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Pros and cons of transdisciplinary research: A case study of Swedish lawns and their sustainable alternatives

Authors: M. Ignatieva^{1*}, F. Eriksson², T. Eriksson², T. Kätterer³, P. Tidåker⁴, J. Wissman⁵, K. Ahrné⁶, J. Bengtsson³, M. Hedblom²

^{1*}School of Design, University of Western Australia, 35 Stirling Highway, Perth, WA 6001.

²Department of Urban and Rural Development, Swedish University of Agricultural Sciences, P.O.

Box 7012, Uppsala SE-75007, Sweden.

³Department of Ecology, Swedish University of Agricultural Sciences, P.O. Box 7044, Uppsala SE-75007, Sweden.

⁴Department of Energy and Technology, Swedish University of Agricultural Sciences, P.O. Box 7032, SE-750 07 UPPSALA

⁵Swedish Biodiversity Centre, Box 7016, SE-75007 Uppsala, Sweden.

⁶Swedish Species Information Centre, Box 7007, SE-75007 Uppsala, Sweden

Highlights

- Analysis of pros and cons of transdisciplinary research on lawns
- Ability to involve stakeholders in different project activities and to disseminate the research results
- Ability to incorporate results of natural and social studies into landscape design
- Initial concept-the management was the central factor
- Management routines shape urban green areas and people aesthetic perceptions

Abstract

In this article, we discuss the pros and cons of transdisciplinary research using the results of a research project on lawns carried out in Sweden from 2013 to 2016. We viewed lawns as a

complex ecological and cultural phenomenon and searched for different sustainable lawn solutions in urban areas of Sweden.

Constraints on the research included the time and effort required for team members to become familiar with the different research approaches, participate in regular meetings and agree on joint methodology. Later in the project, the integration, analysis and understanding of field data, theoretical sources and practical implementation approaches were also time-consuming obstacles. Thus, the initial and final phases of the project were extremely important and demanded a lot of time and effort. Especially challenging was the cross-use of different methodologies from natural and social sciences. Such ambitious multiscale and multitask projects dealing with living urban nature and people require at least five years to complete, rather than the three years typically suggested for classical research projects.

The pros of the transdisciplinary approach was its ability to incorporate results of natural and social studies into landscape design, the ability to involve stakeholders in different project activities and to disseminate the research results in practice. This research revealed that lawns are a relatively recent phenomenon that is still expanding globally. The social study component showed that mowing and creating smooth, green lawn surfaces is important to stakeholders (lawn users, planners and managers). However, in Sweden, there is a tendency for local citizens to accept more biodiverse plant communities. Working closely with open-minded stakeholders led to the real implementation of lawn alternatives, which, in turn, increased media attention. The initial concept—that management was a central factor to the whole transdisciplinary project—was confirmed. The goal of this article is to share the unique experiences and lessons learned by researchers of conducting transdisciplinary research and to make such complex research more successful.

Keywords: Lawns; cross-use of different methodologies; overarching hypothesis; natural, social sciences and landscape design, Sweden, transdisciplinary research

Introduction: Why do research on lawns?

Since most people now live in cities, lawns are one of the most common green habitats encountered in daily life. They are used for play or picnicking in parks and residential gardens,

and provide aesthetically pleasing frontages to theatres and museums. As a symbol of prosperity and success, a smooth, green lawn has become desirable worldwide, regardless of climate or geographical zone. In many cities and towns, a limited pool of lawn grasses, together with selected tree and shrub species, have successfully replaced native plant communities (Fig. 1).

Fig1. is here

People are so accustomed to lawns in everyday life that they seldom question their presence. For many, a lawn is a 'given' element of the urban landscape and is associated with the beauty of green grass. Lawns reflect a 'nature-like' urban environment since they are green and give access to urban 'nature'. They are expected to provide many positive ecosystem services, such as recreation and other social activities, soil carbon sequestration and rainwater infiltration (Monteiro, J.A. 2017). However, a lawn is a man-made (designed) ecosystem, the need for which is being questioned in the time of climate change, particularly in the United States of America (Thompson and Kao-Kniffin, 2017) because of its use of large amounts of water and maintenance by fossil fuel-consuming mowers.

