Chapter 10

Managing Forestry in a Sustainable Manner: The Importance of System Analysis

Ingrid Stjernquist and Peter Schlyter

Abstract This chapter examines from systems and livelihood perspectives, with Nemoral and Boreal forest zones of the Global North and Sweden as examples, how forestry may meet current and future sustainability challenges both as a traditional resource base and with respect to other ecosystem services. Previous and current forest policy/governance is briefly described against the background that Swedish forestry is based both on huge holdings by few industrial owners as well as on a multitude of small individual, often family owned, forest estates. Successful delivery against environmental objectives will require careful balancing of interests and the active participation of local forest owners. Cumulative effects of old and new societal demands on forestry and their impact on local livelihoods poses in this respect a systemic risk as economic and social sustainability often gets limited consideration. There is a need for a more synoptic and systemic analysis of how forestry is affected by multiple, partly contradictory, demands from an increasing array of stakeholders, in order to enable a move towards a biobased economy. Stakeholder-based group modelling is a potentially powerful analytic and conflict reducing approach that could help improve forestry's contribution to the acute need to handle the climate change and current sustainability challenges.

Keywords Forest management • System analysis • Stakeholders • Livelihood • Social sustainability • Cumulative effects

10.1 Introduction

Environmental and sustainability issues have scale and spatial dimensions. Traditionally, policies or action to address these types of issues has focussed on achieving improved outcomes with regard to the environmental effect or sustainability aspect,

I. Stjernquist (✉)

Department of Physical Geography, Stockholm University, Stockholm, Sweden

e-mail: ingrid.stjernquist@natgeo.su.se

P. Schlyter

Department of Spatial Planning, Blekinge Institute of Technology - BTH, Karlskrona, Sweden

© The Author(s) 2022

P. Künkel and K. V. Ragnarsdóttir (eds.), *Transformation Literacy*,

https://doi.org/10.1007/978-3-030-93254-1_10

issue by issue, at the spatial unit where the problem to be addressed occurred. As such, in most cases, trade-offs usually were between the outcome and the cost for regulating the issue (e.g., for the land owner, resource extractor, industry, regulator or consumer). While trade-offs between different policy objectives is nothing new, the overriding challenge of anthropogenic climate change, and the increasingly acute need to act against it, is likely to generate new and stronger conflicts between a number of environmental and sustainability issues at different scales and locations. This is particularly evident with respect to the ambition to reduce our reliance on fossil carbon for energy or for raw materials by increasing the use of biomass. Forests and forestry provide, a major potential resource for a biobased economy, a prime example of an area where conflicts between different environmental and wider sustainability policy objectives are likely to grow in the future.

The concept of sustainability, though widely embraced, has no generally accepted definition (Bennich, 2019). The concept has clear temporal and dynamic components, i.e., with regard to renewable resources their long-term productivity and rate of regeneration over time, but also a systems ability to function as a sink with respect to emission loads of various kinds. Additionally, it also has a problematic scale component; i.e., what is the appropriate spatial scale for assessing sustainability? While some aspects of sustainability like GHG emissions are relevant at the global scale, others are more meaningfully assessed at regional scales, at the extreme end of the local scale, the concept risks losing its utility. Nevertheless, at a general rhetorical level, the normative aspect of sustainable development would appear as relatively unproblematic and uncontentious even if the modern sustainability concept is continuously developing (Jordan, 2008).

