Community Participation in Habitat Mapping: Learning through the Emergence of an Eelgrass Stewardship Network

by

Leanna Boyer
B.Sc., University of Victoria, 2001

A Thesis Submitted in Partial Fulfillment of the
Requirements for the Degree of

MASTER OF ARTS

As an Interdisciplinary Pursuit through the
Department of Curriculum and Instruction

Supervisory Committee

Dr. W.-M. Roth, Supervisor (Department of Curriculum and Instruction)

Dr. R. Canessa, Co-Supervisor (Department of Geography)

Dr. N. J. Turner, Outside Member (School of Environmental Studies)

Dr. C. E. Harris, External Examiner (Department of Educational Psychology and Leadership Studies)

Abstract

This thesis explores learning in and through the emergence of a network of communities who participated in the B.C. Coastal Eelgrass Stewardship Project (the Project). I draw on a two-year ethnographic investigation of 20 community groups who were trained to map and monitor eelgrass habitat and carry out education and stewardship-related activities. People from a multitude of backgrounds, including scientists and non-scientists, and a diversity of places, from small coastal communities to urban centers, worked towards the collective goal of mapping and conserving the extent of eelgrass habitat along the coast. Using cultural-historical activity theory, I develop an alternative framework for understanding learning and change in a network of communities. The collection of three main chapters, shows that learning, emergence, and stabilization of the network arose through the following dialectical relations: individual|collective, social|material, and agency|structure. This thesis shows that viewing and supporting the Project as a dynamic learning network makes it more stable.

Table of Contents

Chapter 3

Chapter 4

Chapter 5

Chapter 6

List of Tables

List of Figures

Acronyms

CHAT	Cultural-Historical Activity Theory
CMN	Community Mapping Network
GPS	Global Positioning System
SCWG	Seagrass Conservation Working Group

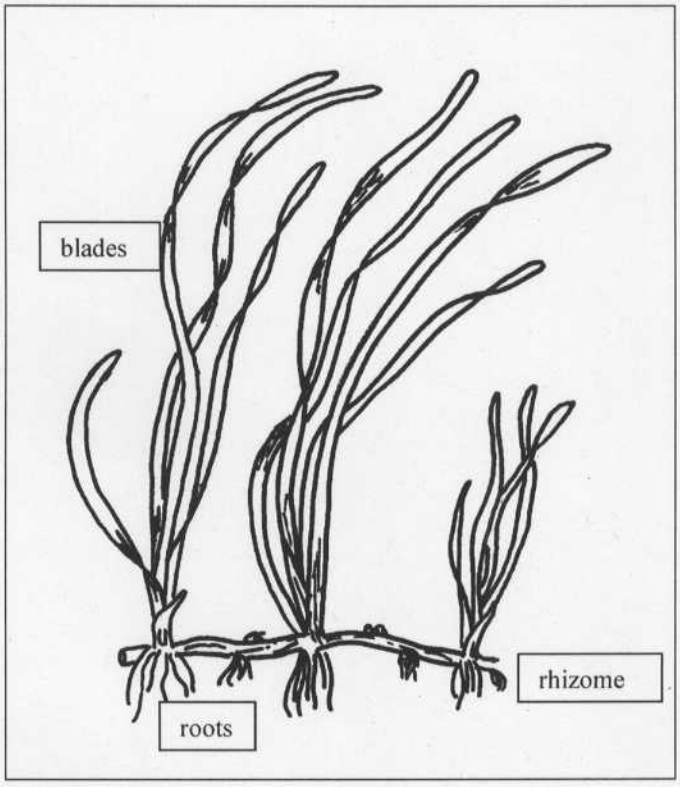
Acknowledgements

Thank you to all of the members of the eelgrass network and the SCWG for sharing your stories, eelgrass meadows, and homes so graciously. Without all of you this project would not have been possible. I am honoured and inspired by the numerous interactions I have had with community coordinators, biologists, and government employees who continue to work towards promoting balance between humans and the plants and creatures that enrich our lives. Thank you to my family and friends who were always fiercely supportive and gently critical. Thank you to my lab mates in A420, including those who have come and gone, who provided creative space and support that enabled me to learn and grow. Thank you to the lovely ladies down the hall who helped me to learn the administrative aspects of being a grad student and always reserved a smile and laugh for me, even on Mondays. Thank you to the computer technicians who were all so helpful, even though they were not supposed to! Thank you to my most cherished mentors, Michael and Nikki. Your wisdom and endless support helped me to grow. The way you both nurtured the best in me and taught me how to better nurture others will be etched in my being forever.

Chapter 1

Introduction

The theme of this thesis can best be described by using the metaphor, eelgrass, which is also the primary focus of the network of communities that participate in this study. Eelgrass is a grass-like plant that makes its home underwater in the sandy-muddy places at the edges of the sea. The plant anchors itself in this medium with a fibrous root-like structure called a rhizome (see below), from which tufts of roots emerge. The rhizome also functions in reproduction, extending a network of rhizomes under the sandy or muddy surface, sprouting new emerald green blades that reach for the sunlight.



Zostera marina Leanna Boyer

Humans also make their homes at the edges of the sea and sometimes our actions negatively impact eelgrass by digging it up or blocking the vital sunlight. Damaging eelgrass habitat also means compromising the shelter or food source of numerous species of invertebrates, fish and birds. The focus of this thesis is the activities of an emerging grassroots network of communities who learned to map and monitor eelgrass habitat in order to steward it. This network is much like the underground network of rhizomes that make up an eelgrass community (meadow)—the rhizomes representing connections between distant community groups and the photosynthetic green blades representing local networks that are developed and maintained. Those community members who make environmental stewardship and conservation the focus of their lives first and foremost inspire this thesis. These people are characterized by compassion, dedication to collaboration, and astute awareness of relations between humans and natures.

I was first introduced to the stewardship community in 2000 when I volunteered to help restore eelgrass habitat in Saanich Inlet at the Tsartlip Village near Victoria, British Columbia. I was fresh from the Bamfield Marine Station (west coast Vancouver Island) where I learned about marine invertebrates and seaweeds, but not eelgrass. Upon first introduction to eelgrass, I lamented about how kelps (brown seaweeds) were much sexier. But before too long I began to view eelgrass in a different light. I learned about how important eelgrass habitat is for fish, invertebrates and birds and how its productivity rivaled that of cultivated tropical agriculture (Zeiman & Wetzel, 1998 cited in Precision Identification, 2002).

I continued to volunteer on eelgrass transplants coordinated by SeaChange Marine Conservation Society (SeaChange) and accompanied Nikki, the executive director, to

Galiano Island where we participated in an environmental program at the school. Through these experiences I not only learned about eelgrass, I started to see the intimate connection between eelgrass habitat conservation (and restoration) and education. I discovered how vital it was for me to participate in conservation (as this related to my marine biology background) and at the same time, share what I had learned and learn from others by participating in public education. I could do all the conservation I wanted but if I could not communicate my understandings to others, young and old, and be receptive to their understandings of the world, then my efforts would be fruitless.

Thus began my interest in investigating learning amongst a network of communities that participated the B.C. Coastal Eelgrass Stewardship Project coordinated by SeaChange. I was first introduced to eelgrass habitat conservation by attending an Eelgrass Conservation Working Group (now called Seagrass Conservation Working Group or SCWG). In 2001, SeaChange joined a consortium involving other individuals concerned with the state of eelgrass in B.C.— other non-profits, scientists, and government representatives. The SCWG formed to evaluate the state of eelgrass distribution and research along the B.C. coast and support further actions to conserve it. Soon after, the BC Coastal Eelgrass Stewardship Project began with Nikki as the coordinator, trainer and administrator of the project. Nikki traveled with a biologist from Vancouver to train eleven community coordinators from Semiahmoo Bay to Port Clements to map and monitor eelgrass and carry out stewardship in their communities. The project was initiated to fill the gaps in knowledge about the extent and health of eelgrass along the coast of British Columbia, a critical habitat that is being considered by

the provincial government as an indicator of nearshore health (Precision Identification, 2004).

The project intrigued me. I had been to a few SCWG meetings, and each time I left with a "high". People from many different backgrounds came together (volunteering for the most part) to make decisions and produce knowledge that they hoped would influence government decision making. More importantly they wanted to see work get done and have communities be supported in their efforts to conserve eelgrass. In these initial meetings, I was curious about how non-scientists and scientists interacted. Some members of the group wondered whether there should be two different meetings, one for the scientists and one for community groups, because they seemed to speak different languages. By the time I started my research, two years after the SCWG formed and one year after the project began, there was still a single meeting of non-scientists and scientists. They seemed to be speaking a language both could understand. They had learned about each other.

1.1 Purpose and objectives

The purpose of this thesis is twofold. Firstly, a) to explore how learning comes about in the network of communities and b) whether learning, facilitated by individuals and the collective, contributes to its stabilization. The theoretical foundation, cultural-historical activity theory (CHAT), is centrally concerned with the relationship between individual and society. It is particularly well suited for analyzing networks and learning, especially if I take a sociocultural view of learning. Secondly, the purpose of this thesis is to provide an alternative theoretical framework for understanding learning and change in the everyday (informal) lives of people who engage in conservation activities in British

Columbia, Canada. Specific objectives and associated research questions are outlined in Table 1.1.

Table 1.1. Objectives and research questions.

Objectives	**Chapter**	**Research Questions**
1. To exlplore and explicate the relationship between individual and collective as it relates to learning in informal settings[1].	3	How does change in participation (learning) among network members change the practices of the network as a whole?
2. To investigate learning and teaching in and through participation in an eelgrass mapping event in one community.	4	How do teaching and learning come about through participation (of communities) in eelgrass mapping?
3. To document the emergence and stabilizing features of the network of eelgrass stewarding community groups.	3, 5	How are resources produced, used, and distributed across the eelgrass network? How do network members and network partners support the activities of other members whose ultimate goal is to conserve eelgrass habitat?
4. To elaborate a dialectical conception of relations between constituents of social and material culture as a basis for exploring learning and change.	3, 4, 5	How does a dialectical conception improve upon existing heuristics for understanding learning and change?

1.2 Rationale

Why is this research important? At a personal and local level, I observed the destructive outcomes of numerous cutbacks in both social programs and the environment-related sector initiated by the provincial government elected in 2001 (e.g., West Coast

Environmental Law Association, 2005). These cutbacks included grant programs that supported volunteer and non-profit stewardship and conservation groups and occurred around the same time that the federal Department of Fisheries and Oceans (now Fisheries and Oceans Canada) cut back on grant programs as well as the highly successful stewardship coordinator positions[2].

The provincial budget cutbacks also constrained the ability of branches of government mandated for habitat conservation to do their work. In fact, some employees were forced to compete for the same grants as non-profit groups to get important work done (interviewee). Non-profit groups perceived an increased urgency to fill the spaces where governments were divesting themselves, namely, in the areas of enforcement by increasing, for example, public education and industry outreach (e.g., David Suzuki Foundation, BC Stewardship Centre, Friends of Semiahmoo Bay), habitat and species inventory by hiring professionals or recruiting volunteers (e.g., Project Watershed Society, Community Mapping Network, Streamkeepers), decision-making by forming working groups (including government partners) or coalitions to influence policy and collaborate on projects (e.g., Seagrass Conservation Working Group, Coastal Alliance for Aquaculture Reform).

In the past four years, large and small environmental non-government organizations (ENGOs) have been collaborating in an unprecedented way despite the differences that

---

[1] In this thesis I use informal setting and free-choice setting interchangeably. There is debate among scholars about the differences between the two, however, I will not contribute to this debate. This setting is defined in Chapter 3.

[2] My understandings of the state of the environmental stewardship sector are informed by presentations given at the Leading Edge Conference (2004), a Canadian national conference on conservation and stewardship, and a meeting of non-profit groups in B.C. and the associated report commissioned for the meeting that surveyed non-profit and volunteer groups in B.C. (Finding Solutions Network, 2004).

isolated them in the past. However, this positive shift has resulted in an increasing gap between the large ENGOs and the grassroots in terms of capacity, trust and political power (Penn & Thomson, 2005). To compound matters, there is a sharpening ideological divide between groups that collaborate with industry and those who do not and those who advocate for incremental change versus those who favour revolutionary change. The question then arises, how can groups with differing ideologies work together on common goals?

This thesis is, in part, an attempt to contribute understandings about how a network of groups learn from and support each other. This can give insight into how groups can work through challenges and continue to further the goals of the network—eelgrass stewardship. Furthermore, other groups or government agencies wishing to develop and support this kind of network could benefit from understanding how learning comes about. How groups learn and support each other is taken up in Chapters 3 and 5.

This thesis also has the potential to contribute to an alternative view of teaching and learning in informal settings. Chapter 4 in particular, explores teaching and learning during a day-long eelgrass mapping event in one community. There are few studies that research learning and teaching in informal settings, especially in relation to science. There are also few studies that seriously look at the relationship between the material and social world as learning unfolds. Furthermore, theories of learning most often isolate the individual as the primary unit of analysis. This leads to an impoverished understanding of learning that is more richly understood by attending to social, cultural and material relations between individuals and the collective that supports them and who they in turn support. These themes are taken up in Chapters 3, 4 and 5.

1.3 Cultural-historical activity theory and learning

This thesis is grounded in a theoretical approach to learning and change that takes "activity" as its smallest unit of analysis. Therefore, everything that an activity like mapping eelgrass implies—individuals working with others, working with tools, working with eelgrass, producing knowledge—cannot be understood in isolation from the community, society, and culture within which it is embedded. Therefore, all entities of an activity system are dialectically related (see section1.3.1). This approach is elaborated from cultural-historical activity theory (CHAT) (Figure 1.1). In this framework, cultural change and psychological development are made possible through activity, that is, only by examining concrete human actions can we begin to understand learning. Instead of isolating learning to the psychology of the individual, CHAT focuses on the interaction between an individual, systems of artifacts, and other individuals in historically developing situations and settings (Miettinen, 1999). For studying the network of communities this means tracking social and material exchanges in inter-actions among members.

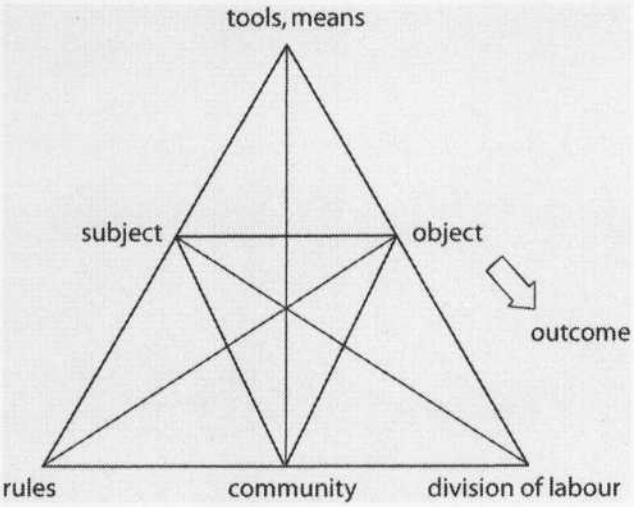


Figure 1.1. Cultural-historical activity theory heuristic (activity system) adapted from Engeström (1987).

In an activity system the *subject* is a person or group of people that is motivated (acts) toward a specific *object* (in the sense of an objective); without an object there is no activity. For example, eelgrass stewardship is the overall *object* of activity for members (*subject*) in the context of the eelgrass project. The relation between the subject and object of activity is always mediated by other social and material means: *community*, *division of labor*, *rules* and *tools*. In the eelgrass project, eelgrass maps, brochures and educational materials are the *outcomes* of activity (eelgrass stewardship) that is itself mediated by: *community* (other members of the project), *division of labour* (trainers, mappers), *rules* (mapping methodology) and *tools* (quadrat, GPS, underwater camera). The constituents of activity are not static but can dynamically change as conditions change (Nardi, 2001).

In CHAT learning is understood as changing forms of participation in a changing world (Lave, 1993). As individuals change their participation (i.e., innovations, new relationships), they also change the collectivity. In turn, the changing collectivity expands the opportunities for individuals to act in different ways. Activity theorists explicitly oppose Cartesianism and thus do not believe that consciousness resides in the mind, but rather cognition and consciousness are social and all that social envelops (Nardi, 2001). By participating in activity we reproduce culture but at the same time produce new forms of participation (learning) that are available to the collective[3]. The term *activity* has a different meaning than in normal educational use. Rather than constituting a context in which participants are active, pursuing some task, activity refers to societally motivated sets of tasks and actions that contribute to maintenance and survival (Leont'ev, 1978).

For example, in schools, students are most often asked to pursue predefined activities that constitute the setting for action. In activity theory, activity envelops both action and setting together, that both transform and are transformed by the trajectory of activity.

The role of setting, or context, is a significant theme that I explore in Chapters 3 and 4. In CHAT, the structural aspects of a setting (i.e., all entities in Figure 1.1) mediate activity and these structures can be fully understood only by considering their cultural and historical context. Structural aspects are always both material and social.

For the purposes of this thesis, I focus on three dialectical units of the activity system (Figure 1.1) and each is explored in turn in Chapters 3, 4 and 5. Figure 1.2 shows the relationship between the dialectical units that I explore in the CHAT triangle. Each chapter focuses on a different unit but all relationships are interdependent and not reducible to the others. Thus the bolded (black) portions represent the focus, while the other portions are grey, emphasizing that the remaining interdependent relations are in the background. In addition to having different focuses, I zoom in and out at different scales. In Chapters 3 and 5, the entire network is the activity system with the object of activity being eelgrass habitat conservation. In Chapter 4, I focus on learning and teaching in one community, therefore the activity system is one community.

---

[3] For the purposes of this thesis, the collective is made up of all of everyone who participates in the B.C. Coastal Eelgrass Stewardship Project. However, there are no solid boundaries that bind the membership exclusively to the Project because participants also engage in other collectives.

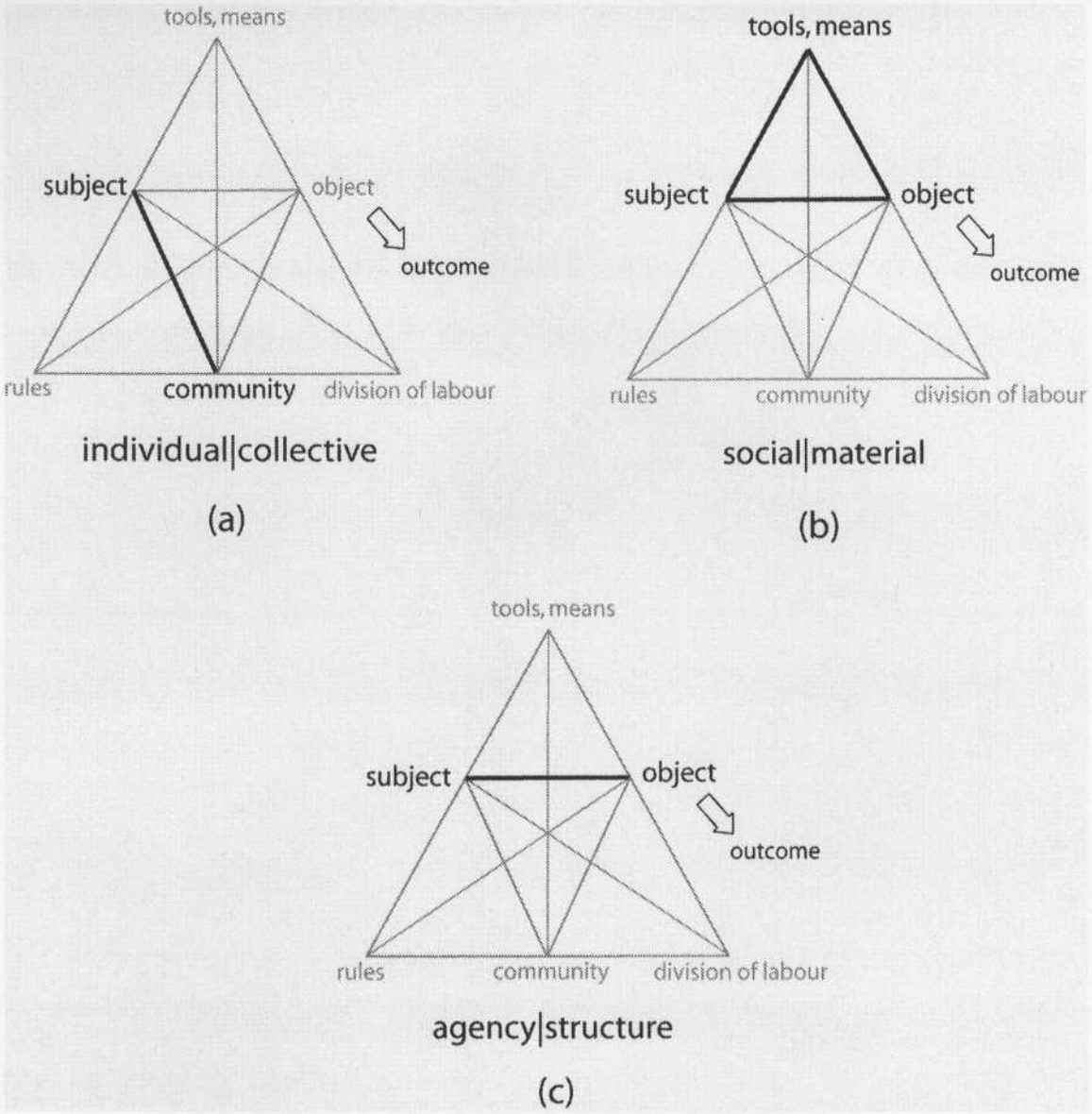


Figure 1.2. Dialectical units (in bold) that are the focus of Chapters 3 (a), 4 (b), and 5 (c).

In the three chapters I attempt to expand theoretically on some aspect of CHAT using empirical evidence. In Chapter 3, I explore the relationship between individual and collective learning (Figure 1.2(a)). Here, the subject is a community group or individual in relation to the collective (community) network. In Chapter 4, I investigate the relationship between social and material in the unfolding of an eelgrass mapping event (Figure 1.2(b)). The subject is a group of individuals learning how to map eelgrass, the

object is eelgrass mapping and quadrats and measuring tapes constitute tools and means to carry out the activity. In Chapter 5, I look at the relationship between agency and structure as a dynamic that is useful for understanding how the network of communities becomes more stable (Figure 1.2(c)). The whole activity system constitutes the structure (social and material) and agency arises from the subject (individual or group) modifying the object of the immediate activity.

1.4 Important concepts

Throughout this thesis, various concepts are used that are important in understanding the focus of my theoretical practices. In this section I provide an explanation of key concepts.

1.4.1 Dialectics

> The dialectic is a process and not a thing and it is, furthermore, a process in which the Cartesian separations between mind and matter, between thought and action, between consciousness and materiality, between theory and practice have no purchase (Harvey, 1996).

Cultural-historical activity theory is grounded in dialectical conception of the relation between entities in an activity system. Each part of a system can only be understood in relation to all other parts—all parts are interdependent. Therefore, a change in one entity leads to a change in the whole system. As a hypothetical example, if I take an eelgrass mapping exercise as my unit of analysis, the breakdown of an underwater camera (tool) used to delineate a subtidal eelgrass bed would transform the object of activity from mapping eelgrass to sending the camera away to be fixed. Of course, the relation to other entities would change, such as using the postal system as a tool to send the camera away.

Internal to dialectical relations of entities are contradictions (which occur at the level of consciousness) and resistance (which occurs at the level of materials). Material resistances and salient contradictions are the drivers of change in a system. In the

hypothetical example given above, there existed a material resistance in the system; the camera ceased to work, thus leading to change in the activity system. In Chapter 5, I explore the role of resistances in the dialectical relation of agency and structure as drivers of change in the eelgrass network.

Another way to explain a dialectical relation between two entities is that they mutually presuppose each other. The existence of one entity is predicated on the existence of the other and vice versa. This way of thinking about relationships eschews deterministic modes of thinking. For example, in social theory the relation between agency and structure is often explained deterministically whereby the structure of social life is theorized as determining the actions of individuals who thus seem to have no agency. I take a dialectical approach to the relation between structure and agency (Sewell, 1992) in Chapter 5.

Throughout this thesis I use the Sheffer stroke, '|' to denote the relationship between entities that stand in a dialectical relation (see Roth, Hwang, Lee, & Goulart, 2005). It expresses the fact that the two entities (e.g., individual and collective) exist not in an either-or relationship but concurrently stand in an X *and* not-X relation, that is, when the expression contains a contradiction.

1.4.2 Networks

My use of the term "network" in a non-colloquial sense is most closely aligned with the Science and Technology Studies (STS) literature: networks emerge through heterogeneous configurations of human and nonhumans entities (i.e., eelgrass mappers, eelgrass, GPS) (Latour, 1987). These kinds of networks constitute processes rather than merely relations between fixed entities that denote given order of things. In other words,

links and nodes do not exist in and of themselves, but they are *both* resources *and* results of network processes (Law, 1997).

In Chapter 3, I investigate how the network emerged through overlapping activity systems (e.g., community groups, SeaChange, biologists). I borrow the notion of a *fluid social topology* from Mol & Law (1994) because I find it consistent with dialectical thinking. For them, boundaries and regions are subject to leakage and it is the flow—the existence of the fluid material—that produces social phenomena and their stability rather than the existence and presence of particular actors.

In Chapter 5 I expand on my analysis of the emerging network, drawing from an additional year of ethnographic inquiry. Moving from my general claim about the network emerging through overlapping activity systems (Chapter 3), I document specific kinds of practices that members enact as network stabilizing and extending performances. I diverge from the fluid social topology of Mol and Law (1994) in this chapter as it was obvious in my analysis that particular members of the network, in addition to fluid material, played key stabilizing roles.

1.5 Orientation to thesis

Chapter two first introduces the focus of this thesis, the B.C. Coastal Eelgrass Stewardship Project and outlines the research settings and forms of engagement that I undertook in my ethnographic study. The chapter also describes methods of data collection and data analysis employed in this thesis.

The middle three chapters (three, four, five) form the body of this thesis. Each chapter was first written for submission to international peer-reviewed journals. Therefore, readers will notice different arguments made in each chapter that address particular

scholarly audiences. Chapter 3, "Individual|Collective Dialectic of Free-Choice Learning in a Community-Based Mapping Project," was submitted and published in the Environmental Education Research journal (Boyer & Roth, 2005a) and addresses an audience concerned with learning about the environment in free-choice settings. Chapter 4, "Learning and Teaching as Emergent Features of Informal Settings: An Ethnographic Study in an Environmental Stewardship Group," is written for a science education research audience (Science Education journal). "Stabilizing Performances: The Emergence of a Community Eelgrass Mapping Network" (Chapter 5), was written for a science and technology studies (STS) audience and submitted to Public Understanding of Science.

The final chapter (six) concludes the thesis by outlining potential contributions to theory and the larger conservation and stewardship community and suggests implications of this study.

