiesinger, 2007).

This is followed by a phase during which a governance reform is deliberated and designed. The decision-making structure and rules, actors' views on the alternatives, and reciprocal trust shapes the length, legitimacy and costs of the deliberation process.

Once the reform is approved, the affected agents are compelled to align their behaviour to the new norms for the common good. Still, path dependence may hamper changing actions (Akamani and Hall, 2015). Enforcing these norms may thus require some type of control and corresponding sanctions. Regulatory frameworks and their enforcement are taken into consideration (typically at national level) when assessing forest governance (e.g. Cowling et al., 2014). Awareness measures are also required to inform affected agents. Reaching the environmental or socio-economic objectives reflects effectiveness, i.e. one of the most important good governance principles. In the case of effective collective action, environmental or socio-economic concerns lessen; such an assessment hinges on a more or less formal evaluation process. That feedback eventually provokes different stages of policy implementation (Brooks, 2010; McDougall and Banjade, 2015).

2.5.2. Conception phase

The analysis of this phase starts form the pre-existing community structure of relationships, which materialises in collective action (e.g. norms' abidance) and economic results (Figure 3).

The configuration of the community flows defines the spread of information and the presence of hierarchies in the community. More cohesive communities tend to show more efficient information diffusion. The

community knowledge pool can be affected by agents in core positions holding symbolic power (see 2.4.1.2), who could modulate information in their interest creating dominant discourses. In some cases, actions towards maintenance of the status quo of local elites (e.g. large landowners) are aligned with the community wellbeing (e.g. adaptation activities benefiting all), whereas in other cases there may be a trade-off (e.g. capture of benefits at the expense of minorities' livelihoods). Impartiality and equal opportunities to community members would reflect the implementation of the good governance principle of equity/fairness (e.g. Cowling et al., 2014).

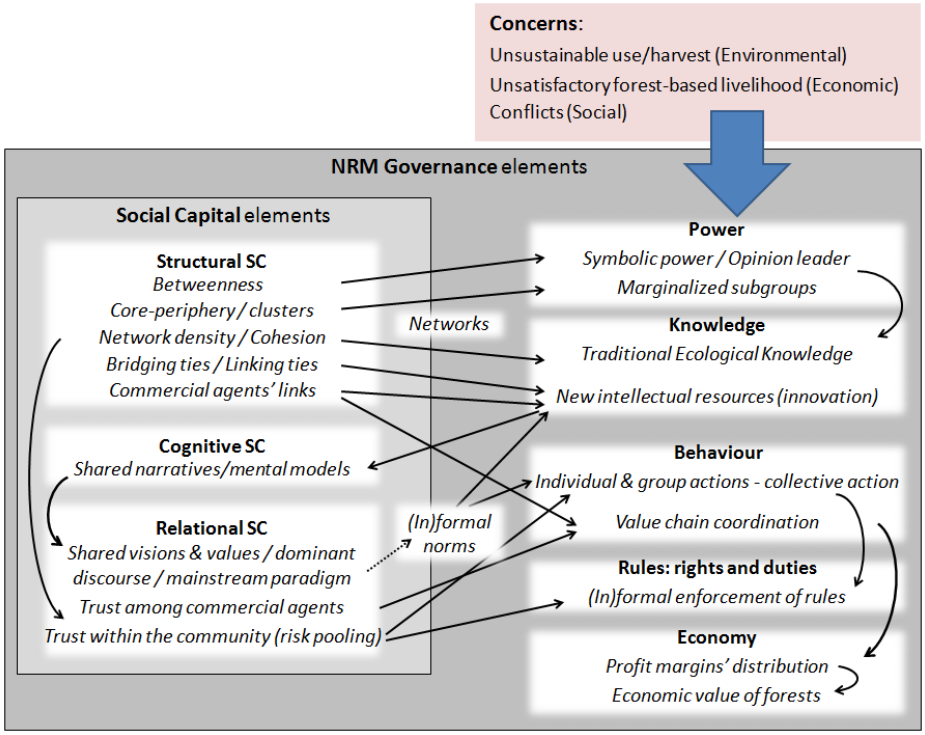

Figure 3. Relations between SC and governance elements and their variables during the policy conception phase.

Crucial for NRM is the perception of environmental processes (SES dynamics), which depend on local community knowledge. Linking different knowledge elements in mental models delineates shared narratives. This knowledge can stem from community experience (personal experiences,

TEK), or from information supplied by outside agents, reflecting the influence of bridging links (see 2.4.1.2). We suggest that rights' and duties' perception over NR is also relevant, e.g. who is seen as having legitimate access to the forest, or to harvest/use some forest product. Shared narratives give rise to value-laden visions of how community should act, that is, to paradigms that operate through behavioural norms.

The strength of community relationships determines trust levels. Confidence that other members abide by the norm motivates following that behaviour, resulting in the coordinated behaviour of individuals that represents collective action. Enforcement mechanisms are in place to avoid free-riding: formal control and sanctioning by public authorities or third parties (e.g. certification audit), or informally by community penalisation (see 2.4.2.2).

The relations among commercial agents (e.g. landowners, wood dealers) and their level of mutual trust affect value chain (lack of) coordination (see 2.4.2.2). Moreover, commercial agents benefit from their trustful linkages to obtain crucial information for their business. Their economic performance partly derives from that knowledge exchange, with ideas for portfolio diversification or trade information strengthening their bargaining positions.

We conjecture that when community members perceive a forest-related problem (e.g. climate change, overharvesting) and the need for a social norm change, a debate is held to develop new, more acceptable behavioural patterns. The cognitive aspect at the outset is the triggering factor for any endogenous, bottom-up governance reform.

2.5.3. Formulation phase

Debating, negotiating and decision-making are the main actions during this stage (Figure 4). Cognitive SC connects the conception with the formulation phase, through problem perception and awareness of alternative solutions (Wiesinger, 2007). The information about alternative solutions, their benefits and constraints stems either from intra-community experiences or from external sources (see 2.4.1.2), i.e. knowledge-transfer initiatives.

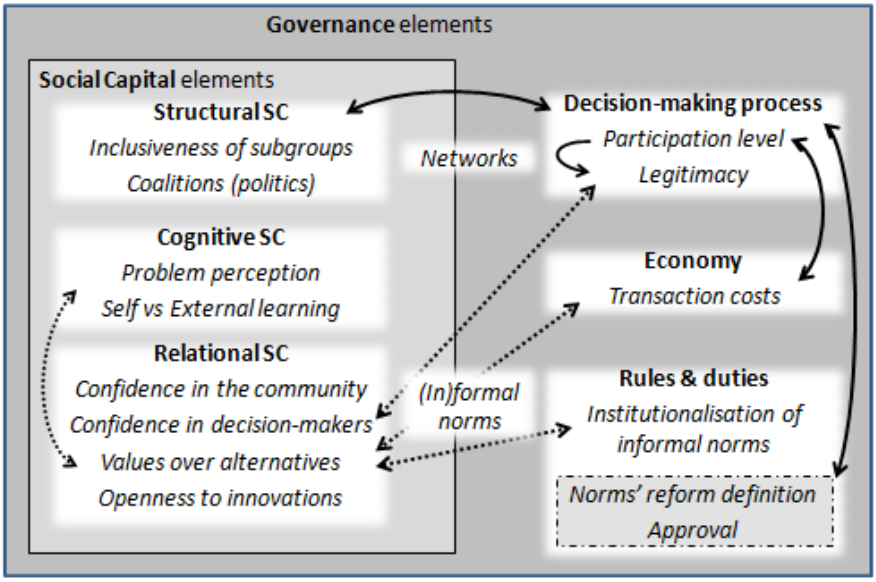

Figure 4. Social Capital and governance interactions during the decision-making phase.

The inclusiveness of the decision-making group (i.e. the agents discussing the governance reform) represents a key structural SC element at this stage. Decision-makers' networks forming coalitions can use their power to influence cognitive aspects (see 2.4.1.2) and thus hinder change or favour certain policy design features. Participation, a key good governance principle (e.g. Cowling et al., 2014), emerges at this stage as crucial for community involvement, thus forging ownership. Empowering (marginalised) subgroups entails including their representatives (Ishihara and Pascual, 2009), which improves process legitimacy; however, finding appropriate interlocutors becomes challenging in non-organised subgroups. There is a trade-off between the benefits of inclusiveness and the corresponding costs and delays. The degree to which community members agree with the new norms also determines the efforts required for the negotiation process, namely transaction costs (Coggan et al., 2010).

We propose that shared narratives determine the intensity and basis of the perceived problem, its consequences, and the factors community members

can control to tackle it. The social dilemma occurs when selecting the preferred intervention scenario from the alternatives. Community values play a key role in ranking individual preferences, moulded by their openness to innovations. We suggest that once the old norms are questioned and the new ones are implicitly accepted, a process of internalisation follows.

Community confidence in their representatives determines the legitimization of the decisions they make. We conjecture that trust in decision-makers rests upon their alignment to and support of the shared norms; in other words, their accountability as community representatives. Conversely, decision-makers' trust in the community allows them to adopt riskier decisions (e.g. drastic normative changes). The outcomes of this phase are the definition of the terms of the new governance mode, with its consequent approval procedure.

2.5.4. Implementation phase

The governance change may materialise in new arrangements, contractual modes, social innovations or new policy instruments, which ultimately refer to changes in norms and behavioural patterns (Figure 5). Policy instruments address the social dimension in two ways: (i) explicitly strengthening networks for executing actions, or (ii) targeting certain activities where the decentralised but coordinated action of community members is desirable to reach a common benefit. In both cases, enhancing the frequency of agents' interactions (e.g. joint events) facilitates access to information and hence transparency - one of the good governance principles (e.g. Cowling et al., 2014), ultimately benefiting policy tools based on trust. However, while community trust-building may constitute a policy-maker goal, individuals are likely to take part for other benefits (e.g. better prices, voting rights), although this may also imply additional duties (e.g. annual fee, risk sharing).

Effectiveness of the new governance mode measures the ratio of agents engaged in the new behavioural norms, which is likely to lead to changes in the network topology and trust (see 2.4.2.1 and 2.4.2.2). Policies promoting

new bridging ties can improve the openness to innovations, implying a potential for novel adaptation strategies and hence increased community resilience. Still, it remains unknown how agents in powerful positions would react to any reorganisation, as they may prefer their status quo over the community good.

Other forest governance reforms deal with rights' reformulation, mainly on forest access, products harvesting and trade, and management decision-making. We hypothesise that the degree of congruence between previous informal norms and the newly agreed rights, and the perception of a legitimate agreement, affect the acceptance of the new rules by forest users.

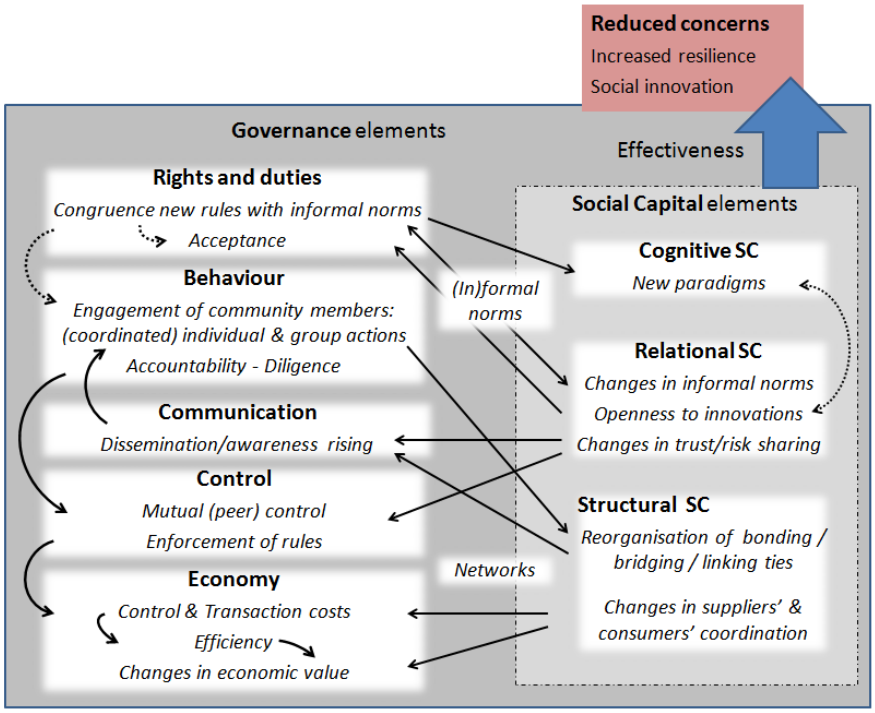

Figure 5. Governance and SC inter-relations during the implementation phase.

Diligence is likely in individuals convinced of the benefits of the new behavioural norms (being "good fellows"), and who perceive reciprocity from their bonding ties or those holding moral authority. Others, however, may behave in the expected manner just to avoid community sanctions (see

0). The degree to which policy-makers trust people's diligence is partially reflected in defensive costs such as a budget for inspections, which ultimately affect economic sustainability of the public sector.

Regarding market aspects, the value chain may be affected by the reorganisation of links. This can be in terms of scale (in vertical or horizontal integrations), of negotiation power (changing intermediaries' power), or of access to key information. Examples include the establishment of small owner groups facilitating sustainable forest management certification, or rules to reduce monopolistic advantages. Commercial agents may become affected by rules restricting their access to the full potential of NR, e.g. limiting tree/NWFP species for harvesting, requiring harvesting fees, official registration or reporting procedures. Commercial agents should then adapt their trade strategy to maintain their livelihood in terms of profit margins. This provides incentives for buffering additional production costs through e.g. restructuring of commercial ties, or diversifying the portfolio of products. The market value of a forest and its products and services then varies accordingly.

Public and private economic sustainability being one of the pillars of rural development, the way SC affects the implementation of governance arrangements represents its contribution to the economic performance of rural communities. The success of the governance reform also has to be assessed through outcomes in the form of reduced environmental and social concerns that motivated the change.

2.5.5. Evaluation phase

The evaluation phase includes monitoring and assessment of the outcomes of the policy formulation and implementation (Krott, 2005:281). Such an appraisal may be conducted in an informal and decentralised manner (i.e. local perceptions), or could be formal scientific assessments or participatory monitoring. Citizen science -common in NR- has shown potential for strengthening naturalists' networks and thus structural SC (Conrad and

Hilchey, 2011). The evaluation information feeds back to the community, modifying awareness on ecosystem processes (Stepenuck and Green, 2015); such new cognitive SC provides feedback (Easton, 1957) to community members about the need for continuing, amending or closing the governance reform down.

2.6. Discussion

In this paper we analysed the role of social capital and its interaction with forest governance. Networks and institutions are identified as connectors between governance and SC concepts. Information flows, trust, norms or power relationships play a role at different stages of a forest governance reform, hence we propose a dynamic model to depict these interlinkages during the process.

The global forestry trend towards decentralised governance modes materialises in diverse collaborative forest management initiatives, which seem to entail an explicitly agreed collective action. Broadening such a simplified conception, the model aims at representing individual acts pursuing a common-shared objective. In order to address the "tragedy of the commons", communities elaborate their own norms and behavioural patterns, which ultimately shape the forest governance mode. SC of rural communities hence acts as the "invisible hand" that aligns community members enabling collective action, desirably towards a sustainable forest management and use. Forest governance reforms may be triggered by changing values and other social cognitive aspects, but also exogenously through emergent NR problems, economic opportunities or adoption of higher-level premises.

Within a policy network analysis (Arts, 2012), we overcome the typical critique of overly socialised models acknowledging the "social infrastructure" as complementing what traditional forest policy analysis (based on rational-agency, individual-incentives), and (technical, financial or human) capital-based development theories fail to explain for rural areas.

A SC perspective on NRM governance may be of special interest for forestry, where high uncertainty levels caused by the long time-span of forest cycles induce short-sighted, individualistic behaviours. High level of intra-community trust is required to (partially) compensate the risks of long-term decisions, -"risk pooling" in the words of Bowles and Gintis (2002). Yet trustworthy environments require internal norms to deal with the flexibility in the likely changing conditions during the lengthy period. Cognitively, a vision of the rural communities facilitates local-level long-term decisions (i.e. mitigation of natural hazards), which become consistent with a broader progress plan. The cognitive aspects, such as traditional ecological knowledge on forestry illustrating community memory on i.e. wildfires, or the social construction of preferred alternatives, deserve further attention. Given the risks of unbalanced benefits of networks (Ishihara and Pascual, 2009), additional insights into information and power relations are needed for analysing the political nature of forest governance reforms. Moreover, the model highlights the role of trust and informal norms; in practice, however, forest actors often lack the ability or tools for managing such elements.

The model is relevant for open-access resources in forests, entailing the coordination of many agents. Fuelwood or NWFPs have typically benefited local communities independently of the land ownership; hence the model can help to analyse changes in collective harvesting. How the model functions in the presence of non-community forest users (i.e. external harvesters) imposing pressure on resource competition has to be further investigated, as they may either encourage the development of harvest norms (Brooks, 2010), or reduce effective enforcement of norms (Van Laerhoven, 2010). In this context, SC is a necessary but not sufficient condition for collective action (e.g. Tole, 2010) if community members lack the capacity to sanction non-community free-riders; thus, action from the public authorities may be required.

We identify niches in this model for policy measures requiring landowners' cooperation in ecological processes comprising adjacency externalities

(spatial spillovers) of forest management, like wildfire prevention (Agrawal and Monroe, 2006), habitat corridors like river woodlands (Plummer and Fitzgibbon, 2006) or wooded patches acting as biodiversity stepping stones (Saura et al., 2014), control of invasive/exotic plants as well as pests and diseases (Holdenrieder et al., 2004). This model may also serve the purposes of policy tools facilitating upscaling (e.g. landscape-level wood mobilisation), such as the establishment of landowners' networks or adapting previous interaction patterns.

Finally, SC features related to good governance principles provide insights into their potential use as indicators for assessing governance at the local level (Secco et al., 2014). Several good governance principles have emerged from the model, as follows: decision-making network structure and interactions build trust (e.g. Baral, 2012), and ultimately legitimacy; transparency derives from the information sharing through participatory processes (e.g. McDougall and Banjade, 2015); reduced transaction and control costs yield efficiency (e.g. Chand et al., 2015) and affect value chain development (e.g. Vennesland, 2004). Conversely, the "dark side of SC" perspective helps to find forest governance weaknesses regarding equity/fairness - power division, corruption and patronage in rural areas, or community blockage to the entry of innovations (e.g. Wilshusen, 2009).

2.7. Conclusion

Through a review of the scientific literature we analysed the relationships between social capital and forest governance in rural areas, and their complex and systemic cause-effect interlinkages. SC has been identified as input for forest governance, given that actors' networks are considered to influence different governance reform stages: conception, formulation and implementation. SC is also revealed as an outcome of specific network- and trust-building policy interventions, i.e. support to cooperatives, or creation of inter-communities dialogue platforms. Networks and institutions are identified as connectors between governance and SC concepts. Network

elements are condensed into structure, information and power; while institutional elements are represented by norms, trust and enforcement.

We suggest a process-based model for SC and governance elements' interaction applied in the forestry sphere. In our model, cognitive SC is fundamental for triggering governance reforms, network (and power) structure becomes relevant during the policy formulation, while trust and informal norms play a key role in the implementation. Existing research has proved some of the relationships in selected case studies (i.e. trust in Borg et al. (2014)), while others remain to be empirically proven: the social cognitive processes leading to collective action, the dynamics (politics) of governance formulation, trust-building measures, the downside of SC, or innovation diffusion in forestry.

The model also provides some insights into SC features as potential local-level indicators for some of the key good governance principles, but further development of such a normative approach is needed. Having evidence on the role of SC as an asset for improving forest governance -i.e. better economic outcomes in rural areas-, decision-makers are advised to consider investing in "social infrastructure" to help unlock the potential of rural communities and their forest resources. Enhancing the social environment would facilitate desirable social innovations, such as public-private partnerships, new contractual agreements, dynamic and inclusive value chains, more resilient societies or less marginalisation. Sound information on these aspects contributes to improving the design and implementation of forest measures within rural development policies or forest adaptation strategies. Furthermore, the model fits well in environmental challenges entailing adjacency externalities requiring landowners' cooperation; thus, strengthening their SC is expected to smooth their collective action towards greater social, environmental and economic benefits.

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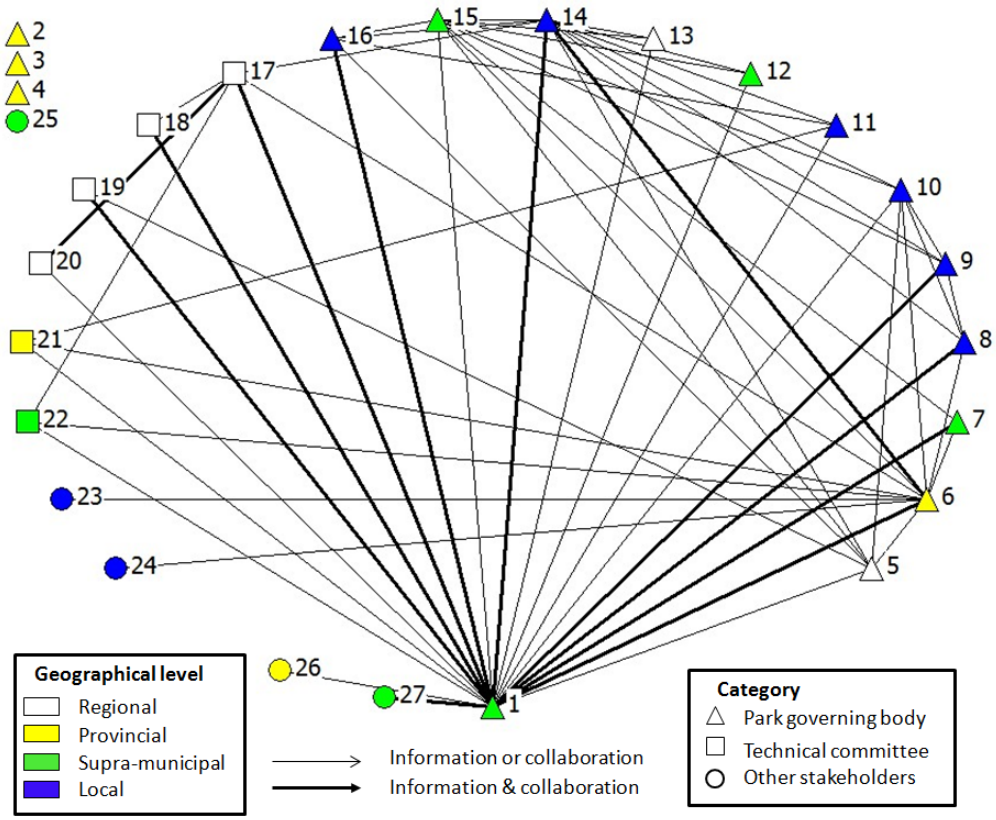
3. Structural social capital and local-level forest governance: do they inter-relate? A mushroom permit case in Catalonia



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3. Structural social capital and local-level forest governance: do they inter-relate? A mushroom permit case in Catalonia

Abstract

In diffuse forest uses, like non-timber forest products' harvesting, the behavioural alignment of pickers is crucial for avoiding a "tragedy of the commons". Moreover, the introduction of policy tools such as a harvest permit system may help in keeping the activity under control. Besides the official enforcement, pickers' engagement may also derive from the perceived legitimate decision of forest managers and the community pressure to behave according to the shared values.

Framed within the social capital theory, this paper examines three types of relations of rural communities in a protected area in Catalonia (Spain) where a system of mushroom picking permits was recently introduced. Through social network analysis, we explore structural changes in relations within the policy network across the policy conception, design and implementation phases. We then test whether social links of the pickers' community relate to influential members of the policy network. Lastly, we assess whether pickers' bonding and bridging structures affect the rate of permit uptake.

Our results show that the high degree of acceptance could be explained by an adequate consideration of pickers' preferences within the decision-making group: local pickers show proximity to members of the policy network with medium-high influence during the three policy phases. The policy network also evolves, with some members emerging as key actors during certain phases. Significant differences are found in pickers' relations among and across the involved municipalities following a urban-rural gradient. A preliminary relation is found between social structures and differential pickers' engagement. These results illustrate a case of positive social capital backing policy design and, probably, also implementation. This calls for a meticulous design of forest policy networks with respect to communities of affected forest users.

Keywords

Social capital; non-wood forest product; forest policy; networked governance; policy network; Social Network Analysis

3.1. Introduction

In this paper we focus on the interactions among the forest community as a relevant factor for forest governance. The relations among community members in different levels constitute their social structure, which is a key dimension of social capital (Nahapiet and Ghoshal, 1998). Social capital (SC) has been defined as the features of social organizations that facilitate coordination and cooperation for mutual benefit of the members (Bourdieu, 1986; Coleman, 1988; Putnam, 1993) and eventually of the society in general. These features include networks, reciprocity, norms and trust (Bowles and Gintis, 2002) which, if used in a positive manner, encourage collective action to achieve sustainable development (Pretty and Ward, 2001; Woolcock, 2001). Hence, networks of information and collaboration in rural communities become relevant when managing natural resources requiring coordination as per their consequent generated behavioural pool.

Diffuse uses take place in not-fenced woods when e.g. hikers, Non-Wood Forest Product (NWFP) pickers or fuelwood harvesters practice their activities in a dispersed manner. When these diffuse users do not align around formal and informal norms to use the forest, a "tragedy of the commons" (Hardin, 1968) may ensue, with ecological, social and economic consequences, e.g. resource depletion, conflicts or decreased benefits, respectively -see, for example, Pandit and Thapa (2003) or Yang et al. (2009)-. Coordinating these different actors at landscape-level –among and between land managers and users– to deal with diffuse uses constitutes a key challenge in forest governance.

Network-based community governance (Jones et al., 1997; O'Toole and Burdess, 2004) is emerging as an alternative or complementary to traditional governing approaches (market and informational policy tools, or top-down regulations), as community incentives could contribute to solve the prisoners' dilemma by aligning community members around a socially desirable behaviour (Bowles and Gintis, 2002), e.g. improved management and use of forests. Such community incentives are grounded on social capital,

as recurrent interactions among community members derives in peer control, social sanctions and recognition (Bowles and Gintis, 2002).

We aim to answer the question on how community social structure interplays with aspects of forest governance, and its dynamics when introducing a reform. Studying this interplay is relevant insofar as the forestry domain is increasingly adopting network governance approaches (Glück et al., 2005). Most studies have concentrated on forest policies explicitly designed to establish networks: community forestry (Baynes et al., 2015), participatory processes (Nath et al., 2010), or co-management (Akamani and Hall, 2015). However, there has been little analysis on how existing rural networks influence the broader set of forest policies at local level. Specifically, there is a lack of empirical knowledge on how forest policy and users' networks -and hence SC- interact, how they affect local forest governance (in terms of acceptability or engagement), and whether the changes in governance modes (e.g. a policy reform) affect SC as well.

It is important to have evidence of the social network consequences of policy reforms, especially at the level of end-users. For this reason we focus on the local scale, given that it constitutes the spatial and administrative level where abstract policy goals are implemented in practice by means of projects and management choices (Secco et al., 2014). At this local level, previous scholars have usually focused on disentangling power structures affecting different policy phases, namely: policy design (McDougall and Banjade, 2015) or implementation (Rico García-Amado et al., 2012; Wilshusen, 2009).

In this paper we analyse three components of forest governance from the network viewpoints: changes in flows within the policy network, community acceptance of a policy reform, and abidance by the new norms. Our specific research questions and vision thereof are:

a) How do the social relations within the policy network vary during the policy process? We hypothesize that changes in the relations

among policy network members vary according to their influence at each phase.

b) Whether and how do the structural relationships between decision-makers and affected forest users relate to the outcomes of the governance reform? We conjecture that if affected citizens have contacts with influential decision-makers, the latter will be in a better position to translate their opinion into the deliberation process. That is likely to bring about legitimacy (Rantala, 2012) and consequent acceptance.

c) Do significant differences in social structure across local communities effect the engagement in the new policy? We suggest that the SC of forest users relates to the abidance level, as more interactions would mean increased possibilities for controlling peers' behaviour. The level of engagement would illustrate the effectiveness of the policy reform.

We utilise empirical data from a case study on the policy process connected with the introduction of a mushroom picking permit system in Catalonia (north-eastern Spain). The novelty of this paper relies on (i) the social analysis of both spheres: decision-makers and final forest users; and (ii) the longitudinal approach to the analysis of a policy instrument, including not only the pre and post situations, but also the deliberation phase.

The paper is structured as follows: section 2 sets the theoretical background and analytical framework, section 3 explains the methodology, section 4 presents the results and discusses them, conclusions are in section 5.

3.2. Structural social capital during the policy cycle

3.2.1 Theoretical background

Policy networks are "*problem-specific entities, organizing a policy area*" (Sandstrom and Carlsson, 2008), involving actors highly interconnected but with heterogeneous interests (Carlsson, 2000). Coordination in a strongly regulated European context may stem from the official mandates assigned to

decentralised decision-making bodies such as boards of protected areas. Still, the network governance[11] approach acknowledges the vested interests of actors who may not necessarily be formally involved in the political processes but relevant in the collective action. This wider perspective allows certain subgroups to be visualised which eventually become marginalised in the environmental decision-making with consequent community conflicts (Ishihara and Pascual, 2009).

Based on the Social Capital theory, the relations within networks have different functional meanings depending on their strength (Granovetter, 1973): "bonding" SC labels the strong ties among individuals of the same circle, while weak ties connecting individuals of different circles constitute the so-called "bridging" SC (Andriani and Christoforou, 2016). Bonding SC generally contributes to fulfilling basic needs, with bridging SC highlighted for its potential to introduce innovations e.g. from other sectors (Bodin and Crona, 2009). In addition, the "linking" SC connects community members with higher hierarchies, e.g. decision-makers. This network structure affects and is affected by other network dimensions (Nahapiet and Ghoshal, 1998), namely the relational SC (trust among members, behavioural norms and sanctioning), and cognitive SC (shared understanding). SC affects community members behaviour insofar as through their network they transmit information, control their peers with consequent social sanctioning, and share risks (Bowles and Gintis, 2002).

Social capital of communities interacting with natural resources, then, shapes their governance patterns, given e.g. their connectedness, reciprocity, social norms, and sanctions (Bodin and Crona, 2009; Pretty and Ward, 2001). The analysis of social structures in forest-dependent communities is emergent, with studies so far focusing on specific SC aspects. Typical questions addressed include: policies explicitly establishing forestry

[11] Network governance stands for the structures and processes by which collective action among a diversity of social actors is coordinated toward upholding certain publicly held values and resources (Ernstson et al., 2010)

networks, such as community forestry, co-management or participatory processes (Akamani and Hall, 2015; McDougall and Banjade, 2015); the assessment of project performance based on policy network relations (Harrison et al., 2016; Jedd and Bixler, 2015); or the role of SC in policy implementation with respect to other forms of capital (Akamani and Hall, 2015).

It has been found that collective action is more likely to occur in communities with denser networks (e.g. Akamani and Hall, 2015). At the individual or node level, it is also important from whom information derives when making decisions on forest management (Rickenbach, 2009). Bridging SC in forest communities has been proved important for spreading innovations on adaptation -e.g. fire prevention practices in Macdougall et al. (2014)- and contributing to better-off value chains (e.g. Vennesland, 2004). Alignment of forestry hierarchies with local-level initiatives potentially smoothes community welfare (e.g. Baral, 2012) but can also bolster an elite capture (Kamoto et al., 2013). Lastly, other scholars have explored the relation between forest stakeholders' constellations and the role of trust (Borg et al., 2015; Guillén et al., 2015). While we acknowledge the relevance of trust, its analysis is beyond the scope of this study.

3.2.2 Analytical framework and approaches

In this study we focus on the structural aspects of a rural community and its related policy network during a governance reform leading to collective action in a field different from the explicit bolstering of networks (Górriz-Mifsud et al., 2016). The analyses are done on two levels of policy actors, namely: the (potential) decision-makers –representatives of stakeholder groups, in this paper the "policy network" (PN); and the citizens affected by such decisions –e.g. forest users. The decision-makers set the normative and operational context for the collective action to thrive (Ostrom, 2000) driven by problem-solving objectives (Arts, 2012), while forest users are expected to adhere to the collective action. Their network structures contribute to explaining the policy deliberation and implementation level (Sandstrom and

Carlsson, 2008). Based on the rational policy and network theories (Arts, 2012), we analyse the phases of the policy cycle applied in forestry (Krott, 2005) -policy conception, design, implementation and evaluation- from the viewpoints of social structures. Formal or informal policy networks play a role during these phases.

We assume that the PN structure at the conception phase informs about pre-existing power structures and the predisposition to collaborate (Table 1). Instead, the information and collaboration flows among PN members during the design phase inform about stakeholders' inclusion and potential power changes. Linking SC at this stage puts pressure on PN members for accountable decision-making (i.e. reflecting community preferences), and this affects community acceptance of the resulting changed norms. With the change accepted, the community structure affects the engagement with the new behavioural norms –i.e. community diligence– by disseminating the norms, peer control in the field and social sanctioning. Community structure, then, shapes not only collective action effectiveness, but also its enforcement costs. Lastly, PN collaboration flows during the implementation affect the logistics (e.g. bureaucracy, equipment) and resulting efficiency.

Table 1 - Analytical framework: throughout the policy cycle, the three hypotheses relating governance and SC concepts. Source: own elaboration.

	Effects in each policy cycle phase					
Relevant relations	**Conception** →		**Design** →		**Implementation**	
Decision-makers' structure (Policy network)	Predisposition to collaborate Power	H1	Inclusiveness Power	H1	Collaboration Logistic costs	H1
Users' Linking SC			Accountability Acceptance	H2		
Users' Bonding and Bridging SC					Diligence (collective action) Enforcement costs	H3

Focusing on policy conception, design and implementation phases, in this paper we analyse the influence of the structural aspects, according to the following hypotheses:

Hypothesis 1 (H1): Information and collaboration flows within the policy network change during the three phases of the policy process: from the general situation to the specific policy design phase, and its consequent implementation. PN composition informs of the inclusiveness of actors' interests and resources, where Sandstrom and Carlsson (2008) found that heterogeneous policy networks relate to resource mobilisation in the process of policymaking; this shapes the logistic costs of implementation. The relative position of PN members also informs of their predisposition to collaborate and influence during the policy process.

Hypothesis 2 (H2): The connections between forest users and members of the policy network in central positions relates to a policy outcome accepted by the community. Proximity to political representatives makes it easier for citizens to influence municipal decisions (Ruppert-Winkel and Winkel, 2011). Harrison et al. (2016) found the relevance of strong linking SC for development projects to thrive –and hence, adaptive capacity– in forest-dependent communities. Forest users being a large group implies that Social Network Analysis (SNA) is hardly logistically feasible and that policy network members likely do not know all of them. Ww therefore analyse these linking SC connections measured as per the proximity to PN members as reported by forest users. We assume that the opinions of the forest users' community are constant throughout the policy process.

Hypothesis 3 (H3): The stronger cohesion among community members and across other communities improves the policy performance. The cohesion is measured through the bonding and bridging SC of forest users, i.e. the breadth of their networks. The performance is understood in terms of implementation success, as high engagement, low control costs and few infractions. High cohesion levels among a homogeneous community constitutes a success factor (Dahal and Adhikari, 2008). Jedd and Bixler (2015) found that bridging positions help to maintain the network governance, inducing authentic engagement and consequently accountability.

By identifying interactions between SC and forest governance variables, recommendations for policy makers can be derived (Górriz-Mifsud et al., 2016). Appendix A3.1 summarizes previous scholars' works with some common elements to our study. McDougall and Banjade (2015) conducted an exhaustive study on the several stages within a policy implementation and their related SC changes; unlike them, we focus rather on the conception, deliberation and implementation phases. Similar to Akamani and Hall (2015), we check SC in the pre- and post- situations, but focusing only on participating citizens and using SNA techniques. Our study is similar to that of Jedd and Bixler (2015) insofar as we analyse in depth a case combining qualitative information and quantitative data elaborated by SNA from interviews with decision-makers; we also add the citizens' (users') level. Harrison et al. (2016) took into account both types of agents, but from a qualitative approach.

3.3. Methodology

3.3.1 Case study description: wild mushroom picking permit in Poblet forest

The protected area of Poblet forest is located in Catalonia (Spain), 126 km from Barcelona, and 50 km from the provincial capital Tarragona capital. It contains a wide diversity of Mediterranean forest ecosystems due to its variable geology, vegetation, altitude, and flora relicts.

In medieval times, a Cistercian monastery was established on the northern slopes of these mountains. It became a strategic actor of the Kingdom of Aragón, which gave the monks ownership of the forest. The process of seizure and privatisation of Church lands led to a period of unsustainable management. In 1862 this process was halted due to the inclusion of 3,000 hectares of outstanding value in the catalogue of "forests of public utility", and the State took over the ownership of the forest. After a period of intense reforestation programmes, the area was declared protected in 1984. In parallel with other protected natural areas in Catalonia (law 12/1985), the

operational management of Poblet park is conducted by a technical office, while its strategic management relies on a Governing body (*Junta Rectora*) which gathers local stakeholders with provincial and regional decision-makers.

In the last years Poblet has become famous in Catalonia for the establishment of a wild mushroom picking permit, a rather new instrument in the region. Catalonia being a mycophilic area, with 23% of its citizens declaring that they pick mushrooms at least once per year (CEO, 2014), the pressure on the resource has increased in the last decade. This has led to a debate about regulating this activity and the adequacy of a picking fee to contribute to the management of the forest used by pickers. Two factors ensue:

- the difficulty of regulating an activity conducted mainly in private, small forestlands –73(Fletas et al., 2012)(Fletas et al., 2012)% of Catalonian forest area is privately-owned (Fletas et al., 2012), Poblet is one of the few public forests;
- the pickers' acceptance of the restrictions to a traditional activity in terms of control, practices and fee.

In Poblet this debate found a positive local setting, which facilitated the establishment of a pilot area for mushroom picking permits in 2012. Table 2 shows the different permit categories, corresponding fees and pickers' rate of engagement. The permits are valid during the autumn season, which officially opens after confirming the production of mushrooms. Weather conditions precluded opening the 2013 permit season, with other seasons showing a permit numbers somewhat proportional to the productivity –see table 2 for the most sought-after mushroom species. A technical committee (*Commissió de seguiment*) was assigned to advise on permit design and supervise its functioning, producing annual reports.

Table 2 – Mushroom picking permits issued per season according to categories with correspondingfees. Proxies for affluence of pickers: mushroom

productivity and car counts per season. n.a. = not applicable. Source: Poblet technical office; pers.comm. Martínez de Aragón.

Seasonal permits and fees		**Permits issued per season**			
		2012	**2013**	**2014**	**2015**
Adult (>18 years old)	10 €	247	n.a.	215	71
Non-local young pickers (14-17) and retirees	5 €	107	n.a.	138	70
Local citizen (>14 years old)	1 €	1718	n.a.	1629	755
Children (<14 years old)	0 €	78	n.a.	96	55
Daily permit (only after 2013)	3 €	n.a.	n.a.	154	54
Total permits		2,158	0	2,232	1,005
Nr of infractions found		13	n.a.	5	1
Proxies for pickers' affluence		**2012**	**2013**	**2014**	**2015**
Weeks with mushroom production		8	0	8	2
Productivity of *Lactarius* group *deliciosus* (kg/ha)		16.12	0.22	26.91	0.68
Car counts October 1st until December 15th		3,650	2,430	3,988	2,253

Permit "local" category encompasses the inhabitants registered in one of the four municipalities where the regulated area is located: Montblanc (county capital, with the neighbourhood of Rojals), L'Espluga and Vimbodí, in the lowlands; and Prades in the mountainous area. Montblanc does not reach the urban category according to the inhabitants' criterion of the Spanish Statistics Institute (INE, 2001) (Table 3). But being an historical strategic point and current county capital endows it with characteristics typical of a so-called "small urban centre" intended as: most of the population working in the industrial and services (e.g. governmental) sectors, and with businesses useful to farmers from neighbouring villages – i.e. "*activities based on backward and forward linkages with agriculture*" (Satterthwaite and Tacoli, 2003) –. Prades is instead located on the plateau with less connection to the other municipalities and indeed administratively depends on another county. Moreover, Prades is surrounded by extensive woodlands, hence with nature-based tourism, while tourism attractions Montblanc and Espluga are more cultural-based (e.g. Cistercian route).

Table 3 –Characteristics of the municipalities surrounding Poblet forest and representativeness within our study. Source of population data: IDESCAT; of permits and forest features: Poblet technical office.

Municipality characteristics		**Montblanc**		**L'Espluga de Francolí**		**Vimbodí i Poblet**		**Prades**	
Population in 2015 (15-84 years old)		total	15-84	total	15-84	total	15-84	total	15-84
		7,283	(5,906)	3,818	(3,087)	966	(796)	623	(523)
% registered employees [a] in agriculture		1.08%		3.98%		7.78%		4.74%	
in industry		51.04%		28.45%		12.22%		3.88%	
Population density (inhabit./km^2)		80		67		14.6		19.1	
Local permits issued (% 15-84 years old population)	season	N	15-84	N	15-84	N	15-84	N	15-84
	2012	668	11%	655	21%	178	22%	33	6%
	2014	830	14%	686	22%	198	25%	36	7%
	2015	468	8%	202	7%	76	10%	8	2%
Pickers' available contacts		470		447		90		3	
Interview sample (% permits issued in 2014 per municipality)		N	%	N	%	N	%	N	%
		15	3.2%	15	3.4%	10	11%	1	33%

[a] Absolute figures are not relevant due to incongruence in the official data (acknowledged by IDESCAT) reason for not mentioning other sectors; still the comparison across towns is still relevant.

