Salvage Cartographies: Mapping, Futures, and Landscapes in Northwest British Columbia

by

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Submitted to the Program in Science, Technology, and Society in partial fulfillment of the requirements for the degree of

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ABSTRACT

This dissertation examines how the proliferation of digital mapping technologies and the contraction of government research institutions have reformatted contests over resources, sovereignty, and local belonging in the neoliberal era. The two groups at the heart of this multi-locale ethnography, government forest ecologists and Indigenous Geographic Information Systems (GIS) specialists, share entangled histories throughout rural North America. This is particularly true on the Gitxsan and Gitanyow traditional territories in northwest British Columbia. As climate change and emergent forest diseases destabilize both Indigenous and settler communities' abilities to predict and plan for environmental shifts, disparate experts are learning to leverage marginalized maps and ecological succession models to reconstitute modes of professional succession rendered precarious by government reforms and internal tribal conflicts. The opening chapters of the dissertation examine two experimental institutions – an independent forest ecology research center in Smithers, B.C., and a defunct GIS analysis team based on a nearby Gitxsan reserve – to examine how rural scenes of collaboration complicate the modalities of influence and organizational coherency often attributed to professional scientific networks. Later chapters explore experimental forest and traditional territories where ecologists and Indigenous GIS specialists have sought to articulate risks and project landscape futures by producing technical knowledge. For both communities, transects, grids, and other techniques of marking space have forced them to negotiate tensions between the temporal decay of these spaces and the lifespans of individual researchers. The concluding chapter examine the agencies of archives and simulations produced by two separate long-term forestry modeling groups. By treating their discarded models as anchors of a kind of professional legitimacy no longer stably recognized by a changing provincial government, I argue that senior forestry modelers are struggling to frame their work within longer historical narratives which supersede the temporalities of the state. Twentieth century conservationism drew heavily on essentialized discourses of "nature" and "culture" to construct old-growth rainforests and other contested spaces as objects worthy of protection. This dissertation examines the destabilization of these classification systems, and the palimpsest of legal definitions and lived concepts of territory left behind as regulatory responsibilities devolve and dissolve.

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Glossary of Acronyms

BVRC	Bulkley Valley Research Centre
CRB	Bulkley Valley Community Resources Board
EBM	Ecosystem-Based Management
FLNRO	British Columbia Ministry of Forests, Lands, and Natural Resource Operations
FRBC	Forest Renewal BC
FRPA	Forest and Range Practices Act
GHASA	Gitxsan Huwilp Advisory Services Association
GWA	Gitksan-Wet'suwet'en Alliance
GWES	Gitksan-Wet'suwet'en Education Society
JRP	Joint Review Panel for Enbridge Northern Gateway Project
LRMP	Land and Resource Management Plan
MOE	British Columbia Ministry of Environment
MOF	British Columbia Ministry of Forests (defunct)
NDP	New Democratic Party
SWAT	Gitxsan Strategic Watershed Analysis Team
TASS	Tree and Stand Simulator

Acknowledgments

By the time I walk across the stage in Killian Court in June, 2016, I will have spent 21% of my life as a graduate student in the History, Anthropology, and Science, Technology, and Society program at MIT, and over 33% of my time on earth as an MIT student in total. It is with these preposterous numbers in mind that I begin this list, since it shows how foolish it would be to distinguish between those who helped me shape the work presented in these pages and those who helped me find my way through life in the meantime. Most of the fantastic people whose names are listed below will never read a word of my professional work, and that's okay: perhaps putting their names in text here will accidentally remind them of the debts I owe them after an idle Google search or ProQuest perusal brings this document onto their screens some decades down the road.

Immediately before I joined the HASTS program at MIT, Naomi Kohen, Jessica Shu, Matt Brooks, Greg Sanz, Chris Kelty, Colin Koopman, Ronald Gronsky, Daryl Chrzan, Donna Haraway, and Paul Rabinow and his "labinar" group at Berkeley all offered wisdom and encouragement that gave me the confidence I needed to transition away from a career in engineering toward a less certain future in anthropology. Before I began traveling to and writing about British Columbia, however, I spent several years exploring metallurgy laboratories and other scientific spaces in southeastern Brazil. Paulo Jacob Silva and his family, Marília, Manoel, and Livia, welcomed and hosted me during my initial visits (including long, recuperative periods when I wasn't thinking about much of anything academic whatsoever), and I will always be grateful to them for helping, however inadvertently, to energize my transition into anthropology. Paulo also did me the great service of introducing me to the excellent Hélio Goldenstein, who, with his wife Marlene and son João, hosted me on subsequent visits and introduced me to scientists and other scholars all over Brazil, including Pablo Mariconda at the Instituto de Estudos Avançados at the University of São Paulo, and his visitor Hugh Lacey. Hélio's brother Pedro, Pedro's wife Ana Lefèvre, and their children (now adults!) Lais and André subsequently hosted me during my first period of sustained fieldwork at the Laboratório Nacional de Síncrotron Luz. Jamille Pinheiro, Thaícia Stona, and Stelio Marras welcomed me back to Brazil for exciting meetings with both anthropology and mathematics students, and Jamille and Thaícia have remained thoughtful friends ever since. During my summer at the LNLS, Harry Westfahl, Mateus Cardoso, Leide Cavalcanti, and Gabriel Moreno all proved to be wonderfully engaging interlocutors; while I have yet to follow up on these initial visits, it was Leide's exuberant anecdotes about her postdoctoral appointment in northern Norway and her visits to Svalbard that made start thinking for the first time about moving my ethnography north (a point that I'm sure Leide would be bewildered to learn after all of these years).