10.2 A Livelihood Perspective

Forests are a resource that with wise use may be regarded as renewable. Forest management aiming for sustainable use is older than our current post-Brundtland debate on sustainability. An intensive use of the forest resource is not new. Increased need for forestry products in the Nordic countries in the early nineteenth century developed a forest management focused on long-term sustainable productivity. The concept of forest husbandry (Fritzbøger, 1994; Af Ström, 1837) illustrates this, and it is noteworthy that it was an object for French legislation as early as the seveneenth century (Glacken, 1967). The sustainability concept in modern terms is often, in the literature, linked to small-scale husbandry (Du Pisani, 2006), even when the perspective is more narrowly defined towards soil quality and productivity. Forest management and practices, however, vary enormously between different parts of the world, owing to the influence of a large number of factors, i.e., abiotic, edaphic and biotic conditions, social, legal, economic, technological, industrial and market conditions, as well as through path dependency with regard to most of these factors. Sustainable forestry requires the balancing of environmental, social and economic objectives, but the latter two aspects, affecting forestry dependent livelihoods, are,

nevertheless, frequently neglected in the sustainable forestry debate. This is due to the growing complexity of using forests as a resource and the unclear picture of causalities and the multi-effect consequences.

Finally, in discussing sustainable forest use, there may be a need to remind the reader that forests in Europe are cultural products. The forests were in no sense any wilderness but dynamic managed components in a man-made landscape changing over time owing to the resources needed. Also, ideas that the highest biodiversity is to be found in pristine forests in the Nemoral or Boreal zones reflect a false analogy with tropical rain forest. Ideas of pristinity or wilderness ought to be viewed with scepticism as they tend to reflect a romanticised, or outside Europe often an eco-colonial, perspective on forests and land use. Local people all over the world have managed and transformed forests and other habitats in various ways and degrees over centuries (Boivin et al., 2015; Lewis, 2007; Nelson & Callicott, 2008). Rachham (1998) stresses, in a European context, the importance of a mix of man-made and semi-open woodlands for creating a high biodiversity on the landscape level. The cultural landscapes of Europe by the end of the nineteenth century was composed of a mix of managed forests, pasture, and arable land, producing to the highest biodiversity over the last millennium both with regard to species and their distribution (Emanuelsson, 2009).

We use Swedish forest management as an example of forest management in the Nemoral to Boreal forest zones. Sweden, as the other Nordic countries, provide a useful example as it has ownership structures that represent both a large number of small-scale private (family) owners as well as a limited number of industrial corporate owners managing large tracts of land. As such it may be used to illustrate aspects of the complex environmental and social dynamics of sustainability. Over the last two centuries, these forests have been influenced by social, economic and environmental changes (Schlyter & Stjernquist, 2010) as well as a growing number of different stakeholder interests (Sverdrup & Stjernquist, 2002). The reader is cautioned against uncritically extrapolating arguments to institutional and ecological settings outside our geographical scope, e.g., the Global South.

10.3 New Challenges

Current concern over **climate change** and the attendant acute need to leave fossil carbon for energy, as well as a quest for renewable materials for a variety of uses currently based on fossil carbon, are strong drivers towards what has been termed a biobased economy. A more biobased economy is, however, likely to increase already existing conflicts between different uses of land (i.e., for food, raw materials, energy, conservation of biodiversity and landscapes) and the use of biomass, e.g., energy vs. food, food vs. raw materials, traditional biomass use vs. use for new materials or products, biomass use for use vs. as a carbon sequestration sink, etc.). Additionally, a wish to extract more biomass per unit area (be it for food, energy or raw materials) is likely to come in conflict with environmental concerns like biodiversity

loss, landscape impacts, eutrophication, long-term nutrient mass balance and soil productivity. Suggestions to fertilise forest to increase productivity is likely to result in competition with food production over globally scarce resources, e.g., phosphorous. The demands for increased biomass productivity, or paradoxically set aside for sequestration, are in some locations likely to come in conflict with local or indigenous land use. That is, the quest for global/large regional sustainability may conflict with local social and economic sustainability objectives. These issues will require careful consideration and a more multi-faceted and sensitive deliberation with a view to the larger social-ecological system than have hitherto often been the case. Given the urgency to address the climate challenge, the temptation to disregard complexity and systemic links between issues and at different scales, with attendant negative impacts on other aspects, scales and weaker stakeholders, is a risk to keep in mind.