Figure 1 shows the regulated area and the four municipalities where the forests are located. There are also other initiatives concerning mushrooms in the park. Since 2008 a network of permanent plots has been established for scientific monitoring of mushroom production. They are used for constructing growth models and scientists provide accurate data to the park technicians about the beginning and end of the season, as well as the productivity (Bonet et al., 2012a).

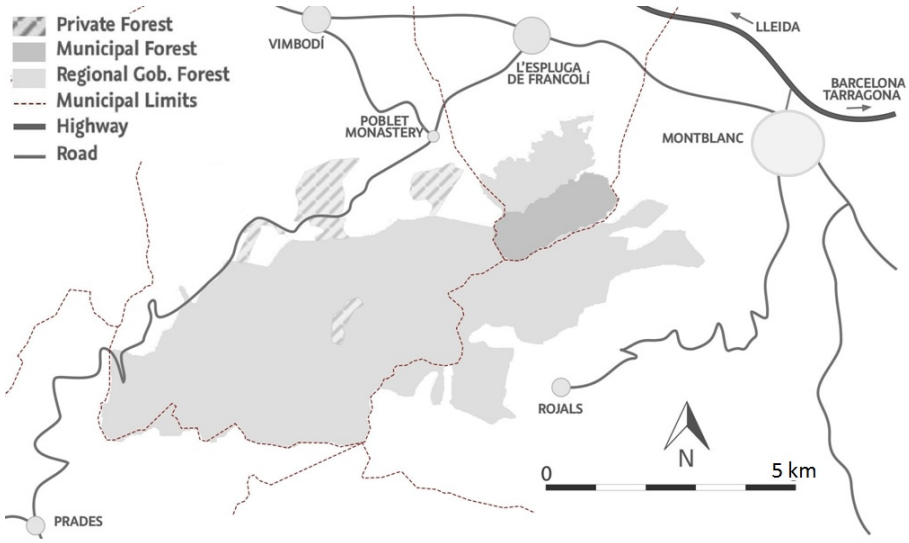

Figure 1 - Map of the forest area requiring a mushroom picking permit. Graphics: Luis Górriz-Mifsud.

3.3.2 Data collection

The local relations have been explored at two units of analysis:

- The Poblet protected area as a whole, represented by its policy network (PN) and local forest users (i.e. mushroom pickers). The policy network contains three stakeholder types: the Governing body, the Technical committee and other stakeholders we thought to be relevant (Appendix A3.2);
- The municipalities, with the local pickers from each.

Given the impossibility of interviewing the entire census of pickers with a permit, a random selection had to be made. To avoid the novelty effect, we first identified the pickers who got a permit at least two years (seasons 2012 and 2014) and left a phone contact. After deleting Governing body members and non-adults, contacts were ordered by surname for each municipality, and randomly selected every 15 names. First contacted by phone (225 calls), the rate of acceptance for an interview was 18%; therefore when one declined, we passed to the next on the list unless that person was a relative of an already interviewed picker.

In-depth interviews were conducted during 2014-2016 with 16 members of the policy network, and 41 randomly selected pickers from the four municipalities (Table 3). Two questionnaires (one for PN members and another for pickers) were drafted according to a set of indicators derived from the analytical framework; they combined semi-open and closed questions.

We acknowledge the low number of observations, which derives from the low acceptance rate by pickers to be interviewed. After rechecking the approach, we attribute this to the general reluctance in Spain to participate in studies –15% is the usual response rates, see Harzing (2000), and their unfamiliarity with the interviewers' institution. In contrast, 75% of the decision-makers –who generally know our institution– took part in the interview. Perhaps more interesting than increasing the sample size would be to confirm community member characteristics of those who did not engage in the system or non-local pickers, which was out of the scope of this study and opens avenues for further research. Assessing changes in relations in over a longer period is another concept for further analysis.

Ad-hoc indexes were built to check the previous hypotheses (Table 4). Indexes include structural aspects –mostly used for SNA– and governance aspects of perception of inclusiveness, acceptance of the permit, the enforcement and levels of non-compliance.

Drawing upon SNA techniques, community structural relations can be assessed quantitatively (Borgatti et al., 2009), allowing for policy network comparison during the policy cycle. SNA conceptualises network actors as nodes and their interrelations as links among nodes. Following SNA protocols (Hanneman and Riddle, 2005), adjacency matrixes were built showing the social distance in terms of binary information and collaboration among stakeholders at each policy phase. The impossibility of interviewing all stakeholders implied incomplete matrix information. Therefore pairwise relations were assumed as bounded ties,

Table 4 - Indexes used and their variables. PN = Policy Network interviews, P = Pickers' interviews, 2 = secondary sources. Source: own elaboration.

Index		**Concept *(reference values where applicable)***	**Source**
PN Density		Information and collaboration cohesion among PN members	PN
PN Centrality	Degree centrality	Proxy of influence: to what extent a PN is sought-after by others and how many s/he can reach	
	Closeness	Indicates the efficiency of information spread by a PN member	
	Eigenvector	Proxy for connection to powerful nodes.	
	Betweenness	Indicates which PN members could act as brokers, e.g. connecting subgroups	
PN popularity index		PN members' average degree of communication flow with pickers in the general situation, aggregating the scores given by interviewed pickers. *(0: unknown, 1: only able to identify; 2: occasionally talking; 3: regularly talking)*	P
PN influence degree		Aggregation of influence degree of each PN member for each policy phase, as assessed by other PN members *(5: most influential - 0: no influential)*	PN
Pickers' bonding SC	Ego-network size	Average of pickers known by interviewed pickers within the same municipality, as ratio of total pickers with permit.	P
	Communication ego-network	Average of pickers with whom interviewed pickers talk about mushrooms within the same municipality, as ratio of total pickers with permit.	P
Pickers' bridging SC		Average of pickers known or with whom interviewed pickers communicate from other municipalities, as ratio of the total pickers with permit.	P
Inclusiveness		Perception of missing stakeholders in the Governing body or technical committee	PN
Acceptance		Degree of agreement with the policy reform (permit with payment), of the different design aspects *(0: disagree, 1: agree)*	P
Diligence	Pickers' engagement	Ratio of municipality inhabitants with permit	P
	Non-compliance	Awareness of non-compliant neighbours	P
		Number of infractions	2

and consequently symmetrised. The symmetrised approach provides an average score per node, simplifying the In- and Out- interpretations of centrality indexes. Matrixes were symmetrised using the maximum reported relation (Hanneman and Riddle, 2005:76), i.e. if only one of the two nodes reported a relation but not the other, that relation is considered as happening between both sides. The maximum criterion risks over-representation of respondents with tendency to exaggerate their relations.

Next, information and collaboration matrixes were summed to provide a simpler but more robust index of the intensity of PN relations (Hanneman and Riddle, 2005). These matrixes set the ground for stakeholders' centrality indexes computation using UCINET software (Borgatti et al., 2002). Our focus on centrality is justified by the several nuances of power sociologists find reflected in each index (Hanneman and Riddle, 2005).

Community's bonding and bridging SC are measured as the ego-network of the average picker, i.e. the average number of ties per actor since that metric is less affected by varying network size (Bodin et al., 2016); in our case total network size varies across municipalities.

3.3.3 Statistical analyses

Given the limited amount of observations, bivariate analyses have been conducted. The strategic comparison of SNA centrality scores of each PN member during the policy cycle serves the first hypothesis. Moreover, a correlation analysis between the PN centrality indexes and PN influence as assessed by themselves would confirm the potential linear association.

For the second hypothesis, correlation analysis was used to test linear association between the popularity of PN among pickers with the variables of PN centrality. This degree of association informs about whether the PN nearest to the pickers are central actors potentially translating pickers' perceptions and values. Given the not normally distributed variables, the Spearman test was used.

For the last hypothesis, different means' tests were applied to contrast the presence of significant differences in bonding or bridging SC across the municipalities. The Shapiro-Wilk test for pickers' links within and among municipalities revealed their not-normal distribution across the towns. The Kruskall-Wallis test was therefore conducted complemented by the Mann-Whitney U test to identify the statistically different pairs. Due to the limited number of observations, the municipal-level statistical analysis excluded the replies from Prades; nonetheless, results take into account references to that

town by pickers from other municipalities in order to provide robustness. Correlation analysis was conducted to test association between structural community variables and permit engagement per municipality.

3.4. Results and Discussion

Following the research questions, section 4.1 describes the policy network structure and its changes throughout the policy process; section 4.2 analyses the pickers' linking social capital; section 4.3 analyses pickers' SC per municipality; and section 4.4 relates those pickers' differences with the engagement levels per town.

3.4.1 Dynamic stakeholders' structure depending on competences

a) PN inclusiveness

When asking the PN about any relevant stakeholder missing from the mushroom permit-related decision-making, 61% felt complete the current composition to be complete; however, agents from the technical committee tended to miss some representatives. A consensus emerged on the lack of local opinion-leaders beyond the PN. The fact that neither the rural tourism sector, nor two of the mayors out of the four municipalities affected are involved would in principle indicate that some important actors are missing in the PN. However, they are not perceived as key actors by PN or pickers. Having contacted all three, only one mayor agreed to be interviewed and indeed did not feel disadvantaged by the fact of not being in the decision-making, as mayors communicate regularly with the park authorities. As there is no mycological association in the area, the environmental NGOs somehow represented pickers' interests from a nature conservation approach.

b) PN information and collaboration throughout the policy process

Derived from the SNA, Figure 3 shows the relationships among the PN for the policy conception phase (i.e. general park management). The circular layout improves the comprehension of the dynamics (see Appendix A3.3 for corresponding graph for the conception phase). The network shows that

those who collaborate also talk to one another; even if that might appear to be obvious (for the stronger link of collaboration), in a context of public administration context the collaboration could stem from competences rather than from effective communication. The park directorate holds the most central position, which would be expected given the unit of analysis (the park) and its role as facilitator of the reform. Local stakeholders do not report collaboration with one another, but exchange information, especially those belonging to the same political party. Density is 0.179 and no particular coalitions are observed.

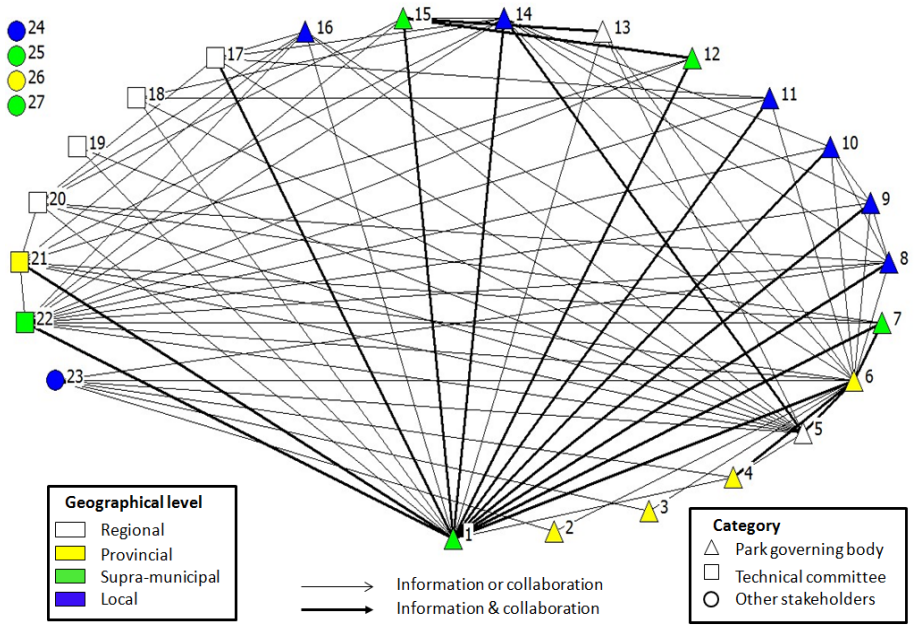

Figure 2 – Policy network representation of information and collaboration in the policy conception phase. Nodes' shapes stand for the stakeholder role in the permit system. Nodes' colour corresponds to the geographical level. Lines width represents the reported flows. Isolated circles represent isolated nodes. Source: own elaboration.

Several network structural changes are observed when transitioning from the policy conception to the design (spring 2012) and implementation phases (2012-2015). Figure 3 shows that network density decreases during the design phase (density = 0.105), when the park directorate still maintains

a core role, now with stronger ties towards some members of the technical committee. The provincial section of the Agriculture department emerges as connecting with mayors of municipalities not included in the Governing body, but affected by the policy instrument. An NGO emerges as key actor for transmitting information. Governing body members remaining outside the network (nodes 2 to 4) correspond to those with other topical competences (e.g. culture, urban planning).

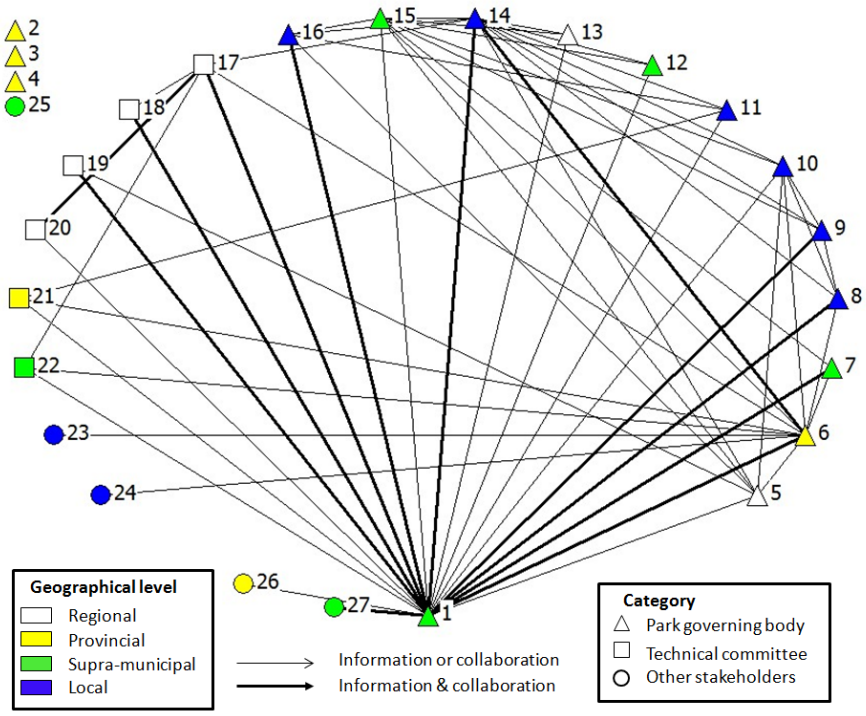

Figure 3 - Information and collaboration flows during the design phase within the PN. Source: own elaboration.

During the implementation phase (Figure 4), instead, the network becomes more active (density = 0.174), with increasing role of the technical committee following up the implementation (collaborating among them and with the park), and of the two municipalities not included in the decision-making but collaborating in the implementation, as well as the county office. The last three collaborate through issuing the permits in their facilities with

their personnel. There is also more information exchange among local stakeholders. Interestingly, technical committee members increase their interlinkages, especially with the mycological expert and the forest guard. Moreover, those at county and provincial level strengthen connections with local-level Governing body members, while those at regional level rather reinforce connections with park directorate.

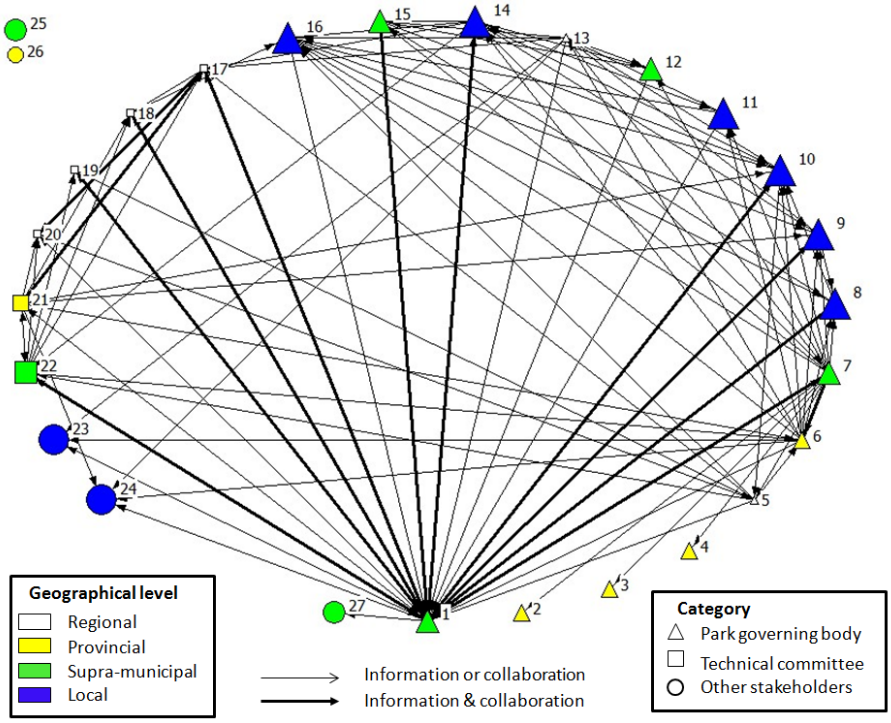

Figure 4 - Information and collaboration flows in the implementation phase among PN. Source: own elaboration.

c) Changing influence during the policy cycle

The strategic comparison between centrality indexes (Appendix A3.5) reveals three key actors in during the policy process, namely: the park directorate, the monastery and the provincial representative of the Agriculture department. The four top centrality indexes confirm the graphic with regard to the main position of the park directorate in the three phases.

This maintained central position acts as "leader" boosting the policy process. Such a position matches findings in Bodin et al., (2016) regarding collaborative networks, where leader centrality is positively related to the level of system thinking and degree of integration across different aspects and management phases in ecosystem management.

The provincial representative shows a second (or third) position in the indexes during the policy process. This key node is surprising given its low influence reported by PN members. When disentangling the direction of these flows, we find that the relations are reported by this person, but the PN counterparts do not report back. This might be an overrepresentation deriving from the symmetrisation approach used. The monastery is a key actor in third place, especially in the conception and design phases with all centrality indexes. These three actors, corresponding to the government, politics and the church (technical park management, provincial representative and monastery, respectively), would represent the "elite"[12] in this particular setting. They could behave either as leaders towards the common benefit, or rather manipulate towards their own interests, capturing the benefits (e.g. Oyono et al., 2005).

Other PN members act as brokers in one specific policy stage. For example, town representatives hold secondary positions during the conception phase in terms of centrality degree, eigenvector and closeness; i.e. they have influence and are efficient disseminators of information but are less likely to act as brokers within the PN. They were also expected to become key actors during the design phase, with their vested interest to protect their citizens' traditional use. Indeed, they were reported as having a second level of influence among the PN, but this is not so clearly supported by the SNA.

The scientific representative is a secondary broker in the general park management situation, and emerges again in the implementation as secondarily popular among PN and efficient in spreading information.

[12] A group or class of people seen as having the most power and influence in a society, especially on account of their wealth or privilege (Oxford dictionary)

During the design phase, the environmental NGO seems to have a quite influential position, i.e. third place regarding popularity among PN and efficient role in information sharing, and fourth in terms of broker and power of connections. The county office for agriculture and the representative of fire volunteers instead become relevant in the implementation phase. The county office seems to be related to the competences, as during the implementation this constitutes one of the permit issuing points.

The Spearman test (Appendix A3.4) confirms significant positive correlation between the reported PN members' influence and all their centrality indexes during the policy cycle. The correlation shows a stronger intensity (i.e. higher coefficient) in the general and design phases, which lowers in the implementation phase. So, the structure confirms that those in a more central position are also powerful for decision-making. We can therefore consider centrality indexes as proper indicators of power within the policy network.

3.4.2. Relations between pickers and the policy network (linking SC)

Regarding our second question, the results show that in the case of Poblet the main actors are at the core, and that local pickers have the channels for their views to reach the PN discussions.

The Spearman test between PN members' popularity among pickers and PN structural variables (Appendix A3.6) informs about significant and positive correlations in the conception and design phases, but not in the implementation. In terms of legitimacy, for the acceptance of the governance reform the conception and design phases are the crucial, insofar as they represent the identification of the problem and need for reform, and devising how that reform could be better adjusted to forest users' preferences.

In the general situation, PN members' proximity to pickers is significantly correlated with PN closeness (rho=.438, p-value=.022) and eigenvector (rho=.395, p-value=.041). This means that for the general management of the

park, the proximal PN member from pickers coincides with the efficiency in spreading information among the PN and their connection with powerful nodes. So town representatives behave as brokers at this stage. In the policy design, however, pickers' proximity is only correlated with PN structure in terms of eigenvector (rho=.408, p-value=.035). This implies that their ease of transferring information into the PN is decreased with respect to the conception phase, but they are still strong in keeping contact with the PN members with powerful contacts.

The centrality indexes (Appendix A3.4), with disaggregated SNA information per PN member, allows for deeper analysis backing these correlations. The fact that one of the majors (Montblanc) starring popularity with pickers does not show any of the highest positions during the policy stages works against the correlations. However, other town representatives (Espluga and Vimbodí) have rather high popularity among pickers, showing a secondary node network position. Similarly, the monastery plays a key role and is in the second group of proximity to pickers. The representative of fire volunteers holds an important information and collaboration position during the implementation phase while also holding a third position in terms of popularity among pickers. Curiously, that person is better known for working in the forest than as a fire volunteer; many interviewed pickers report meeting him while roaming in the forest. He also explained about helping pickers to identify the species and orienting those lost. This seems to have contributed to his positive reputation, even among pickers from other municipalities.

The fact that local preferences have been translated into the actual decision-making is supported by the not-structured conversation with PN members. Town representatives supported a free-of-charge permit for locals; this was contested by other PN members' view that "*priceless permits would not be considered seriously*" and that forest managers could legitimately ask payment for a product legally belonging to them and reinvest in forest-related improvements. Consensus was finally reached with the 1 € decision.

Still, this amount contrasts with experiences in other parts of Spain (see e.g. www.micocyl.es in Castilla y León) or Italy (Gatto et al., 2009), where for equivalent permits locals pay 6 to 10 €/year. Finally, the weak relation between pickers and park directorate could be improved through the provision of useful information e.g. using the mycological plots to predict yields. This service has proved much appreciated in other mushroom reserves[13].

3.4.3. Social structure of pickers' communities

For exploring our third question, interviewees were asked about the number of pickers they know from their own municipality, and with how many of them do they usually talk about mushroom picking. In this way we can estimate the degree of mushroom networking of the respondent within the pickers' community. Interviewees were also asked about pickers in other municipalities.

Sketching the aggregated pickers' relations using municipalities as nodes, Figure 5 shows the relations of an average picker from each one. The pickers from Vimbodí show the largest communication network within their community, and contact with more pickers from neighbouring municipalities. Montblanc also shows a large outflow in absolute terms towards Espluga. Prades figures for outflows (i.e. from them to others) are to be taken with caution given that they represent a single interviewee. However, they are relevant with regard to the order of magnitude of the relations from pickers from other municipalities towards them (i.e. inflows). In that sense, the results show weaker connections from the other municipalities towards Poblet. Indeed, interviewees noted that "municipalities on the plain" (Montblanc, Espluga and Vimbodí) have natural communication with each other, while those on the plateau (e.g. Prades) relate to others on the mountains.

[13] see Borgotaro (Parma, Italy): www.fungodiborgotaro.com/ita/stanno-nascendo.jsp# or Ultzama (Navarra, Spain): www.parquemicologico.com/micolo.php

Regarding bridging social capital, the joint statistical analysis shows no significant differences across municipalities. Regarding bonding relations, Montblanc and Espluga show networks of a similar magnitude. However, Montblanc is statistically significantly different from Espluga and Vimbodí. In relative terms, Vimbodí's network spans a larger portion of the total pickers' community than Montblanc and Espluga (Table 5). Moreover, that difference is statistically significant (Appendix A3.7).

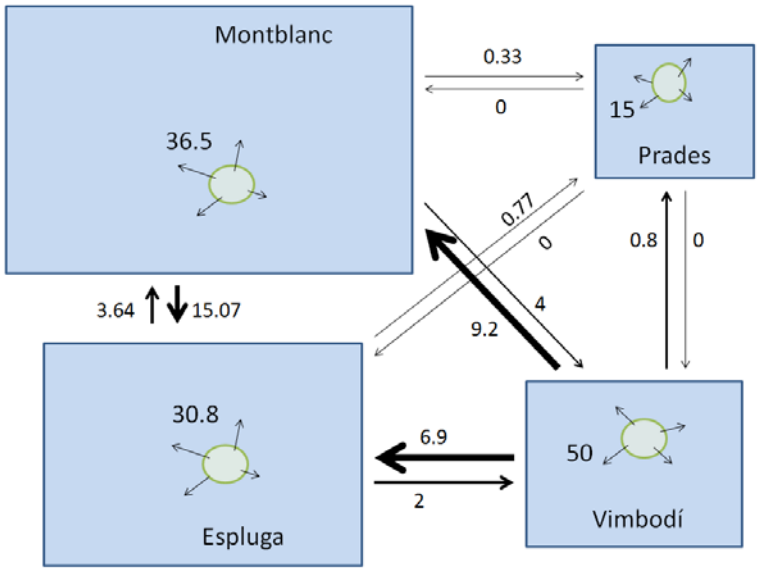

Figure 5 - Bonding and bridging SC per municipality in absolute numbers, as average pickers with whom they talk about mushrooms from own municipality and the others. Source: own elaboration.

The relatively larger ego-network of Vimbodí interviewees is also reflected by their greater awareness of non-compliants in their own municipality, i.e. were able to identify more pickers who did not get a permit but went mushroom picking anyway (0.7 on average, in contrast with 0.5 in Espluga and 0.46 in Montblanc).

Table 5 - Bonding and bridging SC per municipality: average number of pickers known per respondent, and pickers with whom they talk about mushrooms, as a ratio of the permits issued in 2014 (considering the maximum pickers' community size). It reads from row to column. Relations starting from Prades are not presented due to their dubious representativeness. Source: own elaboration.

	Espluga		Montblanc		Vimbodí		Prades	
Municipality	known	talk	known	talk	known	talk	known	talk
Espluga	9.8%	4.5%	1.2%	0.4%	2.2%	1.0%	4.5%	2.1%
Montblanc	2.6%	2.2%	10.3%	4.4%	2.4%	2.0%	1.3%	1.0%
Vimbodí	3.1%	1.0%	1.2%	1.1%	51.1%	25.3%	6.7%	2.2%

These results confirm Montblanc as a small urban town, given the dissimilar SC features (Maru et al., 2007; Onyx et al., 2007). Small villages are usually such that the chances for interaction with other inhabitants are high (Debertin and Goetz, 2013:6), and consequently bonding relations are consequently denser (Beggs et al., 1996; Sørensen, 2016). However, our results do not show clear trends regarding bridging SC.

Moreover, the significant differences across municipalities seem to indicate the municipality as a community, in a first step. This fits with the community sense at local level found by O'Toole and Burdess (2004). However, there is also a sense of "local" pickers' community confronted with "external" pickers. Indeed, Vimbodí shows the strongest divergences between how locals (including the neighbouring municipalities) and non-locals pick mushrooms in the forest (Table 6): on average, Vimbodí interviewees assess that "nearly all" local pickers follow the good practices, while less than half of external pickers do. This fits with Flora's (1998) findings that a strong bonding SC may derive into lack of diversity inclusiveness; this could cause greater aversion towards external pickers, who are blamed for most harvest-related problems.

Table 6 - Perceived degree of abidance with good mushroom picking practices between locals (pickers from the four municipalities involved) and non-locals. 0: nobody, 1: a few, 2: half, 3: most, 4: all. Source: own elaboration.

	Locals	Non-locals
Espluga	2.64	2.00
Montblanc	3.08	1.78
Vimbodí	3.20	1.63

3.4.4. Engagement of pickers

The interviews inform that the new regulation is well accepted, and its first years of implementation have had a satisfactory performance without requiring extra control efforts.

Acceptance of the policy reform

Most pickers interviewed agreed with the permit system with its current design, i.e. a permit against payment valid for the park and buffer area, earmarking earnings for forestry (Appendix A3.8). The only questioned aspect is the geographical validity of the permit, i.e. some pickers prefer a single permit valid also in other areas of Catalonia. No relevant differences are observed across municipalities.

When asked about the fee, many agreed with a symbolic payment. This was confirmed with a later question, where respondents differed depending on their municipality: 92% of respondents from Espluga and 70% from Vimbodí stated that they bought the permit because of its symbolic price in contrast with 43% in Montblanc. However, 91% from Espluga and 70% from Vimbodí agreed with paying a bit more (3 €/season was suggested) in front of 64% of interviewees from Montblanc. These replies show that social constructions fit with the policy reform, hence giving it legitimacy (Kobayashi et al., 2013).

Engagement of pickers

The data from the picking permits issued reflect the experience from three mushroom seasons of the new regulation (see Table 2). In 2012, when the season lasted for 61 days, 2,158 permits were issued, 80% to locals. The

2013 season was not opened as the mushroom production was extremely low. In 2014 the season lasted for 47 days, with 2,232 permits issued, 73% to locals. Finally, 2015 offered only two productive weeks, with 1,005 permits issued (75% to locals).

2014 being a short but very productive season, the fact that the number of permits did not increase with the same trend as mushroom productivity shows that there was a novelty effect among locals in 2012. Still, the number of pickers was high in the second season, with an increase of non-locals. Contrasting this with the expected number of permits, PN members were asked about their satisfaction level (0: unsatisfied, 1: satisfied; 2: very satisfied), the average being 1.53. Indeed the director of the park stated that they had been expecting around 500 permits, which was by far exceeded.

Non-abidance could be intuitively assessed with the car count. Reasonably assuming that cars counted during the worst season (2013) correspond to the baseline of typical hikers, it could be interpreted that almost all pickers in the quite bad year (2015) got their permits, which indeed fits with the lowest infraction number; instead, the theoretical maximum number of permits would have been place in the best season (2014), corresponding to the highest car count. All these indicators point out an effective implementation of the permit system.

Control efforts

There have been no additional costs due to the implementation of the permit, as the patrolling has been performed by regular forest guards. The only difference reported has been that forest guards have received instructions to make as part of their ordinary tasks friendly control on the road during the season, especially at the weekends. Given their limited personnel, control was felt as challenging by most interviewees: the overlap between the mushroom and hunting seasons implies trade-offs in the control strategy.

When asked about satisfaction with the current vigilance, interviewed pickers scored slightly less than adequate, hence claiming more field control. In parallel, the perception of PN members regarding infractions reflects a general adjustment of the number of offenders to their expectations (or even slightly fewer offenders than expected).

Intuitive relation between social structure and pickers' engagement

The relation between SC and engagement could be substantiated by the work of Sagor and Becker (2014), where personal networks were found affecting forest-related behaviour, e.g. in forest owners. Significant correlations are observed when comparing pickers' permits over different seasons and the bonding and bridging SC ratios per municipality (Table 7). A positive correlation is found between bonding SC aspects and the engagement in the permit (in three seasons), whereas the bridging SC correlates negatively (in two seasons). Still, there are differences among the dimensions of bonding SC, mere knowledge of community pickers being significantly correlated in some years and actual communication with those pickers significant in other seasons.

Table 7. Spearman correlation coefficients between SC variables and the ratio of pickers with permit per municipality each studied season. N= 3. ** p<0.05. Source: own elaboration.

Mushroom season	Local permits issued (%16-84)	Bonding SC % known pickers	Bonding SC % talk pickers	Bridging SC % talk pickers
2012	Correlation coeff.	1.000**	1.000**	-1.000**
	Sig. (bilateral)	.	.	.
2014	Correlation coeff.	.500	1.000**	-1.000**
	Sig. (bilateral)	.667	.	.
2015	Correlation coeff.	1.000**	.500	-.500
	Sig. (bilateral)	.	.667	.667

These results are the consequence of the small number of observations (i.e. municipalities involved in a permit system only for three seasons). This initial work could thus inspire future research with larger samples to check the robustness of these findings and eventually the actual causal relations,

e.g. through modelling also with non-social independent variables, such as forest accessibility or composition for each municipality.

Our results therefore suggest that local networks are an important factor when dealing with implementation of a forest policy requiring coordination to be successful. This is especially important when most forest users belong to the same community (which is the case of Poblet). Instead, when a relatively large number of outsiders to the community also use the forest in a diffuse manner, interaction between the two groups is usually reduced and thus the actual effectiveness of community incentives may thus remain limited (Gibson et al., 2005). SC indicators, as those used in this study, could be meaningful for good governance assessment (Secco et al., 2014) based on a set of principles, e.g. accountability, effectiveness, efficiency, fairness, participation and transparency; see Cowling et al. (2014).

3.5. Conclusions

Several forest governance aspects seem to be linked to social structures. This study provides empirical evidence of such relations within the context of a governance reform, i.e. the introduction of a mushroom picking permit. Three analytical levels have been employed: the information and collaboration flows among the policy network, information flows among mushroom pickers in four involved municipalities, and information flows between forest users (i.e. pickers) and decision-makers (i.e. policy network).

By studying the policy network throughout the policy process, changes are observed in terms of centrality indexes. Three PN members emerge as holding relevant network position; two of them are scored the highest by their peers for their influence in the decision-making. They could play a role as facilitators or blocking the process; whether they could be considered as the elite or rather the leaders of the process has to be studied further. Local political representatives emerge in a second level of centrality and influence only in the conception phase. Other PN members hold strong network positions during specific policy stages. Hence, even if the analysed

governance reform does not explicitly address modifications in the social networks, policy-makers and analysts should pay attention to the structural changes in flows among the PN and forest users derived from the policy tool.

The proximity of forest users (i.e. local pickers) to decision-makers (i.e. the PN) is correlated with the structural influence of PN. This case, hence, exemplifies a well-designed policy network where forest users count with channels for transmitting their policy preferences to the discussion, i.e. strong linking SC.

Pickers' structure reveals differences in bonding and bridging SC across municipalities following an urban-rural gradation. Stronger relations have been found in the smallest town, which also refer to awareness of non-compliants and shows higher engagement rates. The studied structure sets the ground for other SC dimensions to thrive; therefore, cognitive (shared knowledge) and relational SC (confidence, diligence, peer-control…) is worth studying to complement the governance analysis. The few observations restrict the correlation analysis. Moreover, besides social factors, geographical features partly explain the pickers' engagement. Further case studies could therefore contribute to check the robustness of such relations.

In terms of methodology, the development of SC indicators tailored to forest governance analysis adds to the body of literature developed by Conley and Moote (2003) on the strategy to evaluate collaborative NRM, or by Da Re (2011) on assessing National Parks' performance.

Beyond diffuse forest uses, a similar challenge would be the spatial spillovers, where the interventions of a forest manager affect the neighbouring plots. Habitat continuity (e.g. green corridors) to ensure species survival, or preventive actions at landscape scale for e.g. fires or pests, exemplify the need for coordinating forest managers to tackle spatial externalities within their decisions. This approach is also valid for instruments aiming at changing and coordinating land managers' behaviour to tackle spatial spillovers. Policy makers should therefore give careful

attention to develop (or benefit from existing) decision-making groups addressing such spatial or coordination problems based on their actual networks with final users. This is of special relevance for some groups willing to participate in crucial policy design as spokespersons for certain communities but actually representing a very reduced part of it or not counting with a widespread presence in the territory. Also of critical relevance is the communication with key local actors such as town representatives, and their idiosyncrasy with regard to communication and protocols. We support the recommendations for trying to gather all possible stakeholders.

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Appendix A3

A3.1 Differences with previous scholars analysing structural SC and policy instruments

Table 8 - Focus of previous scholars vs focus of this study

	Pre- & post-policy implementation	Bonding & bridging SC	Linking SC	Other capitals	Policy makers & citizens	SNA	Qualitative analysis	Trust
Our study	x	x	x	(x)	x	x	x	
McDougall & Banjade (2015)	x	x	x				x	x
Akamani & Hall (2015)	X	x		x			x	x
Harrison et al., (2016)	x	x	x		x		x	
Borg et al. (2015); Guillén et al. (2015)		x				x		x

A3.2 Policy network composition

Table 9 - Members of the Poblet policy network

Governing body (*Junta Rectora*)			**Technical committee (*Comissió de seguiment*)**		
Organisation	**Nr**	**Position**	**Organisation**	**Nr**	**Position**
Poblet park office	1	Director (JR secretary)	Agriculture dept. Public forests' unit	20	Technician
Culture department	2	Provincial representative	Agency for private forest owner	18	Manager
Territory and Sustainability department	4	Provincial representative	Agriculture dept. Protected areas' unit	19	Technician
Local private landowners	11	Landowner	Mycologist	17	Researcher
Government and Institutional relations department.	3	Provincial representative	Agriculture dept. Provincial public forests' office	21	Technician
Poblet Monastery	14	Prior (JR president)	Forest guards	22	County head
Agriculture, Livestock, Fisheries and Food department.	5	Biodiversity service	**Other stakeholders**		
	6	Provincial representative	**Organisation**	**Nr**	**Position**
	7	Head of County office	Prades	23	Major
Espluga de Francolí	8	Major	Montblanc	24	Major
	9	Counsellor for Environment	County hotel business' association	25	President

Vimbodí	10	Major	County office	27	President
County NGOs	12	Environmental representative	Provincial association of private forest owners	26	President
	15	Patrimony representative			
Science	13	Researcher			
Fire volunteers	16	Representative			

A3.3 Stakeholders' relations in the general park management

The network graph of the inception phase (Figure 6) shows the core position of the park directorate (1) with respect of information and collaboration flows. Also the monastery (14) in terms of information flows.

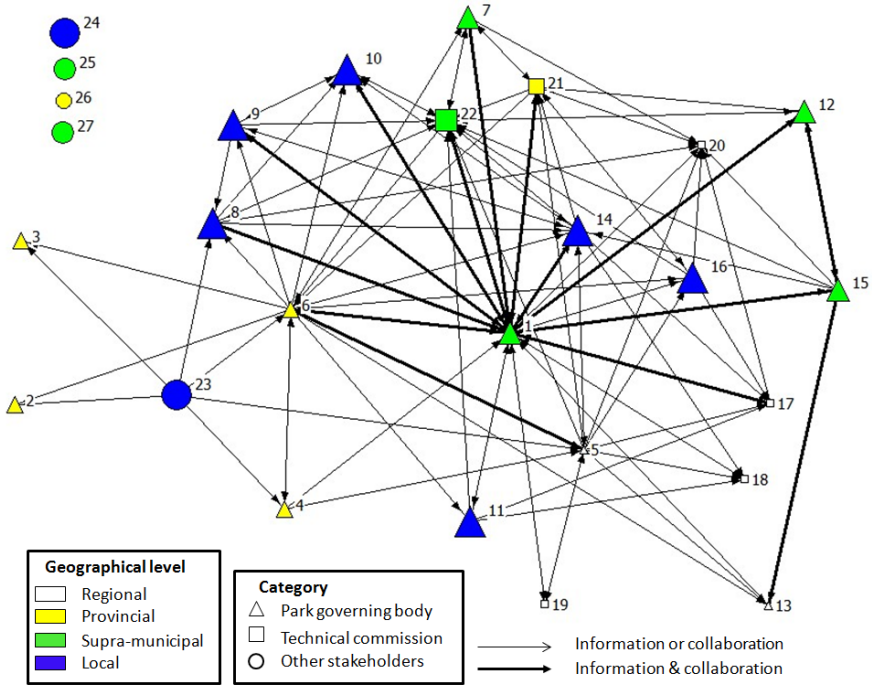


Figure 6 - Information and collaboration flows in the general situation among stakeholders

A3.4 Correlation between PN centrality and reported influence

The normality test revealed that all centrality indexes were not normally distributed. Also the reported influence is not normally distributed for any of the policy stages. Therefore, the non-parametric Spearman test was applied to non-normal distributed contrasts, while Pearson test was conducted for normally distributed.

Table 10 – Spearman test of correlation between PN centrality indexes and their reported influence in each policy phase. N=27. Significance level: *: < .001, **: < .01, *: <.05**

Policy cycle phase		GENERAL	DESIGN	IMPLEMENTATION
Degree	Corr Coeff	.885***	.761***	.507**
	Sig. (bilateral)	.000	.000	.007
Closeness	Corr Coeff	.821***	.714***	.474*
	Sig. (bilateral)	.000	.000	.013
Eigenvector	Corr Coeff	.861***	.763***	.479*
	Sig. (bilateral)	.000	.000	.012
Betweenness	Corr Coeff	.684***	.679***	.484*
	Sig. (bilateral)	.000	.000	.011

A3.5 Structural changes in the policy network – SNA indexes

Summing the symmetrised matrixes of information and collaboration flows, Table 10 summarizes the different SNA indexes for the policy network members. Here we report the highest and the secondary positions, the rest having very low influence.

Table 11 – Nodes with the three largest scores (fourth in grey) for Centrality degree (D), Betweenness (B), Closeness (C), Eigenvector (E). The three main scores of Influence assessed by other stakeholders (I) and Proximity to pickers (pickers' popularity) are marked in yellow and the fourth in light-yellow.