The grass family Poaceae contains over 10,000 species, but only a few are used in lawn seed mixtures (Harvey, 2001). Turf, grown in nurseries and distributed through garden centres, is leading to the ecological homogenisation of urban landscapes (Groffman et al., 2014). It also results in visual unification of urban environments (Ignatieva, 2018; Fig. 2). The design, site preparation and routine management of lawns have become universal. However, lawns could be replaced by something far more sustainable than in its present form which would increase human well-being and biodiversity (Ignatieva and Hedblom, 2018). If the present societal norms of lawns are to be changed and also implemented in practice there is a need for transdisciplinary studies (Hadorn et al., 2008).

Fig. 2. is here

From disciplinary to transdisciplinary approach in lawn research

Despite the important role of lawns in the urban landscape, few studies have examined their unique and complex combination of social, ecological, cultural, historical and environmental effects and their intensive management requirements. All these aspects need to be studied in order to achieve sustainability and avoid incompatible epistemologies (e.g. social

sciences versus natural sciences) or trade-offs between sustainability goals (Arts et al., 2017). Most lawns studied in the Anglo-American literature are in private urban gardens (Groffman et al., 2014). In recent years, interest in researching lawns in public green areas of Europe has grown; however, it has mostly focused on the composition of lawn flora (Bertoncini et al., 2011). Research on lawns in Sweden is important since lawns are dominant features in all types of public open green areas (Hedblom et al., 2017). By the late 20th to early 21st century, like everywhere else in the world, lawns in Sweden were widely advertised and used in urban planning and landscape architecture (Ignatieva, 2017). To be able to suggest alternative, sustainable, nature-based solutions, we decided to go beyond the perspective of classical biology, geography or conservation ecology and view lawns as a field of research shaped by environmental factors, human activities and management factors, and as a complex subsystem of a great urban ecosystem.

The LAWN project “Lawn as an ecological and cultural phenomenon: Search for sustainable lawns in Sweden” (2013-2016), from the very beginning, adopted a transdisciplinary approach (Ignatieva et al., 2015, Fig. 3).

Fig. 3 is here

There are different definitions and understandings of transdisciplinary research depending on the character of the research question and the research team “ranging from a diffuse conceptual term located above individual disciplines, to any research that involves stakeholders” (Hadorn et al., 2008). Our understanding of transdisciplinarity is close to Tress et al. (2004) who defined a transdisciplinary approach as “integrative research concepts” which involve academic researchers from different disciplines and stakeholders (non-academic participants). For example, in our case, it was urban citizens, golf players, golf course managers, city council managers, plant nurserymen, politicians and landscape architects. The lawn project was ‘blessed’ from the very beginning by one of the stakeholders from the Uppsala municipality. Economics (spending too many resources and money for taking care of conventional lawns) and environmental awareness were behind this initial interest of stakeholder participation throughout the whole project. Established stakeholders were integrated into the project through the research activity not only by involving them in semi-structured interviews but by their participation in methodology (choice of municipalities and neighbourhoods as case sites), supplying research

data (policies, facts, maps, ongoing activities, etc.), meeting with the research team (updating with ongoing activities, sharing results and discussing next steps) and disseminating the final results. Stakeholders were directly involved in the implementation of demonstration sites of alternative lawns. Thus, the LAWN project fits into the transdisciplinary category and combines transdisciplinarity with a participatory approach (Tress et al., 2004)

Ultimately, this transdisciplinary framework encourages productive dialogue and synthesis across a broad range of disciplines and approaches (Shi, 2004). As underlined by van Kerkhoff (2001), transdisciplinary research requires a conceptual structure that allows the individual to transcend existing disciplines, which requires building an entirely new language. Transdisciplinarity goes beyond interdisciplinarity to a higher level of coordination and implies cooperation from the beginning to the end (Shi, 2004). In our case, landscape architecture, a discipline that is very interdisciplinary in its nature (based on integrating spatial design, planning, ecological, biological, social sciences and engineering) became an important inspiration for constructing the overarching transdisciplinary foundation of the research.

