The Role of Science in Environmental Governance: Competing Knowledge Producers in Swedish and Norwegian Forestry

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Scientific knowledge plays a role in the management of diffuse, transboundary and complex environmental problems. In recent years, knowledge of the effects of forestry on biodiversity and ecosystem services such as wildlife habitats, flood mitigation, and climate stabilization has featured prominently in discussions about environmental protection in forestry. Deforestation and loss of biodiversity in tropical forests have been the main concerns internationally, but there is growing recognition that loss of biodiversity and environmental degradation constitute serious threats to all types of forest.

This study examines the influence of scientific knowledge in rule-making processes aimed at enhancing environmental protection in Swedish and Norwegian forestry. Since Sweden and Norway have large forested areas and major forest industries, environmental protection measures are likely to affect a number of forest owners and forest companies. In recent years, both countries have adopted new policies and instruments to enhance environmental protection in forestry. However, while Sweden is in the process of protecting five percent of its forestland and has created a number of small reserves, Norway has thus far protected only one percent and is lagging behind in the set-aside of small reserves. Moreover, voluntary forest certification standards generally appear more stringent and demanding in Sweden than in Norway. These differences are surpris-

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ing, given that the two countries are quite similar in terms of forest ecology, dependence on paper products exports, administrative traditions, and relationship between business, NGOs, and the state. This study explores whether the differences in performance of Sweden and Norway can be explained by variation in the state of knowledge about environmental protection needs; the access of different stakeholders to the science-policy dialogue; and the distribution of costs and benefits in the forestry sector.

The article is organized as follows. Section two sets out the analytical approach. Section three describes the findings on knowledge and environmental protection policies in Norway and Sweden. Section four discusses the cases in light of the analytical approach. Section five discusses the lessons of the study and implications for future research.

Exploring the Science-Policy Interface

In exploring the science-policy interface, this article draws on what we may call a rational-instrumental approach, a political-institutional approach and a political economy approach to studying science and politics. The *rational-instrumental approach* sees science as providing verifiable facts about reality on which rational policy decisions can be based. Science is viewed as a source of facts and theories about environmental problems that can and should settle disputes, guide policy-makers, and influence political action.[1] The rational-instrumental approach assumes that policy-makers generally recognize scientific research as a major supplier of credible and salient knowledge; that they rarely explicitly dispute what the scientific community considers to be consensual and certain knowledge; and that they are more likely to take some kind of action to address (urgent) environmental problems in a climate of scientific consensus and certainty than of controversy and uncertainty.[2] We would expect, then, that the level of *scientific consensus and certainty* is related to the influence of knowledge on policies.[3] In particular, rationalists would expect that the greater the level of scientific consensus and certainty, the greater the influence that knowledge is likely to have in the rule-making process. Divergence in the stringency of environmental protection measures could then be explained by variation in the state of knowledge about the problem at hand.

To investigate this proposition, we attempt to establish the level of scientific consensus and certainty in assessments of environmental protection needs in forestry. We would expect a high level of scientific consensus and certainty to facilitate the integration of environmental protection measures into forest policy. Conversely, the absence of consensus and certainty would likely impede the integration of such measures. It should be noted, however, that a

1. Sarewitz 2004.
2. Andresen et al. 2000.
3. Underdal 2000.

high level of consensus combined with low certainty could also result in environmental protection measures. This is precisely what the precautionary approach prescribes: when there is consensus that we do not know the environmental risk associated with a particular problem, we should take precautionary action to minimize the risk.

The *political-institutional approach* to the science-policy interface challenges the assumption that "science speaks truth to power" and the idea that scientific objectivity is divorced from the political aims and values of interest groups and governments. Elaborated in the "social studies of science" literature, scholars criticize the rational-instrumental approach for separating knowledge and science from the world of politics.[4] In the idiom of *coproduction* of science and social order, there is a "constant intertwining of the cognitive, the material, the social and the normative."[5] Jasanoff explains coproduction as "shorthand for the proposition that the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it."[6] Scientific knowledge is not independent of political context but is produced by scientists who are embedded in particular natural and social orders. Political-institutional work on the negotiated boundary between science and policy focuses on the interactions between scientific inquiry and political processes, and the ways in which the production, framing and use of knowledge shape policy outcomes. Since the resolution of environmental problems not only requires scientific autonomy but also interaction between knowledge producers and policy-makers, this work analyzes the role of political actors, interest groups, and institutions at the science-policy interface.[7]

In this study, we are particularly interested in knowledge producers with privileged *access* to the science-policy dialogue and the nature of the scientific information they produce or consider relevant. The policy style or particular way of policy-making and implementation in Norway and Sweden is often referred to as "the Nordic model," characterized by close interaction between the regulators and the regulated, extensive participation of major interest organizations, and the dominance of consensual, give-and-take decision-making.[8] With the accent on state-centered corporatist solutions, the state defines what counts as valid knowledge and knowledge production, and tends to absorb ideas and initiatives that emerge outside the established system of science-policy interactions. In a system favoring close interaction between regulators and the regulated, strong interest groups will also have a stake in knowledge production and policy development. However, with the emergence of new policy instruments at the science-policy interface—forest certification schemes being an example—

4. See, for example, Jasanoff 1987, 1990, 2004; and Jasanoff and Martello 2004.
5. Jasanoff 2004, 6.
6. Jasanoff 2004, 6.
7. See, for example, Litfin 1994; Andresen et al. 2000; Social Learning Group 2001a and 2001b; Cash, Clark et al. 2003; Dimitrov 2006; and Mitchell et al. 2006.
8. See, for example, Olsen, Roness, and Sætren 1982; Richardson 1982; and Micheletti 1995.

other knowledge producers and stakeholders will be encouraged to take part in the science-policy dialogue. As such policy instruments proliferate, the traditional research sector will face increasing competition from other producers and users of knowledge that can influence environmental rule-making.

