Qualitative Comparative Analysis: A Useful Tool for Research into Forest Policy and Forestry Conflicts

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ABSTRACT. The internationalization of the forestry debate and forest policy brings about a growing need to develop, apply, and discuss comparative methodologies in forestry research. This paper illustrates and discusses the use of Qualitative Comparative Analysis (QCA), a new comparative tool in forest policy research. The advantages and disadvantages of the method are demonstrated by reanalyzing previous research on public environmental criticism of forestry in Finland, Sweden, Norway, West Germany, France, and the United States between 1950 and 1983. In particular, the reanalysis illustrates the potential benefits of systematic techniques of comparison as supplementary tools to traditional "common sense" interpretations of qualitative data. In addition to arguing on behalf of the technical applicability of the method to comparative forest policy research, a need is expressed to expand the use of the method from causal to noncausal applications. For. Sci. 44(2):254–265.
Additional Key Words: Qualitative data, comparative methodology, computer-based analysis, causation, interpretation.

Comparative methodologies are frequently applied and developed in social and political sciences. Forestry research, however, has weak traditions in comparative analysis. Nevertheless, the internationalization of the environmental forestry debate and forest policy introduces a growing need to also use international frameworks and comparative strategies within forest policy and conflict research.

For example, even though conflicts between wood production and environmental protection are today viewed as one of the major forces promoting revisions of forest policy and forest management both nationally and internationally, comparative conflict research is rare. Individual forestry conflicts and the conflicts of individual countries have been successfully described in numerous publications (e.g., Yaffee 1994, Lehtinen 1991), and some researchers have even compared conflicts in two countries (e.g., Kajala and Watson 1997, Sidaway 1997). However, conflicts in several countries have only been simultaneously presented in a few reports (e.g., Banuri and Apffel Marglin 1993, Hellström and Reunala 1995). Even then, different countries have seldom been compared through the use of specified comparative methodology or a common framework (Hellström 1997)

Because there has been far less discussion about comparative methodologies than environmental forestry conflicts within forestry research, forestry conflicts are not discussed to any great depth neither theoretically nor empirically in this paper. Instead, data from previous research on forestry conflicts (Hellström and Reunala 1995) are used to illustrate and discuss a new comparative tool, Qualitative Comparative Analysis (QCA) developed by Charles Ragin (1987, 1994a), and its potential for forest policy and conflict research. The final aim of this illustration is to strengthen the foundation for further discussion of comparative methodology, which clearly needs to be expanded within the scientific community working with national and international forest policy issues.

This paper will proceed as follows: First, the technique of QCA will be briefly described. Second, the technique will be illustrated by applying it to a study of forestry conflicts Finally, problems related to this reanalysis and the applicability of this new comparative tool in forest policy research more generally will be discussed.

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Introduction to Qualitative Comparative Analysis

The Strategy of QCA

Comparative researchers are generally thought to examine patterns of similarities and differences across multiple cases. However, no single definition exists for the comparative research strategy. In relation to the number of cases involved, many political scientists make a distinction between single- and multiple-case study strategies, and call the latter the "comparative case method." Yin (1994), on the other hand, suggests that single- and multiple-case studies are basically two variants of one common case study strategy. The comparative strategy "to study diversity" has also been interpreted as an additional approach to "qualitative methods to study commonalties" and "quantitative research to study covariation" (Ragin 1994b). Alestalo (1992), to the contrary, considers both qualitative case-oriented and quantitative variable-oriented studies as individual comparative strategies (Figure 1).

There exist abundant approaches and various research strategies and methods in comparative research. In comparative social research of today, a particular emphasis is the development of synthetic approaches integrating diverse comparative strategies and methods (Ragin 1987, Janoski 1991). QCA is a method of comparison that combines features of qualitative case-oriented methods with features of quantitative variable-oriented methods. It is able to compare such numbers of cases that are considered by most social scientists to be too few for sophisticated statistical analysis, but too many for in-depth, case-oriented analysis. According to Ragin (1994a), QCA "bridges" some of the gap between qualitative and quantitative research. In Alestalo's model (Figure 1), being based upon the idea of seeking variation, QCA would correspond to endogenous case-oriented strategies.

Charles Ragin presented his first application of QCA in 1984 (Ragin et al. 1984), but the technique itself was not thoroughly explicated until 1987 (Ragin 1987). Since then, QCA has been applied in the social sciences on several occasions (bibliography of early QCA applications in Ragin 1994a; see also Brown and Boswell 1995, Coverdill and Finlay 1995, Hicks 1994, Ragin 1994, Ragin et al. 1994c). A decade after its introduction, it seems that the application presented in this paper is the first one in forestry research.

In introducing QCA, Ragin (1987, 1994a) repeatedly attaches the notions of explanation and causation to the macro-social phenomena to which he applies QCA. In doing so, he places special emphasis on the concept of multiple conjunctural causation, which means that cases are viewed in the context of the whole they form, and there can be different combinations of causal conditions that