Our understanding of transdisciplinary work is also similar to the most recent approaches, where transdisciplinary studies use an overarching paradigm that comprises different fields of knowledge (Cincera et al., 2019). This is also in accordance with Hadorn et al. (2008) who frame transdisciplinarity "...as a form of research that is driven by the need to solve problem of the life-world". In our case, management intensity was hypothesized to be the central factor influencing all aspects of lawns and how they are perceived by people (Fig. 3; Ignatieva et al., 2015) and like Tress et al. (2004) we acknowledge the importance of posing the specific research question at the start of any new integrative research project.

This transdisciplinarity encompassed an attempt to combine the quantitative methods used in natural sciences (e.g. replicate sampling and reproducible research designs) with the quantitative and qualitative methods employed in the social sciences (e.g. questionnaires, semi-structured interviews, focus group and observational studies, which included recommended questions related to urban biodiversity) and the study of history (literature reviews, observation and analysis of old paintings and engravings depicting meadow and lawn species).

At the beginning of this research project, we had a series of intensive meetings and workshops where the methods and theories from the different academic disciplines were shared

and discussed. It was necessary for our learning and understanding, planning and design process of the fieldwork, discussions concerning how we could integrate and analyse the results collected by the team from social and natural sciences and how stakeholders should be involved.

Meetings and workshops over three years were an important tool for discussing results and handling unexpected challenges. While researchers were in contact with different stakeholders during the data collections, we also invited stakeholders to the joint meetings. The aim was to receive stakeholder's feedback and update about ongoing policies, upcoming changes of masterplans and how research results can be applied for the city's strategical planning, design and management documents.

While working with case studies, we used a triangulation method (Stake, 2010) for validating the cases. Social studies also used the theory of Ferdinand Tönnies (1963) investigating the relationship between communities and society (attitudes, preferences, values, needs, experiences among different types of households). The project applied surveys and interviews (asked people who used the green areas in the housing sites); questionnaire/enquiries (sent to people living in our case study neighbourhoods); observational studies (observations how and when the green areas and lawns were used) and focus groups (with dwellers, politicians, planners, plant nurserymen, etc.).

We used a multiscale approach going from the large scale (estimating the total coverage of lawn as a land-use type in Swedish case study cities) through the medium scale neighbourhood level (public open spaces; typology, coverage of lawns, their functions, values and use) to the fine scale (the specific lawn itself), with emphases on biotope characteristics (such as biodiversity and carbon sequestration) and social observations. We studied public lawns in the major Swedish cities of Uppsala, Gothenburg and Malmö in a multi-family house typology, due to their predominance in Swedish settlements. Within each city, two types of lawn were identified for study: conventional (utility) and meadow-like lawns (broadly defined as infrequently mowed grassland, usually with flowering forbs; Norton et al., 2019) in multi-family residential housing areas. The classification of lawns was based on their management intensity, including frequency of cutting (conventional lawn-12-20 times per season and meadow-1-2 times per season), and the height of cut grass. This classification reflects the existing typology recognised by Swedish municipalities (national guidelines for grass maintenance). Since, in Sweden, the use of pesticides and herbicides in publically accessible green areas was prohibited

in the 1990s, we also included golf courses, with their greens considered the end-point of our management intensity gradient. The management of golf course greens is more intensive than that of conventional lawns and includes frequent mowing, irrigation and application of fertilisers, and so has a high energy input.

The management of lawns has various biodiversity and environmental impacts and may affect the species diversity and community composition of plants, bees, butterflies and soil invertebrates, energy usage, and carbon footprint. Soil carbon sequestration was estimated in relative terms at various management intensities by comparing soil carbon stocks. The balance between negative emissions through soil carbon sequestration and emission of greenhouse gases (GHG) was also assessed from a lifecycle perspective. As a part of our transdisciplinary approach, we also included an extended history of Swedish lawn-related etymology (the origins and meanings of words) by consulting a Swedish language linguist (Ignatieva et al., 2018). Native plant nurseries and park managers were crucial stakeholder players in the final stage (dissemination) of the project results; i.e., the implementation of identified alternative lawns in local parks of Uppsala and Stockholm. Final book- the practical manual entitled *Lawn alternatives in Sweden: From theory to practice* based on the project results and written in scientific-popular language (in Swedish and English) has become the most important dissemination tool. It was particularly in demand in small municipalities across the country. The project's results were shared with international and national scientific communities via peer-reviewed publications and conference presentations and received wide social media coverage (TV, radio and publications in popular magazines) in Sweden, Germany and Australia.