The political-institutional approach leads us to expect that divergence in the stringency of environmental protection measures can be explained by variation in the access of various knowledge producers and users to the science-policy dialogue. Specifically, we would expect more stringent environmental regulations in the country in which environmental stakeholders had wider access to the science-policy dialogue. We therefore have to examine the access to the science-policy dialogue of a broad range of stakeholders such as various research communities, environmental NGOs, and forest industry associations.

The *political economy* approach to the science-policy interface focuses on the extent to which the influence of knowledge depends on how environmental problems and solutions are related to the distribution of costs and benefits within specific sectors and society at large. Private goods are only available to those able and willing to share what it costs to obtain them, or to whom providers decide to give access to the goods. By contrast, public goods are benefits that cannot be denied to anyone once the goods are provided; they are nonexclusive and available for all to consume.[9] Differences in private and public benefits may result in failure to provide ecosystem services such as biodiversity conservation and wildlife habitats; resource managers will tend to provide too little of ecosystem services when the benefits primarily go to the public.[10] This perspective leads us to expect that those policy measures most easily implemented are those that provide benefits to a specific sector or group while they distribute costs throughout society. Conversely, policy measures that have diffuse benefits but concentrated costs, will prove more difficult to implement.[11] We would expect, therefore, that consensual knowledge is less likely to influence policy when costs are concentrated within certain sectors or segments (and benefits are distributed) than when costs are widely distributed (and benefits are concentrated). In short, contrary to the rational-instrumental approach, the political economy approach would lead us to expect that science will influence policymaking when economic stakes are low; when stakes are high, science will have little or no influence.[12]

The political economy approach leads us to expect that divergence in the stringency of environmental protection measures in forestry is explained by variation in the distribution of costs and benefits in the Swedish and Norwegian forestry sectors. As many environmental protection measures in forestry are likely to be costly for landowners while the benefits are likely to be widely distributed throughout society, forest owners and their associations could be

9. Olson 1965.
10. See, for example, Perrings and Gadgil 2003, 535.
11. Underdal 1998, 14–15; and Underdal 2000; see also Wilson 1973.
12. See also Collingridge and Reeve 1986.

expected to mobilize to prevent the enactment of such measures. The misalignment of the public's and resource managers' interests would impede environmental protection efforts. On the other hand, forest companies could benefit from implementing environmental protection measures, especially if exposed to substantial societal mobilization or strong market demands to protect the environment. In particular, large forest companies involved in timber extraction, processing and sales may be more likely than small forest owners to acquiesce to advocacy group pressure to adopt environmental standards, owing to their public and market exposure.[13] Moreover, large forest companies may find it easier than small forest owners to comply with some environmental policies, such as set-aside requirements, owing to economies of scale. We therefore have to consider ownership patterns and forest industry structure in Sweden and Norway when analyzing the distribution of benefits and costs related to environmental protection measures.

To summarize, based on each of the three approaches to studying the science-policy interface, we propose that the differences in the environmental stringency of forest policy in Norway and Sweden can be explained by variation in: 1) the state of knowledge about environmental protection needs; 2) the access of various stakeholders to the science-policy dialogue; and 3) the relationship of the environmental problem and its solutions to the distribution of costs and benefits in the forestry sector. These are largely alternative rather than complementary propositions, but they can be combined to explain outcomes of different rule-making process. For example, in state-driven processes, variation in the state of knowledge or in the access to the science-policy dialogue may explain the different performance of Norway and Sweden, whereas in forest certification processes, variation in the distribution of costs and benefits in the forestry sector may have greater explanatory power. Of course, other explanations are possible, not related to the science-policy interface, but our interest in this study is primarily in exploring the influence of knowledge in rule-making processes. The comparative case-study design allows for an in-depth study of the science-policy interface and a systematic examination of similarities and differences between the cases.[14] This research design is used in combination with process-tracing within each case, identifying causal chains of events and path dependencies that resulted in particular outcomes.[15] The data in the study consists of primary documents such as scientific reports, environmental assessments and public policy documents; 22 interviews with researchers, policymakers, environmentalists and forest owners; and secondary sources.[16]

13. Cashore, Auld, and Newsom 2004.
14. Collier 1993.
15. George and Bennett 2005.
16. 12 interviews in Norway were carried out in 2001, 2003 and 2005 while 10 interviews in Sweden were carried out in 2005. All interviewees have been granted anonymity.

Scientific Knowledge and Environmental Protection in Forestry

Three strategies are used in Sweden and Norway to enhance environmental protection in forestry: 1) mapping and protecting small reserves; 2) establishing a network of large reserves; and 3) establishing forest certification standards in all commercial forestry.[17] In what follows, we compare and contrast the development of these strategies in the two countries.

Mapping and Protecting Small Reserves

Methods for mapping habitats of great value for threatened species have important policy implications for environmental protection measures in forestry. Here, the concept of "key biotopes" and the implications of adopting the so-called "key-biotope method" to environmental protection in forestry are of particular interest. In the early 1990s the Swedish Forest Agency developed a method for identifying and registering what they called key biotopes in forests.[18] A comprehensive research project, including a number of field studies, was carried out and a number of reports published before and during the first phase of the Swedish inventory of key biotopes, from 1993 to 1998.[19] The concept and method explicitly linked biological hotspots to the identification of habitats with red-listed (threatened and vulnerable) species. Since many red-listed species are hard to find and identify, the Forest Agency compiled a list of 350 "indicator species" through interviews with species experts. The use of indicator species to identify "species richness" is based on the assumption that there is a strong clustering of species in certain forest areas. Whereas the common species are expected to be found everywhere, rare species are expected to occur only in the richest sites. One implication is that if species within certain well-defined ecological communities is strongly clustered, then biologists could identify indicator species in order to map biological hotspots with great biodiversity.[20] The use of such indicator species is appealing because it is easier to identify a few indicator species than to map all species within a certain ecological community.[21]

