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How Formality Works: The Case of Environmental Professionals

Abstract: This article provides an overview of our research on environmental professionals in Switzerland over the last twenty years. From the beginning, we were interested in studying how formality functions in this field and how abstraction drives jurisdictional change. We started with the goal of examining professsionalization, i.e., the question of whether a new environmental profession arises. Our findings suggest this has not yet occurred; instead, we observe increased scientification of the field, underlining the role of science-based formalization (providing social capital in the form of a science-based language). We analyze a survey on environmental professionals and show how abstraction works: reduction and formalization as two distinct forms of abstraction are specifically related to inter- and intra-professional competition.

Keywords: abstraction, environmental professionals, scientification, professional competition, linked ecologies

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Stinchcombe (2001) conducted a study on governing-by-abstraction in law and within organizations, and concluded that "Formality works." A similar theoretical claim was made by Abbott (1988) when describing dynamics within the system of professions: abstraction—the use of abstract knowledge—drives the changing access of professions to tasks in our societies. The aim of this article is to document, reflect and complete our research on the role of formality and abstraction in the field of professional environmental tasks in Switzerland—as the process of professionalizing environmental tasks now seems have to reached a steady state.

Our point of departure is three propositions by Abbott (1988, 2005):

Proposition 1: Professions have to be considered in a system; they compete for jurisdiction – that is, access to subsets of the finite set of tasks arising in a society. "The professions, that is, make up an interdependent system" (Abbott, 1988, p. 2).

Proposition 2: A profession and its jurisdictions represent an "ecology" (Abbott, 2005); this is linked to two other ecologies: the universities and the political system (state ecology).

Proposition 3: These jurisdictions, the ties between the occupational groups and their work, are not fixed, but are mediated by task definitions. Other occupational groups may challenge them by suggesting alternative definitions.

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These three propositions do not cover Abbott's contribution to the sociology of professions. Here, we focus on abstraction as a quality or element of the system of professions. As to individual professional practice, Abbott's position relates to earlier work, claiming that professional work has an intellectual component (Parsons, 1968) and consists of subsuming specific cases to general, abstracted knowledge (Goode, 1957). Abbott speaks of professional "inference," a "purely professional act" of turning a diagnosis into a proposed treatment (Abbott, 1988, p. 40). We found empirical evidence for this discrete, professional role of inference (cf. Mieg, 2000b, 2008a). However, this is not within our focus here.

Abbott's perspective on the system of professions gave rise to empirical research in diverse areas and arenas of professionalism. We find, for example, studies on jurisdictional conflicts between pharmacy and medicine (Gilbert, 2001), between lawyers and judges in court (Olgiati, 2002), and in the fields of management (Whitley, 1995) and teaching (Yinger & Nolen, 2003). In a similar vein, we find studies showing how task definitions are used as means in professional competition, such as that conducted by Saks (1995) in the case of the British medical profession, or by Dezalay and Garth (1996) in the field of law.

Since the 1990s, we have studied competition within the field of environmental expert services in Switzerland (cf. Mieg, 2001a, 2002; Mieg et al., 2012). We chose Abbott's work as our point of departure in order to observe the changes to the system of professions resulting from upcoming environmental tasks. In particular, we were interested to explore whether a new environmental profession would arise (Mieg, 2008b) in addition to, or as an effect of, the efforts of universities to establish research on environmental issues. For us, Abbott's approach seemed well suited to reveal the nature and dynamics of the more-or-less abstract knowledge-base activated for this competition within the field of environmental expert services (Mieg, 2001b, 2009). After 20 years of research, we have identified substantial evidence in support of Abbott's proposals; however, we still struggle to resolve some details, such as the question of how formal, scientific knowledge influences this particular professional field.

In 1990, the field of environmental expert services in Switzerland was still developing and looked like the basis for a new professionalization project (Larson, 1977; Mieg, 2008b). There was a young professional association of Swiss ecologists that relabeled itself during the 1990s as the Swiss Association of Environmental Professionals (SVU, Schweizerischer Verband der Umweltfachleute). As a nation state, Switzerland was rethinking the lessons of 1986, from Chernobyl and Schweizerhalle – the latter a severe accident in the Swiss chemical sector that proved catastrophic for the entire river Rhine. The university ecology reacted in a similar way: At the Swiss Federal Institute of Technology (ETH Zürich), the environmental sciences were installed as a new study program. This course program started with the explicit aim of providing a system-theory-based, integrative approach to environmental problems, with a clear focus on application (cf. Brunner et al., 2010).

A professionalization project (Larson, 1977) would have implied some kind of social closure (Weber, 1972; Murphy, 1988; Weeden, 2002) or monopolization of this field of environmental expert services, with a strong environmental profession, most probably lead by professionals trained in environmental sciences. However, what we observed in 2010, twenty years later, looked slightly different. The Swiss

association of environmental professionals has now been integrated into the strong Swiss Society of Engineers and Architects (SIA). Switzerland, as a nation state, is on a path to what can be described as "ecological modernization" (e.g., Hajer, 1995), integrating environmental concerns within industry, as exemplified by the strong industry orientation of the new Federal Office for the Environment. Following several re-organizations, the aforementioned Department of Environmental Sciences at ETH Zürich has become the Department of Environmental Systems Science, with a strong global perspective (www.usys.ethz.ch). Rather than professionalization within the national field of expert environmental services, we observe an intense scientification: science has taken the lead in defining the scope and content of environmental tasks.

The process of introducing environmental tasks into the system of professions in Switzerland seems to have reached a steady state in recent years, as demonstrated by the rise of environmental science as a separate discipline and the subsequent integration of environmental professionals within the engineering profession. We therefore wish to review and better understand the role of the involved linked ecologies and the significance of scientification as a form of abstraction. In the following, we will introduce our basic concepts as well the research conducted so far. We will then use our accumulated data pool to further analyze some open details. In conclusion, we call for renewed, formality-centered research on professional work. In short, abstraction matters.