Chapter 2

Research Settings, Forms of Engagement, and Analysis

The purpose of this chapter is to render the past two and a half years of ethnographic investigation (2003-2006) in textual form: to explain the ways in which I went about studying interactions among people, places, resources, and eelgrass, in a setting that spans the coastline of B.C. Through my engagement with the B.C. Coastal Eelgrass Stewardship Project (the Project) I witnessed transformations, but I was also transformed. Traces of my participation can be found in SCWG meeting minutes, videotapes of a mapping event, and GPS points scribbled in a community coordinator's field book. In the following sections I provide the research context through which I generated claims about learning and social change within the Project. First, I introduce eelgrass as the object of the Project's activities; secondly, I describe the research setting; next, I articulate the forms of engagement that I enacted; and lastly, I describe my data analysis.

2.1 The object of activity: Eelgrass

Eelgrass (*Zostera marina*) is a member of a group of flowering saltwater plants called seagrass. Seagrasses, important both ecologically and economically, can be found on all continents of the world and this overlooked habitat has declined or been totally destroyed worldwide (World Atlas of Seagrasses). Of particular interest to those who initiated the Project are two species of eelgrass that exist along the coast of B.C., *Zostera marina* (Figure 2.1) which is the most dominant (native) species and *Zostera japonica* which is an introduced or exotic species. *Z. marina* grows in sandy or muddy substrates both subtidally, below the lowest tide, and intertidally, where it is exposed during low tides. *Z. japonica* is smaller than *Z. marina* and therefore cannot out-compete *Z. marina* for

substrate, although, *Z. japonica* can be found adjacent to or intermixed with *Z. marina*. (Precision Identification, 2002).

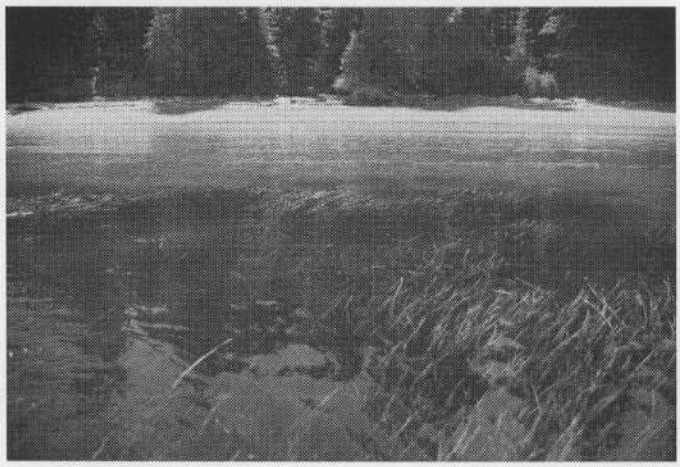


Figure 2.1. Zostera marina meadow (Photo by Ramona C. deGraaf, used with expressed permission).

Z. marina provides habitat for juvenile salmonids, migrating waterfowl, resident forage fish, invertebrates and wading birds (Phillips, 1987 cited in Wyllie-Echeverria & Ackerman, 2003). It is also highly productive and is therefore of tremendous ecological importance to coastal marine environments. *Z. marina* is also valuable as a cultural and food resource. There are a number of First Nations people (Straits Salish, Nuu-chah-nulth, Haida and Kwakwaka'wakw) consume fresh rhizomes and leaf bases or dry them into cakes for winter food. Eelgrass was also used by coastal groups such as the Coast Tsimishian, Nuu-chah-nulth and Haida for collecting herring roe (Kuhnlein & Turner, 1991). Current research is investigating whether Kwakwaka'wakw traditional rhizome (ts'ats'ayem) harvesting techniques promotes compensatory growth, or positive growth due to damage (Cullis-Suzuki, Dick, Sewid-Smith, Turner, & Wyllie-Echeverria, 2006).

The Project was initiated in order to document the extent and health of eelgrass habitat along the coast of B.C. Although government agencies have undertaken eelgrass

mapping projects in the province, data gaps exist at coarse and fine scales of eelgrass mapping (Dunster, 2003). *Z. marina* is protected as "fish habitat" under the Canada federal *Fisheries Act*. However, unless Fisheries and Oceans Canada is alerted to eelgrass habitat destruction, infractions go unnoticed. A variety of human activities, including, logging, foreshore development, and anchoring boats can impact eelgrass—anything that covers, shades or rips up the plant compromises it. The participation of communities in mapping and stewardship all along the coast (Figure 2.2) is therefore of paramount importance to eelgrass conservation.

2.2 Research settings

The multiple sites in which I conducted my ethnographic research were all connected through the Project. In the following sections I describe each of these sites (including an eelgrass bed) and then describe a typical intertidal eelgrass mapping exercise.

2.2.1 SeaChange Marine Conservation Society

The Project was coordinated and administered by the executive director of SeaChange Marine Conservation Society. SeaChange became a non-profit society in 1998 and has since developed numerous programs focused on marine education, conservation and restoration, in relation to eelgrass habitat.

2.2.2 B.C. Coastal Eelgrass Stewardship Project

The Project ran from 2002 to 2004 with funding secured by SeaChange. In 2002, the Project coordinator and a biology consultant from Vancouver, B.C., trained 12 groups who expressed interest in mapping and monitoring eelgrass habitat. In 2003, I accompanied the Project coordinator and eelgrass biologist as they trained nine more groups. The groups were spread along the coasts of mainland British Columbia and Vancouver Island (Figure 2.2) and were made

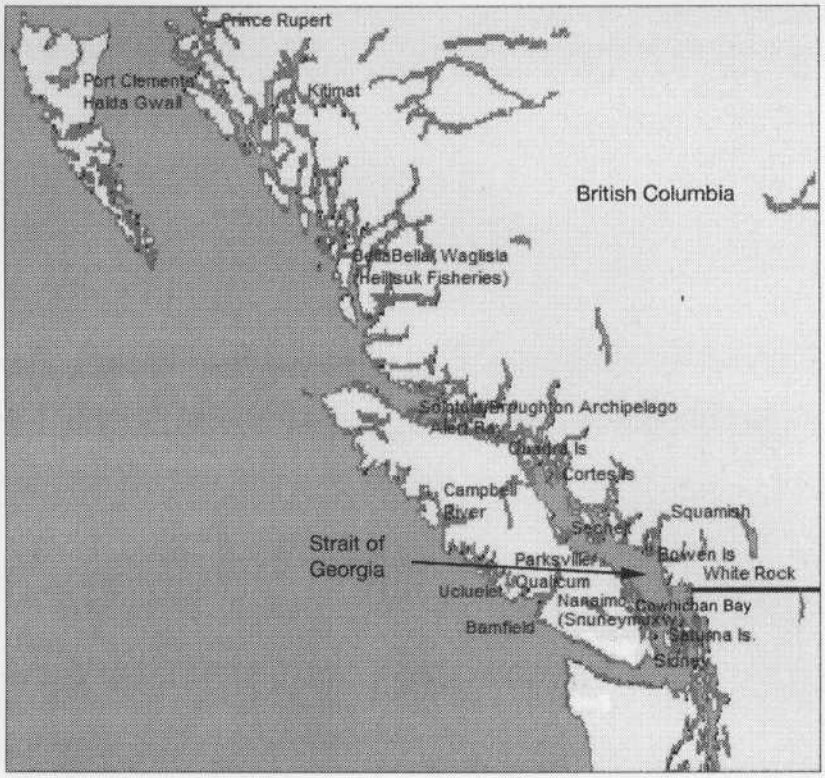


Figure 2.2. Locations of 20 community groups in British Columbia, Canada.

up of (a) already existing organizations (stewardship and conservation groups, land trusts, marine stations, natural resource centers and First Nations); (b) independents who already volunteered in their local community; and (c) an artist. Most of the groups were small, either containing one or two employed people, or entirely volunteer based and therefore relying heavily on volunteers to carry out projects.

Most of the groups were already engaged in conservation, education, and outreach activities in their communities (some also work region-wide). Given that some groups had charitable status (where only ten percent of activities can be political) and the collaborative nature of their work, most groups avoided overtly political activities such as campaigns that the larger environmental groups in Canada undertake (e.g., Greenpeace). There were two First Nation groups who joined the Project to map eelgrass within their

territories. Their activities were intended to contribute to treaty negotiations and general self-governing issues.

The majority of groups participated in the project to expand their repertoire of tools to engage the public in environmental stewardship, as well as to carry out conservation and education goals (see Table 2.1 for summary of activities). Each group or individual had a coordinator, who is paid a small wage. The Project was not the major means by which the participants make their living; much of their time spent on the Project was voluntary. The community coordinators were tasked with recruiting volunteers, developing educational resources and opportunities, and forging partnerships with businesses, governments, biologists, and other stewardship groups within their local communities. Not all groups had the expertise or capacity to assume all of the responsibilities just listed; therefore, each group took on two or three of them; however, some have assumed all responsibilities.

In addition to the biology consultant who volunteered most of her time, the Project was partnered with the Seagrass Conservation Working Group (SCWG, see next section). The Project also had partnerships with provincial and federal agency representatives who offered expertise (technical, GPS manual and data entry training) and resources (interactive mapping webpage management, small funding for research documents, meeting sites, strategic project planning, information sharing and letters of support).

Table 2.1. Summary of activities of the eelgrass network.

Group/individual	Activities (2002-2004)	Sphere of Influence	Activities (2004-present)	Attending Conference ?
1. Community member	Mapping and monitoring; presentation to Parks Canada; developed website for SCWG	Local	Managing SCWG website	Can't make it
2. Community member	Mapping; letters/ conversations with municipal councilors	Local	Communications coordinator for SCWG; mapping; public education; organizing eelgrass conference; strategic planning for SCWG	Yes
3. Marine sciences centre	Mapping and monitoring; public education; volunteer recruitment; public education; educational resource development; eelgrass research (university students)	Local	Public education	Yes
4. Marine Ecology Centre	Mapping; public education	Local	No activity	Can't make it
5. First Nations Fishery	Inventory; fisheries management	Local	No activity; new coordinator	Yes
6. First Nations Fishery	Mapping; treaty negotiations	Local	Attempting to make new connection*	No
7. Land Trust	Mapping, public education	Local	No activity; new coordinator	Yes

Group/individual	Activities (2002-2004)	Sphere of Influence	Activities (2004-present)	Attending Conference ?
8. Land Trust	Mapping and monitoring; estuary management plan; volunteer recruitment; public education; community workshop; restoration planning	Local/ Regional	Mapping; volunteer recruitment; eelgrass restoration; public education	Yes
9. Stewardship Group	Mapping and monitoring educational resource development; inventory/research; community outreach; volunteer recruitment	Local	Regional coordinator for eelgrass network; monitoring; same activities as before	Yes
10. Stewardship Group	Mapping; watershed planning; volunteer recruitment; educational resource development; public education; restoration	Local/ International	Mapping; watershed planning; volunteer recruitment; public education	Yes
11. Stewardship Group	Inventory/mapping; community outreach; volunteer recruitment	Local/ Regional	Regional coordinator for eelgrass network; monthly newsletter; inventory	Yes
12. Stewardship Group	Inventory; working with grad student on research; First Nations collaborations; restoration planning	Local	First Nations collaborations; regional planning for eelgrass restoration; strategic planning for SCWG	Yes
13. Conservation Association	Mapping; public education	Local/ Regional	Mapping; public education; research	Yes

Group/individual	Activities (2002-2004)	Sphere of Influence	Activities (2004-present)	Attending Conference?
14. Naturalist Club	Mapping; restoration	Local	Same activities as before	Yes
15. Naturalist Club	Mapping	Local	New coordinator	Yes
16. Naturalist Club	Mapping	Local	No activity; attempting to make new connection*	No
17. Natural Resource Society	Mapping; coastal resource planning	Local/ Regional	Little activity; attempting to rekindle connection*	Can't make it
18. Marine Research Society	Mapping; public education	Local	No activity; attempting to rekindle connection*	Unable to make contact
19. Resource Management Society	Mapping	Local	Community advocacy; regional planning for eelgrass restoration	Yes
20. Conservation Society	Inventory; public education	Local/ Regional/ National	Regional coordinator for eelgrass network; mapping; public education; new coordinator	Yes

Group/individual	Activities (2002-2004)	Sphere of Influence	Activities (2004-present)	Attending Conference?
21. SeaChange Marine Conservation Society	Fundraiser for Project; administration of Project coordination/training of Project; chair of SCWG; community outreach; public education; eelgrass restoration	Local/ Regional/ Provincial	Chair of SCWG; fundraising; alternative funding strategy; eelgrass restoration; organizing eelgrass conference; strategic planning for SCWG	Yes
22. Eelgrass biologist	Developed eelgrass mapping methodology; training of Project participants; technical support for participants attends conferences & reports to SCWG	Provincial	Same activities as before; updates of eelgrass manual; alternative funding strategy; strategic planning for SCWG	Yes
23. Canadian Wildlife Service Representative	Inspired SeaChange to apply for funds for Project; some funding support; strategic planning for SCWG; government liaison	Provincial	Same activities as before	Yes
24. Fisheries and Oceans Canada Representative	Developed CMN; technical support for mapping & data entry; assisted with development of eelgrass manual	Provincial	Same activities as before; produced GPS manual	Yes
25. Canadian Wildlife Service Representative	Mapping support; assisted with development of eelgrass manual	Provincial	Same activities as before	N/A

Group/individual	Activities (2002-2004)	Sphere of Influence	Activities (2004-present)	Attending Conference
26. Provincial Ministry of Environment Representative	Developed CMN; assisted with fundraising planning; mapping support	Regional/ Provincial	Manages CMN; mapping support	No
A. University Graduate Student	Participates & supports mapping activities for a number of groups; public education; ecology research (pipefish-eelgrass relations)	Provincial	Same activities as before; regional coordinator for eelgrass network	Yes
B. Fisheries and Oceans Canada Representative	Attended a few SCWG meetings	Provincial	Strategic planning for SCWG; government liaison	Yes
C. Consultant	Attempted to make connection*	Regional	Attempting to make connection*	Yes
D. University Graduate Student	Attended SCWG meeting; ethnobotany (eelgrass) research	N/A	Works with eelgrass community coordinator (see N)	N/A
E. University Graduate Student	Attended SCWG meeting; geography research (eelgrass restoration)	N/A	Contributed to eelgrass network newsletter; worked with community coordinator (see 12)	N/A
F. First Nation	Hosted SCWG meeting	Local	N/A	Yes

Notes.(*) denotes actions undertaken by the Project coordinator. The first three columns were generated at the end of Project funding in 2004. It consists of core participants and does not include individuals who participate peripherally. A First Nation group and an individual dropped out of the Project. The individual explained that they did not have the time required to take it on and it is not known at this point why the First Nation dropped out, although efforts are being made by the Project coordinator to rekindle this connection. The two right-most columns and lettered rows, were added at the end of the study detailing the activities of participants since the cessation of project funds. The right-most column refers to those members who attended the eelgrass conference in January 2006. The information contained in this table was gleaned from formal and informal interviews and conversations (field notes) with individuals/groups (although not everyone) listed in this table.

Funding for the Project ended in 2004 despite the efforts of the Project coordinator to secure more funding through government and foundation grants. Coordination of the eelgrass network was regionalized (five regional coordinators) during the eelgrass festival in the summer of 2004. The network decided to try out this configuration so that funding, eelgrass mapping and stewardship support could be organized by region given that different regions would have access to different sources of funding (i.e., logging companies, local businesses). For more discussion on "after the Project", see Chapter 5, section 5.4.

2.2.3 Seagrass Conservation Working Group

The Seagrass Conservation Working Group (SCWG) was formed in 2001. The executive director of SeaChange chaired the group. The working group is a consortium of conservation groups, scientists, consultants, and public agencies who work together to protect and conserve seagrass meadows in British Columbia, Canada. "The purpose of the SCWG is to conserve the ecological integrity of seagrass ecosystems by promoting research, inventories, communication, and partnerships" (website). The Project proposal was initially brought to the SCWG by the chair for endorsement. Two members[4] of the group failed to endorse it[5]; therefore, the chair coordinated the Project as a SeaChange endeavor. Although separate, the SCWG provided for and received direction from members of the Project.

---

[4] It turns out that one of these groups will be attending an upcoming eelgrass conference (January 2006) for the network.

[5] There were two stewardship groups that preferred to start with a few groups and a smaller geographic area for the pilot project. Other groups in the SCWG did in fact endorse a coast-wide project, however, the views of those against it won out. Those groups ended up dropping out of the SCWG.

After the Project ended in 2004, the coordination of the eelgrass network was shifted over to the SCWG. Although SeaChange still takes on the bulk of the work (applying for grants and organizing meetings and conferences), others are starting to take on more responsibility. For example, one community coordinator was hired by the SCWG to develop communications and another coordinator assists with grant writing.

2.2.4 Rocky Island Stewardship Society (pseudonym)

This group, located in a small rural community, joined the Project in its second year (see 11, Table 2.1). The coordinator, Samantha (pseudonym), attended a training session for another nearby group. She expressed a keen interest in the project and was invited by the Project coordinator to join. Samantha and I established an immediate rapport; therefore, I decided to follow this group in more detail.

Samantha was already a stewardship coordinator, responsible for bringing various stakeholders (industry, government, environmental groups) together to make decisions on improving conditions for wild fish in the region. For the eelgrass Project, she was responsible for a large geographic area, spanning fjords, inlets, and islands. Samantha describes some of the challenges of recruiting volunteers in an excerpt in Chapter 5 (Page 106).

2.3 Community eelgrass mapping

Over the course of the 2-year project, each group received a day-long mapping workshop that consisted of a classroom[6] component dedicated to eelgrass (*Z. marina*) biology, ecology and mapping methodology, as well as brainstorming about how education and stewardship could be carried out in each community. There was also a

[6] "Classrooms" were, for example, in participant's homes, a meeting room in a salmon hatchery and meeting rooms of non-profit societies.

field component where a simplified version of intertidal mapping was demonstrated and identification of flowering plants and introduced species (*Z. japonica*) was practiced (although not all workshops had a field component because of accessibility to low tides). For the most part *Z. marina* and *Z. japonica* are easily distinguishable because of the small size of *Z. japonica*. In some cases, however, they are similar in size. During the training the eelgrass biologist showed the trainees the differences between the two.

The groups were given a binder that contained images of eelgrass, education materials and outreach materials. They were also given an eelgrass mapping manual that was designed by the eelgrass biologist with the help of other professionals in the field to map and monitor *Z. marina*.

> Field Methods for Mapping and Monitoring Eelgrass Habitat in British Columbia was designed to provide readers with a basic understanding of eelgrass (*Zostera marina L.*) ecology and to provide a standardized set of methods to map, classify, and monitor eelgrass habitat on a local level. The mapping and monitoring system described herein enables community groups and other agencies to contribute consistent and reliable data to a central database (Precision Identification, 2002).

The document has four levels of mapping complexity that the groups choose from. These range from placing a dot on a map, indicating the location of an eelgrass bed, to measuring subtidal eelgrass density, to taking water quality measurements (Precision Identification, 2002). They could also choose between roughly drawing on a map or taking Global Positioning System (GPS) points to delineate eelgrass beds or just indicate their existence. The intention of the design is to allow community groups of any capacity (i.e., expertise, resources) to be able to gather scientifically defensible data. The document will always remain in draft form so as to accommodate potential changes or additions requested by its users. For instance, some community groups who identified *Z. japonica* in their area requested that a methodology be designed specifically for it.

Organizing a mapping activity is a complex process: training of volunteers, locating appropriate sites according to numerous factors (i.e., number of volunteers, capabilities of volunteers, accessibility and safety of site), coordinating volunteers, using GPS units, and recording measurements on data sheets are among the tasks that must be accomplished. In Chapter 4, I provide a more detailed description of an eelgrass-mapping event organized by one group.

2.4 Forms of engagement

The research that forms the basis of this thesis was conducted in the ethnographic and anthropological tradition (e.g., Marcus & Fischer, 1986) to understand cultural change in community groups that focus their activities on environmental issues. Prior to the commencement of my fieldwork in June, 2003, I had volunteered for SeaChange for three years and therefore had considerable understanding of the history of the Project. To gain a deeper understanding of the Project, I engaged alternatively as participant observer and, taking the role of a volunteer, as observer participant (on apprenticeship as method see Coy [1989]). My supervisor, Wolff-Michael Roth, acted as a critical sounding board for empirical and theoretical issues and represented the researcher community of practice, in which I enacted my second apprenticeship (e.g., Lee & Roth, 2003a).

My role as both participant observer and observer participant warrants further discussion as this has implications for the research context, the Project participants, and my relationship to my supervisor. As a dedicated volunteer and close friend of SeaChange's executive director, I had access to the kinds of information required to conduct a detailed ethnographic study (e.g., informal and formal interviews, documents, maps, email correspondence, narratives of conversations etc.). By accompanying the Project coordinator and the eelgrass biologist to trainings and meetings, 18 of the 20

project community coordinators and the core group of government representatives and university students were aware, to varying degrees, of my participation in the Project as a researcher, depending on how often they met with the Project coordinator. I attended the trainings of the last nine groups and participated in eelgrass mapping and monitoring activities, took minutes at meetings, video documented meetings, and acted as a sounding board for the Project coordinator.

I followed in more detail the activities of the Rocky Island Stewardship Society. I visited the coordinator periodically and made regular phone calls. In doing so, I became familiar with some of the nuances of her community and the kinds of challenges she faced carrying out the goals of the Project. Through this engagement, the complexity of stewardship became particularly salient. Already familiar with SeaChange, I noticed similarities and differences between geography and the social, cultural and historical fabric in which the two societies operated. For example, the northern Vancouver Island group was responsible for a large geographic area with a very sparse population and a growing salmon aquaculture industry. Residents and fishermen have been witness to the negative impacts of the farms (sea lice infestations, shellfish fouling, dislocation of orca populations). Other communities are more urban and therefore were responding to different eelgrass impacts such as sandcastle building in the southernmost community of the BC mainland. This alone could have been the topic of a thesis, but I decided to focus on learning and emergence of the network.

I began to embody some of the traces of the interactions I observed and engaged in with Project participants and other supporters of the Project. I subsequently used these new understandings in further interactions with other Project participants. To give a

concrete example, during one of our site visits to a Project coordinator we helped her do intertidal mapping of a local beach. Before that point, I had never actually mapped eelgrass having only been to eight training sessions. Whatever I came to embody in that experience I put to use later (learning became salient to me in practice), when I helped another Project coordinator carry out an eelgrass mapping event in her community (Chapter 4).

In this way, I am a member of the eelgrass network and thus also constitute its setting as others members do. My closeness to the Project has its strengths and weaknesses. Sometimes my closeness to the data restricted other points of view; however, I am also a member of another community of practice, my research group, who challenged my explanations in group analysis sessions. By participating in the kinds of activities that the research participants do, I stumble where others may have stumbled, thus gaining a more visceral understanding of what it takes to enact the eelgrass project. I also have a better understanding of what aspects of the social and material world become salient to others who may be groping in the dark (Roth, Hwang, Lee, & Goulart, 2005).

2.5 Data collection

The data sources for Chapters 3, 4, and 5 include: (a) extensive field notes; (b) maps, publications, and outreach materials (brochures, educational materials, posters, public displays) produced and used by project participants; (c) videotapes of training and mapping activities, meetings and presentations; and (d) informal and formal interviews recorded on videotape and audiotape and field notes. I transcribed videotapes as soon as possible after an activity. By transcribing most of the recordings, personally, I became familiar with the data.

The three core chapters of this thesis were grounded in the same overall data sources that were collected as a matter of course in this ethnographic study. However, each study focused on some specific sources that I outline in the following sections.

2.5.1 Chapter 3

By the time I began the writing of this chapter I had completed a year of fieldwork and videotaped nine training sessions, attended two conferences where the Project coordinator and a community coordinator presented, attended SCWG meetings, participated in two ad hoc NGO funding crisis meetings, videotaped an eelgrass mapping strategy meeting (sponsored by provincial government's State of the Environment Reporting) and the eelgrass festival where 15 out of 20 Project coordinators attended, and accompanied the Project coordinator on site visits with community coordinators. All of these data sources, in particular the eelgrass festival, constituted the empirical basis of this chapter.

2.5.2 Chapter 4

In this chapter, I focused on one particular day, an eelgrass mapping event organized by the community coordinator that I followed in detail. I wanted to look in detail (micro-scale) at knowing, learning, and teaching within one group. For this event, I enlisted the help of three of my lab mates to take video recordings and photographs. There were two video cameras running over the duration of the mapping activity with one camera following the community coordinator, and another one capturing the entire group. My third helper took photographs throughout the activity. Because participants were moving about unpredictably, there were moments when individuals moved out of the field of view and earshot of the camcorders. The intension of having two camcorders running was to capture as many interactions as possible. Although I present data from the video

footage and verbatim transcriptions, my understandings; (a) developed through my ongoing ethnographic inquiry and (b) were necessary for and entered into the interpretation of the events.

2.5.3 Chapter 5

The bulk of the data that forms the foundation of this chapter comes in the form of field notes, videotaped activities, and 16 semi-structured interviews (12 taped and four over the telephone) with members of the eelgrass network and those who support it. Those interviewed include the Project coordinator, eelgrass biologist, ten community coordinators, and four government representatives. Most of the video- and audiotapes were transcribed soon after they had been recorded. The data that ground this chapter is a continuation from Chapter 3, in which I introduced the emergence of the eelgrass network. Chapter 5 looks more closely at particular relationships and people that served to stabilize the network.

2.6 Data analysis

In the following sections I describe how I conducted data analysis for each of the three main chapters.

2.6.1 Chapter 3

My understandings of the dialectic relationship between the individual and collective learning, in the context of the Project, is in part, derived from video and associated transcripts of meetings where participants came together, and in part by my visceral understandings of as both participant observer and observer participant. As a critical sounding board for empirical and theoretical issues, Wolff-Michael Roth challenged assumptions that potentially arose from my closeness to the data. Analyzing field notes and transcripts from the eelgrass festival and other recorded meetings, I looked for

particular instances where Project participants interacted and then traced how the outcomes of those interactions spread. I looked for these traces in subsequent conversations, in material artifacts, and in bodily actions.

2.6.2 Chapter 4

Focussing on the daylong eelgrass mapping event, I analyzed the transcripts and footage pulling out salient themes. The themes and associated transcripts were presented during a collective analysis session following the principles of interaction analysis. The goal of this approach is to identify patterns in the ways in which participants interact with the complex social and material world of objects, people, and in this case, eelgrass (Jordan & Henderson, 1995). Interaction analysis was conducted with the participation of the members of my research laboratory. The themes were described and shown on video until a participant requested a stop (making an interjection) at which point he or she provided a tentative hypothesis. Other participants added additional comments to confirm or disconfirm the original hypothesis, or supported a counter proposal. Over a one-hour video-recorded session, several hypotheses were generated. I then returned to the data to attempt to revise or discard hypotheses. In the second iteration of collective analysis, additional themes were explored in the same manner as above. I subsequently refined the hypotheses through the writing process. My research group constituted a panel of disinterested peers, who read advanced drafts and thus had a chance to respond to my emerging ideas.