The Swedish Forest Agency tasked ecologists with identifying key biotopes on all private forestland (i.e. land controlled by small, non-industrial owners), while ecologists employed by forest companies and other large owners mapped key biotopes on their land. Between 1993 and 1998, the authorities conducted the first phase of a large-scale inventory of key habitats on all small private forestland in Sweden, totaling almost 12 million hectares of forestland. The completion of the inventory was planned in a second phase between 2001 and 2003, but it is still not completed (2007). Thus far, the Swedish Forest Agency

17. Liljelund, Pettersson, and Zackrisson 1992; and Eckerberg 2000, 239.
18. Swedish Forest Agency 1991.
19. Swedish Forest Agency 1999.
20. See, for example, Honnay, Hermy, and Coppin 1999; and Jonsson and Jonsell 1999.
21. Jonsson and Jonsell 1999; Gustafsson 2000; and Sætersdal, Gjerde, and Blom 2005.

has mapped 56,000 key biotopes on land belonging to private, small forest owners.[22] While progress in protecting these habitats has been slow as a result of the cost of buying forestland and budgetary constraints, the Swedish government has adopted quite ambitious habitat conservation objectives and provided funding for land purchases and compensation to landowners for the creation of small reserves of up to five hectares each.[23]

In Norway, the NGO Last Chance quickly adopted the key biotopes concept and published the book *Key Biotopes and Diversity of Species in Forests* (in Norwegian) intended as a reference for identifying small reserves.[24] Inspired by One Step Ahead in Sweden, a group of environmentalists dedicated to protecting forests, Last Chance was founded in 1992 by a group of biologists and biology students as a subgroup of Friends of the Earth in Norway. Similar to the Swedish inventory, the method they developed was based on the identification of certain indicator species in the field, in particular those on the Norwegian Red List of threatened and vulnerable species, as a tool to map woodland key habitats.

While the Swedish government tasked the Forest Agency with defining the concept of key biotopes and developing a method for field mapping of forest biodiversity, the Norwegian Ministry of Agriculture in 1996 responded to the method developed by Last Chance by setting up a large-scale research project named "Environmental Inventories in Forests" to develop a "scientifically documented method" for woodland habitat mapping.[25] The Ministry of Agriculture questioned the scientific validity and usefulness of the Norwegian Red List and claimed that it was necessary to develop an alternative to Last Chance's methodology for environmental inventories of forests. The Norwegian Forest Research Institute, a state-owned but autonomous research institute under the Ministry of Agriculture, was tasked with developing the method. In total, the research institute received 50 million NOK (about 8 million USD) for the work.

The research group concluded that indicator species of species richness—such as those used by Last Chance and by the Swedish Forest Agency—should not be used as indicators of biological hotspots because they did not find evidence that mapping indicator species was useful for identifying species richness in particular sites. According to the researchers, the selection of indicator species often seemed to be based on the intuition of species experts and anecdotal information rather than empirical testing. They concluded that in practical site selection of small reserves, indicators related to amount and quality of habitats—such as dead wood, old trees, deciduous trees and cliffs—should be used in combination with identification of vascular plants instead of lists of indicator species of species richness. Their results were later published in a report[26] and

22. Swedish Forest Agency 2006, 109.
23. Swedish Environmental Objectives Council 2006, 61.
24. Haugseth, Alfredsen, and Lie 1996.
25. Norwegian Ministry of the Environment 2000–2001, 118.
26. Gjerde and Baumann 2002.

several journal articles,[27] but at the time, no results from the project had been published.

After being presented with the project results in 2000, the Norwegian Ministry of Agriculture concluded that the new method developed by the researchers, unlike earlier inventories, was based on the best available knowledge and advised against letting the old method based on inventories of key biotopes inform forestry practices. By proposing a grant to stimulate voluntary environmental incentives in forests, the Ministry could be said to monopolize the method. Eligibility for the grant requires forest owners to use the habitat mapping method developed by the Norwegian Forest Research Institute or "similar scientifically documented methods."[28] In practice, alternative methods, including that developed by Last Chance, have been dismissed as not meeting this latter criteria.[29] According to the new method, deemed by the Ministry as scientifically documented, responsibility for environmental inventories lies with forestry planners, usually employed in forest owners' associations, or companies owned by these associations. Forestry technicians would now be doing work previously done by biologists.[30] The Norwegian Ministry of the Environment objected to this policy and claimed that other methods for mapping smaller forest conservation areas also should qualify for receiving grants,[31] but their objections were ignored.

In 2003, environmental organizations in Norway responded to the Ministry of Agriculture's handling of the forest biodiversity mapping project by filing an official complaint to the National Committee for Research Ethics in Science and Technology (NENT), an independent expert committee established by Parliament in 1990, accusing the Ministry of inappropriate allocation of research funds and use of research results. The issues were discussed in a public hearing held by NENT in 2004.[32] The environmentalists pointed out that the Ministry had dispensed the research grant to the Norwegian Forest Research Institute without collecting tenders from other research institutes, and supported the new method before any results from the research project had been published or scrutinized by other stakeholders. This meant, according to the environmentalists, that the Ministry was more concerned with developing a method favorable to forest owner's interests than one based on the best available knowledge.