The **boundaries for forest biomass productivity** are governed by climate, soil characteristics including nutrient content and other edaphic factors and, of course, forest management. Tree species composition and biodiversity reflect the basic conditions and constraints. Biomass extraction or rather the rate of nutrient export from the system beyond the influx either through weathering or fertilisation will over time cause nutrient deficiency. This will in turn impact the long-term biomass production negatively (Akselsson & Belyazid, 2018; Cartwright et al., 2020) and thus the degree to which a biobased economy can be supported. The need to mass balance the system should be considered as the hard outer boundary for biomass producing systems' long-term sustainability. The **time** perspective for assessing sustainability is fundamental as the effects of extraction, i.e., the nutrient loss, may only become apparent after several decades (Sverdrup & Stjernquist, 2002).

Under climate change, **biodiversity** in the Nemoral to Boreal forest zones will considerably change owing to higher temperature, changed precipitation volumes and patterns in space and time as well as more extreme weather conditions (Sverdrup & Belyazid, 2015).

Forest governance reflects technology, economic and other societal values, as well as current knowledge, at a given time. It also reflects path dependency, not only in the sense that e.g., legislation may reflect earlier values, but above all in the physical forest. Owing to the fact that a rotation period in managed Boreal forests is about a century, current stands, to varying degrees, reflect previous states of knowledge, values, economic incentives as well as legal demands and constraints. Forests are palimpsests, representing a complex mixture of biophysical conditions, processes, human influences and wills.

10.4 Forest Management in Perspective—Sweden as an Example

10.4.1 Forestry and Livelihoods

Over several hundred years forest estates have, as economic and ecological units, been managed by landowners for a multi-objective sustainable resource outtake while, at the same time, providing livelihoods. Forested land has historically been used mainly for grazing but also as a source for fencing, firewood, building materials, and tar. Selling timber and pulpwood to the forest industries is a relatively late, and initially unregulated, development that contributed, from the late nineteenth century, to an improved economical output for the farmer.

The forest legislation during the period from 1903 to 1970s can be considered as an deliberative period in Swedish forestry governance (Schlyter & Stjernquist, 2010), illustrated in the causal loop diagram (CLD) in Fig. 10.1. The forest owner's management load is driven by national forest policy through hard law (the Forest Act) and an advisory organisation which's advisory officers allowed for adaptation to local economic and ecological conditions in order to support livelihoods. This

Fig. 10.1 Outcome efficiency depends on owner planning activity, period 1903–1979. In this causal loop diagram (CLD), arrows are used to show causal relationships between system variables. If they move in the same direction, the arrow is marked with +, and if they move in the opposite direction the arrow is marked with -. Feedbacks are either reinforcing (R) or balancing (B)

approach results in higher production and owner income through the forest owner's management loop. This income reduces industrial profits counteracting forest (over) exploitation (the reason for the first Forest Act 1903). Reduced industrial profits increase the need for an increased forest policy and a more detailed hard law to balance the forest sector. The diagram also illustrates how other framing activities contribute to the forest owner's income, livelihood, while at the same time reducing the need for forest management

