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Preface

Our goal in writing this book was to develop a way of theorising activity systems and specially their dynamic nature at all temporal scales. To do so, we wanted a way of thinking about systems where change was endemic rather than external to the system, that is, every instance of activity had to be able to produce change even though these changes may not be noticeable on first sight. Because of our background in materialist dialectics, we theorise concrete systems that we not only researched but also in which we participated doing the everyday work of our research participants thereby helping them in getting their jobs completed. That is, we use the studies of concrete systems as a starting point for theorising the continuous changes that they undergo over longer time-scales.

The studies reported in this book were conducted as part of a large research project, *Coasts Under Stress,* designed to understand the impact of social and environmental restructuring on environmental and human health in Canada. As part of this project involving more than 60 natural and social scientists, we conducted a study to understand the interaction of scientific and local knowledge. Our study specifically involved one scientific laboratory that specialised in fish vision (Craig Hawryshyn's research group), which collaborated with one salmon hatchery in particular, Robertson Creek Hatchery. In this book, we are concerned with the work process in the hatchery and scientific laboratories specifically and the ways in which they are connected to events at different levels, both at the micro-level operations and actions that individual human subjects perform and at the macro-level historical events and systems that both constitute resources and constraints to the actions of all actors however located in the salient societal hierarchical relations. Across the different levels, our research design was informed by standard practices of workplace ethnography[1] and by the hermeneutic analysis of historical documents that allowed us to reconstruct the cultural-historical development of the Salmon Enhancement Program (SEP) as one, society-constitutive system in British Columbia, Canada.

Two grants from the Social Sciences and Humanities Research Council of Canada and one grant from the Natural Sciences and Engineering Council of Canada supported this research. We are grateful to all the members of the Salmon

Enhancement Program who have participated in our interviews and who have allowed us to join them in their workplaces to teach us what we know about salmon enhancement. We are particularly grateful to Mike Wolfe and Erica Blake, who taught us most of what we know about pisciculture, and to all of their co-workers and managers who had been incredibly generous in accepting us into their workplace. We are equally grateful to Craig Hawryshyn, Shelby Temple, Theodore von Haimberger, Elmar Plate and Samuel Ramsden for allowing us to participate in their projects and for teaching us every step of their research, from the sacrificing of coho salmon to running the instrumentation and to interpreting the images and data. And we are grateful to Stuart H. Lee, who accompanied us on a number of trips to Robertson Creek Hatchery and assisted in the data collection. All opinions and remaining errors are, of course, ours.

Some of the chapters derive from text that had been published in different forms elsewhere. The materials in chapter 7 come from an article that appeared in *Mathematical Thinking and Learning;* and chapters 3 and 8 derive from articles that appeared in *Mind, Culture, and Activity,* both journals published at the time by Lawrence Erlbaum Associates, the latter on behalf of the Regents of the University of California. Some paragraphs in chapter 6 originally appeared in earlier versions in articles published by the *Journal of Workplace Learning* and *The Learning Organization*. Chapter 9 derives from an article published in *Science, Technology, & Human Values*. We thank the publishers for their permissions given as part of the copyright transfer procedures.

Victoria, Singapore and Mayne Island
August 2008

Introduction

Beginnings

In this rethinking of activity theory so that its *dynamic* aspects become more prominent than they currently are in the literature, we draw on a long-term study of one particular form of activity: salmon enhancement. When we began this work we knew very little about salmon, salmon hatching, the history of salmon hatching, its life cycle, its economic importance to the First Nation peoples and White Western fishermen[1], and so on other than in the most general way.[2] Initially we stumbled upon the system that would become the topic of our research as we began to participate in *Coasts Under Stress*, a large-scale project that sought to better understand and alleviate the problems that has been besetting many communities along the Atlantic and North West Pacific coasts of Canada: economic downturn and hardship arose because the single-industry economies that they depended on disappeared for one or the other reason. Thus, lumber disputes with the US led to heavy tax levies, which all but brought a halt to the Canadian softwood lumber industry. On both coasts of Canada, the fisheries have seen declines in the traditional fish stocks they harvested to the point that in Atlantic Canada a moratorium was imposed on the cod fishery, which had sustained the area and its early seasonal fishermen for over four centuries. The *Coasts Under Stress* project, which brought together natural scientists, social scientists, scholars from the humanities (e.g., historians), and educators, sought to understand the many dimensions of the social and psychological difficulties that these communities and their inhabitants face and have faced, and to propose policies and solutions for assisting the people.

When we became familiar with the intentions of the project during its inception, an important dimension that others did not sufficiently attend to from our perspective was the interaction between scientists and local people. We were familiar with the common problem facing the communicative gaps between practitioners on the one hand and the inhabitants of the 'ivory tower' on the other hand. How would scientists of all ilk be able to interact and work with local people to assist them if there was a perception that the former do not really understand the lives and problems of real people? How would scientists and local people be able to work together towards solutions if there was a gap between 'scientific knowl-

edge', on the one hand, and the various forms of 'local knowledge' (including traditional ecological knowledge of the First Nations peoples, professional knowledge of the inhabitants of the areas such as fishermen), on the other hand? In our research proposal for the larger project, the issue to be addressed was articulated in this way:

> Expert knowledge is produced within disciplinary and bureaucratic boxes and used to develop policy. We can comprehend our natural environment only through the knowledge we generate about it and that has usually been seen as the domain of the expert. Expert understanding is communicated as knowledge or 'received wisdom' about environmental and social processes and shapes the way we problematise and solve issues in the social and natural environments. In sharp contrast, lay knowledge is often not even taken as information, although it is lay people who actually transform their communities and environment, often in response to those policies, and who must live with the health effects of what happens as a result. In this theme area, we look at expert knowledge as it operates in relation to the industrial, resource management, social and environmental processes that direct industry, government and community. Although, of course, essential to our analysis throughout, the work we identify here emphasises particular aspects of knowledge building and transfer which we consider to be of vital importance in understanding what is going on and what could be done to aid the process of restructuring for all concerned. As a result of our examination of vernacular and expert knowledge production and communication, we hope to generate a 'stronger objectivity', and more effective methodologies—in effect, a new and richer knowledge.