A cognitive approach to professions

We have chosen Abbott's concepts because they match findings from cognitive science and research on expert performance (cf. Mieg, 2001b, 2003). In the following, we first define some basic concepts of our cognitive approach, then summarize the findings of a series of studies that we conducted on environmental professionals, and finally define the research questions for the analyses of the data presented in this paper.

Basic concepts

Abbott conceived of the "mechanisms of jurisdiction shift" (Abbott, 1988, p. 98) as two forms of abstraction: Reduction – referring to the content of task definitions; and formalization – referring to the way tasks are conceptualized within a particular knowledge system.

Reduction applies to the content of a task. It may involve the definition of the task as well as the knowledge-system of the occupational group. Within task definition, reduction means to highlight a specific aspect of a task definition (and necessarily neglect other qualities) in order to subsume it under the claimer's own jurisdiction: it "shows some new task to be reducible, in principle, to one of the attacker's already-secure jurisdictions. Child misbehavior is reduced to the disease of hyperactivity, and hence to the jurisdiction of medicine" (Abbott, 1988, p. 98). On the other hand, reduction applied to the knowledge-system is connected to "mere lack of content; that is abstract (in the sense of reduced, the authors) which refers to many subjects interchangeably" (Abbott, 1988, p. 102). Therefore, shift-

ing a knowledge system towards a higher degree of reduction means to empty its categories of the concrete content they were originally built for and to allow thereby covering a larger area of tasks. Hence, reduction serves an offensive function in inter-professional competition. For example: "Psychology, sociology, administration, economics, law, banking, accounting, and other professions all claim some jurisdiction in business management, each by extending its own abstraction, emptying them of content, and claiming that they cover the whole field" (Abbott, 1988, p. 103). In sum, reduction is a means of offensive redefinition of tasks, thereby putting forward professional claims on these tasks.

The second form of abstraction is called formalization. Formalization "emphasizes positive formalism … that knowledge is abstract (in the sense of formalized, the authors) which elaborates its subject in many layers of increasingly formal discourse" (Abbott, 1988, p. 102). Formalization refers to the way in which tasks should be treated in order to be solved. Strong formalization is particularly implied by the use of complex mathematical models for task treatment. Connected to an established jurisdiction, a high degree of formalization prevents other occupational groups from successfully claiming jurisdiction. Formalization thereby plays a defensive function within the system of professions. To refer again to an example by Abbott (1988, p. 103), "No one tries to explain particle interactions without mastering the abstract knowledge of physics. More practically, no one offers insurance companies advice on underwriting without having mastered actuarial theory." In sum, formalization is a more-or-less defensive means of defining methodological standards.

To study the impact of abstraction on competition within the system of profession, we can distinguish two forms of professional competition. Inter-professional competition occurs between different professions. Intra-professional competition occurs within one profession. We assume:

> Monopoly Assumption: Professionalization of a set of tasks is indicated by the substitution of inter-professional by intra-professional competition.

Professionalization is defined as the social enclosure of a field of tasks such that the tasks become monopolized. Even though other occupations might be involved, the definitional power for these tasks is in the hands of one profession.

The semantics of the field of professional environmental tasks

In order to describe the system of professions that deals with environmental tasks, we require an appropriate semantics. In 1997, we conducted a survey among environmental professionals in Switzerland (N = 406; cf. Mieg, 2000a). We wanted to know: What tasks are such professionals contracted to undertake? Thus, we assessed tasks and task-specific competition (see Appendix 2). To view the whole field of tasks, we used the systems metaphor, as a core concept of Environmental Sciences at the Swiss Federal Institute of Technology in Zürich, and of environmental research in general since Meadows et al. (1972).

Figure 1 provides an overview of the field of professional environmental tasks. The core professional arena – the heartland – was defined by direct reference to one or more of the natural systems: water, air, soil. Such task definitions were con-

sidered as unreduced. From this perspective, any definitions linked to societal tasks that imply interaction with one or more natural systems – such as transportation, construction, agriculture – were considered as somewhat reduced. Task definitions without direct implications for natural systems – for example, management, or data processing – were considered as highly reduced. Formalization was defined as procedural standardization. Again, the heartland (water, air, soil) was considered as unformalized. Task definitions that implied procedural standards were considered as medium-formalized (e.g., nature conservation) or highly formalized (e.g., environmental impact assessment, EIA), depending on the degree of standardization.

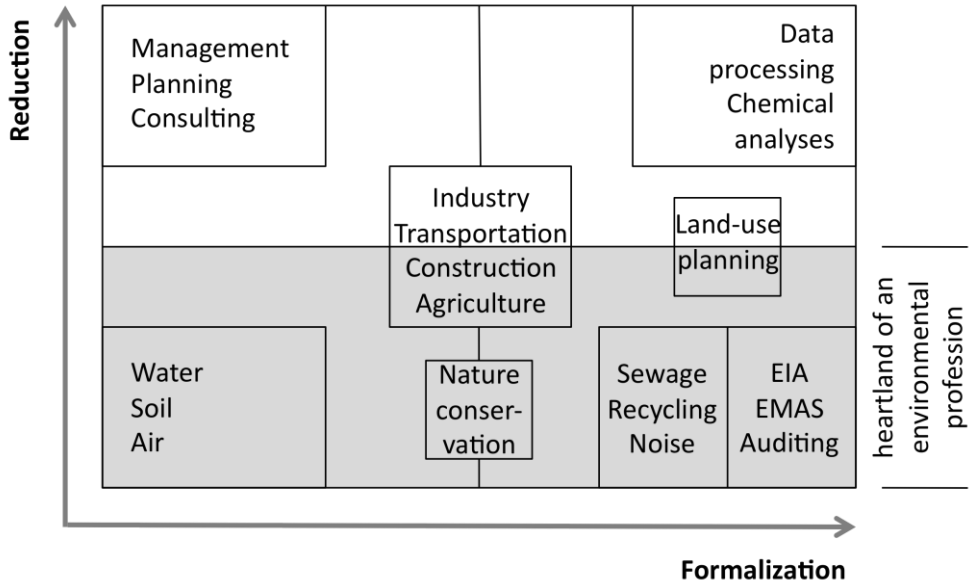

Figure 1. The 1997 model of the field of environmental tasks: Reduction and formalization as two dimensions that define the field of environmental tasks in Switzerland. Here, formalization is defined as degree of professional standardization (not scientification, mathematization, etc.)