	General					Design					Implementation					Pickers' popularity
Stkd	D	B	C	E	I	D	B	C	E	I	D	B	C	E	I	
1	1	1	1	1	67	1	1	1	1	78	1	1	1	1	80	0.56
2					3					0					0	0.15
3					0					0					0	0.00
4					3					0					0	0.15
5	4				14	4		4		6					3	0.00
6	2	2	2	2	6	2	2	2	3	0	2	3	3	2	0	0.35
7					0					0	2	2	2	3	0	0.15
8	4		4	4	7					11					0	1.83
9	4		4	4	37					11					11	1.33
10	4		4	4	36	4		4		13					11	1.05
11					0					4					0	1.18
12					3					4					0	0.63
13		4			6					4	3		4		3	0.00
14	3	3	3	3	66	2	3	2	2	34	3		4		29	1.03
15					8	3	4	3	4	7					5	0.40
16					7					19	3		4	4	8	1.36
17					0					25					12	0.08
18					0					7					3	0.05
19					0					0					0	0.00
20					0					0					4	0.00
21					0					3					0	0.23
22					0					3					6	0.35
23					0					0					3	0.15
24					0					0					5	1.65
25					0					0					0	0.23
26					0					1					0	0.15
27					0					0					0	0.46

A3.6 Correlation tables pickers-stakeholders

The Shapiro-Wilk test informs that proximity to pickers is not normally distributed, nor the centrality indexes (except three in implementation stage). The Spearman correlation is only significant for closeness and eigenvector in the general situation.

Table 12 - Summary of Spearman correlation tests for pickers' popularity along the policy phases. N=27. Significance level: *: < .001, **: < .01, *: <.05**

Policy cycle phase		GENERAL	DESIGN	IMPLEMENTATION
Degree	Corr Coeff	.375	.365	.220
	Sig. (bilateral)	.054	.062	.270
Closeness	Corr Coeff	.438*	.309	.302
	Sig. (bilateral)	.022	.117	.126
Eigenvector	Corr Coeff	.395*	.379	.342
	Sig. (bilateral)	.041	.051	.081
Betweenness	Corr Coeff	.016	.364	.042
	Sig. (bilateral)	.936	.062	.837

A3.7 Means' test of Bonding SC differences across municipalities

Table 13 – Mann-Whitney U test at p≤ 0.05 of SC difference across municipalities

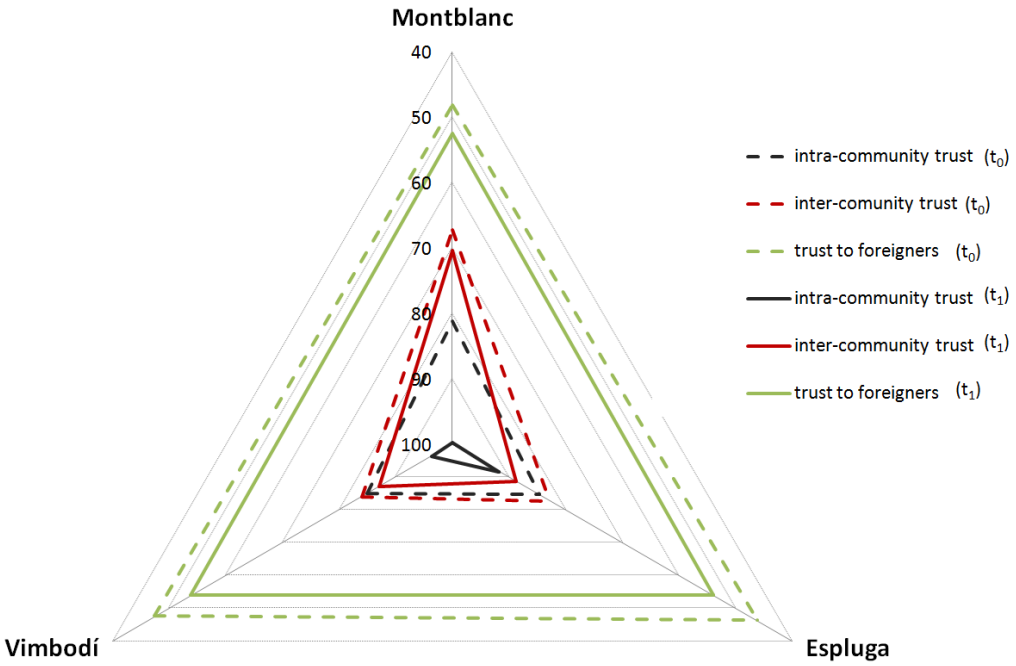
Municip. 1	Municip. 2	Pickers' network			Pickers' information network		
		U-value	Critical value	α = 0.05	U-value	Critical value	α = 0.05
Montblanc	Espluga	78	49	not signific.	48	49	significant
Montblanc	Vimbodí	22	29	significant	25	29	significant
Espluga	Vimbodí	16	22	significant	27	22	not signific.

A3.8 Pickers' acceptance of difference aspects of the governance reform

Table 14 - Pickers' acceptance to the mushroom picking permit system. N=41

What do you think of the different aspects of the mushroom permit? *1 - Agree / 0 - Disagree*	**average**
Requirement of a mushroom harvest permit	0.95
At local level *(↔ entire Catalonia)*	0.70
Permit fee	0.97
Proceeds to be reinvested in forestry	1.00
Permit link to harvest norms	0.95
Do you agree, then, with the current permit system? *4 - Totally agree / 3 - Agree / 2 - Not agree nor disagree / 1 - Disagree / 0 -Totally disagree*	3.60

4. Building on relational social capital for governing mushroom resources: community enforcement and trust among pickers



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4. Building on relational social capital for governing mushroom resources: community enforcement and trust among pickers

Abstract

Relational social capital entails trust, norms and their enforcement, which have different roles at each policy phase. We search empirical evidence from the introduction of a permit for mushroom picking in Spain affecting four municipalities.

We confirm the presence of a radius of trust between pickers from the same town, the neighbouring town and outsider pickers. Differential behavioural perceptions underpin this gap. Moreover, changes in trust take place owing to the permit introduction because the fee and potential control act filtering pickers and strengthening the good picking norms.

A suggested diligence index links with the permit acquisition in each town. Reputation and community pressure seem to play a stronger role in the smallest municipality. Moreover, pickers seem to behave as peers when reprimanding others for their inadequate behaviour, but do not like to police the administrative requirement of the permit. Stronger formal surveillance is demanded, mainly from pickers mistrustful with outsiders.

Keywords

Community; informal control; non-wood forest products; norms; relational social capital; Spain; trust

4.1. Introduction

Communities managing natural resources during long periods normally develop norms on how to use them (Ostrom and Ahn, 2009; Pretty and Ward, 2001). These codified and customary norms govern the inter-relations among individuals and with the ecosystem. Norms set how community members should behave based on shared values, for example, following good practices or not (Ostrom and Ahn, 2009). Norms aim at aligning community members to reduce possible conflicts over the use of common pool resources and consequently meet the shared goal of resource maintenance. These inter-relations require coordination of actors and organizations within the system, the so-called social capital[14] (SC) emerges as a key characteristic that shapes collective action. SC is grounded on the networks of information and collaboration flows among actors, setting the norms for their interaction. Such relations constitute fundamental elements of socio-ecological systems and norms become the backbone of a governance system, ensuring their sustainable management (Hahn et al., 2006).

Community members, hence, behave not only in accordance to individual factors (e.g. motivations, human capital), but are also affected by the rules of the social system they are embedded in. Individuals coordinate their behaviours towards collective action according to specific sets of criteria (shared values, joint visions). Schneider and Ingram (1990) suggest that norms are respected in some cases because of own's accord (i.e. diligence), but in others due to the probability of (in)formal sanctions. Thus, peer control and sanctioning play a role in motivating individuals to abide by the social norms (Bowles and Gintis, 2002).

However, social capital mechanisms have some limits at the local scale, and are not always effective in resolving some types of conflicts (Sanginga et al.,

[14] In this paper, SC is defined as the features of social organizations that facilitate coordination and cooperation for mutual benefit of their members (Coleman, 1990; Putnam, 1993).

2007). The effectiveness of the norms may be challenged when outsiders to the community start using the same natural resources in disconnection to traditional users. The lack of recurrent interactions among these two groups prevents local users from applying the tools to informally punish non-compliance with the good practices. In the current context of increasing mobility and migration, the limitations of the effectiveness of traditional norms (i.e. customary rules) may become more visible. Often, that context calls for government intervention to establish formal rules and enforcement. Such governance reform represents critical questions insofar as transition in usage rights with the consequential transfer of management power implies breaking some form of customary rules with possible acceptance problems.

This study focuses on the relational dimension of SC in the management of forest resources. Relational SC refers to the norms (formal and informal[15]) ruling the interactions among community members and the strategies to ensure their application, prominently trust, but also peer control and informal sanctioning (Nahapiet and Ghoshal, 1998). In sectors with a multiplicity of spatially dispersed users – as forestry is - their field control is very costly. In this framework of limited field control, the abidance with the informal "good behaviour" codes remains crucial for the sustainable use of natural resources. Analysing these aspects is relevant for forest policy-making insofar as the effective enforcement of norms benefits from synergies with community relations.

Several scholars have highlighted the relevance of trust for the management of natural resources (e.g. Nowak and Sigmund, 2005; Pretty and Smith, 2004). Trust is generally built from direct recurrent interactions, through which reciprocity emerges and contributes to the development of long-term obligations between people (Pretty and Ward, 2001). Trust has been studied in forestry as a factor influencing participation in policy instruments entailing cooperation (e.g. Borg et al., 2015; Bouma et al., 2008; Guillén et al.,

[15] Hereinafter we refer to "norms" as rather informal and to "rules" when they become formalised.

2015), its role in conflict management (Sanginga et al., 2007), or post-disaster views (Papanikolaou et al., 2012).

In this paper we develop a method to analyse the relational dimension of SC and consider its links with forest governance at local level. Hence, we study the interactions between trust and norm enforcement with the introduction of a policy instrument. The novelty of this article relies on the quantitative micro (i.e. individual) and meso-level (i.e. community) evidence of the theoretical "radius of trust", the discrepancies between local and foreign pickers underpinning the reform of the harvesting rights, as well as the methodological suggestions of relational indexes.

We search empirical data from a case study regarding a governance reform on wild forest products, where we presume that relational variables play a relevant role. Specifically, we focus on Catalonia (north-eastern Spain), which is a mycophilic region with 23% of its citizens declaring that they pick mushrooms at least once annually (CEO, 2014). Moreover, the pressure over the resource has increased in the last decade. This has led to a debate about regulating this activity and the adequacy of a picking fee to contribute to the management of the forest used by pickers. However, concerns arise regarding pickers' acceptance of restrictions to this traditional activity in terms of control, practices and fee. Hence, community norms and control may play a role in its implementation.

4.2. Theoretical background

4.2.1. The evolution of norms

The practices seen as (in)correct match with the definition of social norms, because they "*specify what actions are regarded by a set of persons as proper or improper*" (Coleman, 1990:243). Norms, trust, and peer control constitute elements of the relational SC of a community (Tsai and Ghoshal, 1998). The SC approach widens the rational agent model by inserting individuals within a community. Consequently the agent's behaviour is not exclusively based on self-determined and utilitarian decisions, but is also negatively affected by

social costs derived from informal punishment for non-compliance to the norms or, contrariwise, positively affected by the social reward.

To explain the emergence of norms regarding the management of open-access natural resources, Brooks (2010) developed a model of institutional evolution. After informal norms arise, their spread among the community during a period of voluntary adoption and social sanctioning, to finally reach a critical mass that transforms them into formal rules. Good practices could exemplify the starting of informal norms, which could be incipiently formalised as voluntary codes of conduct[16], and eventually become institutionalised as formal norms (e.g. standards, prohibitions).

The institutional evolution can be conceptualised as a policy cycle where the problem is identified during the conception phase, a suitable solution is then designed, which is later implemented (Krott, 2005). By evaluating the outcomes, new amendments to the design can be introduced, which jumps the governance system into a new institutional stage.

4.2.2. Social sanctioning and trust

Abidance by the norms stems from self-enforced psychological feelings and/or third-party-enforced punishment (Chen et al., 2009). In Brooks' terms, self-enforced individuals correspond to the "voluntary conservationists", whereas those informally sanctioning others correspond to "punishers" (Brooks, 2010).

The implementation of informal norms by forest users' configures the trust[17] among them. Specifically, the perception by community members on whether someone who is internal to the community abides by commonly shared norms or cooperative behaviour sets the ground for the others to assess the trustworthiness of that individual or, in Gambetta's (2000) words, the probability that the individual will perform what is expected from

[16] Examples: Scottish Code of Wild Mushroom picking, or French code of Good Silvicultural practices.
[17] For simplification, we consider trust as synonym for trustworthiness, even we acknowledge the differences (Sharp et al., 2012).

him/her. Moreover, trust can be specific to certain subset of people with whom one has directly experienced a relation; the so-called particularised or interpersonal trust (Uslaner, 2008). In contrast, generalised trust refers to the confidence towards the overall population, including people with no direct relation (Uslaner, 2008).

Fukuyama (2001) conceived communities as a set of concentric circles of trust networks -the "radius of trust"- where each circle represents the people among whom a set of cooperative norms are operative. In this framework, the closest circle (i.e. own community) is assessed as particularised trust, whereas the widest circle represents the generalised trust, with intermediate trust levels to nearby communities.

Recurrent interactions allow for verification of counterpart actions –i.e. peer control (Bowles and Gintis, 2002). Trust is also based on the reputation built from others' information (Ostrom and Ahn, 2009; Tsai and Ghoshal, 1998). Trust is functional because it lubricates cooperation (Pretty and Ward, 2001) by decreasing transaction costs, and hence facilitates collective action at the macro level. At the micro level, trust also increases the efficiency of contracts and agreements with consequent economic benefits. Moreover, peer control spreads monitoring and sanctioning costs among community members to efficiently ensure cooperation and reduce free-riders of the common good (Lazega, 2000; Pisani et al., 2014).

Mistrust also sets the basis for the negative side of SC. A large trust gap between one's circle and outsiders precludes interchanges which probably affect the community development. Depending on the shared values, such strong gap reinforces the internal vision and impedes the introduction of new viewpoints -i.e. more difficult acceptance of externals- and some negative practices may endure longer -e.g. corruption.

4.3. Analytical framework

Three research questions guide this study, setting the ground for our analytical framework (Table 1). We search empirical evidence in a case study

on the introduction of a mushroom picking permit in a protected area in Catalonia (Spain) which affects four municipalities. We assume that the administrative town borders delimit the pickers' community identity (Falk and Kilpatrick, 2000). *Ad-hoc* indexes were developed for two analytical units: the towns whose municipal territory is affected by that policy instrument, and the park, i.e. decision-makers (DM) and pickers (forest users). Our research questions and the analytical variables of thereof are:

Table 1 –Variables analysed during the policy cycle for each governance actor type.

Actors	Policy phase			
	CONCEPTION	**DESIGN**	**IMPLEMENTATION**	**EVALUATION**
Forest users (pickers)	• Pickers' intra-community trust • Pickers' inter-community trust • Trust to outsider pickers • Foreign pickers' behaviour • Local pickers' behaviour	• Risk of pickers' disengagement	• Trust in pickers from own town • Trust in pickers from neighbouring towns • Trust in outsider pickers • Peer control • Informal sanctioning • Norm uptake • Diligence	• Opinion on surveillance
Decision-makers		• Risk of pickers' disengagement	• Pickers' peer-control • DM trust in pickers • Pickers' trust in DM	• Satisfaction with permits' uptake • Judgement on offences

Q1) *What is the radius of trust among mushroom pickers?* Trust is analysed in three levels: toward the closest circle (intra-community trust), toward nearby municipalities (inter-community trust), and toward external pickers (generalised trust). We also explore whether this is related to the differences in pickers' behaviour between local and non-locals.

Q2) *How is the radius of trust among pickers affected by the permit introduction?* Pickers' expectations on community members' behaviour (e.g. negative reactions, level of engagement with the reform) are tested during

the implementation phase. This allows for modifying the level of trust, which we compare before and after the permit introduction.

Q3) *How do trust and formal/informal control relate to the individual abidance in terms of mushroom picking permit?* Pickers' engagement level in the policy reform consists of individual abidance in terms of permit uptake. By untangling the relational SC dimension, we contrast pre-reform variables (e.g. trust level, fears) with implementation variables of informal enforcement (e.g. peer control, diligence) and formal enforcement (e.g. offences). Informal enforcement variables are synergic with the formal ones in policy effectiveness. We analyse effectiveness in terms of DM satisfaction on permits, infractions and pickers engagement.

4.4. Materials and methods

4.4.1. Case study: wild mushroom picking permit in Poblet forest

The protected area of Poblet is located in Catalonia (Spain), 126 km far from Barcelona, and 50 km far from Tarragona. Spreading over 3,000 hectares, this forest is mainly owned by the Government of Catalonia with some municipal and small private patches. Poblet forest spans over four municipalities, namely: Montblanc, Espluga and Vimbodí, in the low lands; and Prades in the mountainous area. It hosts a wide diversity of Mediterranean forest ecosystems dominated by holm oak and maritime pine. Declared a protected area in 1984, the strategic management of Poblet park relies on a governing body that gathers local stakeholders with provincial and regional decision-makers.

Montblanc is the county capital and its most populated town (7,283 inhabitants). In terms of exposure to outsiders (e.g. non-local pickers), Montblanc is the more cosmopolitan while Vimbodí is the smallest (966 inhabitants) and most remote among the towns in the plain. Montblanc and the monastery of Poblet are touristic poles owing to their cultural assets. The monastery is located within the administrative boundaries of Vimbodí. Nevertheless, the monastery access and Poblet park office are in Espluga

(3,818 inhabitants), which benefits more in terms of touristic infrastructure. Prades (623 dwellers) administratively depends on another county and is surrounded by extensive woodlands, hence with nature-based tourism.

The Spanish Forest law establishes that the landowner owns the non-wood forest products growing on his land, e.g. mushrooms. Owing to the harvesting pressure and acting as land decision-makers, in 2012 the Poblet governing body decided to pioneer the introduction of wild mushroom picking permits in Catalonia. Permit prices differ for local (1 EUR/season) and non-local pickers (10 EUR/season and 3 EUR/day) for a maximum of 6 kilos/picker/day. "Local" permit category encompasses the inhabitants registered in the four municipalities of the regulated area (see map in Appendix 4.1). Locals constitute the largest part of pickers, getting around 70-80% of the permits (Appendix 4.2).

The permits are valid during the autumn season, which officially opens after confirming the production of mushrooms. Climatic conditions precluded opening the 2013 permit season, with other seasons showing a permits' number somewhat proportional to the productivity of the most preferred species[18]. A technical committee was assigned to advise the permit design and supervise its functioning; elaborating annual reports. In the following we refer to the governing body and the technical committee as the "decision-makers" (DM).

4.4.2. Data collection and analysis

Interviewed pickers were selected among those recurrently getting the permit -i.e. those who registered two seasons (2012 and 2014). From this group we used those who left a phone number. After deleting governing body members and non-adults, contacts were ordered for each municipality using the surname, and a systematic random selection was applied. After 258 phone calls, the rate of acceptance to be interviewed was 20%. The sample is

[18] 2012: 2,158 permits and 16.32 kg *Lactarius*/ha; 2014: 2,232 permits and 26.91 kg/ha; 2015: 1,005 permits and 0.68 kg/ha (Source: Poblet technical office and pers.comm. Martínez de Aragón)

balanced in terms of age, but masculine pickers dominate (77%). Only one interview was possible to conduct in Prades; hence its results are not considered for the municipal-level analysis, but they are for the aggregated analyses. In-depth interviews were conducted during 2014-2016 to 16 DM members and 52 pickers (confidence interval of 0.15).

Two corresponding questionnaires were drafted according to a set of indicators derived from the analytical framework. The interview combined semi-open and closed questions. The questions covered the familiarity with the Poblet forest, mushroom picking and its related knowledge, questions about the permit design and implementation, interspersed with relational SC questions.

Pickers were asked to assess to which degree they trust that other pickers follow the good practices, against a 5-point scale (0: I trust no one, 4: I trust all). Next, a cause-effect question was posed to pickers and DM to assess the change in the trust level due to the governance reform. Trust changes were asked to DM members based on a 3-points scale (decrease/equal/increase), and to pickers within a 7-points scale to capture further nuances (-3: strongly decreased, +3: strongly increased). Trust scores were normalised into a 100% scale for comparability reasons.

Trust questions were contrasted with the perception of differences in pickers' behaviour regarding the good practices between locals and non-locals (Table 2). Another set of sentences aimed at capturing the risk to the reactions by pickers because of the introduction of the permit.

A set of statements emerging from the DM interviews (Table 3) reflected diligence and informal enforcement aspects. Compliance is represented by the number of picking permits issued (and hence, the abidance by the new requirements). Diligence is conceptualised as the actions of self-compliance and diffusion which may help persuading neighbour pickers. Assuming a linear relation among the statements, we aggregate the proactive behaviour and deduce the reactive ones, hence building a normalised diligence index.

Besides, two questions were posed to pickers in order to assess the intensity of control exerted by peers. Firstly, whether they asked other pickers if they have a permit. The other second question regards the degree to which they reprimand others when they do not follow good practices.

Mann-Whitney tests analysed the differences between DM and pickers. Kruskal-Wallis test checked differences across towns. Linear associations were tested through Spearman correlation analyses.

4.5. Results

Following the research questions, we present the trust-related (4.5.1), enforcement (4.5.2), and permit implementation (4.5.3) results. Excerpts of the pickers' interviews are reported with their initial town letter (M,V,E,P) followed by the interviewee number.

4.5.1. On trust

4.5.1.1. Trust in the community of pickers

Figure 1 shows the normalised degree of trust towards pickers from the different municipalities before the permit (t_0) (see Appendix 4.3 for further details). On average, intra-community and foreigners' trust is similar across towns: almost all pickers one's town are considered trustworthy, whereas only half of foreign pickers are. In an intermediate position lies the intercommunity trust, with similar levels for Espluga and Vimbodí, but Montblanc interviewees suspect more of those from neighbouring towns. Responding to our first research question, these results confirm the "radius of trust" (Fukuyama, 2001) as trust level increases along with the proximity and recurrence of interactions.

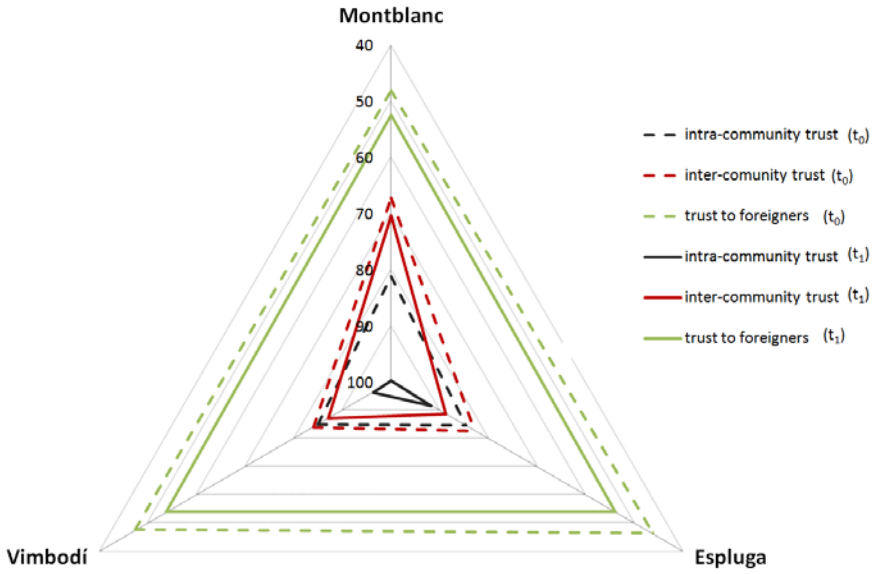

Figure 1 – Average ratio of trustworthy pickers assessed by interviewees from three towns. Intra-, inter-community and generalised trust, and variation due to the permit introduction.

These different trust levels seem to derive from the behavioural perception of "local" confronted to "external" pickers (see Appendix A4.4 for further details). Table 2 aggregates pickers' perceptions at town's level. At the individual picker level the Spearman test shows a significant negative correlation between trust on foreigners and good practices gap (rho=-0.438, p=0.020). Hence, the larger perception of divergent practices between locals and outsiders decreases the generalised trust, which consequently increases the width of the radius of trust.

Table 2 – Replies to the community enforcement and differences locals-outsider pickers. No significant differences are found between towns (Kruskal-Wallis tested)

	Interviewed pickers…			
Perception of abidance by the good practices by…	**… from Montblanc**	**… from Espluga**	**… from Vimbodí**	**Average picker**
… Local pickers	77%	66%	80%	75%
… Non-local pickers	45%	50%	41%	48%

Informal control statements				
Collective action simile: *"I see the mushroom permit as a "village work", where it's desirable that everyone collaborates to become success"* 1: Yes, 0: No.	65%	81%	70%	70%
Reputation importance: *"How important do you think is for pickers here what other pickers think about him/her picking mushrooms?"* 0: no important, 1: a bit important, 2: quite important, 3: very important.	33%	27%	52%	35%
Informal sanctioning of practices: *"How many pickers reprimand others when these don't follow the good practices?"* 0: none, 1: a few, 2: around the half, 3: most of them, 4: all.	25%	33%	38%	30%
Peer control of permit: *"I asked the pickers I found in the forest whether they had the permit"* 1: Yes, 0: No.	10%	13%	0%	9%

4.5.1.2. Changes in trust in the community and organisation

After the implementation, no interviewee has reported a negative change in trust. Instead, most respondents report no to some improvement in confidence (increments always below 30%, Appendix 4.3), which responds to our second research question.

Large increases in intra-community trust emerge, whereas inter-community trust shows more restrained figures (figure 1, t_1). The largest intra-community trust improvement occurs among the pickers from Montblanc. This enlarges its pre-existing gap between intra- and inter-community trust, which is reduced in Vimbodí and Espluga after-permit. In addition, there is a small general improvement in confidence towards foreign pickers (13%), justified by the dissuasive effect of a potential control and/or the payment. The fear of control affects outsider pickers because "*[the permit] works as a self-regulation"* (E9) and "*it increases awareness*" (M1, M11, M13). Having alternative non-regulated forest areas, the fee implies that only pickers who can afford it or with strong preferences towards this specific forest acquire the permit: "*the permit is a sort of filter*" (E4, E13), because "*having to pay, even small amount, some people don't go*" (V6, V11), "*only aware outsider*

pickers come" (M13), given that "*for outsider pickers, no matters whether it's Poblet or another forest; they'll go somewhere else*" (V4). Contrariwise, a few respondents hold that "*I don't trust them more because now they've to pay*" (M4), "*they don't necessarily change with the permit*" (V9).

A 23% trust increase is reported towards DMs, to whom pickers tend to appreciate more after the permit introduction. On their side, DMs report on average some increased confidence towards local pickers (29%).

4.5.2. On enforcement: peer controlling community members

4.5.2.1. Diligence and collective action

The diligence index (table 3) shows that Montblanc hosts the least diligent community of pickers, while Vimbodí pickers rank as the most diligent ones. Self-enforcement (i.e. presence of "voluntary conservationists") is similar across towns, but Montblanc shows more evidence of third-party enforcement.

Table 3- Municipal ratio of affirmative respondents of diligence statements, and ratio of adults with permits.

		average	Interviewed pickers from…		
Diligence-related statements			**Montblanc**	**Espluga**	**Vimbodí**
self-enforcement	I've read the pamphlet with the good practices	85%	90%	69%	100%
	I commented the picking norms with my family or acquainted	74%	75%	80%	70%
	I was very proud of having the permit and I told it to others	41%	40%	40%	50%
	I've changed some points on the manner I pick mushrooms	9%	14%	0%	10%
	Most of us think that having the permit is the correct thing	98%	93%	100%	100%
	self-enforcement	61%	63%	58%	66%

third-party enforcement	I took the permit only after seeing that other neighbours took it	6%	14%	0%	0%
	I took the permit because a friend spurred me to do so	11%	14%	13%	10%
	third-party enforcement	9%	14%	7%	5%
	Diligence index	53%	48%	51%	61%

Local permits issued (% adult population)			
Season	**Montblanc**	**Espluga**	**Vimbodí**
2012	11%	21%	22%
2014	14%	22%	25%
2015	8%	7%	10%

We tested whether the interviewed pickers understood the permit as a collective action using the term "village work"[19], which emerged during the DM interviews and is rooted in the Tarragona province. Calls for "village works" occurred mainly in the past when the level of public services was low, and joint action of villagers was needed to improve a common asset. Interestingly, 70% of respondents considered the permit as a collective action (Table 2). Collective action is positively correlated with the gap of local-outsiders trust, but neither with intra-community trust nor diligence.

4.5.2.2. Community pressure: reputation and peer control

Reputation, according to respondents, covered three aspects: the ability to find and identify different mushroom species (the "wise"), the amount picked (the "hero") and the example-to-follow in terms of picking practices ("the model"). When asked about the role of pickers' reputation, on average interviewed pickers tended to score low the relevance of others' opinion (Table 2). Yet, reputation correlates with the size of pickers' networks, i.e. bonding SC (rho=0.369, p=0.012).

Regarding peer control, very few pickers reported having asked others for the permit. Instead, when asked for informal sanctioning, on average 30%

[19] translated from the Catalan "*obra de vila*"

pickers reprimand others in the field if not following the good practices. As one interviewee stated: "*those usually telling off others are old people and locals*" (V7). Decision-makers, however, perceive peer-control higher (47%).

Some interviewees did not feel comfortable with the "reprimand" verb, specifying that "*I don't reprimand others, but sometimes comment or inform them about what they're doing wrong*" (M3, M5, V9). Others explain that "*as soon as I hear someone nearby I run away, so that they don't find my picking spots; hence there aren't chances for me to check how others behave*" (E2, E17, E18, M10, M18). There is a trend of intra-community control of practices, but they fear strangers: "*if they're from our own town, yes; but if you don't know them, you try to avoid the conflict because you don't know how they'll react"* (E14, M1, M8); "*If I go alone, no; but when I go with another, sometimes we tell them off*" (M10); *"remember that they bring a knife and you're in the middle of the forest*" (M8). Indeed, 81% are of the opinion that the chastising of pickers should be carried out entirely by forest guards.

A close to significant correlation occurs between informal sanctioning and average changes in trust (rho=0.292, p=0.063). Despite this, no statistically significant correlations are found between informal sanctioning and specific intra- or inter-community trust, nor towards outsider pickers.

4.5.2.3. Enforcement efforts

There have been no additional costs for the implementation of the permit, as patrolling has been performed by regular forest guards. Forest guards received instructions to make awareness-raising control on the road during the weekends along the season, among their ordinary tasks. DMs justified control difficulties by the scarce personnel and the overlapping mushroom and hunting seasons, which they have to control as well.

Pickers were asked about the adequacy of surveillance, while DM members were asked about their perception regarding infractions. This dissimilar perspective responds to the differential knowledge: DM knew instructions given to forest guards, whereas pickers did not know about infractions (was

tested), but had an opinion on the field control. DM members assessed the number of offences (13, 5 and 1 in the respective seasons) as low with respect to what they anticipated.

Interviewed pickers scored the level of surveillance slightly below the adequacy. They typically reported not having met the guards themselves, nor their acquaintances. While some agree with the current approach (M8: "*I wouldn't like a policy after each tree*"), others would prefer stronger field control (E12: "*Guards should also enter into the forest, not only control by the road*"). Vimbodí pickers differ significantly, being the most critical to the level of guards' control (Appendix 4.5).

Field control opinion correlates negatively with the diligence index (rho=-0.334, p=0.028). Moreover, the opinion on field control is positively correlated with trust on foreigners (rho=0.344, p=0.040), but negatively with the trust gap between locals and foreigners (rho=-0.381, p=0.020).

4.5.3. Permit implementation

This aspect is assessed as per the *ex-ante* permit acceptance (i.e. risk of pickers' reactions), the acceptance of the reform to picking rights, and the actual engagement of pickers in the new system by acquiring permits.

4.5.3.1. Risk of pickers' reactions

The fear of pickers' reactions to the permit was assessed against a set of sentences expressing incremental concerns during the design phase (Appendix 4.6). Significant differences are found between interviewed DM and pickers (U-value: 617.5, p-value: 0.0125). All DM though about pickers' reactions in advance and were rather afraid of negative reactions (33%) than interviewed pickers (10%). Instead, a substantial amount of pickers (29%) were convinced of the good acceptance (against 11% of DM).

Over the half of pickers and DM foresaw protests due to the novelty of the measure followed by an acceptance of the measure. When asked about foreseen reactions beyond complaints, some DM members thought of

damages to the field signs, while a few pickers mentioned arsons as vengeance. Several pickers referred to the Poblet park closing forest roads with chains in the 1990s as a more controversial measure than the mushroom permit.

Confirming their expectations, only 9% of the interviewed pickers and 17% of DMs reported individual complaints as reactions actually observed during the implementation; this means, without occurrence of vandalism with signs or arsons. Instead, 34% of pickers witnessed positive reactions to the permit.

4.5.3.2. Acceptance of the policy reform

Most interviewed pickers agree with the permit system as it is now designed (87%). Yet, the aspect of the geographical validity of the permit is sometimes questioned. That is, some pickers would like to have a unique permit for picking in other areas of Catalonia as well. Appendix 4.7 shows a large acceptance consistent across municipalities. The picking fee is largely supported, often specifying the current symbolic amount.

4.5.3.3. Pickers' uptake of permits

Permits show a rather stable gradient according to town size (table 2): Vimbodí issues permits for a larger ratio of adult inhabitants than Espluga, which is larger than Montblanc in turn (see details in Appendix 4.2).

Lastly, DMs were asked about their satisfaction level with the permits issued within a 3-points scale, being the normalised average 77% (between satisfied and very satisfied). Indeed the Park director stated that they were expecting around 500 permits, which was by far exceeded.

4.6. Discussion

4.6.1. On trust and governance

The evidence of the radius of trust confirm the social psychology theories of outgroup derogation, by which group identity can entail social perceptions with in-group bias (Brewer, 1999). The inverse relation between diverging

perceptions local-outsiders and generalised trust implies a longer radius of trust. In very cohesive communities (i.e. with strong bonding SC) the divergence with outsiders may increase, especially if bridging links are scarce. This fits with Flora's (1998) findings that a strong intra-community cohesion (typical in small communities) may derive into lack of diversity inclusiveness. Weak inclusiveness could cause larger aversion towards external pickers' to whom most harvest-related problems are blamed.

The differential perception of outsider pickers' behaviour and consequent trust towards them seems to set the ground for DM positively discriminating locals when designing the policy tool. We put forward that such differentiation, as well as the symbolic price, partly explain the increased trust towards DM. On their hand, the increased trust from DM towards pickers is justified by the permit uptake level and the low amount of infractions.

After the permit introduction, intra-community trust increases more than inter-community trust. This discrepancy may correspond to the relatively recent permit implementation. Such short time frame has surely allowed pickers to verify the improvements in practices by their closest counterparts. Their chances to interact with pickers from neighbouring towns, though, may have been still limited. Yet, pickers report slight trust improvements towards outsiders owing to the permit, which alleviates previous conflicts.

Moreover, the cautious level of trust changes could reflect that the implementation just confirms a pre-assessed level of engagement (expectations), both in terms of permits and good practices. Asymmetric information seems to underlie the lower DM expectations and their greater risk perception. DMs were more afraid of negative reactions but got a surprisingly high rate of permit uptake. In contrast, pickers were closer to the real behaviour of their community members, hence less concerned and their trust did not change substantially.

4.6.2. On informal control and governance

The findings regarding relational SC aspects of three mushroom picking communities seem to act synergistically in the governance of the mushroom resource by adding a new explanatory dimension. Peer control and diligence variables, jointly with the comments on the low permit price, confirms that individual picker behaviour -i.e. acquiring the permit and following its related good practices- is based on individual -economic incentives- and community factors -social norms- (Lindbeck, 1997). Community factors are especially relevant when dealing with a common resource management (Levin, 2006; Vincent, 2007), like wild mushrooms in non-fenced forests.

In our case study, the introduction of the permit seems to underpin pre-existing social norms. The subjacent conflict between local and outsider pickers urges the need of formal rules (i.e. policy intervention) for tackling forest users beyond the community, which are felt "out of community control". Such policy intervention demonstrates the demand for the institutionalisation of traditional rights, as put forward by Brooks' model for evolution of norms (Brooks, 2010).

Interviewed pickers were generally critical of surveillance efforts. Yet, more diligent individuals demand less formal enforcement measures. On the other hand, outsiders-averse respondents demand higher surveillance. Instead, evidence of peer control and informal sanctioning among pickers have been revealed during the interviews, even if their level is lower than what DMs expected. This confirms theories of Wittek et al. (2000), with strategies of informal social control (e.g. third party gossip) influencing cooperation among actors and ultimately the collective action at the aggregated level. This is a key contribution, insofar as SC studies typically measure trust without assessing the level of peer control. That is, scholars generally appraise trust as outcome assuming an implicit process of mutual control. With this study, then, we suggest an approach for analysing peer control which opens ways for further methodological development. The interest in this measure relies on its easiness when confronting interviewees: the

interviewer experienced leery reactions when posing the trust-scoring questions, while the questions on informal sanctioning or peer control were rather fluent.

Evidence of informal sanctioning relate to improvements in pickers' trust after the permit introduction, hence being synergetic to formal control. Community pressure, however, takes place in two dimensions. Our results suggest that interviewees behave as "peers" when scolding other pickers for their inadequate behaviour, but do not like to "police" the administrative permit requirement. This contrasts with the Borgotaro (Italy) permit case, where neighbours behave as police (Vidale and Moratli, pers. comm.). Policing might be related to the economic consequences in each rural location: while in Poblet most pickers are for self-consumption, Borgotaro is well-known for its commercial mushroom harvesting (Pettenella et al., 2007), hence locals have incentives to restrict illegal activities.

Our results show that forest users (i.e. pickers) make their harvesting decisions (permit, harvest modes) without complete information (e.g. on field control), hence showing a bounded rationality mediated by community norms (Ostrom, 2011). The role of the government, with regard to social norms, is difficult, owing to its very definition[20]. Kinzig et al. (2013) suggests that official support of the social norms should be considered as beneficial through e.g. campaigns. The correlation between local networks and reputation importance indicates that policy makers need to strengthen key networks through, for example, promoting community linkages with pickers with an acknowledged "wise" and "model-to-follow" reputation. A local steward picker award or public speeches within mushroom fairs could help to consolidate their network position.

[20] Social norm is defined as "*a rule governing an individual's behaviour that third parties other than state agents diffusely enforce by means of social sanctions*" (Ellickson, 2001:3).

4.6.3. Permit enforcement

The satisfaction of decision-makers, jointly with the positive acceptance by pickers and their engagement levels suggests an effective implementation of the permit. By triangulating actual permits issued with the provincial ratio of pickers -28% according to CEO's data (2014)- actual infractions are quite below the expected number of offences. Besides good compliance, low offence figures could also indicate either insufficient field control or an overestimation of the ratio of pickers, i.e. CEO's surveyed people overstated their picking frequency.

With the limitations of our small sample, we find that the community size relates to the permit engagement. A greater ratio of pickers in smaller villages -with more farmers- could explain this. Yet, it could also show that small town inhabitants face more social pressure and hence abide more by the norm (i.e. fewer illegal pickers). With the required caution owing to the confidence interval, our results yield a preliminary relation to diligence or informal sanctioning variables. Finally, the perception of the permit as a collective action indicates the commitment of the local civil society towards a desirable management of its natural resources. This commitment puts forward the link between new forms of local-level governance and the social capital of rural areas. Such positive context sets the ground for considering further citizenship involvement through sharing responsibilities with the park authority (e.g. co-management schemes). This context might differ from other areas with opposed mental models supporting norms and/or dissimilar visions of development paths. For example, mushroom-dependent rural tourism or commercial pickers, which were negligible in the studied towns, may be more relevant in other mountainous areas.

4.7. Conclusions

This study has analysed potential links between a forest governance reform and the relational social capital of rural communities of mushroom pickers.

By interviewing pickers and decision-makers, differential trust levels between local and outsider pickers have been traced. These differences confirm our first question regarding the radius of trust (Fukuyama, 2001). We find slight support in the governance reform changing intra-community trust levels, and especially trust improvement is evident towards outsider pickers.

Our results confirm that relational SC is linked to forest governance enforcement. Local pickers perceive a limit in the effectiveness of their internal norms insofar as they consider themselves somewhat competent to informally sanction their peers, but feel impotent to act against outsider pickers. Hence, the policy intervention formalises previous informal norms and is appreciated for burdening mainly foreign pickers and align their practices. Yet, more surveillance is generally requested, while synergies are also found with informal mechanisms. The satisfaction of decision-makers and the acceptance and engagement by pickers suggests an effective implementation of the permit.

This study opens the ground to test linkages relevant in forest policy-making regarding the challenges posed by open access (e.g. common-pool) resources and their related rural communities. Yet, further empirical evidence is required to contrast our finding in other case studies.