Equally important, the environmental organizations did not accept the results of the research project. The environmentalists asked the committee to consider whether the researchers had deliberately sought to discredit the concept of "key biotopes"; whether the researchers had yielded to pressure from the Minis-

27. Sætersdal et al. 2003; Gjerde et al. 2004; Rolstad et al. 2004; and Sætersdal, Gjerde, and Blom 2005.
28. Norwegian Ministry of Agriculture 2001.
29. Gulbrandsen 2003, 104.
30. Gulbrandsen 2003, 104.
31. Norwegian Ministry of the Environment 2001.
32. The author participated as an observer at the public hearing.

try of Agriculture by designing a method that would provide less protection to red-listed species and natural forests than alternative methods; and whether the researchers had ignored arguments put forward by other research communities. They also pointed out that the Swedish forest inventory method, unlike the new method in Norway, was based on identification of key habitats for threatened species.

The researchers and the Ministry of Agriculture denied these allegations. The researchers pointed out that the project had issued a main report in 2002, and that a number of scientific articles flowing from the project had been published more recently. They argued that the new environmental inventory method would result in conservation of more forestland and larger areas than the method preferred by the environmentalists. And they claimed that the Swedish method of selecting woodland key biotopes had several weaknesses, including a bias toward sites with red-listed plants at the expense of sites with other species groups (e.g. invertebrates). The forestry authorities in the Ministry denied having exerted pressure on the researchers to produce results favorable to the forest owners or to support a method forest owners would find easy to apply.

In the end, NENT concluded that the researchers and the Ministry of Agriculture had not behaved unethically in the development of the new method. The disagreement over the method, according to the committee, stemmed from the complexity of the issues and scientific uncertainty rather than political considerations. The committee found, however, that the Ministry could have handled the research project better and would have avoided some of the controversy if it had given the biologists in Last Chance, environmental organization representatives and other stakeholders a greater role in the process.[33]

While there is scientific uncertainty about the most useful methods to map forest biodiversity, and discussions continue, Sweden has clearly done more to map and protect small reserves than Norway. Sweden has mapped a number of woodland key habitats, adopted concrete conservation objectives, and provided limited funding for the protection of such habitats. By contrast, identification and conservation of small reserves in Norway is entirely based on voluntary measures and the authorities have not adopted any conservation objectives.

Protecting Large Reserves

The development of plans for a network of large forest reserves is among the most wide-ranging efforts to enhance environmental protection in Swedish forestry. Since the initiation of such plans in the 1970s and 1980s, the reports and recommendations produced by researchers have informed forest protection discussions. More recently, in 1997, the Swedish Environmental Advisory Council,

33. NENT 2004.

composed of 22 members primarily from the scientific community and chaired by the Minister for the Environment, presented a seminal report about the need for forest protection. The Council recommended that in the short term (10–20 years) an additional 900,000 hectares of forestland needed protection and in the long term (about 40 years) some 9–16 percent of the forestland should be protected.[34] Environmental organizations welcomed the report and have used it to support their claims about the need for a substantial increase in the level of forest protection in Sweden. A few years later, the Swedish Parliament followed the Council's recommendation; the new target was for a further 900,000 hectares of forestland of high conservation value to be protected by 2010. The Government is tasked with protecting 400,000 hectares of this area, while forest owners are expected to set aside a further 500,000 on a voluntary basis.[35] While the situation looks quite promising with regard to voluntary undertakings, progress in setting aside forestland in nature reserves has progressed quite slowly. According to the Swedish Environmental Objectives Council, the Government's target will not be met until 2020 given current funding and existing price levels for forestland.[36] The forest areas in nature reserves and national parks are primarily located in the montane zone in northern Sweden while areas safeguarded by habitat protection and nature conservation agreements are primarily located in southern and central parts of the country.

While Sweden is in the process of protecting five percent of its productive forests, Norway has thus far only protected about one percent of the productive forestland. The Norwegian Institute for Nature Research (NINA) has recommended protection of at least 4.5 percent of the productive forests in Norway.[37] Remaining wilderness areas in Norway have decreased significantly, from 48 percent in 1900, to 34 percent in 1940, to 12 percent in 1995 and only five percent in southern Norway.[38] In environmental performance reviews, the Organization for Economic Co-operation and Development (OECD) has repeatedly criticized Norway's poor protection of coniferous forests, which is far below scientific recommendations.[39] Norway's poor performance on this indicator is also highlighted in an evaluation report of protected forestland by NINA from 2002:

> Compared to Sweden and Finland which have protected 4–5% of their productive forest area, Norway has so far protected less than 1% of productive forest. Protected forest is not representatively distributed by geography or natural gradients, showing insufficient protection for Eastern Norway, for

34. Statens Offentlilga Utredningar 1997.
35. Of the area that is to be protected by the government, 320,000 ha are to consist of nature reserves; 30,000 ha of habitat protection areas; and 50,000 ha are to be covered by (voluntary) nature conservation agreements.
36. Swedish Environmental Objectives Council 2006, 61.
37. Framstad et al. 2002.
38. Norwegian Ministry of the Environment 1996–1997. Wilderness areas are defined as areas which are at least five kilometers away from the nearest technical intervention.
39. OECD 1993 and 2001.

Table 1
Area of National Parks and Forest Reserves (1000 Ha)[41]

	Productive forests		*Poorly productive*		*Other land*		*Total land area*	
	Norway	*Sweden*	*Norway*	*Sweden*	*Norway*	*Sweden*	*Norway*	*Sweden*
North boreal	34	534	147	1335	1180	1515	1361	3384
Mid boreal	18	108	7	72	19	60	44	240
South boreal	5	28	1	8	6	7	12	43
Hemi boreal	8	77	2	39	5	42	15	158
Nemoral	1	18	0	14	0	6	1	38
Total area	66	765	157	1468	1210	1630	1433	3863

> the nemoral, boreonemoral and south boreal vegetation zones, as well as for low-lying forests in all regions.[40]

In sum, Sweden has moved faster in complying with scientific recommendations on forest protection levels than Norway. Table 1 shows the area of national parks and forest reserves in Norway and Sweden.