Before my fieldwork in British Columbia began in earnest, I spent a bewildering six months guiding my dad through a brief and unsuccessful skirmish against lung cancer. A tremendous number of people offered me wisdom, kindness, and free housing during this period, and I am particularly grateful to Jim Hollenbach and Allison Piasecki, Kristen Schwarz, Lauren

and Danny Ahkiam, Yaman Salahi, Colin Jenkins and Hannah Rosenau, Nikki Sanchez, Brigitte Liebowitz, John Grant, Ellie Attarian, David Mordetzky and the staff of Hallmark Lighting, and the doctors, nurses, and social workers who spent so much of their time with my dad and me at Huntington Memorial Hospital and Marlinda Nursing Center in Pasadena, California. During a furious period of grant-writing back in Cambridge between my months at the hospital and my year in the field, Aslı Arpak and Ekin Kurtiç kindly welcomed me as a guest roommate despite not having any idea when I intended to leave. A few years later, Matt Brooks and Kristen Ashford reprised this gesture by hosting me in North Carolina during my periodic escapes from New England. My profoundest thanks, though, are reserved for Elizabeth Miglecz and her daughters Agnes and Adrianne Gyorfi, who fed and housed me pro bono for an entire summer during my dad's illness. The fact that I stayed in graduate school and completed my dissertation at all, and that I was able to transition more or less directly into fieldwork after such a difficult and disorienting period, is a testament to their generosity and grace.

In keeping with the theme of recognizing people whose contributions had little direct effect on my dissertation, I owe thanks to a number of people who hosted me during periods in Vancouver, Victoria, and Edmonton, Alberta. Jonathan Buchanan, 'Lyn Anglin, Eliana Macdonald, Jim McKenzie, John Veltheer, Jenna Hardy, JoAnne Nelson, Yao Cui, Kirk Hancock, Tian Han, Nicole Barlow, John Gorham, Brad Ulry, and Matt Carter were all generous and patient with their time and answers during my initial forays into the world of mineral exploration. Lance Murakami, a longtime friend, personally chaperoned me to a prospective field site in northeastern Wyoming during this period, too, and regaled me with enough geological knowledge along the way that I was able to ask intelligent questions upon our arrival. Peter Teng and his family, Candis Callison, Tyler McCreary, and Thomas Chudy became much needed friends during my first visits to Vancouver, as did Esra Bakkalbaşıoğlu, Zeynep Kaşlı, and Filiz Kahraman during my extended stays in Seattle.

During the part of my fieldwork actually discussed in the dissertation (finally!), I found a remarkably welcoming community in and around Smithers, B.C. Yvonne Lattie and her family, Bridie O'Brien, Neil J. Sterritt, Kenny Rabnett, Doug Donaldson, Amanda Follett, David Belford, John Ridsdale, Daryl Hanson, Roger McMillan, Don Morgan, Rick Budhwa, and many others all helped me to find my bearings and get myself entangled in the joys and dramas that come with small town life. Perhaps more than any other single individual, Richard Overstall helped to connect me with potential interlocutors (to all of whom I am intensely grateful, even if I cannot reveal their names here) and demystify the dense and complicated recent history of the Bulkley Valley for me during long, patient conversations. My hosts in Smithers, Tracy and Bill McIntyre, emphatically made me part of their family throughout my time in the northwest, and helped me to feel like I had known them, their friends, and their neighbors for years.

Elsewhere in B.C., I also enjoyed gracious welcomes and good conversation. In Prince George, Gail Fondahl, Staffan Lindgren, Kathy Lewis, Dezene Huber, and Greg Lowan-Trudeau helped to expand and improve my project through productive and engaging correspondences. During my second period of fieldwork in Victoria, a large number of employees of the B.C. Ministry of Forests, Lands, and Natural Resource Operations were similarly generous and reflective (but, government being government, would prefer that I not list their names). Greg Lawrance, Zaid Jumean, Marc Porter, and Matt Austin also offered perspectives on their work with other ministries and consulting groups, opening up avenues that I hope to pursue in later work. My long conversations with Marvin Eng provided a Rosetta Stone that helped me to

unlock the meanings and insinuations of Victoria's particular dialects of ministry-speak, and I am genuinely grateful to him and his wife for making sure that my time in the capital wasn't spent solely in interviews and office visits. Andrew Fall was similarly expansive and inclusive during my brief visit to his home on Lasqueti Island.