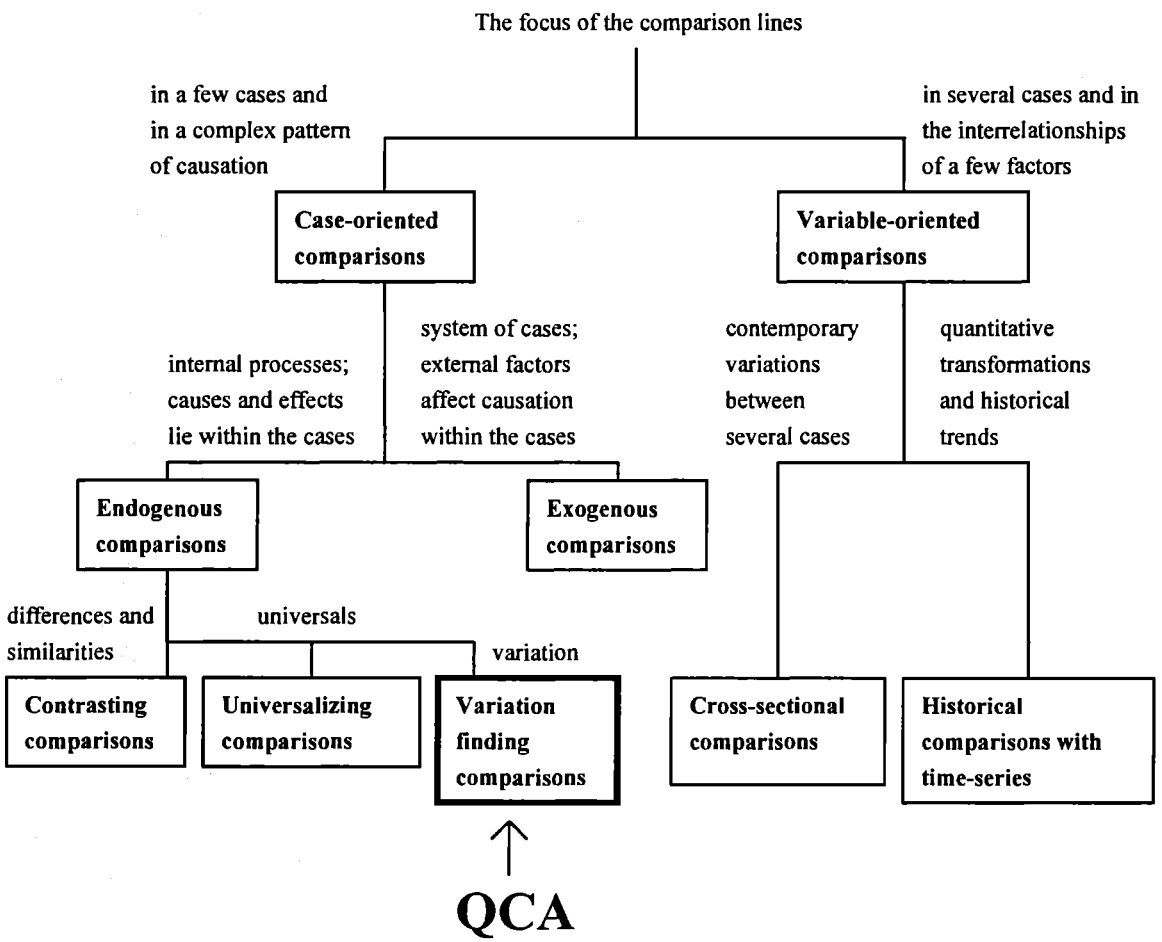

Figure 1. Qualitative Comparative Analysis (QCA) as a comparative research strategy (typology based on Alestalo 1992).

produce similar outcomes. Despite Ragin's holistic approach to causation, some researchers have found Ragin's use of causal terminology problematic. In an article discussing the limits of QCA, Alasuutari (1993) argues that Ragin "writes like a true positivist seeking for causal and universal explanations." He seems to be critical not only of the causal examples of applications of QCA available so far, but also of the limits of the method itself (Alasuutari 1995). Before evaluating this criticism, we must first understand the basics of the technique.

The Technique of QCA

QCA uses Boolean algebra (the algebra of logic and sets) to implement principles of comparison. A basic requirement for the use of Boolean algebra as the technical instrument for comparison is that variables are presented in dichotomous form: capital letters indicate the presence of a condition, and lower case variables indicate the absence of a condition. From the data, a "truth table" is constructed. As can be seen from the exemplary truth table (Table 1), cases with similar values for all variables are considered as one group which is presented in one row. Each row forms a causal equation in which the values of the independent variables (*a/A, b/B,* and *c/C*) are joined with the logical operator "and" (marked with *) to produce *x/X*. For example, the third row ($A*b*C => x$) in the truth table (Table 1) would be interpreted as "the simultaneous presence of condition *A, and* the absence of condition *B, and* the presence of condition *C produces* the absence of outcome *X*.

In the truth table (Table 1), all possible combinations of values of the independent variables are present, and two similar rows do not exist. Although there are 30 cases in total, the number of rows with differentiating values for the independent variables equals $2^3 = 8$. The rows that produce *x* can be derived from the rows that produce *X*, and vice versa. Therefore, the analysis only needs to focus on those types of cases that produce either one of the outcomes *X* and *x*.

The analysis is based on two subsequent minimization procedures. First, all groups receiving the value *X* for the dependent variable are combined into one equation by joining them with the logical operator "or" (marked with +):

Table 1. The exemplary data is organized as a truth table. Each case is described by joining three independent variables (*a/A, b/B,* and *c/C*) with the logical operator "and" (marked with *) to produce the outcome variable (*x/X*). Capital letter variables indicate the presence of a causal condition or outcome, and lower case variables indicate the absence of a causal condition or outcome.

Row no.		Variables	
(type of cases)	No. of cases	Independent	Dependent
1	6	$A * B * C =>$	X
2	2	$A * B * c =>$	X
3	3	$A * b * C =>$	x
4	8	$A * b * c =>$	x
5	1	$a * B * C =>$	X
6	5	$a * B * c =>$	x
7	2	$a * b * C =>$	X
8	3	$a * b * c =>$	x
Total	30		

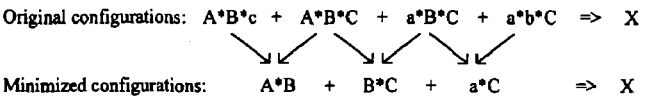

Figure 2. The first minimization process of QCA is based on the logic of Boolean algebra.

$$A*B*C + A*B*c + a*B*C + a*b*C => X \quad (1)$$

This equation can be interpreted as follows: the combinations of conditions that are simultaneously present in group 1 ($A*B*C$), *or* group 2 ($A*B*c$), *or* group 5 ($a*B*C$), *or* group 7 ($a*b*C$) *produce X*. With the help of Boolean algebra, this equation can be minimized into a simpler one. For example, the combination $A*B$ receives the same value *X* regardless of whether it is combined with *c* or *C* (see rows 1 and 2 in Table 1). Thus, $A*B*c$ and $A*B*C$ combine to produce $A*B$. This minimization is based on the principle that if two groups receive similar values for all other variables except one, this deviating variable can be excluded (for more information see Ragin 1987, 1994a) Correspondingly, $A*B*C$ and $a*B*C$ combine to produce $B*C$, and $a*B*C$ and $a*b*C$ combine to produce $a*C$ (Figure 2).

Thus, a minimized equation is received:

$$A*B + B*C + a*C => X \quad (2)$$

In order to illustrate the second minimization procedure, a chart is constructed (Table 2) from the configurations of the original equation, and the configurations of the minimized equation (see Figure 2).

The goal of this second phase of minimization is to find the smallest possible number of minimized configurations needed to explain the outcome *X* (for more information see Ragin 1987, 1994a). When a minimized configuration is part of an original configuration, it is marked with "X" in the chart (Table 2). In this example, either one of the minimized configurations $A*B$ or $a*C$ is present in all the four original configurations. Thus, the configuration $B*C$ can be excluded from the final equation which receives the following form:

$$A*B + a*C => X \quad (3)$$

This equation can be interpreted as follows: either the simultaneous presence of conditions *A* and *B* or the simultaneous absence of condition *A* and the presence of condition *C* produce the presence of condition *X*. Accordingly, QCA has enabled us to minimize Equation (1) into a considerably

Table 2. The second minimization process of QCA is based on the construction of a Minimization Chart. This chart indicates how many of the minimized configurations are needed to explain the whole variation that exists among the original configurations.