Pros and cons of a transdisciplinary approach

This transdisciplinary research has demonstrated the challenges of designing and implementation of transdisciplinary projects. The complexity and diversity of research methods require time to adjust to and understand the problem, to learn the essentials of other disciplines, to digest the data, to try different types of analyses, to discuss results and to arrive at conclusions. In reality, the nature of our project initially was, to some extent, more multidisciplinary (i.e., work within several disciplines and without crossing the boundaries between them), then it became more interdisciplinary (links and intersections between different disciplines). However,

in the third year, the transdisciplinary approach was more pronounced and became a case of, as Cincera et al. (2019) said, “*bringing together new hypotheses and worldviews, creating new vision*”. However, a transdisciplinary unified ‘thread’ was visible through the project because of the constant interaction and involvement of stakeholders in the project.

Especially challenging were the attempts to cross-use different methodologies from the natural sciences and social disciplines. Such ambitious multiscale and multitask projects dealing with living urban nature and people requires time. It was also partly personnel-dependent, as the participants needed a willingness to really understand another field of science and then allow time to find common ground and new angles of research. For our project (including field-based sampling of pollinators, plant species and earthworms, interviews, life-cycle analyses, spatial GIS analyses, historical studies and practical implementations), at least five years were necessary. There was value in testing research results in practice, which also required extra time to organize regular meetings with stakeholder-practitioners. By the third year of our project, the team has just started to understand the essence of Swedish lawns and their potentials for people, urban biodiversity, sustainable design and planning practice. Additional years would have been beneficial for continuing the study of the dynamic character of lawn plant communities, monitoring newly established alternative lawns, and finding effective ways to implement our recommendations in Swedish planning, design and management documents. Today, however, there is a tendency to provide funding for projects shorter than five years as research agencies have pre-defined targets. However, some major funding sources linked to Horizon 2020 (a major EU funding source) are a potential foundation for future research. Unfortunately, these are mostly rather spread out among numerous co-applicant countries and do not facilitate in-depth national study.

Our research also confirmed the importance of having a strong hypothesis and overarching concept, as well as clear research questions, logical organisation, good leadership and careful management of the budget (Cincera et al., 2019). Another crucial component of the success of transdisciplinary projects was to create a coordinated team where each researcher was willing to not only contribute their existing expertise, but was also ready for a challenge and to learn from other disciplines. We also found that the focus group and outside academic advisors invited to the project at the first stage were helpful for the theoretical and methodological setup of the project.

The LAWN project has fulfilled most of its original goals and objectives. However, there were some components of our project that could not be completed (Fig. 4).

Fig. 4 is here

For example, an economic analysis (cost of establishing and managing different types of lawns, property values) was too complicated to perform due to the specifics of Swedish housing and surrounding areas ownership systems (small housing cooperatives, variety of owners and related regulations). Some economic parameters were, however, included in the life cycle analysis and a rough estimate of the management costs of municipality-owned public lawns was made (Hedblom et al., 2017)

Private lawns were not studied as planned. There was only a pilot study of the social use of lawns in three cities. Compared to the Anglo-American model of suburban extended lawns, Swedish urban private lawns are smaller and have a different history that reflects the country's unique political and socioeconomic pathway. Private owners described many different motives and ways of using and managing their lawns, so it is just a matter of time before this part of the research is completed. Transdisciplinary research into private Swedish lawns should be a future research topic. Golf course research was an important part of the gradient approach and was particularly illustrative in the carbon sequestration and life cycle assessments, as well as specific social aspects. The conclusion was that there is an interest among golf players and managers to promote biodiversity and environmentally-friendly management (Wissman et al., 2016). However, due to the specific characteristics of golf course lawns (designed for a very specific game), it was difficult to integrate these results into the overall project framework. There is an ongoing discussion in some Swedish cities to open the outer parts of golf courses for non-golfers recreational activity.

There are also a lot of social aspects that can be followed up in future studies. For example: How lawns are used seasonally and daily? Other social parameters still to be studied are the influences of lawn scale, neighbourhood population density, and connections to the other green-blue elements (water sources, amenities and design elements).