During the early meetings for the project we met a biologist, Craig Hawryshyn, specialising in fish vision who talked about his idea of developing a device to determine the best time of the year for the release of young salmon back to the ocean. In fact, Canadian biologists monitoring the coho smolts have found mackerel off the west coast of Vancouver Island with these salmon in their stomachs.[3] Thus, in 1993, mackerel corralled migrating salmon smolts in Barkley Sound (see map in Figure 2.2) and wiped out most of that year's run. The biologist told us that there still existed too little knowledge about the life cycle of the salmon and that there were considerable variations in the return rates from year to year, that is, variations in the rates of salmon that returned to the fish hatcheries after having been released some two to five years before—the precise number varying according to species and even within species.

> *Aquaculture*, a relatively new and vitally important form of resource restructuring, is now practised on both coasts in response to the degradation of wild stocks, and we will examine the problems and promise of this strategy for the future health of fish populations and the survival of fishing. On the West Coast, the cost effectiveness of salmonid aquaculture and enhancement has been affected by the transfer of juvenile salmonids to the marine ecosystem and this has had an impact on the viability of the West Coast salmonid fishery and hence the economic health of local communities. We will investigate the creation of technologies that might improve aquaculture and enhancement

> programs and the viability of salmon and cod farms and we will also examine the impact (negative as well as positive) of aquaculture on wild stocks on both coasts. We will increase the accuracy of establishing smoltification[4] status of juvenile salmon through a visual pigment analysis technique. This work will be used to reduce losses due to parr reversion subsequent to transfer of juvenile salmon to sea pens and or the marine environment and thus our research will have major economic implications for the salmonid aquaculture and stock enhancement program on both the west and east coasts of Canada. We propose to use biomarker compounds and inorganic nutrients to assess ecosystem health at the base of marine food webs in these coastal waters: using these to establish food web interactions is a new, integrative approach that is receiving attention by ecologists. Extending this approach to investigating the environmental impact of aquaculture is unique. We will, of course, also look at wild salmon stocks in their own right, using the [South East] Labrador region, where there is a paucity of data on small-scale local movements of salmon, which needs to be addressed, as does their effect on fishing communities. This we will do, using [local ecological knowledge] to test fish behaviour and local catch and effort data to assess stock status.

The biologist and ourselves decided that while he was engaging in his research concerning the physiological changes salmon undergo during their life stages prior to the release into the wild, which required him to work with salmon hatcheries to get a steady supply of fish, we would conduct research in the hatchery and in his laboratory to focus on the respective sociocultural practices and knowledge exchanges during and following these interactions. This engagement allowed us to study not just one activity system but in fact two systems that were actively engaging each other, exchanging information and material. The changes in both systems, mediated by and through the exchanges, are understood here in the context of larger societal relations of which both systems are constitutive parts. We came to understand that we had to take into account these various societal relations, because neither activity system could be understood independent of some driving orienting force, which precisely is the satisfaction of collective needs, differently articulated and realised in individual needs such as (improving) the production of salmon or producing scientific journal articles.

Our method of inquiry involved collecting data both (a) as contributing participants in the major daily and seasonal tasks at the respective sites and (b) as 'mere' observer of events. As part of our research agreement with the hatchery, we contributed as helpers in the various tasks that have to be done on a daily, weekly, monthly, and even yearly basis. By working in the hatchery and thereby contributing to the realisation of its object/motive, we apprenticed to the different tasks and got to know the hatchery activity system from the inside. As helpers, our goals are therefore those defined by the task and motive of activity; in this case, reflection on the day's work constituted the means of collecting informa-

tional sources. At other moments, we engaged in observation and recording. In this mode, the data sources included observational field notes, videotapes of everyday activities, recorded and transcribed formal interviews, photographs, documents, scientific and mathematical representations, and various other notes and reports created and used as part of the everyday work in the study site. The two forms of ethnographic work—participant observer and observing participant—provided different perspectives of, and constituted complementary ways of experiencing, the productive work in the study site.

To understand the hatchery activity system in general and (science-, mathematics-related) knowing and learning of individuals in particular, we conducted a five-year ethnographic study. To understand the different work processes at a concrete level, we actively participated as apprentice to relevant work tasks, from the taking of eggs and milt, to fertilisation of eggs, fish feeding, and marking.[5] Engaging in these chores allowed us to learn the embodied skills and knowledge that are required for each task. For example, feeding certainly means more than dumping feed into a pond. It requires careful observation to ascertain that the fish are actually feeding, to establish that food size is appropriate, to monitor fish behaviour, and so forth. Past practice showed that it is economically more viable and better for the fish (e.g., there is no wasting food that attracts bacteria) to hire temporary personnel rather than using machines (thus the fish culturists motto, 'Machines feed ponds, humans feed fish'). Because many knowledgeable practices and expertise resist description[6], taking someone's place in the work cycle, even temporarily, allowed us to gain a better, embodied, practical understanding of what embodied hatchery work is and what hatchery workers and fish culturists know.

As part of this large interdisciplinary research project concerned with the socioeconomic changes of coastal communities, Craig Hawryshyn and Michael Roth joined efforts. Michael became both a contributing member in the laboratory group and, functioning as a sociologist, researched the practices in the laboratory in addition to the fish hatcheries that were the potential beneficiaries of the research. As a trained physicist and statistician, he had been familiar with absorption spectra, how to obtain them, and with the mathematical concepts underlying data acquisition, processing, and transformation techniques used in this biology laboratory including Fourier analysis, Fast Fourier Transformation (FFT), inverse FFT, polynomial curve fitting, curve smoothing, convolution, deconvolution, mathematical modelling of transmission and reflection phenomena, and so on.