The official forest management objective shifted after 1979 towards optimising forestry's economic contribution to the national economy, geared to supply existing and planned industrial capacity and providing industrial employment (Appelstrand, 2007). The state deployed the forestry organisation to in detail monitor, control and, potentially, sanction the forest owner's activities against schematic regulations down to the stand level to maximise long-term production; resulting in well ditched, uniform, even-aged single species forest stands with resulting low biodiversity. A reaction against reduced owner influence, schematic management guidelines and negative environmental outcomes resulted in new forestry legislation 1993 where production and environmental concerns were given equal weight, forest owners given greater freedom to manage their forest based on local conditions, and the official monitoring and control apparatus was greatly reduced in size and cost. At the same time, non-forest sector demands on forestry practices grew, and forestry is now subject to, partly contradictory, soft law requirements like 16 national environmental objectives, set aside demands, market governance through certification and a multitude of sectorial and NGO demands of various kinds and weight without analysing the impacts on the livelihood for the local actor who produce the biomass or the effects on the resource volumes available for a biobased economy. Figure 10.2 summarises the situation. As in Fig. 10.1, the forest owner depends on wood extraction for livelihood and the income depends partly on national forest policy through hard law and advisory activity, shown in the left side of the CLD. However, the reinforcing loop in Fig. 10.1 is replaced by a nutrient deficiency balancing loop. An increased wood extraction increases the soil nutrient deficit, resulting in decreased forest stand production. The wood extraction is driven by the demand from forest industry and the biobased economy. The right side of the CLD illustrates how drivers external from the forest sector, like EU regulations and NGO activity, influence wood extraction and livelihoods. The key factor is management for ecosystem services, increased by national soft law. The demand of biodiversity management and protection (biodiversity set aside and voluntary set aside agreement) decrease the wood extraction. The demand for carbon sequestration to counteract climate change decreases wood extraction through land set aside. The reinforcing loop of increasing soft law increases the voluntary land set aside agreement increases management for ecosystem services, which increase the need for more soft law. This loop is driving the land set aside demand. The CLD illustrates the need for a systems view to achieve sustainable forestry at all levels and the high risk of stymieing a biobased economy owing to single issue actor influence.

Fig. 10.2 Factors influencing forest management, period 1999–2020. For explanation of the CLD structure, see Fig. 10.1. Broken arrows indicate policy linkages likely to increase in importance in the future

10.4.2 A Revised Forest Strategy

The increasing top-down requirements on the forest resource resulted in a National Forest Strategy for Sweden 2018 (Government Offices of Sweden, 2018). Following the advisory tradition of earlier Swedish forest management governance, the strategic objectives have been specified on a regional level and forest ownership is a key component. The process has been participatory in its approach including a wide array of stakeholders from different parts of the forest value chain in order to give legitimacy to the strategy.

10.5 Scale Conflicts and Future Tensions

Current demands on forest management and forest resource use emanating from different levels in society—e.g., through international law, various EU regulations, national law as well as from softer approaches like the SDG's, national environmental objectives and different certifications schemes, etc. This creates a highly complex

management context for the forest owners likely to generate conflicts between these various objectives as well as between scales and different stakeholders.

10.5.1 Global and Regional Scale Influence

Calls for using forests as a carbon dioxide sink, both with regard to soil carbon content and tree biomass, in order to mitigate climate change require longer forest rotation periods. As an objective, this will be in conflict with the need to increase the use of wood resources in a biobased economy in order to shift away from fossil carbon, which would push forest management towards a shorter rotation time span. This driver is likely to become very strong as society increasingly will need not only to change the energy and transport sectors from using fossil fuels but also change to an economy where biomass resources are needed as substitute for fossil carbon resources in general. Building a biobased market with new innovations and job opportunities will require substantial biomass production. The demand for forest resources may push forest management towards long-term unsustainability with regard to nutrients through a too large biomass extraction. A choice of fast-growing tree material may have similar results.

A management strategy based on fast-growing spruce monocultures or selection breed trees may result in negative soil nutrient feedback from a high wood demand and is worsened by the increased tree growth caused by the man-made nitrogen deposition during the last decades as well as the higher carbon dioxide content in the atmosphere due to climate change. A nutrient imbalance in European forest is already identified as having the potential to reduce biomass production (Jornard et al., 2015).

10.5.2 The Landscape Scale

The landscape scale is the appropriate scale for managing biodiversity conservation (cf. Angelstam et al., 2018; Michanek et al., 2018). This poses a challenge as forest ownership frequently is distributed between a large number of individual owners each with a relatively small holding. Practical management occurs at the estate level (whether small-scale private or large-scale company/industry owned), while the landscape is affected by a large number of landowners with varying preconditions, abilities, opportunities, degrees of freedom of action and objectives with regard to forest management. However, ongoing climate change with higher temperatures and changes in precipitation patterns will affect the forest biomes, habitats and biodiversity on the landscape scale. For large areas in the Boreo-memorial and Boreal zones, the currently dominating tree species will change from conifers to deciduous species, profoundly affecting forest type and dependent flora and fauna. While a higher temperature stimulates tree growth, it also increases the risks associated with both traditional and new exotic forest pests and pathogens (Bentz et al.,

2019). Together with decreased tree vitality owing to summer drought (Akselsson & Belyazid, 2018), the negative effect of insect outburst on forest biomass production is likely to reduce the resource input for a future biobased economy.