Since beginning the writing process in early 2014, I have had the good fortune to share still-forming pieces of this dissertation with a number of helpful readers and audiences. Students at the State University of New York in Oswego and the Environmental Studies program at Tufts University offered a range of productive and often unexpected questions which significantly improved chapter five of this dissertation, and I am grateful to Lindsay Bell for arranging the former encounter, and to Colin Orians for overseeing the latter. Attendees of the "Fields of Inquiry" workshop at U.C. Berkeley provided helpful comments on early writings that have diffused into multiple chapters; Bill Leslie and workshop convener James Skee were particularly generous in their feedback there and in subsequent conversations. Paul Nadasdy served as a discussant on a panel that Tyler McCreary and I organized for the 2014 meeting of the American Anthropological Association, and his comments have proven to be crucial in pushing me to broaden my conceptualization of the dissertation as a whole. Members of the Harvard Anthropology Department's Political Anthropology Working Group and Political Ecology Working Group were indispensable in helping me to re-work an early draft of chapter one; Delia Duong-Ba Wendel, Eve McGlynn, Jared McCormick, and the indefatigable Rachel Thompson were particularly generous with their time and feedback. Also at Harvard, Sheila Jasanoff and numerous members of the Science and Technology Studies Circle (the ones who braved the first awful blizzard of 2015 to hear my talk, that is!) offered extremely useful comments on what became chapter two, as did thoughtful audiences at Rice University's Humanities Research Center and the College of Environment and Natural Resource Management at Cần Thơ University in Vietnam. My visit to Cần Thơ took place during a semester-long appointment at the Singapore University of Technology and Design (SUTD), and the International Design Center at MIT and my advisor Mike Fischer are due no small thanks for making this possible. The faculty at SUTD, particularly Nilanjan (Nina) Raghunath, Alan Kolata, Lyle Fearnley, To Kien, Judy Jia, and Keng Hua, helped turn Singapore into an ideal place to live, think, and write during our too-brief stay on the island.

In my first year back from Singapore, I found a warmly supportive community at Tufts University. Lynn Wiles and Jamie Gorman have made me feel welcome and well looked-after during my time as a lecturer in the Department of Anthropology, and Ninian Stein, David Guss, Cathy Stanton, Rosalind Shaw, Nick Seaver, Sarah Pinto, and Amahl Bishara have all been excellent colleagues. My undergraduate students, some of whom were subject to an early draft of chapter four of this dissertation, have been relentlessly engaging, patient, and challenging throughout. I could not have invented a more inspiring gateway to teaching anthropology at the university level.

After eleven years as an undergraduate and Ph.D student and candidate at MIT, my debts on and off campus here have become intricate enough to fill a phone book. Stephen Tapscott has been a stalwart friend, model, and life coach since I first enrolled in his course, "Modernist Poetry," in 2003. With his late husband Andy Arling, Stephen has been indispensable in helping me build a sense of continuity in Cambridge amidst a steady stream of friends (first from undergraduate, now from HASTS) swimming away from New England in search of better jobs and warmer waters. Among the few close friends whose extended stays in the Boston area have

overlapped with my own second stint in Cambridge, I'm particularly grateful to Amelia Evans, Peter McMurray, Derek Noad, Lysa Clavenna, Matteo Visentin, Ben Wunsch, Melanie Barton Wunsch, Jeff Kuna, Tyler Hutchison, Emily Alexander, Alejandra Azuero, Anton DeWinter, Gabe Cira, Gillian Osborne, Brian Pettite, Seohyung Kim, Alex Donnelly, Paul Tillberg, Charlotte Gopinath, and James Silva, all of whom have done much to break up the anxiety and drudgery of academic life. Even after he moved to Hartford, Connecticut, Dan Miles has spent hours on the road every month to restock my bourbon collection and keep me company on long weekends.

My cohort mates in the HASTS program (one of whom has earned a special paragraph below), Emily (Xi) Lin, Canay Özden-Schilling, and Amah Edoh, and many of our fellow graduate students in the program have struggled valiantly to make Cambridge both an intellectual community and a place of belonging and care. For sharing beers, words, and miniature dramas with me, I am particularly grateful to Michaela Thompson, David Singerman (and Mary Kuhn), Marie Burks, Shreeharsh Kelkar, Peter Oviatt (and Jamie McPartland), Shira Smu'ely (and Itamar Mann), Teasel Muir-Harmony, Ben Wilson, Rebecca Woods, Chihyung Jeong, Alma Steingart, Orkideh Bezrouhan, Nate Deshmukh-Towery, Ellan Spero, Reneé Blackburn (and Victor Parkinson), Lisa Messeri, Michael Rossi, Candis Callison, Ashawari Chaudhuri, Amy Johnson, Clare Kim (and Rui Gao), Rijul Kochhar, Jia Hui Lee, Lan Li (and Chaosong Gao), Grace Kim, Beth Semel, Luisa Reis Castro, Alison Laurence, Mitali Thakor, Catarina Scaramelli, Nicole Labruto (and Alessandro Angelini), and Shekhar Krishnan. A few of these kind souls have even read my work – I am particularly appreciative of the time and attention of Lucas Müller and Emily Wanderer for alternately leading discussions on drafts of my chapters and reading and commenting on them in depth.