Results and confirmation of primary hypotheses

Our results show that the history of lawn development in Sweden is similar to that in many other European countries. Swedish lawns have the favourable precondition of pre-existing pastures and meadows, which were used for collecting seeds and cutting sods. However, the widespread use of lawns is a relatively recent phenomenon connected to the 19th-century public park movement and the modernist post-WWII model of prefabricated mass production. In Sweden, lawns comprise 52% of the total 'green' areas (parks, urban woodlands, allotments; Hedblom et al., 2017). Today, lawns cover a large proportion (26%) of outdoor area in all multifamily residential areas and 0.6% of the country's terrestrial surface. Conventional lawns clearly dominated in all researched neighbourhoods (Fig.5)

Fig. 5 is here

We found that intensively managed lawns, in general, produce more biomass and sequester more carbon in soil than meadow-like lawns. However, intensively managed lawns demand more energy and management effort. The positive effect of soil carbon sequestration, on the greenhouse gas balance, was partly negated by mowing (in the case of conventional lawns), and by the mowing, irrigation and fertilization of golf courses, which require fossil fuel energy. There is also an increased cost of labour. Mowing is the main contributor to greenhouse gas emissions from most Swedish lawns. Even public lawns are managed without fertilizers and pesticides, but rely on fossil fuels for frequent mowing.

Soil carbon stocks are greater in lawns than in nearby agricultural land, because carbon input to the soil through production of aboveground and belowground biomass is stimulated by frequent cutting (Poeplau et al., 2016). The climate footprint of Swedish meadow-like, conventional lawns and of golf courses was calculated (Tidåker et al., 2017; Wesström, 2015). Data from golf courses were considered to represent intensively managed lawns, and were compared with conventional and meadow-like lawns in cities. Depending on the carbon sequestration which counteract greenhouse gas emissions, lawns may act as either a source or sink of greenhouse gases. Reducing the mowing frequency, lowering the N fertiliser rate and using electric machines instead of fossil fuel-powered ones may reduce the carbon footprint of lawns (Tidåker et al., 2017).

The social studies conducted for the LAWN project showed that lawns are regarded as enjoyable places. People usually think more about the positive features of lawns than their negative effects.

Lawns have many functions; they provide space for different activities and serve as arenas for social meetings and aesthetic pleasure. Lawns also have important symbolic values, since they are perceived as beautiful places, even when not used (Ignatieva et al., 2017). However, people do not only want to see monotonous lawns, but also a variety of outdoor spaces that provide conditions for additional activities and sensual stimulation (sound, smell, touch and sight). The majority of people preferred conventional, tidy green lawns, but more biodiverse meadow-like planting and, alternative to lawns grass-free (tapestry) lawns consisted of low-growing flowers, received positive feedback from many respondents (Ignatieva et al., 2017).

The project supported the findings of previous studies regarding the role of management intensity, which was included at the very centre of our transdisciplinary diagram (Fig. 4). Carbon sequestration, biodiversity, history and social studies clearly show that management routines shape our urban green spaces and influence people's aesthetical perceptions, as well as contribute to the visual and ecological homogenisation of urban environments.

The 'normative' urban lawn and the biodiverse lawn

The LAWN project indicated that social aspects and aesthetic habits influence the large-scale planning of lawns and routine management at the community or city scales (Ignatieva et al., 2017). However, there seems to be a need to challenge the existing paradigm of the 'tidy green' lawn and introduce more sustainable, resource-saving and cost-effective practices.

Comparisons with research on lawns in the United States and many other countries are difficult, as they are mostly based on private (suburban) lawns subjected to the use of chemicals (pesticides, herbicides, fertilizers) and water (Groffman et al., 2014). In Sweden, the main negative feature of lawn management is mowing (using fossil fuel-powered mowers), which affects biodiversity and the carbon footprint.

Increases in environmental awareness and sustainability debates are prompting searches for alternatives to the present normative monoculture lawn. Alternatives to conventional lawns are now emerging in public landscapes in projects in the UK, Germany, France and Switzerland. Our landscape architecture concept of establishing alternative lawns is mainly inspired by an acceptance and appreciation of Nordic 'meagre nature' (Ignatieva et.al., 2018).