Abstraction and professional competition

The 1997 model of the field of environmental tasks (Fig. 1) proved empirically fruitful. As shown by Figure 2, the sets of tasks were related to differences in the task-specific activities of professions, in clients served, knowledge applied, and professional competition. We thereby demonstrated that professional competition was linked to abstraction (Mieg, 2002): Inter-professional competition was correlated with reduction; intra-professional competition varied with formalization.

According to the Monopoly Assumption, we expected some kind of monopolization of the heartland of the field of environmental expert tasks in Switzerland – that is, the subset of low-reduced tasks. We expected that, in low-reduced tasks, inter-professional competition would be reduced or even substituted by intra-professional competition. However, we found the most intense inter-professional competition for the low-reduced tasks. We interpreted this finding as indicating a low degree of professionalization within the field of environmental expert tasks in Switzerland (Mieg, 2002).

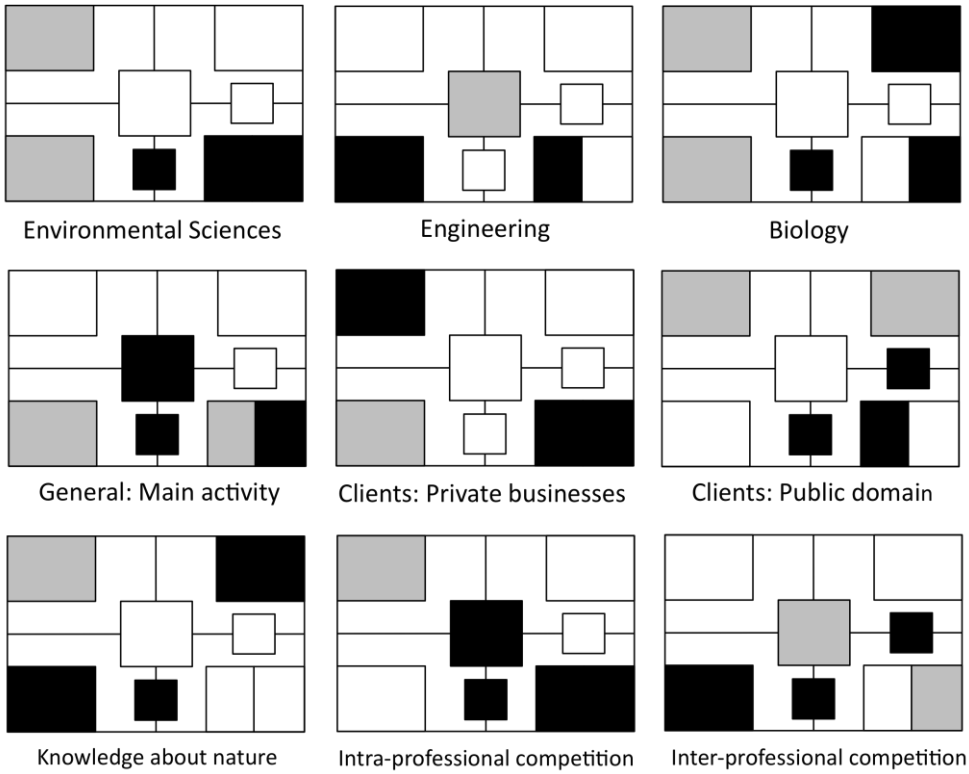

Figure 2. Applications of the 1997 model of the field of environmental tasks (see Fig. 1). Black fields: ranking first or highest; white fields: ranking last or lowest; grey: medium results. Analyses of variances (df = 7), differences are statistically significant ($p < .05$). cf. Mieg (2001a).

Linked ecologies: professions, universities and nation state

Our early analyses exploited the link between the ecologies of professions and universities. We wanted to know how professions applied abstract knowledge. We found empirical evidence for Abbott's (1988) distinction of forms of abstractions (e.g., Mieg, 2002; de Sombre, 2004). Ten years later, we shifted the perspective, focusing on the link between the two ecologies defined by universities and the political system. For Abbott (2005), professions, universities, and states can be described as different but linked ecologies. Abbott defined ecologies as related entities: "When we call a set of social relations an ecology, we mean that it is best understood in terms of interactions between multiple elements that are neither fully constrained nor fully independent" (Abbott, 2005, p. 248).

In 2009, we conducted a national outreach study for environmental sciences in Switzerland, involving both a survey among professionals and interviews with representatives from industry and the political system (Brunner et al., 2010; Mieg et al., 2012). The most surprising finding was the emergence of science-based standards (language, models, concepts …) as a form of social capital between the involved ecologies (Mieg et al., 2012). We had expected to find different codes and models, for instance, originating from legal or technical norms. Instead, what we saw was that environmental sciences impacted society by providing a language for cross-sectorial expert communication within and between administrations, com-

panies, and other institutions. Figure 3 presents the role of standards among the linked ecologies.