Establishing Forest Certification Standards

The Forest Stewardship Council (FSC) was established by private initiative in 1993 to provide a voluntary, market-based certification and labeling scheme. In Sweden, in 1994, an informal group of scientists and stakeholders formed by WWF Sweden and the Swedish Society for Nature Conservation worked out a set of criteria for conservation of biodiversity in Swedish forestry. At the initiative of these organizations, a Swedish FSC working group was established in 1996, with participation from all the major environmental groups, the indigenous Sámi people, the large forest companies, non-industrial forest owners' associations, and other players. By the end of 1997, the members of the working group, with the exception of the forest owners' associations, had agreed on a Swedish FSC standard. All large Swedish forest companies were subsequently certified by the FSC, totaling almost 40 percent of the Swedish forestland. The forest owners' associations in Sweden decided to pull out of the FSC working group owing to disagreement over environmental standards and the indigenous Sámi people's rights related to reindeer herding on private forestland in the northern region.[42] Following their withdrawal from the FSC working group, they developed their own standards and contributed to the creation of the Pan

40. Framstad et al. 2002, 3.
41. Adapted from Stokland et al. 2003, 88.
42. See Elliott 1999, 385–387; and Cashore, Auld, and Newsom 2004, 204.

European Forest Certification scheme, since 2003 known as the Programme for the Endorsement of Forest Certification (PEFC).

By contrast, in Norway, the 1995–98 Living Forests project was established by the Norwegian Forest Owners' Federation, representing the forest owners' associations in Norway, and Norske Skog, the only major Norwegian pulp and paper company, to work out national standards for sustainable forestry and to build environmental skills among forest owners. Environmental organizations and other NGOs participated in the project. All participants in the Living Forests project agreed on 23 standards for sustainable forest management in 1998. These standards, accompanied by criteria and indicators, were used to certify forest owners' associations. However, because WWF and the Norwegian Society for Nature Conservation wanted the standards elaborated with a view to certifying forestry operations, they suggested setting up a Norwegian FSC working group to adapt the Living Forests standards to FSC's principles and criteria. The forest owners rejected the proposal and opted instead for the International Organization for Standardization (ISO) environmental management system standard ISO 14001 in combination with the performance level defined by the Living Forests standards. Following disagreement with the forest owners over the interpretation and implementation of some of the key standards, the environmental organizations in 2001 withdrew their support for the Living Forests scheme. Currently, about 90 percent of the forestland in Norway is certified in accordance with the Living Forests standards, which are endorsed by the forest owner dominated PEFC umbrella scheme.

The Swedish FSC standards are generally more stringent and demanding than the Norwegian Living Forests standards. The most salient difference is that while the FSC requires at least five percent of the most biologically valuable forestland to be permanently set aside, the corresponding figure in the Living Forest standard is about one percent.[43] The tension between FSC and PEFC supporters in Sweden and Norway is part of a broader worldwide competition for credibility, rule-making authority and landowner support. While FSC provides prescriptive performance-based standards, PEFC-endorsed schemes tend to place greater weight on organizational measures, procedural rules, and discretion in forest management.[44]

Discussion

On all issues examined, namely the protection of small reserves, the protection of large reserves, and the making of forest certification standards, Sweden has enacted more stringent environmental rules and policies than Norway. The following section discusses whether these differences can be explained by variation in: 1) the state of knowledge about environmental protection needs in forestry;

43. Gulbrandsen 2005.
44. See Cashore, Auld, and Newsom 2004; Gulbrandsen 2004; and Humphreys 2006.

2) the access of stakeholders to the science-policy dialogue; or 3) the distribution of costs and benefits in the forestry sector.

State of Knowledge

Knowledge about biological diversity and ecosystem services features prominently in forest policy discussions and all stakeholders now seem to accept environmental protection as a legitimate objective. The 1992 Convention on Biological Diversity established global principles and norms that, *inter alia,* require the parties to the convention to protect ecosystems, natural habitats and viable populations of species in their natural surroundings.[45] Ecosystem services are the benefits provided by ecosystems to people.[46] Forests provide a number of valuable ecosystem services, including commodities such as timber and fuel, and services such as wildlife habitats, erosion control, water filtration, and carbon sequestration. In the course of only a few years, what we now know of forest biodiversity and ecosystem services has fundamentally changed the ways in which public authorities, environmentalists and forestry interest organizations talk about and discuss environmental protection in forestry.[47] Whereas a few decades ago science was primarily used to increase productivity and yield, knowledge about the environmental effects of forestry is now seen as salient and relevant to policy-making.

In public discourses, all stakeholders seem to agree that forest companies and forest owners must take account of environmental considerations in all forestry operations. There is wide consensus among researchers on promoting certain forestry practices, for example leaving dead wood, setting aside biodiversity hotspots, and restricting forest road construction and other technical interventions in forestry operations. However, they disagree about the proportion of forestland to be protected to conserve biodiversity; the use of indicator species of species richness; how to identify particularly valuable forest areas for conservation; and how to quantify necessary protection measures. The effect of forestry practices on biodiversity is an extremely complex issue. According to one estimate, 17 percent of the forest-dwelling species on the Norwegian Red List are threatened by forestry, 13 percent are at risk from other threats, while the threat to the remaining 70 percent is unknown or inconclusive.[48] In some cases the effect of environmental protection measures on ecosystems may be impossible to detect in the short term; some effects may not appear for 100 years or more. And how we measure the more immediate effects of both environmental protection measures and forestry operations on the ground is also contested.