The LAWN project demonstrated the need for change via a new generation of planning, design, and management policies that make urban environments more diverse, environmentally friendly and closer to nature. Urban managers, planners and designers need to be constantly updated about the research of different types of lawns and sustainable management. Through their dominance of urban spaces and association with a relatively recent idea of ‘urban nature’, lawns can become a universal model for the experimental design and monitoring of the urban environment.

In challenging times there is definitely a necessity for more transdisciplinary projects. The main goal of this article was to share the unique experiences and lessons of conducting transdisciplinary research and to make such complex research more successful.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author Statement

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This present version of the article “**Pros and cons of transdisciplinary research: A case study of Swedish lawns and their sustainable alternatives**” is a revised version of our manuscript. Following the editor’s recommendation, in we outlined in the Resonce to Reviewes all changes we have made in the manuscript.

We have changed the title of the manuscript. Now it is “**Pros and cons of transdisciplinary research: A case study of Swedish lawns and their sustainable alternatives**”.

We have also changed the **order of authors**. Now it is M. Ignatieva *, F. Eriksson, T.

Eriksson, T. Kätterer, P. Tidåker, Wissman, K. Ahrné, J. Bengtsson, M. Hedblom

The reason of this slight changes is to acknowledge the contribution of particular authors in writing and revision on this manuscript.

The corresponding author of this article is Dr. Maria Ignatieva, School of Design, University of Western Australia, 35 Stirling Highway, Perth, WA Australia, 6009. Email address: maria.ignatieva@uwa.edu.au Tel. +61426885125

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Figures

Fig. 1. Climate-zones showing examples of native vegetation (top), cultivated lawns (middle) and the most common lawn species (bottom). Photos: M. Ignatieva and J. Bengtsson.



Fig. 2. The unification of urban environments makes it difficult to distinguish between different parts of the world. From the top: Hyde Park, London (UK), Central Park, New York (USA), Safa Park, Dubai (UAE), one of public green spaces in Panama City (Panama), Fuxing Park, Shanghai (China), and one of public green spaces in Uppsala (Sweden). Photos: M. Ignatieva



Fig 3. Diagram of the planned transdisciplinary project. The four main areas overlap in terms of the main hypothesis, research questions, and some methodology. Management intensity was

hypothesized to be one of the central overarching influences on all aspects of lawns. Established stakeholders play an important role in research activity.

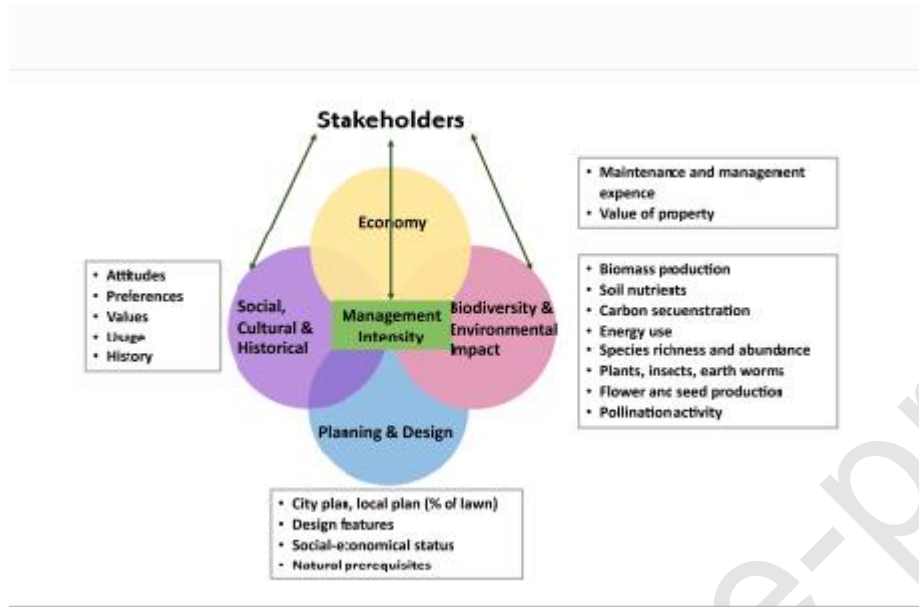


Fig. 4. Realised LAWN transdisciplinary project. Management intensity was confirmed to be the central factor. The practical output of the project (the book *How to create alternative lawns in Sweden and implemented sites in Uppsala and Stockholm*), implemented demonstration sites and the mass media attention gained were particularly valuable for stakeholders.