10.5.3 Potential Local Conflicts Between Different Aspects of Sustainability Objectives

From a societal perspective, many forest-related ecosystem services, besides the tree, have frequently been seen as free. Conflicts have frequently arisen over areas for biodiversity conservation (Niemi et al., 2005), less so with regard to nature reserves than in areas with a large number of designated key habitats where the forest owner is expected to set these aside without economic compensation. Maintaining biodiversity and traditional forest qualities requires older forests, usually less intense forest management, mixed age and species composition, i.e., a forestry yielding lower growth and delayed harvest (Sverdrup & Stjernquist, 2002).

10.5.4 Potential Conflicts Between Forest owner's Livelihood and Interests of National and International Objectives

Objectives of global climate governance, national and other public environmental objectives may come in conflict with social and economic sustainability at the forest owner scale. Such conflicts between collective and individual rationality may exist but are more likely to develop through 'mission creep', i.e., the aggregation of multiple, each by itself non-controversial restrictive demands. At some point, increased demands on the forest owners to produce ecosystem services for society will require adequate economic compensation, in particular for small-scale forest owners depending on forestry for their livelihoods (cf. Gren et al., 2021).

10.5.5 The Relationship Between Trust, Cooperation and Local Legitimacy in Forest Management

The gaps between the objectives of the actors directly involved in forest management and the increasing number of objectives defined outside the sector increase the scope for conflict over outcomes. Perceived poor delivery by the forest owner toward external demands is likely to increase demands for hard governance approaches; in particular from stakeholders otherwise lacking means to directly affect local outcomes. This may be exemplified by the Swedish Society for Nature Conservation forest policy from 2014, which suggested a shift in forest governance from the

Forest Act to the Swedish Environmental Code. Such a shift is based on the assumption that a potentially harder legal framework *a priori* would be more successful in securing biodiversity preservation and other values of nature. As an adaptive management taking local conditions into account is needed for retaining biodiversity and may be an objective in itself, local owners/managers need to be involved. An alternative is difficult to envisage, as it would require detailed monitoring of compliance as well as enforcement over large areas, about half the Swedish territory, and be costly but also in other respects problematic. The forest owners, who anyway will be the main actors implementing any forestry policy on the ground, need to find policy objectives and means proportionate for perceived legitimacy to ensure effective implementation. Trust in central authorities and objectives will be central for any effective policy implementation. As Ostrom (2007) noted, authorities often operate on simplified predicative models of more complex social-ecological systems thereby often employing poorly suited universal solutions of resource overuse. As demands on forestry have multiplied, management by objectives has seemed increasingly attractive as a governance strategy. This is partly a chimaera as the difficulty of prioritisation between, or rather balancing of, different objectives still are left to local actors. As, frequently, operational objectives at the actor level are lacking, self-monitoring or for that matter external monitoring becomes very difficult. This has the obvious effect that self-adjustment towards objectives in practical terms is near impossible. Additionally, some environmental objectives have the weakness that they are more of a vision. This is true both for the global SDGs and the Swedish environmental objectives. Objectives may be classified into those easily scientifically defined, monitored and possible to operationalize and in those that are more value based or utopian in character, e.g., the Sustainable Forest Objective (Emmelin & Lerman, 2008). Poorly defined objectives obviously risk an implementation deficit through poor delivery. Even clear objectives risk poor delivery, in particular in situations where monitoring and enforcement of existing environmental policies and agreements are lacking or under-funded. Legitimacy and trust are important prerequisites for bottom-up approaches in contrast to top-down governance based on control and sanctions. Finally, vague general objectives not only make for ambiguous operational objectives and difficult monitoring, opens for ‘mission creep’. Even voluntary agreements need clarity. Stakeholder legitimacy is at risk if the end point risks becoming a moving target (cf. Jordan, 2008).