Researchers have been reluctant to recommend forest protection levels and other environmental protection levels (operationalized as, e.g., number

45. Convention on Biological Diversity 1992, article 8(d).
46. Daily 1997; and Millennium Ecosystem Assessment 2005.
47. Cf. Lisberg Jensen 2000.
48. Norwegian Ministry of the Environment 2000–2001, 118.

and size of small reserves, number of large trees to be left standing, or amount of dead wood to preserve), but these are precisely the kind of recommendations policy-makers are calling for. As a consequence, biologists and other forestry researchers have been forced to enter the world of politics and policy-making. This boundary work is typical of environmental assessments where there is no clear demarcation between doing science and making policy, but rather a negotiated boundary that can shift in response to scientific and political priorities.[49]

As highlighted earlier, the Norwegian Institute for Nature Research (NINA) recommends protecting at least 4.5 percent of the productive forest in Norway in a network of large reserves. Critics at the Norwegian Forest Research Institute claimed that NINA made this recommendation simply by proposing that all forest types in Norway should have the same level of protection, without considering the need for biodiversity protection in different forest types and climatic zones.[50] NINA's comparisons to protected areas in Sweden is also misleading, they allege, first because Sweden has a higher concentration of protected low-productive forests in northern areas and in higher elevations and second because montane topography renders large areas of Norway commercially unexploitable, reducing the need for forest protection. In response, environmental organizations, who endorse NINA's recommendation, say that the level of exploitation depends on market prices and demand for forest products. There is therefore a more urgent need for statutory protection of forests. Moreover, the protected forestland in Norway is biased towards the north boreal zone and has a higher proportion of poorly productive forests than productive forests in all vegetation zones.[51]

Despite these discussions on how to quantify the need for forest protection, most researchers in Norway want to see more forests protected and greater commitment to environmental protection in forestry. Norway, they add, has done less than Sweden to take action on forest protection in response to scientific advice. While there has been more controversy about methods of mapping forest biodiversity in Norway than in Sweden, the major difference seems to lie in variation in access to the science-policy dialogue and in the policy process itself (see next section). In conclusion, then, differences in the state of knowledge of environmental protection needs in the two countries do not seem to explain why Sweden has protected more forestland and enacted stricter environmental protection rules than Norway.

Access to the Science-Policy Dialogue

The development of methods for identifying and protecting small reserves has been quite different in Norway and Sweden. While the national forestry author-

49. Salter 1988; Jasanoff 1990; Cash, Clark et al. 2003; and Mitchell et al. 2006.
50. Gjerde and Rolstad 2004.
51. Stokland et al. 2003, 88.

ities controlled the process from the start in Sweden, an independent group outside the traditional research community initiated the process in Norway. Interestingly, when the group Last Chance introduced a method for environmental inventories more or less based on the method already developed in Sweden, the Norwegian Ministry of Agriculture responded by initiating a large-scale research project of its own and granting funds for the project to the Norwegian Forest Research Institute, which is accountable to the Ministry. In this case, the need for research-based knowledge was used as an argument by the authorities to regain control of a policy field of increasing importance to the forestry sector and, arguably, to implement policies preferred by the forest owners. In short, the authorities responded to knowledge producers that emerged outside the established research system by reclaiming the issue area and giving privileged access to a select group of knowledge producers. This was a key decision point or branching point in the policy process that foreclosed certain paths in the development of the method and steered the outcome in a direction different than that preferred by the environmentalists.[52]

Claims about scientific knowledge can be used to legitimate some policies and give some stakeholders privileged access to policy processes. They can also be used to exclude actors from rule-making processes, as when the Ministry of Agriculture's called Last Chance's method of environmental inventory in forestry "unscientific" and "ideologically motivated." The Last Chance biologists, who in fact had pioneered environmental inventories in Norwegian forests, claimed they subsequently were excluded from the development of the "scientific method" for environmental inventories. When they appealed to NENT, protesting that the Ministry of Agriculture and the Norwegian Forest Research Institute had behaved unethically, it was in part in response to this exclusion. In general, researchers working with regulatory (policy-relevant) science are more likely to face accusations of unethical or inappropriate conduct than those working with basic science because the boundary between political and scientific spheres in the former case is blurred.[53] As a consequence, it becomes increasingly difficult to distinguish "facts" from "values" and "scientific" from "normative" arguments. This helps explain why environmental organizations claim that the Ministry of Agriculture and the Norwegian Forest Research Institute behaved unethically, even though NENT acquitted them of the accusations.

Whereas state-driven policy-making in the forestry sector was dominated by governmental agencies and certain forestry research communities, environmental, social, and economic stakeholders participated on an equal footing in forest certification projects. In state-driven protection processes, the access structure could be described as a *hierarchic system* in which participation is controlled by the national authorities who choose among alternative knowledge producers.[54] Stakeholders give input to the process and may influence policy decisions,

52. Cf. George and Bennett 2005, 212.
53. Jasanoff 1990.
54. Cf. March and Olsen 1989.

but privileged access for a select group of scientific input providers is granted by the authorities. By contrast, forest certification standard-setting projects could be characterized as *loosely structured systems* with few formal or practical barriers for actors who seek to provide scientific input,[55] although they tend to become more institutionalized over time. In both Sweden and Norway, environmental organizations had greater access to nonstate-driven rule-making processes than to state-driven processes.