Thanks in huge part to a Social Science Research Council Dissertation Development Proposal Fellowship group called "Mediated Futures" organized by Arvind Rajagopal and William Mazzarella, my early attempts at dissertation drafts have by seen by far more eyes and far better brains than I've deserved. For four years, Bryce Peake, Eric Hirsch, Yana Stainova, Andrew Brandel, and Samuel Shearer have been some of my most diligent and thoughtful readers and friends. Together with Aslı Arpak, Leksa Lee, Julia Yezbick, Lindsay Bell, and Tyler McCreary, this group has contributed to the words and ideas spelled out here more than almost anyone whose signature does not grace the cover page of this dissertation. In different settings, Jesse C. Jackson, Richard Daly, Bill Rankin, David Kneas, Madeleine Clare Elish, and Josep Simon have each greatly helped to improve my ideas as well. In addition to the generous support I received from the SSRC for preliminary fieldwork in British Columbia, summer research grants from the MIT International Science and Technology Initiative (MISTI) Brazil office, the MIT Center for International Studies, and the Wenner Gren Foundation (Dissertation Fieldwork Grant #8720) have all provided critical financial support for different stages of the project.

Faculty in the departments of History and Anthropology, and the Science, Technology, and Society Program at MIT have also been instrumental in making the rooms and hallways of E51 and E53 into welcoming spaces these past seven years. For this, I am particularly grateful to Jeff Ravel, Susan Silbey, David Jones, Natasha Schüll, Amy Moran-Thomas, Jean Jackson, Jim Howe, Elizabeth Wood, Anne McCants, Craig Wilder, Robin Scheffler, Will Derringer, Hannah Shell, Clapperton Mavhunga, Ros Williams, and Lerna Ekmekçioğlu. I am permanently indebted to Harriet Ritvo for exposing me to the engrossing world of environmental history (and, by extension, environmental anthropology): had I not taken "Nature, Environment, and Empire"

with her during my first year in graduate school, these acknowledgments would almost certainly be prefacing a dissertation about nanotechnology in Brazil. Chris Boebel and Christine Walley introduced me to filmmaking in such a vital and exciting way that I very nearly convinced myself to drop the printed word for camera work immediately after I enrolled in HASTS. Heather Paxson's influence on my trajectory in HASTS (and beyond) has been profound, given the measureless time and energy she has poured into helping me think about how to assemble intellectual projects into a satisfying academic life. Other staff at MIT, including Bianca Singletary, Paree Pinkney, Judy Spitzer, Amberly Steward, Randyn Miller, and Carolyn Carlson have patiently helped me to navigate the myriad hurdles that frame student life at the Institute. Karen Gardner is a wizard and a saint: she has shepherded me through bureaucratic mazes and inter-personal force fields with warmth and poise, and, like all of my classmates, I literally cannot imagine how I would have fared in HASTS without her. Outside E51 and E53, I have had the good fortune to teach alongside Merritt Roe Smith, Vincent Lépinay, and Graham Jones, and I learned valuable pedagogical skills from each of them. I am particularly indebted to Graham Jones, without whose insights and examples I would have been utterly lost when I first began leading anthropology lectures of my own.

Each of my faculty mentors and committee members have invested more care and intelligence into my project and my development as a scholar than any student could possibly deserve. Through a reading list we designed together early into my time in the HASTS program, David Kaiser was the first professor to help me explore a single passionate interest – visualization and simulation – in detail and depth. Earlier than any other mentor, David helped teach me how to place my questions within broader conversations, and to situate myself within the academy, all without losing a microgram of the fascination that had drawn me to these topics in the first place. Julie Cruikshank became my first real friend in British Columbia shortly after I arrived in Vancouver for fieldwork. The generosity and intelligence she shared with me during our periodic conversations and correspondences energized every step of my project, particularly during my first few months in the northwest, when I still wasn't quite sure what I was looking for. At more than one distressing juncture, Julie's well-informed insights gave me the confidence to pursue ethnographic avenues that I would not have had the wisdom or courage to follow on my own: whatever measure of usefulness and coherence this dissertation achieves is a testament to her influence. Christine Walley worked to shape my project goals and fieldwork strategies for years before I had any inkling of what conceptualizing a dissertation topic truly meant. Her incredible patience and empathy gave my work a soul and a moral compass that has permanently transformed the way I do anthropology, and her example has exponentially expanded my ability to draw meaning and satisfaction from my work. Stefan Helmreich's contribution to my development as a person and as a scholar cannot be quantified. His timely and painstaking comments on every draft of every chapter included herein stacks up against the aggregate efforts of a dozen generous readers. To say that he has provided an exemplary model of a teacher, advisor, and scholar during the years he has spent darkening my doorway would be too modest: if I ever become a third as competent as Stefan is at any of these things, I'll probably be unbearably smug. My advisor Mike Fischer is the single biggest reason I left my career in engineering to become an anthropologist, and I have learned more from him in the dozen years we've known each other than any student ought to be able to draw in a lifetime from a university full of good mentors. His questions have generated the most daunting intellectual challenges I have ever faced, and the responses I have struggled to assemble have become some of my most

satisfying intellectual rewards. With his wife Susann Wilkinson, Mike has shared his curiosities, discoveries, experiences, and life events with Canay and me in a way that has made us feel like a part of their family, and we look forward to learning with them for decades to come.