Minimized	Original configurations			
configurations	$A*B*C$	$A*B*c$	$a*B*C$	$a*b*C$
AB	X	X		
BC	X		X	
aC			X	X

X = The minimized configuration is part of the original configuration.

more simple Equation (3) without losing any relevant data during the minimization processes.

For illustrative reasons, the example presented above is simplistic. Moreover, QCA can be used for grouping cases into categories and for systematic comparisons of initial hypotheses with results (see Ragin 1987). Ways to include quantitative data in the analysis have also been developed (Ragin 1994c).

Reanalysis of a Study of Forestry Conflicts

Material and Main Findings of the Original Study

In an early example of comparative conflict research in forestry, Aarne Reunala described forestry conflicts in six Western countries (the United States, West Germany, France, Sweden, Finland, and Norway) from the 1950s to 1983, and outlined the reasons for such conflicts. In his original reports (Reunala 1986, Reunala and Heikinheimo 1987), Reunala uses the concept "public criticism of forestry" instead of forestry conflicts. In relation to such criticism, he clearly identified two groups: the critics (environmental groups, the public at large, and in some cases, forest owners), and those who were criticized (the forestry profession). Conflicts within the forestry profession, as well as conflicts that did not directly involve the forestry profession (e.g., between recreation and environmental protection) were excluded from the analysis. The concept "forestry conflict" was used in a rather narrow sense: forestry conflicts were considered to be *public disputes between the forestry profession and its critics.* These conflicts were mainly based on disagreement over wood production and other functions of forestry.

During 1982–1983, approximately 20–30 specialists were interviewed in each country (169 in total). The majority of the interviewees represented forestry (e.g., researchers, practitioners, authorities, forest owners, the forest industry), but interviews with people representing recreation and protection interests were also conducted in order to obtain a sufficiently broad understanding of the criticisms being articulated. The research material also consisted of written sources which had been recommended by the interviewed specialists (over 3000 writings, including books, articles, and covers). The incidents that led to forestry conflicts are described individually for each case study country in the research reports (Reunala 1986, Reunala and Heikinheimo 1987). For interested readers, a condensed version of this original study, with a complete list of the interviewees, has recently also been published in English (Hellström and Reunala 1995).

This extensive qualitative material was analyzed through traditional qualitative methods, where the researcher's theoretical knowledge and previous experiences constantly interacted with the image that he formed from the material. Although this process was not documented in any detail within the research report, the logic used in the analysis can be formulated into methodological concepts according to some simple descriptions given in the original research report. The analysis was based on the notion that the incidents that led to the conflicts were not only similar but also rather simultaneous within all the observed countries. Therefore, it was assumed that the *backgrounds of the conflicts* were related to some *common features* to all the subject countries in a larger framework of social development. This assumption corresponds to John Stuart Mill's (1936) classic "Method of Agreement." In using this method, one assumes that if two or more instances of the phenomenon under examination have only one of several possible causal circumstances in common, then the circumstance in which all the instances agree is the cause of the phenomenon.

Following Mill's logic, Reunala found one macro-level phenomenon consisting of three simultaneous subconditions to be common to all the subject countries and, accordingly, assumed that these were the major causes for forestry conflicts. In all the case study countries, three simultaneous phases of development were particularly noticeable: (1) the intensification of wood production, (2) the increase of recreational needs, and (3) the growth of the environmental movement. It was argued that the increases of such pressures were basically consequences of *economic growth,* which led to a growing efficiency in the exploitation of forest resources. An efficient economy raised the standard of living and increased the possibilities and willingness of the public at large to seek recreation within forests. On the other hand, economic growth caused deterioration of the environment and fear for the exhaustion of natural resources. Thus, the factors that led to forestry conflicts were integral parts of the social development of industrialized countries. This is why criticism of forestry arose simultaneously in many countries.

Data for the Reanalysis

In addition to the common trends described above, differences were also found among the countries. Following Ragin's (1994b) notion that the primary goal of comparative research is to seek variation, this reanalysis will examine the differences rather than the common trends identified in the previous section.

Reunala claimed that conflicts were more intense in the United States, France, Sweden, and Finland than in West Germany and Norway. In addition, Reunala found several factors to have affected the intensity of the conflicts (Table 3). This setting gives a fruitful starting point to explore the applicability of QCA. In the reanalysis presented in the following section, the intensity of conflicts is chosen as the dependent variable, and the factors listed in Table 3 are used as the independent variables. Accordingly, the construction of these variables need further elaboration.

Unfortunately, no definition or classification of "the intensity of conflict" was presented by Reunala. It seems, however, that the intensity of the conflicts was more indicated by the duration of the most aggravated period of criticism than by the intensity of individual struggles. For example, it was noted that in Norway and West Germany, strong criticism of forestry was mainly related to the first few years of the strong general environmental agitation that occurred in these societies in the beginning of the 1970s, whereas in the United States, Sweden, and Finland, intensive conflicts continued to exist until the beginning of the 1980s when the study was finished. In France, public criticism of forestry also lasted longer than in Norway and West Ger-

Table 3. Factors explaining differences in the intensity of public criticism of forestry during 1950–1983 in Finland, Sweden, Norway, Germany, France, and the United States (Hellström and Reunala 1995).

	Factors which increased the intensity of public criticism	Factors which decreased the intensity of public criticism
Change in wood production methods	Rapid (Fin, Swe, Fra, USA)	Slower (Nor, Ger)
Isolation of the forestry profession	High (Fin, Swe, Fra, USA)	Lower (Nor, Ger)
Cultural factors	Wilderness areas (Fin, Swe, USA) Importance of forests (Fin) Role of state forestry (Fra)	Multiple-use traditions (Ger) No public right of access (Fra, USA)
Social change	Rapid (Fin, Swe, Fra)	Slower (Nor, Ger, USA)
Role of forestry in the national economy	Important (Fin, Swe)	Less important (Ger, Fra, USA)
Existence of common interests among wood production, recreation and protection	No (Fin, Swe, Nor, USA)	Yes (Ger, Fra)
Dissemination of forestry information		Intensification (all countries)

many; conflicts intensified in the mid-1960s and were not significantly reduced until the mid-1970s. The intensity of conflicts seemed to be more related to the speed of changes in forestry management practices than to the eventual level of intensity of forestry management. In those countries where such changes were rapid, forestry conflicts were clearly more intensive than in the countries, where they occurred during a longer period.