In the certification standards development process, scientific experts, forest owners, environmentalists, and other stakeholders engaged in a process of coproduction of knowledge that was used as a basis for standard-setting. The Norwegian Living Forests working group produced a number of comprehensive and detailed reports to facilitate knowledge-based standard development for issue areas such as protection of old, large trees and dead wood, harvesting methods, fertilizing, forest area protection, forest affected by fire, biological hotspots, and so on. The group also reported results from research and development (R&D) projects, such as harvesting method test areas, initiated and overseen by all stakeholders. Unlike the Norwegian Living Forest working group, the Swedish FSC working group did not initiate R&D projects, but experts were involved in the standard-setting process and references to expert knowledge were commonly used to substantiate claims about appropriate environmental protection measures. Some of the environmental NGO representatives were biologists who earlier had arranged training courses for forestry company staff and conducted field studies of ecological landscape planning.[56] They frequently referred to research reports and scientific recommendations to substantiate proposals for strong environmental protection measures. While conceding to the pressure for quite stringent forestland set-aside requirements in the FSC-standard, the forest industry representatives rejected other proposals from the environmentalists, particularly requests to prohibit the introduction of exotic species and ban the use of chemical fertilizers and pesticides in forestry, claiming that the scientific evidence of ecological impacts was inconclusive.[57] The industry representatives maintained that any provision in the standards that would change or restrict forestry practices should be based on firm scientific evidence and facts.[58]

Despite having different interests, the parties were able to handle scientific uncertainty and resolve controversies through rule-setting and institutional arrangements. First, they agreed on rules that provided direction for forestry operations, but at the same time allowed forest owners discretion in applying the rules and adapting them to local circumstances. Second, in the absence of conclusive scientific evidence, they referred to "further research" and the need to adapt standards in light of new evidence on the effects of forestry practices on biodiversity and other environmental qualities in forests. Third, they required a

55. Cf. March and Olsen 1989.
56. Elliott 1999, 386.
57. See also Boström 2002.
58. Elliott 1999, 386.

re-negotiation of all standards in a process involving the major stakeholder groups after the first five years of operation. Managing knowledge uncertainty by referring to further research, allowing for different interpretations of rules, and creating organizational procedures for adapting rules to new knowledge facilitated agreement among environmental, social and economic interests.[59]

It is evident that science was considered a legitimate and authoritative source of reference by all stakeholders in the Norwegian and Swedish standard-setting processes. Indeed, scientific information about the environmental impact of forestry practices fostered compromise and consensus among them. Although the parties sometimes presented competing knowledge claims, they generally trusted scientific research and agreed that scientific knowledge ought to play a prominent role in the standard-development process. In practice, however, the scientific basis of the agreed standards was not always clear. Considerations about the costs and feasibility of implementing, monitoring, and verifying compliance with environmental standards were sometimes more important than discussions about environmental protection needs (see next section). Nonetheless, the parties referred to expert knowledge and cited scientific evidence to justify and legitimize the agreed standards. Such references and citations were important in order to convince relevant constituencies and audiences that all standards were based on credible scientific knowledge.

The question, then, is whether differences in access structure can explain why the Swedish FSC standards became more stringent than the Norwegian Living Forests standards. As mentioned earlier, environmental, social and economic stakeholders were represented in equal measure on the standard development groups in both countries. However, while the Swedish process was initiated by the WWF, the Norwegian process was initiated by the Norwegian Forest Owners' Federation and other forestry interests. The Swedish working group's agenda was largely set by the green NGOs.[60] This was accepted by the Swedish forest companies, but led to resentment in the forest owners' associations, who eventually withdrew from the standard development group. Stakeholders participated on a level playing field in the Norwegian group, but the process was initiated and driven by forestry interests. And although the environmental NGOs participating in the Living Forest group favored FSC certification, the forest owners opted for the less demanding PEFC scheme. Hence, NGO access to and influence in the standard development groups partly explain why the Swedish standards became stricter than the Norwegian standards. That said, in order to explain why Swedish forest companies accepted more stringent environmental rules, we also need to consider variation in ownership patterns and forest industry structure.

59. See also Boström 2002.
60. Elliott 1999, 385–389.

Distribution of Costs and Benefits in the Forestry Sector

In Sweden, large forest companies, of which the largest in terms of forest ownership is state-owned, control 39 percent of the forestland. Some 51 percent of the forestland is controlled by small non-industrial owners, and the rest by other owners. By contrast, about 80 percent of the Norwegian forestland is owned by small non-industrial owners, with only 20 percent divided among a handful of major landowners. Variation in the distribution of costs and benefits in the forestry sector helps explain the differences in performance of Norway and Sweden. First, it is less costly for big Swedish forest companies to comply with set-aside requirements like the Swedish FSC requirement to permanently set aside five percent of the forestland than for small owners. Because biologically valuable set-aside areas have to be of a certain minimum size, it is easier to preserve such areas in larger properties. It may in fact not be meaningful to conform to a five percent set-aside requirement on small properties with no biological hotspots. Other small owners may have a significant proportion of high conservation value forestland on their land, but conservation of these areas could force them out of business. Economies of scale also make it less costly for the large forest companies to employ ecologists, conduct environmental inventories on their forestland, and implement environmental management systems. Thus, although the Swedish forest ownership structure facilitated agreement on stringent environmental standards, the Norwegian forest ownership structure made forest owners less willing to accept stringent environmental rules.

Second, the Swedish state, through the state-owned company Sveaskog, owns 18 percent of the country's forests. This facilitates the adoption of non-commercial objectives such as forest protection and biodiversity conservation. In comparison, the state is a minor forest owner in Norway and has sold off most of the forestland it previously owned.

Finally, the greater acceptance of environmental protection measures in Sweden can also be explained by the fact that the Swedish forestry sector is much larger and more export oriented that the Norwegian forestry sector. As a result of transnational environmental activist campaigns and pressure from professional purchasers of paper and forest products, all Swedish forest companies adopted the relatively stringent FSC certification standards. Being vertically integrated companies, with their own sawmills and pulp and paper mills in Sweden, the large forest companies are directly exposed to international NGO activism and market pressures to protect the environment. Publicly announced preferences for FSC certified paper and wood products by powerful buyers in Germany and Britain convinced the Swedish forest companies to support FSC-style certification.[61] Although this did not prevent the non-industrial forest owners from choosing another scheme, the preferences of major buyers and transnational NGO targeting of the large forest companies largely explains FSC's success in Sweden.