10.6 Future Strategic Challenges Call for a Systems Perspective on Sustainable Forest Management

A growing number of interest/actors outside the forest sector, with varying degrees of single issue objectives, are likely to make it increasingly hard for forest managers

to deliver what may be deemed positive or reasonable outcomes by the stakeholder community. This development with multiple, frequently contradictory, societal demands, and policy objectives at different spatial and temporal scales is likely to increase further in the future; as will conflict over agendas and objectives. There will be a need to strike a balance between social, economic, and environmental sustainability if future forestry is to simultaneously contribute to a functional countryside, local livelihoods, a biobased economy and mitigating climate change as well as providing a wider set of ecosystem services. Single issue perspectives and seemingly simple solutions need to be avoided. Ineffective decisions often are an effect of a misalignment between an objective, reality and what is attainable (Kim & Andersson, 2012). Balancing between objectives will be needed if forestry is effectively to help meeting future economic, environmental and social challenges. The sustainability debate frequently focuses on the environmental aspects to the detriment of the social and economic aspects of sustainability (Schlyter et al., 2013). This is unfortunate, as the full triad is needed for policy legitimacy among a wider field of stakeholders and for achieving sustainable development in reality. Forestry, stepping up to the future challenges, will need to contribute towards global objectives, while at the same time at the local scale deliver sustainable livelihoods for forest owners and other actors as well as to locally acceptable outcomes with regard to ecosystem services, biodiversity and landscape values. This is a tall order, and success will require improved deliberative approaches to identifying conflicts and trade-offs between different societal and stakeholder objectives, at different scales, in order to arrive at working compromises seen as meaningful and legitimate by the involved parties.

Conventional consultations are unlikely to achieve the joint overview, social learning and shared understanding needed. In view of the negative silo governance effects illustrated in Fig. 10.2, we suggest that a systems approach through stakeholder group modelling is a more promising way forward in order to improve analysis and reduce conflicts over discourse (Schlyter et al., 2013). Ostrom (1998) identified trust as dynamically linked to reciprocity and reputation and, also, to cooperation for the common good. If the trust among local forest managers towards the authorities is low, the marginal costs for society is likely become high when it comes to effect change. Building a wider societal transformation literacy will require the use of local knowledge and involvement of a multitude of stakeholders (Kuenkel, 2019)—this calls for a systems thinking approach. A systems dynamic approach to forestry, with clear objectives and boundaries, will make the mental models of the different actors testable (cf. Kim & Anderson, 2012) through scenarios for sustainable forest management on different scales and geographical areas. Analysing feedback effects for alternative scenarios will improve decision making and deliberation on how to balance different objectives and management demands and helps avoiding imposing expert-driven top-down ‘solutions’. This concept was tested with forest owners on scenarios for forest growth, energy biomass extraction, soil acidification, and nutrient sustainability using a model of long-term soil nutrient balances (Sverdrup & Stjernquist, 2002) and later developed into an educational programme offered by the Swedish Forest Agency to Swedish private forest owners.