2.6.3 Chapter 5

The 18 interviews that constitute the basis of this chapter were analyzed following *discourse analysis* methods (Roth, 2005b). The purpose of this method is to analyze language use in particular social contexts. I was interested in peoples' understanding of

the Project and its activities and their relation to it. I asked questions that elicited talk about their interactions with other people, things, and eelgrass. In the analyses, I was primarily concerned with content rather than analyzing how things were said.[7] I began by reading through the interviews, highlighting "interesting" text and labeling them using descriptive codes (see Table 2.2 for example). These codes were then organized into broader categories that served as the basis for generating assertions (one sentence statements of some pattern in the data). Analyzing the relationship between assertions, I then came up with the claims that were supported by both the interviews and the ethnographic database (in Chapter 5).

Table 2.2. Example of analysis of interview transcripts.

Transcript	**Code**	**Category (Assertion)**
Interviewee 1: apparently [Parks Canada] went out and mapped all the eelgrass beds in the Gulf Islands – or somebody did – and they never shared that information with us [SCWG]… I heard about it at the George Basin-Puget Sound meeting *Interviewee 2*: we started the community mapping network with the intent that we'd facilitate that information management sharing because we could see how dysfunctional it all was *Interviewee 3*: * it has taken years to get the maps but of course [the consultants hired] would have liked to see the data disseminated earlier. The province said that they were waiting until it was finished but the data could have been used in an unfinished form	Problems with data sharing	Data (knowledge) must be made to flow
Interviewee 1: it's nice knowing though that you're part of a group um and I've talked to Sabina a few times and so yeah it is nice knowing you're part of a group you don't feel like you're out there sort of on	Important for coordinators to feel as though they	Communication is a form of emotional support

[7] Analyzing how things were said requires measuring (in seconds) pauses between utterances, observing turn taking, or measuring tone and pitch of voices. I was interested in what people said.

your own *Interviewee 2*: sometimes you just need to have a little bit of support when you think that you're not really accomplishing...you just you can sort of bounce this off other people that are doing the same thing and you realize that you do what you can do *Interviewee 3*:* need more help, I am really alone. Have some support from Squamish and DFO, nobody has stood up to help with project, lack physical human support. Unless you have those people to work as a team, it's difficult to get motivated. Work much better with other people that have ideas.	are part of a group	

Notes: (*) Indicates that the interview excerpt is paraphrased because it was transcribed over the phone (not audio recorded). There is more than one code for each category that is not shown here.

Chapter 3

Individual | Collective Dialectic of Free-Choice Learning in a Community-Based Mapping Project

Abstract

In this ethnographic case study I describe an instance of free-choice learning in the context of an eelgrass mapping and stewardship project (the Project) that covers over 500 kilometers of coastline in British Columbia, Canada, and involves 20 volunteer groups. I sought to (a) explicate the relationship between individual and collective learning in this free-choice setting and (b) understand how a network of Project participants could both constitute a free-choice learning setting and support such a setting. I articulate a dialectic relationship between individual and collective learning, which, unfortunately in my view, has not yet been explored in educational research. In this relation, collective learning fosters individual learning and vice versa, whereby individuals produce resources in action and as outcomes of their activities. These resources expand the action possibilities of the collective, and thus constitute learning. The stability of the network of Project participants, which brings about and supports collective and therefore individual learning, rests on the flexibility of the Project that enables local innovation and tailoring of mapping activities as well as access to expertise and tools produced by other groups and Project partners. The possibilities that arise in the Project for local people to participate in relevant ways constitute free-choice learning settings.

3.1 Introduction

Free-choice learning settings are ubiquitous in everyday life—television, books, Internet, museums, and zoos are all ways in which individuals engage to learn

environmental science and related practices of their own accord. When looking at instances where people and material resources gather together and act towards a collective goal, researchers can gain a better understanding of learning. The main point of this article is to argue that in out-of-school free-choice learning settings, individual and collective learning mutually presuppose one another; they stand in a dialectical relationship (see Figure 1.2 (a)). As individuals participate in ongoing collective activities, learning arises out of changing participation in a changing world (Lave, 1993)—individuals change their participation (i.e., innovations, new relationships) and in doing so change the collectivity. In turn, the changing collectivity expands the opportunities for individuals to act in different ways. Free-choice settings provide a unique opportunity to study learning because they are not constrained by the rigid structure of school curriculum or excised from larger societal culture producing and reproducing activities. In fact, many people who engage in free-choice learning settings do so because they are concerned about those aspects of cultural reproduction that fail to take into account activities that they endorse (i.e., habitat conservation).

My study is situated in the context of learning and the environment where educators and community activists alike seek to represent the environment as a complex interconnected web of organisms that includes individuals and collectives, human and non-human resources. In a case study, I followed the activities of a non-profit charitable marine conservation organization, SeaChange Marine Conservation Society, which coordinated the Project aimed at training communities how to map and monitor the health of eelgrass meadows. The following transcript, in which a participant in the Project tells a

story during an eelgrass festival organized to bring all of the groups together, exemplifies the experiences participants had.

> On Beaver [Island] ((pseudonym)) [on] the last day of mapping … I was invited to attend the Beaver Island Nature Club annual general meeting.... So it's my turn to get up there and say what we've been doing for three weeks…and people are like, "Well, we used to think that eelgrass was this, this weed, you know I can't drive a boat through and it gets around my propeller." So I said, "Look, it's not a noxious weed … yeah it can get around your propeller but just lift it or whatever." And there's this wonderful elderly woman there, a matriarch of Beaver Island … she was on Beaver before the destruction happened in the days where they offloaded all the sand from the ballast of the ship. She used to remember this emerald meadow of [eelgrass], and she goes, "There's still eelgrass there?" and I said, "Yes, I think, yeah, there's a little bit you know we could bring it back." … And then they showed this video on Blue Herons, "Blue Heron forages in, ah eelgrass which is a weed" ((mimicking of video narration)), "Weed! Weed!" People went, "it's not a weed! It's an essential part of marine habitat!" So talk about, Leanna, [a] community changing perceptions, it was a blast. (Project participant)

This talk given at a naturalist club meeting exemplifies the kind of free-choice learning setting that has emerged from the Project. The biology masters student who gave the talk is a participant in the project and in a very short time, through talking about "what we've been doing for three weeks," she made available resources for the audience to learn that, "it's [eelgrass] not a weed! It's an essential part of marine habitat!" In fact, having been enrolled in the Project by its leader, the student herself has become a resource that others draw on to enlarge their action possibilities to assist in and further the common cause. The eelgrass festival, where this story was shared, and the event related in the story are two of many free-choice learning settings that are organized and engaged in by the participants of the Project. These settings include local events (e.g., Marine Day, shoreline cleanup) and eelgrass mapping, training and workshops. The public attends these events that serve as an opportunity to learn as well as an opportunity for participants to recruit volunteers. Not only do the participants provide free-choice learning settings but also the Project itself constitutes such a setting for the participants to learn.

I contend that this Project as a whole constitutes and supports free-choice learning, a form of learning that is "self-directed, voluntary, and guided by individual needs and interests" (Falk & Dierking, 2003, p. 9) which, for the most part, takes place outside formal institutions (schools, universities, workplaces). The Project constitutes a kind of free-choice learning setting that is relatively unexplored in a literature that has largely focused on zoos (Tofield, Coll, Vyle, & Bolstad, 2003), aquariums (Falk & Aldeman, 2003), museums (Falk & Dierking, 2003; Sandifer, 2003) and science and technology centers (Dierking, Luke, & Büchner, 2003). Here, I use the concept of free-choice learning in an expanded way to include the kinds of activities that the Project encompasses, where a network of people and resources constitute the infrastructure rather than a building or place that people visit for a learning experience.

In this article, I respond partly to issues that appeared in a policy document put forward by the Ad Hoc Committee on Informal Science Education formed as an outcome of a meeting of the National Association for Research in Science Teaching (NARST) in 1999:

> Out-of-school learning is strongly socioculturally mediated, so research designs need to offer opportunities to explore social and cultural mediating factors including the role of conversations, *social learning networks*, cultural dimensions, and the use of *groups* as well as *individuals* as the *unit of analysis* (Rennie, Feher, Dierking, & Falk, 2003, p. 115, original emphases).

As a case study, the Project allows me to show the relationship between *individuals* and *groups* (collective) that make up *learning networks* in out-of–school (free-choice) settings.

The research methodology and analysis that I employ in this chapter is described in Chapter 2 (Page 32-33). In the final sections of this chapter I address my research questions: (a) how can I explicate the relationship between individual and collective

learning in free-choice settings; and (b) how does the network of Project participants engender a free-choice learning setting and support the continuance and maintenance of this web of relationships.

3.2 Individual | collective (free-choice) learning in the community eelgrass *Project*

This study was designed to understand knowing and learning in the community more generally, and in one environment-oriented project in particular. As outlined in Chapter 1 of this thesis I use CHAT as my theoretical framework. This research is inductive and I, as does every human being, have certain presuppositions. My assumption is that whole activities constitute the smallest unit of analysis. Learning and development is understood to be the outcome of participation in activity, itself mediated by culture, community, division of labor, rules and tools. This approach allows me to theorize the relationship between individual and collective learning as mutually presupposing (dialectic).

As a result of my work, I came to understand that individual and collective learning in the Project are tightly linked. Within the Project, individuals who are members of groups or participate as consultants or government representatives, constitute the Project and act in culturally relevant ways, orienting themselves towards the goal of eelgrass preservation. In each action[8] in and for the Project, these individuals engage in practices that others, newcomers and old-timers alike, recognize and emulate, and which therefore constitute resources for learning. More so, each action, verbal or material, has a concrete outcome, which becomes a (discursive, material) resource within the collective that

---

[8] In CHAT *actions*, such as counting the number of eelgrass shoots in a quadrat or making a comment at a meeting, refer to conscious individual (group) goals. A series of actions realizes a given *activity*, therefore, counting shoots is one action that realizes the collective goal of mapping an eelgrass bed (at level of a community) and giving input at a SCWG meeting, for example, realizes the collective goal of the eelgrass network (at level of the eelgrass network).

others can use in their own actions (Figure 3.1). New resources provide opportunities for new actions and practices, which enhance action possibilities and thus constitute learning.

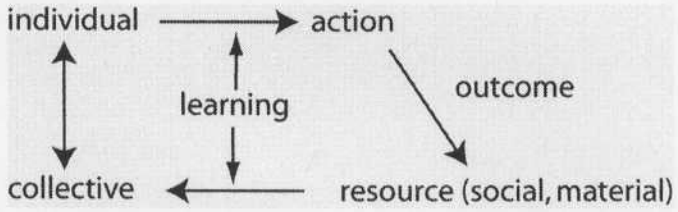


Figure 3.1. Relationship between individual and collective learning.

As part of my study in the midst of the Project, I came to recognize that it comprises a complex network of relations between participants, other stewardship and conservation groups, government agency representatives, volunteers, the public and the array of materials (tools) used for eelgrass mapping, monitoring and education activities. It became apparent to me that no single individual—even the principal coordinator or any of the scientists—exerts more power in decision-making than others, but that all individuals who choose to participate, do so towards a collective goal, which is the protection and conservation of eelgrass habitat along the coast of British Columbia. For the most part, the scientists participate in and frame technical and methodological decisions, however, groups and volunteers are routinely called upon and volunteer inconsistencies and improvements to the scientific frameworks. Both parties rely on each other to realize their collective goal(s).

I began asking how such a diverse network of geographically dispersed people—including scientists, educators, artists, and stewardship and conservation groups—separated by hundreds of kilometers of land and sea, could become knowledgeable as a

collective. From studying another environmental group, I already knew that community-based non-governmental organizations (NGOs) and their members learn in ways that are unlike learning in school. I came to understand learning in this highly distributed set of centers and relationships using the metaphor of traversals—indicating the necessity of people and nonhumans (tools, texts) to traverse both institutional and occupational boundaries in order to engage in "knowledge-producing activity" (Lee & Roth, 2003b, p. 121). In the case of the Project, I sought to understand how the collective and the individuals that constitute it learn in relation to each other in this free-choice setting.

It is possible to identify a collectivity in many different ways, for example, size and affiliation. For the purposes of this study I identify the 20 groups and the other individuals (agencies, volunteers, university students, funding institutions) participating in the Project as a collective. In making this distinction I emphasize that it is impossible to talk about this collective as completely discrete from other environmental activities on the coast of British Columbia; rather, they are very tightly linked. This became apparent during an ad hoc meeting organized by SeaChange in response to the environmental NGO funding crisis then being experienced in the province. The attendees at this meeting included several Project participants and ranged from a volunteer steward, to federal government representatives and well-established conservation organizations. This meeting constituted a forum for the stories of those who were hit hard by the funding shortage as well as for the exchange of expertise in fundraising, planning and organizational development.

Individual | collective learning

In the Project, new members freely choose to participate and learn in and through participating. One of the groups trained in the course of the first year, is located on an

island sandwiched between Vancouver Island and the mainland of British Columbia. The coordinator of this group, Nadine [pseudonym], works as an educator for home schooling students and volunteers for a local community group. As a volunteer, she has participated in recording annual inventories of the rocky intertidal plants and animals on the island for the past several years. She began to participate in the eelgrass mapping and monitoring project in its first year and completed two consecutive years of mapping and monitoring. As an educator Nadine recruited students who created resources—an information binder and posters called Creature Features—that are displayed in the local museum (Figure 3.2) and were also displayed at an eelgrass festival that SeaChange organized for Project participants.

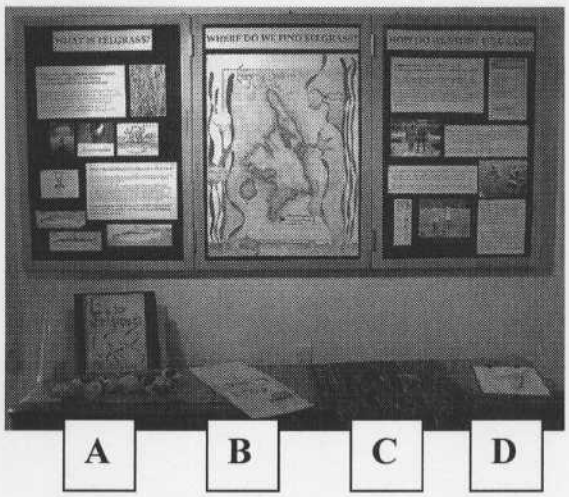


Figure 3.2. Museum and public education display.
From left to right on table: (A) information binder, (B) Creature Features, (C) mock-up eelgrass bed and (D) quadrat, data sheet on clipboard with ruler.

New resources available at the collective level enhance action possibilities of all members, and therefore constitute the potential for collective learning. For example, the resources Nadine created were distributed to the schools on the island. The students are

currently designing activities associated with eelgrass, and a young woman has volunteered to contribute drawings for a field guide of "critters" most commonly found in an eelgrass bed. Nadine also recruited a young SCUBA diver who assists with underwater eelgrass mapping and monitoring. In this way, Nadine expanded her own participation by engaging in the Project, and her practices and the concrete outcomes of the groups' actions produced resources for the actions and learning of others. Thus, students came to participate through the preparation of an exhibit. Through their actions, they became more knowledgeable about eelgrass and their exhibit became a material resource that further mediated the actions and learning of still others. Both the expanded possibility and the concrete learning of others constitute learning at the collective level: the former in a generalized way, the latter in a concrete way.

As part of the museum and public display, the group created a mock-up of an eelgrass bed consisting of a rubber grid to represent the rhizome net (anchoring structure of plant) and green ribbons to represent the length and width of eelgrass blades that would typically be found around the island (Figure 3.3). A small quadrat (standardized square-shaped tool used to count eelgrass shoots), ruler and clipboard featuring the data sheet used by the group to document eelgrass, were situated beside the mock-up eelgrass bed. Visitors were presented with written instructions and invited to measure the density and productivity of the eelgrass using the tools that individuals actually mapping would use.

During a visit by the Project coordinator, Nadine pointed out the display in the community museum. At that moment, the mock-up eelgrass bed became a resource that spread across the collective and therefore expanded the opportunities of others to learn. Subsequently, the mock-up eelgrass bed became a tool for the biologist and coordinator

of the Project to train other groups when the tide was too high to work with live eelgrass beds. That is, it became a resource for the biologist and Project coordinator to act in new ways and opportunities became available that were not present beforehand. I understand such increases in generalized action possibilities or "room to maneuver" as learning at the collective level (Holzkamp, 1983).

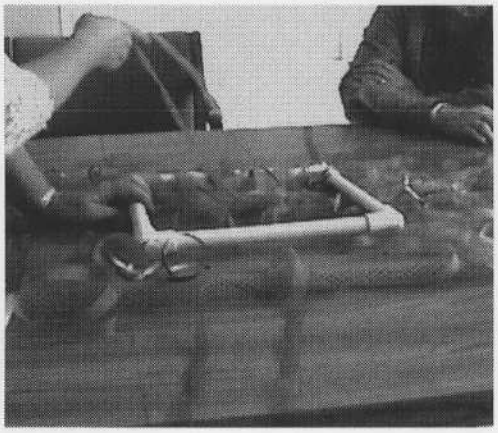


Figure 3.3. Mock-up eelgrass bed being used during a training workshop.

When the new invention entered other activity systems, for example, that of the Project coordinator, it underwent transformation. As happens when most technologies are transferred to new contexts, they are altered, added to, or subtracted from, to suit the situational needs of the new activity system (deLaet & Mol, 2000). At first the mock-up eelgrass bed was replicated almost exactly in the new activity systems (biologist and Project coordinator), but over the course of training three new groups, the Project coordinator learned, in and through these inter-actions, that it did not adequately represent a typical eelgrass bed and thus was not an ideal tool for mapping training. I hyphenate the term inter-actions to emphasize the root *action* that represents the moments

within the doings of an activity system where learning or expanded opportunities for action takes place.

The Project coordinator transformed the invention by adding eelgrass zones with different sizes of shoots. With this alteration, the invention that served as an educational resource in the first activity systems (museum and schools) was transformed through the actions of a different activity system to mediate a slightly different goal of eelgrass mapping training. This is one example where the outcomes and actions of one group led to increased opportunities for action of others, and therefore for the collective. I do not presume that all individuals or groups will always take on new resources that are presented to them, however, the flexibility of the Project allows individuals to make choices that are relevant for them and their community.

Events like those articulated above, where people and material resources inter-act, not only expand action opportunities for individuals who constitute a collective, but also create social and material connections that enable a network to emerge. I show in the next section that, as activity systems overlap and resources become available to the collective and reflexively to the individual, the network becomes more stable.

3.3 Emergence of the community eelgrass network

By joining others to form collectives, individuals (or groups) expand the range of actions possible and thereby increase control over their own conditions (Holzkamp, 1983). A hint of this phenomenon was provided in the previous subsection where I described how bringing Nadine into the project expanded the possibilities in and of the Project. Forming a network means enlarging the collective, which expands the possibilities that exist before the networking in the individual communities (for summary of activities of Project participants–see Table 2.1). That is, the network enhances the

possibilities of free-choice learning that exist for the collective and the individual. This was what I observed as the community eelgrass network emerged.

The network began as a conversation between the Project coordinator and a federal government representative who encouraged SeaChange to submit a proposal for federal funding to support the Project. The Project was initially conceived as encompassing a small geographic area. However, groups from almost the entire coastline expressed interest in the Project, spurring the government representative to encourage the Project coordinator to "make the boat bigger" by adding more groups. In this way the network emerged, not as a pre-crafted plan or government-mandated agenda, but through inter-actions and overlap of activity systems. Telephone and face-to-face conversations, like the ones between the Project coordinator and government representative, and emails sent by interested groups to SeaChange, constitute moments in which different activity systems overlap and create conditions for the emergence of a network: it is the overlap and the flow it enables that makes the network (Mol & Law, 1994). By developing an understanding of how this network emerged, I articulate how environmental oriented free-choice settings can be supported.

Activity systems overlapped, for example, when the biologist and Project coordinator conducted training and when the coordinator of one group, Nadine, assisted another group by conducting an additional training of its members (see Table 3.1 for summary of Project inter-actions). After a year of participating in the Project, Nadine became a resource for another group, which was expressing uncertainty as to how to go about organizing volunteers and initiating the eelgrass mapping activity in their community. They had undergone the initial training, as had all other groups, but were still unclear

about how to proceed. Nadine, having mapped several beds with volunteers the year before, offered to travel to their island (nearby) to train them using the techniques that she and her volunteers had learned and developed within their experience. Nadine and her volunteers initially stumbled through the subtidal mapping protocol as their initial training did not adequately prepare them for this component. They devised innovative ways to deal with counting and measuring eelgrass blades and recording information underwater became possible with SCUBA gear. The outcome of Nadine's learning, which co-evolved with her volunteers' learning, became a resource not only for her group reflexively, but it also led to increased action possibilities (learning) for another group.

Table 3.1. Inter-actions between Project participants and associated activities.

Activities	**Inter-actions**
Mapping	1-21, 4-8, 10-A
Map Production	3-22, 9-24
Technical Support	2-24, 4-9, 1-24
Sharing Resources	11-21, 4-8, 9-24
Sharing Ideas	9-13, 4-9, 2-8, 2-21, 2-9, 9-24, 7-9
Training	9-15
Workshops	1-10, 10-12
Festivals	9-A, 10-A
Fundraising	21-A, 8-21, 8-22
Planning	10-22

Note. See Table 2.1 for groups/participants that correspond with numbers and letters. This list of inter-actions is in addition to those referred to in the text (i.e., eelgrass festival where 15 out of 20 groups convened). The list was compiled from field notes and interviews with six participants, including the Project coordinator, and therefore should be considered a sample of the total inter-actions within the network.

I contend that inter-actions such as those between Nadine and the neighboring group, as well as exchange of material resources (e.g., the mock-up eelgrass bed), serve to stabilize the eelgrass-mapping network. In the context of the Project, a stable network consists of groups and individuals that continue to engage in Project activities that are

relevant for their community or institution. There need not be permanent overlapping of activity systems for the network to become stable; in fact, the very fluidity of inter-actions between activity systems enables stability. In this kind of network, membership and relations may shift and new relations are continually being made. This is reflected in the fact that the Project coordinator did not directly mediate the inter-action between Nadine and the other group; she took it upon herself to make the connection.

The decentered position of the Project coordinator within the network—who nonetheless plays a key role in providing funding, facilitating inter-actions between groups, providing access to equipment and expertise, and maintaining working relationships with government agencies—allows for grassroots emergence of collaborations, which are stable because they do not depend on a master coordinator. That is not to say that all collaborations are persistent; some are opportunistic, fulfilling the needs of the participants for a particular purpose (e.g., a one-day workshop offered by one Project participant to others in the network). One Project participant, who is also a biological consultant, reported the following in an eelgrass mapping review:

> The formation of the Seagrass Conservation Working Group has been an important development in the coordination of fine-scale eelgrass conservation efforts, and establishment of a communications network between NGOs, First Nations, university researchers, and various levels of government. Similarly, the initiatives of [SeaChange] to act as an NGO umbrella group in order to coordinate funding, training and mapping ventures that involve many different groups should be recognised as an excellent way to avoid duplication of effort, minimize administration time and encourage cooperation between groups (Dunster 2003).

The Seagrass Conservation Working Group, which is chaired by the Project coordinator, serves as the decision-making body that guides the research, mapping and monitoring priorities of the network. Because this group is made up of community groups, in addition to scientists and government representatives, there is a dialectic relation between an individual's actions (production of resources) and the directions that

the collective takes as a whole. The flexibility of this network is enacted and enabled by all participants, thus constituting a free-choice setting.

The achievement of the goal of the network—the baseline documentation (mapping and inventory) and conservation (and stewardship) of eelgrass meadows along the coastline of British Columbia—has experienced some challenges. Two groups that signed on for the second year of the Project dropped out six months later; the coordinator of one of these groups confessed to not having enough time to participate. In free-choice-learning settings, not participating and therefore not learning is also a possibility; it should be evident that dropping out not only truncates the learning of these groups but also the learning of the collective. However, two new groups signed on and were trained.

The most pressing challenge for the Project is to secure the funding required to continue after the two-year granting period ends. Already, the structure of the network has shifted in attempts to accommodate the cessation of funds and to keep the network alive. The Project coordinator addressed the network of groups with the proposal of creating regional Project coordinators who would oversee training, coordination and fundraising, and support the groups in their region. Now, the Project coordinator is working with four regional coordinators, three of whom are already members of the network, to come up with funding to support the entire network. By gaining an understanding of the emergence of the network I learned that not only do material artifacts (i.e., information binder, Creature Features, mock-up eelgrass bed) that get moved around constitute resources, but resources also become available in action, whereby the practices of some members became resources for others to expand their opportunities for action.

The network—consisting of both momentary (phone calls, emails) and enduring (day-long meeting or mapping activity) repeated overlapping of activity systems—constitutes the mechanism that links individual and collective learning that always stand in a dialectic relationship. I found that some resources became available to the collective through the coordination and movement of the Project coordinator, whereas others became available through inter-actions between groups and participants. The Project coordinator's learning, or increased opportunities for action, is in turn enabled by inter-actions and overlapping of activity systems (e.g., the mock-up eelgrass bed) that constitute the network.

3.4 Supporting free-choice learning

> I'm new to the project, I'm an artist and not a scientist and don't have a huge background in marine biology or fish or anything but I, I'm learning to love the plant from all this interaction and . . . [William] and our little boat and myself and my dog have just started cause I feel that I need to learn as much about the project as I can before I can feel comfortable going out and telling other people how to do it so I'm still learning. (Project participant)

What the Project participant explains in this vignette is that through mapping and participation in the Project, she draws from the resources given in and through the collective, thereby expanding her action possibilities until, "I can feel comfortable going out and telling other people how to do it." By participating, however, she expands the possibilities of the collective; her participation therefore also constitutes collective learning. The flexibility of individual and collective actions that are enabled in the context of this Project shows that learning arises in and through a free-choice learning setting. Here I show how learning in these complex settings is distributed throughout the collective and is enabled by the network that is constitutive of and emerged from inter-actions between Project participants. The very stability of the network arises out of (a)

the "free choice" or room to maneuver that groups were allowed in order to tailor the Project to their local needs and, (b) the overlapping of activity systems where opportunities for action (learning) by individuals and thus the collective expanded. The Project coordinator had a key, yet decentered role in the stability of the network. Her movements and actions—including regular site visits (overlapping) with groups and participants, fundraising for meetings and events, and volunteering—served to help make knowledgeable practices available as resources in and across the network. Because the Project coordinator was able to participate in more than one activity system, her action possibilities expanded and in turn increased resources for the collective.