Speaking of family: my brother Greg; my sisters Tess Schilling and Trina Arling; my niece Hannah; my brother-in-law Steve Arling; and my soon-to-be-sister-in-law Wendy Fonseca have all listened to me ramble and groan about this project for so many hours these past seven years that I'm half expecting them each to send me a bill after I graduate. My mom, Gail Schilling, has cheerfully insisted on taking a passenger seat on this seemingly never-ending emotional roller coaster, too. She has patiently listened to my grumbles about academia's indignities even as she has been tirelessly propping up huge numbers of her own struggling students on far more meager resources than those I have enjoyed. More than anyone else, my mom has helped me to see the difference between teaching and professing, and to recognize when the latter is getting in the way of the former. In addition to the ever-expanding Schilling clan, I have picked up several other new family members since joining the HASTS program who have worked to break up my professional stresses with frequent injections of distraction and joy. My parents-in-law, Aytül and Ercan Özden, have hosted me for weeks at a time during our now-regular summer visits to Turkey, and the experiences we have shared are inextricably enmeshed with all of the happy memories I have accrued since we first met five years ago.

Now for the really real: Canay Özden-Schilling has been my alpha, omega, and medulla oblongata since we first began dating six years ago, and if I was more diligent in following the criteria I've used to structure these acknowledgements, her name would be listed in every single one of the paragraphs above. She has lived with the problems and practicalities of this project for the past half decade as much as I have, and sometimes more. Canay took time away from her own work to stand watch, for weeks on end, as my dad deteriorated in California. The nurses in Pasadena noticed this, and made sure I realized that precious few people in my position received anywhere near the grace she bestowed on me (and as observers of the human thing, you must realize, hospice nurses are second to no one). In happier times, Canay spent a month with me in B.C. and Yukon Territory, and over Skype from Pittsburgh and Cambridge, she helped me think through each one of the obstacles I encountered and the ideas I dreamed up while I worked up there. When we both returned to New England and began writing our tomes, she surveyed every page and paragraph I coughed up, made them more concise (not this section, obviously), made them better, and made them smarter. That her name is not listed as a co-author on the cover page here is an absurd artifact of Ph.D conventionalism. She has allowed her own life to be shaped and limited by my selfish professional choices. She has inspired me to do useful and interesting things with my own time on Earth, if only to validate her endorsement of my being. I'm proud to call her my interlocutor, my best friend, and my baby mama, and I feel privileged to be able to dedicate this dissertation entirely to her.

A Note on Maps

As this dissertation illustrates countless times, any cartographic object should be treated with considerable caution and care. This same warning applies to the four original maps displayed in this document, all of which were "hand drawn" based on maps produced by the Gitanyow Hereditary Chiefs (2008), the Gitxsan Watershed Authorities (2004), Google Earth, Open Street Map, Natural Resources Canada (NRCan) and the Bulkley Valley Community Resources Board (1998). The lines, points, and polygons depicted on these maps are meant to provide readers with visual heuristics for navigating the stories herein, but they are also meant to underline the persistence of the different kinds of claims that have been made on the landscapes of northwestern British Columbia since the 1980s. The precise borders of the Gitxsan, Witsuwit'en, and Gitanyow territorial claims have been subject to substantial legal debate and bureaucratic action, and I have deliberately chosen to leave them vague (i.e. not geo-referenced) in the new maps I have created for this dissertation. I have also decided not to depict the "internal" boundaries of individual clan and house group territories for any of the three nations, despite the fact that for adherents of traditional governance systems, house group "boundaries" have longer and more established histories of recognition than the geo-bodies of any of the three First Nations as a whole (Napoleon 2005). Information on individual house groups is available on the maps cited above and in other documents cited throughout the following chapters.