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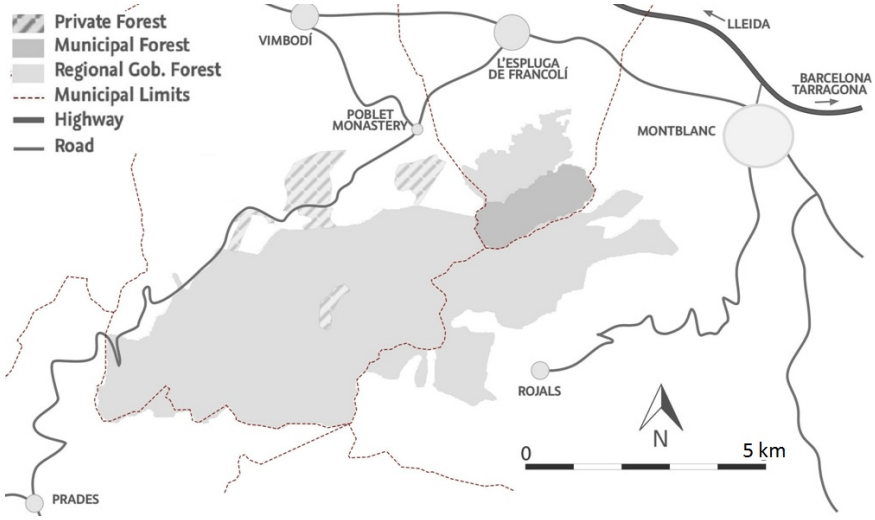
Appendix A4

A4.1 Case study area

Figure 2. Map of the forest area requiring the mushroom picking permit with the four municipalities, accesses and land ownership.



A4.2 Mushroom seasons: permits per town, sample, fungal productivity and frequentation

The permit categories show that most pickers are local adults, but often the monetary contribution of non-locals is equivalent.

The permit was established in autumn 2012. 2013 season was not opened for permit acquisition given that extremely low productivity. In contrast, 2014 was an exceptional year all around Catalonia. Besides the fungal productivity, the affluence of pickers can be approximated assessed through the car counters available in key forest roads of the Poblet park. Yet, this is a proxy given the other activities conducted in the park and the fact that some pickers go by foot, or go more than once.

Table 4 – Mushroom picking permits sold per season according to categories with corresponding prices. Proxies for affluence of pickers: mushroom productivity and car counter per season. n.a. stands for "not applicable". Source: Poblet technical office; pers.comm. Martínez de Aragón.

Seasonal permits	permit prices (€/picker)	Permits sold per season			
		2012	2013	2014	2015
Adult (>18 years old)	10	247	n.a.	215	71
Non-local young pickers (14-17) and retirees	5	107	n.a.	138	70
Local citizen (>14 years old)	1	1718	n.a.	1629	755
Children (<14 years old)	0	78	n.a.	96	55
Daily permit (only after 2013)	3	n.a.	n.a.	154	54
Total permits		2,158	0	2,232	1,005
Nr of infractions found		13	n.a.	5	1
Proxies for pickers' affluence		**2012**	**2013**	**2014**	**2015**
Weeks with mushroom production		8	0	8	2
Productivity of *Lactarius deliciosus* (kg/ha)		16.12	0.22	26.91	0.68
Car counts October 1st until December 15th		3,650	2,430	3,988	2,253

Table 5 – Municipality characteristics: inhabitants, permits issued and sample (% with respect to the most productive year, 2014). Source: Poblet technical office; IDESCAT.

Municipality	Total population	15-84 years old	Permits issued per season			Sample	
			2012	2014	2015	N	%
Montblanc	7,283	5,906	668	830	468	22	2.7%
L'Espluga de Francolí	3,818	3,087	655	686	202	29	2.8%
Vimbodí i Poblet	966	796	178	198	76	10	5.1%
Prades	623	523	33	36	8	2	2.8%

Source: IDESCAT. Catalan Statistical Institute. Population and Housing Census 2011. Web access: 22/04/2016

Montblanc:
http://www.idescat.cat/pub/?geo=mun%3A430862&id=censph#Plegable=geo

L'Espluga de Francolí:
http://www.idescat.cat/pub/?geo=mun%3A430542&id=censph#Plegable=geo

Vimbodí i Poblet:
http://www.idescat.cat/pub/?geo=mun%3A431763&id=censph#Plegable=geo

Prades:
http://www.idescat.cat/pub/?geo=mun%3A431166&id=censph#Plegable=geo

A4.3 Intra- and inter-community trust and changes at the municipal level

Pickers usually other pickers from their own municipality more than from neighbouring ones, or from further away in terms of following the good picking practices. Vimbodí interviewees tend to hold intra- and inter-community trust levels of similar magnitudes, whereas Montblanc pickers make a difference, especially with pickers from Prades. On average, close to half of foreign pickers are considered trustworthy.

After the permit introduction, local pickers interviewed reported increases in trust mainly towards their own municipality (Montblanc) and to foreigners (Espluga and Vimbodí). All coincide also in increased trust towards the park decision-makers.

Table 6 – Intra-, intercommunity trust and trust to foreign pickers, and changes of thereof.

interviewee from		Montblanc	Espluga	Vimbodí	average
Ratio of pickers trusted from…	Montblanc	81.3	79.5	84.4	71.3
	Espluga	73.2	84.6	83.3	71.9
	Vimbodí	75.0	82.5	85.0	66.3
	Prades	53.6	86.1	84.4	47.5
	Foreigners	48.2	46.2	47.5	45.0
interviewee from		**Montblanc**	**Espluga**	**Vimbodí**	**average**
Changes in trust towards pickers from…	Montblanc	22.8%	9.5%	0.0%	14.2%
	Espluga	10.0%	8.3%	0.0%	7.1%
	Vimbodí	3.7%	7.1%	13.3%	8.1%
	Prades	0.0%	5.1%	11.1%	5.6%
	Foreigners	8.9%	16.7%	13.3%	13.0%
	Decision-makers	25.5%	17.8%	26.7%	23.0%

A4.4 Pickers' opinions on different behaviour locals-outsiders

Besides the differences in relation to good picking practices (table 2 of the main text), pickers were asked about their perception regarding features of local and outsider pickers. Respondents tend to find differences, especially those from Vimbodí. Interviewed pickers point out that "*locals love the forest more than outsiders*" (V5), "*locals go more often*" (E1), "*locals feel this forest as their thing, even if they aren't the landowners*" (E4), but "*for outsider pickers no matters whether it's Poblet or any other forest*" (V4). Besides, "*locals usually know every handspan of the forest, know the places where milkcaps are produced*" (M11, M19, V8) and "*locals can always return, there isn't need to pick everything one day*". On the contrary, "*outsider pickers go usually in groups, are more boisterous*" (M17, V7, E18). A few respondents, however, remark that some foreign pickers are actually respectful "*because if they like forests, they respect*" (M15), "*they're sons of locals*" (M5) e.g. have strong family ties. Others suggest that bad practices have changed substantially in the last years: "*20 years ago, people took less care of the forest*" (E17), or that the key to explain this difference is the rural culture: "*the difference between city and town inhabitants are customs, the savoir-faire*" (E15).

A4.5 Pickers' opinions on field control

Table 7 – Opinion on the level of surveillance

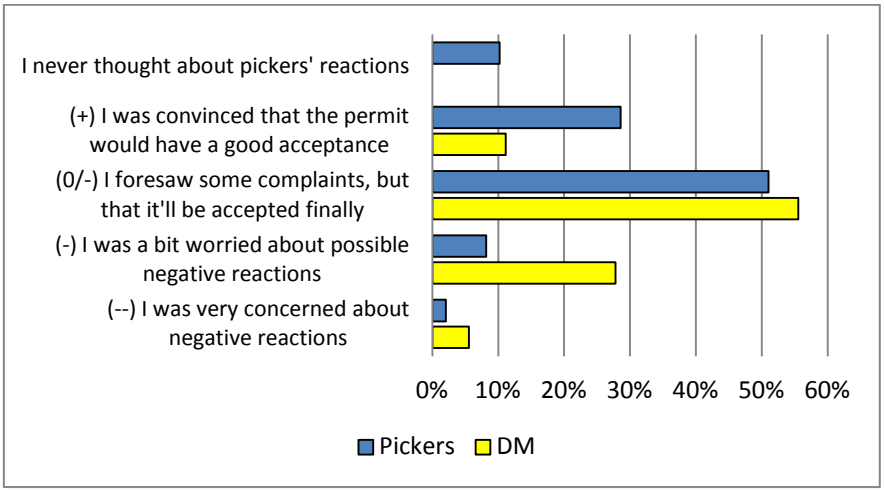
Opinion on the level of surveillance	average	Montblanc	Espluga	Vimbodí
How do you score the field surveillance? 100% very good; 66% adequate; 33% insufficient; 0% - low	57%	60%	71%	33%[1]

[1] Mann-Whitney test shows significant differences between Vimbodí and Espluga (p=0.011808) or Montblanc (p=0.047021).

A4.6 Perception of risk of pickers reactions

Interviewed pickers and decision-makers were asked about their fear of possible complaints, vengeances or other negative/positive reactions during the permit design phase (figure SOM 02).

Figure 3 - Frequency rate of statements regarding for fear from pickers' reactions



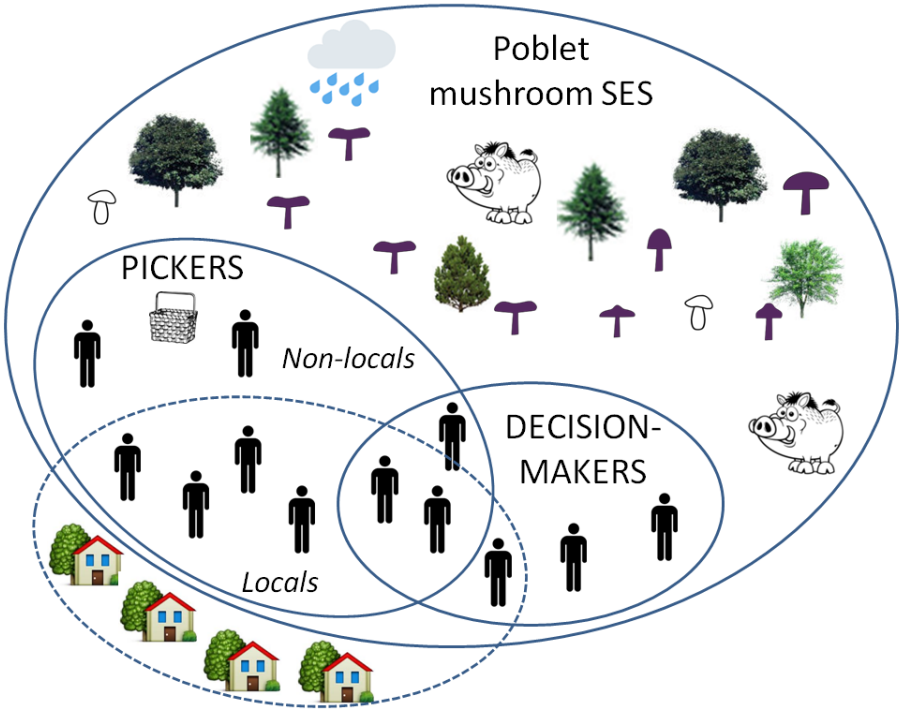
A4.7 Permit acceptance aspects

Interviewed pickers have a positive acceptance of the permit system (87%). The most controversial aspect is the appropriateness of the geographical coverage of the picking permit: especially pickers from Montblanc, but also from the other towns would like a permit allowing picking across the whole Catalonian territory.

Table 8 – Acceptance of the different dimensions of the governance reform in Poblet, for each town.

Permit acceptance aspects	Montblanc	Espluga	Vimbodí	average
Requirement of a harvest permit	95%	100%	90%	96%
At local/massif level (↔ entire Catalonia)	52%	75%	60%	64%
Permit fee	95%	100%	90%	96%
Proceeds to be reinvested in forestry	100%	100%	100%	100%
Permit link to harvest norms	100%	93%	90%	96%
Degree of agreement with the current permit system	85%	89%	85%	87%

5. Cognitive social capital and local forest governance: community ethnomycology grounding a picking permit



This chapter has been submitted to Human Ecology

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5. Cognitive social capital and local forest governance: community ethnomycology grounding a picking permit

Abstract

The ecological knowledge shared in rural communities shapes their norms for using their nearby open-access natural resources. We suggest a method to analyse this cognitive social capital and apply it to a forest governance reform, taking the case of a mushroom picking permit in Spain.

When searching the convergence between decision-makers of a protected area and local pickers, analogous perceptions were found in most mushroom-related problems, which align with most norms and seem to underlie the large permit acceptance. Moreover, some mental models of decision-makers showed statically consistence.

The similar cognitive indicators at town level indicate a single hermeneutic community among local pickers, which did not explain the differential permit uptake. At individual level, no cognitive factors related to the permit acceptance. However, we found evidence of knowledge spread factors: mushroom literacy relates to family learning and proximity to decision-makers; while bonding and bridging links increase the forest profitability expectations.

Keywords

Social capital; Non-wood forest products; norms; institutional evolution; rural knowledge; eco-literacy

5.1. Introduction

The socio-ecological systemic approach allows for a holistic, dynamic and complex analysis of ecosystems, featuring the inter-relations between ecosystems and people -through ecosystem management contributing to people's welfare- and among people -through formal and informal norms underlying such management (Hahn et al., 2006:575). If these inter-relations require coordination of actors and organizations, the so-called Social Capital[21] (SC) emerges as a key characteristic influencing collective action. SC conceptualises individuals interacting with other societal actors, which constitute communities when sharing some common features. SC is grounded on the networks of information and collaboration flows among actors, which set the norms for their interaction.

In Socio-Ecological Systems (SES), the flows among network members relate to knowledge transfer regarding ecological processes -including natural resources management-, and norms that rule such management. Norms aim at aligning community members' behaviours in order to maintain the shared utilisation of natural resources (NR) (Jones and Lynch, 2002:45). In this study we address forest SES, where norms constitute the "*formal and informal, public or private regulatory structures– on how to use forests"* (Giessen and Buttoud, 2014:1). The interactions between and among public and private actors regarding the management of forest resources, and the norms ruling such interactions make up forest governance.

Our study focuses on the cognitive dimension of SC (Nahapiet and Ghoshal, 1998). Cognitive SC refers to the pool of shared[22] knowledge among community members. When referred to NR dynamics, cognitive SC refers to the collective perception of e.g. forest-related processes based on "mental models". This is, the community constructs around forest problems and the

[21] SC is defined as the features of social organizations that facilitate coordination and cooperation for mutual benefit of their members (e.g. Putnam, 1993).
[22] the "shared" feature distinguishes SC from human capital, which consists of the individual assets (Coleman, 1988).

portfolio of solutions -i.e. management options-, which ultimately shape development "paradigms" or "shared visions" (Górriz-Mifsud et al., 2016). Mental models regarding how to manage NR derive in a set of practices which are valued by a community as correct or incorrect -i.e. "norms" (Ostrom and Ahn, 2009). In sectors with multiplicity of spatially dispersed users – as forestry is- the field control of such practices is very costly, resulting in information asymmetry on how users behave. In limited field control contexts, the abidance by "good behaviour" codes remains crucial for NR sustainability. Analysing cognitive SC in communities of forest users is relevant for policy-making insofar as non-expert knowledge affects community understanding of norms with consequent acceptance and behaviour towards the collective action.

We concentrate on the perceptions of local communities regarding mushroom picking. We analyse collective knowledge on the ecological, economic and social dimensions which underpin the mushroom governance. When socio-economic and/or ecologic changes alter the demand or supply of those NRs, their traditional management may become suboptimal, and hence the pre-existing normative may be felt insufficient by community members. Thus the norms could evolve and influence the positioning of the community towards policy interventions.

In this paper the inter-relation between cognitive dimension of SC with forest governance are analysed at local level because it represents the sphere where citizens have more direct influence in policymaking (Ruppert-Winkel and Winkel, 2011). We provide empirical data from a case study of the introduction of a mushroom picking regulation in Spain. This analysis is particularly relevant given the increasing emergence of mushroom picking permit systems (Jones and Lynch, 2002:44).

Methodologically, this study contributes to link the traditional and local ecological knowledge (T/LEK) with SC theories through assessing specific knowledge variables. These variables can be functional to understanding

subjacent cultural features of local communities and consequently provide support to the forest policy design. Content-wise, our results add to the ethnomycology field from a governance perspective.

5.2. Theoretical background

5.2.1. Ecological knowledge learning process within the community

Cognitive SC reflects the knowledge of a community, created through the combination and exchanges of existing (explicit and/or tacit) knowledge among community members (Nahapiet and Ghoshal, 1998:245). These complex social processes base on shared codes (means) and narratives (content), which facilitate a common understanding of collective goals and proper ways of acting in a social system (Tsai and Ghoshal, 1998).

Applied for NR in general -and forestry in particular-, cognitive SC aspects are reflected in the ecological knowledge of rural or urban communities. LEK stands for "*people's knowledge of abundance and distribution of species usually gained from individual's observations"* after interacting with landscapes over longer time spans than are possible in scientific investigations (Pacheco-Cobos et al., 2015). When such wisdom is transmitted and accumulated across generations, we talk about TEK (Berkes, 2000).

Previous scholars analysed the cognitive aspects of NR users from three angles, namely: (i) the TEK hold by rural inhabitants and its relation to resilience in a context of global change (e.g. Berkes, 2000; Linares, 2007); (ii) how information regarding the management of NR is spread -spontaneously or through policy instruments- with the consequent adoption of certain mental models (e.g. Schlüter and Koch, 2009); and (iii) fuzzy cognitive mapping of mental models on NR (e.g. Isaac et al., 2009). Yet, they did not focus on knowledge aggregation and convergence among different NR users and decision-makers. Analysing T/LEK from the cognitive SC perspective is relevant insofar as it spreads through social networks (Jones and Lynch, 2002:43).

Two eco-pedagogy concepts which are useful for community-level analysis, i.e. eco-literacy and eco-mentorship (Kulnieks and Longboat, 2013; Pilgrim et al., 2007). Here we concentrate in two eco-literacy levels, namely: the names of ecosystem components, and the NR management systems and the social institutions that govern them (Berkes 1999, in Pilgrim et al., 2007:1743). Folk wisdom on ecology processes around fungi and their multiple uses constitutes the field of ethnomycology (Yamin-Pasternak, 2011). Specifically, macro-fungi picking knowledge has been a little explored (Pieroni, 2016) in Spain, with a few descriptive studies (e.g. de Román and Boa, 2004; Verde et al., 2015) but without analysing the perceptions of picking dynamics, related concerns and derived governance implications.

5.2.2. From perceptions to mental models and norms

Cognitive SC is here conceptualised as the degree of cohesion (or inversely, divergence) of the perceptions –i.e. knowledge-, mental models –i.e. narratives- and positioning –i.e. vision- of community members.

Mental models constitute a key tool for interpreting the reality when agents count with incomplete information to make decisions or to construct their opinion regarding a phenomenon (Denzau and North, 1994). When interpersonal relations contribute to building mental models, individuals often rely on referent agents such as opinion leaders, factual powers, or so-perceived experts. This might be positive in some cases, like forest owners' associations which configure their members participation rates or positioning towards certain topics (Schlüter and Koch, 2009).

Mental models lay the foundations to the practices seen as (im)proper, i.e. social norms (Coleman, 1990:243). How norms emerge is the main concern of evolutionary institutional studies. Brooks (2010) developed a model of institutional evolution, which puts forward that local knowledge about NR management leads to behavioural norms (e.g. good practices), which could be incipiently formalised (e.g. voluntary codes of conduct), and eventually become institutionalised as formal rules (e.g. formal permits or

prohibitions). The fit between previous informal norms and the formalised institutions likely reflects the reform acceptance.

5.3. Analytical framework

We analyse the collective knowledge on wild mushroom picking in the case study on the introduction of a picking permit in Catalonia (Spain). *Ad-hoc* indexes have been developed for three levels of analysis: the individual picker, the towns whose municipal territory is affected by that policy instrument, and the aggregation of decision-makers and pickers.

Specifically, our study aims at responding to two research questions, setting the ground for our analytical framework (Figure 1):

Q1) *Whether and to which extent is there a convergence of concerns around mushroom picking?*

Q2) *Whether and how these concerns relate to mushroom picking governance?*

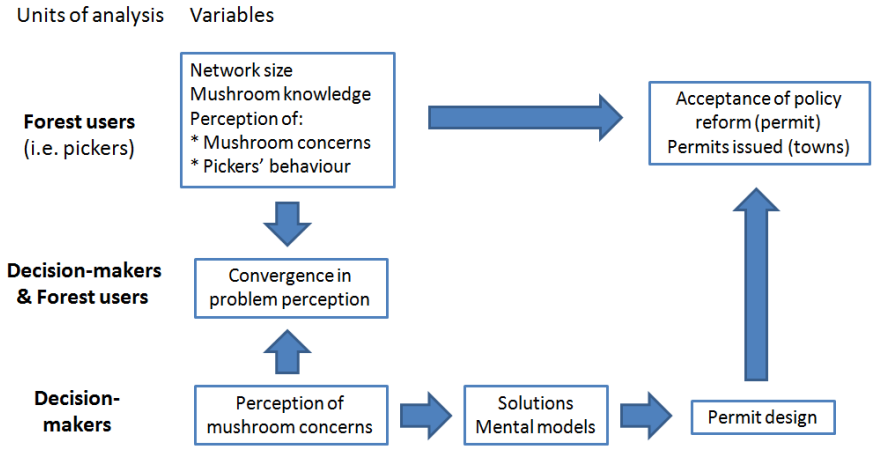

Figure 1 - Analytical framework

Each question is approached through different angles using complementary analyses. For the first question, we study the collective knowledge around picking concerns before the permit both for local pickers and decision-makers and their justifications. We analyse pickers' perception convergence

across towns. Next, we analyse the convergence among the decision-makers and between them and pickers.

For the second question, we search which mental models decision-makers ensue to mushroom-related concerns, hence affecting policy design. Moreover, we contrast whether town-level cohesion correlates with permit uptake, given that strong divergences indicate the likely existence of opinion subgroups. Finally, we examine whether individual picker variables (namely, perceptions, mushroom literacy, learning source or network size) explain their permit acceptance level.

5.4. Materials and methods

5.4.1. Case study description: wild mushroom picking permit in Poblet forest

The protected area of the Poblet forest is located in Catalonia (Spain), 126 km far from Barcelona, and 50 km far from Tarragona capital (Appendix 5.1). Spreading over 3,000 hectares, this forest is mainly owned by the Government of Catalonia with some municipal patches. It hosts a wide diversity of Mediterranean forest ecosystems dominated by holm oak and maritime pine. Declared protected area in 1984, the operational management of Poblet park is conducted by a technical office, while its strategic management relies on a Governing body which gathers local stakeholders with provincial and regional decision-makers.

The Spanish Forest law establishes that the landowner owns non-wood forest products growing on it, e.g. mushrooms. Hence, the Poblet Governing body decided to pioneer in Catalonia the introduction of the "mushroom picking reserve" concept. Being Catalonia a mycophilic area, with 23% of its citizens declaring to go mushroom picking at least once annually (CEO, 2014), the pressure over the resource has increased in the last decade. This has led to a debate about regulating this activity and the adequacy of a picking fee to contribute to the management of the forest used by pickers.

Yet, managers often worry about pickers' acceptance of restrictions to a traditional activity in terms of control, practices and fee.

In Poblet this debate found a positive local ground, which facilitated the establishment of mushroom permits in 2012 (see map in Supplementary material 1). The permit authorises the daily collection up to six kilograms per person. Most permits (between 70-80%) are acquired by locals (Table 1), who have to pay 1 EUR/season, whereas the price for outsider pickers is 3 EUR/day or 10 EUR/season. "Local" permit category encompasses the inhabitants registered in one of the four municipalities affected by the regulated area: Montblanc, L'Espluga and Vimbodí, in the low lands; and Prades in the mountains. Climatic conditions precluded opening the 2013 permit season, with other seasons showing a permits' number somewhat proportional to the productivity. A technical committee advised the permit design and supervises its functioning, elaborating annual reports. In the following we will refer to the governing body and the technical committee as the "decision-makers" (DM).

Table 1 –Target population, permits issued and pickers sampled in the municipalities surrounding Poblet forest. Source of population data: IDESCAT; of permits: Poblet technical office.

Municipality characteristics		**Montblanc**		**L'Espluga d Francolí**		**Vimbodí i Poblet**		**Prades**	
Population in 2015 (total and 15-84 years old [a])		total	15-84	total	15-84	total	15-84	total	15-84
		7,283	5,906	3,818	3,087	966	796	623	523
Local permits issued (absolute values and % 15-84 years old population)	season	N	15-84	N	15-84	N	15-84	N	15-84
	2012	668	11%	655	21%	178	22%	33	6%
	2014	830	14%	686	22%	198	25%	36	7%
	2015	468	8%	202	7%	76	10%	8	2%
Pickers' available contacts		470		447		90		3	
Interview sample (absolute values and % permits issued in 2014)		N	%	N	%	N	%	N	%
		22	2.7%	19	2.8%	10	5.1%	1	2.8%

[a] Active pickers are considered until 84 years old

Poblet park also hosts a network of permanent plots for scientific monitoring of fungal production and diversity (Bonet et al., 2012). These plots are fenced, hence the impact of picking is not appraised there; instead trends of climate change or forestry interventions are measured.

5.4.2. Data collection and analysis

Interviewed pickers were selected among those recurrently getting the permit -i.e. registered in 2012 and 2014- and left a phone number. After deleting governing body members and non-adults, contacts were ordered by surname for each municipality, and a systematic random selection was applied. After 258 phone calls, the rate of acceptance to be interviewed was 20%. Only one interview was possible to conduct in Prades; hence its results are only considered for the aggregated analyses. In-depth interviews were conducted during 2014-2016 to 52 pickers (confidence interval of 0.15) and 16 DM members.

Two questionnaires (one for DM and another for pickers) were drafted combining semi-open and closed questions. The interview guideline contained a section regarding familiarity with Poblet forest and with the mushroom picking activity there, followed by a section on mushroom-related eco-literacy, interspersed with questions on permit acceptance and network connections.

Interviewees were confronted with a table of different mushroom-related issues, expressed as statements regarding forest management and mushroom ecology (For), economic (Econ) and social (Soc) concerns, based on previous qualitative research (Górriz-Mifsud et al., 2015). Ecological aspects included mushroom production factors and the harvesting practices which could affect them. Economic concerns referred to rural value chains regarding landowners and commercial pickers (the last were posed only to interviewees who reported knowing some commercial picker). Social concerns included pickers' behavioural factors potentially causing annoyance to other forest users. Interviewed pickers were asked to which degree they considered the statements as a problem at the time of the permit introduction (before 2012) by scoring in a 5-points Likert scale from "totally disagree" to "totally agree". The statement formulation indicated a judgement of what is correct or not, hence representing interviewee's values. There was also a "don't know" option, and a space for commenting.

The shared knowledge on problem perception and preferred solutions stems from own experience interacting with the ecosystem and from information exchanges with peers. The inter-quartile range (IQR) -i.e. the difference between first and third quartiles- was used as simple but meaningful indicator for the degree of convergence (or conversely, dispersion) among community members. This indicator is adequate for ordinal variables and is robust to different sample sizes. Null IQR indicates that at least half of the sample shares a score and is interpreted as low dispersion. We also considered that two points of difference of IQR and/or median between DM and pickers indicates large discrepancy.

Non-parametric statistics were applied for assessing differences: Mann-Whitney U test between DM and pickers, and Kruskall-Wallis test across municipalities. Besides concerns, DM were asked about their perception on possible "solutions". Spearman correlation was applied for testing DM mental models within the DM, showing the linear association between concern and appropriate measures.

As governance indicators, we used permits per town, and asked pickers about their acceptance of the current permit design. We tested Spearman correlation between such governance and cognitive variables.

5.5. Results and Discussion

The mycological knowledge is first set out (section 5.1), followed by the problem perception and convergence (section 5.2). The final section presents the governance variables and its relation to cognitive SC (section 5.3). Excerpts of the pickers' interviews are reported with the initial letter of the town they belong to (M,V,E,P) and DM for decision-makers, followed by the number of interviewee. Further supporting excerpts can be found in Appendix 5.2.

5.5.1. Mycological knowledge

5.5.1.1. Familiarity with wild mushroom picking in Poblet

90% of interviewed pickers declared having lived in Poblet area over fifteen years. Most of them (80%) report having alternative forests to go mushroom picking beyond Poblet. All interviewees picked for self-consumption. Commercial picking in Poblet seems to be quite limited, and interviewees reported knowing barely one picker per town selling them.

The mushroom species most typically mentioned are the Saffron milk-cap (*Lactarius* group *deliciosus*), Slippery-caps (*Hygrophorus gliocyclus*), and Grey knight (*Thricholoma terreum*). Pickers show a wider knowledge of mushrooms than DM members (6.8 vs. 5 species on average, respectively), which is reasonable given that not all DM live in the area or are pickers. Moreover, older pickers tend to identify more species (rho: 0.281, p=0.044). Yet, most pickers used technically incorrect terms, such as "seeds" for spores or "roots" for the mycelium in the soil, whereas DM tend to use more accurate words. Mushroom literacy is found related to having acquired the knowledge through the family (rho=0.287 p=0.039), and the proximity to the Governing body (rho: 0.287, p=0.039).

Only 57% of the respondent pickers know the land ownership affecting Poblet forest. The main error is assigning it to "the State", understood by some as Spain and others as the Catalonian Government. Finally, only 22% were acquainted with the legal ownership of mushrooms and hence collecting rights.

5.5.1.2. Informal norms and their transmission

Asked about how to define a "good mushroom picker", interviewees described it as respectful, picking only the species one is sure of, and leaving no trace in the forest. The motivation for behaving as good pickers is justified by their own interest (i.e. recurrent visit to the same spot) or by deference towards others. Having the adequate equipment, orienting oneself in the forest, and knowing diverse mushroom species and locations is also

considered by many as characterizing good pickers. Still, there is some confusion among pickers regarding the convenience of cutting or picking. The scientific literature has found no differences (Egli et al., 2006), but this information seems not having arrived to them yet.

Asked about how such good practices are learned, 71% of interviewed pickers point out the family, followed by friends. Being all recreational pickers, this confirms Pilgrim et al. (2007) that in non-resource dependent communities TEK is spread mainly through network relations. Interviewed pickers stressed the fact of being exposed since infancy to rural environments imbues them with the norms. Another group explained that good practices can be learned through going with wiser pickers –hence, these acting as eco-mentors (Kulnieks and Longboat, 2013)- but also through external sources, e.g. internet. Many respondents, moreover, highlight the self-experience for internalising the code of conduct. Such vertical (i.e. across generations) and horizontal (i.e. across peers) knowledge transmission trajectories fit with those found for truffle pickers in northern Italy (Pieroni, 2016).

5.5.2. Convergence in problem perception

5.5.2.1. Problem perception and convergence within pickers

Table 2 illustrates that social and ecological statements are considered as rather problematic, whereas economic aspects are scored differently. A consensus is found regarding the need for forestry interventions (For1), the gathering of both mature and small mushrooms (For2), the yells of some pickers (Soc1), and their preference for silence while roaming in the forest (Soc2).

Regarding the forest-related concerns, virtually all respondents report a shrinking productivity of mushrooms in the last decades. The mental models explaining such decline diverge considerably, between caused by pickers -i.e. the largest dispersion falls in the risk of mushroom overexploitation (For8)-, driven by wild boars expansion (For9) or induced by climate change (For3) –

with less dispersion. Climate change affects the mushroom yield in terms of increasingly irregular and meagre precipitations. Rain is crucial, as the local rule on climatology referred by several interviewees: "*21 days after raining in the end of August-beginning of September mushrooms ripen; afterwards they need a couple of days more of rain"* (E2, E11), "*and without wind*" (DM1, DM15).

Wild boar is spreading all along Catalonia (Cahill et al., 2012), but being the Poblet park a hunting sanctuary, control measures are extremely difficult to be taken. Wild boars are blamed for turning the ground upside down. Pickers become especially upset because they come across spoilt mushrooms. Apparently the animals "*do not eat the mushrooms but leave them destroyed*" (M17). Why wild boars behave in this manner is differently explained across pickers, with some of the opinion that the animal searches roots or worms and destroying mushrooms as side-effect. Many interviewees are not able to distinguish wild boar soil damage from that caused by pickers, whereas a few do because "*a mushroom picker does not leave saffron-milk caps or dark knighters* (M15)".

Interviewed pickers support forest thinning and brush cleaning (For1). Respondents justify them for fire prevention (hence tackling For7), wild boar control (For9) and easiness to roam. Indeed, a rather high but variable wildfire risk is perceived. Moreover, the past fuelwood use by local families for heating endures in the collective memory of Espluga and Vimbodí; this was referred to contribute to keep a lower forest density and a "clean" understory.

The null IQR confirms a wide full agreement that some pickers collect both small and mature mushrooms (For2). However, 25% of respondents do not recognise that practice as problematic given that small *Lactarius* are typically used for conserve, which is considered a delicacy in the area. They either do not reflect on the consequence of restricting spore spread or conceive that such usual practice cannot be damaging. Moreover, others are

Table 2 – Pickers' perceptions regarding mushroom- and forest-related statements. Within each typology of concerns, the table is ordered according to the pickers' IQR from the largest consensus until the largest divergences.

			Pickers			Decision-makers			DM-pickers difference (U-value)
Type		Statements	Med	IQR	N	Med	IQR	N	
Ecology-Forestry concerns	For1	Forests required forestry interventions	5	0	51	5	0	18	422.5
	For2	Some picked both small and mature mushrooms	5	0	50	5	1	15	314
	For3	Climate change causes more damage than pickers	5	1	49	n.a.	n.a.	n.a.	n.a.
	For4	Some destroyed non-edible species	5	1	52	5	1	16	355
	For5	Some used plastic bags	5	1	51	5	1	18	411.5
	For6	Some used tools that damage the soil	5	1	50	4	1	18	338
	For7	There is high wildfire risk	5	2	52	4	3.50	18	336
	For8	There was risk of mushroom overexploitation	4	4	48	2.5	3	18	296.5
	For9	Wild boars cause more damage than pickers	4	4	52	n.a.	n.a.	n.a.	n.a.
Social concerns	Soc1	Some shouted in the forest	5	0	52	5	2	17	341
	Soc2	Pickers appreciate silence and wild nature	5	0	51	n.a.	n.a.	n.a.	n.a.
	Soc3	Some pickers didn't know that the forest has an owner	5	1	49	n.a.	n.a.	n.a.	n.a.
	Soc4	Some pickers threw trash	5	1	52	5	1	17	423
	Soc5	Foreign pickers cause problems	4	2	47	4	2	18	338
	Soc6	Some pickers are impolite	4	2	45	4	2.25	16	346.5
	Soc7	Locals help to the forest when required	5	4	48	5	3	17	380.5
	Soc8	Controlling pickers in this forest is complicated	4	4	47	4	2.75	18	403
	Soc9	Some parked the car in a wrong manner	4	4	40	n.a	n.a.	n.a.	n.a.
Economic concerns	Econ1	Commercial pickers didn't ask for permission	5	0	25	5	0	16	192
	Econ2	Commercial pickers didn't gratify landowners	5	0	27	5	0	18	207
	Econ3	Pickers benefited from the forest without contributing	5	1	49	5	1	18	395.5
	Econ4	I trust on marketed mushrooms	5	1	35	n.a	n.a.	n.a.	n.a.
	Econ5	Forests must be profitable and they aren't	4	2	43	5	0	18	246.5
	Econ6	Mushrooms is an underexploited asset	2	2.75	46	4	2	18	237*
	Econ7	Locals are accomplices of grey market	1	3.5	15	4	2	13	70
	Econ8	There are few income alternatives in this rural area	3	4	43	4	2.75	18	287
	Econ9	Commercials aren't experts	2	4	26	3.5	3.25	12	127

Med: Median. n.a. = not available. *=significant differences at p<0.05 level.

of the opinion that once uncovered these small mushrooms will not grow further and become spoilt if not picked (E12, E14, E18).

The use of plastic bags (For5) is conducted by some pickers and is generally considered as a problem, but the reasons diverge. The dominant idea is that spore spread requires porous containers. Yet, some think that the wicker basket is a fashion (V4, V10, V11) and the problem of transporting with plastic bags is "*that mushrooms become spoilt*" (E14, M10, V8), hence not practical for those spending the entire day in the forest.

Respecting the ground is well shared among respondent pickers, who consider that the use of tools damaging the soil constitutes a problem (For6). Regarding the tools, most interviewees refer to the past local practice with hooks. The reason for their use varies: for easier visualisation of mushrooms amidst the large maritime pine needles, or to accessing forest areas with dense or thorny shrubs. Such practice is attributed to both (mainly old) locals and foreigners. In any case, 20% of the interviewees point at its reduction as one of the immediate effects of the permit introduction. The use of rakes, instead, is a new practice reported barely and solely for foreigners. With regard to the social concerns, some interviewees justified shouting (Soc1) to communicate in areas with low phone coverage when going in groups, and especially solitary pickers dislike that behaviour. A high consensus applies for tranquillity as part of the activity (Soc2). Trash is the most disgusting aspect expressed by pickers (Soc4), but a few pointed out an improvement in the last years. Whether this can be attributed to the recently established permit or to generalised civility campaigns is unclear. The largest divergences are on the wrong parking (Soc9) –which does not seem to be problematic in this area- and the locals' help in the event of forest contingencies (Soc7) –e.g. through the fire volunteer groups. Yet, some interviewees justify that non-locals do not help simply because they are not situated nearby.

Regarding the economic aspects, the largest cohesion falls on the lack of landowner's permission request from commercials before the permit system (Econ1), followed by the lack of gratification towards the landowner for allowing that activity (Econ2). The largest dispersion in opinions among interviewed pickers fall on the presence of income alternatives (Econ8), and regarding the expertise of commercial pickers (Econ9). Pickers tend to score low the chances of mushrooms as a potential economic sector (Econ6). Indeed, the scarce entrepreneurship is justified by the uncertain autumn climate in the area that precludes ensuring the inputs to develop businesses more sophisticated than occasional and opportunistic selling of fresh mushrooms. Interviewees tend to disagree when asking about complicity of locals with the grey market (Econ7). Being some local inhabitants aware of the small informal trade, this scoring is likely indicating that respondents do not perceive illegality in such activity. Large dispersion occurs regarding the perception of forest profitability (Econ5). Only this aspect has been found with a robust positive correlation with pickers' network, both in terms of bonding connections with pickers from the same town (rho: 0.369, p: 0.018) and bridging with the neighbouring towns (rho: 0.411, p: 0.007).

Finally, when analysing across municipalities, neither statistical differences nor clear trends appear (Appendix 5.3). Only the cognitive aspect of forest profitability shows significant differences (Econ5, p= 0.0189). Vimbodí pickers "strongly agree" with the idea that forests should be profitable assets but they are not so far; Montblanc pickers just "agree" with that positioning whereas pickers from Espluga are rather neutral, with a large variability. Yet, this difference alone does not sufficiently justify the stronger permit uptake of Vimbodí in terms of ratio of adult inhabitants.

The lack of significant differences across towns in the perception of concerns may reflect two aspects, namely: a possible sample bias (given that all interviewees were "legal"), or the likely unique "community of practice" (Poe et al., 2013) regarding mushroom picking across the three towns. A single hermeneutical community would challenge the validity of the administrative

town boundary for studying the community knowledge. In contrast, non-locals could be interpreted as another community of practice with fuzzier boundaries, often newer in the practice and with less attachment to a specific forest. Reticence toward non-locals can stem from the uncertainty regarding the length of pickers' learning process (Jones and Lynch, 2002:43).

5.5.2.2. DM concerns on mushroom picking

To avoid repetitions, we present here only a few aspects and DM justifications that complement those given by pickers. Table 2 shows that DM coincide in the need of forestry interventions (For1) for drought adaptation and positive effects on *Lactarius spp.* productivity. These statements ground on the scientific experiments conducted in the park regarding mushroom productivity in pine plots (Bonet et al., 2012) and on climate change effects on *Quercus ilex* plots (e.g. Barbeta et al., 2015). These results are reported to DM regularly. Large dispersion occurs with the risks of wildfire -perceived as high, but not at the top- and of mushroom overexploitation –which does not seem to justify the permit introduction.

Most forest-related and social concerns are reflected in the picking norms they approved. DM were also rather worried about the economic aspects of mushroom picking. While they did not seem willing to promote commercial picking, they found in mushrooms a resource that could contribute to the forest economic sustainability. We put forward that this sensibility towards the economic concerns is rooted in their awareness of the park budgetary restrictions and their related challenges.

5.5.2.3. Cognitive convergence between pickers and DM

Table 2 shows that the largest convergence between pickers and DMs concentrates in the need of forestry interventions in Poblet forest. Interviewees also coincide in the two commercial picker-related statements. The Whitney-Mann test indicates significant statistical differences regarding the consideration of mushrooms as an infra-utilised resource, where DM

perceive a potential for promoting the area through e.g. mycotourism (de Frutos Madrazo et al., 2012).

A few other aspects are not statistically significant different, but still show large divergence between DM and pickers. Decision-makers completely agree (i.e. high convergence) with need of forests to be profitable, while pickers assign it less relevance with larger divergence. Besides, DM median perception considers economic aspects related to the current informal market as problematic in contrast with pickers. DM differ three points from local pickers regarding finding neighbours as grey market accomplices, and 1.5 points in questioning commercial pickers' expertise, which poses a sanitary problem. In both cases large divergences occur within DM, but they are even larger among interviewed pickers.