As part of our research, we also observed and videotaped people as they did their normal jobs; we conducted interviews concerning aspects of the work and the hatchery operation more broadly, kept observation notes, and photographed people, places, and objects. An important aspect of understanding any organisation is the trail of inscriptions it produces, stores, and leaves behind; following the paper trail and the transformations involved in moving data from one form onto another is a key methodological procedure.[7] Thus, we collected (copies, photographs of) artefacts produced as part of the ongoing work. These were digitised (if not already in this form), imported into a word processing program and annotated as a way of providing image-enhanced reports from the field. Alternatively, especially when there were many or large image files requiring lots of computer memory, html format for the production of field notes was chosen. We regularly interviewed individuals from other activity systems, such as research scientists working for the Department of Fisheries and Oceans within the Salmon Enhancement Program and support biologists, who interact, collaborate, and exchange information with hatcheries. We also interviewed the veterinarian responsible for the different hatcheries and former support biologists. All interviews were transcribed in an ongoing manner, as soon as possible after they were recorded.

Laboratory sessions were likewise videotaped in an ongoing fashion and accompanied by daily field notes. The fish retinas, the focal research of the science laboratory, required almost complete darkness during analysis, so that we used a night vision feature on a digital-8 camera. The videotapes were transcribed verbatim, enhanced by images of the graphs being talked about. Subsequently, the tapes were analyzed, which also involved annotating the transcripts where appropriate and modelling mathematical procedures when it was unclear just what was going on when the experiments seemed to fail. In addition, laboratory meetings in which the group collectively analyzed data and designed new experiments were videotaped. The PowerPoint slides used during presentations of the project, draft manuscripts prepared for publications, and videotapes of meetings with the hatchery personnel also entered our database.

The videotapes were transcribed in their entirety, including video images of important moments that cannot be understood without the photographic reference to the situation (or would require complex verbal description). Entire videotapes or episodes of apparent theoretical appeal were digitised to make them available to frame-by-frame analysis and production of high-fidelity transcripts, including,

where appropriate, pauses, overlaps, and emphases. As a first step in the analysis, the transcripts were carefully annotated and analyzed using the highlight and comment functions of a word processor; this analysis proceeds slowly and from a first-time-through perspective aiming at a description of events as these would have been evident to participants at the moment and without hindsight. These annotations provided additional information required for understanding a particular sentence or event, and which was collected as data and available elsewhere in the database. During subsequent passes over the materials, emergent categories were related to one another and to theoretical concepts from activity theory. For example, when we felt that we had represented mathematics in the hatchery, we sent the draft manuscript to two fish culturists, Erin and her mentor Jack, the most senior fish culturist in our primary hatchery, and, according to numerous research scientists we interviewed, one of the most knowledgeable fish culturist they know. We then interviewed both individuals to discuss, clarify, and elaborate the text; the minor changes that they proposed are included in the present text.

This book is thus the result of a concerted and extended effort in collecting and interpreting data over a period of five years. As we engaged with the data sources, we developed an increasing understanding of the varied moments of our activity systems and the difficulties in separating them from society at large. In this book, we articulate and theorise the many existing connections and mediation, which do not easily lend themselves to linear representations, linear information and material transfer channels, or simple *inter*actions. There are repeated instances when we return to 'the same' issues, which in the very fact of our returning, they no longer are the same. We offer not only a historical account of salmon hatching, laboratory research and detailed studies of how the cultural history was produced and reproduced over the five years, but also a dynamic fluid model that is based on an ontology that differs from the ubiquitous structural models in cultural historical activity theory or in actor network theories. Ours is an ontology of difference in and of itself, difference as such, which we, thinking of Heraclites, express in terms of non-self-identical fluids.

4

From the Cultural History of a Salmon Hatchery

Systems are notoriously complex beasts but accounts of their evolution often reduce complexity to simple cause–effect accounts where Machiavellian actors make history, or where some system or distant, impersonal and institutional actor forces ('causes') actors to do what they do. Such explanations are common in scientific thinking, which, as a recent article in *Science* suggests, focused on simple relations between two variables at a time rather than on the complex interplay of many (even innumerable) variables that cannot be independently understood on their own.[1] Such complexity is also shown, for example, with computer models of how decision-making emerges when there are multiple facts and choices are available that mutually enhance and constrain each other, leading to quite unpredictable paths to final decisions (e.g., a classification of specimen by scientists).[2] This complexity is further increased when the model is allowed to develop in time and when irreversible temporal relations enter the equation. In essence, then, properly unravelling such models about systems tend toward chaos or catastrophe theory.

Cultural-historical activity theorists, however, grounded in materialist dialectics, always have attempted to understand systems as *whole* entities, as units, that cannot be reduced into constituent parts (e.g., elements) from which the whole can be re/constructed like molecules are re/constructed from elements. Although Lev Vygotsky pointed out that unit thinking needs to replace thinking in terms of elements[3], many present-day researchers who attempt to make sense of and use cultural-historical activity theory still focus on one or the other moment of a system—for example, the *object*, the *tools* (signs), or the *subject*—without heeding the recommendation to do unit rather than elemental analysis. Here, 'moment' is a constituting and constituted part of a system that can be understood only in its dialectical part|whole relation to the system. Using one moment of an activity system specifically—subject, object, tools, etc.—and of human society more generally to explain the movement of history is a cultural phenomenon in its own right: we tend to attribute discoveries to individuals, awarding them with Nobel Prizes or wins or losses of sports team competitions to this or that person, and our historical museums are still filled with the 'achievements' of kings at the expense

of the history of those who slaved and hungered for these 'achievements' to become possible in the first place. In all these cases, the achievements of complex systems are reduced to individual subjects, who stand in but a synechdochical (metonymical) relation to the system. Apart from the necessity of adopting holistic unit analyses of activity systems, their temporality and interconnectedness between systems and levels need to be considered as well, to which we now turn.