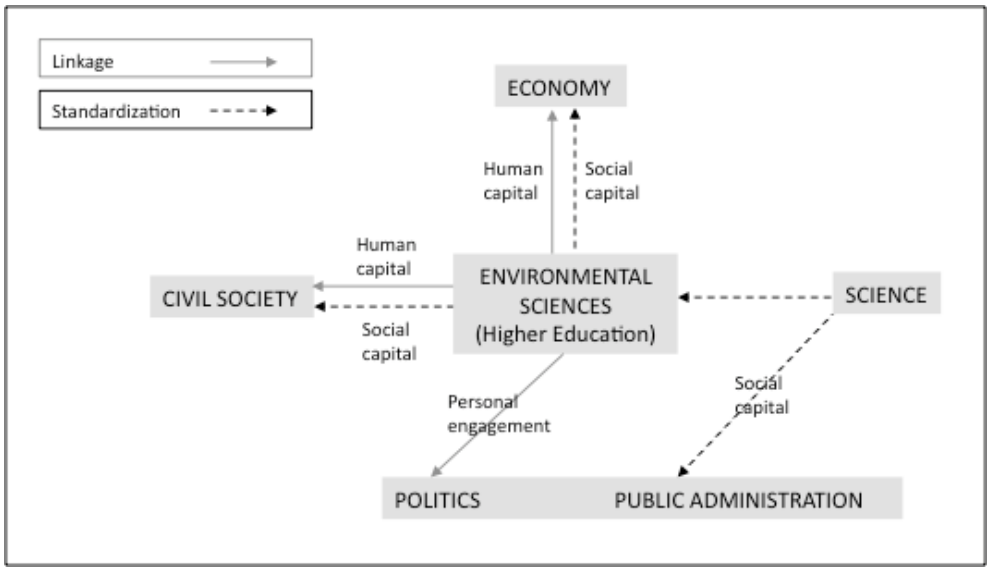

Figure 3. Standardization as a form of social capital provided by environmental sciences in Switzerland (2009 data, simplified version, cf. Brunner et al., 2010; Mieg et al., 2012). Interactions outside environmental sciences are suppressed.

Research questions

We started our research in the 1990s, using Abbott's work on the system of professions (1988) as a theoretical framework. Reviewing our research of the last twenty research, we see two puzzling details – one concerning reduction, the other formalization. Applying Abbott's paper on linked ecologies (2005), these open details appear in a new light and help to define research questions that we can answer through further analysis of earlier data. The two research questions are:

1. Reduction defined from the state ecology view: The first research question concerns the link between the professions and the state ecology. The field of environmental expert tasks is definitely law-driven. Without environmental legislation, this field would be almost nonexistent. Moreover, about two-thirds of the core professional environmental tasks were directly ordered and funded by public institutions (cf. Mieg, 2000a). Thus, we should redefine the field of environmental expert tasks from the perspective of public administration (as part of the state ecology); we could then consider the un-reduced tasks as linked to the task definitions of the administration. It then becomes clear that the most intense competition occurs in the arena of un-reduced tasks. So the question is: Would a definition of reduction clearly derived from the state ecology view confirm the 1997 findings using?

2. Formalization as scientification: The introduction of environmental tasks into the Swiss system of professions clearly led to greater scientification than to strengthening of the environmental professions. Furthermore, between 1997 and 2009 we observed the success of the systems metaphor (cf. Fig. 1) and science-

based formal standards (cf. Fig. 3). The second question concerns the understanding of abstraction as formalization. In our early studies among environmental professionals, we understood formalization as standardization, with standards being more or less scientific. The research question is: Do we also find empirical support for impacts of formalization as (pure) scientification? By scientification, we refer to science (in contrast to law, for example) as the source for terms and methods.

The data

To answer the two research questions, we can further analyze data from the national survey we conducted in 2001 (de Sombre et al., 2002). In the next two sections, we introduce the sample and the core variables.

Sample

To obtain an overview of the ecology of environmental professionals in Switzerland, the postal addresses of potential environmental professionals were collected in co-operation with 74 Swiss associations and educational institutions. A pool of 15,012 addresses was gathered, from which a sample of 10,000 was drawn on a mainly selective basis, to include all individuals associated with "core institutions" of the field (n1 = 8,545) as well as all institutions that provided addresses (n2 = 404). The remaining n3 = 1,142 addresses in the sample were included on a random basis. With four more professionals included by personal request, the final sample consisted of 10,004 participants (cf. Table 1)

Table 1
Sampling

	German	French	Total
Sent (total)	8,504	1,500	10,004
Addressee not reached	1,011	110	1,121
Sent (reached)	7,493	1,390	8,883
Return (absolute)	2,983	531	3,514
Return rate	39.8 %	38.2 %	39.6 %
Excluded	136	17	153
Final sample	2,847	514	3,361

By the end of February 2002, we received 3,514 completed questionnaires, representing a (corrected) return rate of 39.6 %. Of those, 3,361 were included in the final sample; the remaining 153 respondents specifically indicated that they were not occupationally active within the field (student, retired, etc.). Compared with indicators of the Swiss national statistics (Bundesamt für Statistik, 2001), this final sample (n = 3,361) was not biased in language or age-structure (approximated binomial tests, $p > .2$). With regard to gender, no bias was found for three of the four most frequently indicated occupational groups, namely engineers, biologists and environmental scientists; the gender distribution only appeared to be somewhat biased among agronomists/foresters (see de Sombre, 2004 for details).

Variables: competition, abstraction

The task definitions were obtained via an open question asking respondents to note their "three most important environment-related professional activities" (see Appendix 2 for a translated version of the question).

Connected to the task definitions, the issue of competition was measured via a closed question asking respondents to indicate their activity-specific competitors (see Appendix 2). For that purpose, for each indicated professional activity, a list of 20 disciplines was presented, in which the respondent was asked to indicate his/her own professional affiliation.

Based on each respondent's self-assessed professional affiliation and competitors, we defined inter-professional competition as the number of indicated disciplines that differed from those the respondent claimed as their own professional background. The resulting metric has a range of possible integer values from 0 to 20.

Intra-professional competition was defined as a dichotomous variable. If at least one of the competitors was a colleague of the respondent (same discipline), we categorized this as intra-professional competition.

To assess abstraction, we had to structure the set of task definitions. To this end, we used the so-called DSPIR-model. This model was developed by the European Environmental Agency (cf. e.g., European Environment Agency, 1999, p. 9) and by BUWAL, the Swiss Environment Protection Agency, and was the de facto model for environmental protection among public administrations.