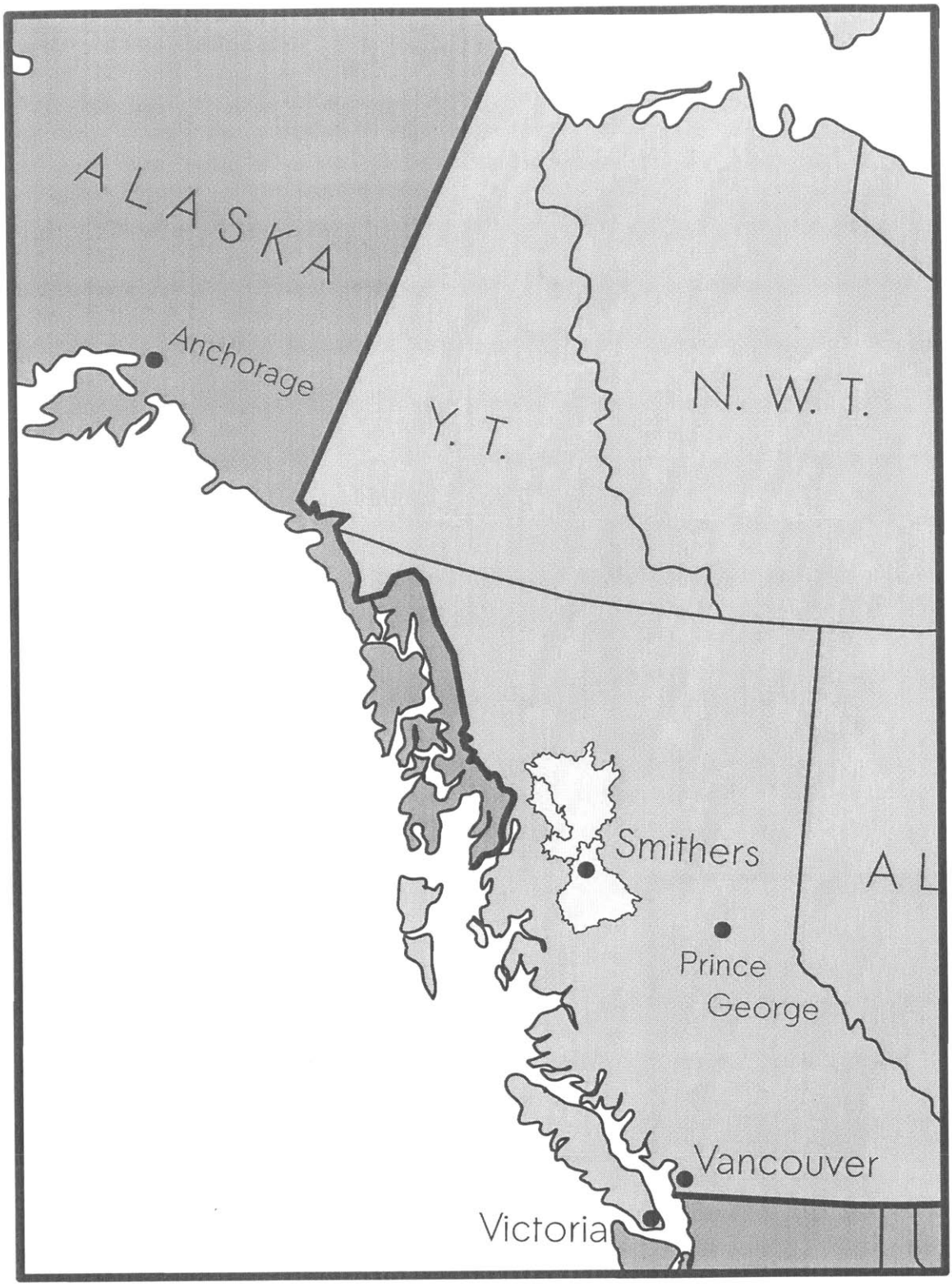

FIG 0.1. Map of northwest North America, with traditional territories of Gitxsan, Gitanyow, and Witsuwit'en First Nations depicted in light grey. For an explanation of the relative positions of the borders of these territories, see A Note on Maps above.