My study suggests that free-choice learning is not exclusively an individual thing nor exclusively an effect of collective activity. Free-choice learning arises from the individual|collective dialectic that exists as soon as individuals join to form collectives. More so, in my study, the different groups joined to form a network, a group of groups. In analyzing environmental free-choice learning settings where, as the Project illuminates, a complex and distributed web of communities and individuals inter-act, I show that understanding the dialectic relationship between individual and collective is paramount. In this, my study differs from analyses of learning that take individual students in classrooms as unit of analysis. Following one individual's learning over the course of the Project, would have led to serious misunderstandings of the complexity of persons-acting-in-settings, where site visits or mapping activities constitute occasions where resources become available in action and as outcomes of knowledgeable practices (activity systems).

Chapter 4

Learning and Teaching as Emergent Features of Informal Settings: An Ethnographic Study in an Environmental Stewardship Group

Abstract

Around the world, there are many among those concerned with the state of the environment who participate in environmental action groups. Much of their learning occurs informally, simply by participating in the everyday, ongoing collective life of the chosen group. Such settings provide unique opportunities for studying how people learn science in complex settings without being directly instructed. This study was designed to investigate learning and teaching that occurs through ordinary, everyday participation in environmental action. I draw on data collected during a two-year ethnographic study of a coast-wide eelgrass-mapping project. Taking a whole activity as my unit of analysis, I articulate the forms of participation that volunteers take, and theorize learning in terms of changing participation and expanding opportunities for action. The community-based eelgrass stewardship group I studied is both socially and materially heterogeneous; made up of people young and old and with different expertise; the rising tide, beach, eelgrass, quadrats, critters, field guides, GPS, and data sheets. I show that changing forms of participation are emergent features of unfolding sociomaterial interaction, not determinate roles or rules. Furthermore, when individuals have the opportunity to frame problems that arise in ongoing activity the possibilities for learning expand. In the setting of this study, attributions (dichotomies) such as "off-task/on-task" and "teacher/learner" are artificial. I suggest that by providing expanding opportunities, in the form of a variety of social and material resources, science educators can rethink the design of school-based science learning environments.

4.1 Introduction

Over the past decade science education researchers have begun to investigate informal settings, such as the one I describe here, as important areas for coming to understand science learning (Feher & Rennie, 2003). This interest is apparent in the dedication of special issues on the subject in the *International Journal of Science Education* (1991, 2003) and *Science Education* (1997) and in the inclusion of a special section on informal science education in *Science Education* (1999). For the most part, research on science learning in informal settings is carried out in museums, science centers, zoos, and community-based science activities (science clubs)—settings that provide rich opportunities for understanding learning in out-of-school, that is, free-choice settings. Less than a decade ago, a concerted effort began to develop theory and methodology for informal science learning settings using social science research in related areas (Dierking & Martin, 1997). More recently, leading researchers in the field elaborated a policy statement approved by the Board of the National Association of Research in Science Teaching (NARST), to establish a cohesive initiative for research in out-of-school settings (Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003). Research in the field of informal learning of science in museums has made considerable progress (Martin, 2004).

While there are some who study other informal settings such as social and environmental action (Foley, 1999; Lee & Roth, 2002), youth urban planning and gardening (Fusco, 2001), and students collecting data for local community groups (Helms, 1998), such learning settings remain largely understudied in the context of science education. Most science learning settings that are studied are mandated to present or teach scientific knowledge; few look at how science is actually practiced—as in the

case of eelgrass mapping—as part of a collective conservation effort. More often than not students of science (including undergraduate students) replicate the same experiments over and over in laboratory classes, rarely contributing to any kind of collective knowledge gathering process.

Much of the knowledgeability required and displayed in everyday settings is not learned in school (Lave, 1988; Saxe, 1991). Although there is much less evidence from science, there are some studies that show that much of public understanding of science arises in and through participation in everyday, collectively motivated activity rather than from school science classrooms (Roth & Lee, 2002). If this is the case, I may ask questions such as, "What and how do people learn by participating?" "Who are the teachers and how do they teach?" and "What is the role of problems in learning?" The purpose of this paper is to provide answers to these questions. To better understand what kinds of opportunities environmental stewardship groups constitute for teaching and learning, consider the following episode.

4.1.1 An episode from an eelgrass mapping event

The eelgrass-mapping event that forms the basis of this article took place in a small island community (population around 800). This event is part of a larger ethnographic study of a coastal communities eelgrass stewardship project involving 20 groups along the coast of British Columbia, Canada. Samantha[9] is one of twenty coordinators trained to carry out the project in her community. She organized a daylong eelgrass-mapping event and recruited members of the community (volunteers) by word of mouth and by posting a flyer at the village co-op that read, "Fill your boots on Oceans Day! Join

---

[9] All individuals in this study are presented as pseudonyms except Leanna who is the author of this thesis.

Leanna Boyer and Rocky Island Stewardship Society (pseudonym) for an afternoon of Eelgrass Mapping." Members from this community and a nearby larger town participated in the day. The following vignette is a description of the typical kinds of inter-actions[10] that unfolded throughout the day—this is three minutes at the beginning of the mapping activity.

The group of volunteers ascends to the beach to the eelgrass meadow that is exposed at low tide. After explaining to the group the purpose of the event, Samantha and Leanna begin by laying out a transect line across the eelgrass bed parallel to the shore. One volunteer, Jen, asks Leanna whether she can identify the large number of tiny golden eggs that she has observed attached to the eelgrass. Leanna replies saying that she has been told they are lacuna snail eggs, but concedes to not actually having seen the snail herself and continues with the task at hand.

Four other volunteers peer at the eelgrass to locate the eggs. Cathy says that the eggs look like seed beads. Jen agrees and suggests that they look like donuts and then passes the pre-teenaged Mandy a field guide and asks her to look up lacuna in the back. Josef says that another type of snail, the moon snail, makes a great big donut. Mandy asks whether those huge donuts are its eggs. Jen replies that yes they are. Samantha and Leanna adjust the transect line, moving it up the beach a little. Another volunteer Garth, watches us and alerts Jen to move away from the transect line. Mandy continues to search through the field guide and Jen spells out the first two letters: L, A. Two elderly crab harvesters with buckets in hand walk towards the group and pause. Cathy shouts, "having any luck?" Cathy speaks of another beach where she has seen trappers, but where she has

[10] The term inter-action is hyphenated to emphasize the root action that represents the moments within the doings of an activity where learning or expanded opportunities for action takes place.

not attempted to harvest. Mandy's mother, Natasha, and Josef are engaged in conversation. Mandy proclaims that she has found only two words starting in L, A, C. One of the crab harvesters asks jokingly whether the participants were buying land here and Cathy explains, "We're just checking out the eelgrass bed." Josef jokes that they are planning to harvest all the crabs. Jen says to Mandy that they should be able to find the snail that lays the eggs in the eelgrass. Mandy agrees. Jen puts the field guide in her backpack and tells Mandy that she is free to access it whenever she wants.

In this description it is already apparent that the setting is both materially and socially heterogeneous and complex. There are many different processes unfolding simultaneously; people of different ages engaging in different actions and participating in different ways. The setting is materially rich with eelgrass, moving transects, passers-by, a field guide, golden eggs, and a rising tide. These materials frame actions but also are framed by actions. One can witnesses several learning moments in the span of three minutes. First, two people attempt to identify the tiny golden egg masses that adorn the eelgrass by questioning Leanna and studying a field guide. Second, one person observes the transect line setters. Third, another person engages in conversation with passers by. Fourth, two people engage in discussion and three other youngsters (three twelve year old girls) explore the beach. Here, there are multiple orientations rather than a single teacher, as is characteristic of most school settings. Each person pursues forms of participation in relation to the activity, against which all actions take their sense.

4.1.2 Purpose

The purpose of this study is to investigate how people teach and learn while engaging in environmental action, in particular eelgrass habitat stewardship. My central claim is that *learning*—theorized in terms of changing forms of participation (Lave, 1993;

Rogoff, 1997)—*is an emergent feature of sociomaterial settings*. The setting that I report on here is both highly socially and materially heterogeneous compared to most classrooms; such informal settings therefore expand forms of participation that are less available in more structured school settings (e.g., Roth & Barton, 2004). I analyze two common forms of participation that are constrained by the more limited sociomaterial resources of the classroom: (a) one teacher among many learners (teacher vs. learner) and (b) forms of participation that are on- or off-task (on-task vs. off-task).

4.2 Theory: A focus on whole activities

In the introduction of this thesis I articulated the CHAT framework that I will elaborate here. Again, the focus here is on whole activities as the unit of analysis. The term *activity* therefore has a different meaning than in normal educational use. Rather than constituting a context where participants are active, pursuing some task, activity refers to societally motivated sets of tasks and actions that contribute to maintenance and survival (Leont'ev, 1978), including farming, doing research, or enacting environmentalism.

In Chapter 3, I showed how the resources and learning of one individual community led to expanded learning opportunities for the collective and, in turn, the collective provided resources for learning at the individual community level (Boyer & Roth, 2005a). In this way, individual and collective learning presupposed each other. This relation may strike readers as being relatively intuitive. However, in schools the unit of learning is the individual: isolated from those cultural, social and material resources that mediate their learning in the first place. For example, students write exams on their own with pencil and paper—social and material resources that are severely limited compared to the original learning experience (i.e., working in groups with lab equipment and texts).

Instead of theorizing learning as a property of individuals, I theorize culture and cultural knowledge in terms of generalized action possibilities that exist at the collective level (Roth, Hwang, Lee, & Goulart, 2005). Therefore, individual knowing and learning is understood as an increase in action possibilities that in turn increase collective action possibilities.

In ongoing activity, individuals produce sociomaterial resources, which are the outcomes of the activity. Thus, while mapping eelgrass, individual actions have the potential to change the culture (collective) in the local setting and the entire coastal eelgrass project as a whole. Not only are resources products and outcomes of individual actions, they also constitute resources to support subsequent actions of anyone in the community (Figure 3.1). Resources therefore are both social and material (Figure 1.2 (b)), or, as is the practice in science studies, resources are sociomaterial (e.g., Suchman, 2002). Thus, a field guide serves as a resource for one volunteer to identify the critter that lays golden eggs on eelgrass and at the same time orients and enlists others to investigate with the volunteer. Because each action produces resources and is itself a resource for future action, a setting never is the same but continuously unfolding. If stable structures (things or systems) seem to precipitate out of these relations it is the outcome of processes (persons acting in sociomaterial settings) that are always at work producing and reproducing those structures (Harvey, 1996).

4.3 Research design

Chapter 2 in this thesis outlines the research design employed in this study.

4.4 Informal learning and teaching in/as/for environmental stewardship

To begin my analysis, I first articulate overarching characteristics of learning in this informal setting by describing how volunteers attempt to classify eelgrass plants and

frame problems in the ongoing activity. I show how: (a) individuals acting-in-and-for-setting both produce sociomaterial resources and constitute such resources; (b) the sociomaterial heterogeneity thus produced (and reproduced) in turn allows for expanding possibilities for action of individual and collective; and (c) individuals are able to frame issues and have control over seeking their resolution. The first subsection sets the stage for the next two themes (subsections): (a) who teaches is an emergent feature and in this heterogeneous setting there are multiple teachers; and (b) those who may *appear* to be off-task indeed are not if I take as my unit of analysis the whole activity and the mutually presupposing individual–collective unit. I make the case that such sociomaterially heterogeneous and complex environments allow individuals to participate in a multitude of ways and whose learning is supported by collective actions—opportunities that for the most part are not available in more homogeneous school settings.

4.4.1 Classifying eelgrass/ framing problems

The sociomaterial heterogeneity of the eelgrass-mapping event was made up of quadrats, transects, GPS, field guide, eelgrass, critters, and other human bodies. The heterogeneous nature of the event was apparent not only to my research team but also was articulated by the volunteers as they encountered variability in the natural world. This became particularly salient while the volunteers, who ranged in ages from twelve to elder, learned to identify flowering eelgrass shoots, requiring them to distinguish between flowering and non-flowering. It turns out that in and through their inter-actions with the eelgrass and other volunteers, realized that there was no neat and tidy classification of

plants into flowering and non-flowering: there was a gradient of forms[11]. Using fragments of video transcripts I show how in these kinds of settings individuals have control over the ways that they participate, over framing problematic (a personally meaningful problem) issues, and pursuing particular lines of inquiry (reaching more stable classifications) by drawing on the sociomaterial resources available.

Figure 4.1. Volunteers counting flowering and non-flowering eelgrass shoots.

As part of the mapping activity the volunteers were asked to count the number of flowering shoots[12] that appeared in each quadrat, a 1 by 1 meter square biologists use for standardized sampling (Figure 4.1; photo in fragment 1 of transcript 1). Two quadrats were set up along a previously established transect (a line along which biologists conduct their sampling episodes). The two trainers (Samantha and LB), each in her respective quadrat and through their actions, began to model identifying flowering eelgrass shoots (see configuration in Figure 4.1). For the purposes of this analysis I focus on the

[11] This fact was not even apparent to one of the trainers, who was supposed to be familiar with classifications. But as a recent study of scientists showed, apparently simple (i.e., settled) classifications may be problematic for highly trained scientists working collectively (Roth, 2005).
[12] "Shoot" refers to the portion of the plant that emerges from the under the substrate. Eelgrass reproduces predominately vegetatively, through underground rhizomes, thus a single plant could be represented by more than one shoot.

unfolding actions of one group (quadrat 2), providing additional evidence from the actions of the neighboring group (quadrat 1). As the classification of flowering eelgrass shoots unfolds volunteers attempt to render the material (eelgrass in particular) and social world of eelgrass mapping understandable, to participate in culturally relevant ways (culture of community eelgrass mapping). They do this by framing problems or issues and then draw on available resources to seek a more stable classification. The following transcripts constitute a series of continual inter-actions.

In the episode, Samantha begins to look for flowering shoots in the quadrat (see picture below, Samantha on the right), Jen crouches down and observes (on the left), and Garth stands and observes.[13]

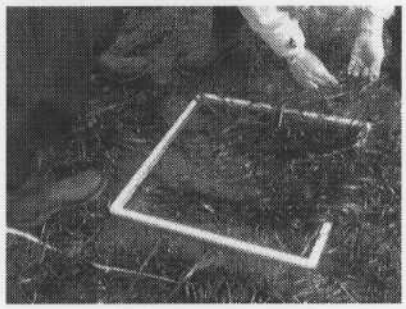
Transcript 1 Fragment 1

01 S: The other thing we're gonna be looking for is if you see any, the beginning of any flowering, lets see like and how do I recognize flowering or

02 J: gee well, I'm tryin' to see if I can ah * (??s) have you

03 S: got a flowering one over there?

04 L: yeah we got tons (from quadrat 1)



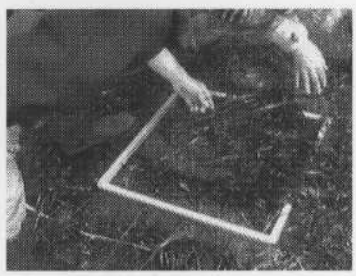
In the first turn Samantha articulates the goal of the task that realizes the activity: looking for "the beginning of any flowering." As she picks through the eelgrass shoots Jen frames a problematic: "How do I recognize flowering?" (turn 02). Drawing on the social (Jen and Garth who are unfamiliar with the appropriate classification) and material

[13] The following transcription conventions are used: (??) – double question marks in parentheses indicate a single indecipherable word; (…) – indicates that a portion of the transcript was removed for the purposes of analysis; * – asterisk indicates the place in the verbal transcript corresponding to a photograph; ((walks to quadrat 1)) – transcriber's comments are enclosed in double parentheses; [gee well] [yea we] – square brackets in consecutive turns indicate

resources (eelgrass, quadrat) at hand, Samantha does not find a flowering shoot and therefore draws on her neighbors Leanna, Cathy, and Mandy (turn 04). After Samantha explores some more, Jen starts to sift through the eelgrass. At this point the setting for Samantha and Jen's immediate actions is made up of eelgrass framed by a quadrat (see photograph) and each other's bodily movements and utterances. So far neither Samantha nor Jen have articulated and therefore made salient any differences between eelgrass shoots.

Transcript 1 Fragment 2

06	S:	oh good, oh yeah there's one, this'll be one right here
07	J:	okay
08	S:	at least it feels like it is
09	J:	should I just pop over to the other one
10		This looks different * no, is ah
11	S:	okay how come I'm not seeing any flowering ones?
12	J:	(??) flowering ((walks to quadrat 1))



Jen continues to explore the perceptual field by manipulating the eelgrass looking for differences (see picture, Jen on the left). Samantha announces that she has found a flowering shoot (turn 06) and through her talk and bodily movements she implies that there are particular tactile properties of flowering shoots (turn 08). This also suggests that she has an embodied understanding of what the differences feel like that will distinguish the categories. But at this time, she has not yet verbally articulated specific characteristics that her "trainees" could use as resources for their own classification and counting actions.

Jen nearly abandons looking for a suitable candidate for illustration, suggesting that she should "pop over to the other one [quadrat]" (turn 09); but then notices something

---

overlapping speech. Duplicated utterances, and "um" were also removed as they are not important for the present analysis.

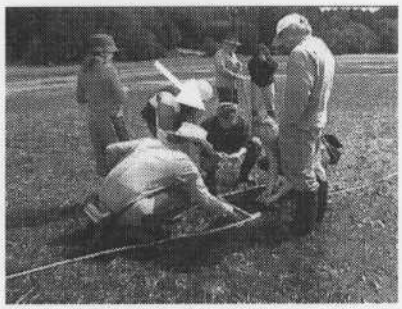
and picks up an eelgrass shoot (turn 10). Samantha questions again why she is "not seeing any flowering ones" (turn 11): there is a lack of material resources (flowering eelgrass shoots) in the quadrat for Samantha to show Jen how to classify the eelgrass. Jen follows up on her utterance by walking over to quadrat 1 (turn 12). Through this movement she *actively* enlarges the number and amount of sociomaterial resources available thereby increasing her action possibilities. For Jen the existing resources had been exhausted so she sought further resources to mediate the overall object (motive) of the activity, classification of flowering shoots.

As Jen walks away Samantha continues to search and then exclaims that she has not, "found any yet" (turn 18). Jen arrives at quadrat 1 just after Leanna has described to Cathy and Mandy (Andrew also observes) particular features of a flowering shoot that contrast to non-flowering: wheat-like seeds are located at the tip of the shoot and the shoot branches.

Transcript 2 Fragment 1

18 S: I haven't found any yet, Leanna said she was finding a lot over there ((Jen walks over to quadrat 1))
19 J: okay now I got it, it looks like (??) grain *

20 S: okay let me see one of your flowering ones here ((walks over to quadrat 1))

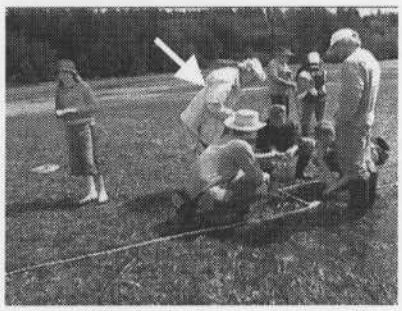


Picture 1. Jen crouching (see arrow)

21 C: it's got a little wheat on it

22 S: oh yeah there's one, you found one right off the bat *

23 L: and it's also kind of round
24 S: yeah it's fatter
25 L: fatter and this is these are just (??) the blades.



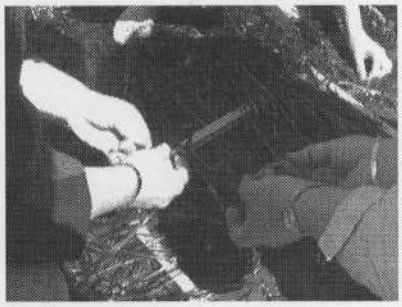
Picture 2. Samantha (see arrow) standing beside Jen

Mandy holds up a flowering shoot for Jen to observe and feel. Jen immediately notices the grain, "Okay now I got it" (turn 19). Samantha arrives and immediately recognizes the flowering shoot (turn 22), at the same time that Cathy points out the seeds (turn 21). In this sequence, both Mandy and Cathy offer verbal and material resources for Jen and Samantha to classify the shoots. Leanna then provides an additional resource indicating that the shoot is, "kind of round" (turn 23) and Samantha concurs by saying that "it's fatter" (turn 24). Leanna then holds up a non-flowering shoot for comparison, "these are just (??) the blades" (turn 25).

From the perspective of Jen and Samantha, the number of sociomaterial resources increased to include a flowering specimen and three other individuals; through these inter-actions their possibilities for acting or room to maneuver expanded, which is a sign of learning (Holzkamp, 1983). This expanded room to maneuver allows new forms of actions to become realized, which over time may turn into recurrent patterned actions. Such new forms of patterned actions are typical instances of learning (Roth, Hwang, Lee, & Goulart, 2005). Importantly, the situation was not given beforehand and the setting did not *determine* their actions. Their actions and movements actively changed the setting and therefore changed their future possible actions.

Samantha and Jen return to quadrat 2 and count all of the shoots in the quadrat before searching for flowering ones. As the searching unfolds Jen and Samantha express ambiguity in the classification of flowering shoots and Jen frames a new problematic.

Transcript 1 Fragment 3



13 S: we have to look for flowering ones and to be honest I didn't even really notice any
14 J: I didn't feel one . . . kinda feels a little rounder (feeling shoot)
15 S: ah this one feels like
16 J: see these feel different but I don't see evidence of the flower here
17 S: yeah I'm with ya
18 J: they feel so round, they feel like they're ripe but the flower's not visible yet so I don't know whether they
19 S: oh see here's one finally but they're just started *
20 J: kay well I imagine that's here too
21 S: no you I think your just feeling like a number of *
22 J: or it looks like it's just in a developmental stage that doesn't have a flower but I guess it has to be visible or you don't count it right cause you're gonna have it in an underdeveloped stage
23 S: but see what I see one, two, three, four, five all growing in that shoot I think that's the bulk of it

Samantha and Jen search through the eelgrass, each picking particular shoots and running them through their fingers; Jen *feels* one that is a "little rounder" (turn 14). They articulate resources that were made available to them at quadrat 1: roundness and the existence of a seeds. Given these sensory resources Jen frames a new problematic: They feel round but "the flower's [seeds'] not visible yet" (turn 16). Samantha posits that the seeds "just started" developing (turn 19). Samantha does not just say anything but articulates a description for everybody to hear that is available to all those overhearing her. The description is a new resource for action, making new forms of action possible that did not exist prior to this resource being available. Samantha's suggestion therefore is available to become a resource for Jen, who is in a position to expand her understanding and articulate the problematic in a subtly different way: She suggests that shoots that do not have seeds but are round potentially represent an underdeveloped stage

(turn 22). In this situation Jen not only identifies a problematic issue associated with classification, but frames a new problem: "It has to be visible or you don't count it right" (turn 22). She thereby draws implications for the broader activity of counting and mapping eelgrass, especially for establishing a protocol aimed at measuring the health of the entire eelgrass bed.

The learning opportunities available in the setting do not stop at this moment in the event, but continually unfold as participants produce resources that have not been available previously. In the following fragment, Garth has just returned from quadrat 1 where he asked the others to see a flowering shoot. Leanna volunteered to show him one and moved from quadrat 1 to a space in between the two quadrats. She located one and first commented on its yellow appearance—a feature that she had not yet articulated and which therefore constituted another resource for expanding the action possibilities of others and her own. She then points out the branching and roundness of the flowering shoot. Garth, having observed the inter-actions between Samantha and Jen at quadrat 2, augments the immediately accessible sociomaterial setting by seeking further resources that Leanna provides. In the following fragment, Garth realizes the new possibilities by incorporating these new resources into the collaborative classification of flowering shoots in quadrat 2.

Transcript 1 Fragment 4

24 G: yeah that's the flowering one, it divides
25 J: not that one, it is?
26 G: does it divide yeah
27 J: okay that is apparently
28 G: yeah
29 S: [but you don't have to see the seeds?]
30 J: [you don't have to be able to see the flower?]
31 G: no you can see the seeds
32 S: where okay check that one out * ((holds up

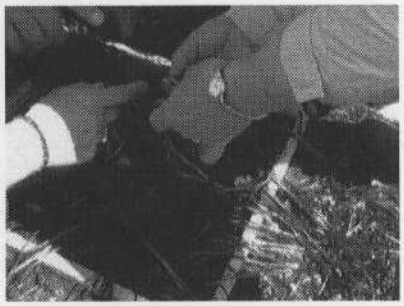
shoot))
33 J: and that one, see this one's much thicker too, but I don't feel the seed either

Garth has been observing but has not contributed until now. Here, however, he brings the branching to the attention of others by saying, "it [flowering shoot] divides" (turn 24, see picture, Garth holding shoot on the left). By describing the shoot in this way, he provides a new resource for action and thereby enlarges the immediate setting. Any participant can use the resource to contribute to the unfolding classification that up until now has been articulated by Samantha and Jen. At first Jen appears convinced: "Okay that is apparently" (turn 27); but Samantha frames the problem again questioning Garth whether the seeds must be visible (turn 29). Simultaneously, Jen poses a similar question (turn 30). Garth asserts that the seeds are indeed visible: "You can see the seeds" (turn 31). Samantha then asks him to look at the specimen that she holds in her hand (turn 32, see picture, Samantha on the right). Jen elaborates by referring to the shoot in her hand, articulating its thickness as a potential resource for classification and suggesting that the absence of a seed excludes the specimen from the classification of flowering (turn 33).

The first two episodes show that different individuals contribute resources that then become available to the collective. Here, Garth's utterances advance the classification task in a significant way. In the following fragment, Garth probes Jen's eelgrass specimen and continues to offer his resources.

Transcript 1 Fragment 5

34 G: it's almost rounded (pointing from upper left corner; see picture) … down here (??) it feels almost rounded
35 J: so that's what we're trying to do is feel them
36 S: I think it's just a whole bunch of leaves on that one …let's say opposed to this one
37 G: yeah, that one actually show (??) yeah there it is
38 S: you can actually see them
39 G: yeah
40 S: but you can't on that other one
41 J: It might be in a reduced state of development I don't know
42 S: that's right it could be
43 J: what do you call the flower right
44 S: see but there's so many shoots in there
45 G: yeah and (??) (??) do you (??)
46 S: I think it's just the bulk we're feelin ((Garth continues to feel and observe the shoot))
47 J: oh look there's a flower developing
48 S: oh good, there ya be



Garth introduces a second feature, "it feels almost rounded" (turn 34), as a potential resource for classification. Jen indicates that they too have felt the roundness (turn 35) but that they are still struggling with the classification. Samantha again offers an explanation for the roundness: A "whole bunch of leaves" makes up the thickness (turn 36), suggesting that non-flowering shoots could also be round. She then holds up a contrastive example that has seeds. Garth attends to the seeds while Samantha reiterates the problematic; some round shoots have seeds and some do not (turn 40). Jen further elaborates the problematic issue suggesting that the shoots without seeds may be in, " a reduced state of development" (turn 41). Again, she articulates the implications for the broader activity, "what do you call flowering" (turn 43). Garth seems to agree that this is a problem (turn 45). In the end, the classification seems to rest on the appearance of seeds (turn 47, 48).