In Norway, forestry management practices changed rather slowly because of difficult logging conditions, and the tradition of forest work mostly being conducted by nonindustrial forest owners themselves. This also made the areas to be treated rather small. In addition, the recreational use of forests is strongly traditional in Norway. This traditional need to recognize multiple interests seemed to have also decreased the isolation of the forestry profession, to some degree. In West Germany, the long tradition of multiple-use forestry also reduced the pace of intensification of forestry.

Cultural factors affected the intensity of forestry conflicts in various ways. For example, the conquest—and preservation—of wilderness areas is part of the American cultural tradition. This explains why strong emotions were related to the wilderness issue in the United States. Forests also had a central role in the Finnish culture and national inheritance. In France, conflicts arose when the traditional role of state forests was changed. In France and the United States, the absence of public right of access to private forests also led to the concentration of the criticism on state forests.

In Finland, the traditional agricultural society was transformed into a modern industrial society later than in the other five countries. When industrialization and urbanization finally began to accelerate in the 1950s, changes took place more rapidly than in the other countries, thus intensifying concern for overemployment and traditional landscapes. In Sweden and France, some criticism of forestry in the 1950s and 1960s was also based on new forestry practices (e.g., clearcutting and afforestation of fields) threatening to bring about rapid social change by damaging the traditional village structure and traditional landscapes. Such concern appeared more limited in the other countries.

A significant difference in the role of forestry in the national economy existed between Finland and Sweden and the other countries of the study. For example, the forest sector's value of exports for Finland (36%) and Sweden (18%) was considerably higher than in all the other countries (3–4%). Annual removals per inhabitant also indicated the important role of forestry in Finland (10 m^3) and Sweden (8 m^3) compared to the other countries (3 m^3 in Norway, 2 m^3 in the United States, and slightly less than 1 m^3 in France and West Germany).

Particularly in France, but also in West Germany, significant areas of forest were lost to other land uses in the 1960s and 70s. This led to rapid fragmentation of the existing forest structure. In fighting against these developments, a common concern existed among wood production, recreation, and protection interests. This promoted mutual understanding in other forestry issues as well. Similar common interests did not exist to the same degree in the other countries.

Furthermore, in all six countries, the forestry profession claimed that despite some "justified" criticism, much of the criticism was based on ignorance, wrong information, and sentimentality. This led to the conclusion that with intensified dissemination of forestry information, the criticism could be diminished, or at least decreased. The whole debate resulted in a "debate between the deaf," where the attackers and defenders used totally different languages and were unable to communicate.

Because this reanalysis aims primarily at illustrating the use of QCA, and not at providing in-depth examination of the phenomenon of forestry conflicts, the variables are described briefly. More detailed descriptions are found in the original research reports (Reunala 1996, Reunala and Heikinheimo 1987) as well as in a recent English review of these reports (Hellström and Reunala 1995). In fact, the results of this reanalysis should be treated with some caution because of some constraints imposed by the data, methodology, and findings of the original research. Some of these concerns are

presented below, and a more detailed discussion is provided toward the end of this paper.

The description above gives a reasonable basis for constructing a truth table (Table 4). Yet, a few choices need further clarification. First, forestry management practices were only rapidly intensified in countries where the forestry profession was very isolated, and vice versa. Therefore, these two characteristics, "intensification of forestry management" and "isolation of the forestry profession," are considered to form one macro-variable. Second, the variable "intensification of the dissemination of forestry information" is excluded from the analysis. It would not affect the outcome because it receives a similar value in all the cases. Third, the national economic importance of forestry in Norway is assigned the value "low importance" (see figures presented above).

Finally, cultural factors are excluded from the analysis because they are not classified consistently enough in Table 3 It has been claimed that some cultural factors increased public criticism of forestry, and some decreased it. The decision to exclude cultural factors from the analysis is made primarily because of insufficient information in the original data, which makes it difficult to sufficiently construct operational and reliable variables for the analysis. By no means should the role of cultural factors in the conflicts be underestimated. The possible effects of this decision on the results will be discussed later.

Minimization

Because Sweden and Finland receive the same values for all variables, the data in the truth table (Table 4) only represents five countries (5 rows) with different values. Yet, the potential combinations of a set of four dichotomous variables is 24 = 16. Accordingly, 11 potential combinations of variables (11 rows) from the truth table are "missing." For the results of the analysis to be valid, we have to assign assumed values for the dependent variables of these 11 "missing" rows. These values can be assigned according to the researcher's theoretical views. In this reanalysis, these values can be treated as "don't cares." This means that the computer-based program (Drass 1992) designed to conduct the minimization accords the dependent variables of the "missing" rows such values that make the final minimized equation structurally as simple as possible.

Although the minimization process is not presented here in detail, it follows the same principles of minimization described in the example used as an introduction to QCA. The results of the first minimization procedure are presented in a minimization chart (Table 5). As the minimized configuration "FOR" alone is sufficient to cover all original configurations, the final equation receives the following form:

$$FOR \Rightarrow INT \qquad (4)$$

This solution would suggest that rapid change of forestry management practices by an isolated forestry profession is a sufficient condition for intensive forestry conflicts. However, this solution is too simplistic for any meaningful interpretation of the complex phenomenon of forestry conflicts.

In order to receive a more multidimensional solution, it is assumed that any of the independent variables, which tended to intensify conflicts, alone would be an insufficient condition for intensive conflicts. According to Reunala's judgment (Table 3), the conditions *FOR, ECO, SOC,* and *com* individually tended to increase the intensity of the conflicts. This assumption seems logical in relation to the variables *FOR, SOC,* and *com.* Yet, the assumption related to *ECO* needs further examination. According to the truth table (Table 4), forestry only has high national economic importance in Sweden and Finland. In both of these countries, forestry conflicts had become intensive. On this basis, Reunala concluded that high national economic importance of forestry tended to increase the intensity of the conflicts. This was explained by the forestry profession's high resistance to public criticism in such cases. However, it can be argued that strong resistance to criticism is more related to the isolation of the profession than to the national economic importance of forestry. Also, that in countries where forestry has high

Table 4. The Truth Table formed from the Reunala data (Table 3) illustrates the different ways in which four causal conditions (for/*FOR, eco/ECO, soc/SOC,* and *com/COM*) combine to produce different levels of intensity of public criticism of forestry (*int/INT*). Capital letter variables indicate the presence of a causal condition or outcome, and lower case variables indicate the absence of a causal condition or outcome.