10.7 Conclusions

Given the acute and overriding interest at a global/national scale to use the forestry sector for reducing the climate change threat, this policy objective is likely to increasingly come in conflict with environmental concerns and social, economic and environmental sustainability objectives at local scales (Fig. 10.2). Careful considerations will be needed to balance different objectives and interests, not the least in order to ensure policy legitimacy with regard to global and national policy objectives. However, action is always local, as are some impacts, and local stakeholder interests need to be taken into account. This calls for a systems perspective analysing objectives, means and outcomes at different scales and for different stakeholders. A suitable approach needs to include dynamics and:

- An understanding of the forestry system, including soil, climate (including climate change dynamics) productivity and the vegetation components
- A systems perspective that allows the inclusion of major stakeholder perspectives in an analysis of biomass production, other ecosystem services, feedbacks, policy trade-offs and leverage points for system change
- A balancing of the components of ecological, economic and social sustainability
- A bottom-up and participatory approach involving forest owners and stakeholders for the development of trust between actors
- A learning process for all actors to reach transformation literacy

Developing integrated simulation models that allow assessments of different policy scenarios will be needed if gains and trade-offs are to be analysed with any precision by owners, industry, spatial planners and other stakeholders. Such models would also allow different stakeholders to analyse and game their interests and trade-offs for various scenarios. Models are available that allow analysis of the interplay between soil, hydrology, climate, air pollution, climate change, management and biomass extraction as well as for field layer biodiversity (Sverdrup & Belyazid, 2015; Sverdrup & Stjernquist, 2002).

References

- Af Ström, A. D. (1837). *Handbok för skogshushållare (Manual for Forest Husbandry)*. Nordströms Boktryckeri.
- Akselsson, C., & Belyazid, S. (2018). Critical biomass harvesting—Applying a new concept for Swedish forest. *Forest Ecology and Management*, 409, 67–73.
- Angelstam, P., Naumov, V., Elbakidze, M., Manton, M., Priednieks, J., & Rendenieks, Z. (2018). Wood production and biodiversity conservation are rival forestry objectives in Europe's Baltic Sea Region. *Ecosphere* 9(3). <https://doi.org/10.1002/ecs2.2119>
- Appelstrand, M. (2012). Developments in Swedish forest policy and administration—from a “policy of restriction” toward a “policy of cooperation.” *Scandinavian Journal of Forest Research*, 27(2), 186–199.