4.1 History and Constitutive Levels in Activity Systems

It may appear alien to some that an attempt to understand human psychology and behaviour in systems should ever consider questions of history. Yet, this is not accidental for the 'H' in CHAT signifies that all activity systems are temporal: systems constitute dynamics and therefore they have a past, a present and a future. Because of the bifurcations that a chaotic system undergoes (see Figure 3.1), its future development cannot be predicted and it is path-dependent. When any researcher considers materials collected during a research project, what he or she encounters is the 'analytic present', a frozen slice that remains as the residue of a dynamic and coordinated activity that is now receding from us. Focusing on static structural representations, such as the popular mediational triangle used in third-generation activity theory, substantially mediates the choice of explanatory accounts: constitutive moments are taken as elements.[4] Unless an effort is made to examine its diachronic aspects, analyses would be always incomplete as Foucauldian genealogical analyses have demonstrated. Furthermore, each of the elements within the activity system has its unique developmental history that requires explanation rather than assuming any apparent stability and permanence: Structures of a system are better conceptualised as moments to emphasise both their temporal and their irreducibly constitutive nature. Some of the temporal relations occur at long time-scales (e.g., capitalism, schooling, child-rearing) so that the moments might *appear* as 'given and transmitted from the past' that are 'directly encountered', as what might seem wholly obvious or given by Nature. This situation reflects what is known as 'la longue durée'—events and structures that persist over long time-scales with which historians are well acquainted. It has only recently been recognised, however, that what happens on global historical dimensions intrude on the everyday lives, cognitive development, discourses, and identities of individuals.

Social anthropologists, sociologists, and micro-historians have only in the last few decades emphasised the exploration of the links between individuals or small communities with macro-historical forces. In fact, global history does not exist

independent of our personal realisation of cultural possibilities at hand, which is the sociological tale that we tell here about salmon, people and Canadian society. To elaborate, people are not mere robots or passive recipients to structural forces no matter how 'given and transmitted from the past' the latter might appear. Through human agency, individuals can marshal recognised resources that are at hand, which then result in contingent and unpredictable outcomes. Each time a person or group of persons (on behalf of an organisation) make a decision, the system goes through a bifurcation point, because the choice of an action alternative that can be calculated does not require a decision and therefore is not inherently linked to responsibility: 'A "responsibility" or "decision" cannot be founded on or justified by any *knowledge as such*, that is, without a leap between two discontinuous and radically heterogeneous orders'.[5] Hence, we realise a dialectical, interweaving process is at work: historical outcomes or situations constitute and construct subjects (i.e., people live history and culture) just as subjects orient to these situations and create new forms of culture (i.e., people make history and culture). In the past social scientists have variously explored this important theoretical understanding that one is both determined by yet also determining of culture; but educators have not done so to any significant extent. Here, we interrogate this longstanding yet intriguing problem of how people make history but not as they please when we use one instant of a concretely realised activity system as exemplar—salmon enhancement in the hatchery at Robertson Creek.

As we do throughout this book, we emphasise that salmon enhancement is an activity interrelated with other activities and society as a whole. The historical movement of the salmon enhancement program cannot be understood independent of the movement of society, on the one hand, and the movement of those entities (e.g., hatcheries) that constitute and concretely realise the program, on the other hand. But 'hatcheries' are not agents in the same way as individual human beings, though from afar they may look as though they were, especially from the perspective of actor network theory[6] and even in everyday usage of our participants, who often refer to 'Ottawa' or 'DFO' as doing this or that *as if* they were/denoted individual human actors rather than institutions. The advantage of actor network theory over many other approaches is that its constitutive moments, the actors, cannot be thought independent of others: any node in a network affects any other node. Any future state is a function of a node's current state plus the mediating effects of all other nodes that it experiences. These nodes therefore are connected by means of mediators, which may be people or artefacts (e.g., inscriptions). The disadvantage of the approach is that the network itself is stable,

though the values and influence of individual nodes may vary. As we show in chapter 5, a fluid ontology is much more suitable to our reframed cultural-historical activity theoretic account, for it allows the very material ground itself to change. This is also the case in our account of the salmon enhancement program, which, as we show in chapter 3, undergoes continuous quantitative change and periodic qualitative turnovers between alternate planes. Here, non-dominant changes do not always get expressed and therefore are not visible. Robertson Creek Hatchery, the institution that we researched, contributes to the constitution of the quantitative and qualitative changes that the Salmon Enhancement Program specifically and the Department of Fisheries and Oceans generally experienced in the historically changing context of Canadian society, and its own change is in turn constituted by events occurring at the systemic level.

A changing Salmon Enhancement Program means that the hatcheries constituting and materialising the institution change: changes at one level mean changes at the other level. It is not that changes at one level *cause*—in the sense of cause and effect—something different at the other level. When things are tied up in a knot, as Nietzsche writes, everything is interrelated with everything else: cause–effect relations no longer explain well the historical trajectory of events and institutions, a trajectory that is inherently path dependent. Rather, we understand changes at different levels of the system to be mutually constitutive: each level presupposes the other.

Similarly, the changes at the hatchery level cannot be understood independent of changes at the level of individuals who, in and through their actions, concretely realise the daily life and routine of a fish hatchery. What individual managers and fish culturists can do and want to do is mediated by the affordances and constraints at the hatchery level, just as the existing personnel and the existing human relations that currently enact hatchery life mediate what happens in this workplace. For this reason, the history of this as that of any other hatchery is tied to the history (biography) of its people as much as the biographies of the people mediate the history of a fish hatchery. Thus, for example, Robertson Creek Hatchery became an indicator hatchery, and, relatedly, many of its staff engaged in scientific experimentation and the development of innovative practices. Being an indicator hatchery and having highly competent and innovative employees go together but do not cause one another, for highly competent and innovative employees come to be what they are because of the particular resources and constraints that mediate what they can do. Furthermore, as an employer for fulltime and part-time

workers, the hatchery contributes to the local economy. Furthermore, the increased numbers of salmon in Barkley Sound and in the Somass/Stamp River system provide employment through the opportunities that fishing and tourism generate.