What is evident from the series of fragments in this collaborative classification is that the problems were framed and solved through emerging (and ongoing) *inter*-actions (Roth & Bowen, 1993) that make use of social and material resources at hand and also draw on the concomitant resources produced individually|collectively. By moving back and forth between quadrats, Jen, Samantha and Garth actively enlarge their action possibilities, producing additional resources, which allow them to make sense of classifying flowering shoots. This bodily movement effectively increases their actional room to maneuver, thus deepening their practical understanding. Furthermore, the individuals are aware (at least intuitively) that moving between the quadrats increases their action possibilities, which contrasts much of school learning settings where moving about and visiting other groups (unless instructed to) is often considered to constitute cheating or off-task (Shapiro, 1989).

The volunteers finish counting the flowering shoots and then move on to count in other locations. The membership shifts at both quadrats as these move to new locations. Jen and Garth work on a second quadrat; Garth counts the flowering shoots independently after which Jen performs a count. There is no conversation about the problem that Jen articulated at the previous quadrat. However, at another quadrat Jen works with Mandy at which time Leanna also helps to locate flowering shoots. This gives Jen the opportunity to articulate the problematic issue for the final time that day, and in this case Leanna serves as yet another resource for Jen to expand her understanding. Natasha, Mandy's mother was also present—standing and observing.

Transcript 3 Fragment 1

01	N:	so what do they look like when they're flowering?
02	M:	they look like wheat
03	J:	that's a very good way to say it… they feel much thicker…that was something I was wondering about is because you can actually feel but you may not be able to see it and so you'd get some difference…are you allowed to count those? And is everybody counting those cause that could bring the margin of error in
04	L:	right well you make sure that it's branching...because they could be starting if you can feel one that's
05	J:	kinda *round*
06	L:	yeah it could be starting you wanna go with the ones
07	J:	that are at this stage (holding up a shoot)
08	L:	at that stage okay yeah and they're kinda yellow and like she said… and this is kinda round

Natasha frames the subsequent actions of the group by asking, "What do they [eelgrass] look like when they're flowering?" (turn 01). Mandy responds by saying that they "look like wheat" (turn 02) and Jen praises her use of words. Jen then begins to frame the original issue: some shoots are thicker but there are no visible seeds and there are differences within what could count as flowering (turn 03). Once again she also raises the implications of this variability to the goal of the mapping activity as a whole. Leanna introduces branching (turn 04), as Garth had previously, yellow color and roundness (turn 08) as resources and conditions for classifying the flowering shoot. However, Leanna does not respond to the implications (problematic issue) raised by Jen: If everybody is counting differently, " that could bring in a margin of error" (turn 03).

In this situation, resources that have been made available to Leanna over the nine previous training workshops have perhaps not prepared her to properly respond to

questioning this situation. She has not noticed the variation in the first place. This suggests that whereas coparticipation in such events contributes to enhancing action possibilities (enacting correct classification) this does not necessarily lead to lasting or context-independent practices. But as pointed out, this is also true for scientists as research in science studies literature shows (e.g., Roth, 2005a).

In the end, the volunteers may not have learned what a prototypical flowering eelgrass shoot looked like but they brought attention to a potential problem with the overall mapping protocol. It is important to note, therefore, that the event constituted learning opportunities not only for the "trainees" but also for the "trainers." For example, Jen has made available further resources (in the form of a problem) for Leanna to expand her understanding and consequently seek the advise of the eelgrass biologist for clarification of how much variation is allowed for classification. The volunteers have had the opportunity to negotiate the process of classification in a heterogeneous (complex) setting, similar to the one in which seasoned biologists do their fieldwork (Roth, 2005a).

My analysis of these episodes highlights how in everyday out-of-school (informal) environments, learning emerges as a matter of course—where I understand learning to be coextensive with changing ways of doing things and increasing control over one's environment. In school science, the situation is usually different. As Larochelle (2002) suggests, if science learning environments are highly structured (homogeneous) by allowing standardized answers (truths) to reign, learning about the reflexive process of doing science will be truncated severely. The problem is worsened by the fact that most children end up learning that there is one answer that can only be known by the teacher and thus are consumed by seeking that one right answer rather than learning the complex

process that is typical of scientific practice (e.g., Gooding, 1990; Pickering, 1995). This complex process involves framing problems that emerge in *situations*—through interactions with members of a culture, the physical environment and preformatted texts—not as products of individual minds and their contents (Roth & Bowen, 1993).

4.4.2 Who is teaching whom?

In schools, most often the roles of teacher and student are institutionally defined and enacted. The teacher is "in the know" and therefore responsible for assessing the level of understanding or competency that students display. Sometimes, teachers make use of peer teaching models, which also assign specific roles to different participants (Palincsar & Brown, 1986). But teachers, including professors, do not always know more than their (undergraduate) students; depending on the situation, this may lead to collaboration and learning or conflict in the course of which awareness of who knows what may be the outcome (Roth & Middleton, 2006).

In everyday settings, however, learning and teaching generally are not the primary motives that drive events; rather, participants of all ages learn to expand their action possibilities in the pursuit of the goals of actions and motives of activities (Roth & Barton, 2004). My observations in the present study show that this leads to the situated constitution of both learners and teachers.[14] That is, who teaches what and how is the result of particular configurations that emerge in ongoing activity. In these kinds of settings, therefore, *teaching* has an emergent character that is contingent on the unfolding sociomaterial relations.

---

[14] The theory of learning that I utilize in this thesis is also informed by the field of situated cognition (Lave, 1988). In this approach, individual learning can only be understood "in context" and is therefore situated. Whether we are teachers or learners in a given situation, is context dependent.

The eelgrass-mapping event was both a celebration of Ocean's Day and an opportunity for community members to participate in assessing the health of a local eelgrass meadow. Although there was an intentional learning aspect to the activity—Samantha and Leanna were tasked with training volunteers—they were not the only individuals engaged in teaching others. Samantha previously participated in two training workshops. Leanna had participated in nine and was introduced to the volunteers as having mapped eelgrass once before. Despite this attribution she was not deferentially treated, as one might be treated in the role of a teacher. Leanna's teacher role was a contingent outcome of the inter-actions, even though these inter-actions were shaped at the outset by the common knowledge that she had previous experience in identification and mapping of eelgrass. In most instances, volunteers would turn to the nearest individual as a resource to mediate his or her learning.

It therefore turned out that who "taught" was an emergent feature that was mediated by inter-actions with other individuals, tools (transect, quadrat, ruler, data sheets), and reflexively, the eelgrass itself, which thereby became both topic and resource of the actions (see Roth & Barton, 2004). For instance, at the beginning of the mapping activity Samantha and Leanna each placed one quadrat at random points on the transect and proceeded, each in their distinctive way, to enact eelgrass mapping. Samantha started by pulling the eelgrass shoots into the center serving as a perceptual resource, whereas Jen asked Leanna to put Mandy to work because she was as a "biologist in training." Leanna momentarily became a teacher not only because she described what was to be done and provided facts about eelgrass biology, but also because the others acted as learners. Before interacting with Jen and Mandy, Leanna had been participating in different forms:

she was not in a teacher role. For example, she figured out how to generate random numbers without a random number table—learning how to deal with the material constraints by devising a method she had not used before—and therefore in a learner rather than a teacher role.

In the following vignette, who is the teacher shifts from moment to moment and in this case there were three people responding to the young girl's (Mandy) question:

Transcript 3

01	L:	does anyone wanna choose two random numbers on here? ((meter stick in hand))
02	M:	(??) for what
03	L:	well what we're gonna do is line up the quadrats along, this is a transect, which just means a line and well it has to be random so that we
04	S:	we're not picking,
05	L:	scientific
06	S:	going ah I like that
07	L:	that looks nice yeah
08	J:	nineteen, pick a number nineteen and
09	L:	but you can just point to somewhere on here
10	S:	just close your eyes and
11	M:	seventy-three
12	L:	seventy-three. Okay do another, keep your eyes closed
13	M:	right there, a hundred and twenty-five
14	L:	so we'll do seven and twelve because we only have 30 meters
15	S:	seven and twelve okay
16	M	what's this line for?
17	J:	they have to make sure they're sampling is random so not that you go oh there's a really healthy piece or a really bad piece they have to have some way that it's and biologist will even pull out numbers or whatever else or get a computer to generate them and then that's where they that's the spot that we'll do and then they have to do several to make sure that it's representative

This inter-action begins with a request for participation by Leanna followed by the question "for what" (turn 02) from Mandy. Leanna starts explaining and Samantha and Jen chime in for elaboration (turn 03, 04, 05, 06, 07). After the numbers are chosen and Leanna and Samantha walk away, Mandy asks of Jen, "what's this line for" (turn 16), who then further elaborates the attendant issues (turn 17).

In this episode there are multiple "teachers" and from moment to moment who was teacher shifted. When Samantha and Leanna walk away there still is someone available to respond to Mandy's question. In this setting there are multiple individuals who potentially serve as teachers. Each in turn, Leanna, Samantha, and Jen made available resources for Mandy to understand why they would want to choose random numbers. Collectively they make available resources for the individual. In and through her *inter*-actions, Mandy recognizes and realizes the possibility of drawing on others. Furthermore, if I tried to pick apart each teacher's individual contribution to the explanation, I would not be able to make sense of the situation. In fact, analyzing the explanation outside of the context of the whole activity—including tools, division of labor, societal motives for engaging in environmentalism, and community—provides at best a one-sided understanding rather than with understanding appropriate to the situation as a whole (e.g., Hegel, 1977). There have been many other occasions throughout Ocean's Day in particular and in the ethnographic study of the eelgrass network generally where participants contribute to enacting the responsibilities for both teaching and learning. There are many examples where an older person asked a younger person. Indeed, who taught was not always elder to the learner.

Some individuals are acknowledged by other members of the group—through their talk—as having particular expertise. For instance, many volunteers refer to Jen as a "natural teacher," being particularly knowledgeable about marine organisms. She enacts this role carrying field guides and responding to opportunities, such as a direct question or when an marine organism fortuitously emerges from under the eelgrass, she shares her understanding with others. Again, Jen's participation is an emergent feature of the

setting. Had she been in a different setting such as a golf tournament, she probably would have participated in very different ways and I would not necessarily find out that she is particularly knowledgeable about marine biology. The presence of individuals such as these (diversity) is characteristic of heterogeneous settings and can greatly increase opportunities for action, and thus learning.

4.4.3 On being on/off-task

In traditional schooling, if an individual is not performing their prescribed role they are considered to be off-task and therefore not learning. To be on- or off-task are important categories for establishing whether students participate in school tasks in the way teachers design them (Lee, Kelly, & Nyre, 1999). There are doubts, however, whether off-task behavior and the often-associated attention deficit hyperactive disorder (ADHD) are predictors of competency. For example, a recent report shows that a student who was considered to be chronically off-task and labeled ADHD actually outperformed his peers on very similar tasks in an out-of-school context where a myriad of resources (social and material) were at his disposal *and* where he was in control of the means of his learning (Roth & Barton, 2004). In an open learning setting not unlike that described here, the student was enabled to participate in different ways, in ways that transformed his identity from learning disabled to peer teacher. Through my analyses, I learned that individual attributions of being on- or off-task would be artificial and meaningless in informal settings and do not correlate with individual or collective learning. Thus, during the eelgrass-mapping event there were volunteers who *appeared* to be off-task (if I take the traditional view) because they were not directly participating in the mapping; however, it turned out that they participated in relevant and significant ways toward achieving the collective goal.

Throughout the day, individuals participated differently and the forms of their participation sometimes shifted from moment to moment. My video footage shows, for example, how two individuals in particular—who seemed to be participating very little in forms such as counting and measuring eelgrass shoots and identifying flowering shoots—actually contributed concretely in different ways. Thus, Josef and Natasha could be seen standing and chatting throughout most of the day. Before everyone had arrived and the mapping activity was underway, Josef engaged the research crew, Samantha and two volunteers, in talk about local natural history. Josef emerged as a storyteller not only through his telling of stories, but also through the recognition of volunteers who constitute a shared history.

Transcript 4

Cathy:	hey guys!
Andrew:	hi Cathy
Samantha:	Cathy!
Cathy:	how's it goin?
Andrew:	we're organizing
Samantha:	Josef's telling us stories
Cathy:	no!
Andrew:	would you believe that?
Cathy:	he never does that
Andrew:	never does that
Josef:	a couple of people the other day referred to it as enjoying my monologues…

It is obvious from the conversation (teasing) that Josef is known for his stories. Aside from telling stories in the beginning, Josef has had a brief conversation with one of the crabbers and provided the Finnish and colloquial name of the beach for the data sheet. Other than that, he did not *seem* to do much. However, there were at least two ways in which he participated that were important contributions to the collective goal of mapping eelgrass. First, even though he had to leave part way through the mapping activity his presence endured, in the following transcript Samantha re-invokes Josef's participation at

the end of the activity when all of the volunteers gathered together to talk about the importance of eelgrass.

> There's lots of stories you hear from, you know, from some of the long time residents, well Josef just telling us today even some of the local areas where there are other things happening in the ocean environment that could be effecting the eelgrass beds, putting them into decline.

Given that the ultimate goal of the day is to map and possibly restore eelgrass habitat, having local knowledge about the history of its decline is of paramount importance to the project because this history is largely unknown and unavailable in official records. Second, given that Josef is a storyteller it is almost certain that he will talk to others about the day. Given that raising awareness is one of the major goals of eelgrass stewardship, Josef participates in the collective in a very relevant way. In fact, a month later he responded to an invitation by Samantha to attend a meeting to identify future potential mapping and restoration sites.

There are other examples in my video footage where individuals, who *seemed* to be participating only minimally in the actual mapping activity, yet who turned out to be crucial to the success of the day. Natasha, who spends most of the time conversing with Josef, participates by helping her daughter Mandy keep count of eelgrass. In the following vignette, Natasha inquires about the appearance of flowering shoots giving Mandy and Jen an opportunity to articulate their understandings by explaining, which stands in a dialectic relation to understanding. That is, to understand one must explain but at the same time one must have a practical understanding to explain (Ricœur, 1991; Lee & Roth, 2005).

Transcript 5

01	N:	so what do they look like when they're flowering?
02	M:	they have they look like wheat
03	J:	that's a very good way to say it …they feel much thicker…that was something I was wondering about is because you can actually feel but you may not be able to see it like and so you'd get some difference . . . are you allowed to count those? And is everybody counting those cause that could bring the margin of error in right
04	L:	well you make sure that it's branching
05	M:	found one
06	L:	because they could be starting if you can feel one that's kinda round
07	J:	yeah
08	M:	see mom ((Natasha))
09	L:	it could be starting
10	N:	oh okay
11	L:	but you wanna go with the ones that are at this stage
12	N:	you're right it does look like that
13	J:	at that stage okay
14	L:	and they're kinda yellow, more yellow and like she said…and this is kinda round so
15	M:	just feeling it
16	J:	feeling it seems to be easiest way eh

Natasha participates by enabling Mandy and Jen to potentially deepen their understanding of what constitutes a flowering shoot. Her question (turn 01) elicits explanations from Mandy (turn 02, 08, 15), Jen (turn 03, 16), and Leanna (turn 04, 11, 14) who serve as resources for everyone else. At the same time, the conversation turns out to reveal the problem of what counts as a flowering shoot. In and through inter-actions with different people and through explaining, Jen deepens her understanding of what constituted a flowering shoot. Here again, there are multiple teachers, their participation shifting from moment to moment, including the teenager Mandy teaching those elder to her.

4.5 Pervasiveness of knowledgeability (learning, teaching) in everyday settings

In this study, I am centrally concerned with how learning and teaching comes about in heterogeneous (informal) settings exemplified by a particular everyday activity in an environmental stewardship group. The purpose is to construct answers to three main

questions: "What and how do people learn by participating?" "Who are the teachers and how do they teach?" and "What is the role of problems in learning?" My analyses highlight the distributed nature of knowledgeability, spread across both people and things, as no one person would have been able to carry out the mapping single-handedly and without the tools the task would have been impossible. More importantly, because individuals like Jen and Samantha framed issues and had control[15] over the transforming object (eelgrass) important questions surfaced like, "what counts as flowering" and " is everybody counting those?" These questions have implications for the collective who has the potential to learn from these individual resources.

Understood as an increase in opportunities for action, learning is an outcome of the mutually presupposing relation between social and material resources within the activity as a whole. In other words, the activity as a whole is the mediating element, the irreducible unit within which knowing, learning, participation, and so forth are meaningful. Volunteers identify problematic issues concerning classification, through locally emergent *inter*-actions with the eelgrass (material) and other volunteers (social and material bodies). As an outcome, the object of inquiry (eelgrass) undergoes transformation—from unproblematic counting of shoots to the emergence of various stages of flowering—at the same time transforming individual (and collective) understanding.

In addition to drawing on the resources that are on hand, Jen and the others also constitute and therefore enact control over the setting. Thus the setting itself is unfolding, not only mediating the actions of those present but itself being mediated by the actions.

---

[15] Here control refers to individuals being able to identify and utilize the means by which they participate in an activity. It does not mean that individuals control or dominate others.

The perceived setting undergoes constant change as volunteers expand their action possibilities. The ways in which volunteers participate themselves are emergent outcomes of the activity. Even the roles of "teacher" and "learner" are not established beforehand but are the products of *inter*-actions.

4.6 What science educators can take from learning in informal settings

Informal settings provide a unique opportunity for understanding the ways in which people learn out of school. In such settings, participants pursue goals and in the process expand their action possibilities, which means, they learn those things required to get the task done. Given this broader understanding, educators can design school programs that more closely resemble the kinds of settings that students encounter out of school and after graduation. There have been suggestions and evidence that by concretely realizing the societal motive for environmentalism and being in control over object/motive and tools, students are inherently motivated and come up with a variety of sophisticated analyses (Roth & Lee, 2002; Roth & Barton, 2004). Most often, however, school science lessons have only a modest structural resemblance to everyday out-of-school situations in scientific labs or fields. Furthermore, there is evidence that less school learning is actually transferred into the everyday world contrary to the declared legitimization of schools and schooling (Holzkamp, 1993; Lave, 1988).

Some readers may think that this was an unsuccessful day because in the end there was ambiguity surrounding the classification of flowering shoots as initially framed by Samantha and Jen. However, biology experts in the field also encounter these kinds of problems: a group of fisheries biologists with B.Sc., M.Sc., and PhD degrees failed to come to definite conclusions when faced with a particular specimen in a river that was part of their familiar research environment (Roth, 2005a). In this particular case, the

biologists ended up abandoning the classification task because they could not adequately classify the fish. Failure is as much a part (and sometimes the most pervasive outcome) of everyday out-of-school activity as is success. What is more important is that people have the *opportunity* to engage in classification and articulate what it takes to become competent. Research on open-inquiry learning environments supports the contention that students learn precisely when they learn to cope with the indeterminate nature of activities (Roth, 1995).

My research also suggests that science educators need to reconsider the on-task/off-task classification as indicative of engagement and learning. Following volunteers who seemed to be off-task revealed that they made important contributions to the collective goal of the day. Josef's participation persisted even though he was absent and Natasha elicited others to explain their understandings, thus deepening their own learning and serving as a resource for others to learn. If educators track their students throughout the day(s) and through different subjects they may find that students participate in different ways in different sociomaterial settings, an indication that learning is contingent on setting. Heterogeneous settings with a variety of social and material resources allow for numerous participatory modes. Thus, I suggest that educators might want to set up *situations* that facilitate a variety of participatory modes—an approach more consistent with the democratic ideals of Western societies (Roth & Lee, 2004)—rather than focusing on changing *individual* behavior.

My analyses imply that individuals are constitutive of the setting. They both respond to but also transform the resources available. If educators only attend to the material situation this would be insufficient. As the volunteers exhibited in their actions, the object

(eelgrass) transformed—from a bundle of green blades to a number of developmental stages—as the activity unfolded. In the beginning, one of the trainers assumed that her explanation of a flowering shoot was sufficient, only to learn that there were more forms of eelgrass than she anticipated. Therefore educators might want to *assume* a variety of interpretations of their explanations and embrace uncertainty as discoveries can be made that were not anticipated beforehand. In this light, it makes more sense to evaluate the process of individuals' participation in and contributions to the ongoing activity, rather than on "outcome" and individuals possessions of concepts and skills (Rogoff, 1997).

I finally suggest that science educators provide a variety of sociomaterial resources for their students, including access to people of a broad range of expertise and age. Educators should also consider facilitation as a form of participation rather than teaching directly, at the same time allowing students to teach each other because as I have shown explanation leads to a deeper understanding of the nuances of a phenomenon. Similarly, when designing learning environments sociomaterial resources should not be considered to determine desired outcomes on the part of the teacher (curriculum) as individuals draw on and constitute these resources in differing ways.

Chapter 5

Stabilizing Performances: The Emergence of a Community Eelgrass Mapping Network

Abstract

The purpose of this chapter is to document the emergence of a network of stewards concerned about protection of marine habitat along the coastline of British Columbia, Canada, generally and about the protection of a flowering plant called eelgrass (*Zostera marina*) particularly. By engaging with professional biologists, government scientists and representatives, volunteers, eelgrass and various mapping tools (quadrats, measuring tapes, Global Positioning System, underwater cameras), these stewards contribute to the generation of "legitimate" ecological knowledge and work to convince their communities and governments that eelgrass is worth protecting. My two-year ethnographic study began in the second year of a project that was designed to train twenty community coordinators how to map and monitor eelgrass habitat. The coordinators were faced with highly complex social, cultural, political, historical, and material landscapes—which made me wonder how it was possible for the complex network to hold together (stabilize) while extending its reach. I provide evidence to support the claim that the network became more stable and extended by particular performances. These performances emerged from an agency|structure dialectic, in which the network was both resource for and object of its activity. In the process, (a) knowledge produced also is made to move and do something, (b) coordinators and scientists involved act as knowledge brokers between their various communities, and (c) communication between coordinators and scientists is enabled and maintained.

5.1 Introduction

The public understanding of science is of interest to researchers in a variety of domains, including science education and science and technology studies (STS). Research in these disciplines suggests that it may not be so fruitful for researchers to be preoccupied with how the public comes to understand science or construct scientific knowledge; rather it may be more revealing to study science/public hybrids in-the-making (Lee & Roth, 2003b; Ellis & Waterton, 2004). It is more fruitful to rethink scientific literacy as an emerging collective property rather than in terms of minimally required standard pieces of knowledge that *every* individual in a given group should know. Such a reconceived literacy has been shown to nurture the potential for lifelong participation in and learning of science-related issues (Roth & Lee, 2002).

STS scholars have long visited the sites of scientific research and, rather than arguing how science should proceed, they told ethnographic stories about the ways in which science is actually practiced (Law & Mol, 2000). This is the approach taken in my two-year ethnographic study, the purpose of which is to understand how a particular environmental stewardship network emerged in order to bring about positive social change to activities that damage marine habitat, in particular eelgrass meadows.

As pertains to most environmental organizations, scientific expertise in the network I researched is the principle form of legitimization (Yearly, 1996): the network employs scientific methodologies and generates scientific representations to advocate for nature. However, more interesting than the scientific knowledge that is deployed in and constitutive of a network are knowledgeable performances that get things *done* and how science/public hybrids are *practiced* in an adverse (political, ecological, economic) climate. The adversity comes about as (a) governments devolve responsibilities for

conserving ecosystems (e.g., West Coast Environmental Law Association, 2005), (b) the non-profit environmental sector as a whole is undergoing a funding crisis (Finding Solutions Network, 2004), and (c) small coastal communities are grasping for economic opportunities that may or may not harm the environment.[16]

In an effort to transform those social practices that are detrimental to local contexts and people, non-scientists have become participants in constructing various kinds of—and including scientific—knowledge (e.g., see Epstein, 1995). In the present context, this means knowledge about the distribution of eelgrass and what actions might be required to conserve it. While other studies look at how governments initiate public participation models for conservation policy in the UK (Goodwin, 1998; Ellis & Waterton, 2004), I investigate an example of grassroots initiated public participation in habitat conservation in Canada.

This grassroots network of community coordinators, professional biologists, government employees, places, and habitats came about to respond to a perceived gap in knowledge about the distribution of eelgrass along the Pacific coast of British Columbia, Canada (see Figure 2.1). While I was particularly interested in finding out how the network managed to hold together in the face of adversity while expanding its reach, I do not suggest that the network has finished becoming—over the course of the first three years its reach has extended into new regions while retreating from others, behaving much like its own object: eelgrass forms complex networks of underground rhizomes that continually expand and renew themselves while fragmenting and disappearing from other sites (Precision Identification, 2002). I do not know what will happen to the network after

[16] Many small coastal communities are divided on the issue of economic development such as salmon aquaculture and off-shore oil and gas exploration (McAlpine, 2005).

this study is completed—which actually is an advantage because I report on an open rather than a closed case and therefore do not have (inappropriate) recourse to teleological explications.

I can show, however, the strategies employed to make things "hold together" (Mol & Law, 2002, p. 10), how they avoid the decay and disappearance of the network in some cases, and how the network manages to expand despite facing precarious funding and resources. I also show how joining the network affords individual stewards and their communities greater agency, that is, increased possibilities for action and control over their life conditions. But the network also is in a precarious state, requires continual maintenance, and the action possibilities are not necessarily distributed evenly across the network. Indeed, it initially was an intended outcome of the network to provide equal access to resources and expertise to all those involved.

Understanding networks

As I explained in Chapter 1, networks constitute processes rather than merely relations between fixed entities that denote given order of things. In other words, links and nodes do not exist in and of themselves, but they are *both* resources *and* results of network processes (Law, 1997). Indeed my ethnography of the eelgrass mapping network shows that coordinators (nodes) do require support from other nodes—sometimes just finding out what other coordinators are doing—to maintain the momentum of their individual projects; and their very being as nodes presupposes something to be coordinated, a network of nodes. The coordinators consistently talk about the need for knowledge, embodied in its various forms (maps, methodologies, data, people), to move, to do something.

To describe the network, I borrow the notion of a *fluid social topology* (Mol & Law, 1994). It is the flow, the existence of the fluid material that produces social phenomena and their stability rather than the existence and presence of particular actors. Where I diverge from this social topology is in the existence of particular actors in the network who play stabilizing roles. I call these actors *knowledge brokers* because of the function I have observed them serving in the network. The eelgrass network is fluid in that it is always in a process of becoming *and* stabilizing and thus the question of whether the network could ever be stable is an unanswerable one. This is why I avoid the use of the term "stable" to characterize the network because it denotes rigidity and stasis. Therefore, I use the verb "stabilizing" and the phrase "more stable" interchangeably to explain processes that correct potential instabilities. I consider the network to be more stable when individual and collective actions continue to realize the object of the network—eelgrass stewardship.