Finally, the perception of mushroom overexploitation differs 1.5 points between DMs and pickers –the last more concerned; nevertheless the opinions of both groups fluctuate considerably. Overexploitation of the fungal resource originated by an unsustainable open-access management has been reported in some Asian countries (Pandit and Thapa, 2003; Yang et al., 2009). Poblet pickers, instead, seem to put forward that a set of norms are applied by locals in order to avoid a tragedy of the commons, but perceive foreign pickers not following them. Lacking sound data on such effect, the precautionary principle would suggest regulating mushroom harvesting based on an intuitive overexploitation. This would fit well with the Catalan Forest Act, which contemplates the conservation of forest resources as one of the reasons for regulating non-wood forest products. Yet, the lower concern by DM may justify the quite generous daily quota.

These differences show that pickers assign more weight to ecological challenges and DM to economic opportunities. Such diverse diagnoses could ground a conflicting permit design; yet, these aspects are not incompatible to each other. There are more aspects (77%) of convergence than disagreement, mainly related to the improvement of social aspects and most

ecological practices. Instead, outsider pickers are the most affected by the permit. Interviewees tended to blame them for most poor behaviour (Soc5), which may be behind the DM introducing a positive discrimination towards locals.

Regarding the picking fee, it could be argued that the convergence about the previous missing contribution from pickers to forest tending is prioritised versus the grey market divergences. Indeed, the commercial picking was left out of permit focus, which follows pickers' priorities. The need for forest tending covering thinning and shrub reduction is linked to reduced wildfire risk (Regos et al., 2016), whose consideration as a problem is similar both for pickers and DM.

5.5.3. Mushroom picking permit governance

5.5.3.1. DM mental models to design the permit

Table 3 illustrates the level of congruence between problem perception and policy intervention statements. Further correlation analysis can be found in Appendix 5.4.

A statistically significant trend is found between DM members perceiving a high fire risk with those requiring the execution of forestry interventions. The economic-related statements and the positive discrimination to locals contend that forestry actions are to be born mainly by foreign pickers. The support for an increased forest profitability links to the preference for earmarking permit revenues to forestry. This goes in line with the logics of Payments for Ecosystem Services, where beneficiaries of a forest ecosystem service financially contribute to its targeted forest management (Wunder, 2005). Finally, the perception of mushrooms as an asset relates to perceiving few income opportunities in Poblet municipalities.

Regarding pickers' behaviour and consequent policy reaction, we find that DM's perception of pickers throwing trash correlates with the claim for forbidding such behaviour. However, similar statements do not hold such

legal reaction (e.g. use of plastic bags, rakes, picking small mushrooms), where the behaviour is detected but not problematized, or a prohibition is rather considered disproportionate for the impact caused.

Table 3 – Mental models: correlation analysis between problems and policy interventions related to mushroom picking. * = p<.05, ** = p < .01, *** = p<.001. "Don't know" observations are deleted.

Problems	Solutions	Spearman Rho coeff.	N
A - There was a high wildfire risk	G - This forest required forestry interventions	.532*	18
C - Forest must be profitable and they weren't	6 - Raised funds must be reinvested in the forest	.514*	18
B - There was a mushroom overexploitation risk	2 - The access to the forest should be limited	-.344	18
	16 - Landowners must conduct mycosilvicultural practices	.452	17
D - Mushrooms were an underused asset in this area	F - There were few income alternatives in these rural areas	.742***	18
R - Pickers benefited from a forest product without contributing to its maintenance	3 - Landowners should be allowed to put a price for pickers in their forests	.194	18
E - Foreign pickers caused problems	4 - Local pickers must be positively discriminated	.278	18
	18 - Foreign pickers must contribute to the forest	.261	18
4 - Local pickers must be positively discriminated	18 - Foreign pickers must contribute to the forest	.716**	18
J - Some pickers picked both small and mature mushrooms	8 - Picking small mushrooms must be forbidden	.029	14
L – Some pickers use rakes and other tools which damage the ground	10 - Stirring up the mycelium must be forbidden	.392	18
	12 - Only a knife must be used	.242	18
M - Some pickers used plastic bags	11 - Only wicker basket must be allowed	-.331	18
Q - Some pickers throw trash	17 - Throwing trash must be forbidden	.568*	17
15 - Commercial picking must be regulated	19 - Commercial pickers must gratify the forest owner	.576*	15

Contrary to expected, a few potential mental models do not show statistically significant correlations. DM's perception of overexploitation does not necessarily lead to the preference for limiting pickers' access or oblige landowners to change practices towards mycosilviculture. Moreover, there is no linear relation between the lack of pickers' contribution to the forest and the landowners' permission to establish a picking fee. A plausible reason for the mismatches might be the very coercive formulation of the policy interventions, while the overall consideration of the permit was more an awareness-raising than sanctioning tool.

5.5.3.2. Acceptance of the policy reform

Most interviewed pickers agreed with the current design of the permit system, which is largely consistent across municipalities (Table 4). However, the geographical validity of the permit is sometimes questioned; this is, some pickers would like to also cover other Catalonian forests.

Table 4 - Pickers' acceptance (percentage on N=52) to the mushroom picking permit system (overall and by municipality).

aspect	average	Montblanc	Espluga	Vimbodí
Requirement of a mushroom harvest permit	96%	95%	100%	90%
At local level (vs. entire Catalonia)	64%	52%	75%	60%
Against a permit fee	96%	95%	100%	90%
Proceeds to be reinvested in forestry	100%	100%	100%	100%
Permit linked to harvest norms	96%	100%	93%	90%
Degree of agreement with the current permit system	87%	85%	89%	85%

The permit requirement is felt positively by many "*in order to know who's entering the forest*" (E19). Having a picking fee is largely supported, but 27% respondents specify that "*if it's symbolic, as it's now*". The positive side of a payment is justified as a dissuasive mechanism, as awareness-raising tool about the mushroom value, and for covering the permit costs. Moreover, a few note that with the current prices the aim is conservation rather than

fund-raising. Yet, most interviewed pickers were neither aware of the actual amount of money raised nor the use of the proceeds.

As for DM, they reported a satisfaction level of 77% (normalised average between satisfied and very satisfied). Indeed the Park director stated that they were expecting around 500 permits, which was by far exceeded.

5.5.3.3. Pickers' uptake of permits

Table 1 reveals the experience of three mushroom seasons of permit implementation. A rather stable gradient in permits emerges according to town size: Vimbodí issues permits for a larger ratio of adult inhabitants than Espluga, and this more than Montblanc in turn. They have either more percentage of pickers or they abide by the norm more (i.e. less illegal pickers).

No significant differences regarding the cognitive aspects are found across municipalities that could help explaining the differential permit uptake. Hence, it could be interpreted that the mushroom-related behaviour responds rather to cognitive factors of subgroups smaller than towns.

5.6. Discussion: intertwining forest governance with cognitive SC

Along the paper the cognitive SC aspects of mushroom picking governance have been analysed. The ecological knowledge and socio-economic perceptions stem mainly from family transmission, but also from standardised knowledge and media (Pieroni, 2016). Moreover, proximity to DM also provided more advanced eco-literacy indicators, which shows the relevance of social networks.

We find a rather cognitively cohesive community of pickers, where half of the knowledge statements hold one or less points of dispersion (Table 2). The robustness of these findings indicates the strong cultural significance of mushroom picking within these communities (Garibay-Orijel et al., 2007). Such local knowledge constitutes a valuable capital which could be used for

monitoring and further reinforced in synergy with new technologies (citizens' science, see Pacheco-Cobos et al., 2015). Yet, some justifications (regarding immature mushroom picking, the use of basket and hooks) shows that the so-considered proper picking practices do not always fit with the "official" good practices stipulated by the permit. This analysis then helps to uncover the specific logics of social practices, which set the basis for modifying them from somewhat "external" governance initiatives.

Our results show that forest users (i.e. pickers) make their harvest decisions (permit, harvest modes) without complete information (e.g. on mushroom ecology), hence showing a bounded rationality which is mediated by community norms (Ostrom, 2011). What is the role of the government with regard to social norms is difficult owing to its very definition[23]. Kinzig et al. (2013) suggest the support of the social norms considered as beneficial through e.g. campaigns. Interviews have shown that pickers base their behaviour on their constructed reality, and hence on their mushroom ecological knowledge but also on the integration with other community members. We can derive then that cognitive SC influences mushroom governance. Policy makers are then advised to take into account existing networks of local wisdom in view of reducing ecological illiteracy of forest users (Hahn et al., 2006) while simultaneously strengthening key networks. For example, a local steward picker award or public speeches within mushroom fairs could help to consolidate their network position as "example-to-follow" or eco-mentor.

Beyond the environmental awareness, in our case study most of the policy instrument design underpins pre-existing social norms. Indeed, the sharp differentiation between local and foreign pickers' behaviours jointly with the perception of local pickers' competences, urges the need of formal rules (the state intervention) for tackling forest users beyond the community. Such

[23] Social norm is defined as "*a rule governing an individual's behaviour that third parties other than state agents diffusely enforce by means of social sanctions*" (Ellickson, 2001:3).

policy intervention demonstrates the demand for the institutionalisation of traditional rights, as put forward by Brooks (2010). This paper then contributes to the etnomycology field by providing a methodological framework to proof how the traditional and local knowledge on mushrooms sets the basis for subsequent picking norms, ultimately shaping its governance system.

5.7. Conclusions

The management of open access (e.g. common-pool) resources poses challenges regarding their related community of users. We search evidence that the ecological knowledge shared in rural communities shapes their usage norms for natural resources. Our proposed methodology to assess cognitive SC combines IQR indexes for community cohesion, pair-wise comparisons across social groups, and correlations for mental models.

The mental models of decision-makers link problem perceptions and the portfolio of solutions, which result relevant for the policy design. These perceptions are partly shared by the pickers' community: the perceived dissimilar behaviour between local and foreign pickers, the need for forest tending -mainly addressing the wildfire risk-, and the problem of trash left in the forest. However, pickers and decision-makers partially differ regarding the economic aspects of the governance reform. At the aggregated level, this pool of knowledge sets the basis for the norms that the new permit system underpin, and hence its design and large acceptance.

The comparison across municipalities regarding the cognitive aspects does not show significant differences that could help explaining the differential engagement in each town. Hence, it could be interpreted that in terms of mushroom knowledge, values and perceptions, local pickers constitute a single community, whereas the actual behaviour responds rather to smaller circles.

At the individual level, yet, no cognitive factors relate to the permit acceptance. However, we find evidence of knowledge spread factors:

mushroom literacy (nr. species) relates to learning from the family and being proximal to the decision-makers. Pickers' network plays a role insofar as the bonding (i.e. intra-municipality connections), bridging (i.e. inter-municipality) and linking social capital (i.e. proximity to decision-makers) positively affects the requirement of profitable forest management.

We therefore highlight the relevance of the networks of forest users in SES governance reforms, and suggest investing in eco-literacy programs with community-level influence (e.g. eco-mentorship) for improving the acceptance of institutional changes.

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Appendix A5

A5.1 Poblet area map

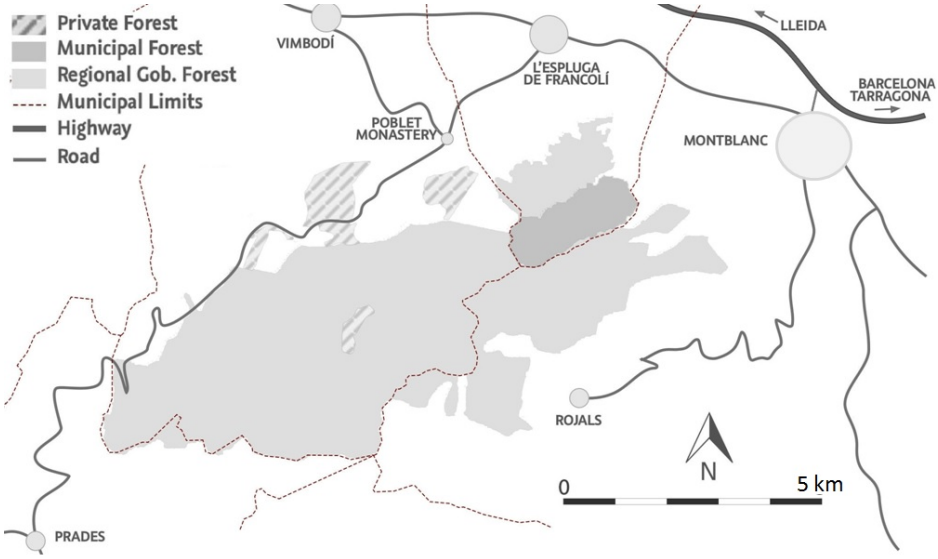

Figure 2 - Map of the forest area requiring the mushroom picking permit.

A5.2 Interview excerpts

On informal norms and their transmission

Asked about how to define a "good mushroom picker" (*"bon boletaire"*, an existing Catalan expression) interviewees described it as respectful, picking only the species one is sure of, and leaving no trace in the forest. "*I recognise whether there was a good picker if the forest looks untouched, but without the good mushrooms. This is, from the past weather conditions and the type of forest I know that there should be mushrooms there, but just someone passed before you*" (M6). A good picker is not necessarily a mycologist: "*Besides [the good pickers], there're "mycologists", who bring a book and like finding both good and bad mushrooms*" (M13).

The motivation for behaving as good pickers is justified by their own interest (i.e. recurrent visit to the same spot) or by deference towards others:

"*because you'll return or someone will pass after you and will find what you left*" (M15).

Interviewed pickers stressed the fact of being exposed since infancy to rural environments imbues them with the norms: "*The [good] picker is built since a child, s/he enjoys and learns progressively*" (V3); "*Being a picker is a transmitted culture; it cannot be built when being in its 40s. It's like the farmer: it cannot be taught, for example, to weak up very early*" (V6), "*By living in the rural area you learn them*" (M3). Interviewed pickers stressed the fact of being exposed since infancy to rural environments imbues them with the norms: "*The [good] picker is built since a child, s/he enjoys and learns progressively*" (V3); "*Being a picker is a transmitted culture*" (V6). Many respondents, moreover, highlight the self-experience for internalising the code of conduct: "*they sprout from inside*" (M9, M11, M13), "*it's like an intuition*" (E12).

On mushroom-related ecological, economic and social concerns

Interviewed pickers support forest thinning and brush cleaning (For1). Respondents justify them for fire prevention (hence tackling For7), wild boar control (For9) and easiness to roam: "*Forestry interventions do not harm mushroom productivity, but affect the comfort for picking them*" (E3, E4).

Respecting the ground is well shared among respondent pickers, who consider that the use of tools damaging the soil constitutes a problem (For6): "*When people say 'mushroom harvesting' I get aghast. It should be said 'picking mushrooms'. The root has to be left for the mushroom to sprout again*" (V8).

Why wild boars behave in this manner is differently explained across pickers, with some of the opinion that the animal searches roots or worms and destroying mushrooms as side-effect: "*the wild boar doesn't like the mushroom, but the worms. Hence they turn them down and come back once worms are inside while the mushroom gets rotten* (E12)".

On permit acceptance:

The positive side of a payment is justified as a dissuasive mechanism ("*a payment reduces the amount of pickers*", E2), as awareness-raising tool about the mushroom value ("*what isn't paid, isn't valued*", E13), and for covering the permit costs (E9).

A5.3 Municipality-level perception of Social, Ecological/Forestry and Economic problems related to mushroom picking in Poblet

Table 5 – Pickers' degree of agreement with statements related to mushroom picking (5= completely agree, 1=completely disagree) and convergence (IQR). Md = median.

		Pickers		Montblanc			Espluga			Vimbodí			Kruskal-Wallis
Complete problem statements	**Type**	**Md**	**IQR**	**Md**	**IQR**	**N**	**Md**	**IQR**	**N**	**Md**	**IQR**	**N**	
Forests required forestry interventions	For1	5	0	5	0.00	22	5	0.00	18	5	0.00	10	
Some picked both small and mature mushrooms to fill in the basket as much as possible	For2	5	0	5	1.00	21	5	0.00	18	5	0.00	10	
Climate change causes more damage than pickers	For3	5	1	4	2.00	20	5	1.00	18	5	1.00	10	
Some pickers destroyed (e.g. kicked) non-edible species	For4	5	1	5	0.00	22	5	1.00	19	5	0.00	10	
Some pickers used plastic bags	For5	5	1	5	1.00	22	5	0.75	18	5	0.00	10	
Some used tools that damage the soil (e.g. rakes, hooks)	For6	5	1	5	1.00	21	4.5	1.00	18	5	0.00	10	
There is high wildfire risk in this forest	For7	5	2	5	0.00	22	4	3.00	19	5	2.50	10	
There was risk of mushroom overexploitation	For8	4	4	3	4.00	21	4	4.00	17	4	4.00	9	
Wildboars cause more damage than pickers	For9	4	4	4	3.75	22	4	3.00	19	1.5	2.75	10	
Some shouted in the forest to communicate with other pickers	Soc1	5	0	5	0.00	22	5	0.00	19	5	0.75	10	
Pickers appreciate silence and wild nature	Soc2	5	0	5	0.00	22	5	0.00	18	5	0.00	10	
Some pickers didn't know that the forest has an owner	Soc3	5	1	5	1.00	22	5	1.00	16	4	1.75	10	
Some pickers threw trash in the forest	Soc4	5	1	5	0.00	22	5	0.50	19	4.5	1.00	10	
Foreign pickers caused problems	Soc5	4	2	4	1.00	18	4	3.50	18	5	0.75	10	
Some pickers were impolite	Soc6	4	2	4	2.00	20	3	4.00	16	5	1.00	9	
Local pickers helped to the forest when required (wildfire, snowstorm)	Soc7	5	4	5	4.00	21	4	3.50	18	5	1.00	8	
Controlling pickers in this forest is complicated	Soc8	4	4	4.5	1.75	18	1	4.00	18	4.5	1.00	10	
Some pickers parked the car in a wrong manner	Soc9	4	4	3	3.00	21	4	2.50	19	4.5	4.00	10	
Commercial pickers didn't ask the landowner for permission	Econ1	5	0	5	0.00	9	5	0.00	14	5	0.00	4	
Commercial pickers didn't gratify landowners	Econ2	5	0	5	0.00	7	5	0.00	13	5	2.00	3	
Pickers benefited from the forest without contributing to its maintenance	Econ3	5	1	5	1.00	21	5	2.00	17	5	0.75	10	
I trust on marketed mushrooms	Econ4	5	1	4.5	1.00	14	5	0.00	14	5	1.00	7	
Forests must be profitable and they aren't	Econ5	4	2	4	1.50	19	3	1.50	15	5	0.50	8	
Mushrooms is a underexploited asset	Econ6	2	2.75	3	2.00	19	3	3.00	17	1	1.00	9	
Locals are accomplices of grey market	Econ7	1	3.5	2	2.00	3	3	4.00	9	1	0.00	2	***
There were few income alternatives in this rural area	Econ8	3	4	3	4.00	20	4	3.00	13	3	3.00	10	
Commercial pickers aren't experts and this is a public health problem	Econ9	2	4	5	3.75	10	1.5	1.75	14	1	0.00	1	

A5.4. Correlations showing DM mental models

Table 6 – Non-parametric correlation between problem statements and policy interventions (solutions). *: significant correlations at 5% level.

Problems	Solutions	Spearman Rho coeff	signif	N
A - There was a high wildfire risk	6 - Raised funds must be reinvested in the forest	-.249	.319	18
	G - This forest required forestry interventions	.532	.023*	18
G - This forest required forestry interventions	6 - Raised funds must be reinvested in the forest	.067	.791	18
C - Forest must be profitable and they aren't	6 - Raised funds must be reinvested in the forest	.514	.029*	18
B - There was an overexploitation risk	2 - The access to the forest should be limited	-.344	.162	18
	16 - Landowners must conduct mycosilvicultural practices	.452	.068	17
D - Mushrooms were an underused asset in this area	5 - Mushrooms should benefit the local community in general (market, restaurants, hotels)	-.087	.732	18
	3 - Landowners should be allowed to put a price to pick mushrooms in their properties	.221	.378	18
	F - There were few income alternatives in these rural areas	.742	.000*	18
R - Pickers benefited from a forest product without contributing to its maintenance	3 - Landowners should be allowed to put a price to pick mushrooms in their properties	.194	.440	18
F - There were few income alternatives in these rural areas	3 - Landowners should be allowed to put a price to pick mushrooms in their properties	.195	.438	18
	5 - Mushrooms should benefit the local community in general (market, restaurants, hotels)	-.014	.955	18
E - Foreign pickers caused problems	4 - Local pickers must be positively discriminated	.278	.265	18
	18 - Foreign pickers must contribute to the forest	.261	.296	18
4 - Local pickers must be positively discriminated	18 - foreign pickers must contribute to the forest	.716	.001*	18
S - Local pickers help when needed, while foreign pickers don't do that	4 - Local pickers must be positively discriminated	.134	.607	17

H - Controlling in this area is complicated	1 - Nothing should be changed	.155	.540	18
J - Some pickers pick both small and mature mushrooms	8 - Picking small mushrooms must be forbidden	.029	.923	14
K - Some pickers destroy non-edible mushroom species	9 - Pickers must be obliged to distinguish the species they pick	.307	.248	16
L - Rakes and other tools damage the ground	10 - Stirring up the mycelium must be forbidden	.392	.107	18
	12 - Only a knife must be used	.242	.333	18
M - Some pickers use plastic bags	11 - Only wicked basket must be allowed	-.331	.179	18
N - Some pickers get lost in the forest	13 - Pickers must be obliged to not get lost in the forest	-.220	.431	15
O - Some pickers shout in the forest	14 - Shouting in the forest should be prohibited to pickers	.284	.269	17
Q - Some pickers throw trash	17 - Throwing trash must be forbidden	.568	.017*	17
15 - Commercial picking must be regulated	19 - Commercial pickers must gratify the forest owner	.576	.025*	15
U - Commercial pickers aren't experts	21 - Commercial pickers must proof their mushroom knowledge	-.136	.673	12
W - Local neighbours are accomplices of the grey mushroom market	23 - Locals should dissimulate more the grey market	.039	.910	11

6. What to do with mushroom pickers in my forest? Policy tools from the landowners' perspective

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http://cpf.gencat.cat/ca/detalls/Article/Silvicultura-72

6. What to do with mushroom pickers in my forest? Policy tools from the landowners' perspective

Abstract

Wild mushroom picking is a growing recreational and commercial activity. In Spain, wild mushrooms legally belong to the landowner, who seldom benefits from trade in mushrooms or from their recreational value. Cultural aspects (tradition, picker-related harms) and economic aspects (costly forestry works, income opportunities) constitute elements of the debate on how to deal with mushroom picking. Through a survey of private forest owners in Catalonia (north-eastern Spain), this paper examines their experiences with mushroom pickers, the factors shaping their related policy preferences and their willingness to engage in mushroom reserves.

The results show broad support for introducing mushroom picking norms. A regulation would allow outsider pickers to enter private land, but only under certain conditions, i.e. to comply with socio-ecological rules of the area. Among respondents who support the regulation, active land owners who report instances of picker-related harm (both tangible and intangible) tend to support the establishment of a fee system which could be reinvested into forest management. That is also the position of the respondents who perceive mushrooms as a private right, i.e. they believe to have a legitimate right to exclude outsider pickers and, eventually, to raise revenues from that asset. On the contrary, forest owners who conceive mushroom picking as a free-access activity prefer neither to regulate it nor to charge fees. The option to establish a mushroom picking reserve depends on the landholder being a fee-supporter and perceiving instances of harm. Harm, instead, is mainly determined by the perception of congestion of pickers, which in turn is determined by the

mushroom productivity of their forest, their level of privacy protection and their involvement to the primary sector. These findings help policymakers to better understand the logic and sensitivities of forest owners in view of designing mushroom picking policies that can effectively solve picker-landowner conflicts.

Keywords

Policy instruments; non-wood forest products; ecosystem services; property rights; wild products; non-industrial private forest owners.

6.1. Introduction

Wild forest products[24] (WFP) are gaining attention in Europe for their capability to provide tangible goods and recreational experiences (Reyes-García et al., 2015; Schulp et al., 2014). The benefits related to wild mushroom picking can be captured either by traders involved in commercial picking (Cai et al., 2011; de Román and Boa, 2006) or recreationists who pick mushrooms for their own consumption (De Frutos et al., 2009; Martínez de Aragón et al., 2011), while also generating revenues in rural areas through mycotourism (De Frutos et al., 2012). Landowners rarely benefit from this activity, though. Hence, a mismatch between WFP rights and the benefits derived is observed.

WFP-related property rights and their enforcement have increased the academic and political interest to potentially retain greater value of WFP in rural communities and to ensure the ecological dynamics, as shown by studies in Europe and North America (Bouriaud and Schmithüsen, 2005; Ginger et al., 2012; Sténs and Sandström, 2013; Tedder et al., 2002). The same parcel of land can include a diverse array of rights holders across the different dimensions of access, use (i.e. picking), management, exclusion and alienation (Schlager and Ostrom, 1992). Formally or informally, gatherers often collect WFP on non-fenced private and public land that they do not own (Laird et al., 2010), acting as *de-facto* free access and *res nullius* use rights. In sparsely populated areas with low WFP scarcity, policies guaranteeing open access may incentivise rural economies, such as the Finnish everyman's right (Rekola, 1998). However, in areas which experience high resource pressure and instances of rivalry, conflicts may emerge among pickers, or between pickers and landowners.

Limiting the people who can pick, where, how and how much they can pick – i.e. establishing clear usage rights- would lessen those conflicts. For example, picking permits or mushroom reserves such as that in Borgotaro, Italy (Gatto et al., 2009) have emerged to help to control the activity and raise revenues for local populations. Permits and licences constitute rights-based governance

[24] Hereinafter we use WFPs as synonym for Non-Wood Forest Products (NWFP)

mechanisms beyond property ownership (Ribot and Peluso, 2003). Moreover, there is evidence that open access systems without additional norms might lead to a "tragedy of the commons" of mushrooms (Pandit and Thapa, 2003), while governance arrangements show positive sustainable harvesting results both in private mushroom picking systems (e.g. Yang et al., 2009) or community systems (e.g. Brooks, 2010). Questioning the legitimacy of picking restrictions arises after traditional uses, actual fungal ecology (Arora, 2008) or potential rent-seeking behaviour of landowners.

Besides harvest rights and practices, mushroom production is driven by weather variables (mainly precipitation and temperature), on local site conditions and forest stand composition (De Miguel et al., 2014). Hence, certain forest management interventions can enhance mushroom production, i.e. mycosilviculture (Bonet et al., 2012a; De Miguel et al., 2014). Nevertheless, when making decisions, landowners will probably not take mushroom production into account insofar as they do not internalise its value (Palahí et al., 2009). It has been found that earmarking funds raised from paid mushroom picking permits to forestry is fundamental for long-term income generation, alongside the efficacy of field control (Vidale, 2012).

Modifying picking rights in private forest properties imply a governance reform entailing multiple components, namely the supply of mushrooms, an economic reward, as well as the ecological, social and market control of the picking activity. When designing environmental policy interventions in private land, landowners' preferences regarding natural resources management are crucial for their later involvement (Janota and Broussard, 2008; Moon and Cocklin, 2011). Scholars have identified different typologies of forest owners according to their management decisions (e.g. Marey-Pérez and Rodríguez-Vicente, 2011; Novais and Canadas, 2010) and the factors driving their management decisions (e.g. Domínguez and Shannon, 2011). However, little is known about the views of private landowners regarding external mushroom pickers on their properties. From an exploratory, qualitative approach, Górriz-Mifsud et al. (2015) found that landowners' policy preferences derived from

their perceptions both of picking rights and of damages caused by pickers. That study showed that forest owners who express annoyance –often linked to overcrowding- are more likely to support the regulation of mushroom picking. In addition, those who claim private rights are more inclined to support picking permits. Respondents in this group who see mushrooms as an asset also tend to support permit fees. On the contrary, those who complain less and conceive of mushrooms as *res nullius* advocate for free access or just awareness campaigns. Using these propositions as a guide, in this paper we aim to test the factors that dictate forest owners' preferences through a quantitative analysis. Our specific research questions include:

- What factors determine the willingness of owners to establish a picking fee system?
- What factors determine the willingness of owners to participate in a mushroom reserve?
- What factors determine the perception of picking-related damage and congestion?

To answer them we conducted a survey in Catalonia (Spain), a mycophilic region where forest owners hold the legal right over mushrooms, but pickers have traditionally gathered without landowners' authorisation.

6.2. Methodology

6.2.1. Case study area

This study focuses on Catalonia (north-eastern Spain), a region with 64% of its territory covered by woodlands (including open forest, scrublands and grasslands). Some 80% of the forest area is owned by non-industrial private owners, mainly of small property sizes (Fletas et al., 2012) and with a low level of management (Farriol, 2006). The region is characterized by a Mediterranean climate near the coastal area, whilst a continental climate is characteristic of central and western Catalonia, being the alpine climate typical of the Pyrenean areas of the northern zone. The forest area is dominated by conifer species (60%), being (in order) *Pinus halepensis, P. sylvestris* and *Quercus ilex* the most abundant tree species (Gracia et al., 2004). Mushroom yields follow the abovementioned geo-climatic patterns (figure 1), with

P.sylvestris in the Pre-Pyrenees constituting the most productive habitat for the mushroom species with the largest socio-economic impact in Catalonia, i.e. *Lactarius deliciosus* (Bonet et al., 2014).

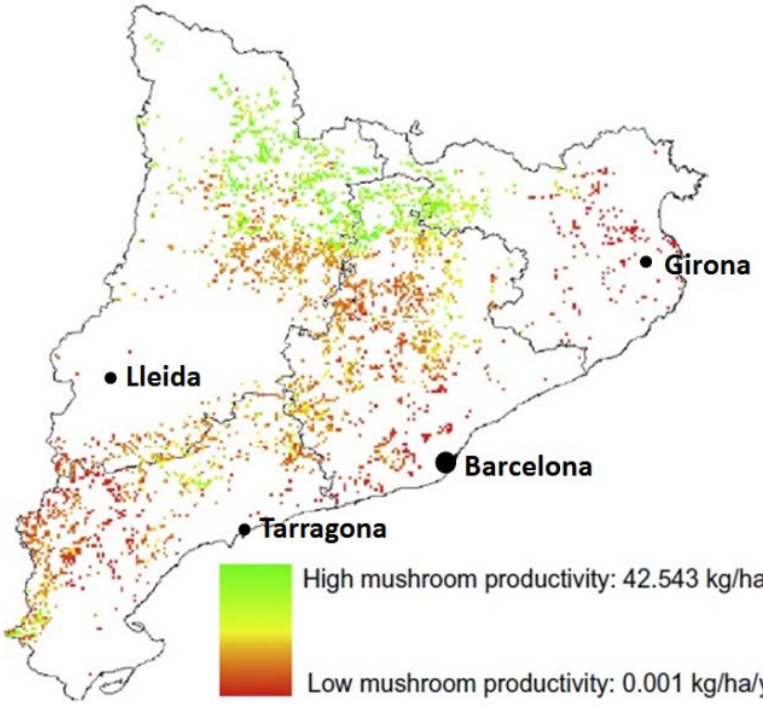

Figure 1 - Mushroom productivity map in pine forests in the four provinces of Catalonia. Adapted from De Miguel et al., (2014)

Catalonia is considered one of the most mycophilic regions in Spain (de Román and Boa, 2004). A recent large survey demonstrates that 23% of the adult Catalan population (i.e. 1.2 million people) pick mushrooms at least once a year (CEO, 2014). Moreover, Catalonia's capital Barcelona hosts Mercabarna, the wholesale market which concentrates approximately 50% of the Spanish mushroom trade (Voces et al., 2012). Still, most people pick mushrooms for their own consumption and conceive mushroom picking as a traditional recreational activity.

The Spanish Civil Code and the Forest Act stipulate that mushroom ownership is a landholders' right. The enforcement of such a right relies on formal civil rights law procedures, which are restricted by unclear control competency

(e.g. private guards), difficulties in proving guilty and low fines. Moreover, the forest property fragmentation hinders informing pickers on property boundaries and picking limitation. For these reasons, formal mushroom ownership rights are rarely enforced. Some autonomous communities provide an exception, where mushroom permit systems are established at municipal or county-level, and usually comprise public forests (Górriz-Mifsud and Bonet, 2016). Moreover, most of those permits relate to specific regional norms on mushroom picking rights, which often standardise categories of picking activities and specifications for mushroom reserve signposting. These norms provide the basis for administrative rights procedures which facilitate the enforcement of control and penalties. The introduction of a specific law for mushroom picking is an ongoing debate in Catalonia.

Previous studies on Catalan citizen views show that most people would accept the introduction of picking fees, so that pickers contribute to the forest management for improving mushroom production (Prokofieva et al., 2016b). Still, the implementation of such mycosilvicultural practices is in its infancy. Some manuals have been edited for forest owners -e.g. Bonet et al. (2012b)- but applied only in pilot zones. Regarding a picking fee, to date there is only one private mushroom reserve in Catalonia (Simoncic et al., 2013). Conversely, in other Spanish regions which have specific mushroom norms, more examples of private forest reserves exist (Górriz-Mifsud and Bonet, 2016).

6.2.2. Data collection

To ascertain the views of forest owners, a survey with 35 closed and open questions was produced (see Appendix 6.1). The questionnaire was structured as follows:

- questions about the property and the forest typology;
- a section on forest management and aspects associated with mushroom picking issues;
- a section on the owner's own mushroom use and also mushroom picking of others, and related property rights;

- preferences about policy interventions at the Catalan level, and perception of their consequences;
- their willingness to implement mushroom picking reserves, and preferred design features;
- debriefing questions.

The survey was undertaken between May to July 2015 via two means: a paper survey with a pre-paid envelope, and an online survey. This approach was taken in order to capture the views of as many forest owners (FO) as possible, owing to the lack of a comprehensive contact list of private forest owners in Catalonia. The researchers counted with the collaboration of the public agency for fostering private forest management for spreading the paper survey, while the online version was circulated among members of private forest owners' organizations.

Determining the total number of FOs contacted remains difficult, given that data privacy restrictions precluded from double-checking contact databases. Hence, it is possible that some landowners simultaneously received the magazine and email, although they were asked not to reply twice, and no repetitions were verified. The researchers took into account that some landowners probably did not receive either the email or the magazine, especially those without a management plan or who are not members of associations. We considered these forest owners to be non-motivated or absent owners, consequently without active interest in mushroom picking activities on their properties. Approximately 4,390 people were contacted, with a 10.2% response rate, equivalent to 4.5% of the private forest area in Catalonia (Table 1). Despite this low response rate, our results are significant as they form the first extensive survey of private forest owners in Catalonia.

6.2.3. Data processing

By removing four erroneous or partially answered questionnaires, we used 444 valid observations. A detailed description of all variables directly derived from the questionnaire is in the Appendix 6.2. Additionally, three new

variables were derived from the forest characteristics: distance to cities, nearest population density, and estimated fungal productivity.

Table 1- Survey sample size.

Data collection mean	Number of contacted people	Received replies	Response rate	Accumulated forest area (ha)
Paper	3,300	325	9.9%	49,302
Online	1,090	123	11.3%	21,814
Total	4,390	448	10.2%	71,116

Górriz-Mifsud et al. (2015) identified complex nuances in the continuum from private to free access rights' perception, including special treatment towards local pickers. To capture this nuance, the survey included four statements related to property rights to be assessed against a 5-points Likert scale. Transformed into a -2 and +2 scale, negative scores were given for pro-free access replies, and positive for the pro-private answers. Statement values were later aggregated to estimate the picking right perception (PRIGHT: [-8,8]). Te aggregation to compute this variable is further supported by a preliminary Principal Component Analysis (Appendix 6.3).

6.2.4. Hypotheses and statistical models

T-test was the statistical technique used to identify significant differences between mushroom regulation supporters and non-supporters. Four different regression models were used to test the research questions, namely, the drivers affecting the perceptions of forest owners regarding: (i) establishing a picking fee system, (ii) participating in a mushroom reserve, (iii) damages and (iv) picker congestion. Deducing missing data, resulted in a total number of 383, 371, 398 and 405 valid observations for the respective research questions and associate models.

For binary dependent variables (i.e. fee agreement and mushroom reserve interest), a logit model was used. An ordered logit was used for the congestion

model, owing to the categorical character of the variable. Instead, damage drivers were scrutinized by using a multiple linear regression. Backward stepwise regression analyses were used in order to find the most parsimonious model achievable for each outcome. Model results were tested for collinearity showing no major correlation among variables. Additional tests were run so as to check the specific assumptions for each of the four designs. All statistical analyses were performed using the programming software R (R Core Team, 2014; Studio Team, 2013).

6.2.4.1. Picking fee model

Regarding the first question, we hypothesize that landowners who experience more damages, are supportive of a picking regulation (REGUL) and whose property access (ACCESS) is already physically restricted –e.g. fences- are expected to be more likely to demand a fee system. On the other hand, those who hold more pro-free access (PRIGHT) opinions would be less supportive of a fee. Also, the forest owners who either work in the primary sector (PRIMARY), are active managers (i.e. have a management PLAN) or place importance on the revenue-generating function of their forest (RENEVUE), are expected to claim a payment to make their living off their land. Given that a fee would increase costs for recreational pickers, we anticipate that forest owners working in the rural tourism sector (TOURISM) would oppose it.

The model run (Table 2) considers the property size (AREA) as a fixed effect in terms of nine categories (Fletas et al., 2012:9). The ACCESS variable corresponds to the accumulative weighted restrictions, from the livestock fence, to a sign, a chain and a fence. As for REVENUE, the commercial motivation was an ordered categorical variable from 0 (not important) to 2 (very important).

6.2.4.2. Mushroom reserve model

Concerning the establishment of reserves for mushroom picking (RESERVE), we hypothesize that multiple factors could affect their support (Table 2). Large and medium-size landowners (AREA), are expected to be more capable to

establish a reserve. Respondents with larger social capital (SOCCAP) –i.e. experience in cooperation as accumulative membership in FO associations (e.g. Guillén et al., 2015), fire volunteer groups (see Prokofieva and Górriz, 2013), farm cooperatives or hunting club-, are expected to be more willing to establish a reserve in collaboration with neighbours. We propose that the remoteness of property (DIST, DISTB) is correlated to the willingness of landowners to limit access (ACCESS) to (mostly urban) pickers. Additionally, owners who identify arson by aggrieved pickers as a threat (FIRETHR) are expected to be less inclined to join a reserve (Górriz-Mifsud et al., 2015).

Table 2- List of the models applied in the analysis and their dependent and independent variables.

Dependent variable	Independent variables	Model fitted
FEE	ACCESS; DAMAGE; PLAN; PRIMARY; PRIGHT; REGUL; REVENUE; TOURISM Fixed effect: AREA categories.	Binary logit model
RESERVE	ACCESS; AREA; DIST; DISTB; DAMAGE; FEE; FIRETHR; GAMERES; MUSHPROD; SOCCAP; TRUFFLE	Binary logit model
*Ln(*DAMAGE+2) [a]	AREA; CONGES; DIST; DISTB; FREQ; PLAN; PRIMARY; TOURISM	Multiple linear regression
CONGES	ACCESS; DIST; DISTB; FREQ; MUSHPROD; POPDENS; PRIMARY	Ordered logit model [b]

[a] DAMAGE was transformed in order to achieve normality of the model residuals.
[b] Additional R package used: MASS (Venables and Ripley, 2002); VGAM (Yee, 2015).

Besides, owners of larger fungal productive woodlands (MUSHPROD) or those who have experience with similar reserve schemes –e.g. truffle or hunting grounds (TRUFFLE and GAMERES, respectively)- would be more incentivized to capture the mushroom value through reserves. Mushroom picking is usually compared to hunting and truffle picking owing to their highly dispersed and seasonal products, encompassing traditional *res nullius* rights with *usus inocui* approaches (Bouriaud and Schmithüsen, 2005). Hunting and truffle picking are

generally regulated to some degree (sometimes with associated reserves) from which the mushroom sector can extract lessons.

Finally, joining a reserve is understood as having an end goal to control potential 'bad' picking behaviour on landowner properties, as well as to potentially increase revenues. Hence, the landowner's DAMAGE perception and support to the introduction of a fee (FEE) is expected to positively influence the decision to join a reserve.

DIST refers to the kilometres from the forest until the closest province capital, and DISTB refers to the distance in kilometres from the forest until the city of Barcelona. MUSHPROD was computed based on the average productivity in kg/ha/year of coniferous habitats estimated in the region (Bonet et al., 2014). Broadleaved habitat productivity was equated to that of coniferous with similar climatic requirements.

6.2.4.3. Perceptions of damage and congestion models

DAMAGE is computed as the accumulative presence of nine listed problems perceived from pickers. The model built (Table 2) expects that landowners who visit their forests more frequently (FREQ) are more aware of damage. Besides, congestion (CONGES) of pickers is a likely driver of perceptions of damage. We also expect that forests closer to urban agglomerations are visited by pickers who are less knowledgeable about harvest practices (Górriz-Mifsud et al., 2015). As a consequence, their owners perceive more nuisances. As instances of damage tend to affect farming systems, the sensitivity of landowners to damage is expected to be higher if they make a living in the primary sector. Sensitivities may be reduced if the landowner captures recreational value through rural tourism business. Finally, being an active forest owner generally implies a specific vision on how the forest should look (Domínguez and Shannon, 2011) which may be challenged by pickers' activities.