As shown by Figure 4, the DSPIR-model comprises five components: Drivers (D), Pressures (P), State (S), Impact (I), and Responses (R). The first four components are meant to represent a cause–effect chain:

- The Drivers (for example transportation, agriculture) are areas of human activities that are sources of pollution and emissions with environmental impacts.
- The Pressures denote sources of environmental effects already detached from the actions producing them. It is the "stresses from the anthropic system on the natural environment: release of polluting substances (emissions to air, to water, waste …), radiation emissions, intake of natural resources, use of soil, other changes in natural environment" (Constantino et al., 2003, p. 8).
- The State denotes the condition of the environment. It is connected to elements of "the environment," (e.g., soil, water, nature, landscape, climate) to which a state may be assigned.
- Impact refers to the "effects on the anthropic system due to changes in the state of the natural environment: negative consequences on human health, economic loss in production activities, floods …" (Constantino et al., 2003, p. 8).

The component Responses completed the model by including societal reaction to the environmental situation.

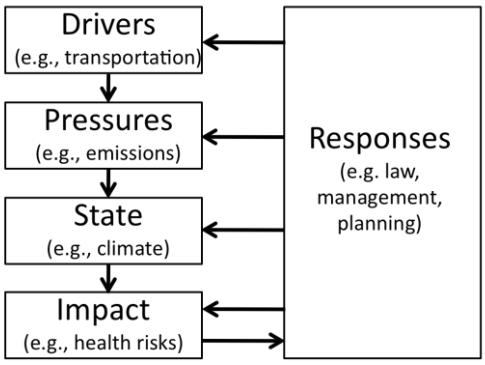

Figure 4. DPSIR model

The degree of reduction[1] of a particular task definition could be defined relative to the DPSIR model, in particular with reference to its D–P–S–I chain. Therefore, a task definition is considered to have:

- A low degree of reduction if it implies a reference to the causal chain of the four model-elements D, P, S and I. This is the case for task definitions referring to one element of the chain while at the same time implying the connection of this element with other elements of the chain. For example, "nature protection" makes reference to the complex environmental element "nature" to be assigned to the DPSI component "State" while at the same time referring implicitly to the element "Pressures" by claiming the need for protection.
- A medium degree of reduction if it refers to one of the elements of the chain (DPSI) without implying the "embeddedness" of this element in the cause–effect chain. This is the case for examples such as "agriculture," "transportation," and "water."
- A high degree of reduction if it establishes no direct connection to the DPSI chain. This is the case for examples such "management," "consulting," "education," and "science," which only refer to "Responses."

For the definition of formalization, we referred to the scientification – that is, formal knowledge as it is provided by the university ecology. We could then define formalization through the amount of scientific knowledge entering into a task definition. Based on this idea, a task definition was assigned:

- A low degree of formalization if the terms only refer to plain objects or executive actions (e.g., "construction," "service," "administration," "water").
- A medium degree of formalization was assigned if the task definition contains terms referring to abstract, complex objects or to activities that imply systematic reflection (e.g., "planning," "project," "consulting," "controlling").
- A high degree of formalization if it makes reference to science or science-related knowledge or objects (e.g., by using terms as "science," "biology," "model").

[1] The definition of degrees of reduction and formalization was part of the dissertation by Steffen de Sombre (2004).

The ecology of environmental professionals

The ecology of environmental professionals comprises occupations and experts from a variety of educational backgrounds and disciplines. Table 2 shows the ten most frequent disciplines. The two largest groups, each accounting for almost one third of the sample (30.1 %), were agronomists/foresters and engineers, in which the engineers were represented by several subgroups such as environmental or transport engineers. The third-largest group was the biologists (16.1 %), followed by environmental scientists (15.2 %).

Table 2
Most common disciplines (multiple responses allowed)

Discipline	n	%
1. Engineers (total)	859	30.1 %
Environmental Engineers	323	11.3 %
Transport Engineers	161	5.6 %
Other Engineers	375	13.1 %
2. Agronomists/Foresters	858	30.1 %
3. Biologists	459	16.1 %
4. Environmental Scientists	433	15.2 %
5. Geologists	295	10.3 %
6. Land-use Planners	293	10.3 %
7. Chemists	252	8.8 %
8. Geographers	172	6.0 %
9. Economists	139	4.9 %
10. Urban Planners	134	4.7 %
Total disciplines	5,401	100 %

By grouping professionals according to their disciplines, we could determine inter- and intra-professional competition. The mean number of indicated inter-professional competitors was 2.45; 60.4 % of all respondents indicated intra-professional competitors. Table 3 shows that the most frequently indicated inter-professional competitors were engineers and environmental scientists, each accounting for more than one third of all competitors. When comparing Tables 2 and 3 – that is, the frequency of disciplines and the frequency of their being indicated as competitors – we see that agronomists/foresters, although being very well represented, were considered as less important competitors. In contrast, environmental scientists, geographers, and lawyers ranked higher with respect to competition than frequency.

Table 3
Most relevant inter-professional competitors (multiple responses allowed).

Inter-professional Competitor	%
1. Engineers (total)	40.0 %
2. Environmental Scientists	34.6 %
3. Biologists	22.5 %
4. Geographers	20.1 %
5. Land-use Planners	19.3 %
6. Agronomists/Foresters	16.8 %
7. Lawyers	11.7 %
8. Urban Planners	11.7 %
9. Economists	11.7 %
10. Chemists	10.2 %

Note. The percentages are based on the respondents not having indicated the respective subject as their own academic educational background.

Figure 5 depicts inter-professional competition in the ecology of environmental professionals. We had a core group of competitors comprising environmental scientists, environmental engineers, and biologists.

We see that two fields of competition were opened, one being related to nature, the other to planning. In the nature-related field, we also found geographers and the agronomists/foresters; the planning-related field included land-use planners and more engineers (e.g., civil engineering). In this depiction, the environmental scientists had a central position, as they were present in both fields of competition.