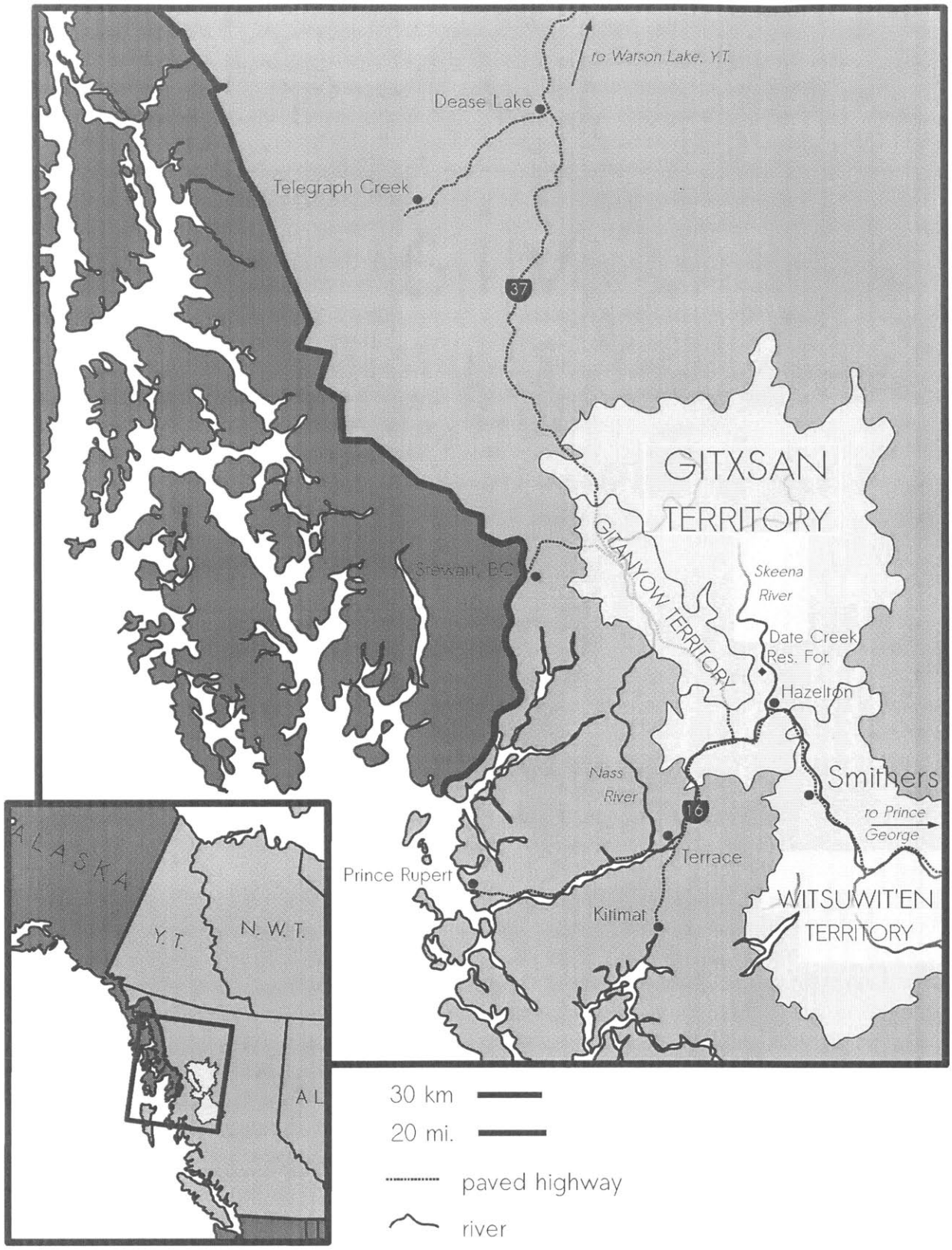

FIG 0.2. Map of northwest British Columbia.

Introduction

Maps, Landscapes, and Expertise in the Wake of Neoliberalism

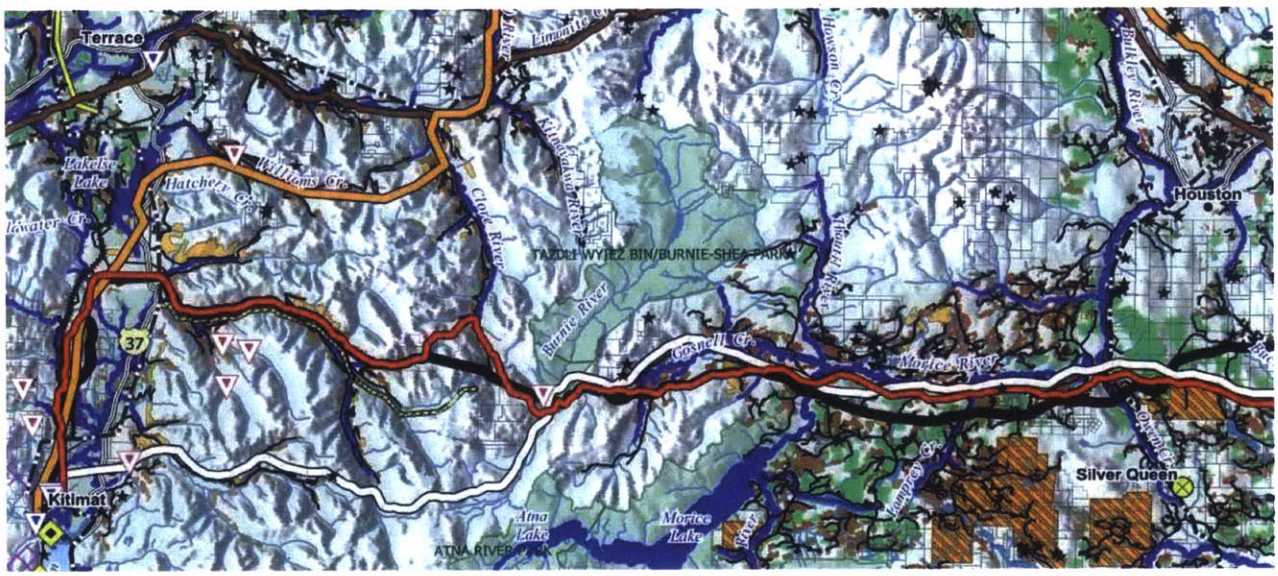

FIG. 0.3. Detail of map of northwest British Columbia infrastructures and proposed developments. Modified from SkeenaWild 2014.