In this chapter, we provide an intermediate-level account of salmon hatching by focusing on the historical events of one hatchery in particular and the community within which it is situated. Robertson Creek Hatchery played an important role in SEP in that it came to stand for innovation, on the one hand, and its innovation mediated considerable change in the system as a whole. Robertson Creek Hatchery also is an integral part of the city of Port Alberni and it frequently features in the local news media, especially the *Alberni Valley Times*, the articles of which are posted or filed in the archives of the hatchery. Much of what we learned about the hatchery history other than from interviewing employees came from these articles that tell us of the relations of this institution to the region. The importance of the hatchery to the local economy was recognised when the federal Minister of Fisheries and Oceans (David Anderson) announced the funding to the latest expansion in 1998:

> The federal government recognizes the hatchery's vital contribution to a significant sport fishery on the west coast of Vancouver Island and to the economy of Port Alberni. The work will maximize the efficiency of the hatchery, improve safety for its staff and secure abundant production from Robertson Creek in the future.[7]

On June 7, 2001, just after beginning our research in the hatchery, we witnessed the official opening of the new buildings and expanded facilities (see Figure 2.6a, b), enacted in an opening ceremony that included Ron Kadowaki, the Fisheries and Oceans Canada Area Director at the time.

4.2 The Singularity Called Robertson Creek Hatchery

On the afternoon of November 4, 1960, a crowd gathered beside a 700-metre stretch of straightened riverbank on the west coast of Vancouver Island to witness a highly anticipated public ceremony—the official opening of the Robertson Creek spawning channel. The festivities lasted for three hours with displays by scuba divers demonstrating salmon enhancement machinery as well as movie screenings on fisheries research conducted within the area. By all accounts, this technological marvel—the largest artificial spawning channel in North America at that time and costing $325,000—held great promise to boost pink salmon numbers for the Pacific Northwest. When the guest of honour was later interviewed, the Honourable J. Angus MacLean then Minister of Fisheries declared

that Canadian fisheries management was among the most effective in the world. He confidently added that the 'program doesn't concern itself with the protection of fish for the fish's sake, but rather, the creation of conditions whereby the resource can be maintained or improved for the benefit of generations to come'.[8] Although 1.6 million eggs were planted in the specially engineered gravel beds that saw spectacular increases (up to 85%) in hatching over natural rates, Robertson Creek welcomed back very few adult pink salmon in subsequent years. Following on the heels of the nearby pilot cum research hatchery on the Big Qualicum River, a similarly successful pilot project was initiated here in 1971 and salmon production began afresh but now was stocked with Chinook and coho by the fall of 1972. From these somewhat tentative beginnings was born what we now know as Robertson Creek Hatchery.

The histories of British Columbia, the Salmon Enhancement Program (SEP), hatcheries and people therefore are mutually interdependent at three levels: macro (society in British Columbia and Canada), meso (SEP and its constituent hatcheries) and micro (fish culturists and other SEP staff). The development of SEP and Robertson Creek Hatchery as an organisation parallels that of making salmon as a societal goal, just as SEP allowed the hatcheries to flourish and have justification to spend money on construction and staff salaries even though adult salmon numbers were often seesawing. Likewise, this guiding vision of restoring salmon numbers to 19th-century levels gained legitimacy in the eyes of the scientific community and the public as they witnessed one hatchery after another being erected. And fish culturists could be employed because there were institutions like fish hatcheries that defined and gave a societal context for salmon aquaculture and the labour for these workers in the first instance.

Apart from constraining the evolution of salmon-biology-related knowledge through limiting resources and stopping even successful enhancement programs, the economic malaise affecting SEP had concomitant mediations at the psychological level, expressed and exhibited in low worker morale and employment. As well, there was a slow but inexorable move toward an acceptance of conservation values by the mid-1980s in British Columbian society thus surfacing enormous tensions for the organisation and all workers in SEP. Whereas these biological considerations were not absent from its inception, policymakers in SEP had favoured massive artificial technologies for making salmon as their best bet to achieve early and continued success. When pressures from conservationists and scientific awareness grew over time, these amplified contradictions and tensions

at the ground level, which, in turn, fed pressures and the articulation of scientific awareness. From these episodes, we gain a deeper appreciation that the three levels—society, institutions (SEP and hatcheries) and human agents—are mutually constitutive albeit operating at different time-scales. Yet at every instant, micro-, meso-, and macro-history are necessarily intertwined as individual operations and actions constitute the concrete realisation of hatcheries, which constitute the concrete realisation of SEP; but SEP both orients and constrains hatcheries, which both orient and constrain individual employees. After we describe the importance of the hatchery to the town, we show how a cultural sociology that considers the individual and collective within the same unit of analysis provides a proper lens to understand human behaviour and ultimately how complex systems change.

4.3 The Stakeholders of Robertson Creek Hatchery

How vital Robertson Creek Hatchery is to the local economy can be gleaned from a few unhappy incidents in the past. In the early 1990s, a big protest was mounted outside the headquarters of the Department of Fisheries and Oceans in Vancouver by sport and commercial fishers in response to alleged over-fishing by Native bands in the hatchery vicinity. Whereas we are uncertain about how this dispute was resolved, equitable distribution problems have been persistently plaguing the federal Department of Fisheries and Oceans and the government: First Nations people are allocated a certain number of fish by law and enjoy more harvesting privileges than non-Natives. When the law was also amended around that time to permit Native fishers to sell their surpluses where formerly disposing of all food fish was illegal, this spawned open confrontation and feelings of unfairness among non-Natives. And if a price tag can be stuck on the value of sport fishing to the town, it could nudge $50,000 per day according to angry citizens during a sockeye fishing moratorium in 2001. This particular complaint reached many members of parliament in Ottawa such was the degree of disgruntlement.[9] It is therefore not difficult to imagine the tensions arising among residents whenever hatchery production was and is trimmed. Usually such a decision makes headline news in the local dailies and the manager has to explain his rationale to the extent of sounding apologetic at times. Public reaction typically greets these announcements with much dismay but they are helpless and can only trust that DFO and the hatchery staff know what they are doing.