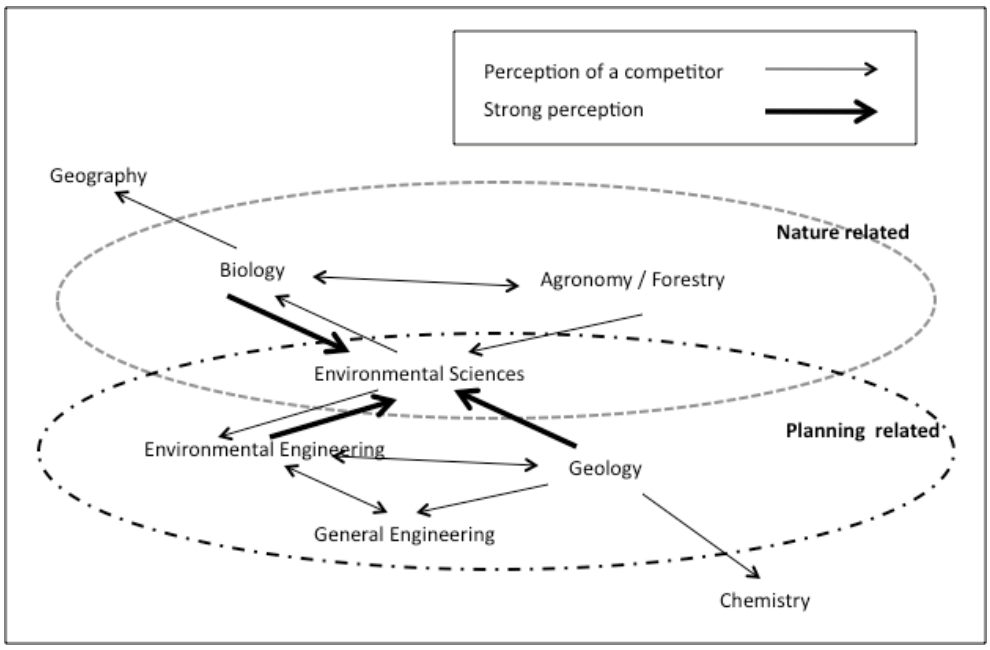

Figure 5. Two fields of inter-professional competition among Swiss environmental professionals (cf. Mieg & de Sombre, 2004)

The role of abstraction

The 3,361 respondents included in our final sample indicated a total of 7,588 environment-related professional activities. For the purpose of exposition, we grouped these task definitions into categories, which were developed with respect to the above DPSIR model (for details, see de Sombre, 2004). For 7,138 professional activities, this grouping was possible.

Degrees of abstraction could be assigned to the 7,138 classified task definitions. We found a dominance of highly-reduced definitions (48.6 %), whereas highly formalized definitions were relatively uncommon (15.4 %). Both findings could be interpreted as indicating the non-professionalized status of environmental expert services. Table 4 provides an overview of the task definitions.

A cornerstone of our analysis was to examine the connection between abstraction and competition. Tables 5 and 6 show cross-tabulations of the two forms of abstraction with inter- and intra-professional competition. We tested the connections between abstraction and competition (Kruskal–Wallis test). Inter-professional competition was significantly linked to reduction ($p < .001$); greatest competition occurred for low-reduced tasks (Table 5). Intra-professional competition was significantly linked to formalization ($p < .001$); greatest competition occurred for highly formalized tasks (Table 6).

Table 4
Most important categories of task definitions

Task definition	n	%	Degree of reduction	Degree of formalization
1. Professional & further education	417	5.8 %	high	medium
2. Construction	317	4.4 %	medium	low
3. Consulting & expert opinions	313	4.4 %	high	medium to high
4. Agronomy	292	4.1 %	medium	low to medium
5. Waste	265	3.7 %	low	low to medium
6. Environmental impact assessment	249	3.5 %	low	medium
7. Management	217	3.0 %	high	medium
8. Science & research	184	2.6 %	high	high
9. Soil contamination	181	2.5 %	low	low
10. Water	180	2.5 %	medium	low
Total of grouped activities	7,138	100.0 %		

Table 5
Reduction and professional competition (N = 5,131 tasks)

Competition by	Degree of reduction			
degree of reduction	low	medium	high	total
Inter-professional competition (mean)	2.94	2.42	2.38	2.53
Intra-professional competition (mean)	0.63	0.65	0.63	0.63
n	1,222	1,525	2,384	5,131

The results are in line with former conclusions (Mieg, 2002). With our first research question, we wanted to further clarify the link between professional ecology and the nation state. For this, we redefined the task on the basis of the governmental DPSIR model. Again, we found the greatest inter-professional competition for the low-reduced, state-defined tasks, which emphasizes that this market is still driven by regulation.

The second research question concerned abstraction as formalization. Formalization was defined via scientification (following Abbott, 1988) rather than standardization (as in Mieg, 2002). Again, we found a connection between formalization and professional competition. The results confirm scientification as a viable interpretation of formalization.

As shown by Table 6, for highly formalized tasks, we found significantly low inter-professional (= inter-disciplinary) competition and increased intra-professional competition. Here, our Monopoly Assumption applies: Professionalization of a set of tasks is indicated by the substitution of inter-professional competition by intra-professional competition within one profession. However, instead of one profession monopolizing the whole environmental tasks field, we find some form of partial professionalization of highly formalized tasks – namely sciences. For the time being, not a new integrated profession, but a new scientific discipline is arising: Environmental Science.

Table 6
Formalization and professional competition (N = 5,131 tasks)

Competition by	Degree of formalization			
degree of formalization	low	medium	high	total
Inter-professional competition (mean)	2.57	2.55	2.36	2.53
Intra-professional competition (mean)	0.60	0.63	0.72	0.63
n	1,836	2,423	872	5,131

Implications for the study of professions

Abstraction is working – this could be the conclusion from our research on the market of environmental expert services in Switzerland over the last twenty years. In particular, we observed the productive, competitive role of two forms of

abstractions: reduction and formalization, as defined by Abbott (1988). Our findings underline Abbott's general assertion that "abstraction is the quality that sets inter-professional competition apart from competition in general" (p. 8–9).

Our twenty years of research on Swiss environmental professionals support all three general propositions by Abbott (1988, 2005): We first observe that dynamism in this field is caused by the interactions within a system of professions, including environmental scientists but also engineers, biologists, geographers and specialists in land-use planning (see Figures 2 and 5; Tables 2 and 3). Secondly, we find evidence for jurisdictional shift, for instance from nature-oriented tasks and planning towards more integrated environmental tasks (see Fig. 5), mediated by the diffusion of standards (see Fig. 3). Thirdly, we find close interaction between the professional ecology and the ecologies of the nation state and universities (Fig. 3, research question 1).