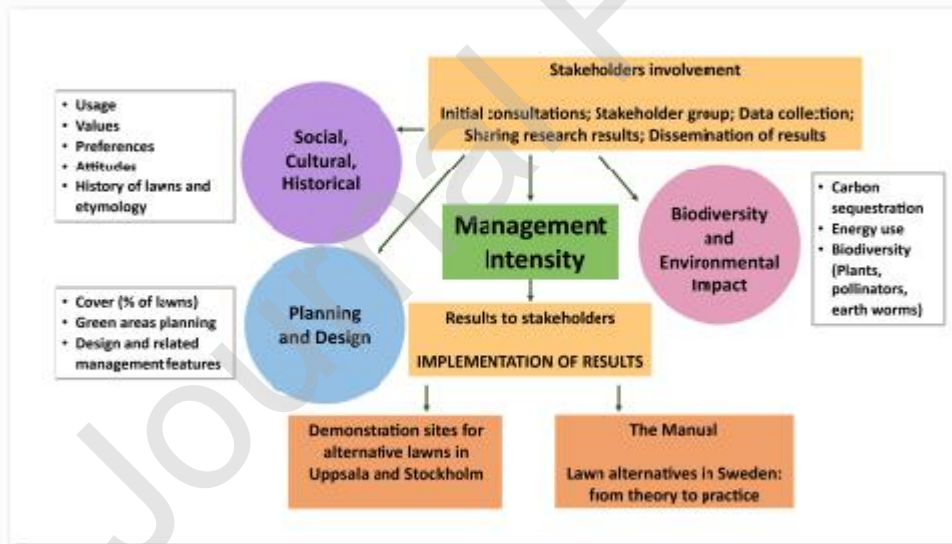
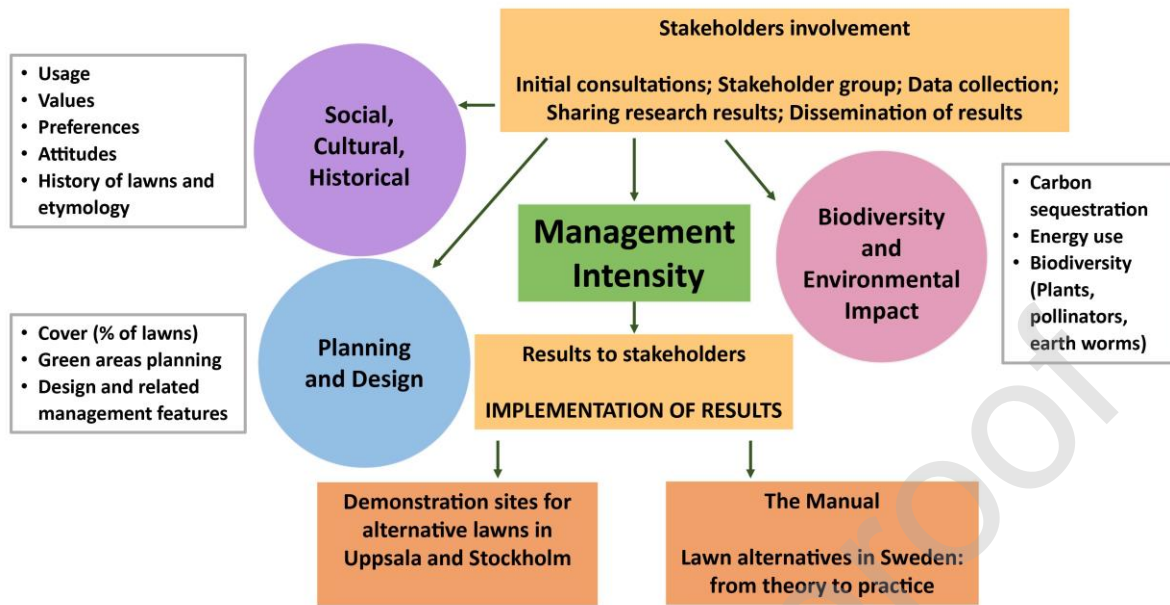


Fig. 5. Proportions of lawn cover in three types of housing areas in three Swedish cities.