Perception of pickers' congestion within the property is an ordered categorical variable ranging from 0 ("no" and "a little" presence of pickers), to 1 (a

"bearable amount") and 2 ("too many pickers", that is, more than what they consider tolerable). We speculate (Table 2) that the level of congestion of pickers is determined by the proximity of the forest to urban centres or population density nearby, and also by the fungal potential of the property (Górriz-Mifsud et al., 2015). Assuming that pickers usually go to forests located in their neighbouring municipalities, population density (POPDENS) was assigned at the level of the county where the forest is located, based on data from the Catalan statistics institute (www.idescat.cat).

Furthermore, the sensitivity of forest owners to the presence of outsiders is thought to depend on the efforts employed to restrict access to their property, i.e. showing a higher value for their privacy (Janota and Broussard, 2008). Working in the primary sector would decrease landowners' acceptance of externals in the land, therefore being more sensitive to the frequency of pickers' visit.

6.3. Results

6.3.1 Descriptive data of survey respondents

Respondents were predominantly men (87%), typically middle-aged (60%) and the majority had a university degree (60%). Only 5% make a living exclusively from forestry, while another 24% combine forestry with other activities, mainly with farming (Appendix 6.4).

143 ± 9.6(SE) hectares -not necessarily continuous in the field- constitute the average forest area owned per respondent. When contrasting the area structure with the reference for Catalonia, the researchers observed an over-representation in terms of forest owners who own 10 hectares or more, and in terms of the area of large landowners (over 300 ha). Smaller holders are, on the other hand, under-represented in number and in area size (see Appendix 6.5).

Our respondents are considered mostly active landowners, as 79% have a forest management plan of their property. Interestingly, the potential source of

revenues from timber, cork or fuelwood is scored on average as barely "important". By far, the most important factor when making forestry decisions is the risk of wildfires (selected as "very important" to 74% of the respondents), with 40% of the respondents having experienced a fire on their property. The maintenance of the landscape beauty and the moral task of conserving the family patrimony were seen as "very important" aspects to half of the sample.

In terms of social capital, 66% of the respondents belong to a forest owners' association. Participation of respondents in the local group of fire volunteers is also quite common (56%). Regarding access infrastructure, most respondents do not limit public access to their forest. One-third of respondents have barriers in place to restrict motorized access, 19% have livestock fences, 4% have a fence and 15% have signposted the property. These are grounded respectively on the conservation of road status, the cattle and game control, or securing their privacy.

As main forest habitats, the main reported broadleaved and coniferous trees are *Quercus ilex* (61%) and *Pinus halepensis* (31%). By far, the most mentioned mushroom species is *Lactarius deliciosus* (present in 76% of the respondents' forests), followed by *Cantharellus cibarius* (43%). Almost all respondents pick mushrooms for their own consumption, with only 2% for commercial use and 4% to be used in their food services businesses. Yet, only 20% consider mushroom picking to be "very important" when making forest management decisions, and 39% consider mushrooms as a potential source of income. In terms of who is considered as legitimate to raise revenues from mushrooms picked in their forests, only 15% of landholders are against local commercial picking activities, while 17% oppose forest owners becoming wealthier due to mushroom-related business.

Almost all respondents report instances of external mushroom pickers entering their properties. Over half (60%) consider that current picking processes are harnessing the fungal resource. Approximately one-fifth (22%)

of the respondents want to restrict mushroom use for themselves; hence the rest would accept this use by outsider pickers (Appendix 6.5). Overall, 64% do not accept that anyone picks in their property. This ratio decreases to 41% when it is specified that pickers follow good harvesting practices. Finally, over half of the respondents (56%) do not feel comfortable with limiting the traditional activity.

6.3.2. Forest owners' perception on mushroom picking regulation

This study provides evidence of a "nested" model on how forest owners develop their preferences on policy tools, as shown in Figure 2.

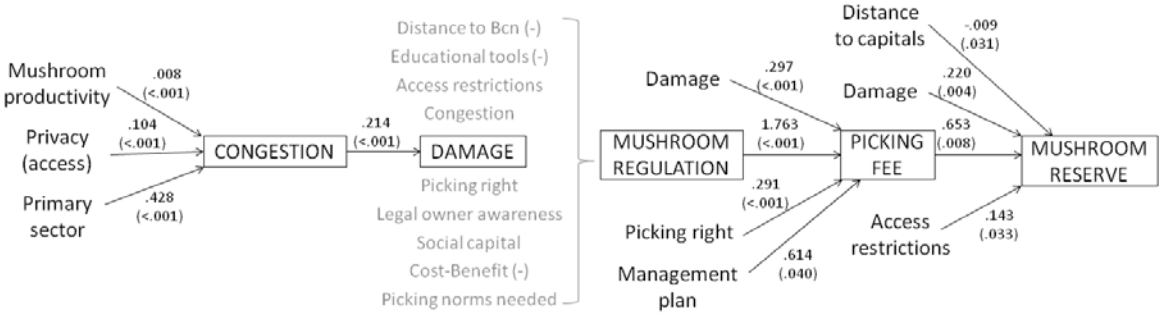

Figure 2. Summary of significant factors for predicting forest owners' perceptions and positioning towards policy tools tackling mushroom picking in their forests. Grey: T-test results.

Among the respondents, 82.4% are in favour of a regulation of mushroom picking (Table 3). The t-test (Appendix 6.7) shows that respondents who support regulation have forests significantly closer to Barcelona and with more access limitations than those who are against regulation. They also experience more picker congestion and picker-related problems. On the contrary, those who do not support the regulation are significantly more inclined to support free-access rights, are less likely to be aware of mushroom legal ownership, and participate less in sector cooperation groups. Moreover, regulation supporters agree that it should define norms on how to pick and believe that it will improve the sustainability of mushrooms as a resource. Respondents contrary to the regulation advocate instead for educational tools and tend to believe that increased regulation will bring about more costs than benefits.

Table 3 – Respondents' positioning (%) towards the policy intervention statements.

Policy intervention statements (N=433)	Agree	Indifferent	Disagree	Not answered
I support the regulation of mushroom picking, in general	82.4%	9.7%	6.0%	1.8%
A permit or authorisation is a good idea	74.6%	12.9%	9.2%	3.2%
Picking must include a payment	58.2%	22.2%	15.0%	4.6%
Related raised funds should be reinvested in forestry	83.8%	7.6%	5.8%	2.8%
The regulation must include norms of how to pick mushrooms	81.3%	11.3%	3.7%	3.7%
The amount of mushrooms picked has to be limited	61.9%	27.3%	6.7%	4.2%
Regulating isn't needed; education is what's needed	34.1%	15.3%	43.6%	7.0%

6.3.3 Forest owners' support of a mushroom picking fee

Over half (58%) of the total respondents supports the establishment of a picking fee (Table 3). Regarding the second research question, the binary logit model (Table 4, Figure 2) shows that the inclination towards the mushroom regulation is the strongest factor in explaining the preference for a picking fee (5.83 times more than those against or indifferent to a specific regulatory framework). Confirming our hypotheses, forest owners who report more damage, who view mushroom picking as a private right, and who have a forest management plan in place are significantly more likely (1.35, 1.30 and 1.87 times respectively) to advocate a payment system for mushroom picking. On the other hand, respondents who perceive of mushroom picking as a public right are significantly less likely to demand the implementation of a fee. Working sector of the respondents or access restrictions do not significantly affect the fee positioning.

Table 4 - Results of the binary logit model on forest owners' picking fee drivers.

Independent variable	Estimate	z value	Odd Ratio	95% CI	p(>|z|)
Intercept	-2.150	-4.518	0.12	0.04; 0.28	<0.001***
DAMAGE	0.297	3.512	1.35	1.15; 1.60	<0.001***

PRIGHTS	0.260	5.823	1.30	1.19; 1.42	<0.001***
PLAN	0.628	2.016	1.87	1.02; 3.46	0.043*
REGUL	1.763	4.125	5.83	2.63;14.17	<0.001***

Starting AIC: 384.2; final AIC: 378.3. Significance levels: *** p<0.001; ** p<0.01; * p<0.05.
Cragg and Uhler's pseudo R^2: 0.448'. *d.f:* 4 and. 378.

6.3.4. Willingness to establish a mushroom reserve

Some 64% of surveyed landowners reported an interest in establishing a mushroom picking reserve with neighbouring landowners. As hypothesised, respondents who agreed with a fee system, who perceived mushroom picking as damaging, whose forests are closer to urban areas and who have more access restrictions in place, are significantly more likely to be willing to participate in a mushroom reserve (Table 5, Figure 2). Contrary to our hypotheses, the experience with truffle or hunting reserves does not significantly contribute to support the mushroom counterparts.

Table 5 - Results of the binary logit model on drivers for establishing a mushroom reserve.

Independent variable [a]	**Estimate**	**z value**	**Odd Ratio**	**95% CI**	**p(>|z|)**
Intercept	-0.051	-0.163	0.95	0.51;1.75	0.871
ACCESS	0.143	2.138	1.15	1.02;1.32	0.033 *
FEE	0.653	2.635	1.92	1.18;3.13	0.008 **
AREA	0.001	1.400	1.00	1.00;1.00	0.161
DAMAGE	0.220	2.875	1.25	1.08;1.45	0.004 **
DIST	-0.009	-2.154	0.99	0.98;1.00	0.031 *
TRUFFLE	0.482	1.600	1.62	0.91;2.97	0.110

[a] Starting AIC:455.5; final AIC 446.4. Significance levels: *** p<0.001; ** p<0.01; * p<0.05.
Cragg and Uhler's pseudo R^2: 0.168; *d.f.*: 6 and 364.

Neither the social capital of respondents appears to be a significant factor affecting their willingness to partake mushroom reserves. Nevertheless, social capital does affect their ideal intermediary entity to manage mushroom

reserves. Forest owner association is the most preferred (46%) intermediary between respondents, other forest owners and pickers. Moreover, a positive relationship between this preference and their membership is observed (see contingency table in Appendix A6.7).

The willingness of land owners to participate in a mushroom reserve is strongly related to the preference of implementing a combination of picker licenses for the entire region and a specific permit for each forest area. The support of mushroom reserves is not correlated with the support of the permit system only (see Table 12, Appendix 6.7). On the contrary, respondents who support a unique license for the whole Catalonia region are generally against the idea of joining a reserve, selecting the "indifferent" response.

6.3.5. Drivers of forest owners' perception of damage

The majority (63%) of respondents report specific instances of damages, with half of those related to rubbish. The perceptions of respondents regarding damage appears to be significantly and positively driven by the perceived congestion of pickers on the property (Table 6, Figure 2), which confirms the initial hypothesis. Instead, the distance to the closest city and involvement in rural tourism remain unconfirmed explanatory factors.

Table 6 - Results of the multiple regression model on damage perception drivers.

Independent variable[a]	Estimate	SE	t value	p(>|t|)
Intercept	0.682	0.087	7.790	<0.001
FREQ	0.024	0.014	1.740	0.083
PRIMARY	0.061	0.043	1.417	0.157
TOURISM	0.140	0.075	1.859	0.064
CONGES (=2)	0.214	0.059	3.623	0.000***
CONGES (=3)	0.567	0.054	10.454	<0.001***
DIST	0.001	0.001	1.830	0.068

[a] Starting AIC:-720.5; final AIC -725.4. Stars indicate the significance levels: *** p<0.001; ** p<0.01; * p<0.05. R^2: 0.307; *d.f.*: 6 and 391.

Using congestion as a categorical variable, the post-hoc analysis showed that all congestion levels significantly differ from one another (Appendix 6.9). Forest owners who believe that there are too many pickers on their land perceive a significantly greater harm than those who feel that there is a tolerable amount of people (Tukey: $p<0.001$), which in turn have a significantly larger harms perception than those with no or little congestion (Tukey: $p=0.001$).

6.3.6. Drivers of forest owners' perception of congestion

In terms of congestion, 49% of respondents report that they receive "too many" pickers on their estates, 29% report "a reasonable amount", 17% "a few", and 2% did not report any picker. Moreover, perceptions about congestion are unequally distributed across the Catalan territory (Figure 3). The FOs in the interior, pre-Pyrenean counties, and those very close to the capitals (with the exception of Lleida, in the centre-west) report more instances of mushroom picking on their properties than in other areas.

The model confirms the hypotheses that the congestion perceived is significantly related firstly to the forest owner's involvement in the primary sector, but also to the mushroom productivity and to the property access limitations (Figure 2). Holding all of the other variables constant, an additional unit of mushroom productivity increases the odds of having a higher congestion perception by 1.01; having more restricted access increases the odds of perceiving higher congestion by 1.11, and working in agriculture or forestry increases the odds of higher congestion perceived by 1.53 (Table 7).

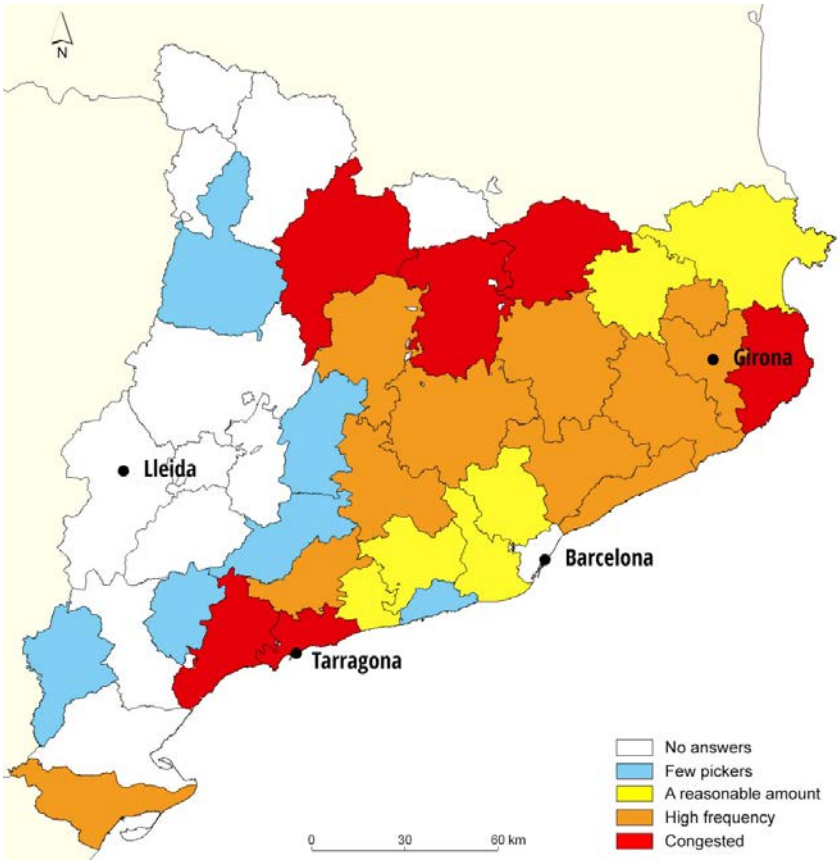

Figure 3 - Average perception of congestion per county according to the location of respondents' forest holdings. Zones without responses reflect the small ratio of forest area (predominant farmland in the centre-south) or are mostly public-owned (north). Own elaboration based on the ICC map (2002).

Table 7- Results of the ordered logit model on FOs' congestion perception drivers.

Independent variable [a]	Estimate	t value	Odd Ratio	95% CI	p(>|t|)
Cut1[b]: "a bearable amount"	-0.825	-4.806	-	-	<0.001 ***
Cut2[b]": too many pickers"	0.609	3.650	-	-	<0,001 ***
MUSHPROD	0.008	3.692	1.01	1.00;1.01	<0.001 ***
ACCESS	0.104	2.054	1.11	1.01;1.23	<0.001 ***
PRIMARY	0.428	2.206	1.53	1.05;2.25	<0.001 ***

[a] Starting AIC:819.3; final AIC 812.9. Significance levels: *** p<0.001; ** p<0.01; * p<0.05.
Cragg and Uhler's pseudo R^2: 0.073

[b] Intercepts/cut points representing the 2 different levels of the cumulative logit.

6.4. Discussion

The social and economic importance of the mushroom picking in Catalonia contrasts with the scarcity of research studies in this field. In fact, to our knowledge, this survey is the first of its type carried out in the region. That fact, together with the difficulty to contact the entire population of landowners, explains the biases in the sample. The categories of smaller forest owners were difficult to reach given their low engagement with forest management planning and with associations. However, such bias may not be critical because - contrary to our initial hypotheses- the area does not emerge as a significant variable in explaining landowner opinions in favour of policy interventions, showing the transversal character of the positioning towards pickers. This supports the research of Janota and Broussard (2008), who found no clear relation between acreage and engagement in policy instruments, or with Vedel et al. (2015) as area owned was not related to increases in claimed compensations for ecosystem service provision.

On the other hand, predominant middle-age forest owners was foreseen, given that the forest land market is not dynamic in Spain (Aunós, 2004), and land tenure is generally acquired through inheritance. The high rate of involvement in associations and their active management was also expected given the contact means employed. While this may be seen as a bias, these subgroups are actually those with more probabilities to constitute a critical mass and most likely to spearhead mushroom reserve initiatives.

The high rate of own mushroom picking of landowners is a novel finding and largely exceeds the average practice by the general Catalan population. Hugosson and Ingemarson (2004) reported mushrooms as one of the utilitarian motivations of Swedish small forest owners, without quantifying them. The importance ratio assigned by our respondents to mushroom fits with that of a Swedish survey, barely achieving the "important" level (Lidestav and Arvidsson, 2012). This relevance level is likely linked to the low implementation of mycosilvicultural practices and the low engagement of landowners themselves with the commercial use of mushrooms. Forest-related

revenues seem to play a minor role on average. Instead, the stimuli of our sampled forest owners to manage their properties are the wildfire threat, the maintenance of the family patrimony and the landscape aesthetics.

6.4.1. Harvesting rights and mushroom regulation

Some forest owners are not comfortable with granting access to pickers for fear of damages on their land (Shumsky et al., 2014). The survey analysis confirms that FO preferences regarding the portfolio of policy interventions addressing wild mushroom picking are mainly driven by the perception (i) that pickers constitute a nuisance in their forests, and (ii) of pickers' rights and duties (Górriz-Mifsud et al., 2015). With evidence of nuisances, most respondents support regulation aimed at enforcing good picking practices. This regulative approach is consistent with the opinion of the overall Catalan population (70% in favour), and pickers in particular (64% in favour) (CEO, 2014). It can be then interpreted that the traditional free right is legitimated by effective informal norms. That effectiveness –and ultimately the traditional right- becomes challenged alongside the current context of non-respectful pickers, though. This trend may be well occurring in countries with similar urban foraging patterns. Picking rights –and ultimately the ability to benefit from natural resources- are thus dynamic, and their adaptation to evolving social processes reflects changing needs and values (Duncan, 2002; Ribot and Peluso, 2003) with a political and technical debate underway. From the policy-maker perspective, it is hard to intervene in the perception of rights. Yet, new right-related demands can be channelled through reforming formal rights. Moreover, acting on damages is a controllable variable by means of limiting picking practices.

From the responses regarding property rights, we confirm the presence of two opposing views (namely, free or private rights to pick) with intermediate positions. As expected, pro-free access rights are rather detractors of regulating mushroom picking whereas supporters show more pro-private harvest right conception. In general, forest owners are ready to accept outsider pickers on their properties (i.e. allowing the tradition) until certain

(subjective) tolerable amount and only if they follow good practices controlled through a regulation. These results resemble the findings of Acheson (2006) in Maine (USA), where private landowners "*think to have the right to keep the public off their land, but they also feel that landowners should not exercise these rights unless forced to by very irresponsible behaviour*" given the open land tradition (Acheson, 2006:24). From the landowner's viewpoint, reformulating picker rights and duties would resolve some of the conflicts between seasonal, extractive forest users and themselves, who take care of the land with a longer term perspective.

Respondents who defend a free access right seem willing to protect the tradition as part of the (rural) Catalonian lifestyle. That view submits landowners with privacy perceptions to guaranteeing the access to the picking practice. This positioning compares with the everyman's right approach, which prevents landowners to restrict access as they consider more appropriate. Yet, everyman's right is also creating conflict in some areas, usually related to newcomers and their behaviour, e.g. Finland -Richards and Saastamoinen (2010)- or Sweden -Sténs and Sandström (2013). On the other hand, Catalan landowners have in principle the legal basis (i.e. civil code) to restrict mushroom pickers in their forests. However, our sample shows the willingness of some forest owners to exert their legally recognised private right over mushrooms but lacking the capacities to enforce it. Issuing a specific governmental regulation would help on clarifying infractions and related control and penalties, lowering FOs constraints to act.

6.4.2. Picking permits and mushroom reserves

While a regulation on the picking practices would be enough for some respondents, others also support stronger control of pickers through a license and/or zone permits, sometimes with a fee. Our respondents follow the logic that owners who do not wish to join a mushroom reserve prefer the control through an overall license, while those willing to join a reserve support the combination "license+permit". An apparent mismatch is found insofar as some supporters of establishing only a permit system do not necessarily want to join

a mushroom reserve. This could respond to several interpretations. Those respondents either correspond to sceptics (e.g. due to uncertain reserve conditions) or to local controversies (e.g. disagreements with neighbours). Moreover, they might also oppose to the requirement to control pickers' identity (i.e. activity license), or rather respect others' interests to establish reserves, without a personal willingness to join. This may be regarded as a generalised willingness of landholders to have a clearer framework to establish mushroom reserves, but with a voluntary joining procedure. However, maintaining decision to join a mushroom reserve at landowners' discretion might conflict with need of having all forest owners involved for spatial cohesion and efficiency reasons. For all these reasons, further exploring this trade-off is required.

Inspiring mushroom picking policy options, the hunting regulation in Spain (established in 1975) and the wild truffle picking regulation in Catalonia (established in 1993) brought about –as in many other European countries- the establishment of hunting/harvest permits, specific land management plans, and a clearer value chain relying on rule enforcement. Surprisingly, our results show that the presence of truffle or game reserves does not explain the willingness of landowners to establish mushroom reserves. The assimilation between the two is then questioned, possibly due to the degree of specialisation required: mushroom pickers need less knowledge to conduct the basic activity (i.e. just collecting the most common species), in contrast with the equipment and ability of truffle gatherers (i.e. specialised dog) or hunters (i.e. gun, checks).

6.4.3. Raising funds from mushroom picking

Expectations regarding whether pickers should contribute to improved forest management or landowner's cash flow is a separate issue to those discussed above. The introduction of a picking fee at the regional level (i.e. when acquiring a picker license) is a more debated aspect, with a higher degree of support if raised funds are earmarked to forest tending. Mistrust of the government's efficiency to manage an earmarked fee might explain the

support towards the "only zone permit" option, while the annual license constitutes a very simple measure for FOs. The combination of these partially solves the dilemma, but increases the effort required of the pickers.

Landowners tend to be willing to capture value from pickers if they are active forest owners and complain about picker-related nuisances. The status quo is seen by some respondents as a lose-win situation, where FOs bear picker-related problems and pickers do not take any clear liability. This consequently creates a latent conflict. The introduction of a harvest fee could be justified by either compensating part of the nuisance caused, improving forest conditions (i.e. mycosilviculture), or extracting net benefits from forest use. The respective underlying criteria would be (i) a "no-net-loss" for the landowner, (ii) a win-win situation for both –picker and landowner-, (iii) and a win-lose situation if the landowner exercises a rent-seeking approach.

The "no-net-loss" approach is aligned with the Pareto-optimum rationale where the fee amount is equal to the external marginal damage. Given the intangible nature of some nuisances, that amount would be difficult to calculate on this basis. Reinvesting in forestry could further benefit pickers (Palahí et al., 2009), and fits well with active foresters' search for options to cover non-profitable silvicultural interventions, typically considered as "a cost" in Mediterranean forests (Domínguez and Shannon, 2011). For example, fire prevention measures are costly while also highly relevant for forest owners and indirectly beneficial to pickers. Thus, the wide support to reinvesting mushroom-related funds in forestry would become a win-win strategy if addressed to fire prevention, or a combination of thereof with mycosilviculture. Instead, the strategic behaviour of not reinvesting in forestry, but simply extracting revenues from a spontaneous production fits the current legal framework but might raise the legitimacy debate.

6.4.4. Perceptions on damages and congestion

Forest owners more jealous of privacy and working in the primary sector are more sensitive to congestion, and hence to negative perceptions of damage.

These landowners are more prone to introduce reserve schemes. Neither the distance to urban centres nor the nearby population density significantly explains the perception of nuisances. Hence, the geographical distribution of perceived picker congestion makes us infer that there are two differentiated types of pickers: the "experts" who travel long distances to pick in very productive areas; and the "occasional" pickers, looking for an outdoor experience of wild foraging. The first group could be either commercial (and may cause more or less harm depending on their predation), or enthusiasts of the practice (e.g. belonging to mycological associations). The second group would likely travel shorter distances and are less knowledgeable of the good picking practices. Additional research on these profiles and their travelling patterns would be worth exploring (McLain and Jones, 1997; Tedder et al., 2002).

The mushroom productivity of a certain area also contributes to its perceived congestion of pickers. Introducing mycosilvicultural practices in non-congested areas would readdress pickers, but would also require the landowner to handle the possible nuisance derived from additional pickers. Having specific picking practices stipulated in a norm could then reduce those potential nuisances.

By finding that proximity to provincial capitals affects landowner willingness for reserves and mushroom productivity contributes to congestion (and indirectly to the so-perceived appropriate harvest rights) we provide further evidence for Ginger et al. (2012) biophysical argument within the general theory of access (Ribot and Peluso, 2003) that environmental conditions –i.e. resource availability- and spatial accessibility influence user access to natural resources.

6.4.5. Policy recommendations

From this study, policymakers are called to consider the explanatory variables conforming FOs positioning regarding WFP qathering policy interventions. The patterns found are likely to be valid beyond the studied region as well as for

other dispersed activities conducted by externals (e.g. illegal Fuelwood harvest, trash dumping or outdoor sports). WFP harvest rights, as part of the bundle of land use rights, constitute the institutional backbone of its governance system. Different right-based governance arrangements regarding public use of forests serve as basis for informal agreements and policy options, which suit specific socio-temporal contexts and stakeholders' constellations. From a social planner perspective, a regulation of mushroom picking should aim to generate win-win or at least "no-net-loss" situations between FO and pickers, which could be based on mushroom picking zoning or licenses, providing an impetus to define a legal framework to ensure its feasibility.

Given the heterogeneity of landowners' opinions regarding wild mushroom picking rights, a comprehensive solution would be complex. This complexity may contrast with a priori "simple" policy approaches such as the Scandinavian everyman's right; yet, the actual Scandinavian informal governance system includes several unwritten provisions with variable enforcement (Sténs and Sandström, 2013). Based on our results, a regulation could entail a portfolio of six complementary options, as follows. (i) By allowing the voluntary adscription to reserves pro-public right FOs could maintain the current open access. (ii) The introduction of ubiquitous picking norms would satisfy those willing free access but restricting harvest manners to diminish nuisances. (iii) The cession of the picking right to a third party also dealing with in-kind reinvestments would target pro-fee FOs but against small-scale reserves. This could be channelled through (iv) a paid license at the regional level –provided enough trust to public bodies-, or through (v) reserves of a minimum size –provided their related transaction costs. Finally (vi), by delineating and facilitating mushroom reserves, pro-fee and pro-reserve FOs would be better positioned to implement their income-generation right; however, it would also allow FOs with a prevailing privacy right to establish reserves without allocating permits.

While accommodating the diversity of FO demands would increase acceptance, the governance system must be prepared to deal with the consequent

implementation complexity (Prokofieva et al., 2016b). Policy tools facilitating the networking of neighbouring landowners would accelerate the development of local-level reserve initiatives, perhaps supported by an intermediary association or some entity acting as a catalyst among the different parties involved. Such aggregation is generally needed to reach a minimum geographical area to effectively introduce a picking permit.

Our behavioural modelling exercise provides an interesting (but limited) inception to disentangle and relate behavioural variables of landowners. Further exploration is recommended on the social capital aspects of landowners with regard to the in-kind rewards or the preferences for treatment towards local pickers. Yet, evidence-based policymaking requires a more comprehensive analysis which can include other stakeholders. Prokofieva et al. (2016) viability analysis contrasted pickers and landowners viewpoints with emphasis in the payment for obtaining the right to pick. Several other aspects remain still to be studied, namely: pickers' perceptions regarding landowner rights (e.g. legitimacy), the rural community approaches to picking rights, an integrative model with pickers' and forest owners' harvest right variables, the effects that policy interventions have in e.g. pickers' welfare, commercial picking, rural tourism, or in the political economy. Moreover, the policy reformulation process would probably also benefit from integrating different methodological approaches (e.g. ethnographic, economic).

6.5. Conclusions

The survey helped to shed light on private FO perceptions and policy preferences towards mushroom picking of external actors who enter their properties. Besides the broad support for the introduction of a regulation encompassing picking norms, our results show that:

- Forest owners with a management plan, who perceive mushroom picking as damaging and who are in favour of stronger private rights tend to support the establishment of a picking fee system.

- Respondents who support a picking fee, who perceive mushroom picking as damaging and who own forests in closer proximity to provincial capitals show more willingness to establish a mushroom picking reserve together with their neighbours.
- The perception of mushroom picking as damaging has been found to be related to the perception of the congestion of pickers. The FO perception of congestion is determined largely by mushroom forest productivity, the involvement of the FO in the primary sector and with a higher degree of access restriction in the forest properties.

Respondents in general call for a reformulation of pickers' rights with regards to norms dictating how pickers are allowed to undertake mushroom gathering. There is, however, heterogeneity regarding the willingness of FOs to take part in mushroom reserves and picking fee initiatives. In order to tackle conflicts over access and mushroom benefit rights, policymakers must design legal frameworks that clarify picking rights and the ways landholders can effectively modulate them. In parallel, they must also ensure that recreational and commercial picking activities can be undertaken in some areas.

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Appendix A6

A6.1. Survey questions

In the framework of the European project StarTree (www.star-tree.eu), the Forest economics department of CTFC is conducting a study of forest owners' opinions towards a possible regulation of wild mushroom picking in Catalonia. We want to collect landowners' views and statistically analyse the different factors. We aim at having all type of landowners' profiles reflected, therefore if you do not receive many mushroom pickers or is a small forest owners, your view is also interesting for us! We would appreciate your replies to the following questionnaire and send to us (scanned or post) **before ...** All data will be kept anonymous. For any related question, contact: email / phone / address

First, a bit on your forest…

1. **Which is the total area of the forest you own?** ____ hectares
2. **It's** □ in a single standalone area / □ divided into multiple separate areas: nr: ____ pieces
3. **In which county is your forest?** _____
4. **How often do you go to your forest?**
   □ I live in the property / □ every day / □ once a week / □ once a week / □ 1-5 times yearly / □ only on holidays / □ only when there are works to do / □ almost never
5. **Which are the main tree species in your forest?**

_____ / _____ / _____ / _____ / _____

6. **Do you have housekeeper (*masover*) at your property?** □ Yes / □ No

About the management of your forest...

7. **Do you have a forest management plan?** □ Yes / □ No
8. **Have you ever suffered a forest fire in your land holding?** □ Yes / □ No
9. **Mark if you belong to:** *(several options valid)*

□ a fire volunteers association / □ forest owners' association / □ agrarian co-op / □ hunting club

10. **Is there a hunting reserve in your property?**

□ Yes, private ground / □ Yes, municipal reserve / □ No, it's free hunting zone

11. When making decisions about your forest management, how do you value the following aspects?

	Very important	Important	Little important
To maintain the family inheritance as a moral task	□	□	□
The landscape beauty	□	□	□
The possibility to go for leisure	□	□	□
The potential source of revenues from timber, Fuelwood or cork	□	□	□
The animals and plants living in the forest	□	□	□
The risk of wildfire	□	□	□
The possibility to obtain fuelwood	□	□	□
The possibility to collect mushrooms	□	□	□

Regarding mushroom pickers in your property…

12. During the mushroom season, are there pickers in your forest?

□ Yes, many / □ Yes, a reasonable quantity / □ Yes, just a few / □ No / □ Don't know

13. Do you have truffle in your property?

□ Yes, wild truffle / □ Yes, I planted [inoculated trees] for truffle / □ No

14. According to your knowledge, who is the legal owner of mushrooms growing on your property?

□ Me, the landowner / □ Anyone who picks them / □ the public administration / □ Don't know

15. You or your family harvest mushrooms in your property?

□ Yes, for own use / □ Yes, to sell them / □ Yes, for our restaurant, bar or rural lodge / □ No

16. Which mushrooms would you pick from your forest?

_____ / _____ / _____ / _____ / _____ / □ Don't know

17. Have you ever restricted the access to your property?

□ Yes, a chain or gate for cars, motos, quads...
□ Yes, with a sign "no trespass"
□ Yes, with a fence so that no one can enter
□ I have a fence but for livestock, not for people; it can be easily trespassed
□ No

18. Have you ever heard about other landowners in your surroundings complaining about mushroom pickers? □ Yes / □ No

19. And yourself, have you ever had problems with pickers in your forest? *Several options possible*

□ No	□ Yes, deteriorating roads	□ Yes, leaving trash in the forest	□ Yes, making troubles with hunters	□ Yes, harvesting too many mushrooms
□ Yes, not using baskets	□ Yes, don't harvest with knife	□ Yes, breaking forest peace	□ Yes, leaving livestock fences open	□ Yes, being impolite

20. How do you agree with the following sentences?

	Completely agree	Agree	Indifferent	Disagree	Completely disagree
a. Anyone has the right to pick mushrooms in my forest	□	□	□	□	□
b. I agree with local pickers picking in my forest, but not with outsiders	□	□	□	□	□
c. Mushroom picking as it is now affects negatively the growth of mushrooms	□	□	□	□	□
d. Mushrooms are for me a potential source of income (to sell to restaurants, farmers' market…)	□	□	□	□	□
e. I want to keep mushrooms for my personal use or of my family and friends	□	□	□	□	□
f. I agree with locals raising revenues from mushrooms picked in my forest	□	□	□	□	□
g. No forest owner should become wealthier from mushrooms	□	□	□	□	□
h. I don't want to limit a traditional activity like mushroom picking	□	□	□	□	□
i. I agree with anyone picking mushrooms in my forest only if s/he follows the good practices	□	□	□	□	□

Regarding a possible regulation...

The adequacy of a specific normative for wild mushroom picking is being considered. That would specify how to organise mushroom pickers: what they can and cannot do, where and when, and would specify the infractions and corresponding sanctions.

21. Regarding this idea of regulating the picking activity, how do you agree with these statements?

	Agree	Indifferent	Disagree
I think that mushroom picking has to be regulated, in general	□	□	□
A permit or authorisation is a good idea	□	□	□
Mushroom picking should include a fee	□	□	□
The revenue from a possible fee should be reinvested in forest management of the same forests	□	□	□
The regulation has to include norms of how to pick mushrooms	□	□	□
The amount of the daily mushrooms picked has to be limited	□	□	□
Regulating isn't needed; education is what's needed	□	□	□

22. Regarding the consequences of a regulation, do you agree with these statements?

	Agree	Indifferent	Disagree
I think a regulation will improve mushrooms as a natural resource	□	□	□
I'm afraid that with a permit, mushroom pickers would be even less respectful and could provoke harms to my property	□	□	□
I'm afraid that mushroom pickers put fire to my forest	□	□	□
I think that the regulation would entail more costs than revenues	□	□	□
I'm afraid that tourists will stop coming if they have to pay	□	□	□
The regulation would be too complex (a headache) for me	□	□	□
I agree with a fee only if it's small (symbolic)	□	□	□
A payment would dissuade many pickers and there'll be less congestion in the forest	□	□	□

A possibility similar to hunting and truffle issues is that every mushroom picker would be required: 1) an annual license valid for whole Catalonia to get the right to conduct the activity, managed by the regional government, and 2) the permit for picking in a concrete forest zone, managed by the forest owner(s).
The license would discriminate between pickers for own consumptions (recreational use), and for selling. To trade mushrooms, then, a "professional" license would be required.

23. Which option do you deem more appropriate? *(choose only one option)*

I agree with a license plus the specific permit for each zone or landowner	□
Only the license for whole Catalonia has to be requested	□
Only the permit for each specific zone or landowners should be requested	□

24. Pickers would have to be required an exam of mushroom species and good practices?
□ Yes, to all pickers / □ Yes, only to professionals / □ An exam isn't needed / □ Don't know

25. Paying has to be required for the annual license for whole Catalonia? These revenues would be managed by the regional government
□ Yes, to all pickers / □ Yes, to professionals, not for own consumption / □ No need to pay /
□ Don't know / □ Yes, only if revenues are earmarked to forest management

A possibility would offer private landowners the choice to constitute "zones of reserved mushroom picking", similar to game grounds. They could be at the single holding level, or jointly with neighbouring private or municipal properties. Posting the borders of the mushroom reserve would be required. If a forest wouldn't be signposted as mushroom reserve, it'd be understood that anyone can collect mushrooms like now. In the reserves, the pickers would require a picking permit, which could entail a payment. The landowner wouldn't need this permit to pick in his forest. The reserve could be managed by an entity acting as intermediary, to whom the landowner would delegate the mushroom management. The landowner (or group of landowners) would decide the type of permits, duration, whether a fee is required and its amount, as well as the destination of the collected money.

With this proposal:

26. Would you be interested in participating in a mushroom reserve with your neighbouring landowners? □ Yes / □ No / □ It's indifferent / □ I don't know

27. Which institution would you prefer as intermediary between you, other landowners and the pickers? *(Several options possible)*

□ Forestal Catalana (public company)
□ a Forest Owners Association
□ a private company
□ regional government (Forest Serv. or CPF)
□ a mushroom picker association
□ I don't want any intermediary, I'll take care myself
□ Don't know / Don't have any preference

28. If there was a payment, it's assumed that the revenue would be used to cover maintenance costs, and the rest would benefit the landowners. About the possible economic benefits that you could get for participating in a reserve: *(choose only one option)*

□ I prefer receiving the money to be use to my discretion (monetary benefit)
□ I prefer receiving the equivalent in silvicultural improvements of my forest (non-monetary benefit)
□ I prefer that they are use for research, information and awareness raising regarding mushrooms
□ None of previous, specify: _____
□ Don't know / Indifferent

29. About mushrooms for self-consumption (no professionals) in the reserves: *(1 option)*

□ I want a costless permit for locals
□ I want a cheaper permit for locals
□ I want that locals and outsiders pay the same
□ Don't know / It's indifferent

30. About pickers selling mushrooms (professionals) in reserves: *(choose only one option)*

□ I want that professionals pay more than those who pick for own consumption
□ I want that both professionals and hobby pickers pay the same
□ Don't know / It's indifferent

And some concluding questions...

22. In which sector did/do you develop your working life? *Several options possible*

□ Forestry / □ Agriculture / □ Rural tourism / □ Public administration / □ Industry / □ Construction / □ Services / □ Other: _

23. Gender: □ Man / □ Woman

24. Age: □ less than 25 years / □ between 26 and 40 / □ between 41 and 65 / □ more than 65 years

25. ZIP code of your usual residence: _____

26. Which is your latest educational level?

□ without studies / □ primary / □ secondary / □ vocational training / □ university degree

27. Other comments: _____

A6.2. Principal Component Analysis of property rights' perception

The first two components of the PCA explain 43% of the variance in property rights' statements (Figure 4). PC1 could be interpreted as the public (negative numbers) versus private (positive numbers) picking right range. PC2, instead, could be interpreted as the right (legitimacy) to benefit from mushrooms (i.e. economic gains/losses). Hence, four statements do not have economic aspects into account (PC2 near zero, see Table 8) and instead they represent the more private right (willing to keep the mushrooms for own use) confronted to the pro-free statements (not willing limitation of the activity to anyone and the condition of following good practices).

Table 8 - VARIMAX rotated matrix with loadings of the first two principal components of respondents' property right perceptions on mushroom picking in their forest

Mushroom picking right-related statements	acronym	PC1 loadings	PC2 loadings
Anyone has the right to pick mushrooms in my forest	any_ok	-0.4379	0.0275
I agree with locals picking in my forest, but not outsiders	loc_ok	-0.2233	0.4883
Mushroom picking as it's now affects negatively the growth of mushrooms	damage	0.24739	0. 5134
Mushrooms are a potential source of income for me (to sell to restaurants, local markets)	my_inc	0.2654	0.4660
I want to keep mushrooms for my personal use or of my family and friends	my_mush	0.3382	-0.0120
I agree with locals raising revenues from mushrooms picked in my forest	loc_inc	-0.2697	0.4757
No forest owners should becomes wealthier from mushrooms	norich	-0.2246	-0.2135
I don't want to limit a traditional activity like mushroom picking	nolimit	-0.4323	0.0126
I agree with anyone picking in my forest only if s/he follows the good practices	ggpp_ok	-0.4497	0.0884
Standard deviation		1.817	1.044
Variance explained		36.71%	12.12%

Other four statements move in the vertical dimension, namely in positive those seeing some economic benefit or loss (e.g. damages) from mushrooms or negative those against landowners being enriched. Economic benefits might derive from their own use (mushrooms as potential landowner's source of income) or from the use by local externals. In an intermediate position (with positive benefits but within the pro-public right) lie those allowing local pickers; this could be

understood as landowners permitting known outsiders, which gives them some intangible benefit within the local community. The well distributed nebulous of observations (Figure 4), then, shows a lack of groupings but continuity in the positioning.