The discussion reviews our two research questions. The first question was: What follows when we redefine the field of environmental expert tasks from the perspective of public administration and consider the un-reduced tasks as linked to the task definitions of the administration: Do we still find most intense inter-professional competition among the "un-reduced" tasks? The second research question concerned formalization and scientification, as Abbott (1988) conceived of formalization: Do we also find empirical support for impacts of formalization as (pure) scientification? We found confirmation for both research questions; however, it is necessary to discuss the details as well as the implications for the study of professions.

Reduction: governmental task definitions as an anchor

To be clear, the degree of abstraction is relative to a profession or discipline. For instance, "discounted cash flows" is a very specific approach used in financial business administration and would appear as "reduced" when applied to environmental tasks. However, if we (re-)interpret the idea of discounting future capital as CO_2 emissions to the atmosphere, then we would arrive at a form of environmental impact assessment, a very common method in environmental professional services. Therefore, for our studies, we required a form of meta-semantics or open field description that allowed for an interdisciplinary integration of approaches to defining tasks in the market of environmental expert services. For the analyses of the 1997 data, we applied the systems metaphor that was in use as an interdisciplinary fundament of the various disciplines of environmental sciences at the Swiss Federal Institute of Technology. For the 2001 data, we have now applied the DPSIR model.

Despite being interdisciplinary, the systems metaphor was very much linked to the environmental sciences at the Swiss Federal Institute of Technology, which appeared as one of the competitors in the professional market. We therefore switched to the DPSIR model that could be more directly linked to the nation state ecology, represented by the Swiss Federal Office for the Environment.[2] The nation

[2] The DPSIR model was designed by the European Environmental Agency as a causal meta-model for sustainability issues, and includes the ability to define sustainability indicators. As a standard, sustainability indicator sets comprise economic, ecological, and social criteria. With the data from the outreach study, we could see how this three-dimensionality

state represents the fundamental regulatory force in the market of environmental professional services. Both approaches – the system metaphor as well as the DPSIR model – delivered similar results, underlining the power of the concept of abstraction for the study of professions, particularly when also taking into account the different ecologies (profession, universities, nation state).

The puzzling finding from analyses of the 1997 data (e.g., Mieg, 2002) was the dominance of inter-professional competition in tasks with un-reduced definition, i.e., in the heartland of an environmental profession (see Fig. 1). We interpreted this finding as indicating the incomplete professionalization of the field of environmental tasks in Switzerland. Although this interpretation might be correct, it cannot explain why we see most competition in this field. Applying Abbott's approach of linked ecologies (2005), we can re-interpret the puzzling finding as inter-professional competition within a task field that has been created by the nation state. When considering the basis of the 1997 analyses, we find that even the systems metaphor was not introduced by the ecologies of universities or professions; instead, the 2009 national outreach study (Brunner et al., 2010) subsequently revealed that a national expert commission at the Swiss Federal Institute of Technology advised applying the systems metaphor as a fundament of environmental sciences. Thus, the heartland field of environmental professional tasks as defined in 1997 (see Fig. 1) originated from a more-or-less governmental task definition.

Formalization as scientification: (social) closure

The operationalization of formalization as scientification did work in a similar way as the 1997 operationalization via standardization (see Appendix 1). In particular, formalization correlated with intra-professional competition, as was previously hypothesized and confirmed in the case of formalization as standardization (Mieg, 2002). However, rather than the greatest intra-professional competition occurring at a medium level of standardization, we now find greatest competition for the highest level of scientification; thus, scientification matters.

Our research on environmental professionals started as a professionalization study of whether we would see the rise of a new environmental profession. As professionalization represents a form of social closure (following Weber), we expected the heartland of environmental expert services (see Fig. 1) to become monopolized by one professional group; inter-professional competition would diminish and be substituted by intra-professional competition within the environmental profession (our Monopoly Assumption). This is not (yet) the case. However, we found a constellation of reduced inter-professional competition and increased intra-professional competition for the highest level of scientification. Hence, rather than social closure among professional groups, we see closure within science: a new discipline is born – Environmental Science (singular).[3] At the Swiss Federal

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of sustainability is reflected in the tasks of alumni from the ETH Environmental Sciences (Hansmann, Frischknecht & Mieg, 2012).

[3] To speak of (social) closure in sciences differs from Abbott's reasoning in his article about linked ecologies (2005). Here, Abbott makes claims that seem incompatible with the idea of social closure in science and introduces the term "settlements" into the university ecology in place of "jurisdiction": "Academic settlements can take the form of a special

Institute of Technology, Zürich, this discipline started in 1990 as Environmental Sciences, and has now become the Department of Environmental Systems Science.

Conclusions

Our findings call for a renewed, formality-centered research on professional work. This should cover:

- The system of professions
- Linked ecologies
- Professional practice
- Expert work in organizations, expert organizations (professional firms, etc.)

"Abstraction works" cannot be reduced to: formal knowledge being transferred into practice. We should instead study "governing by abstraction" (Stinchcombe, 2001); that is: how formality regulates the interactions between ecologies (Fig. 3) or competition with a professional field (Tables 5 & 6). Further aspects would be: formality as a means for professional discretion (Freidson, 2001) or professional "inference" (Abbott, 1988), for instance, the role of methodology (techniques, charts, formulas …) for performing or justifying professional services. Furthermore, we should include research on how formality governs workplace relationships among professionals within organizations that allow for more or less professional autonomy (e.g., Fournier, 1999; Mieg, 2001b, 2003).