Being notoriously difficult to link with certainty the organic interplay between levels and between systems, we have chosen to feature how in the past 30 years shifting political climates have been concomitant with federal mandates that de-

creased (and occasionally increased) hatchery budgets thus constraining the room to manoeuvre in the kinds of scientific knowledge that were being generated in the organisation. The vagaries of funding in SEP generally and the hatcheries such as that of Robertson Creek specifically were in fact an underlying reflection of societal woes especially in the late 1970s and early 1990s though it continues right to the present. Thus, for example, in 2002, the federal government cut the hatchery budget by $30,000, which meant that the coho production had to be cut in half, because, having to be fed for 18 months, it is the 'high-cost item'. The woes were apparent from early on, as already in 1978 the federal government considered contracting out part of the work done at Robertson Creek. This would have meant that two to three long-term jobs would have been lost in addition to eight to ten seasonal workers.[10] In 1980, a confidential government report recommended to immediately scrap all coho and Chinook hatcheries, the two main species produced at Robertson Creek. However, even the successes of the hatchery in production and return rates sometimes mediated the impact in policy planning. Thus, in 1985 the community advisor with Fisheries and Oceans, Brian Allen, pointed toward a positive future for Robertson Creek all the while noting that other hatcheries and spawning channels may have to be cut.

The increasing importance of Robertson Creek Hatchery was mediated in part by its tremendous production outcomes, which was making it the largest Chinook facility in British Columbia. By 1975, the hatchery had increased its rearing capacity by two ponds whereas a second expansion in 1980 increased incubation, rearing and adult fish handling facilities plus a water cooling system for the summer months to reduce stress and disease among fry. At present, the hatchery exerts a wide-ranging influence on commercial and sport fisheries for it releases up to 8 million Chinook, 1 million coho, and 180,000 steelhead smolts every year into the northern Pacific. Although adult salmon return rates varied over the years from 2% to 10%, these have been superior to natural spawning rates and thus turned out to be of great benefit to numerous Canadian, First Nation and Alaskan fishing communities. Thus, for example, because it is the only hatchery with consistent tagging since the beginning, it could be established that—without upward or downward trend—between 54 and 77% of the Robertson Creek coho stock were taken off the west coast of Vancouver Island by troll fishery and up to 50% have been caught in Barkley Sound.[11] These spillover effects from Robertson Creek are not confined to fishermen throughout the coast but also have helped the nearby town such as when the fish culturists from the hatchery double-up as educators and go to school classrooms to teach salmon biology and habitat conserva-

tion (see Section 2.8). Over the years, the Robertson Creek fish culturists have also worked closely with local conservationists, offering their first-hand knowledge of fish biology and creating both goodwill and awareness of ecological issues impacting the community. Other forms of outreach from the hatchery have included opening up the facility to visitors all-year round as well as the annual Salmon Derby whereby scientific fish counting is combined with family-friendly angling competitions. As we have discovered, Robertson Creek Hatchery has an integral relation to the nearby town of Port Alberni (for manpower, goodwill) just as the hatchery serves and contributes to its economic development and livelihood of its citizens over the past three decades. The integral relation between hatchery and community is apparent from the fact page concerning the town on an Internet site featuring British Columbia (britishcolumbia.com) lists the hatchery among its main features and attractions.

This is the case not only for the predominantly white inhabitants of the town but also for the aboriginal communities from different Nuu-chah-nulth tribes that live at the lower part of the river within a mile or two of the estuary.[12] The different Aboriginal communities, as the introductory quote to chapter 3 shows, depended on the salmon that return for food and some find at least temporary employment in the hatchery. They still depend to some extent on this food staple and also have rights to the salmon that make it into the Robertson Creek Hatchery (see Section 2.3.1). This is certainly no mean boast, for the town's very existence was once jeopardised when the forest industry experienced a severe downturn and many locals then turned to the highly lucrative sport fishing business.

It is this very dynamic interplay between global-local interactions that we make thematic here in highlighting portions of the organisational history of Robertson Creek Hatchery. Without the individuals who actually constituted the routine work of producing salmon in hatcheries, their influence on salmon production in British Columbia and Robertson Creek is inadequately theorised. Likewise, neither can one deny the influence that the fishing crisis after the World War II and salmon enhancement as an ongoing societal object/motive had in shaping hatcheries and individuals involved with salmon to become what they are, as Karl Marx articulated in his aphorism, 'Men [sic] make their own history, but they do not make it just as they please; they do not make it under circumstances chosen by themselves, but under circumstances directly encountered, given and transmitted from the past'.[13] This path dependence, observable in our catastrophe theoretic rendering of the movement and evolution of the system

(Figure 3.1), leads to a history that integrates itself over. This idea of the self-integrating nature of a system also is central to the idea of the eternal return in and of complex systems, as Nietzsche put it into the mouth of Zarathustra: 'Und sind nicht alle Dinge so verknotet, daß dieser Augenblick alle kommenden Dinge nach sich zieht? (And aren't all things knot-worked in such a manner that this instant entails all future things?)'[14]

As far as the public is concerned, the raison d'être of SEP hatcheries is undisputed and thus fish production (and conservation) has to be defended at all costs. For example, during occasional labour disputes that affect government employees, strike captains have been known to permit fish culturists and other essential hatchery workers the liberty of continuing work because they know full well the ramifications of jeopardizing the salmon runs. This hardnosed pragmatism was not always apparent a decade ago when hatchery workers were asked to picket for a week during the fish smoltification period, which could have resulted in disaster ultimately for fish and humans. As Erin at Robertson Creek Hatchery said during one such recent strike, 'Salmon don't have time for labour disputes'. Apart from simply making more fish, the hatchery has been slowly increasing a stock of mutant orange-coloured salmon—so-called 'Spirit salmon'—to be displayed at town's annual fall fair and at the Vancouver aquarium. Arising from a rare mutation that similarly accounts for the albino bear in Northern British Columbia and the albino tiger in Bengal, the townspeople have been hoping to make this creature a star attraction in the push for tourist dollars.

4.4 Financial Woes in the Hatchery

The ups and downs in the local economy of Port Alberni are mediated by events at the societal level generally, which also mediates the funding available to the fish hatchery at Robertson Creek. Thus, general societal developments, international markets that mediate the fisheries and lumber industries on which Port Alberni depends and funding levels to the local fish hatcheries are irreducibly knotted together having, as Nietzsche observed, mediating effects on everything else in the future of the system. Financial woes have hit Robertson Creek Hatchery hard in various and multiple ways over the years, and they have hit the town of Port Alberni at different times in equal manner. In the hatchery, it directly curtailed the purchase of equipment such as rearing pens for fry, heat exchangers to control for water temperature, and cuts to water monitoring, fish counting and other vital scientific activities.