Variables											
Independent									Dependent	Country
FOR	*	*eco*	*	*soc*	*	*com*	=>		*INT*	USA
FOR	*	*eco*	*	*SOC*	*	*COM*	=>		*INT*	France
FOR	*	*ECO*	*	*SOC*	*	*com*	=>		*INT*	Finland, Sweden
for	*	*eco*	*	*soc*	*	*COM*	=>		*int*	West-Germany
for	*	*eco*	*	*soc*	*	*com*	=>		*int*	Norway

Variables:

FOR =	Forestry is *rapidly* intensified by an isolated forestry profession	*for* =	Forestry is *not* rapidly intensified by an isolated forestry profession
ECO =	Forestry has *high* importance for the national economy	*eco* =	Forestry has *low* importance for the national economy
SOC =	*Rapid* social change is taking place	*soc* =	*Slow or moderate* social changed is taking place
COM =	*Significant* common interests exist among wood production, recreation and environmental protection	*com* =	*Little* common interests exist among wood production, recreation and environmental protection
INT =	*Intensive* conflicts	*int* =	*Moderate* conflicts

Table 5. The Minimization Chart indicates how many of the minimized configurations obtained as a result from the boolean minimization of Table 4 are needed to explain the whole variation that exists among the original configurations. During the analysis, the following assumptions were made regarding "missing cases": Missing cases with configurations *FOR*ECO*COM, FOR*soc*COM, FOR*ECO*soc,* or *FOR*eco*SOC*com* receive the outcome value *INT.* All other "missing cases" receive the outcome value *int.*

	(Country) Original configurations		
Minimized configurations	(USA) *FOR*eco*soc*com*	(FIN,SWE) *FOR*eco*soc*com*	(FRA) *FOR*eco*soc*com*
FOR	X	X	X
ECO		X	
SOC		X	X

Note: X = The minimized configuration is part of the original configuration.

national economic importance, the population is, in general, more approving of the intensification of forestry management practices, which again might reduce the intensity of conflicts (see Vail 1993).

Therefore, it is assumed that conditions *FOR, eco, SOC,* and *com* tended to increase the conflicts. It is also assumed that alone, any one of these conditions is insufficient to cause intensive conflicts. These assumptions can be written as four separate equations where each of the underlined conditions (*FOR, eco, SOC,* and *com*) is combined with the "negative" value of all other conditions (*for, ECO, soc, and COM*) to produce the outcome *int:*

$$FOR^{*}\ ECO^{*}\ soc^{*}\ CO \Rightarrow int \quad (5)$$

$$for^{*}\ eco^{*}\ soc^{*}\ COM \Rightarrow int \quad (6)$$

$$for^{*}\ ECO^{*}\ SOC^{*}\ COM \Rightarrow int \quad (7)$$

$$for^{*}\ ECO^{*}\ soc^{*}\ com \Rightarrow int \quad (8)$$

Again, the first minimization process follows the same principles as described in the previous section. However, this time, the four assumptions above (5–8) are forced into the analysis as such. Then, a minimization chart (Table 6) is again constructed. This time the solution is more complex. None of the minimized configurations "covers" all original configurations. For covering all original configurations with minimized configurations, a combination of at least two minimized configurations is needed. There are five possible combinations of such pairs of minimized configurations.

$$FOR^{*}\ SOC + FOR^{*}\ eco = FOR^{*}(SOC + eco) \quad (9)$$
(rows 1 and 4 in Table 6)

$$FOR^{*}\ SOC + FOR^{*}\ com = FOR^{*}(SOC + com) \quad (10)$$
(rows 1 and 5 in Table 6)

$eco^{*}\ SOC + FOR^{*}\ com$ (rows 2 and 5 in Table 6) (11)

$SOC^{*}\ com + FOR^{*}\ eco$ (rows 3 and 4 in Table 6) (12)

$$FOR^{*}\ eco + FOR^{*}\ com = FOR^{*}(eco + com) \quad (13)$$
(rows 4 and 5 in Table 6)

This is as far as the technical minimization procedure takes us.

Results

Because the minimization procedure produced five alternative solutions (9–13), it is up to the researcher to consider which one of these solutions makes the most sense in relation to his or her experiences and theoretical views. Notice that each of the combinations of minimized configurations presented above can, in fact, be found in at

Table 6. Like Table 5, this Minimization Chart indicates how many of the minimized configurations obtained as a result from the Boolean minimization of Table 4 are needed to explain the whole variation that exists among the original configurations. The results differ from Table 5, due to four assumptions (5)–(8) that were forced into the analysis. During the analysis, the following additional assumptions were made regarding "missing cases": Configurations *FOR*ECO*SOC*COM, FOR*eco*soc*COM, FOR*eco*SOC*com,* and *FOR*ECO*soc*com* receive the outcome value *INT.* All other "missing cases" receive the outcome value *int.*

	(Country) Original configurations		
Minimized configurations	(USA) *FOR*eco*soc*com*	(FIN,SWE) *FOR*eco*soc*com*	(FRA) *FOR*eco*soc*com*
*FOR*SOC*		X	X
*eco*SOC*			X
*SOC*com*		X	
*FOR*eco*	X		X
*FOR*com*	X	X	

Note: X = The minimized configuration is part of the original configuration.

least some case study country with intensive conflicts. However, none of these combinations of minimized configurations can be found in the case study countries with only moderate conflicts. Thus, even though assumptions concerning "missing cases" were made during the minimization process, real cases can be found to support all of the solutions, as is the case in using QCA more generally. Thus, any of them could, technically, be chosen. However, all technically viable solutions are not necessarily supported by the researcher's experiences and theoretical views.

Forest management practices were rapidly changed by an isolated profession (condition *FOR*) in all the countries where the conflicts became intensive. Simultaneously, the complement condition *for* existed in all the countries where such conflicts remained moderate. This gives rather strong support for choosing a solution where *FOR* is a necessary condition for intensive public criticism (9, 10, or 13). Even after experimentation, through creating some variation in the assumptions, solution (13) seems to be rather constant, whereas the existence of solutions (11) and (12) is more dependent on the assumptions chosen. Therefore, the choice of a final solution is based on solution (13). However, instead of choosing only one solution, solution (13) is combined with either solutions (9) or (10), so that the fourth variable present in the original configurations *(SOC)* can be included. Thus, the final solution receives the following form:

$$FOR*eco + FOR*SOC + FOR*com => INT$$

or

$$FOR*(eco + SOC + com) => INT \quad (14)$$

This solution can be interpreted as follows. Forestry conflicts tended to become intensive when forestry management practices were rapidly changed by an isolated forestry profession at the same time as either (a) rapid social change was taking place, (b) forestry had low importance in the national economy, or (c) there was little common interest among wood production, recreation, and environmental protection.