As an aside: Our studies on environmental professionals in Switzerland supported Abbott's concept of linked ecologies. However, we also found new agents, knowledge, and intermediaries such as NGOs (non-governmental organizations). In Switzerland, the World Wide Fund for Nature (WWF) is an important player in producing and transmitting abstract knowledge on environmental systems and behavior. The WWF was founded as the World Wildlife Fund in Switzerland in 1961; today, it provides expert services across a broad field of environmental issues as well as further education (see www.wwf.ch). We find similar institutions at the United Nations level, for instance OECD, UNESCO, and UN-Habitat, which serve as global knowledge agents (cf. Mieg & Töpfer, 2013). If professional work is constituted on knowledge (Evetts, 1999; Freidson, 2001) and is not simply a matter of social closure, then the study of professions will increasingly have to deal with NGOs, the work of which is based on large, core abstractions: economic development (OECD), education (UNESCO) and human settlement (UN-Habitat).

To conclude: Even though our series of studies since the 1990s has not yet demonstrated the rise of a new, environmental profession, we hope to have made clear at least this one point: abstraction matters and must be dealt with as a fundamental category of the study of professions!

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faculty, a major or concentration, a set of courses, a body of more or less controlled knowledge, or any combination of these. Settlements lack the strongly exclusive character of professional jurisdictions. They may involve research practices, evidentiary conventions, and perhaps systems of knowledge application, as well as all the structural apparatus of journals, degrees, conferences, and so on. Settlements lack the strongly exclusive character of professional jurisdictions" (p. 250).

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Appendix 1

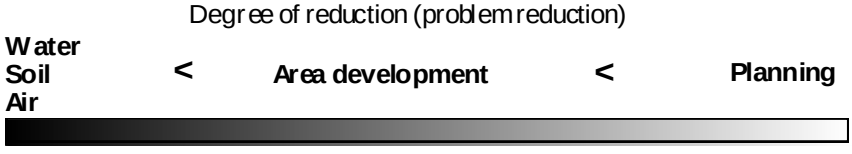
How to derive degrees of abstraction (cf. Mieg, 2001a)

We aim to classify the field of environmental activities from the point of view of abstraction. Two methodological points have to be addressed in advance:

1. The degree of abstraction does not refer to the activity per se, but to the definition of the activity given to it by the professionals. Thus, we analyze definitions not markets. For example, two professionals compete with each other for projects in urban development. One professional might call her activity "area development," whereas the other professional calls it "planning." In this case, the task is the same but there are two different definitions or labels for it. The difference is not simply a linguistic one: Differences in definitions are related to differences in the knowledge base and in professional education.

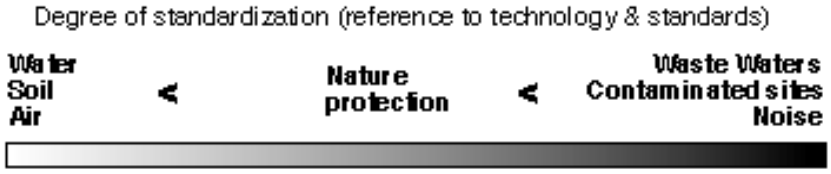
2. We have to consider degrees of abstraction as a relative measurement, not an absolute one. Nevertheless, we can use a paradigmatic definition of environmental problems as a starting point for deriving degrees of abstraction. Referring to the system view approach that is fundamental to Environmental Sciences at ETH Zürich, we can consider an environmental problem as a specific "interaction of the natural systems water, soil, and air systems" (Departement Umweltnaturwissenschaften, 1997, p. 5).

Degrees of reduction (low, medium, high):
In our context, reduction means reduction of the underlying environmental problem to be solved. The paradigmatic anchor is the definition of environmental problems as interaction of natural systems. Then a full, non-reduced understanding of any environmental problem has to reveal the interaction of the natural systems involved. Defining an activity as "area development" does not reveal this interaction; therefore, the degree of reduction of this definition is greater than that of the "paradigmatic" fields "water," "soil," and "air." Nevertheless, a definition such as "area development" still has an aspect related to environmental problems because it includes the possibility of soil contamination. From that point of view, "planning" is still more reduced than "area development," since "planning" can also relate to business project planning or political planning. As to their degree of reduction, we can order "area development" and "planning" in the following way (the dark color of the bar indicates to what extent a definition shows an understanding of environmental problems as an interaction of natural systems):



Degrees of standardization (low, medium, high):
Standardization means that some kind of technology is available to solve a problem. We can derive the degrees of standardization in analogy to the degrees of reduction. The activities "water," "soil," and "air" are the paradigmatic anchor. These three

definitions show a relatively low degree of standardization—they do not indicate specific technological solutions for the underlying environmental problem. In contrast to these definitions, the related definitions "wastewater," "contaminated sites," and "noise" define their tasks in a more solution-oriented manner that indicates what has to be done; for example, there is technology for contaminated site remediation. Thus, the definition "contaminated sites" shows a greater degree of standardization than the definition "soil", which only indicates the natural system concerned. In our classification, medium standardization could be found for definitions such as "nature protection." Thus, we would ascribe degrees of standardization in the following way (the dark color of the bar indicates to what extent a definition of a professional activity takes reference to technology and standards):



Appendix 2

Determination of professional activities and competitors. Questionnaire format used in the 1997 and 2001 surveys (Mieg, 2000a; de Sombre et al., 2002).

Market for environmental expert services

Presumably you work on several professional activities or projects, for example:
- environmental auditing for corporations
- contaminated sites
- EIA,
- environmental data bases,
- academic teaching

Please indicate your three most important environment-related professional activities. Please tick the competitors for each of your activity.

	Main professional activity	Second important professional activity	Third important professional activity

Competitors:

agronomists / foresters	☐	☐	☐
architects	☐	☐	☐
biologists	☐	☐	☐
chemists	☐	☐	☐
experts in arts/humanities	☐	☐	☐
geographers	☐	☐	☐
geologists	☐	☐	☐
computer experts	☐	☐	☐
lawyers	☐	☐	☐
media experts	☐	☐	☐
physicians	☐	☐	☐
economists	☐	☐	☐
teachers	☐	☐	☐
area planners	☐	☐	☐
urban planners	☐	☐	☐
social scientists	☐	☐	☐
environmental natural scientists	☐	☐	☐
environmental engineers	☐	☐	☐
transport engineers	☐	☐	☐
other engineers	☐	☐	☐
others: _____	☐	☐	☐