5.2 Eelgrass mapping: history of an emergent network

The eelgrass-mapping network began as an idea in the office of a government employee whose job it was to develop stewardship projects that correspond to the mandate of the department. A scientist in the same department suggested that someone should study eelgrass. The government employee already had approved a grant to SeaChange Marine Conservation Society, which had recently recruited volunteers from the general public for an eelgrass restoration project. The executive director (Project coordinator) of SeaChange, agreed to apply for funds to coordinate and administer the two-year pilot run of the B.C. Coastal Eelgrass Stewardship Project (the Project). Along with the eelgrass biologist, the Project coordinator initially intended to train 12 groups within the geographic area, the southern Strait of Georgia (see Figure 2.1). However, the

word about the Project spread to other communities leading to an additional nine groups expressing interest. This prompted the Project coordinator to "make the boat bigger," by increasing the number of groups involved, which at that stage amounted to 20. The groups are spread over a large geographical area and the northernmost community is several hours by plane away from the seat of SeaChange, which is located in Victoria, the southernmost city.

The extension of the network began with the Project coordinator and the eelgrass biologist, who traveled along the coast training participants in the twenty groups over two years. The main focus of the training workshop was to increase the knowledgeability of participants concerning the mapping and monitoring of eelgrass habitat (see Table 2.1 for summary of activities engaged in by groups/individuals).

5.3 Eelgrass network: A dynamic of agency and structure

A consistent feature of the network is its complexity, which can be understood as existing in different layers and coordination. Over the course of two years, 20 non-profit community groups (mostly stewardship and conservation groups) took training courses that expanded their knowledgeability[17] required for mapping and monitoring eelgrass (a flowering saltwater plant) populations and carried out education and stewardship activities. The coordinators of these groups had to become familiar—some more than others—with the complex terrain of their communities (e.g., whereabouts of volunteers, resources, and sites to map) and with the process of becoming a part of a coast-wide network (e.g., reporting responsibilities, posting data on a central website). I am therefore interested in the various *stabilizing performances* that were enacted by members of the

network in order to manage multiple layers of complexity and hold the network together. Uniting *stabilizing* and *performance* is meant to stress the dynamic nature of the emerging network: in the process of becoming a collective, ordering practices were necessarily employed to provide stability while at the same time the ephemeral, unpredictable, improvisatory and always contingent "performance" (Szerszynski, 2003, p.3) encouraged innovation.

To understand how change and stability comes about in the eelgrass network, I turned to the dialectical relation of agency and structure (Sewell, 1999). Agency is the capacity inherent in all humans that allows them to exert some degree of control of and transformation of the material and social relations in which they are immersed—we are not just subject to life conditions but are in the position to exert control over them, mediated by the resources that are at hand. The amount of agency a given person has is related to the amount and kinds of resources that are available to them. Sociomaterial resources make up structure, which again is made up of all entities in the activity system triangle (Figure 1.2 (c), p. 11). Agency is spread across the subject and object of activity enabling the subject to act and transform the object—not forgetting also that this relation is mediated (dialectically related) by all other entities in the activity system. In order for an agent to make decisions about what actions to take, they must have knowledge about what the action possibilities are. Therefore, a further distinction in the agency|structure dialectic needs to be made. *Schema,* the knowledge of resources (through practical everyday experience) and how to act in culturally learned ways in relation to those resources, is a constituent of structure along with resources (Figure 5.1). The double

---

[17] I prefer the use of "knowledgeability" because it refers to knowledge-in-the-making embodied in individuals and collectives rather than a static notion of knowledge as properties of individuals.

sided arrows denote a dialect relation, thus there exists a double dialectic: between agency and structure and between schema and resources.

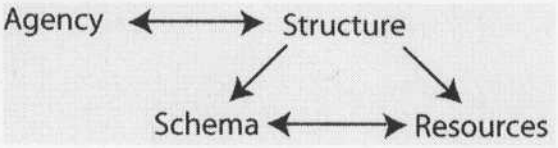


Figure 5.1. Double dialectic relation between agency and structure

The following excerpt, taken from an interview with a community coordinator, illustrates this relation.

> What the eelgrass project has done has expanded my understanding of a given habitat to the point where I have much more knowledge of it . . . I now also have an idea of some of the possibilities for conserving it in the future or I've made connections now that empower me to maybe go further in effecting the conservation of that habitat so I know where the voices are that are listening, who are the organizations that I can go to . . . so I've been empowered in the sense of this particular habitat called eelgrass, I can now be more effective in conserving it because I now have the contacts to do that with through the project, so I feel empowered in this specific habitat. (Community coordinator)

This community coordinator talks about having more knowledge of eelgrass habitat since participating in the project, and that knowing what she does now will enable her to act in the future. She also suggests that knowing who to talk to and what organizations to contact are important aspects of conservation. The project afforded the coordinator more possibilities to act then and subsequently, thus increasing her *agency* in the context of the eelgrass project. Her knowledge of possible actions point to such resources, some of which are sociomaterial[18] *resources*, such as voices that are listening, eelgrass habitat, and other organizations and *schema*—knowledge of how to go about conserving eelgrass.

Throughout this chapter I do use the noun, knowledge, but think of it in the active sense.

[18] I use the adjective sociomaterial, because it makes salient that all resources exist twice, in the material world and in consciousness, which is always mediated by human social nature (e.g., Leont'ev, 1978).

Resources and schema together constitute *structure* that is in turn dialectically related to agency (Sewell, 1992).

Internal to a dialectical conception of agency and structure are contradictions (which occur at the level of consciousness) and resistance (which occurs at the level of materials). Responses to material resistances and salient contradictions are the drivers of change in a system. In the eelgrass network, participants, enacted stabilizing performances individually and collectively in the attempt to overcome resistance and resolve contradictions. For instance, a number of coordinators expressed interest in mapping an exotic species of eelgrass (*Zostera japonica*) that they identified in their area. They encountered *resistance* over the course of mapping eelgrass: the presence of *Z. japonica* resisted inclusion into the current mapping methodology and they were concerned that it should be mapped. Aware of available resources (i.e., supportive eelgrass biologist, unmapped *Z. japonica,* mapping manual) and enabled by their agency, the coordinators voiced their concern to the eelgrass biologist spurring her to develop a specific methodology and update the existing manual. The stabilizing performances directly arose from the agency|structure dialectic, making holding and change possible in the network.

All participants in the eelgrass network played a role in making up its structure and it was their actions that extended, shrank, or maintained it. This was, however, an emerging network so that the participants were all implicated in structure-in-the-making. This new structure became a new resource for action in ways that could not be anticipated; the action possibilities and therefore the type of agency changed as the structure evolved. Analyzing events and inter-actions between participants in terms of an agency|structure

dialectic therefore assisted me in understanding how changes in practices came about for the network to emerge.

5.4 Stabilizing performances

This study was designed to understand the emergence of a grassroots movement that has made eelgrass conservation its object of activity. My central claim is that in order for the network to hold while continuing to extend, members had to enact—consciously or as a matter of course—stabilizing performances and that these performances arose out of a dialectical relation of agency and structure. Out of this relation I show how stabilizing performances serve to maintain the fluidity of change while holding the network together. They include: collecting and producing information or data and making *knowledge flow*; the actions of *knowledge brokers* who facilitate knowledge flow, and the maintenance of *communication* between members.

5.4.1 Making knowledge flow

The central practice of the network is knowledgeability production, in particular in relation to the whereabouts of eelgrass habitat. However, the function of that production is far from singular; knowledge about eelgrass is enlisted to do several things and also is made to travel. This movement (flow) of knowledge embodied in people and texts creates more stability in the network and thus constitutes a stabilizing performance, as has been shown in the context of a community ENGO concerned with watershed health (Lee & Roth, 2003b). I support my claim by analyzing interviews with members but also draw from my ethnographic study as whole. Knowledge flow not only was observed from my outside perspective—an *etic* (Geertz, 1973)—but also was noted from the emic (inside) perspective of the network members who talked about it.

> It's often that you have a workshop or a meeting . . . and people put a lot of energy into making suggestions and then nothing gets done right. So that was something I really wanted to make sure that we followed through with. First of all we posted the report on the web. I made sure all the participants and community members knew it was there, that they could see the outcome of their time and energy. Not only that but then the eelgrass project came up and us being able to go out and have a project that was in some way rather than a passive, sitting-in-a-room-talking-about-it, it was a very active exercise. And it's those kind of exercises that are wonderful because they're cooperative, they're hands on, they're tangible sort of results. (Community coordinator)

In this interview excerpt, a community coordinator talks about a workshop that she organized at the community level and reported on before joining the project. The workshop was designed to involve the public in identifying issues and making recommendations about the health of an estuary. It just so happened that the Project matched one of the priorities identified by the community: eelgrass restoration. She talks about workshops or meetings where nothing gets done and energy is wasted. She expresses the idea that knowledge should flow around a meeting; it also should go somewhere else afterwards. In addition to knowledge moving, she talks about people moving and that active engagement gives more tangible results. Thus, it was also important that the knowledge people embody move about.

All in their various ways, the individuals interviewed for this study—community coordinators, biologists, and government representatives—talked about making information or data move. Figure 5.2 provides a visual representation and summary of inter-actions (knowledge flow) between the networks of groups and the individuals and organizations that supported them. Activities that constitute knowledge flow range from sending an email or making a phone call to organizing a public event or attending meetings. Although it was the role of scientists in the network to train community coordinators, knowledge did not flow in one direction (see double arrows in Figure 5.2). Over the course of the project community coordinators made suggestions that were

incorporated into the draft mapping methodology. Furthermore, the eelgrass biologist learned about what it takes to do stewardship citing, in an interview, the challenges of organizing and keeping volunteers.

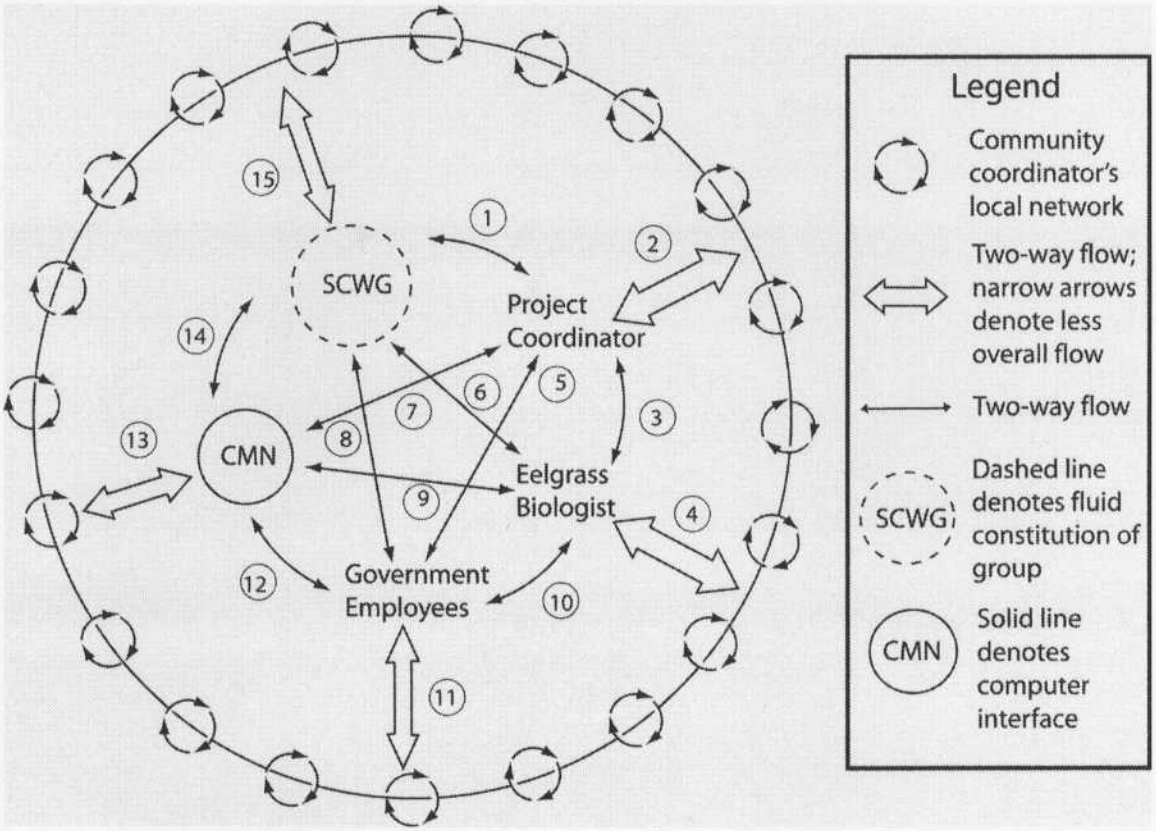


Figure 5.2. Representation of knowledge flows between the eelgrass network and other Project participants (figure continues on following page).

1. Project coordinator (PC) chairs SCWG; PC brokers knowledge between community coordinators (CC) & SCWG; SCWG supports & facilitates decisions PC makes about eelgrass network
2. PC conducts training & administers funds for CC's; gives presentations in CC's communities; PC helps with mapping; PC conducts site visits; PC readily available for support; CC's help with making decisions about network; CC's share history of eelgrass, community, politics; CC's produce resources that PC can distribute to network
3. Eelgrass biologist (EB) & PC conduct joint trainings; EB advises PC on decisions about eelgrass network; PC advises EB on nature of stewardship work
4. EB developed mapping methodology; conducts training; EB readily available for technical support; EB volunteers for extra training and support; CC's provide feedback on training & mapping methodology; EB responds to CC's feedback
5. PC receives funds from government to run project; PC receives advise from government employees (GE); GE learns how to broker their knowledge to CC's through SCWG meetings called by PC
6. EB core member of SCWG; scientific advisor to SCWG; EB reports on conferences & other meetings
7. PC produces resources (newsletter) to be posted on website; CMN provides training & website support for CC's through PC; PC refers granting agencies to site
8. One GE(#) is a core member of SCWG; GE# disperses small funds for resources for SCWG & the network; GE# broker between SCWG and government; other GE's serve as advisors to the SCWG, provide mapping support to network, & provide small funds; SCWG provides good public relations for GE's
9. EB developed mapping protocol to be posted on CMN website; CMN provides high profile for EB
10. Collaborate on decision-making associated with SCWG & eelgrass network; GE's provided feedback on development of mapping protocol
11. GE(*) developed mapping data entry tool on CMN for the network to enter their data; GE* provides free data entry workshops; GE* assisted a CC with mapping techniques; CC's provide feedback on efficacy of CMN website
12. GE* & another GE manage the web site & continuously refine it; some GE's use data on the CMN for their work
13. CC's input mapping data onto CMN (but not all); some CC's use CMN site to print off their maps
14. SCWG reports posted on CMN site; SCWG provides some funds for CMN (non-profit)
15. Some CC's participate in SCWG meetings; SCWG decision-making driven by CC's; SCWG supports & facilitates work of CC's

Note: Contents of figure are a sample of inter-actions based on interviews and therefore do not exhaust all possibilities. All community coordinators interacted with the Project coordinator and eelgrass biologist, but not all interacted with government employees, Seagrass Conservation Working Group (SCWG), and the Community Mapping Network (CMN).

Figure 5.2 (continued).

Knowledge flow also was talked about in terms of absence of flow or stagnation and manifested itself as structural resistance within the network. Thus, absence of flow or stagnation can be considered network destabilizing performances that if, left unchecked, could presumably fragment the network. A community coordinator articulated such a resistance: "[the government employee] was saying that there's people that are like me who have this data recorded but it's not getting on the [web]site so it's no use to anybody right and I need to get that out there." She was not satisfied with just getting data recorded, she wanted to see her data on the Community Mapping Network (CMN) website, but "it's not getting on the [web]site." This website was designed to enable community groups to enter mapping information online and produce maps to be publicly available (governments, industry, citizens) for use. Thus a section of the website is dedicated to eelgrass, but some coordinators have had problems.[19] The quoted coordinator encountered *structural* resistance in her practice: she knows where she wants the data to go and she is aware of resources available to her (online data entry tool, mapping manual), but the website required more knowledgeability than she had. Previously in the interview she talked about trying to get help from the government employee with entering data online over the phone, but she subscribed to a dial-up telephone internet service, making this interaction frustrating.

Although drawing on the available social resources expanded her agency, the latter also was truncated because the coordinator did not have access to adequate material resources (i.e. high-speed internet). Not only this coordinator experienced resistance in

---

[19] For example, one coordinator became frustrated after she had entered a large amount of data into the website data "fields," pressed back button (which was supposed to be a unproblematic command) and lost all of her data. The feedback of these coordinators has led a government employee to improve the website.

the structure but also others: While providing a resource to their agency, the network (through its communicative resources) also constituted resistances that inhibited its unfolding and performance (i.e. website failure, computer avoidance). Over the course of the interview the coordinator said that she offered to travel to the government employee to receive the online data entry training. This type of action, therefore, constitutes a stabilizing performance and it was this action that had the potential to overcome structural resistance (at the time of the interview she had not yet traveled).

I do not mean to suggest that such action will resolve all resistances, indeed it is resistance inherent in a network that constitutes a driver of change when participants become aware of it, at which point they have to deal with the contradictions. It is also important to stress that the coordinator's actions were not isolated: her agency and the perceived resources were also at the same time collective agency and resources. The government employee's agency and role as a social resource was enmeshed in her agency during the performance that had stabilizing effects.

It also happened that data flow was sometimes too slow for the central goal of the eelgrass network—to collect existing eelgrass maps and map new areas along the entire coast of British Columbia to influence marine conservation decision-making. Government staff from different federal and provincial agencies (who are members of the Seagrass Conservation Working Group) had complained for a number of years about trying to get maps from another provincial department that had been mapping the coastline for the past 20 years. The maps contained information on the potential location of eelgrass beds, but the department claimed that the data was not ready to be released. Eventually the eelgrass network gained access to the maps, now hosted on the CMN site,

but there was a lot of frustration when the information did not flow fast enough. However, even though many individuals encountered such resistance, it was not a uniform resistance, as one community coordinator was able to convince individuals in the provincial department to allow her to view (not take) the mapping data regarding another project she was engaged in.

Knowledge also was made to flow to locations where there was a perceived absence of it, to fill apparent voids.

> The provincial government is pretty good at thinking up recommendations . . . but there's not a whole lot of support because if you don't have good information to follow those guidelines . . . you're not much further ahead. And we started the Community Mapping Network with the intent that we'd facilitate that information management sharing because we could see how dysfunctional it all was. And . . . it's quite easy to do a lot with very little resources if you're clever about it. (Government employee)

The government employee talked about the beginnings of the CMN website and that he and others started the site to facilitate information sharing. This series of stabilizing performances—the website has gone through several iterations to improve it—was initiated to fill an absence, that is, the need for 'good information' for local governments to make better land use decisions. Filling in perceived gaps of knowledge about the whereabouts of eelgrass was one of the major drivers of the project; the mapping activities in which the community coordinators engaged therefore constituted stabilizing performances that filled in spaces. These performances clearly had political effects: To protect the habitat, the federal department *Fisheries and Oceans Canada,* which has the mandate to protect eelgrass sites as fish habitat, needs to know where eelgrass grows before it can enact processes that lead to its protection. Unless eelgrass was made visible through the actions of the coordinators (mapping and public education), developers could destroy it if they neglected to report its existence. Once again there were structural

resistances where spaces needed to be filled, however, these performances were not uniform. Some coordinators had problems getting data on the CMN site while others used alternative resources to print their maps and used them locally, thus stabilizing their local network.

Community coordinators also talked about collecting data or information to fill in "data gaps." One coordinator in fact decided to participate in the network, thereby constituting its enlargement, because there was nobody else doing eelgrass stewardship in her geographical area. Eelgrass data was also layered with other kinds of data. For example, one coordinator said that information on eelgrass would add to other kinds of data that she gathered in an effort to have a series of reefs federally designated as a Marine Protected Area (MPA). As this last example revealed, most of the coordinators' knowledge-generating practices were part of smaller networks that they cultivate in their own communities. This further rendered the eelgrass network more complex, because coordinators were occupied with stabilizing performances of the eelgrass and other interconnected networks. This makes the stabilizing performances of knowledge brokers even more important for holding the network together and to undercut any destabilizing tendencies.

The practices that are employed to make knowledge flow are network-stabilizing performances. I am cautioned by the agency|structure approach to think of these performances as enabled by the network, which also is the outcome of these performances. However, I do not want to give the impression that *all* activities, like meetings, are stabilizing performances: as a form of inner contradiction in the network

building and sustaining performances, some coordinators referred to meetings as "paper shuffling" exercises, especially when they felt that very little was accomplished.

5.4.2 Knowledge brokers

This study provides evidence that the performances of particular actors in the network, *knowledge brokers*, who held the network together, thereby stabilizing it while enabling its extension. The knowledgeability of these actors made knowledge flow and in the process translated knowledge across situations, which in turn made the work of these knowledge brokers successful. Strategic brokers are individuals who not only bring others together but also have a vision, the networks, and the practical implementation skills to move issues forward, and get work done (Larner & Craig, 2005). Like the eelgrass network's knowledge brokers, these authors point to moving knowledge along. Unlike networks subject to the all-encompassing power of one Machiavellian actor (e.g., Latour, 1987), many different actors stabilized the network.

In the eelgrass network there were a number of knowledge brokers who worked within different "cultures" of the given societal space. There were those, mostly community coordinators, who mediated between communities and the goals and collective knowledge of the network as a whole, which was in turn facilitated by decisions made by the Seagrass Conservation Working Group (SCWG). Government employees brokered knowledge between government interests and the SCWG; and the eelgrass biologist brokered knowledge between the science community and the SCWG (see Figure 5.2). These mediations were largely informal as some coordinators corresponded directly with government employees or the eelgrass biologist and vice versa. In turn, I elaborate on the knowledge brokering activities of community

coordinators, the Project coordinator, the eelgrass biologist, and various government employees.

5.4.2.1 Community coordinators

As mentioned, community coordinators (one per community) managed their own local networks in addition to being members of the eelgrass network. The diversity of the communities that the coordinators found themselves working in and the diversity of issues that presented themselves made the Project network unique. The various brokering roles involved organizing volunteer mapping opportunities, workshops and events, approaching local governments, talking to fishermen on a local community dock and networking with other volunteer groups. For the most part, the work of the coordinators emphasized their existing knowledgeability, as public educators, field technicians, activists, biologists, or combinations of these functions. In the interviews, the coordinators talked about how much they learned (or needed to learn) about eelgrass biology and stewardship. The following excerpt from an interview is but one example of the kinds of things coordinators learned in order for them to do stewardship activities, including local network building.

> It's been a very steep learning curve for us about learning about the environment and about the issues, learning about basically how it all works . . . both naturally and how a lot of it works [from an] engineering perspective. Also how it all works politically, bureaucratically, and then it's also been a steep learning curve just making contact with people and knowing people and who could do what, who is doing what and where we interface and so it's been a perpetual motion machine. (Community coordinator)

This coordinator was particularly interested in focusing her energy on bringing people together and creating training opportunities for volunteers, university and college students, and other members of the network. So she hired others to do mapping activities. She also articulated the assemblage of different forms of knowledgeability that her group

embodied, as it consisted of individuals knowledgeable about the natural environment, engineering, politics, bureaucracy, and the whereabouts of particular people. As a knowledge broker, she attempted to keep track of, organize and move knowledge around in appropriate ways. She did not need to embody the particular forms of knowledgeability herself; but rather, she brought into play these different forms of knowledgeability embodied in participants and their relations. While some coordinators like this were talented at bringing diverse issues and people together, other coordinators were particularly savvy at mapping and were not so much interested in bureaucracy or politics.

Knowledge brokering activities—learning about the social, cultural, natural, and political dynamics of a place, networking with others, and mapping—are performances that tend to stabilize a network (Boyer, Roth, & Lee, 2003). In the eelgrass network, each stabilizing performance had the potential to increase agency, such as having recruited a sufficient number of volunteers to map an area, but they could also lead to more resistance and thus require additional stabilizing performances. For example, the Project coordinator attempted to secure more funding for the network but received several rejection letters; as a result, she looked at other avenues for fundraising. Knowledge brokering performances inherently were sociomaterial in nature: the products of performances constituted resources for local networks and the eelgrass network as a whole and these included tailoring of available resources such as brochures, data sheets and aspects of the methodology to suit particular needs, production of public education resources and displays for special events, and writing articles for local newspapers.

The coordinators were spread out along the B.C. coastline and they were members of different kinds of communities: some small with populations of around two to eight-

hundred and one in the hundred thousand range; some were small island communities and others were larger towns or metropolitan hubs. The following excerpt of an interview with a community coordinator is illustrative of some of the challenges that small island community coordinators faced.

> We're not incorporated . . . everything from keeping the Info Centre going, to the Rec Association going, to the Fire Department going . . . basically anything that's happening here is volunteer effort . . . and it's all the same people that are trying to do the juggling act and keep things together. . . . But on the environmental front, although people are really concerned there's also an element of anger and frustration and hopelessness, people are feeling like, "Why should we bother?" We did that with the stream work. How many hours did we spend in there assessing and working on these streams but what's the use if they're [salmon] just gonna come into the marine environment and be killed by sea lice. There's that feeling of futility and frustration so it's one thing to be telling them, "But eelgrass is so important for commercial species" if they're feeling like the commercial species are being destroyed. (Community coordinator)

This coordinator points to a number of challenges to carrying out eelgrass stewardship in her community, that is, most services are run by volunteers, the same people volunteer for multiple groups, and volunteers are frustrated that their efforts are counteracted by the detrimental effects of industry such as the sea lice from salmon farms that harm wild salmon. These are resistances to the coordinators' efforts to transform the marine environment-related practices that are detrimental to eelgrass habitat. This coordinator was a knowledge broker because she facilitated the extension of the eelgrass network into her locale. She identified the challenges and articulated a possible stabilizing performance: to get people engaged, "You have to make it really fun, really celebratory, so people will get something out of it, if it can help boost them." This particular coordinator was also responsible for a large geographical area spanning multiple inlets and islands inhabited by a sparse and dispersed population. The challenge of accessing remote and unpopulated sites spurred the coordinator to invite seasonal sailing tourists to report eelgrass sightings to her.

Coordinators from other small communities had similar constraints, but they were only responsible for mapping their islands. In the largest community multiple activities potentially impacted the shoreline generally and the eelgrass specifically; these activities include commercial and recreational crab fishing, sand castle competitions, and wake boarding. Another large community coordinator primarily was concerned with restoring eelgrass in an estuary impacted by former log booming practices.