The existence of the three alternative conditions in the solution (*FOR*eco, FOR*SOC,* and *FOR*com*) can be compared with the original cases. First, *FOR*eco* is a condition fulfilled in the United States and France. Secondly, *FOR*SOC* is a condition fulfilled in France, Sweden, and Finland. Thirdly, *FOR*com* is a condition fulfilled in the United States, Sweden, and Finland. Because the case study countries with intensive conflicts are rather equally divided among these three conditions, the countries cannot be grouped according to the variables of this analysis.

Before this conclusion is accepted, it should be remembered that when assumptions were introduced into the reanalysis, it was assumed that it was *eco* and not *ECO* that tended to intensify forestry conflicts. If *ECO* had been used instead of *eco* in the reanalysis, would not the final solution have also been opposite? This can be tested. If the condition *eco* is now changed to *ECO* and vice versa for the assumptions introduced into the analysis, the final solution receives the following form:

$$FOR * (SOC + com) => INT \quad (15)$$

This solution is reminiscent of the final solution expect for the condition *ECO/eco,* which is missing. This alternative solution would change the interpretation of the result so that the national economic importance of forestry could be considered irrelevant to the intensity of the conflicts, which would, in fact, not support the initial assumption that ECO tends to increase the intensity of the conflicts.

Discussion

Problems Related to the Reanalysis

In this reanalysis, a significant shortcut was taken when arriving at the results, one which is not usually available in forest policy research: the variables were directly received as the result of a previous comprehensive and time-consuming qualitative research project (Reunala 1986). This starting point of "inherited data" also brought about some difficulties in the reanalysis.

In comparative research, researchers usually initiate research with a special analytic frame, but leave these initial frames open to revision throughout the research process (Ragin 1994b). Accordingly, during the analysis, along with the revision of the analytical frame, the researcher using QCA may want to revise his choice of variables. Here, a typical difficulty of reanalyses was faced when only predefined variables, originally not constructed for this kind of reanalysis, could be used.

In addition, another researcher might have interpreted the original extensive qualitative data slightly differently, which may have caused a slightly different composition of variables presented in Tables 3 and 4. For example, the predefined data does not include variables describing interest groups, policy processes, policy goals and means, policy implementation, markets, ownership patterns, cultural differences, and so on, even though these variables are inevitably closely related to forestry conflicts. Neither does the reanalysis use longitudinal data, and it does not discuss the vast economic, social, and environmental value changes that have occurred during the research period (1950–1983).

Another problem related to the data is that the variables used in this analysis could not be defined unambiguously, because they were not originally defined as distinctive variables but as results of a more general nature. Therefore, although short descriptions of the variables are provided earlier in this paper, some reservations have to be kept in mind in relation to the construction and contents of the variables. For example, the decision to exclude cultural factors from the analysis, because of classification problems, may have affected the final solution. If the analysis had been conducted by the researcher who collected the original qualitative material, there is little doubt that a suitable classification for cultural factors would have been found. Although the inclusion of cultural fac-

tors in the analysis would have brought new nuances to the results, it would not have necessarily refuted the results achieved. For example, many of the cultural factors identified by Reunala already affect the speed of change in wood production methods and the isolation of the forestry profession. In fact, as this paper mainly aims at introducing the use of the QCA method to forestry research and not at discussing forestry conflicts in depth, simplistic data can, in this case, be considered sufficient.

A further issue with the reanalysis was the considerable number of assumptions that had to be made. This was caused by the small number of differentiating cases (5) compared to the number of potential combinations of variables (16). The reliability of the analysis could have been improved if more differing cases were added to the analysis. Naturally, this was not possible in this case where the original data had already been collected in the beginning of the 1980s. A relevant question is, does the method really have any significant advantage compared to other qualitative methods, when both clearly imply numerous assumptions? The difference between the use of QCA and traditional qualitative methods is that in using QCA it is not possible to conduct the analysis without systematically and clearly stating the assumptions to be used, whereas in traditional qualitative analysis, corresponding assumptions about all other potentially possible combinations of variables are seldom presented at all. Therefore, the identification of assumptions should be considered a strength of the method and not a weakness. Clearly stating the assumptions to be used in QCA also enables experimentation with the use of different kinds of assumptions, in order to see how these assumptions affect the outcome of the analysis. It should be noted that all assumptions may potentially be checked for consistency with theory, even though empirical cases may not have been present in the analysis to support them. In addition, in this analysis the main features of the solution were arrived at even when there was some variation in the assumptions. This suggests that the chosen final solution is not, in this case, too dependent on the choice of assumptions. Despite the deficiencies discussed above, the final solution seems logical, and adds information to the spectrum of conflict research.

Advantages and Disadvantages of QCA

This introduction to QCA offers a basis for discussion on the advantages and disadvantages of using QCA in more general terms. Case study strategies (e.g., comparative research) generally attempt to answer questions such as "how" and "why" (Yin 1994). If the type of question posed (for example, "what," "where," "how much") is more appropriately answered by other research strategies (e.g., surveys, experiments), comparative analysis (e.g., QCA) might not be the best choice of research strategy.

Even when the type of question posed would be appropriately answered by using QCA, the simplification of social phenomena, which is caused by the construction of dichotomous variables, may be a disadvantage for the use of the method. For example, when sufficient and reliable quantitative data is available for the use of variable-oriented methods of comparisons, or when the number of cases is very small, the use of QCA might not be recommended. In the latter case, other methods of analyzing qualitative data might give more insight into the phenomenon under examination. In addition, the problem related to a potentially high number of assumptions to be used can be avoided.

However, the use of QCA also has some significant advantages. Comparative research generally requires comparisons to be made between each differing case and each differing variable. Even when simple variables are used, but when more than a handful of cases and variables are involved, the capacity of the human brain is usually not sufficient to conduct such comparisons consistently. With the use of QCA, a large amount of qualitative data can be systematically analyzed, and after the construction of the dichotomous variables the existing general patterns and variation within the data can be detected without losing any relevant information during the analysis. In addition, QCA preserves some of the most valued features of case-oriented research by paying attention to:

1. cases as configurations,
2. causal conjunctures,
3. causal heterogeneity,
4. deviating cases and concern for invariance,
5. qualitative outcomes, and
6. outcome complexity (Ragin 1994a).