Though not necessarily affecting the quantity, budget cuts diminished the quality of fish feed that could be bought and thus the quality of fry that were subsequently released. Taken together, these serious knock-on effects where there are lessened resources to go around could mean as much as a 25-percent drop in fish production in a single year. In terms of impacting manpower, which is usually the largest expenditure of a hatchery other than capital costs, hatchery management have oftentimes been forced to release full-time workers and rely instead on a pool of temporary staff. This also happened to Erin, who had 'filled in' for another fish culturist for many years until the person return following budget cuts; Erin's work was handed over to another temporary worker. Granted that budgets can be balanced this way or more part-timers can benefit, the long-term costs have yet to be considered. Newcomers do not know how to properly feed fish and are not attuned to the subtleties of how the fish are 'speaking' to their feeders. Relying on seasonal workers is also problematic for they lack the embodied knowledge of fish culture or do not stay long enough to pass it onto somebody else even if they manage to learn it. This highly precarious state of employment at Robertson Creek and other hatcheries has thus affected the detrimentally as the hatchery manager in office during our study admitted.

This is not to say that when possible, DFO has not tried to support its hatchery facilities. In 2001, a newly renovated Robertson Creek Hatchery was opened at a cost of over a million dollars. Compared to the haphazard assortment of old buildings, the new facility built in parts over a four-year period boasted a new incubation shed, lunchroom and offices for all staff. Not only was a more conducive working environment been created, it has become a quiet but highly scenic tourist spot with abundant wildlife (e.g., black bears, water fowl) to be spotted.

For the staff at Robertson Creek Hatchery, there was an assurance that no matter how bad the situation was regarding funding, the facility would never be completely closed. This was because of its scientific importance to Canada: the quantity of salmon produced from this hatchery featured in a resource sharing treaty with the United States. In scientific terms, the facility was an indicator for stock assessment for DFO in the Pacific, especially for Chinook and coho species. Of course, this fact did not guarantee any *individual* could have been transferred to another DFO office, or worse, laid off.

4.5 Societal Conditions Mediate Institutional Life

As the fish culturists at Robertson Creek complained to us in so many different ways over so many occasions, 'DFO [Department of Fisheries and Oceans] doesn't give a shit about fish, they just worry about dollars!' Even before the beginning of the SEP, as we articulate in chapter 3, fiscal restraint was being imposed upon the program, although its first director Ron MacLeod had reiterated that not everything was to be evaluated on a cost-benefit basis.[15] Still, being the pragmatic leader that he was MacLeod also realised that people in the province of British Columbia wanted and needed to see where their taxes were going. For example, one of the most visible signs that something was being done about the salmon problem was in the actual building of permanent and manned enhancement facilities—hatcheries. No other salmon production technology in SEP quite captured people's hearts and attention as hatcheries, for the others were small, unmanned, blended in with the local environment or tucked away in some secluded area. As well, hatcheries provided public information such as brochures advertising what these facilities were concretely doing in terms of salmon enhancement (e.g., production figures, conservation outreach efforts) so as to deepen their bonds with the surrounding communities. Above all, salmon hatcheries were publicly visible structures—some say 'monuments'—that the authorities far away in Ottawa were taking things seriously. Here we clearly see the interconnectedness of hatcheries, such as Robertson Creek, the general public and politics.

Other SEP employees were even more forthright and strident in emphasizing how the program had to prove itself as an accountable and accounted-for investment for politicians in Ottawa as well as for ordinary folk in British Columbia. Failure to recognise this foundational principle might have diminished the resources in and for the program from the federal government and thus might have endangered its chances of success in an already precarious fishing crisis situation.

Harold: [W]ith this hatchery[Robertson Creek] too there was more money for that kind of work.
Rick: Yea.
Harold: In the eighties there was a great time
Rick: Lots of money around then yeah
Harold: A lot of money around.[16]

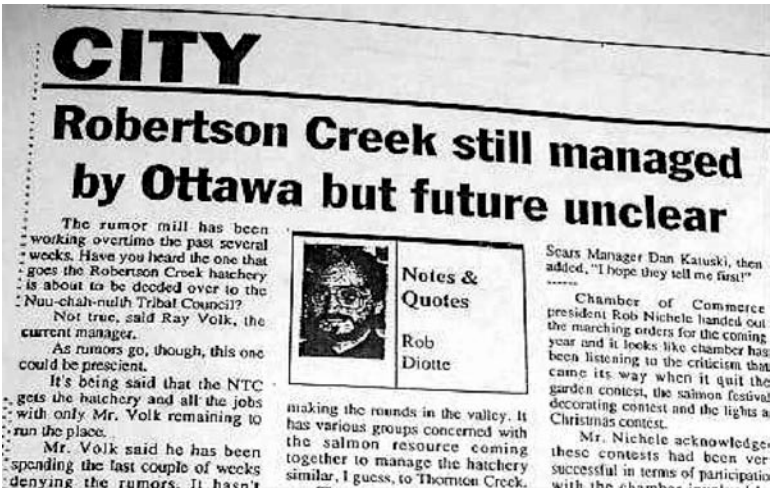
On hindsight that shows historical antecedents ever so clearly (though they are not known as such to participants at the time), larger societal forces were indeed overshadowing the program when it was starting in 1977 for SEP coincided

with a period of increasing economic woes and worsening national debt. Coupled with rising inflation, Canada experienced economic recession in the early 1980s leading to government deficits, unemployment and general disaffection among its citizens from coast to coast. Not surprisingly, the local newspaper reported on the possibility of Robertson Creek to be among other hatcheries to be scrapped. This milieu that times were hard and getting even tougher moved some provincial biologists to note that 'it is the intention of the economic people to prepare a program that will stand up to the Treasury Board scrutiny and make sure the politicians have some valid political arguments in terms of dollars invested. The problem at present is that in today's climate the Treasury Board is ruling more than in the past because of the era of restraints'.[17] Similar to the kind of resentment surfacing during ordinary dinner conversations about how 75 dollars could go fast in a day, these kinds of grumblings were created and sustained, and they received widespread legitimacy during the late 1970s in North America.[18] On the one hand, complaints about (the lack of) money came from individuals who articulated their first-hand frustrations about the rising costs of living. On the other hand, a nascent change was brewing that prepared a social context and justification for those kinds of behaviours and emotions that manifested in contingent forms (e.g., complaints talk, strike action) everywhere.