5.4.2.2 The Project coordinator and eelgrass biologist

Though the Project coordinator was at the center of emergence of the eelgrass network, she was not a Machiavellian actor whose contribution produces and maintains the network. Rather, she served as a knowledge broker among knowledge brokers, stabilizing and extending the network. Together with the eelgrass biologist, she contributed to extending the network among others, by traveling to the communities and offering to them a variety of sociomaterial resources. As the administrator, the Project coordinator enacted formal brokering roles like dispersing funds, requesting quarterly reports from coordinators, reporting to granting agencies, conducting training (along side the eelgrass biologist) and providing some resources (i.e., quadrats, manuals, resource binder). Informally, she was invited by community coordinators to give presentations on eelgrass, help with eelgrass mapping and she attended conferences presenting the work of the network. In the first two cases, the Project coordinator served as a resource, brokering her knowledge with the communities and in the third case increasing the profile of the network thereby increasing potential connections to other networks such as research. The eelgrass biologist also brokered knowledge informally by giving presentations, responding to emails and phone calls from community coordinators, and attending SCWG meetings. Notably, her participation in and to the network was almost all

volunteered, including training where only travel and accommodation were paid for by the Project.

The Project coordinator and the eelgrass biologist nevertheless played key stabilizing roles. They were available to community coordinators for discussing the various challenges of carrying out the Project in their locale.

> I found that [the Project coordinator] was so good with answering questions, I'd fire off an email to her and if she was in town or at the other end of the computer she would be back to me the same day and if I had technical problems I could get a hold of [eelgrass biologist], same thing, really good, really good. (Community coordinator)

The availability of the Project coordinator and eelgrass biologist to respond to the community coordinators in a timely manner contributed to stabilizing the network. This was even more salient when the Project funding ended, forcing the coordinator to pursue other mandates. Not being available to play the knowledge-brokering role in the same way as before was articulated as a form of decay.

> I am feeling badly, not so much on a personal level but an organizational level, that I have not been able to sustain the kind of things that are needed to keep this kind of project alive and well, I don't have the capacity at the moment, so all day I've been talking with and dealing with [a community coordinator's] needs because she emails me and I can't get back to her. (Project coordinator)

This excerpt from an interview was taken at a time when the Project coordinator was receiving several rejection letters following her funding requests. However, not even a month later, sufficient funds were secured in a collaborative effort involving the Project coordinator, a community coordinator, and two government employees. This led to sufficient funds to organize an eelgrass conference and pay for travel and accommodation for all community coordinators. One and a half years after the Project funding ended, the eelgrass biologist told me that she was still receiving weekly emails from coordinators

(more so in the summer field season). Indeed, these stabilizing performances seem to be holding the network together even though funding for the whole network ceased.

5.4.2.3 Government employees

The knowledge brokering performances of particular government employees helped to hold the network together, in particular their ability to listen to the needs and concerns of the Project and community coordinators and facilitate decision-making processes.

> I see it [my role] as a support role . . . as in my own attendance at meetings and the knowledge of other programs. And what's going on to bring to the meetings but also to bring resources where necessary. But we can't lead in them . . . the Community Mapping Network and the SCWG are necessary, they're really good initiatives and they do a lot. They get a lot accomplished and the input is mostly time, you need a person to be there. . . . I am [government agency's (GA)] eyes and ears there and . . . [I] can translate both ways our needs and the needs of the group . . . what it's [GA] willing to do and also take back the interests of the group back to [GA]. So it's a liaison role, it's a support role and hopefully also a shaping role, when decisions are made I listen to what goes on in meetings and people say well this is the next step that needs to be done. I try to find a way to help actualize . . . whatever comes up, so that's my relationship to those groups. (Government employee)

This government employee (conservation project development officer) participated in the network by approving part of the funding, attending quarterly SCWG meetings, but also informally supporting the Project coordinator with decisions about the eelgrass network. She articulated how she brokered knowledge between two worlds, the SCWG and the agency that she works for, helping the SCWG to "get a lot accomplished." Having only missed a few meetings, the government employee enacted several stabilizing performances over the past four years (since the inception of the SCWG). These included providing small discretionary funds for conferences, writing of reports and the launching of a website for the SCWG, and fostered connections between the SCWG and scientists and other groups.

The work of the government employee (inventory biologist) responsible for managing the CMN also enacted network-stabilizing performances, such as mentioned in the

previous section where he was available to answer questions about online data entry over the phone and assisted one coordinator in learning how to map eelgrass in the field. Together with another government employee, he also offered free data entry workshops for community coordinators and developed a manual for the use of a global positioning system (GPS) device. Yet another government employee (senior habitat management biologist) was particularly helpful in supporting the efforts of the Project coordinator to come up with a new strategy to provide funding for the community coordinators. There were a number of government employees who contributed stabilizing performances, such as contributing small funds for production of magnets or offering poster-printing services. Although these were smaller contributions, together they enabled the production of resources for the network to carry out its goal of eelgrass stewardship.

A consistent characteristic of the knowledge brokers described above was their knowledgeability to traverse between local and eelgrass networks. The success of community-based, grassroots organizations appear to be linked to the extent to which some of their members are able to traverse a variety of boundaries that normally segregate and inhibit activities (Lee and Roth, 2003a). For some community coordinators that meant incorporating (extending) eelgrass into already existing stewardship or conservation networks and for others it meant building local networks from scratch. The eelgrass biologist, who had never worked with stewardship groups before, became particularly good at brokering her knowledgeability about eelgrass between research and stewardship networks. As the "eyes and ears" of their networks, government employees, who were particularly invested in the eelgrass network's activities, were able to contribute to decision-making in ways that would potentially lead to an increase in

resources (i.e., funding, research). Finally, the Project coordinator's knowledgeability for brokering knowledge between the networks of community coordinators, the eelgrass biologist, and government employees contributed tremendously to stabilizing the goals of the eelgrass network as a whole.

5.4.3 Communication

Among the performances that stabilized the eelgrass network, communication in its various forms—face to face, telecommunications, internet—and between members of the eelgrass network (community coordinators, Project coordinator, eelgrass biologist) and overlapping networks (of government employees, communities, research, universities) played a central role. But the network and communication needs to be thought in a dialectical way: the communication makes and stabilizes the network, which in turn enables communication to occur. The different forms of communication functioned as resources to get work done; they also were important, as individuals found in them much needed emotional support. Communication necessarily overlapped with the previous stabilizing performances, that is, knowledge flowed through acts of communication and knowledge brokers moved knowledge around in communicative acts. In this section I pay special attention to the particular communication strategies (see Table 5.1) that were employed and how interviewees talked about communication strategies that would potentially constitute stabilizing performances.

Similar to stabilizing performances that were enacted to move about factual knowledge (i.e., entering mapping data on website), lack of communication often led to stabilizing performances. For example, the Project coordinator experienced problems receiving reports from some community coordinators; this led to stress, because without a report she could not hand over more funds to the communities. From the perspective of

the Project coordinator, there existed a structural resistance—the mode of communication, that is, the delivery of reports was not happening despite communication agreements that were made at the outset of the Project. The Project coordinator subsequently changed her communication strategy by making phone calls and eliciting verbal reports, as she wanted to ensure that coordinators got paid. If coordinators were not paid, there existed the possibility that they invest themselves less in the network, thereby leading to a vicious cycle of lack of payment leading to less involvement, then fewer reports, etc. The strategy worked, as it kept information coming and money flowing. Once again this performance was the outcome of perceived resistances, a resource that mediated agency in particular ways.

There were some communication performances that provided an opportunity for opening up space rather than responding to perceived resistance. In the second year of the Project, its coordinator conducted "site visits" traveling to meet with as many coordinators as possible. This enabled the coordinator to collect narrative accounts of the Project in different locales, which expanded her understanding of the social, cultural, historical, and political landscape of enacting eelgrass stewardship in the province. In turn, she was able to make these narratives travel to other locales where community-level coordinators used them as resources. Community coordinators were also brought together by the Project coordinator for an eelgrass festival where they shared stories about enacting the Project in their community. These movements opened up space for knowledge to flow and thereby stabilizing the network (Boyer & Roth, 2005a).

All the coordinators interviewed reported to be happy about how the Project was running and had several suggestions about how communication could be even better. In

particular, they talked about more training for mapping different kinds of eelgrass beds[20], how to enter data into the website and how to influence local government decision making. All of these suggestions point to potential communicative strategies that could stabilize their network. In the case of training for both mapping and online data entry, most suggested that there should be more hands-on training. This suggests that there were insufficient resources and that face-to-face communication would be ideal.[21] I do not suggest that all of these potential strategies would be stabilizing, however, from the experiences of the coordinators' role in extending (structuring) the network they were well situated as both knowledge brokers of local and the collective network to recognize structural resistances and suggest possible solutions.

Communication was not only a resource for sharing information and making knowledge flow but also provided a form of emotional support, as evident in the following quote.

> Sometimes you just need to have a little bit of support when you think that you're not really accomplishing much, cause you come to that point at times. . . . If the weather's lousy you try to go out . . . it goes on for a week or two weeks and then you just give up. . . . You think oh my god I'm not accomplishing anything so you can sort of bounce this off other people that are doing the same thing and you realize that you do what you can do. So that kind of community support is nice. And those connections, that's probably another reason I like to go to the meetings [SCWG] because that's how you get to meet those people otherwise you'd never have that connection right. (Community coordinator)

This coordinator and most of the others talked about the importance of feeling like being part of a collective. This was articulated in interviews as knowing what the other coordinators were doing in their communities, the challenges they faced, their solutions

---

[20] For example, one community coordinator found eelgrass growing in a narrow channel and found the existing mapping methodology (Precision Identification, 2002) difficult to work with for that site.

[21] In Chapter 4 I showed how inter-actions with other individuals in a mapping activity increased the immediately available sociomaterial (verbal communication, movement of bodies) resources and thus increased the possibilities for others to act (learn) (Boyer & Roth, 2005b).

to methodological problems, and just "to chat to people of similar values." Most of the community coordinators reported to be satisfied with the level of communication and purported to feel well supported, however there were two coordinators that felt isolated. One community-based coordinator qualified her comments about isolation by noting that network resources were scarce thus recognizing the constraints of improving communication among coordinators and the other with a recognition of personal constraints, citing lack of experience and the need for collaborative work rather than individual.

5.5 After the Project

Project funding ended in the summer of 2004, which could have posed a major threat to the stability of the network. While the activity of the network as a whole slowed down, it did not disappear (see Table 2.1). I contend that it is the existence of an emergent structure formed and reformed by stabilizing performances of actors—making knowledge flow, knowledge brokerage, and communication—that continues to hold the network together. However, the stability is not a permanent effect; it is an achievement in and of the network. The status of the network is subject to other forces, which mediate its existence, such as the contingency of funding, which continues to be the chief challenge. Thus, new stabilizing performances need to be enacted in order to distribute resources where they are needed (for a summary of stabilizing performances see Table 5.1).[22]

One such stabilizing performance was the regionalization of coordination of the eelgrass network by appointing five community coordinators to be regional

[22] Contents of the table were gleaned from informal and formal interviews with the Project coordinator, community coordinators, eelgrass biologist and government employees. This should not be considered an exhaustive list as I was unable to interview all members of the network (see Chapter 2, section 2.4.3 for details).

coordinators.[23] Their responsibilities entailed coordinating and supporting local community coordinators' stewardship and education planning, plan new areas to map and at what level, assist with data entry and ensure that metadata is collected and entered properly, plan sites to monitor, plan marine life inventories, and integrate projects with other ENGO projects to maintain continuity. This stabilizing performance has had mixed success. The ability of regional coordinators to carry out their responsibilities was hampered by lack of funding after the Project ended.[24]

A year and half after the initially funded period, nine out of 20 community coordinators incorporated eelgrass stewardship into the regular activities of their group (which in itself makes the network structure more stable), three coordinators continue to serve primarily network supporting roles, one coordinator manages the SCWG website, and there are currently attempts to rekindle connections to seven coordinators. The eelgrass biologist and most of the government employees who participated throughout the duration of the project continue to participate and another has more recently begun to play an important knowledge-brokering role by facilitating a new network funding strategy. In addition, one community coordinator has been hired part-time to develop a communication strategy for the SCWG: an important stabilizing performance because it

---

[23] During the eelgrass festival in the spring of 2004, four community coordinators were asked by the Project coordinator whether they wanted to take on responsibility for their region. Subsequently, four regional coordinators were assigned and they decided on the geographical reach of their region. The Project remained as a coordinator for her region.

[24] One regional coordinator remained active and was hired by the community group in her region to coordinate eelgrass-related projects. Another regional coordinator has changed her career path and no longer participates in the network. The other two regional coordinators have been maintaining the activities that they engaged in during the project (at a local community level) on a volunteer basis. The Project coordinator continued to chair the SCWG and was forced to attend to the other mandates of her group.

means that some responsibilities have shifted away from the Project coordinator who was already overworked.

Currently, an eelgrass conference is being organized by the Project coordinator and the communications coordinator of the SCWG to bring the community coordinators together and to attempt to reconnect those coordinators that became silent. So far 18 of the original 20 groups have been contacted (three have new coordinators), 14 have confirmed their attendance, three cannot make it and one has not responded (see Table 2.1). There are also new people attending the conference, thus potentially extending the network. Some others are interested but cannot be funded to attend. The organizers hope that this conference provides a space (opportunity) for coordinators to share knowledge with each other and the guest speakers to revive the network and continue to extend it. The conference is yet another example of a stabilizing performance that will be enacted to respond to perceived structural resistances: In this case to make knowledge move where it has stopped flowing and to generate more resources to support and extend the reach of the network.

Table 5.1. Summary of stabilizing performances.

Stabilizing Performance	**Performed by who?**	**Actions or activities performed***
Making knowledge flow Knowledge production	Community coordinators	• Mapping • Monitoring • Local knowledge gathering • Writing media releases • Developing educational resources • Making museum display • Enter data on CMN • Making public displays and signage
	Project coordinator	• Stewardship binder for groups • Brochures, images, magnets for groups • Eelgrass newsletter • Writes reports on eelgrass network activities • Writes discussion papers for SCWG
	Eelgrass biologist	• Mapping and monitoring manual • Writes reports for SCWG • Creates posters on eelgrass network for conference presentations
	Government employees	• Helped produce mapping and monitoring manual • Produced GPS data entry manual
Knowledge embodied in people and texts moves	Community coordinators	• Attending local council meetings • Attending eelgrass festival and conference (displays) • Attending SCWG meetings • Giving presentations to public (brochures, flyers, magnets) • Giving presentations to government institutions • Giving community workshops and training

Stabilizing Performance	Performed by who?	Actions or activities performed
Making knowledge flow Knowledge embodied in people and texts moves	Project coordinator	• Training (mapping manual, stewardship binder) • Site visits to groups • Organizes SCWG meetings (meeting minutes)
	Eelgrass biologist	• Attending national and international scientific conferences • Giving presentations about conferences to SCWG (posters) • Attending SCWG meetings • Attending eelgrass festival and conference • Eelgrass ecology and mapping training (mapping manual)
	Government employees	• Attending SCWG meetings • Attending eelgrass festival and conference
Making knowledge flow to fill apparent voids	Community coordinators	• Mapping undocumented eelgrass beds • Incorporating eelgrass maps into local habitat atlases or ongoing marine biota inventories • Incorporating eelgrass maps into local, regional, provincial planning processes
	Project coordinator	• Coordination of mapping and stewardship activities • Dedicated advisor and support to the eelgrass network • Facilitating the inclusion of eelgrass into coastal planning
	Eelgrass biologist	• Dedicated advisor and support to the eelgrass network • Facilitating the inclusion of eelgrass into coastal planning

Stabilizing performance	**Performed by who?**	**Actions or activities performed**
Making knowledge flow Making knowledge flow to fill apparent voids	Government employees	• Development of CMN website • Solicit eelgrass maps from other government • Facilitating the inclusion of eelgrass into coastal planning
Stabilizing performance	**Interact with who?**	**Actions or activities performed**
Knowledge brokers Community coordinators	The community (local network building)	• Volunteer recruitment • Public education • Mapping and monitoring • Community presentations • Informal interviews with local residents • Outreach to seasonal tourists • Community workshops and trainings • Marine or Low Tide Day events • Newsletters
	Other community coordinators	• Mapping training • Regional coordination • Sharing stories about eelgrass stewardship
	Project coordinator	• Share stewardship and education resources • Share local history of community, politics and eelgrass • Share eelgrass maps
	Eelgrass biologist	• Request *Zostera japonica* mapping methodology • Provide feedback on mapping manual
	Government employees	• Provide feedback on efficacy of CMN website • Through SCWG and other meetings share local knowledge and politics that are useful for government employee decision making
	SCWG	• Input drives SCWG decision making

Stabilizing performance	Interact with who?	Actions or activities performed
Project coordinator	Community coordinators	• Eelgrass stewardship and education training • Applies for and administers funds • Gives presentations to community coordinators communities • Helps with mapping • Provides equipment for mapping and stewardship
	Eelgrass biologist	• Conducts joint trainings • Advises eelgrass biologist on nature of stewardship work
	Government employees	• Advises government employee on how to broker their knowledge with community groups • Provides reports on the Project
	SCWG	• Chairs the SCWG • Brokers knowledge between community coordinators and SCWG
Eelgrass biologist	Community coordinators	• Provides free training (only travel and accommodation expenses covered) • Volunteers for extra training and mapping support
	Project coordinator	• Conducts joint trainings • Gives advice on decisions about the eelgrass network • Provides eelgrass learning resources

Stabilizing performance	Interact with who?	Actions or activities performed
Knowledge brokers Eelgrass biologist	Government employees	• Collaborate on decision-making associated with eelgrass network and SCWG
	SCWG	• Core member and scientific advisor to SCWG • Reports on conferences and other eelgrass related meetings
Government employees	Community coordinators	• Developed online mapping data entry tool • Technical support for data entry • Help with mapping
	Project coordinator	• Approves funding grants for eelgrass project • Provides advice on decisions about network
	Eelgrass biologist	• Provides feedback on mapping methodology • Collaborate on decision-making associated with SCWG
	SCWG	• One individual is a core member • Attends meetings • Brokers between SCWG and government agencies • Advisors to SCWG

Stabilizing performance	Issue	Actions or activities performed or suggested performances
Communication For remediation of stagnation	Community coordinators not submitting written reports	• Project coordinator changed communication strategy by eliciting verbal, over-the-phone reports
	After funding for project ceased in 2004, Project coordinator not always available to community coordinators for support	• Project coordinator secured funding for an eelgrass conference (2006) to bring all community coordinators together to identify the eelgrass network's needs. • Eelgrass biologist was still readily available as support after cessation of funds.
For opening up space	Learn about other mapping communities	• Project coordinator conducted site visits to community coordinators' communities (not all sites were visited, but as many as possible) • Project coordinator organized eelgrass festival and eelgrass conference to bring community coordinators together
Communication For opening up space	Availability of support	• During the two-year project the Project coordinator and eelgrass biologist were available daily for responding to emails and phone calls from community coordinators asking for support.
Suggestions from community coordinators	Training	• More mapping training for different kinds of eelgrass beds • More data entry training • Training on how to influence local government decision making • More hands on training (data entry and mapping)
As emotional support	Feeling of being part of a collective	• Community coordinators value opportunities to meet face-to-face • Community coordinators value opportunities to share stories and learn about what is happening in other communities, discover what are their challenges

5.6 Conclusions

The purpose of this chapter was to show how the eelgrass network emerged from a grassroots effort and how it became more stable in a highly complex and uncertain social, cultural, political, historical and material setting. I sought to understand how such a diverse network of individuals—community coordinators, biologists, and government employees—dispersed widely along the west coast of Canada could possibly hold together. While there have been some problems holding connections with more remote areas, 13 out of 20 of the original coordinators have continued varying levels of activity involving eelgrass habitat conservation. There is no closure in this account of the network. However, the ability of the network and its nodes to respond to perceived structural resistances via stabilizing performances is a testament to its endurance.

Although I chose to emphasize the knowledge production (flow), brokerage, and communicative practices of the community coordinators' (they made up most of the network), their relationship to the eelgrass biologist and government should be further articulated as there are implications for decisions regarding marine habitat conservation. As governments become increasingly silo-ised[25] and removed from direct interaction with the public, non-profit organizations and networks such as reported here attempt to broker between various publics and governments to fill a perceived void (Larner & Craig, 2005). However, there are no hard and fast boundaries between these publics and governments because individual brokers within governments still play key stabilizing roles. Yet for others there are boundaries, as a government employee told me, although attitudes seem to be changing, his department as a whole is not willing to embrace

[25] This term refers to the vertically accountable nature of government decision-making (Larner & Craig, 2005).

partnerships with stewardship groups. So the boundaries between the eelgrass network and governments continue to be fluid.

Currently, there are no substantial efforts on the part of governments to actively map, monitor and conserve eelgrass habitat. Indeed this is one of the major reasons the eelgrass network emerged. The biologists and government employees involved in the SCWG have said that the kind of mapping that the provincial government does undertake is too "coarse," that is, large scale. Whereas, to make appropriate conservation related decisions and recommendations for land and marine resource uses that minimize impacts to near-shore habitats, "fine-scale" mapping must be employed. Therefore local communities are particularly well suited to do fine-scale mapping or at least be watchdogs for potential impacts. They are also particularly well situated to contribute to decision-making processes about habitat conservation. In the following excerpt a government employee who has worked with communities for several years explains the merit of local decision-making.

> You have an idea that you can do something in a local aspect and you just go out and do it and you be practical about it. . . . Your practices improve, other people think it's a good idea to join and this sort of grassroots, bottom up, pretty soon you come to a standard way that everybody buys in to use. . . . I don't think staff in my ministry and the ministry could have never designed this inventory procedure [like the eelgrass methodology] and mandated it and said this is the standard for the province, thou shalt use it. . . . They couldn't have made it work in the first place because you just can't figure it out from . . . this vision at the top . . . you've got to . . . build it, field test it, refine it, the standards grow with the procedures . . . that's a key message for just about the whole stewardship movement (Government employee).

The government employee goes on to say that they have seen attempts by a non-profit society to impose a "global" structure on parts of the B.C. stewardship movement. In the government employee's opinion, the initiative failed because people want to be able to share resources and work together while maintaining their local identity. My goal is not

to idealize or romanticize the local but to suggest that a more fluid network (structure) of people who have access to adequate sociomaterial resources—and therefore agency—that enables stabilizing performances, could lead to better decisions. The question as to how much sociomaterial resources is adequate is a structural resistance that is currently being addressed through multiple stabilizing performances including the upcoming eelgrass conference.

As this study and others have shown, the public is far from singular and the ways in which they, the "publics," interact with science in relation to environmental issues is complex and multiple (e.g., Wynne, 1996; Lee & Roth, 2003b; Jasanoff, 2005). In the case of the eelgrass network, the science of eelgrass and mapping is enacted through, for example, public education, meetings with city councilors, graduate student theses, and the *Fisheries Act*. Those who are members participate by choice, therefore, scientists and non-scientists work well together. In fact many of the members, both community coordinators and biologists, are scientist/non-scientist hybrids and are capable of enacting the respective discourses.

There are those community coordinators who feel they have a deficit of knowledgeability about eelgrass biology. However, given the fluid structure of the network, constituted of and by its members, sociomaterial resources (i.e., biologists, meetings, manuals) are available collectively so that individuals have increased agency to enact eelgrass stewardship in their locale. This network is not perfect, there are some individuals that feel isolated, however this is no secret as stabilizing performances are currently being enacted, in part, to address this perceived resistance.

What have I learned about public understanding of science? In the context of the eelgrass stewardship network I learned that it was important for knowledge to keep moving, that if someone needed assistance with mapping there would be help available. Therefore, it did not make sense to study how much science each individual understood: Scientific knowledgeability was a property of the collective. It was not enough for biologists to embody knowledge about eelgrass or mapping and contain it in their daily work routines. Instead they moved through communities and SCWG meetings and it was through these inter-actions that knowledge was made to move both ways between stewardship and science.

Chapter 6

Conjunctions

> "A rhizome has no beginning or end; it is always in the middle, between things….the fabric of the rhizome is the conjunction" (Deleuze & Guattari, 1987).

It only seems fitting to invoke the metaphor of eelgrass again for the closure of this thesis; indeed, it is the organism of fascination for the network and for me. The network itself behaved much like eelgrass rhizomes, expanding into new muddy substrates (places, communities) while fragmenting in places where the waters were too turbulent (lack of funding for mapping, volunteer burnout). The eelgrass (rhizome) metaphor also is amenable to the dialectical approach that permeates the three main chapters: Relations of individual|collective, social|material (sociomaterial) and structure|agency have no beginning or end, but are always in a process of becoming. Therefore, this chapter marks the conclusion of my writing (because a masters degree requires an endpoint) but not the conclusion of the eelgrass network. It is still becoming.

The purpose of this thesis was to a) explore how learning came about in the network of communities and whether learning, facilitated by individuals and the collective, contributes to its stabilization; and b) provide an alternative theoretical framework for understanding learning and change in the everyday (informal) lives of people who engage in conservation activities. A dialectical approach enabled me to theorize learning and transformation (change) in and through whole activities, where people, things, and settings are mutually interdependent. However, I realize that my practice of writing this thesis, by attempting to render the dynamic and complex world in textual form, is a static performance. Therefore, I will try not to draw conclusions, because like a rhizome, my

writing should always be in the middle and not an ending. This chapter is a series of conjunctions.

6.1 Conjunction 1: Creating continuity

At this conjunction, I articulate how the three chapters mutually reinforce one another. In the three main chapters, I examined learning (teaching), change, and emergence within the eelgrass network. The major intersections of the three chapters are: a dialectical conception of between entities in whole activities, complexity and heterogeneity of eelgrass network settings (at the levels of one community and the whole network), and learning and emergence of the network arising from production and distribution of sociomaterial resources. In Chapter 3, I showed how individual and collective learning emerged through their dialectical constitution. The individual production of sociomaterial resources led to increase action opportunities for others that constitute the collective. Collective resources in turn supported individual actions. In this chapter I also began the analysis of the emergence of the eelgrass network. Network linkages were made through overlapping of individual (Project coordinator) activity systems and through sharing of sociomaterial resources.

In Chapter 4, I continued to look at learning, this time at the level of a single community. Sociomaterial resources became more of a focus here, showing in detail, how resources for learning also constituted the unfolding activity and setting. It was my intention that this chapter would provide the readers of this thesis with an understanding of the kinds of activities that occurred at the individual nodes (communities) of the network. Although this was just one detailed example, I wanted the complexity and heterogeneity of the eelgrass network as a whole to become salient. I also showed how the activities (learning) of this individual community (node) was connected to the larger

eelgrass network. The eelgrass mapping event furthered the goals of the eelgrass network—extending the network into the community (public education, stewardship) and bringing to the attention of a network participant (me) that there was variation in morphology of flowering eelgrass shoots. I was then able to alert the eelgrass biologist about potential confusion arising from the training sessions. Thus, those within the collective (network) also learned.

Chapter 5 continued where the end of the first study began. In that chapter, I chiefly explored aspects of the network that enabled it to emerge and become more stable. I took clues from the network participants themselves, who talked about knowledge flows and communication aspects of the network. As the network formed, it began to take on a structure; therefore, it made sense to theorize change in terms of the structure|agency dialectic. In addition to a dialectical conception of relations within the network, sociomaterial resources were also maintained as a common thread throughout this and the other two main chapters.