These features will now be illustrated with the example of forestry conflicts. Paying attention to cases as configurations (1) means that each individual aspect of forestry conflicts in a country (for example the national economic importance of forestry) was understood in the context of all the other features related to forestry conflict in the country (e.g., intensification of wood production, isolation of the forestry profession, social change, etc.) and not only in context of the final outcome (the intensity of the conflict). By paying attention to causal conjunctures (2), it was possible to understand how the different conditions combined to produce a specific outcome. For example, a high national economic importance of forestry had to be combined with rapid intensification of wood production by an isolated forestry profession in order to lead to intensive conflicts.

Paying attention to causal heterogeneity (3) means that we can theoretically discover how the different causes of forestry conflicts may have combined in different, and sometimes even in contradictory, ways to produce roughly equally intensive conflicts in varying national circumstances. For example, it might be theoretically possible that low national economic importance of forestry combined with one factor (say, rapid intensification of wood production) might have produced equally intensive conflicts as high national economic value of forestry combined with another factor (say, rapid social change). In

other words, QCA examines true variation instead of covariation.

Furthermore, if countries where the nature of forestry conflict deviates from the common patterns found in other countries are not treated as an error (as is often the case when quantitative data are used and variable-oriented comparisons are made), but instead, special attention is given to this invariance (4), QCA provides a means to elaborate the general perceptions on forestry conflicts. In addition, forestry conflict is a difficult phenomenon to measure in quantitative terms. Accordingly, attention to qualitative outcomes (5) is a basic requirement for a study on forestry conflicts. Finally, the fact that conflicts were intensive in several countries does not mean that they had similar causes, or that the conflicts were alike in other respects. The conditions explaining this complexity are similar to those distinguishing these countries from countries with moderate forestry conflicts. In this way, attention can also be given to complexity within one outcome (6).

From Explanation to Interpretation

Like most QCA applications so far, the illustration presented in this paper is based on the concept of multiple conjunctural causation. Moreover, like in this application, QCA has mainly been used in reanalyzing more or less predefined variables from previous research. Despite the advantages of QCA, described in the previous section, QCA may from the outset seem too mechanical a tool for in-depth studies of such complex social phenomena as forestry conflicts. Indeed, technical feasibility is insufficient for legitimating the adoption of a new comparative tool in forestry research (Hellström 1995).

The fact that QCA has typically been applied in a positivist manner may have been a constraint for the adoption of the method into new fields of research. However, my concern is that causal terminology is often attached to QCA applications without even considering the possibility of noncausal application of QCA.

On the one hand, Ragin (1994a) describes the process of QCA in rather technical terms. Before proceeding to the actual analysis, "the investigator moves back and forth between specification of causal variables and examination of cases to build a combinatorial model with a minimum number of cases having the same combination of values on the causal conditions but contrasting outcomes. Once a satisfactory set of causal conditions has been identified, data on cases can be presented as a truth table, and then the truth table can be logically minimized." On the other hand, Ragin (1987, 1994b) also notes that in using QCA, as in social research in general, a rich dialogue between ideas (theory) and evidence (data) exists through an interaction of the analytical frames created from the ideas and the images formed from the data. This process is retroductive, that is to say, inductive on the one hand, and deductive on the other.

Accordingly, there seems to be no reason why QCA could not be applied more flexibly than in the illustration presented in this paper. Instead of conducting one causal analysis with carefully chosen variables like in this illustration, the use of QCA could be described as a process where several analyses, at various levels, follow each other, resulting in revisions of variables and analytic frames throughout the process. Thus, the whole process may, at best, resemble a hermeneutic circle, where understanding moves from entities to parts and back, so that a higher level of understanding is reached at each circle of the spiral.

In an analysis like the one conducted in this paper, it is essential to remember that the formation of the truth table already involves considerable interpretation of data. In fact, the data presented in the truth table reflects the images of the researcher, derived through interpretation of the "raw data" (interviews, written material, etc.). Therefore, rather than viewing QCA as a tool for organizing and minimizing complex social data, QCA could be viewed as a means for seeking new insight to the phenomenon under examination and for clarifying the interpretations made by the researcher. Thus, QCA is not exclusive of traditional qualitative methods, but is best used to supplement and inform the researcher's own intuition. Looking at the truth table and all the various possible equations may give the researcher new insights to the cases.

The legitimacy of using computerized techniques in qualitative analysis is often questioned, particularly by researchers who are not acquainted with modern computerized methods. To some extent, such concerns are reasonable. For example, Seidel (1991) suggests that computerized qualitative methods can even lead to some interesting forms of behavior called analytical madness. These include:

1. an infatuation with the volume of data one can deal with, leading to a sacrifice of resolution for scope;
2. reification of the relationship between the researcher and the data; and
3. distancing of the researcher from the data.

If QCA is used as a technique to organize predefined data, like in the example provided in this paper, these fears seem rather relevant. However, as discussed above, much depends on the approach to QCA that is chosen. In using QCA, its capability to minimize a large number of cases may not be the most important characteristics of the method, although the "minimization" power has been stressed by Ragin himself (Ragin 1995). Instead, seeking alternative ways to interpret the data may be a more rewarding motivation for using QCA. Furthermore, when using QCA to organize predefined data, the relationship between the researcher and the data is easily reificated. However, if the data for QCA is viewed as interpreted data, which may be reformed through a hermeneutic circle during the analysis, as discussed above, the problems stated in (2) and (3) can be avoided.

Further Applications of QCA in Forest Policy Research

As mentioned earlier, to the best of my knowledge this paper presents the first application of QCA to forestry research. However, QCA will be also applied in a new

research project conducted at the European Forest Institute, in which forestry conflicts between 1984–1995 are examined in the same six countries (Hellström 1997). In this new research, the kind of hermeneutic approach to QCA which was called for in the previous section will be applied. Accordingly, QCA will be increasingly viewed as a flexible tool which can assist in the hermeneutic interpretation of qualitative data, rather than as a tool for categorizing and organizing qualitative data for identifying causal conditions. This new research is also designed to address most of the deficiencies related to the data of this reanalysis, as discussed in the previous section. For example, this new research will incorporate cultural factors as well as data describing changes in values, forest policies (participants, processes, strategies, and implementation), forest products markets, and forest resources.

In this paper, QCA has been discussed only in relation to the specific issue of forestry conflicts. However, QCA has several other potential applications in forest policy research. For example, the increasing internationalization of forestry issues, the expansion of the European Union to include several countries with substantial forest resources, and new international commitments related to forests (e.g., UNCED Conference in 1992, Ministerial Conference on the Protection of Forests in Europe in 1993) all bring forth a growing need to conduct comparative research in forest sciences.