How did the stagflation[19] of those times impact upon institutions like SEP with its myriad hatcheries and the people involved in salmon enhancement? These nation-wide events mediated the kinds of talk and actions within the whole of SEP, especially budget cuts, which mediated what was and could be done at the hatchery level, constituting in terms what the Program could be. After period of intense building or what was often derisory known as 'concrete-pouring extravaganzas', hatchery development slowed down by the mid 1980s.

> Kris: So it's really tough . . . [the Salmon Enhancement Program] right now is faced with some massive they're gonna have to produce some really big budget cuts and they're really struggling . . . it's the only way you can make the cuts is to cut hatcheries . . . because they can't just pare back production you don't' save enough that way.[20]

As we explain below, there were many reasons for this initial building frenzy but what is perhaps more interesting was why it halted quite abruptly. Given the reigning climate of political and economic pressures for more fish, the major mediating factor that presented a large obstacle for massive production goals in the Program was insufficient financing by the government. There were certainly other reasons (e.g., the rise of conservation ethics in the 1990s) but funding issues as a key mediating moment was firmly on the lips of everybody, inside and out-



CITY

Robertson Creek still managed by Ottawa but future unclear

The rumor mill has been working overtime the past several weeks. Have you heard the one that goes the Robertson Creek hatchery is about to be deeded over to the Nuu-chah-nulth Tribal Council?

Not true, said Ray Volk, the current manager.

As rumors go, though, this one could be prescient.

It's being said that the NTC gets the hatchery and all the jobs with only Mr. Volk remaining to run the place.

Mr. Volk said he has been spending the last couple of weeks denying the rumors. It hasn't

Notes & Quotes

Rob Diotte

making the rounds in the valley. It has various groups concerned with the salmon resource coming together to manage the hatchery similar, I guess, to Thornton Creek.

Sears Manager Dan Kaluski, then added, "I hope they tell me first!"

Chamber of Commerce president Rob Nichele handed out the marching orders for the coming year and it looks like chamber has been listening to the criticism that came its way when it quit the garden contest, the salmon festival decorating contest and the lights a Christmas contest.

Mr. Nichele acknowledge these contests had been ver successful in terms of participatio

Figure 4.1. One of the many old newspaper clippings, kept at the hatchery itself, showing threatened closures of Robertson Creek Hatchery. This particular one came from the early 1990s.

side of salmon enhancement. The fish culturists and managers at Robertson Creek noted these connections between possibilities at the local level and the funding levels made available to each hatchery through DFO:

> Erin: I don't know . . . are you gonna give us money, are you gonna give us the time, make up your mind. It's never, it's never the lack at this facility and I think at most places, the lack of will for wanting to do things, it's either, it's not even sometimes, well sometimes it's resources cause I know that, well it all comes down to money and time, because there's been times too with a lot of the scientists, that that because their budgets have been reduced and they're trying to cram everything in, that even though they truly like to do things, if it cost too much money or too much time, they can't.[21]

Apart from the slowdown in building more hatcheries, the belt-tightening exercise caused the closure of those facilities that were deemed underperforming by the department. Because these were usually located in the interior of British Columbia where unemployment was rife, it resulted in additional hardship for local and First Nation communities that depended on them for employment, tourism, and food. Robertson Creek Hatchery had the advantage that it was always very productive and, in time, had become an indicator hatchery, which meant additional security when the question was discussed as to which hatcheries were to be scrapped. The Department of Fisheries thus accrued intense hostility and ill feelings and had to carefully manage public perception that it was producing enough fish to help lift Canadians out of their economic woes. Even Robertson Creek

Hatchery was not spared from periodic threats of closure or being sold to be managed by the private sector or becoming a bargaining chip between the federal government and the local Nuu-chah-nulth Tribal Council (Figure 4.1). This predicament was thus indicative of how a change at the societal level came with concomitant changes in the SEP generally and the hatcheries (meso-level) more specifically: a curtailment of salmon production when this very outcome was supposed to be the magic bullet to lift western Canada out of inflation.

Although stagflation was not to hit the nation again until the early 1990s, this ongoing trope of budget cuts as a convenient account and explanatory device about why SEP has not lived up to public expectations has persisted. In the new millennium, this has visibly manifested itself in curtailment of conservation programs for children, decreased monitoring of adult salmon returns, strikes over pay disputes with management (see Figure 4.2), and decreased scientific activity by the fish culturists to which we now explain in greater detail.

4.6 Institutional Events Mediate Individual Life

Since all three levels of society, institutions, and people are interconnected, it comes as no surprise to see the effects of budget cuts constituting constraints to actions at the individual level, that is, to actions not only on the part of hatchery managers but also those of individual fish culturists. The constraints are apparent in the following statement by a manager of the Robertson Creek Hatchery:

> It seems like it's very difficult to get interest and I think this is a spin-off of the fact that we've been under this umbrella . . . we're gonna cut your budget, we're gonna close half you guys and we're gonna kick you out cause we don't think you're any good anymore and that's basically what we've been told and that has effects all the way down the line so and where do you get the inspiration and the motivation to do these things if you're waiting for a hammer to drop on your head? It's so it's as disappointing as it is and as hard as it is to fight against that it's that's the effect and there are ways to converse with people but I don't it's difficult to if people are concerned about their own like maintaining their job and if this place is gonna be here in two or three years then it's hard to get them inspired in other areas they sort of focused on that.[22]

Within SEP, the frequent budget cuts were affecting the everyday lives of the workers most involved in making salmon: the fish culturists at the hatcheries. These staff were mainly high-school graduates and most of them had risen up through the ranks, starting perhaps in the way one of the fish culturists at Robertson Creek Hatchery (Jack) did, as a maintenance staff who later switched to aquaculture whereas others began as part-timers, that is, one of the thirty odd