6.2 Conjunction 2: Contributions to theory

All three chapters adhered to a dialectical conception of the relation between entities in whole activity systems. Attention to dialectics is at best sparse in educational research and science studies literature. If "dialectic" is mentioned, it is done so as an afterthought. This thesis in its present form, and the publications that have and will be generated from it, thus, constitutes a contribution to educational and science studies theory. In CHAT itself, most studies tend to reify the structural elements of an activity system (i.e., individual/collective, subject/object) into independent relations (Roth, Hwang, Lee, & Goulart, 2005). I attempted to revive the dialectical relation between entities that makes

CHAT so unique as a heuristic for analyzing learning and change. For the remainder of this conjunction I summarize this alternative framework.

In the introduction of this thesis I indicated that each dialectical relation that formed the basis for each chapter was held in focus (Figure 1.2) while keeping in mind their interdependence in the activity system. For the remainder of this conjunction, I show how the dialectical units employed in each chapter relate to one another. To reiterate, in CHAT, whole activities (systems) can be analyzed at different levels or focal planes. In Chapters 3 and 5, I investigated the macro-scale of the whole network as my unit of analysis. In Chapter 4, one community (micro) constituted my unit of analysis. However, as CHAT teaches us, each scale cannot exist without the other; micro/macro (individual|collective) exists in a dialectical tension. Therefore, I shifted between each scale without losing sight of the other.

Figure 6.1 is a visual representation of the theoretical framework that I developed in this thesis. The numbers in the following statements correspond to the numbered arrows in the figure. Sociomaterial resources are the common denominator of the three chapters, linking individuals to collectives (1) and constituting the structure (2) of activity. Resources, both social and material, are the means by which cognitive structures (schemas) become salient to others (i.e., bodily actions, communication, texts, tools). In turn, arrangements of sociomaterial structures (culture) are the means by which we understand others. These relations are only possible through, and are mobilized by, activity directed (motivated) toward a particular goal, in this case, eelgrass mapping and stewardship.

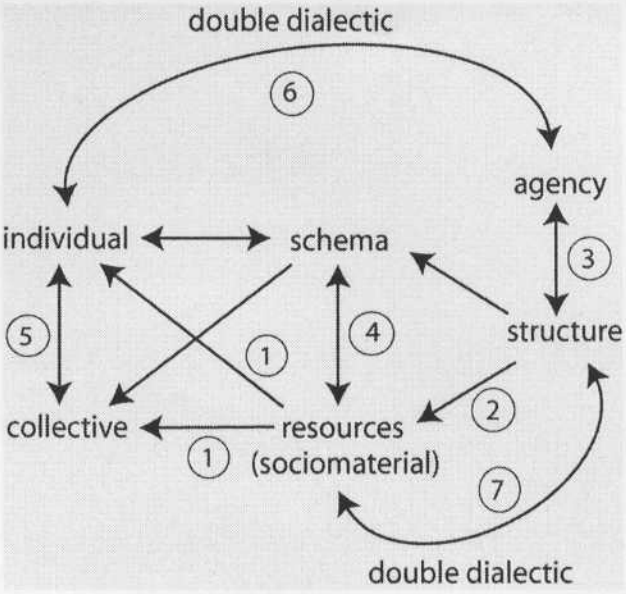


Figure 6.1. Relationships between the dialectical units that constitute each study.

By observing the eelgrass network, I showed how knowledge embodied in people and material resources was made to flow between people and places. These movements connected individuals to the collective and vice versa. Given the power to act (agency), individuals identified resistances in the sociomaterial structure (3) of the network and enacted stabilizing performances to attempt to resolve them; therefore, agency|structure stands in a dialectical relation with resources|schema (4). Knowledge flow and sharing of resources also expanded action opportunities (agency) for others. Thus, as individuals participate in ongoing societally motivated activities, such as the eelgrass network, they learn and, in turn, they change the collective. In this way, individual|collective (5) and agency|structure (3) stand in a double dialectic relation (6) because individual agency can only be realized in relation to collective activity and sociomaterial resources that constitute structure in the first place. Sociomaterial resources are recognizable to individuals through their schema and it is agency, that allows individuals to produce

resources anew or change them; therefore, agency|structure and resources|schema also stand in a double dialectical relation (7).

6.3 Conjunction 3: Contributions to conservation and stewardship

Does learning contribute to a more stable eelgrass stewardship network? I argue that, yes it does. In this network, learning does not only entail remembering the many fascinating attributes of eelgrass habitat or learning how to map an eelgrass bed; learning is also about understanding how others experience "doing" eelgrass stewardship in their communities and in biologist and government employee offices. In this network people with different backgrounds, geographies, and histories have to learn how to work together to make the goal of the eelgrass network—eelgrass habitat conservation and stewardship—a living reality.

The key ingredients or stabilizing performances that created more stability in the network were related to increasing opportunities for people to come together which in turn led to increased action possibilities and enabled people to participate in new ways (learning). In the eelgrass network people came together locally at mapping events, workshops, and celebrations. As a collective, most members (including government employees) of the eelgrass network came together at the eelgrass festival and conference and some members were able to attend SCWG meetings. The Project coordinator and eelgrass biologist also traveled to the different communities to offer support and broker their knowledge.

The production of knowledge such as producing eelgrass maps, gleaning local knowledge about eelgrass, and writing reports was certainly very important to the goal of

the network, but more importantly it was necessary for this knowledge embodied in material objects and people to be moved around.[26]

As I suggested in Chapter 5, moving knowledge around do not always constitute stabilizing performances (i.e., "paper shuffling"). However, if there are more opportunities to move and broker knowledge and for communication, there are more opportunities for resistances and contradictions inherent in the individual|collective, social|material, and agency|structure dialectical units to be identified. Once identified, new stabilizing performances and forms of participation can be enacted.

This thesis shows that it is more fruitful for a network of conservation communities, biologists, and government employees to be viewed as a dynamic learning network rather than as a purely administrative structure. If the Project coordinator and eelgrass biologist imposed rigid parameters on how the community coordinators carried out eelgrass stewardship and did not welcome and provide feedback, I believe the project would have failed. The project did not fail because the members of the network were, for the most part, not only concerned about eelgrass, they were concerned about building relationships in their communities and throughout the eelgrass network.

6.4 Conjunction 4: Implications

As I touched on in conjunction 2, a dialectical perspective of learning and change has been relatively unexplored in the literature, the exceptions coming from work published by members of my research group (Lee, 2005; Roth, Hwang, Lee, & Goulart, 2005). Therefore, this thesis contributes to furthering this work, which for the most part, has

---

[26] I do not mean to suggest that all knowledge must be shared because sometimes local knowledge is not meant to be shared. For instance, in many First Nations communities some knowledge is not supposed to be shared.

focused on learning and identity. My work, in part, diverges from this focus as I articulate the emergence and stabilization of a network. At the conclusion of Chapter 4 I already articulated implications for that study; therefore, in the remainder of this conjunction I draw implications from Chapters 3 and 5 and then suggest further research.

Chapter 3 contributes to educational research on informal (free-choice) settings. Most research in these fields focuses on individual learning as their unit of analysis, isolating the individual from the collective and the complex sociomaterial settings that constitute their process of development in the first place. This study responds to a call for research designs that offer opportunities to explore social and cultural mediating factors including the role of social learning networks, and the use of groups and individuals as the unit of analysis (Rennie, Feher, Dierking, & Falk, 2003, p. 115). The ethnographic method that I used was particularly useful for analyzing complex inter-actions in the eelgrass network. As individuals became part of the collective (network) they produced and constituted new resources for the network and in turn the network provided new resources for individuals. I was able to show how increased opportunities for action (learning), enabled by new resources, was an outcome of the individual|collective dialectic.

Chapter 5 contributes to the field of science studies. Scholars in this field are centrally concerned about relationships between science/technology and society. In the past decade, researchers have attempted to shift analyses of "public understanding of science" by moving away from a science-centered view that theorizes science as a unified and clear body of knowledge and method and the public as having a deficit of scientific knowledge, towards a more relational view of science and public (Irwin & Wynne, 1996).

In the relational view, both "science" and "public" are diverse and complex. Thus the question arises,

> How can we accommodate a proactive, dynamic, epistemically active conception of the "public": a collective that neither passively takes up nor fearfully rejects all scientific advances, but instead (as real publics are doing all over the world) shapes, crafts, reflects on, writes about, experiments and plays with, tests, and resists science and technology—so as to produce multiple forms of life around the same techno-scientific developments? (Jasanoff, 2005, p. 255).

Chapter 5, in particular, takes up this challenge by detailing how community coordinators (public), government employees, and biologists collectively use scientific knowledge to enact eelgrass habitat conservation. This study reveals the complexity of the network and how moving knowledge around (in whatever form it takes), knowledge brokering, and communication between members were important stabilizing performances that held the network together—without which eelgrass habitat conservation in B.C. may not have been so widespread, or even become a reality. Anyone who designs policy about public participation in science-related fields could benefit from the findings of this study. I showed how the fluidity of the network provided stability and how the existence of particular actors (brokers) who facilitated and supported the participation of others, enabled to the network to emerge. I contend that this approach is more successful than other highly structured top-down policy models.

Further studies could examine more closely how the eelgrass network's practices influence (change) the practices of those more distant to the network, such as the public in one community or the practices of higher level management in government. I know from conversations with some members of the network that there is more awareness about eelgrass in the public and governments. It would be interesting to validate this "sense" with empirical evidence. Another study could investigate the transformation of

identities in and through the project. During my ethnographic study I noticed that the eelgrass biologist in particular, changed the way that she talked about eelgrass and volunteer participation in mapping. In the beginning, she used more jargon during trainings and as the Project emerged her talk seemed to change. In some contexts she even began to talk as a community coordinator would, expounding the difficulties of keeping volunteers and other challenges associated with coordinating community mapping events. The eelgrass biologist's identity seemed to become a hybrid.

Eelgrass and the people who participated in habitat conservation through the eelgrass network have taught me many things. Eelgrass has taught me not to make any assumptions about where it grows—because it has been found growing over rocks when it is not "supposed" to—and that it is just as "sexy" as kelp. The members of the eelgrass network, including biologists, graduate students, and government employees have taught me to never give up on my passion for habitat conservation and stewardship, no matter how challenging it can be.

References

Boyer, L., Roth, W.-M., & Lee, Y. J. (2003). Salmon migrate from stream to sea and back again: Knowledge flows within, into and out of a hatchery community. In W.-M. Roth (Ed.), *CONNECTIONS '03* (pp. 251–276). Victoria, BC: Faculty of Education. (CD)

Boyer, L., & Roth, W.-M. (2005a). Individual | collective dialectic of free-choice learning in a community-based mapping project. *Environmental Education Research*, 11(3), 335–351.

Boyer, L., & Roth, W.-M. (2005b). *Learning and teaching as emergent features of informal settings: An ethnographic study in an environmental action group.* Manuscript submitted for publication.

Coy, M. W. (Ed.). (1989). *Apprenticeship: From theory to method and back again.* Albany: State University of New York Press.

de Laet, M., & Mol, A. (2000). Mechanics of a fluid technology. *Social Studies of Science*, 30(2), 225-263.

Cullis-Suzuki, S., Dick, Chief Adam (Kwaxsistala), Sewid-Smith, Daisy. (Mayanilth), Turner, N. J., & Wyllie-Echeverria, S. (2006, February). *An ethnobotanical study of the Kwakwaka'wakw traditional harvesting of eelgrass, Zostera marina L.; Zosteraceae*. Paper presented at the meeting of the Pacific Estuarine Research Society, San Juan Island, WA.

Deleuze, G., & Guattari, F. (1987). *A thousand plateaus: Capitalism and schizophrenia* (B. Massumi, Trans.). Minneapolis: University of Minnesota Press. (Original work published 1980.)

Dierking, L.D., Luke, J.J., & Büchner, K.S. (2003). Science and technology centres-rich resources for free-choice learning in a knowledge-based society. *International Journal of Technology Management*, 25(5), 441–459.

Dierking, L., & Martin, L. (1997). Guest editorial: Introduction. *Science Education,* 81(6), 629–631.

Dierking, L., Falk, J., Rennie, L., Anderson, D., & Ellenbogen, K. (2003). Policy statement of the "Informal Science Education" ad hoc committee. *Journal of Research in Science Teaching,* 40(2), 108–111.

Dunster, K. (2003). *Eelgrass mapping review: Eelgrass mapping initiatives in coastal British Columbia.* Retrieved May 2004, from http://www.shim.bc.ca/eelgrass/Eelgrass_Mapping_Inventory_Final_v1.pdf

Ellis, R., & Waterton, C. (2004). Environmental citizenship in the making: The participation of volunteer naturalists in UK biological recording and biodiversity policy. *Science and Public Policy,* 31(2), 95–105.

Engeström, Y. (1987). *Learning by expanding: An activity-theoretical approach to developmental research.* Helsinki: Orienta-Konsultit.

Epstein, S. (1995). The construction of lay expertise: AIDS activism and the forging of credibility in the reform of clinical trials. *Science, Technology, & Human Values,* 20(4), 408–437.

Falk, J.H., & Aldeman, L.M. (2003). Investigating the impact of prior knowledge and interest on aquarium visitor learning. *Journal of Research in Science Teaching,* 40(2), 163–167.

Falk, J. H., & Dierking, L. D. (2003). *Lessons without limit.* New York: AltaMira Press.

Feher, E., & Rennie, L. (2003). Guest editorial. *Journal of Research in Science Teaching,* 40(2), 105–107.

Finding Solutions Network. (2004, January). *Futures in question: A funding survey of 100 environmental organizations in B.C.* Retrieved November 30, 2005, from http://www.stewardshipcentre.bc.ca/stewardshipcanada/home/scnBCIndex.asp

Foley, G. (1999). *Learning in social action: A contribution to understanding informal education.* New York: Zed Books.

Fusco, D. (2001). Creating relevant science through urban planning and gardening. *Journal of Research in Science Teaching,* 38(8), 860–877.

Geertz, C. (1973). *The interpretation of cultures: Selected essays*. New York: Basic Books.

Gooding, D. (1990). Mapping experiment as learning process: How the first electromagnetic motor was invented. *Science, Technology, & Human Values*, 15, 165–201.

Goodwin, P. (1998). 'Hired hands' or 'local voice': Understandings and experience of local participation in conservation. *Transactions of the Institute of British Geographers,* 23, 481–499.

Harvey, D. (1996). *Justice, nature and the geography of difference*. Malden, MA: Blackwell.

Hegel, G.W.F. (1977). *Phenomenology of spirit* (A. V. Miller, Trans.). Oxford: Oxford University Press.

Helms, J. V. (1998). Science and/in the community: Context and goals in practical work. *International Journal of Science Education,* 20(6), 643–653.

Holzkamp, K. (1983). *Grundlegung der Psychologie.* [Foundations of psychology] Frankfurt/M., Campus.

Holzkamp, K. (1993). *Lernen: Subjektwissenschaftliche Grundlegung* [Learning: Foundations in a science of the subject]. Frankfurt/M.: Campus.

Irwin, A., & Wynne, B. (1996). Introduction. In A. Irwin and B. Wynne (Eds.), *Misunderstanding science?* New York: Cambridge University Press.

Jasanoff, S. (2005). *Designs on nature*. Princeton: Princeton University Press.

Jordan, B., & Henderson, A. (1995). Interaction analysis: Foundations and practice. *Journal of the Learning Sciences,* 4(1), 39–103.

Kuhnlein, H. V., & Turner, N. J. (1991). *Traditional plant foods of Canadian Indigenous Peoples: Nutrition, botany and use*. Philadelphia: Gordon and Breach Science Publishers (104-105).

Larner, W., & Craig, D. (2005). After neoliberalism? Community activism and local partnerships in Aotearoa, New Zealand. *Antipode,* 37(3), 402–424.

Larochelle, M. (2002). Science education as exercise in disciplining versus a practice of/for social empowerment. In W.-M. Roth & J. Désautels (Eds.), *Science education as/for sociopolitical action* (pp. 209–236). New York: Peter Lang.

Latour, B. (1987). *Science in action: How to follow scientists and engineers through society*. Milton Keynes: Open University Press.

Lave, J. (1988). *Cognition in practice*. Cambridge: Cambridge University Press.

Lave, J. (1993). The practice of learning. In S. Chaiklin & J. Lave (Eds.), *Understanding practice perspectives on activity and Context* (pp. 3–32). Cambridge: Cambridge University Press.

Law, J. (1997). Traduction/trahison: Notes on ANT'. Retrieved April 23, 2003, from Lancaster University, Department of Sociology Website: http://www.lancaster.ac.uk/sociology/stslaw2.html

Law, J., & Mol, A. (2000). Situating technoscience: An inquiry into spatialities. Retrieved March 17, 2005, from Lancaster University, Centre for Science Studies, Website: http://www.lancs.ac.uk/fss/sociology/research/resalph.htm

Lee, Y.-J. (2005). Working out work: Learning, identity, and history from the perspective of cultural-historical activity theory. Unpublished dissertation, University of Victoria, August 2005.

Lee, S. W., Kelly, K. E., & Nyre, J. E. (1999). Preliminary report on the relation of students' on-task behavior with completion of schoolwork. *Psychological Reports,* 84, 267–272.

Lee, S., & Roth, W.-M. (2002). Learning science in the community. In W.-M. Roth & J. Désautels (Eds.), *Science education for/as socio-political action* (pp. 37–64). New York: Peter Lang.

Lee, S. H., & Roth, W.-M. (2003a). Becoming and belonging: Learning qualitative research through legitimate peripheral participation, [electronic version]. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, 4(2). Retrieved May 12, 2004, http://www.qualitative-research.net/fqs-texte/2-03/2-03leeroth-e.htm

Lee, S., & Roth, W.-M. (2003b). Of traversals and hybrid spaces: science in the community. *Mind, Culture, and Activity,* 10(2), 120–142.

Lee, Y.-J., & Roth, W.-M. (2005). The (unlikely) trajectory of learning in a salmon hatchery. *Journal of Workplace Learning,* 17(4), 243–254.

Leon'tev, A. N. (1978). *Activity, consciousness and personality*. Englewood Cliffs, NJ: Prentice Hall.

McAlpine (Ed.) (2005). *Voices from the coast: The collected stories of coastal BC community members involved in the research and discussion of oil and gas.* Prince George, BC: University of Northern British Columbia, UNBC Community-Collaborative Studies on British Columbia Offshore Oil and Gas.

Marcus, G. E., & Fischer, M.M.J. (1986). *Anthropology as a cultural critique: An experimental moment in the human sciences*. Chicago: University of Chicago Press.

Martin, L. (2004). An emerging research framework for studying informal learning and schools. *Science Education,* 88(Supp. 1), S71–S82.

Miettinen, R. (1999). The riddle of things: Activity theory and Actor-Network Theory as approaches to studying innovations. *Mind, Culture, and Activity*, 5(3), 170-195.

Mol, A., & Law, J. (1994). Regions, networks and fluids: Anaemia and social topology. *Social Studies of Science,* 24(4), 641–671.

Mol, A., & Law, J. (2002). Introduction. In J. Law & A. Mol (Eds.), *Complexities: Social studies of knowledge practices*. London: Duke University Press.

Nardi, B. A. (2001). Studying context: A comparison of Activity Theory, Situated Action Models, and Distributed Cognition. In B. A. Nardi (Ed.), *Context and consciousness: AT and human-computer interaction* (3rd printing). Cambridge, MA: MIT Press.

Palincsar, A. S., & Brown, A. L. (1986). Interactive teaching to promote independent learning from text. *The Reading Teacher*, 39(8), 771–777.

Penn, B. & Thomson, S. (2005, December 1). What is the future of environmentalism? *Monday Magazine*, p. 8.

Pickering, A. (1995). *The mangle of practice*. Chicago: University of Chicago Press.

Precision Identification. (2002). *Methods for mapping and monitoring eelgrass habitat in British Columbia, Draft 4*. Retrieved January 12, 2006, from http://shim.bc.ca/atlases/atlas.html#eelgrass

Precision Identification. (2004, March). *Next steps in mapping and monitoring eelgrass habitats in British Columbia* A summary report of a meeting held in Vancouver, BC.

Rennie, J., Feher E., Dierking L. D., & Falk J. H. (2003). Toward an agenda for advancing research on science learning in out-of-school settings. *Journal of Research in Science Teaching,* 40(2), 112–120.

Ricœur, P. (1991). *From text to action: Essays in hermeneutics, II*. Evanston, IL: Northwestern University Press.

Rogoff, B. (1997). Evaluating development in the process of participation: Theory, methods, and practice building on each other. In E. Amsel & K. A. Renniger (Eds.), *Change and development issues of theory, method, and application* (pp. 265–285). Mahwah, NJ: Lawrence Erlbaum Associates.

Roth, W.-M. (1995). *Authentic school science: Knowing and learning in open-inquiry science laboratories*. Dordrecht, The Netherlands: Kluwer Academic Publishing.

Roth, W.-M. (2005a). Making classifications (at) work: ordering practices in science. *Social Studies of Science*, 35(4), 581–621.

Roth, W.-M. (2005b). *Doing qualitative research: Praxis of method*. Rotterdam, The Netherlands: Sense Publishers.

Roth, W.-M., & Barton, A. C. (2004). *Rethinking scientific literacy*. New York: RoutledgeFalmer.

Roth, W.-M., & Bowen, M. (1993). An investigation of problem framing and solving in a grade 8 open-inquiry science program. *The Journal of the Learning Sciences,* 3(2), 165–204.

Roth, W.-M., & Lee, S. (2002). Scientific literacy as collective praxis. *Public Understanding of Science,* 11(1), 33–56.

Roth, W.-M., & Lee, S. (2004). Science education as/for participation in the community. *Science Education*, 88(2), 263–291.

Roth, W.-M., Hwang, S., Lee, Y-J., & Goulart, M. (2005). *Participation, learning, and identity: Dialectical perspectives.* Berlin: Lehmanns Media.

Roth, W.-M., & Middleton, D. (2006). The making of asymmetries of knowing, identity, and accountability in the sequential organization of graph interpretation. *Cultural Studies of Science Education,* 1, 11–81.

Sandifer, C. (2003). Technological novelty and open-endedness: two characteristics of interactive exhibits that contribute to the holding of visitor attention in a science museum. *Journal of Research in Science Teaching,* 40(2), 121–137.

Saxe, G. B. (1991). *Culture and cognitive development: Studies in mathematical understanding*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Sewell, W. H. (1992). A theory of structure: Duality, agency, and transformation. *American Journal of Sociology,* 98(1), 1–29.

Sewell, W. H. (1999). The concept(s) of culture. In V.E. Bonnell and L. Hunt (Eds.), *Beyond the cultural turn: New directions in the study of society and culture* (pp. 35–61). Berkeley: University of California Press.

Shapiro, B. L. (1989). What children bring to light: Giving high status to learners' views and actions in science. *Science Education,* 73(6), 711–733.

Suchman, L. 2002, Working artefacts: Ethnomethods of the prototype. *British Journal of Sociology,* 53 (2), 163–179.

Szerszynski, B., Heim, W., & Waterton, C. (Eds.). (2003) *Nature performed: Environment, culture and performance*. Oxford: Blackwell.

Tofield, S., Coll, R.K., Vyle, B., & Bolstad, R. (2003). Zoos as a source of free-choice learning. *Research in Science & Technological Education,* 21(1), 67–99.

West Coast Environmental Law Association. (2005). *Cutting up the safety net*. Retrieved February 20, 2006, from http://www.wcel.org/issues/deregulation/

World Atlas of Seagrasses. *Introduction.* Retrieved February 9, 2006 from http://www.unep-wcmc.org /marine/seagrassatlas/introduction.htm.

Wyllie-Echeverria, S., & Ackerman, J. D. (2003). The seagrasses of the pacific coast of North America. In E. P. Green & F. T. Short (Eds.) *World atlas of seagrasses* (pp. 199-206). Berkeley: The University of California Press.

Wynne, B. (1996). Misunderstood misunderstandings. In A. Irwin and B. Wynne (Eds.), *Misunderstanding science?* (pp. 19–46). New York: Cambridge University Press.

Yearly, S. (1996). Nature's advocates: Putting science to work in environmental organizations. In A. Irwin and B. Wynne (Eds.), *Misunderstanding science?* (pp. 172–190). New York: Cambridge University Press.

Appendix 1

Glossary

Agency	the capacity inherent in all humans that allows them to exert some degree of control of and transformation of the material and social relations in which they are immersed.
Cartesianism	a unifying concept by Descartes, Cartesianism posists the that mind is separate from the body and that identity is located only in the mind.
Change	in the dialectical view change and instability are the norm and the appearance of stability of phenomenon or systems is what has to be explained (Harvey, 1996). Change occurs when *resistences* and *contradictions* in an activity system are resolved.
Contradictions	in CHAT contradictions (or innner contradictions) are drivers of change and occur at the level of consciousness. Thus, a contradiction occurs if the vision of a particular goal of an activity is disrupted by material *resistences*.
Heterogeneity	generally refers to the diversity of parts (social and material) that make up a whole. A "whole" can refer to a sociomaterial setting or a network. This contrasts with homogeneity which would refer to same or similar parts that make up a whole.
Knowledgeability	using this term resists representing knowledge as abstract and static. It is more appropiate for the theory of learning I use in this thesis, that is, knowledge or knowledge-making can only be understood by observing concrete details of practical action.
Learning	occurs when there is a change in forms of participation or expanded opportunities for action. Learning arises out of individual|collective activity.
Machivalianism	a person's tendency to deceive and manipulate others for personal gain. The concept is named after Renaissance diplomat and writer Niccolò Machiavelli, who wrote Il Principe (The Prince)
Networks	constitute processes rather than merely relations between fixed entities that denote given order of things. In other words, links and nodes do not exist in and of themselves, but they are both *resources* and results of network processes (Law, 1997).

Resistences	in a dialectical unit such as social|material resistences occur at the level of materials. Thus, if a GPS unit ceases to work during a mapping exercise, it will change the object of the activity from entering GPS points to figuring out how to fix the problem. There is a resistence between the object of the activity and the material configuration, thus initiating a change in the activity system. Resistences become salient to individuals as inner *contradictions*.
Resources	are both material and social, hence the use of the term sociomaterial resources used in this thesis. A GPS unit, quadrat, eelgrass, human bodies, and language constitute both material and social resources. For example, language is social because we can only make sense if others listen and understand and language is also material because our utterances create sound waves that touch the ear bones of others.
Schema	the knowledge of sociomaterial resources and how to act in culturally learned ways in relation to those resources.
Stabilizing Performances	actions, activities or *performances* that lead to a more stable network.
Structure	is composed of all social and material entities (subject, object, tools, rules, community, division of labour) that make up an given activity system.