QCA has particular advantages in cross-country comparisons in the field of forest policy because of its ability to treat individual countries holistically as historically, culturally, politically unique entities with meaningful combinations of parts, instead of trying to make these countries fit single models. QCA may be a useful tool in comparing, for example, the compliance of various countries with international agreements, and the backgrounds of compliance/noncompliance. Other interesting international issues which could be addressed by using QCA are, for example, the circumstances under which legislative revisions occur, or in identifying the macro-social conditions related to tropical deforestation/nondeforestation. Naturally, the use of QCA is not limited to international comparisons. Several policy issues at state and regional levels may also offer many interesting issues from a comparative point of view (e.g., variation in policy implementation, effectiveness of conflict resolution strategies). Although QCA has been mainly used as a comparative tool in political and social sciences, the method may also be applicable to other research fields, particularly when holistic interpretation of answers for "how" and "why" questions is preferred. Even within traditional natural sciences, QCA can be a useful exploratory tool when planning for efficient settings for further experiments.

In relation to this growing need to conduct comparative international research, comparative strategies have been, surprisingly, rarely discussed within forest sciences. Researchers in forest policy are, in particular, encouraged to increasingly take up, develop, and discuss strategies and methods of comparative research.

Literature Cited

ALASUUTARI, P. 1993. Boolean algebra ja radion kuuntelu. Publications of the Westermarck Society, Finland. Sosiologia 3(1993):216.

ALASUUTARI, P. 1995. Researching culture. Qualitative method and cultural studies. Sage Publications, London. 208 p.

ALESTALO, M. 1992. European integration and comparative research P 21–30 in Changing Europe and comparative research, Kosonen, P (ed.). Publications of the Academy of Finland. Suomen Akatemian julkaisuja 5/92.

BANURI, T., AND F.A. MARGLIN (EDS.). 1993. Who will save the forests? Knowledge, power and environmental destruction. The UN University. World Inst. for Dev. Econ. Res. (UNU/Wider). Zed Books, London. 195 p.

BROWN, C., AND T. BOSWELL. 1995. Strikebreaking or solidarity in the great steel strike of 1919: A split labor market, game-theoretic, and QCA analysis. Am. J. Soc. 100(6):1479–1519.

COVERDILL, J.E., AND W. FINLAY. 1995. Understanding mills via mill-type methods: An application of qualitative comparative analysis to a study of labor management in southern textile manufacturing Qual. Soc. 18(4):457–478.

DRASS, K. 1992. Qualitative comparative analysis. QCA version 3.0. Computer program manual. Cent. for Urban and Policy Res. Northwestern Univ., Chicago. 48 p.

HELLSTRÖM, E. 1997. Environmental forest conflicts from an international comparative point of view. P. 271–287 in Conflict management and public participation in land management, Solberg, B., and S. Miina (eds) Eur. For. Inst., Proc. No. 14.

HELLSTRÖM, E., AND A. REUNALA. 1995. Forestry conflicts from the 1950's to 1983—A review of a comparative study between USA, West Germany, France, Sweden, Finland and Norway. Eur. For. Inst. Res. Rep. 3. 92 p

HICKS, A. 1994. Qualitative comparative analysis and analytical induction The case of the emergence of the social security state. Soc. Meth. Res 23(1):86–113.

JANOSKI, T. 1991. Synthetic strategies in comparative sociological research Methods and problems of internal and external analysis. P. 59–81 in Issues and alternatives in comparative social research, Ragin, C. (ed) E.J. Brill, Leiden.

KAJALA, L., AND A.E. WATSON. 1997. Recreation conflicts in wilderness An international comparison with implications for conflict management research. P. 303–313 in Conflict management and public participation in land management, Solberg, B., and S. Miina (eds.). Eur. For. Inst., Proc No. 14.

LEHTINEN, A.A. 1991. The northern natures—a study of the forest question emerging within the timber-line conflict in Finland. Geogr. Soc. Finland Fennia 169(1):57–169.

MILL, J.S. 1936. A system of logic, rationative and inductive. London, Longmans, Green and Company.

REUNALA, A. 1986. Taistelu metsistä. Voimaperäisen metsätalouden julkinen arvostelu kuudessa maassa. An unpublished manuscript. 214 p.

REUNALA, A., AND M. HEIKINHEIMO. 1987. Taistelu metsistä. Voimaperäinen metsätalous Suomessa ja muissa maissa. Kirjayhtymä, Helsinki. 188 p

RAGIN, C. 1987. The comparative method: Moving beyond qualitative and quantitative strategies. University of California Press, Berkeley. 185 p

RAGIN, C. 1994a. Introduction to qualitative comparative analysis. P. 299–319 *in* The comparative political economy of the welfare state: New methodologies and approaches, Janoski, T., and A. Hicks (eds.). New York, Cambridge University Press.

RAGIN, C. 1994b. Constructing social research. The unity and diversity of method. London, Pine Forge Press. 194 p.

RAGIN, C. 1994c. A qualitative comparative analysis of pension systems *In* The comparative political economy of the welfare state: New methodologies and approaches, Janoski, T., and A. Hicks (eds.). New York, Cambridge University Press.

RAGIN, C. 1995. Using qualitative comparative analysis to study configurations. P. 177–189 in Computers and qualitative analysis, Kelle, U. (ed.). Sage Publications, London.

RAGIN, C., B. GRAN, D. SCHULMAN, AND A. WEINBERG. 1994. Between complexity and generality: A qualitative comparative analysis on village republics. Sosiologi i dag 23(4):67–87.

RAGIN, C., S.E. MAYER, AND K.A. DRASS. 1984. Assessing discrimination: A boolean approach. Am. Soc. Rev. 49:221–234.

SEIDEL, J. 1991. Method and madness in the application of computer technology to qualitative data analysis. P. 107–116 *in* Using computers in qualitative research, Fielding, N.G., and R.M. Lee (eds.). Sage Publications, London.

SIDAWAY, R. 1997. Outdoor recreation and conservation: Conflicts and their resolution. P. 283–301 in Conflict management and public participation in land management, Solberg, B., and S. Miina (eds.). Eur. For. Inst. Proc. No. 14.

VAIL, D. 1993. The internal conflict: contract logging, chainsaws and clearcuts in Maine forestry. P. 142–189 in Who will save the Forests? Knowledge, power and environmental destruction, Banuri, T., and F. Apffel Marglin (eds.). The UN University. World Inst. for Dev. Econ. Res. (UNU/Wider). Zed Books, London.

YAFFEE, S.L. 1994. The wisdom of the spotted owl. Policy lessons for a new century. Island Press, Washington D.C. 430 p.

YIN, R.K. 1994. Case study research. Design and methods. Ed. 2. Appl. Soc. Res. Meth. Ser. Vol. 5. Sage Publications, London. 171 p.