61. Elliott 1999; Cashore, Auld, and Newsom 2004; and Gulbrandsen 2005.

Norwegian forest owners did not escape international pressure to enhance environmental protection in forestry, but were less exposed to it than Swedish companies. Most Norwegian pulpwood is sold to the domestically based pulp and paper company, Norske Skog, the second largest supplier of newsprint in the world. Large publishing houses in Germany, in particular the giants Springer Verlag and Otto Versand, are among the most important buyers of printing paper from Norske Skog. Following environmental NGO pressure in 1993–94, German publishing houses demanded supplier documentation that the paper originated from sustainable forestry. Development of national sustainable forest management standards in Norway came about largely in response to those demands.[62] Although the powerful German publishing houses asked suppliers to verify that Norwegian forests were sustainably managed, they relaxed their former preference for FSC certified wood as a result of limited supplies and protests from non-industrial forest owners in several European countries. And because the Swedish (and Finnish) non-industrial forest owners had already rejected FSC-style certification, Norwegian forest owners could reap the benefits of their efforts to promote competing schemes in the marketplace. Whereas the industrial forest companies in Sweden responded to market pressures by accepting quite stringent environmental standards, the lower market exposure of non-industrial forest owners in both Norway and Sweden helps explain why they rejected those standards. In conclusion, variation in the distribution of costs and benefits in the Swedish and Norwegian forestry sectors seems particularly important for explaining divergence in the stringency of forest certification standards in the two countries.

Conclusion

This study strongly supports the political-institutional proposition that the influence of knowledge producers in rule-making processes depends on access to the science-policy dialogue. Scientific input in forest policy processes in Norway and Sweden has been controlled by national forestry authorities. The forestry authorities granted the forestry research community, particularly national forestry universities and research institutes, privileged access to the rule-making process. Other knowledge producers, such as biologists operating outside the traditional forestry research community, had limited access to these processes. By contrast, forest certification standard-setting projects have been inclusive, stakeholder-owned processes. Although the knowledge producers who accessed and influenced rule-making in forest certification processes were more numerous and heterogeneous than those who dominated state-driven policy-making, knowledge helped build compromises and settle disputes in those processes.

The research also supports the proposition, based on a political economy perspective, that the influence of knowledge depends on the way the environ-

62. Gulbrandsen 2003.

mental problem and its solutions are related to the distribution of costs and benefits in society. In both Sweden and Norway, the scientific basis of the agreed forest certification standards was not always clear, with economic considerations about on-the-ground implementation sometimes dominating over scientific information. In some cases, reference to expert knowledge served to justify standards that had been agreed upon due to pragmatic considerations regarding the costs and feasibility of implementing them. As expected, structural differences such as variation in ownership patterns and forest industry structure help account for why Norway lags behind Sweden on environmental protection in forestry. But the narratives told here also highlight path dependency and the importance of the process by which knowledge is created, as witnessed in the Norwegian forest biodiversity mapping process. When the Ministry of Agriculture first decided to take control of the process, it narrowed the range of options for method development. It would have been extremely difficult to reverse the process after the funds had been allocated to the Norwegian Forest Research Institute. Once these decisions had been taken, they shaped and constrained future choices and actions, resulting in the development of specific paths along which policy processes followed.

This study gives less support to the rational-instrumental approach and the expectation that the influence of knowledge depends on the level of scientific consensus and certainty in environmental assessments. To be sure, consensual knowledge can facilitate agreement among decision-makers and competing knowledge claims can result in stalemates and deep conflicts. As seen in the mapping of small set-aside areas, particularly in Norway, knowledge complexity and uncertainty allowed a wide range of actors to produce competing knowledge claims. But even when consensual knowledge exists within the scientific community, it is difficult to predict the outcome of the rule-setting process without considering the interests, actors, and policy issues involved because the policy implications of scientific findings are not always, and perhaps rarely, clear or possible to derive. Claims about the policy implications of scientific findings are often related to specific interests, power-games and struggles for political influence and resources. Indeed, there is likely to be co-variation between the level of scientific consensus and the economic or political interests at stake in the policy-making process; when economic or political stakes are high, science is likely to be contested. It is problematic, therefore, to view science as a source of verifiable facts that always could and should settle political disputes and guide action. Of course, science provides facts for policy-makers that sometimes guide political action, but more often, science seems to become politicized in public discourse.[63]

In conclusion, science can take on different roles in rule-making processes, depending on access to the science-policy dialogue, organization of the policy process, and the interests at stake. Even conclusive scientific evidence about the

63. See also Sarewitz 2004.

causes of the environmental problem at hand seems to have little influence on policies when powerful economic counter-forces are involved in the decision-making process. But this problem can be ameliorated by deliberate institutional design of the science-policy interface. The Norwegian and Swedish cases show that the influence of knowledge depends on the process by which it is created, particularly the access of various knowledge producers and users to the science-policy dialogue. It seems that science has a greater chance of settling disputes, overcoming economic interests, and guiding action in inclusive, deliberative rule-making processes than in processes dominated by particular interests and groups. The knowledge invoked in the latter type of process will usually not be accepted as credible or useful by the stakeholders that are excluded or marginalized in the process. As a result, disputes over knowledge and policies are likely to continue and science is not likely to settle value disputes or overcome competing interests. By contrast, a process of coproduction of knowledge between scientists, practitioners with tacit knowledge, and decision-makers could create trust, produce credible and policy-relevant knowledge, and facilitate agreement on appropriate environmental protection measures.[64] As seen in the forest certification processes, stakeholder participation in the science-policy dialogue not only creates a sense of ownership of outcomes; it also influences what knowledge gets produced. There is a need for further research on ways to bridge the gap between knowledge producers and knowledge user groups, to encourage shared understanding of relevant knowledge and how it can be incorporated into policy-making.

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64. Cash, Clark et al. 2003; and Mitchell et al. 2006.

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