- Bentz, B. J., Jönsson, A. M., Schroeder, M., Weed, A., Wilcke, R. A. I., & Larsson, K. (2019). *Ips typographus* and *Dendroctonus ponderosae* models project thermal suitability for intra- and inter-continental establishment in a changing climate. *Frontiers in Forests and Global Change*, 2, 1. <https://doi.org/10.3389/ffgc.2019.00001>
- Boivin, N. L., Zeder, M. A., Fuller, D. Q., Crowther, A., Larson, G., Erlandson, J. M., Denham, T., & Petraglia, M. D. (2015). Ecological consequences of human niche construction: Examining long-term anthropogenic shaping of global species distribution. *PNAS*, 113(23), 6388–6396. <https://doi.org/10.1073/pnas.1525200113>
- Cartwright, J. M., Littlefield, C. E., Michalak, J. L., Lawler, J. J., & Dobrowski, S. Z. (2020). Topographic, soil, and climate drivers of drought sensitivity in forests and shrublands of the Pacific Northwest, USA. *Scientific Report*, 10, 18486. <https://doi.org/10.1038/s41598-020-75273-5>
- Du Pisani, J. A. (2006). Sustainable development – historical roots of the concept. *Environmental Sciences*, 3, 83–96. <https://doi.org/10.1080/15693430600688831>
- Emanuelsson, U. (2009). *The rural landscapes of Europe. How man has shaped European nature*. The Swedish Research Council Formas.
- Emmelin, L., & Lerman, P. (2008). Environmental quality standards as a tool in environmental governance – the case of Sweden. In M. Schmidt, J. Glasson, L. Emmelin, & H. Helbron (Eds.), *Standards and thresholds for impact assessment* (pp. 463–486). Springer. <https://doi.org/10.1007/978-3-540-31141-6>
- Fritzboøger, B. (1994). *Kulturskoven. Dansk skovbrug fra oldtid til nutid (Managed forests. Danish forestry in history until today)*. Gyldendal.
- Glacken, C. J. (1967). *Traces on the Rhodian Shore*. University of California Press.
- Gren, I.-M., Höglind, L., & Jansson, T. (2021). Refunding of a climate tax on food consumption in Sweden. *Food Policy* 100 (102021). <https://doi.org/10.1016/j.foodpol.2020.102021>
- Jornard, M., Fürst, A., Verstraeten, A., Timoner, A., Timmerman, V., Potocic, N., Waldner, P., Benham, S., Hansen, K., Merilä, P., Ponette, Q., De la Cruz, A. C., Roskams, P., Nicolas, M., Croise, L., Ingeslev, M., Matteucci, G., Decint, B., Bascietto, M., & Rautio, P. (2015). Tree mineral nutrition is deteriorating in Europe. *Global Change Biology*, 21, 418–430.
- Jordan, A. (2008). The governance of sustainable development: Taking stock and looking forwards. *Environment and Planning C: Government and Policy*, 26, 17–33.
- Kim, H., & Andersen, D. F. (2012). Building confidence in causal maps generated from purposive text data: Mapping transcripts of the Federal Reserve. *System Dynamics Review*, 28, 311–328.
- Kuenkel, P. (2019). *Stewarding sustainability transformations. An emerging theory and practice of SDG implementations*. Springer Nature Switzerland AG.
- Lewis, M. (Ed.). (2007). *American wilderness. A new history*. Oxford University Press.
- Michanek, G., Bostedt, G., Ekvall, H., Forsberg, M., Hof, A. R., de Jong, J., Rudolphi, J., & Zabel, A. (2018). Landscape planning- Paving the way for effective conservation of forest biodiversity and a diverse forestry? *Forests*, 9(9), 523.
- Nelson, M. P., & Collocott, J. B. (2008). *The great wilderness debate rages on—Continuing the great new wilderness debate*. University of Georgia Press.
- Niemel, J., Young, J., Alard, D., Askasibar, M., Henle, K., Johnson, R., Kurttila, M., Larsson, T.-B., Matouch, S., Nowicki, P., Paiva, R., Luigi Portoghesi, L., Smulders, R., Stevenson, A., Tartes, U., & Allan Watt, A. (2005). Identifying, managing and monitoring conflicts between forest biodiversity conservation and other human interests in Europe. *Forest Policy and Economics*, 7, 877–890.
- Ostrom, E. (1998). Behavioral approach to the rational choice theory of collective action: Presidential address, American Political Science Association, 1997. *The American Political Science Review*, 92(1), 1–22.
- Ostrom, E. (2007). A diagnostic approach for going beyond panaceas. *PNAS*, 104(39), 15181–15187.
- Rachham, O. (1998). Savanna in Europe. In K. J. Kirby & C. Watkins (Eds.), *The ecological history of European forests*. CAB International.

- Government Offices of Sweden (2018). Accessed March 6, 2021, from <https://www.government.se/information-material/2019/01/fact-sheet-swedens-national-forest-programme/>.
- Schlyter, P., & Stjernquist, I. (2010). Regulatory challenges and forest governance in Sweden. In K. Bäckstrand, J. Kahn, A. Kronsell, & E. Lövbrand (Eds.), *Environmental politics and deliberative democracy*. Edward Elgar Publishing Limited.
- Schlyter, P., Stjernquist, I., & Sverdrup, H. (2013). Handling complex environmental issues—Formal group modelling as a deliberative platform at the science-policy- democracy interface. In M. Schwanninger, E. Husemann, & D. Lane (Eds.), *Proceedings of the 30th international conference of the system dynamics society at St. Gallen, Switzerland, July 22–26, 2012*, (vol. 4, pp. 3525–3539).
- Sverdrup, H. U., & Stjernquist, I. (2002). *Developing principles for sustainable forestry in Sweden*. Kluwer Academic Publishers.
- Sverdrup, H. U., & Belyazid, S. (2015). Developing an approach for Sweden, Switzerland, United States and France for setting critical loads based on biodiversity including management, pollution and climate change. *Ecological Modelling*, 306, 35–45.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.