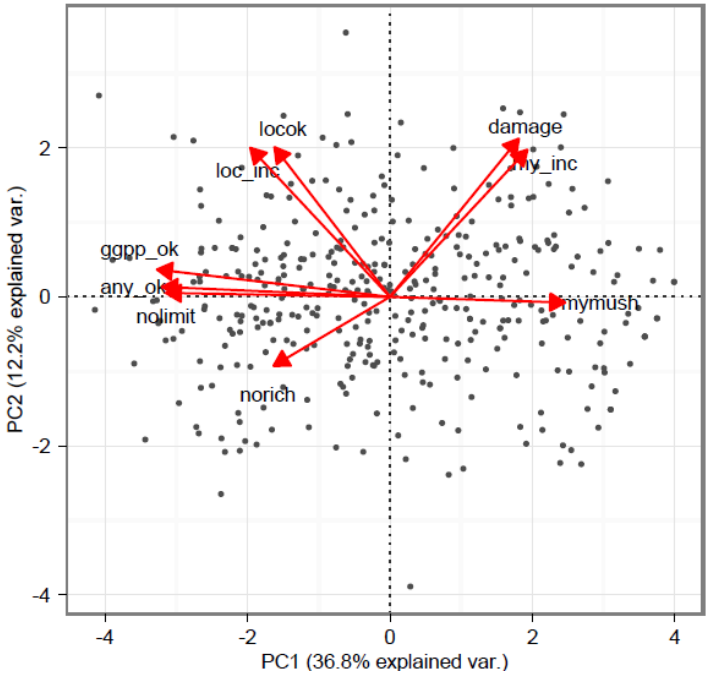

Figure 4. Principal Component Analysis of respondents' property right perceptions on mushroom picking in their forest.

A6.3. Descriptive characteristics of the sample

Table 9. Sample characteristics. Continuous variables: mean (±standard error). Categorical variables: ratio. In bold: largest group. NA: not answered.

Variables	Sample
Area (ha)	159.45 (±18.86)
Gender	**Male: 86.5%;** Female: 12.3%; both sex: 1.2%; NA: 0.2%
Age (years old)	26-40: 6.0%; **41-65: 59.5%;** >65: 33.3%; NA: 1.1%

Educational level	No studies: 0.7%; Primary: 6.0%; Secondary: 15.3%; Professional training: 17.0%; **University: 59.5%**; NA: 1.4%
Working sector	Forestry: 29.4%; **Agriculture: 33.6%**; Rural tourism: 8.1%; Industry: 12.8%; Construction: 6.4%; Services: 26.3%; Public administration: 7.1%; Other: 15.2%
Distance forest to nearest capital (km)	60.3 (±1.4)
Forest access restrictions	Chain: 30.9%; sign: 15.5%; fence: 3.9%; livestock fence: 20.5%; **No access limit: 46.6%**
Pickers' congestion perception	**Many pickers: 48.6%**; acceptable amount: 28.9%; a few: 17.3%; no pickers: 2.5%; don't know: 2.7%
Picker-derived damage perception	No problems: 36.9%; Road deterioration: 18.4%; **Trash: 53.0%;** Troubles with hunters: 10.8%; Overexploitation: 18.9%; No basket: 8.3%; No knife: 15.0%; Peace broken: 19.6%; Livestock fence: 22.4%; Unpolite: 28.3%
Edible mushroom species present in their forests	***Lactarius deliciosus*: 76.4%;** *Cantharellus lutescens*: 30.3%; *Boletus edulis*: 18.7%; *Craterellus cornucopioides:* 15.7%; *Higrophorus spp.*: 40.9%; *Tricholoma terreum*: 41.8%; *Cantarellus cibarius*: 43.4%; *Amanita cesarea*: 23.3%; others: 61.2%; don't know: 6.0%; NA: 2.1%
Own mushroom use	**Family use: 87.0%**; Trade: 2.0%; Own bar/restaurant: 3.6%; No use: 10.5%; NA: 1.9%
Experience in cooperation	Members of: **Forest owners' association: 66.0%**; fire volunteers: 55.8%; hunters' club: 24.1%; agriculture cooperative: 15.2%
Main forest tree species	***Pinus halepensis*: 30.8%**; *Pinus nigra*: 21.4%; *Pinus sylvestris*: 18.5%; ***Quercus ilex*: 71.9%**; *Quercus pubescens*: 60.5%; *Quercus suber*: 26.6%; *Fagus sylvativa*: 10.7%; *Castanea sativa*: 7.8%; *Pinus pinea*: 9.1%

A6.4. Area distribution of survey respondents

Figure 5 shows the distribution of respondents categorised against their forest area (not necessarily continuous in the field). Their representativeness is analysed through contrasting this data with the reference of (Fletas et al., 2012). The reference is the most accurate existing data, but is just illustrative as it is based on the Cadaster data on holdings without exact landowner identification; they do not distinguish, then, whether each estate has a different owner, or one holding has different owners, or a landowner has different holdings. Therefore it is likely that the micro-owners are overestimated, as our sample states that each landowner has on average 2.21 holdings.

We hence compare the distance between the light bars (theoretical for Catalonia) and dark ones (our sample). It can be observed the over-representation in terms of number of forest owners from 10 hectares and more, and in terms of area of large landowners (over 300 ha). Micro-owners are, instead, infra-represented in number and area.

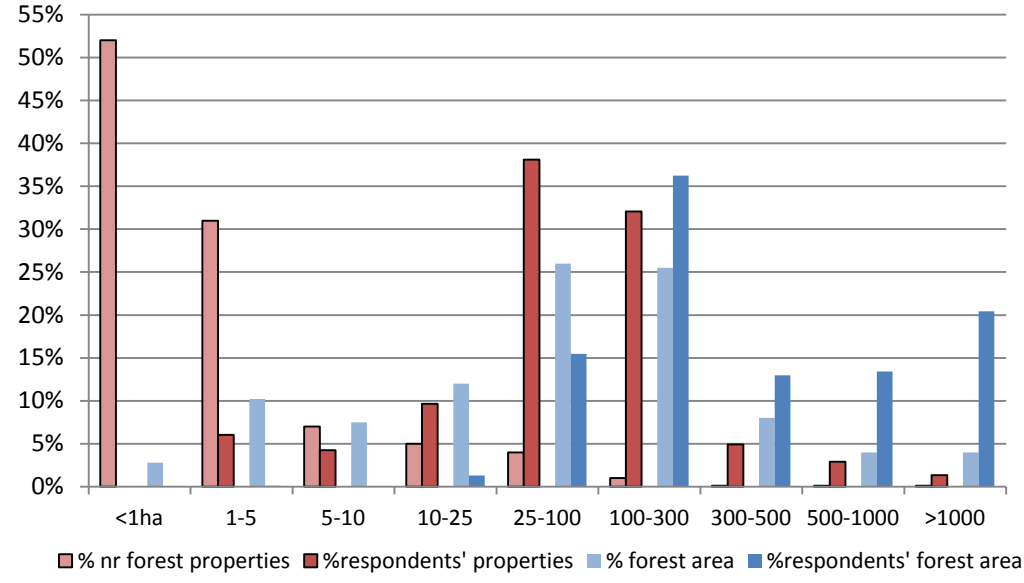

Figure 5 - Representativeness of respondent forest owners according to the size of their properties in terms of number of properties (framed) and area owned (not framed). Light bars: theoretical total for Catalonia (Fletas et al., 2012)**; dark bars: our sample.**

A6.5. Respondents' perception of mushroom picking-related rights

Figure 6 summarises the perceptions regarding the diverse array of property right dimensions. 64% does not agree with anyone having the right to pick in their property; this "refusal" ratio decreases to 41% when specified that those pickers follow good harvesting practices, and to 32% if pickers are locals.

39% consider that mushrooms constitute a potential source of income. In terms of who is considered as legitimate to raise revenues from mushrooms picked in their forests, only 15% are against local commercial pickers, while 14% consider incorrect that forest owners make business from their mushrooms

Over half (60%) of the respondents consider that current picking processes are harnessing the fungal resource. 22% of the respondents want to restrict mushroom use for themselves; hence the rest would accept this use by outsiders. Finally, over half of the respondents (56%) do not feel comfortable with limiting such traditional activity.

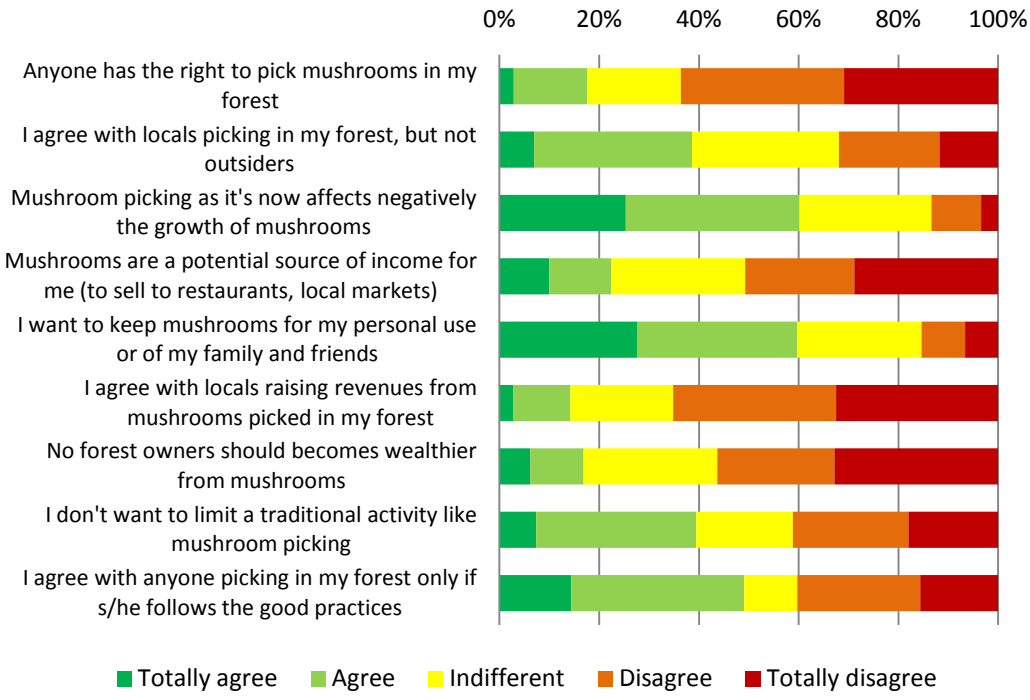

Figure 6 – Distribution of property rights' perception across survey respondents.

A6.6. T-test on the support to a mushroom picking regulation

Those who support the regulation are statistically significantly closer to Barcelona, have more access limitations, perceive more congestion and picker-related problems, conceive more private rights over mushroom picking, show higher awareness of the legal ownership of mushrooms, and report larger cooperation experience. Moreover, those who support the regulation also agree that it should define norms on how to pick and believe that it will improve mushrooms as a resource. Respondents contrary to the regulation advocate instead for educational tools and tend to consider that the regulation will bring about more costs than benefits (Table 10).

Table 10 – Significant differences between variables affecting the preference towards a mushroom picking regulation resulting from the T-test.

Means for each variable (standard deviation)	In favour of regulation	Against regulation	T-test significance
Nr. respondents	356	26	
Age group *(1:>25, 2: 26-40, 3: 41-65; 4:>65)*	3.25 (.30)	3.08 (.128)	
Time from forest to Bcn (minutes)	80.13 (1.095)	90.04 (5.617)	**
Educational level (0-5)	4.33 (.054)	4.17 (.253)	
Forest area owned (ha)	201.88 (36.15)	52.62 (36.14)	
Fungal productivity *(0-199 kg/ha*yr)*	36.67 (2.59)	24.72 (7.45)	
Frequency of visit to the forest *(0-7)*	5.37 (.079)	5.04 (.406)	
Working in the Services sector	.26 (.024)	.25 (.090)	
Having a management plan *(presence: 1, absence: 0)*	.80 (.021)	.62 (.097)	
Regulation should include picking norms (0:disagree; 1:agree)	.90 (.016)	.57 (.106)	***
No regulation but education is needed (0:disagree; 1:agree)	.36 (.024)	.88 (.060)	***
Regulation will improve the mushroom resource (0:disagree; 1:agree)	.82 (.021)	.04 (.038)	***
Regulation will be more costly than revenues (0:disagree; 1:agree)	.23 (.23)	.84 (.075)	***
Access restriction infrastructure (0-10)	1.73 (.108)	0.81 (.283)	***
Perception of congestion of pickers in the property (0-9)	2.34 (.043)	1.58 (.225)	***
Perception of picker-related problems	2.18 (.107)	.56 (.245)	***
Perception of property rights *(-8: open access, 8: private right)*	1.42 (.178)	-2.68 (.660)	***
Knowledge of legal mushroom ownership (0:no; 1:yes)	.73 (.023)	.50 (.100)	**
Social Capital (*nr of membership)*	1.41 (.051)	0.92 (.191)	**

A6.7 Contingency tables

In the event of a possible mushroom reserve, Table 11 shows the cross-tabulation between the preference of having a forest owners' association (FOA) as intermediary between other forest owners and pickers depending on the respondents' experience in cooperation with others within the rural communities (i.e. the respondent's social capital within the sector). Most respondents with the lowest social capital (without any type of membership) coincide with those not marking FOA as a preferred intermediary. Instead, those who belong to two or more associations mostly prefer FOA as intermediary.

Table 11 – Contingency table between the preference of FOA as intermediaries in a mushroom reserve and the aggregated cooperation experience.

		Cooperation experience within the sector (number of memberships)										Total	
		0		1		2		3		4			
		n	%SC	n	%SC	n	%SC	n	%SC	n	%SC	n	%SC
FOA Intermediary	**0**	55	79.7%	102	54.3%	52	46.0%	14	32.6%	5	41.7%	228	53.6%
	1	14	20.3%	86	45.7%	61	54.0%	29	67.4%	7	58.3%	197	46.4%
Total		69	100%	188	100%	113	100%	43	100%	12	100%	425	100%

Pearson X^2: 29.905, p=.000

Table 12 shows that those preferring a combination of a license and a permit (like hunting) are in a vast majority positive to join a mushroom reserve (where the permit would apply). Half of those willing only a license for whole Catalonia are against joining a reserve, which is logic as they likely perceive as too complicated the system at the parcel level. Surprisingly, those supporting only the permit system are not necessarily willing to join a mushroom reserve; that could correspond to those who are against an overall requirement to pickers (i.e. license) and simultaneously respecting that others establish reserves but they are prefer keeping their forest of free access (then willingly keeping their forest outside the reserve system). The intermediate position of "indifferent" towards the mushroom reserve mainly fits with the preference to only require a permit; that might be explained due to specific disagreements with their neighbours.

Table 12 - Contingency table between willingness to join a mushroom reserve and preferences for policy scenarios.

			Opinion on policy scenario				Total
			Not answered	License + Permit	Only license for whole Catalonia	Only permit for each forest	
Mushroom reserve with neighbours	No	Count	21	38	58	41	158
		% within reserve	13.3%	24.1%	36.7%	25.9%	100%
		% within policy scenario	67.7%	20.4%	50.9%	39.4%	36.3%
	Indifferent	Count	4	11	13	24	52
		% within reserve	7.7%	21.2%	25.0%	46.2%	100%
		% within policy scenario	12.9%	5.9%	11.4%	23.1%	12.0%
	Yes	Count	6	137	43	39	225
		% within reserve	2.7%	60.9%	19.1%	17.3%	100%
		% within policy scenario	19.4%	73.7%	37.7%	37.5%	51.7%
Total		Count	31	186	114	104	435
		% within reserve	7.1%	42.8%	26.2%	23.9%	100%
		% within policy scenario	100%	100%	100%	100%	100%

Pearson X^2: 76.743, p=.000

A6.8 Post-hoc test on congestion categories with damage perception

Using congestion as a categorical variable, the post-hoc analysis shows that all congestion levels significantly differ from one another (table 13).

Table 13 – Post-hoc means

Means for each variable (standard deviation)	**Congestion 1 ("no" & "a little")**	**Congestion 2 ("tolerable amount)**	**Congestion 3 ("too many pickers")**	**Post-Hoc significance**
Fungal productivity *(kg/ha/year)*	12.099 (18.349)	18.189 (25.405)	24.949 (27.448)	(1-3)*** (2-3)***
Access restrictions (0-4)	1.37 (2.018)	1.27 (1.683)	1.87 (2.158)	(2-3)***
Distance from forest to closest capital *(km)*	57.835 (24.5133)	55.767 (28.5250)	63.767 (30.7306)	(2-3)***
Forest area owned (ha)	63.5765 (68.96969)	131.7386 (182.45952)	224.6616 (702.88080)	(1-3)***
Frequency of visit to the forest *(0-7)*	5.03 (1.738)	5.42 (1.432)	5.38 (1.502)	
Population density *(persons/km²)*	251.356 (331.3395)	242.674 (312.2607)	285.742 (1064.0271)	
Working in the Primary sector	.31 (.466)	.46 (.500)	.49 (.501)	(1-3)***
N	86	127	214	

7. General discussion

7. General discussion

In the following paragraphs the analytical framework and the findings of the five chapters regarding the PhD objectives are linked and such inter-relations are discussed.

7.1. On the variables at each policy phase of the mushroom picking governance reform

The first PhD objective aimed at identifying and analysing the evolution of the key elements of the governance system connected with the conception, design and implementation of the governance reform of wild mushroom picking by means of a policy mechanism (a picking permit). Inspired by local-level governance indicators (Secco et al., 2014) and institutional analysis of the policy instrument (Corbera et al., 2009; Prokofieva and Górriz, 2013), a collection of governance dimensions and elements were identified (Table 1). They encompass aspects of the policy design, stakeholder involvement, normative framework and before-after contrast. Such variables are found of outmost importance when addressing the policy phases in the establishment of a mushroom picking permit (Górriz et al., 2015). These governance variables were organised according to a relevant temporal perspective, namely the phases of a forest policy process (Krott, 2005).

Table 1 – Key governance elements identified for the mushroom picking permit and relevant policy phase. Source: own elaboration.

Governance dimensions	Governance elements	Policy phase
Stakeholder involvement	Communication Participation Power (symbolic power, opinion leaders, marginalised groups)	Formulation Conception Implementation
Policy design	Decision-makers' accountability Congruence with informal norms Legitimacy of the reform	Formulation
	Acceptance of the reform	Implementation
Normative framework	Property/harvesting rights (in-/formal norms)	Conception
	Enforcement (in-/formal control, in-/formal sanctioning)	Implementation
Effectiveness	Pre-existing concerns (awareness, diagnosis) Pre-existing pickers' behaviour	Conception

	Socio-economic-ecological outcomes Current pickers' behaviour (diligence)	Implementation
Efficiency	Participation/negotiation costs	Formulation
	Cost-Benefit analysis (implementation costs vs. permit revenues) Transaction costs	Implementation
Rural economy (market-related aspects)	Value chain coordination Mushroom added value in local economies Economic value of forests Profit margins' distribution Local employment (commercial pickers)	Conception Implementation

7.1.1. Policy design phase

The need to introduce a picking permit system stems from the need to resolve a problem and/or use a chance to improve the status quo. The problem consists in conflicts among pickers and/or between them and the forest dynamics. Such conflict resolution requires a deep understanding of ecological functioning, social structures, and stakeholder participation, as well as dynamic interactions in the specific social-ecological system (Paavola et al., 2009). In Poblet, the conception and design of the mushroom picking permit derives from the debate among the stakeholders involved. Such stakeholders were the decision-makers (DM) of the Poblet park (*Junta Rectora*), with the advice of the technical committee (*Comité de Seguiment*). The decision-making body had a diagnosis of the mushroom-related problems and opportunities, based on their perceptions, and the technical committee provided insights from the experiences in other areas, the legal and technical (e.g. forest management) framework, and the latest scientific findings (e.g. from mushroom plots, economic valuation). For the analysis, other local actors have been considered due to their potential influence depending on their positioning towards the permit (this is, potential opinion leaders), such as local politicians (i.e. affected majors not included within the *Junta Rectora*, or the county president) or economic actors (i.e. rural tourism sector or private forest owners). The three groups (*Junta Rectora*, technical committee and other relevant local actors) configure what we called the "policy network" in chapter 3 and "decision-makers" in chapters 4 and 5. The different name responds to the emphasis in network relations in chapter 3.

Chapter 5 has studied the perceptions underlying the diagnosis at the policy conception phase. The results seem to indicate that the cohesive perceptions of the decision-makers on social, (and especially) economic and environmental concerns constituted the triggering factor for the introduction of the regulation on mushroom picking. Decision-makers and local pickers were very close in their concerns regarding mushroom picking in the Poblet forest. Yet, it is found that decision-makers bring the focus more towards environmental and economic aspects, whereas local pickers are more concerned about the social and environmental issues. These perceptions stem from their own mushroom picking experience (i.e. local or traditional ecological knowledge) or by the information that reaches them through their diverse network channels. Moreover, these shared perceptions are likely transmitted through the networks of information flows among decision-makers and between them and local pickers, as shown in chapter 3. The cognitive alignment of DM and forest users entailed the generalised good acceptance of the measure.

But the alignment alone might not suffice if pickers' concerns are not translated into the policy discussion. Hence, our evidence suggest that DM were accountant in reflecting the concerns of forest users. According to the literature, cognitive alignment and accountability are deemed crucial for legitimacy and acceptance, because the disconnection leads to unsuccessful policies and even conflicts (Baral, 2012; Jedd and Bixler, 2015; McDougall and Banjade, 2015; Rantala, 2012).

Deepening on the picking rights and related behavioural norms, chapter 4 has studied their perception, their abidance and control. It is observed that a pre-existing set of informal harvesting norms existed among Poblet local pickers. Evidence of informal control and sanctioning has been found, but seem to be valid for the members of the rural communities. These results confirm the pre-existing self-organisation of the forest resource users by devising their own rules (Ostrom, 1999). Foreign pickers are perceived not to follow those good practices, introducing an element of disequilibrium to

the local socio-ecological system. According to Ostrom (2009), this is attributed to the high discount rate of foreign pickers, and their diffuse resource boundaries in contrast with those of local pickers. The discount rate of foreign pickers is higher than recreational local pickers because their preference for immediate benefit, owing to their uncertainty about when they will go picking again and whether that occasion would be as good as the present one. Instead, Grima and Berkes (1989) (in Cole and Ostrom 2010:28) suggest that resource users who live in the same area for a long time do not heavily discount the future harvest because they have more chances for (good) harvests due to their proximity to the resource. Moreover, local pickers recognise and identify themselves with the Poblet forest boundaries, whereas mobility of outsider (chiefly urban) pickers is high, with the consequent differential attachment to the forest and its elements. The perception of local, rural inhabitants behaving in line with the informal norms and blaming externals for their disengagement has been reflected also by other scholars (e.g. Shumsky et al., 2014).

7.1.2. Policy formulation phase

Once the process for the governance reform is launched, the policy formulation phase is the period where power and politics can play a stronger role. Which policy alternatives are discussed, who is actually involved in such a discussion with which power relations constitute the key legitimacy variables at this stage. There was no explicit and open participatory process, but a set of informative sessions in the affected municipalities. Hence, the participation or negotiation costs were kept negligible. Yet, the participation took place at the regular bodies of decision-making of the park, whose legitimacy has no evidence of being challenged. As put forward by Corbera et al. (2007:589), "*legitimacy refers to the way in which outcomes are negotiated, administered and accepted by stakeholders and encompasses issues such as 'the recognition of stakeholders, the acknowledgement and hearing of their concerns, the participation of stakeholders in decision making, and the distribution of decision-making power' (Paavola 2003:8)*". To analyse stakeholder involvement, Chapter 3 has scrutinised the network relations

during the period of the permit design. Chapter 5 has examined the mental models of decision-makers, which would underlie the policy options. The interviews report a feeling of completeness of the decision-making network was felt complete, with no opinion leaders missing from the discussion platform. Missing actors in the debate (two affected mayors, or the rural tourism) has not been perceived as discrimination given the informal communication and collaboration between the park and them. This inclusion or bringing their voices into the official platform for debate is a crucial step to ensure legitimacy of the outcomes and to avoid a design that benefits some elite while marginalising the viewpoints of not represented (De Vente et al., 2016; Ishihara and Pascual, 2009). Moreover, the use of social network analysis at this stage illustrates the potential power relations. It uncovered the powers that be, which act as opinion leaders and influential actors within the decision-making network. However, the interviews did not reflect evidence of conflicts and instead respect and goodwill is perceived towards these actors. It could be argued that this is a government-led paternalistic type of participation which may affect the outcomes (Glicken, 2000); yet, we believe that the interviews were conducted in a formal but open manner which allowed expressing conflicts, if any, and specific questions on the negative reactions were posed.

A sustainability principle for socio-ecological systems is that users of natural resources devise the management rules, which requires less efforts if they share knowledge of the ecosystem components and dynamics, as well as the effects of management actions (i.e. harvesting) (Ostrom, 2009). For the purpose of this study, such cognitive aspects have been conceptualised as the "mental models"[25] through which individuals understand their environment (Denzau and North, 1994). Mental models then connect the diagnosis

[25] The term "mental model" is understood as covering both the more individualistic approach to perceive the environment, but also affected by the information connections. Hence, our approach could be also partially considered as "cultural models" insofar as they interpret the reality both grounded on experience and learning, but with a strong component of the society in which one is embedded, with whom the cognitive structures are shared and often publicly instituted (Guillet, 2000).

(environmental, social or economic concern) with the (so-conceived) preferred solution. The results show statistically significant mental models among decision-makers in all sustainability dimensions, e.g. environmental aspects (the need for wildfire risk management), social aspects (the prohibition of throwing trash in the forest), and economic-related aspects (conception of mushrooms as an asset, the different contribution by local and non-local pickers to the forest tending, or the treatment of commercial pickers).

Another crucial aspect in governance analysis is congruence (Arts and Goverde, 2006). In this study we focus on the structural internal congruence, understood as the compatibility between the behavioural norms and the contrived formal rules. The mental models found are later reflected in the permit design, and hence congruent, owing to the positive discrimination to locals, the requirement of a monetary payment to increase the realised value of mushrooms and the obligations of the good picking practices.

7.1.3. Policy implementation phase

The acceptance[26] of the policy reform by forest users is a crucial variable for its subsequent involvement in the implementation. The acceptance is found to be compound by the opinion regarding the different aspects of the policy instrument, and its analysis requires its disentangling to capture such nuances during the interviews. The interviews with decision-makers and local pickers show a generalised acceptance in the different aspects of the permit design, with a few remarks on the geographical scope of the permit and the maintenance of the symbolic price. The implemented price indeed is a political decision which does not follow the logics of payments for ecosystem services owing to its disconnection with the costs of mushroom yield improvement or to the amount of mushrooms picked (Prokofieva et al., 2016). Yet, it could be argued that the price is line with the low willingness to

[26] Acceptance stands for "the action of consenting to receive or undertake something offered" (Oxford dictionary: https://en.oxforddictionaries.com/definition/acceptance)

pay by pickers and that indeed the dissuasive effect of the price improves the mushroom picking experience as the pickers are perceived as a bit more careful now. The challenges to the geographical scope imply an upscaling of the permit (e.g. to the whole county or entire Catalonia). Such upscaling would, on the one side, exceed the administrative borders of the Poblet park and consequently the correspondent decision-makers would be more distant to local pickers. On the other side, covering with the same permit very different forest and rural areas entails using the same solution to probably different problems related to mushroom picking, this is, different congestion of pickers, forest ownership, mushroom trade, or environmental concerns. While a homogeneous permit would facilitate its administrative implementation, rural inhabitants of the diverse towns could have differential acceptance owing to the unequal adequacy to their specificities.

The degree to which the policy intervention achieves its targets assesses the effectiveness of the permit, a good governance principle (Cowling et al., 2014). Interviewees reported positive feelings in terms of number of permits issued and the lack of negative reactions. Yet, only minor improvements are perceived in the picking behaviour and stronger formal control is requested by interviewed pickers.

Interviewees have reported some degree of informal enforcement of picking norms, primarily among local pickers and regarding picking behaviour. According to crime sociologists, the perception that community control cannot reach outsider pickers with the consequent demand of formal tools would fit under the deterrence hypotheses of replacement between formal and informal rules (Grasmick and McLaughlin, 1978; Sherman et al., 1992). Yet, these theories have been also criticised by the over-socialised conception of man (Grasmick and McLaughlin, 1978). Given the confinement informal enforcement to locals and its limited reach among themselves, it appears that a combination of both formal and informal control and sanctioning might be complementary and mutually reinforcing.

The economic variables have not been studied in the Poblet case study given the weak commercial activity found. Qualitatively, we have found evidence that the productivity of mushrooms determines the chances for NWFP to be considered as a source of stable employment in rural towns (Davidson-Hunt et al., 2001; Marshall et al., 2006). The literature review proposed that the relations among agents of the value chain determines how captive NWFP providers are -ensuing a more or less unequal profits' distribution (Maso et al., 2011; Secco et al., 2009). Such profit distribution and the possibilities of added value –e.g. through some packaging or processing- in the rural areas ultimately determine the benefits the forest and the related agro-food industry mean in the local economies.

7.2. On the changes of the community relations owing to the mushroom picking permit

In line with the second PhD objective, in this section we focus on the Social Capital (SC) variables before and after the introduction of the mushroom picking permit. With SC it is aimed to analyse the individual picker behavioural variables which influence -or are influenced by- their community relations. Such variables are conceptualised according to the three SC dimensions of structural, relational and cognitive aspects (Nahapiet and Ghoshal, 1998).

To analyse the structural SC, social network analysis has been employed to quantify and illustrate the communication and collaboration flows among decision-makers (e.g. Da Re, 2011). The structural SC results confirm changes in the configuration of the network among decision-makers. The density of communication and collaboration flows during the policy formulation stage is reduced with respect to the conception phase. This is because some DM members of non-forest disciplines did not take part actively. The most central DM members maintained their position. Yet, the technical committee entered into the scene, with particular influence of the mycologist while a local NGO appeared as facilitator. Their positive reputation could have helped in achieving an agreement in the permit

design. These reference individuals seem to act as opinion leaders, like Schlüter and Koch (2009) reported for the technicians of private forest owner associations providing advice to their members, where the forest owners end up adopting their mental models. The implementation stage increases the density of relations among DM due to new formal competences but also due to new informal relations.

Evidence has been found of small improvements in trust owing to the permit introduction. Such trust changes are justified by the fee and potential control filtering pickers and strengthening the good picking norms. A conspicuous remark is the methodology employed, which has been simple (two Likert-type questions) but effective to reflect both the radius of trust and the evolution of trust along the policy process.

In terms of norms' enforcement, attention is paid to the degree of pickers' behaviour in accordance to the new community norms. We searched to which degree collective action occurs with respect to the picking practices and permit, and whether there is perception of improvements regarding the pre-permit concerns. Interviewees report slight improvements in trash in the forest and in the lower use of soil-damaging tools. This limited perception of improvements might be attributed to the relatively new introduction of the permit, but also to the weak formal enforcement.

7.3. On forest governance and social capital interlinks

Analysing the potential relationships between social capital in rural communities and the governance variables of the mushroom permit has constituted the third PhD objective. Through the literature review some theoretical and empirical propositions relating governance and SC elements were encountered. Additionally, we put forward new inter-relations into the model which were based on a deductive reasoning. Two typical SC perspectives were integrated in the model due to the relevance of their potential interaction with the governance variables. The first analytical challenge was the "chicken-and-egg" question of SC. Next, the analytical level

had to cover both the micro-level (individuals) but also the aggregated meso- (communities) and/or macro-level (i.e. aggregation of communities, being supra-municipality, region or country).

Putting social relations at the core, the chicken-and-egg question implies that scholars find SC as an input but also as an output (Plummer and FitzGibbon, 2007). This is, SC can affect people's behaviour as part of their context, but also policies and people's actions can modify SC. The proposed model adopts a temporal perspective in the attempt to better reflect the result-chain and thus disentangle which aspects are relevant in one or another direction at each policy stage. Yet, at the empirical level it is difficult to state the cause-effect direction, but at least we find significant correlations.

To analyse the relations among the community of mushroom pickers which affect the governance, communities were conceptualised as networks. This network approach to SC allows looking at the network processes from the node (i.e. individual) or the whole network (i.e. community) viewpoints. SC texts refer to SC as an asset of the individual imbued in a community (micro-level), as a community asset (meso-level), or even at the region/country level (macro-level). The macro-level is out of our concern, as it refers to political networks and general trust levels which are more difficult to be influenced by the individual forest user. At the individual level, game theory would explain the rationale of cooperation, by developing a reputation through repeated interactions, which helps emerging norms of reciprocity and (mis)trust (Ostrom and Ahn, 2009). SC is then highlighted for influencing the typical short-term, self-regarding criteria in decision-making within a community, understanding the community as a group whose members interact recurrently. The community level, instead, refers to the features and dynamics as collective organisation, and hence social network analysis provides insightful indicators.

Taking these SC aspects and other forest governance variables into account, our proposed model puts forward key interlinks between SC and

governance, with norms and networks bridging the two fields at each policy phase (chapter 2). We suggest that cognitive SC drives the need of a governance reform at the conception phase, such as the introduction of a policy instrument. The structural SC at the design phase would shape how the decision-making process takes place, for example with explicit participatory processes or communication channels through which users' messages can reach the decision-makers. The relational SC refers to the changes required of the behavioural norms, and to the trust posed on forest users implying (in)formal control during the policy implementation. In the case study analysis, evidence has been found for parts of the proposed model, as explained in the following for the three analytical levels.

7.3.1. At the aggregated level (i.e. macro)

The aggregated level encompasses the analyses for the whole Poblet park, joining the data from decision-makers and pickers from the four towns. During the conception phase of the policy tool, we find evidence of cognitive SC alignment between locals and decision-makers in most mushroom-related problems, chiefly regarding the need for forest tending and good picking practices. There is also statically consistence in some mental models of decision-makers. Of particular interest are the linking ties between mushroom pickers and the decision-makers (chapter 3). The popularity index shows that local pickers are proximal to members of the policy network with medium-high influence during the conception (and also design and implementation) phase. To our knowledge, this is a key contribution, given that so far the structural and cognitive SC dimensions of the policy processes have not been examined through the social network analysis perspective. The cohesion in structural and cognitive SC aspects is probably indicating the "community of place" that encompasses both pickers and local DM for the fact of sharing a geographical residence area (Nasar and Julian, 1995). Moreover, it could be interpreted that the evidence of proximity and cognitive alignment implies (i) the identification of the need of the government to act to satisfy most concerns, (ii) a link between the local ecological knowledge and the norms of how to behave in the forest while

picking, and (iii) an adequate consideration of pickers' preferences within the decision-making group, resulting in the high degree of acceptance observed. Altogether indicates a synergetic effect of the different SC dimensions: cognitive with linking SC and relational SC.

We put forward that the cohesive networks at the formulation stage, and the positive trust levels helped reducing the transaction costs and permit participative process with relatively low efforts. Yet, this point needs to be contrasted with other areas where local networks include very divergent subgroups (in terms of values, paradigms). While the data collection here presented has not reflected further cases, the PhD candidate participated as an observer in some of the local debates to replicate Poblet system in three other areas of Catalonia, and gathered some evidence of local opinion leaders spreading divergent messages which blocked the processes[27]. Such possible strong networks against the initiative would deserve further research to analyse their potential consideration as negative SC, a failure in the stakeholder participatory process, or rather as an adequacy to the local context.

7.3.2. At town level (i.e. meso)

Holding the legal and cultural context, no similar case studies were found across Catalonia to compare with. Therefore, the town level was analysed treating the municipalities as different cases. The four towns differ in the engagement of their inhabitants in the permit, with the smallest town in the plain (Vimbodí) showing the larger ratio of adults involved, which progressively reduces towards the county capital. Moreover, that trend was constant in the three considered seasons. Hence it was initially considered that such rural-urban gradient could stem from different SC in each town. Unfortunately, the low engagement of the pickers from the smallest town in the mountains (Prades) precludes from an additional observation. We can

[27] From local press: at Els Ports: http://www.diaridetarragona.com/ebre/29649/oposicion-frontal-de-los-alcaldes-al-carnet-del-boletaire-en-els-ports and at el Ripollès: http://www.ripollesdigital.cat/15911

speculate that Prades' low engagement derives from the lower connection of its inhabitants to the park and its vast alternative forests without permit requirement.

The results, however, partially confirm this assumption: a preliminary relation is found between social structures and differential pickers' engagement, whereas the cognitive and relational SC variables did not show that clear trend. The cognitive aspects at town level do not explain the differential number of permits. Hence, local pickers could act as a single hermeneutic community, whereas permit uptake responds to other factors. Significant differences are found in pickers' bonding and bridging SC across the involved municipalities following a urban-rural gradient: it is found stronger cohesion and more bridging links the smaller is the town. A rather constant finding across SC dimensions was that Vimbodí pickers (the smallest town in the plain) show more extreme figures when compared to Espluga and Montblanc, which are closer to each other. For example, relational aspects of outgroup derogation, reputation and community pressure play a stronger role in the smallest municipality. According to urban-rural sociologists, these results epitomize the *Gemeinschaft* relationships typical of rural areas –traditional societies featured by mutual helping ties and family obligations-, in contrast with *Gesellschaft* relations in rather industrialised, urban zones –of individualistic nature, based on functional contracts and agreements (Tönnies, 1940). Previous scholars, however, already challenged this dichotomy, suggesting a continuum for these changes along suburbs and sprawled cities (Bell, 1992). The evidence of the three studied municipalities in Poblet area supports the continuum construct, more palpable for the smallest analysed town.

The questions on confidence in decision-makers, on information, and on negative reactions provide evidence of the lack of negative aspects of SC, such as blockage, corruption or patronage. Some past conflicts were reported by pickers of the time of the Poblet park establishment due to restrictions to the motorized road access or hunting limitations. Yet, when

asked about trust in the decision-making body, it was clear that the reputation is positive or neutral. Potential controversies were not found with regard to the monastery, to mayors (with two exceptions, which seemed to be a personal conflict), or to the park directorate. On the contrary, pickers showed pride when reporting their acquaintance with them.

7.3.3. At individual level (i.e. micro)

At the policy conception phase, individual cognitive factors do not relate to the permit acceptance. However, we find evidence of knowledge spread factors: mushroom literacy relates to family learning and proximity to decision-makers. Besides, the pickers' network plays a role insofar as it increases the requirement of profitable forest management.

Regarding relational SC, pickers' replies confirm the presence of a radius of trust between pickers from the same town, the neighbouring towns and outsider pickers (Fukuyama, 1995) and shows the ingroup bias (Brewer, 1999). Differential behavioural perceptions between local and non-local – especially urban- pickers underpin this gap. Beyond the community of place, this sense of "rural identity" assimilated to good picking practices and the largely shared and transmitted cognitive aspects could indicate that local pickers constitute an implicit "community of practice" (Lave and Wenger, 1991), in contrast with "urban, foreign, and novice pickers". Such community of practice is likely covering not only the specific municipalities of Poblet, but a large part of the Catalonian rural areas.

Regarding the implementation phase, a diligence index is suggested and links with the permit acquisition in each town. Moreover, pickers seem to behave as peers when reprimanding others for their inadequate behaviour, but do not like to police the administrative requirement of the permit. Stronger formal surveillance is demanded, mainly from pickers mistrustful with outsiders.

7.3.4. Social capital and good governance

Finally, this study has not attempted to search whether SC contributes to good governance at local level, but some lessons can be extracted. Attending to the good forest governance principles (Cowling et al., 2014; UNDP, 1997), legitimacy is built upon a trustworthy decision-making process (Baral, 2012); transparency depends on the openness and density of the information flows across the local networks, with possible e.g. participatory processes (McDougall and Banjade, 2015); and efficiency is improved through the reduction of transaction and control costs (Chand et al., 2015). Conversely, the "dark side of SC" perspective helps to find forest governance weaknesses regarding equity/fairness - power division, corruption and patronage in rural areas, or community blockage to the entry of innovations (Wilshusen, 2009).

7.3.5. Avenues for further research

The assertions here expressed based on the empirical analysis might require to be contrasted with further and farther case studies. Further studies should contrast the adequacy of the analytical level as well. The definition of community in terms of geographical/administrative level may differ depending on the SC dimension to study. Structural and relational SC dimensions have shown divergences at the town level, whereas the cognitive has not. While this may be a particularity of the Poblet context, it may also indicate that some of the SC aspects may be better analysed at different scales.

Farther case studies would illustrate how other rural communities are positioned towards the management of the mushroom picking in their nearby forests. The empirical knowledge of the author of other zones of Catalonia, some of the pickers' behavioural aspects are similar, whereas the ecological and economic aspects depend on the fungal productivity (i.e. more frequency of pickers, and more weight of the commercial profile of pickers). It could be then investigated whether the forest cover influence the cognitive SC.

Other areas could also provide further insights on the relational SC regarding "outsider" pickers. From the forest owners' survey we find that the demand for regulation does not necessarily occur in remote areas, but also near the capitals. Hence, the mere exposition to foreign pickers allows to only realising the negative practices without chances to interact in an informal manner and transmit the social norms. Conversely, the more interchanges with foreign pickers, the large chances for alignment between both groups. Such interchange requires then both sides to be open to the relation. Otherwise, formal rules are required to avoid conflicts, being the forest guards the intermediaries ensuring the alignment of foreigners with local and sustainable practices.

Furthermore, the analyses for Poblet have been conducted in a very recent stage of the permit implementation. This has allowed for a reliable examination of the pre-permit variables, given that most interviewees were present at the three policy stages and still remembered the process. Yet, it precludes from checking the evolution or consolidation of findings. Hence, a suggestion would be the need to re-check the validity of findings after five to ten years, or analyse the same variables in areas where new policy instruments (e.g. mushroom picking permit, to be more comparable) have lasted for longer periods.

7.4. On private forest owners positioning towards a mushroom picking policy

The last PhD objective was the quantitative analysis of factors affecting the policy preferences of private forest owners regarding the governance reform. The survey findings of Catalan forest owners perceptions and preferences confirm the strong support to a regional-level regulation, and half of the respondents would like to join a mushroom reserve with a picking permit system (Górriz and Montiel, 2015). The quantitative results confirm that the perception of harms and property rights largely shape landowners' policy preferences (Górriz-Mifsud et al., 2015). It has been found that supporters of free-access advocate rather for a *res nullius* or public right,

whereas those pro-private right prefer a control of pickers entering their property with an eventual monetary contribution. Those advocating for maintaining the status quo either perceive less the nuisances caused by pickers (i.e. report less damages and less congestion of people), or assume them, and advocate more for awareness campaigns which they believe to diminish the nuisances, based on their trust towards the abidance of informal norms. At worst, they estimate a negative cost-benefit analysis, but it can be that they have no confidence in the correct implementation of any regulation. On the other extreme, pro-private right landowners back a profound governance reform, based on the premise that mushrooms are an asset of their property. It has been also found that most of them do not aim at chrematistic enrichment, but rather to help in balancing the budget for forest tending.

Forest owners working in the primary sector, with forest stands highly productive for edible mushrooms, and who have already tried to restrict access in their properties (through fences or signs) complain more about the amount of pickers they receive (congestion) and the related damage they have to bear. These are more likely to support the regulation of the picking activity. The significance of the congestion variable seems to indicate the existence of a threshold of visitors, which is subjective according to landowner's occupation and property location. Exposure to visitors has been pointed as a factor for a higher landowners' willingness to accept, thus requesting less compensation for public use of their lands (Buckley et al., 2009; Vedel et al., 2015). Exposure to visitors could be interpreted as bridging SC ties. Yet, we propose that such acceptance diminishes over certain amount of visitors. In parallel to the Biological Carrying Capacity of ecosystems or the Wildlife Stakeholder Acceptance Capacity (Carpenter et al., 2000; Decker and Purdy, 1988), we could coin the "Pickers Acceptance Capacity" as the amount of individuals accepted to pick in one's land based on the perception of impacts on landowners' wellbeing which sets the threshold for equilibrium. In this line, there would two limitations for picking in a specific area: an ecological criterion based on the impact on the

maintenance of the natural regeneration rate, but also a social criterion based on the fact that rural populations –and particularly landowners in areas with predominant private lands- do perceive annoyances to their traditional lifestyle beyond certain amount of visitors in the forest.

Forest owners with a management plan and closer to the provincial capital are more likely to prefer a picking fee and a mushroom reserve. The fact that landowners have a management plan is a proxy for considering them as active managers. Some papers put forward that active foresters tend to ask for more compensation when asked about an incremental non-timber objectives use of their land, namely recreational (Gadaud and Rambonilaza, 2010). Such compensation could be justified by a productive view of the forest resource, which may underpin the preference of a picking fee.

Paid mushroom picking permits could be conceptualised as payments for ecosystem services if the raised funds were to be reinvested in mushroom provision -e.g. through specific forest tending- (Prokofieva et al., 2016) and if forest owners become aware of their role as ecosystem service providers. The implemented survey has analysed rather the willingness of private landowners to act as providers of the mushroom picking activity, and payments for ecosystem services actually only constitute one combination of preferences as possible policy tool (Engel et al., 2008). Yet, it shows that a portion of landowners would be ready to undertake such approach, through mushroom reserves managed preferably by an association, charging pickers a permit fee, which would be invested in the forest through monetary transfer to participant landowners or through direct forest interventions to improve the mushroom productivity.

In this study, bonding SC has been measured as membership in some forest-related organisation. Bonding SC of landowners has been found as increasing the likelihood to support a regulation of mushroom picking. Yet, no further evidence has been found regarding other policy preferences. This result shows that structural SC might not necessarily affect the perception of free

access versus private property rights. Yet, it may have regarding the treatment towards the local community (an aspect not explored so far). The guess would be that those with more links in the local associations develop a stronger complicity and trust towards the rural colleagues. In this case, SC may lead to a positive discrimination towards locals, and hence support a regulation mainly restricting those out of their network reach, chiefly outsider pickers.

Bonding SC has been found to affect the selection of an intermediary body to manage the mushroom reserve. Therefore, being a member of one or several organisations seems to contribute to building trust on the forest owners' associations (Guillén et al., 2015). Consequently, these associations are considered the most reliable body to manage mushroom reserves. Local links may also entail a larger community pressure not to benefit from a traditional activity. Landowner's social capital aspects deserve further exploration, for example with regard to the in-kind compensation.

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8. Concluding remarks

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This study has attempted to shed light on the rural community processes that affect the governance of Non-Wood Forest Products. By analysing forest governance through the Social Capital lenses, we conceptualise the socio-ecological system as a nested structure where SC is an intrinsic part of SES governance, with networks and institutions as elements bridging both domains. The data collected in the surveys to forest users (i.e. mushroom pickers), forest managers (e.g. private forest owners) and decision-makers has allowed to preliminary evidence of linkages across the SC and governance. The case of wild mushroom picking Poblet forest and its four municipalities illustrates a case of positive social capital backing the policy process around the introduction of a picking permit.

We confirm that the cognitive social capital acts as triggering factor for the institutional evolution, as the perception of forest ecosystem dynamics and related socio-economic and ecological problems challenge the pre-existing behavioural patterns and ask for a change into new picking norms. The results show that forest users and decision-makers are interconnected with potential channels for influence. Moreover, pickers and decision-makers share in a large extent the mushroom picking diagnosis in terms of concerns and informal enforcement, as well as the need for policy intervention and its preferences. The interconnection, shared cognitions and relational patterns determine the basis for an alignment around the governance reform.

The analysis of the preferences of forest owners and their factors confirms that the perception of NWFP-related property (i.e. harvest) rights strongly shape the positioning towards certain policy interventions. Property rights constitute a basic relational (i.e. institutional) variable, and the literature has found no clear results in terms of which property regime is more ecologically sustainable (Brooks, 2010; Pandit and Thapa, 2003; Yang et al., 2009). In addition, this study highlights the relevance of the social sustainability, given that the presence of strangers (e.g. foreign pickers) in the forest property

provokes some annoyance. Moreover, pickers report a limitation in peer control and informal sanctioning with pickers outside their community reach. A Pickers' Carrying Capacity is suggested then to capture the level of visitors considered as acceptable by the rural populations to avoid conflicts. Such indicators would be subjective and dependent on fungal productivity aspects, but also on the exposure of forest owners or rural forest users to foreign pickers, and on the related negative experiences. The results indicate that a permit which prioritises local pickers and ensures that foreign pickers behave as locals do would be rather well accepted.

Yet, our study has not provided empirical evidence of some governance variables, for example in the case of negative SC effects and related conflicts, or those related to the policy evaluation stage. This opens avenues for future research. This study has also given some insights into variable boundaries of "community" in terms of geographical or administrative scope depending on the SC dimension to study. Besides, additional case studies could provide more empirical robustness to our assertions.

The interlinks found between SC and forest governance call for a meticulous design of forest policy networks with respect to communities of affected forest users to ensure that decision-makers transmit their sensibilities and preferences. Moreover, SC is an accumulative asset, which can be boosted. Therefore, policy strategies stimulating networks are likely to contribute to more active rural communities, strengthening their identity, norms, trust and joint vision. The SC theory puts forward that societies with more cohesive and spread networks provide a better platform for wellbeing initiatives.

From a resilience perspective, strong bonding networks facilitate the peer-to-peer learning about adaptive strategies, to informally control their implementation, and to eventually conduct mitigation actions in a collective manner. In the Poblet case it is observed a family transmission of picking practice, the network shares the need to change the current norms and the

alignment motivates them to monetarily contribute towards an improved status of the forest. Yet, when adaptive ideas are limited or –as in our case- the movement of people bring outsiders into the system, bridging SC helps in tracing ties with externals to the community and feed it with new ideas from others (e.g. twinning actions, "out-of-the-box" thinking).

From a productive perspective, high trust levels allow for risk pooling and hence facilitate entrepreneurial actions and reduce transaction costs (Bowles and Gintis, 2002); dense and spread networks permit reaching valuable market knowledge for market access, innovation and competitiveness (Cosyns et al., 2014; Pettenella and Maso, 2011; Secco et al., 2009). Hence, in a very diffuse subsector as NWFP is, networks are crucial for the sustainable management of the resource, but also for achieving a relevant contribution to the bioeconomy.

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General Appendix

Interview guideline for the Policy network members

In this project we are studying how different people participate in the decision-making regarding the establishment of payments for mushroom picking. For the case of Poblet we have selected the members of the Protected Area Governing Board (*Junta Rectora -GB*) and the group of experts (*Comissió de Seguiment*). We will ask you some questions on some related aspects. Please, note that all the information will be anonymous, confidential and only for the purposes of this research. If you wish, we can send you the final results after the analyses.

Questions in general about the Governing Body (*Junta Rectora*)

[for JR members]

0 We first would like to know about your experience in the Governing body of Poblet: how long are you in this group?

1a Could you please enumerate the main topics under discussion in the last two years within the Governing Body?

2a [TABLE 1] Here we have the list of the Governing body members. With whom do you normally talk before the meetings to comment the issues to discuss regarding policies in Poblet area?

2c At the bottom we have the Follow-up Commission for the mushroom permit and other relevant local stakeholders. Who from this list do you know? One by one: unknown (0) / If known: do you talk to him/her often (3), from time to time (2), or do you just recognise him/her (1)?

3 With whom do you normally agree during the different discussions?

[for no-JR members]

1b Could you please tell me what do you know about the Governing Body of Poblet? How do their decisions affect the work of your institution?

2b [TABLE 1] This people are the members of the Governing Body, the Follow-up Commission and other relevant local stakeholder. Who from this list do you know? One by one: unknown (0) / If known: do you talk to him/her often (3), from time to time (2), or do you just recognise him/her (1)?

4 With whom do you normally collaborate in implementing actions regarding Poblet initiatives?

5 To whom would you delegate your vote if you couldn't attend a GB meeting?

6 Who are the members who have the highest influence in taking decisions about the management of the protected area, according to your opinion?

7 Do you miss any important agent of the area in the Governing body regarding the mushroom-picking permit?

Table 1 – Relationships with other members of the Governing body & Follow-up commission – GENERAL PARK MANAGEMENT

(6) the most influential(s): _____

Nº	Junta Rectora Member	Institution	(2a) Known & talk (2b) Talk to:	(3) Agreement with:	(4) collaboration with:
1	Name surname	Director PNIN Poblet	□	□	□
2	Name surname	Dep. Culture - Dtor SSTT	□	□	□
3	Name surname	Dep. Governing - Dtor province service	□	□	□
4	Name surname	Dep. Terr & Sost. Dtor province service	□	□	□
5	Name surname	Dep. Agric – Subdirector Biodiversity	□	□	□
6	Name surname	Dep. Agric - Dtor SSTT	□	□	□
7	Name surname	Dep. Agric – Head county office	□	□	□
8	Name surname	Dip. Tarragona – Local financial office unit	□	□	□
9	Name surname	Councillor Espluga	□	□	□
10	Name surname	Mayor Vimbodí i Poblet	□	□	□
11	Name surname	Agriculture & forest landowner	□	□	□

12	Name surname	Representative CHN CB - conservationist	□	□	□
13	Name surname	Researcher CREAF	□	□	□
14	Name surname	Poblet Monastery	□	□	□
15	Name surname	Friends of Poblet	□	□	□
16	Name surname	Fire volunteer	□	□	□

Follow-up commission and other stakeholders			**(2a) Known & talk**
17	Name surname	CTFC – Mushroom researcher	□
18	Name surname	CPF - Private forestry agency	□
19	Name surname	Dep. Agric, Protected areas	□
20	Name surname	Dep. Agric, Forest service	□
21	Name surname	Dep. Agric, Provincial service Tarragona	□
22	Name surname	Dep. Agric, Forest guards	□
23	Name surname	Mayor of Prades	□
24	Name surname	Mayor of Montblanc	□
25	Name surname	County association of hotels and restaurants	□

General questions about the area

8 When dealing with new approaches, systems, methods, etc in the municipal life, how do you think is the municipality X in relation to the neighbouring municipalities?

For each municipality: Montblanc: ___ Espluga: ___ Vimbodí: ___ Prades: ___

(3) Very innovative, rather pioneers; (2) somewhat innovative; (1) more followers than pioneers; (0) rather reluctant to changes.

9 [only for those belonging to one of the 4 municipalities] Looking at the near past (10 years) in the municipal life, how do you think is your municipality in relation to the neighbouring municipalities?

Municipality: _____ (3) We have introduced many issues before others; (2) we're pioneers only in some aspects, some innovations were introduced earlier by us; (1) pioneers in one aspect; (0) we have not been the first in trying new things.

Questions about mushroom picking

10 How are mushrooms produced in this forest area?

- How do they grow? Season?
- How large is the production? How do you know whether a year is "good" or "bad"?
- Is there anything that the forest manager does in the forest to promote the production of mushrooms?
- Do you have some suggestion in this regard? What do think the forest manager should do?

11 Which species do grow here and would you be able to identify?

12 Mushroom picking is said to be controversial. What do you think? [TABLE 2] I will read a list of issues we have been told in other areas, and I'd like that you confirm me whether they also take place here according to your experience, or whether you think they are actually a problem occurring this area.

Table 2 – Problems related to mushroom picking before the permit (2012)

5= completely agree; 4= partially agree; 3= not agree nor disagree; 2= partially disagree ; 1= completely disagree; 0= don't know

	Was this a problem in Poblet?	**Agreement**
A	There was risk of mushroom overexploitation	
B	There was high wildfire risk	
C	Forests must be profitable and they aren't	
D	Mushrooms is a potential asset, but underexploited	
E	Foreign pickers cause problems when picking	
F	There are few income alternatives in this rural area	
G	Forests required forestry interventions (thinning, shrubs cleaning)	
H	Controlling pickers in this forest is complicated	
I	Some pickers were impolite	
J	Some picked both small and mature mushrooms to fill in the basket as much as possible	
K	Some pickers destroyed non-edible species, hampering their growth	
L	Some pickers used tools that damage the soil and left open holes in the ground	
M	Some pickers used plastic bags or plastic pails	
N	Some pickers got lost in the forest	
O	Some shouted in the forest to communicate with others	
P	Some pickers didn't know that the forest has an owner	
Q	Some pickers threw trash in the forest	
Y	The problem for mushrooms aren't the pickers, but wildboars	
R	Pickers benefited from the forest without contributing to its maintenance	
S	Locals pickers help when required (wildfire, snowstorm) but foreigners don't	

	have such attachment with this forest	
T	Commercial pickers didn't ask for a permit to the landowner	
U	Commercial pickers aren't experts and this is a public health problem	
V	Commercial pickers didn't gratify landowners	
W	Local inhabitants are accomplices of the grey market around mushrooms	

13 In your opinion, which would be the adequate solution to the previous issues? [TABLE 3]

Table 3 – The best solutions to previous problems

5= completely agree; 4= partially agree; 3= not agree nor disagree; 2= partially disagree ; 1= completely disagree; 0= don't know

	Potential responses	**Agreement**
1	Nothing should be changed	
2	The access to the forest should be limited (quota)	
3	Landowners should be allowed to put a price to pick mushrooms in their properties	
4	Local pickers must be positively discriminated: locals should have priority access	
5	Mushrooms should benefit the local community in general (market, restaurants, hotels)	
6	Raised funds must be reinvested in the forest	
7	Pickers must know that mushrooms have an owner	
8	Picking small mushrooms must be forbidden	
9	Pickers must be obliged to distinguish the species they pick	
10	Stirring up the mycelium must be forbidden	
11	Only porous recipients (e.g. wicked baskets) must be allowed	
12	Only a knife must be used (not rakes or similar)	
13	Pickers must be obliged to be responsible not to get lost in the forest	
14	Shouting in the forest should be prohibited to pickers	
15	Commercial picking must be regulated	
16	Landowners must conduct mycosilvicultural practices to increase mushroom yields	
17	Throwing trash must be forbidden	
18	Foreign pickers must somehow contribute to the forest	
19	Commercial pickers must somehow gratify the forest owner	
20	Pickers must ask permission to the landowner	
21	Commercial pickers must proof their mushroom knowledge	
23	Commercial pickers should dissimulate more the grey market	

14 According to your experience, to which degree do pickers follow the previous rules? □ *no one;* □ *a few;* □ *around half of pickers do;* □ *most pickers;* □ *all pickers*

15 You have mentioned X,Y, Z... They sound as "non-written norms". Is like that? What happens if a picker does not follow these practices? Is there anyone who overviews in the field that all pickers do implement these practices?

16 [TABLE 4] Which of these statements is more adjusted to reality, according to your experience?

Table 4. Peer control - consequences of not following good practices

(0) no picker tells off other pickers when they don't follow the indications	
(1) a few pickers tell off other pickers when they don't follow the indications	
(2) around half of pickers tell off other pickers when don't follow the indications	
(3) most pickers tell off other pickers when they don't follow	
(4) all pickers tell off other pickers when they don't follow the indications	
(5) don't know	

17 Some pickers trade with the mushrooms they have picked. Does this happen in your town? Do they sell in the farmer's/weekly market? To the local restaurants? To whom do they usually sell? Is there any intermediary?

Questions about mushroom picking permit design

18 Did you take part in the Governing Body meetings regarding the mushroom picking reform? [Yes/No]

19 [TABLE 5] If we think in the period when the picking permit in Poblet was under discussion, from this list who were, in your opinion, the most influential in promoting the idea of mushroom picking permit?

20 [TABLE 5] With whom did you talk before the meetings to comment the mushroom picking permits in Poblet area?

21 [TABLE 5] With whom did you normally agree during the discussions on the mushroom permit?

22 [TABLE 5] With whom did you collaborate (putting efforts) in designing the Poblet picking permit?

Table 5 – Relationships with other members of the Junta Rectora & Follow-up commission – DESIGN PHASE

(19) largest promoter: _____

Nº	Member	Institution	(20) previous information sharing	(21) Agreement with:	(22) Collaboration with:
1	Name surname	Director PNIN Poblet	□	□	□
2	Name surname	Dep. Culture - Dtor SSTT	□	□	□
3	Name surname	Dep. Governing - Dtor SSTT	□	□	□
4	Name surname	Dep. Terr & Sost. Dtor SSTT	□	□	□
5	Name surname	Dep. Agric – Subdirector Biodiversity	□	□	□
6	Name surname	Dep. Agric - Dtor SSTT	□	□	□
7	Name surname	Dep. Agric – Head county office	□	□	□
8	Name surname	Dip. Tarragona – Local financial office unit	□	□	□
9	Name surname	Councillor Espluga	□	□	□
10	Name surname	Mayor Vimbodí i Poblet	□	□	□
11	Name surname	Agriculture & forest landowner	□	□	□
12	Name surname	Representative CHN CB - conservationist	□	□	□
13	Name surname	Researcher CREAF	□	□	□
14	Name surname	Poblet Monastery	□	□	□
15	Name surname	Friends of Poblet	□	□	□
16	Name surname	Fire volunteer	□	□	□
17	Name surname	CTFC – Mycologist	□	□	□
18	Name surname	CPF – Private forestry agency	□	□	□
19	Name surname	Dep. Agric, Protected areas	□	□	□
20	Name surname	Dep. Agric, Forest service	□	□	□
21	Name surname	Dep. Agric, Province service	□	□	□
22	Name surname	Dep. Agric, Forest guards	□	□	□
23	Name surname	Mayor of Prades	□	□	□
24	Name surname	Mayor of Montblanc	□	□	□
25	Name surname	County association of hotels and restaurants	□	□	□

23 What do you think about the system of permits for mushroom picking? Did you have this opinion also before the permit introduction?

24 How do you see this mushroom permit against a payment? This is, do you agree with the establishment of a picking permit in Poblet against a payment to be reinvested in the forest and with a set of rules for mushroom picking? [Yes/No]

25 [TABLE 6] Which of these sentences better express your feelings? Before the implementation of the picking permit…

Table 6 – Risk perception during permit design

(4) I was very afraid of negative reactions
(3) I was a bit concerned of possible negative reactions
(2) I foresaw only some complaints but accepted in the end
(1) I was convinced that the permit was going to be well accepted
(0) I never thought about the reactions of the people

26 In your view, does this instrument help to solve the previously mentioned concerns on mushroom picking?

27 [If reference to negative reactions] Which type of negative reaction could have taken place? □ Political reaction in the next elections; □ Arson; □ Bad behaviour/revenges; □ other:____

Questions about mushroom picking permit implementation

28 Do you feel has there been any change after the implementation of the picking permit? If yes, in which aspects? And in which direction? [TABLE 11]

29a [park director] How many infractions were identified in 2012 season? (a) pickers without permit (X) (b) pickers not following the picking rules

29b [stakeholders] In your view, this amount (X) of infractions is: *0 – unacceptable; 1- too large, 2- adequate/as expected, 3 – less than what we thought, 4 – negligible*

30a [Only to CS] Do you find that, in general, JR members follow some of the recommendations you provide? [Yes/ No] How is it?

30b [Only to JRectora members] [TABLE 12] In your opinion, how adequate is the report of the first year of mushroom picking pilot implementation done by the FC? How is it?

31 How do you find the information given about the picking permit? *(1) Very good; (2) adequate; (3) Insufficient; (4) Very poor*

32a [TABLE 6] Who were the most influential in the implementation?

32b [TABLE 6] With whom did you share information about the implementation of the mushroom payment in Poblet?

32c [TABLE 6] With whom (if any) did you collaborate in implementing the picking permit, in terms of putting human and material resources?

33 After the implementation, have you seen any negative reaction among your municipality? [Yes/No]

34 In comparison to the situation previous to the implementation of the picking permit…
(+1) I trust more on the pickers; (0) I trust on pickers the same; (-1) I trust on pickers less

35 Do you know any mushroom picker in this area who trades, both regularly or punctually, with the mushrooms picked? If yes, could you please provide us his/her contact data?

36 Is there anything you deem important and we have forgotten?

Thank you for your time and attention.

Interview guideline for pickers

In this project we are studying how mushroom pickers in Poblet conduct this activity, which problems do they perceive and their opinion regarding the newly introduced picking permit. We are interviewing local pickers of the four municipalities affected. Please, note that all the information will be anonymous.

General questions

1 First, I'd like you to explain me a bit on how is your relationship with Poblet forest?

2 How often do you go? Do you go for any of the following reasons? □ only for mushrooms; □ guided visits; □ interpretation center; □ excursions particulars; □ marked routes; □ mushroom paintings; □ know the mushroom fenced parcels; □ other: ____

3 Are you a forest owner? [Si/no] Any professional relation with the forest? [Si: ____ /no]

4 Do you know the ownership of Poblet forests?

□ *Catalonian government;* □ *municipalities;* □ *State (Spain);* □ *Monastery (Church);* □ *privates*

5 Since when are you living in Poblet area? □ > 15 years; □ < 15 years

Questions on mushroom picking

6 Which species would you pick in Poblet? (identification)

7 When you don't pick in Poblet, do you have alternative picking zones nearby? [Only go to Poblet/Yes/No/Don't know]

8 How would you describe a mushroom picker in Poblet?

Man/woman; young/medium-age/old; local/foreign; working days/weekends...

9a Some pickers sell the mushrooms picked. Does this happen in this municipality? [Yes/No/Don't know]

9b [if Yes] How many do you know?

9c To whom do they usually sell?

□ farmer's/weekly market; □ local restaurants; □ Bad intermediary; □ other:____

10 In other parts of Catalonia there is an economy around mushrooms (commercial pickers, processors...). How would you explain the little market in this area?

11 The picking permit makes a distinction between: "locals" (this is, residents in municipalities =V+M+E+P) and "outsiders". Do you find "local pickers" are different to outsiders? [Yes/No/Don't know]

12 In your opinion, who should be allowed to pick mushrooms (ACCESS issues)?

□ Forest owner; □ Local pickers; □ any picker is allowed to access

13 [TABLE 1] I read a list of issues we have been told in other areas. Thinking of before the permit introduction (2012), I'd like that you tell me to which extent did they take place in this Poblet forests, according to your experience.

Table 1 – Problems related to mushroom picking before the permit (2012)

5= completely agree; 4= partially agree; 3= not agree nor disagree; 2= partially disagree ; 1= completely disagree; 0= don't know

	Was this a problem in Poblet?	**Agreement**
A	There was risk of mushroom overexploitation	
B	There was high wildfire risk	
C	Forests must be profitable and they aren't	
D	Mushrooms is a potential asset, but underexploited	
E	Foreign pickers cause problems when picking	
F	There are few income alternatives in this rural area	
G	Forests required forestry interventions (thinning, shrubs cleaning)	
H	Controlling pickers in this forest is complicated	
I	Some pickers were impolite	
J	Some picked both small and mature mushrooms to fill in the basket as much as possible	
K	Some pickers destroyed non-edible species, hampering their growth	
L	Some pickers used tools that damage the soil and left open holes in the ground	
M	Some pickers used plastic bags or plastic pails	
N	Some pickers got lost in the forest	
O	Some shouted in the forest to communicate with others	
P	Some pickers didn't know that the forest has an owner	
Q	Some pickers threw trash in the forest	
X	Some pickers parked the car in a wrong manner, obstructing access	
Y	The problem for mushrooms aren't the pickers, but wildboars	
Z	The problem for mushrooms aren't the pickers, but climate change (=lesser rains)	
R	Pickers benefited from the forest without contributing to its maintenance	
S	Locals pickers help when required (wildfire, snowstorm) but foreigners	

	don't have such attachment with this forest	
T	Commercial pickers didn't ask for a permit to the landowner	
U	Commercial pickers aren't experts and this is a public health problem	
V	Commercial pickers didn't gratify landowners	
W	Local inhabitants are accomplices of the grey market around mushrooms	
X	I trust on marketed mushrooms	
Y	Pickers appreciate silence and wild nature	

14 How would you define a "good mushroom picker"? From TABLE 2: which indications follow yourself?

15 How does a picker learn them? Are they compiled somewhere? [Yes/No/Don't know]

16 According to your experience, to which degree do pickers follow the previous indications?

Locals	□ no one; □ a few; □ around half of pickers do; □ most pickers; □ all pickers;
Outsiders	□ no one; □ a few; □ around half of pickers do; □ most pickers; □ all pickers; □ don't know

17 What happens if a picker does not follow these practices? Is there anyone who overviews in the field that all pickers do implement these practices? [TABLE 2] How many pickers tell off other when not following the good practices?

Table 2. Peer control - consequences of not following good practices

(0) no picker tells off other pickers when they don't follow the indications	
(1) a few pickers tell off other pickers when they don't follow the indications	
(2) around half of pickers tell off other pickers when don't follow the indications	
(3) most pickers tell off other pickers when they don't follow	
(4) all pickers tell off other pickers when they don't follow the indications	
(5) don't know	

18 [TABLE 3] Regarding the reasons for telling off other, do you agree with follow. statements?

Table 3 – Telling off - drivers

I don't tell off other pickers because I'm afraid of their violent reaction towards me	□ *yes;* □ *no*
I don't tell off other pickers because I don't want to create an uncomfortable situation	□ *yes;* □ *no*
People are reasonable: if you tell them off as a constructive critic they understand	□ *yes;* □ *no*
I don't tell off other pickers because I'm sure isn't useful: they won't change	□ *yes;* □ *no*
Each person should be responsible with his/her conscience of doing things right or wrong	□ *yes;* □ *no*
Telling off wrong pickers isn't the task of other pickers but of the forest guards	□ *yes;* □ *no*
I have the duty to inform other pickers of what they are doing wrong because maybe no one has explained that before	□ *yes;* □ *no*

19 [TABLE 4] In general, how important it is for pickers what other think about them regarding the picking activity?

Table 4 – Peers' opinion

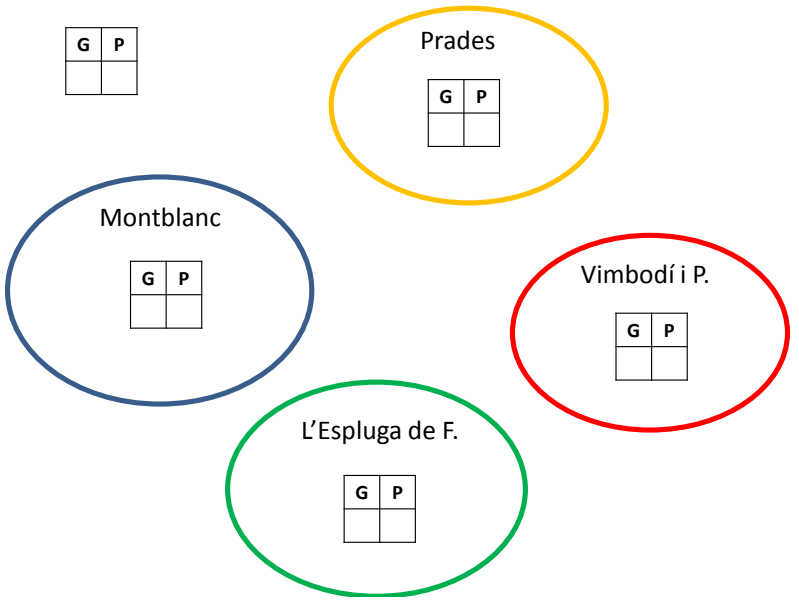
☐ No important: has no influence at all;
☐ Little importance: has very limited influence in the picking activity
☐ Somewhat important: Influences a bit pickers' behavior
☐ Important: pickers are influenced by what neighbors' think of them

20 Do you know what the law says about mushrooms' ownership? [Yes/No/Don't know] (if yes) What?

21 One of the aspects we analyse is the level of confidence towards other picers. Could you please tell me, from 0 (I trust nobody) to 4 (I trust everyone), how would you score the following sentences? [TABLE 5]

- To which degree do you trust mushroom pickers from your municipality?
- To which degree do you trust pickers in the following neighbouring municipality?
- To which degree do you trust outsider pickers?

Table 5 – Confidence in locals



Questions about the permit design

In spring 2012 there were some discussions within the Poblet park around the idea of establishing a mushroom picking permit. There were informational meetings open to anyone in the municipalities willing to attend.

22a: Were you aware of these meetings?

22b [if yes] Did you take part in the open meetings regarding the mushroom picking reform in your town? [YES/NO] [if No] Did you consider any of the participating people as representing your interest? [YES/NO]

22c. [if No] Do you know anyone who went?

23 Protected areas in Catalonia count with a Governing Body to make decision on the park management, with local stakeholders. Did you know that there is a GB in Poblet? □ Si [continue]; □ No [no "trust"]

24 [TABLE 6] These are GB members. Explain CS. Do you know any in person? How do you often talk to them? Who have the largest influence? Do you miss anyone relevant?

Table 6 – Relation with members of the Governing body & Follow-up commission

The most influential(s): _____

Nº	Member of Junta Rectora	Institution	(0) doesn't know (1) knows only (2) talk from time to time (3) talks often
1	Name surname	Director PNIN Poblet	□
2	Name surname	Dep. Culture - Dtor SSTT	□
3	Name surname	Dep. Governing - Dtor province service	□
4	Name surname	Dep. Terr & Sost. Dtor province service	□
5	Name surname	Dep. Agric – Subdirector Biodiversity	□
6	Name surname	Dep. Agric - Dtor SSTT	□
7	Name surname	Dep. Agric – Head county office	□
8	Name surname	Dip. Tarragona – Local financial office unit	□
9	Name surname	Councillor Espluga	□
10	Name surname	Mayor Vimbodí i Poblet	□
11	Name surname	Agriculture & forest landowner	□
12	Name surname	Representative CHN CB - conservationist	□
13	Name surname	Researcher CREAF	□
14	Name surname	Poblet Monastery	□
15	Name surname	Friends of Poblet	□
16	Name surname	Fire volunteer	□

Follow-up commission and other stakeholders			Known & talk
17	Name surname	CTFC – Mushroom researcher	□
18	Name surname	CPF - Private forestry agency	□
19	Name surname	Dep. Agric, Protected areas	□
20	Name surname	Dep. Agric, Forest service	□
21	Name surname	Dep. Agric, Provincial service Tarragona	□
22	Name surname	Dep. Agric, Forest guards	□
23	Name surname	Mayor of Prades	□
24	Name surname	Mayor of Montblanc	□
25	Name surname	County association of hotels and restaurants	□

25 Before the entry into force of the regulation, how came to you the permit introduction?

26 You find the information given about the permit:

(1) Very good (2) adequate (3) Insufficient (4) Little

27 [TABLE 7] What do you think of different aspects of the permits for mushroom picking: do you agree with them?

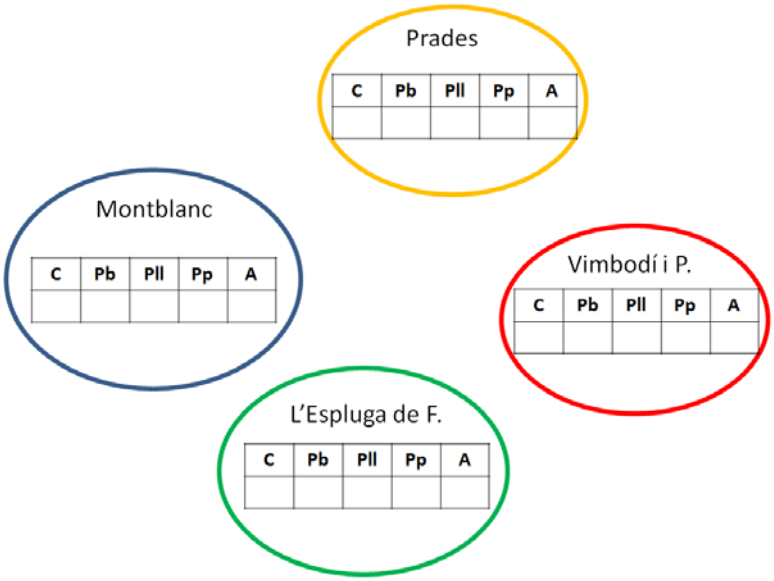
Table 7 – Permit aspects

Permit for mushroom picking	Agree / Not agree
At the local level	Agree / Not agree
Fee for the permit	Agree / Not agree
Funds to reinvest in the forest management	Agree / Not agree
Linked to a set of rules for mushroom picking	Agree / Not agree

28 [TABLE 8] Now we want to estimate the number of mushroom pickers. [Graph on municipalities as helping tool]. Thinking in your municipality:

- How many mushroom pickers do you know? We need an estimated number of those that you are sure that pick mushrooms (C)
- From them (C),with how many do you talk about mushrooms in general? (Pb)
    - From them (Pb), with how many do you talk about places where to go mushroom picking? (Pll)
    - From them (Pb), with how many do remember having talked about the picking permit? (Pp)
        - From them (Pp), with how many did you agree regarding the permit? (A)

Table 8 – Network of mushroom pickers



29 [TABLE 8] Thinking in municipality X:

- How many mushroom pickers do you know? We need an estimated number of those that you are sure that pick mushrooms (C)
- From them (C),with how many do you talk about mushrooms in general? (Pb)
    - From them (Pb), with how many do remember having talked about the picking permit? (Pp)

30 Do you know mushroom pickers in your municipality who didn't get the permit but still went picking? [YES/NO] [If Yes] How many do you know without the permit? ____

31 [TABLE 9] Which of these sentences better express your feelings? Before the implementation of the picking permit…

Table 9 – Risk perception during permit design

(4) I was very afraid of negative reactions
(3) I was a bit concerned of possible negative reactions
(2) I foresaw only some complaints but accepted in the end
(1) I was convinced that the permit was going to be well accepted
(0) I never thought about the reactions of the people

32 Which type of negative reaction could have taken place? □ Political reaction; □ Arson; □ Bad behavior/revenges; □ Signals broken; □ Complaints; □ other:_____

Questions about implementation of the picking permit

33 In august 2012 the picking permit was approved and it started in autumn that year. What do you think about next sentences? [TABLE 10]

Table 10 – Permit acquisition factors

I took it only for the present (a hut)	Yes / no
I took because I wanted the first mushroom picking permits in the history of Catalonia	Yes / no
I got it just in case the season is good	Yes / no
I took it just to avoid possible conflict	Yes / no
Because a friend pushed me to acquire the permit	Yes / no
I got it only after having seen that some neighbours also got it	Yes / no
I see the picking permit as "*obra de vila*", where it's desirable that all join efforts to make it successful	Yes / no
Most of us believe that having the permit is the right thing to do	Yes / no
Having the permit to me is a way to collaborate with the Park of Poblet	Yes / no
Having the permit is a manner to put clear that mushrooms in Poblet are more of the locals than of outsiders (=locals have priority for mushroom picking than externals)	Yes / no
I took the permit only because I know that the money will remain in the Park	Yes / no
I took the permit because its cost was symbolic/very affordable	Yes/no
I would accept paying a bit more (ex. 3€/year)	Yes/no

34 [TAULA 11] Do you feel has there been any change after the implementation of the picking permit? [YES/NO] [If yes] In which aspects? [TABLE 1 categories] And in which direction? [TABLE 11]

Table 11 – Perception of changes during the implementation

(4) it's too early to assess the effects: _____ / _____ / _____
(3) it has been solved: _____ / _____ / _____ / _____
(2) has been some improvement: _____ / _____ / _____
(1) has improved a little bit: _____ / _____ / _____
(0) hasn't changed: _____ / _____ / _____ / _____

35 [TAULA 12] What do you think about next sentences? [peer control / diligence]

Table 12 – Values attached to engaging in the permit

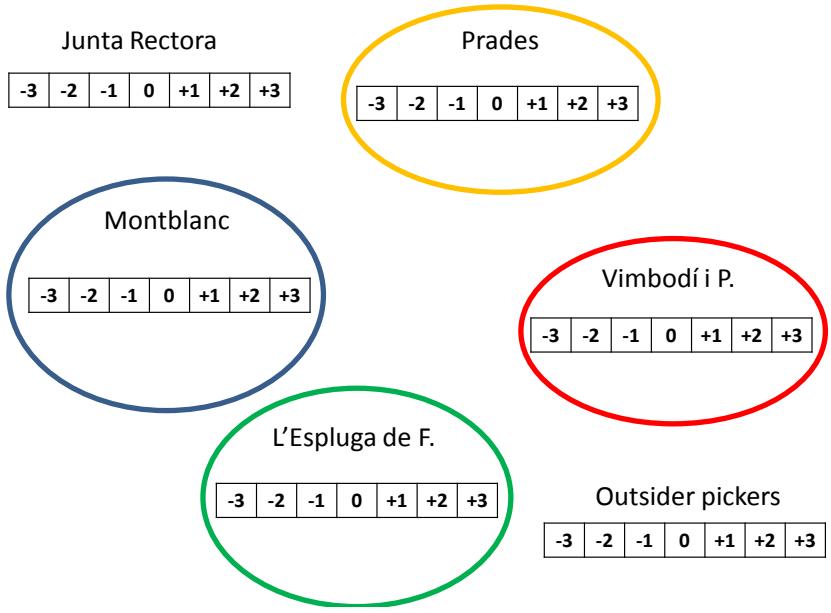
I've read the pamphlet with the good practices	Yes / no
I commented the picking norms with my family or acquainted	Yes / no
I asked the pickers I found in the forest whether they had the permit	Yes / no

I was very proud of having the permit and I told it to others	Yes / no
I have changed some points on the manner I pick mushrooms [how?]	Yes / no
I noticed that some neighbours/other locals have changed the way they pick mushrooms [how?]	Yes / no
I noticed that some outsider pickers have changed the way they pick mushrooms [how?]	Yes / no

36 [TAULA 13] How has your trust versus GB and pickers changed?

Table 13 – Trust changes

-3	-2	-1	0	+1	+2	+3
I trust substantially less	I trust much less	I trust a little less	I trust the same than in 2012	I trust a bit more	I trust much more	I trust substantially more



37 How do you see the controls conducted by forest guards?

(1) Very good (2) adequate (3) Insufficient (4) Little

38 After the implementation, have you seen any negative reaction among your municipality? [YES/NO]. And with outsiders? [YES/NO] And any positive reactions? [YES/NO]

Debriefing questions

39 To other municipalities: how you do often go? For any of these reasons?

(4) for services (doctor, bureaucracy, shopping): ___; (3) for work: _____; (2) for family: _____; (1) for activity: _____; (0) I don't move much from my own town.

40 Do you belong to any volunteer group or association in your town?

(15) Women's assoc; (14) Hiking club; (13) Forest owner assoc; (12) Agriculture coop; (11) Business assoc; (10) Political group; (9) Pensionist assoc; (8) Assoc cultural; (7) Friends of Poblet; (6) Sport club; (5) Hunting club; (4) Natural history center; (3) Music band; (2) Fire volunteer; (1) other: _____; (0) none.

41 [If forest owner] If there would be the possibility to join the regulation system of Poblet, or to replicate it jointly with other owners, would you be interested? [Yes/No/Don't know]

42 [If 9b] Commercial contact?

Thank you!