The first thing Steve did – before showing me to my new desk, before letting me put down my backpack, before introducing me to anyone at all – was to hand me a large paper map.[1] "That's pretty much what it looks like on the ground around here. Or what it will look like, anyway." Unrolling the enormous four foot-by-three foot wall chart atop the vacant desk I would be occupying for the next year as a guest researcher at the Northwest Community College in Smithers, British Columbia, Steve immediately began pointing out the colored shapes and intricate boundaries clustered across the page. Spiderwebs of light purple logging roads braided

1 Throughout the dissertation, all names are pseudonyms unless explicitly noted at the beginning of each chapter. In this chapter, I am using Philip Burton's real name.

together with small blue streams, spreading out for hundreds of kilometers in every direction from the epicenter of the map at Stewart, BC (headquarters for the region's booming gold exploration industry). A quartet of brightly marked pipeline corridors bisected the page from right to left (see figure 0.3 above), dipping below the southern tip of the Alaskan panhandle before reaching the ragged edge of the Pacific near the coastal town of Kitimat, home to one of the largest aluminum smelters in the world. To the left of the dotted line depicting the US-Canada border, the Tsongas National Forest, a wash of mint green, filled nearly a quarter of the page. A detailed key in the bottom right corner differentiated between existing infrastructures and developments as yet unbuilt. As our eyes wandered hungrily across the map, though, the present and future continuously merged into one.

After giving me a few minutes to arrange my notebooks and log on to the building's WiFi, Steve led me to a brightly lit classroom. Uncapping a marker and gesturing for me to sit, Steve then proceeded to spend the next half hour filling the board with acronyms, arrows, and circles. Consultancies. Philanthropic groups. NGOs (including the salmon-focused group that had produced the map sitting on my new desk). Knowledge-sharing trusts. Satellite offices of federal and provincial land management ministries. Providing employment for a sizable portion of Smithers (population: 5,391[2]), this "ecology of institutions," as Steve called it, had proliferated wildly since the twenty-first century had begun. Divisions between industry, academic, and government roles had dissolved and reformed, leaving many of the town's environmental scientists pitched between multiple partial positions. The ethnography of government-led forestry mapping I thought I had traveled north to begin was steadily losing focus as Steve filled up the whiteboard with letters and lines. The "government mappers" I sought had been on the move for

2 Census Profile. *Statistics Canada.* http://www12.statcan.gc.ca/census-recensement/2011/as-sa/fogs-spg/Facts-csd-eng.cfm?Lang=Eng&GK=CSD&GC=5951043. Accessed 2 April 2016.

a decade, and their maps and motives were moving with them.

Not all of the region's mapping experts moved quite as freely as their media did. Months before I first met Lorraine, a First Nations woman and Geographic Information Systems (GIS) expert, I had already seen reproductions of her most famous work all over northwest British Columbia: a digitized map of the Gitxsan and Witsuwit'en traditional territories. The original paper map of the territories had been prepared from affidavits collected in advance of the longest and most expensive land claims trial in Canadian history. The digital version which Lorraine and a few Gitxsan colleagues had assembled shortly thereafter was a visual marvel. Blown up to full scale, hundreds of Gitxsan and Witsuwit'en place-names replaced the Euro-Canadian names of towns, peaks, and rivers throughout the region. Under an impressive heading emblazoned with the icons of various Gitxsan and Witsuwit'en political organizations, intricately detailed polygons bearing the titles of over a hundred different house groups were tiled out across the 58,000 square kilometers encompassed within the original land claim.

As we took a break from plotting out an upcoming field mapping exercise over cups of tea at her house, a little over an hour north of Smithers near the Gitxsan reserve at Kispiox Village, Lorraine gestured to different markings and features in her own copy of the map hanging in her living room. "We really wanted to overlay our presence on the land," Lorraine insisted, deftly mixing the metaphors of GIS map assembly with the legalistic language of traditional use and occupancy tests. Through online message boards and blogs, thousands of digital copies of her map had spread throughout the province and country.[3] The abstract shapes of the overall Gitxsan and Witsuwit'en territories had long since become icons themselves (see figure 0.4),

3 One of the earliest web portals for digital copies of *Delgamuukw*-related materials was the Aboriginal Mapping Network (www.nativemaps.org), a joint venture established in 1998 between Ecotrust Canada and the Gitxsan and Ahousat First Nations. Numerous other websites have come online since, both in British Columbia and throughout the world. For a review of related online initiatives, see Dyson, Hendriks and Grant 2007.

even as disagreements over the handling of the internal boundaries between house groups, lingering since the original trial, remained unresolved. In GIS shapefiles generated for government-authored land management plans covering the same territories, the minute physical details of watersheds sung in feast hall performances of Gitxsan *adaawk* and Witsuwit'en *kungax* had been stored for download on government servers, freely accessible to anyone with an Internet connection.[4]

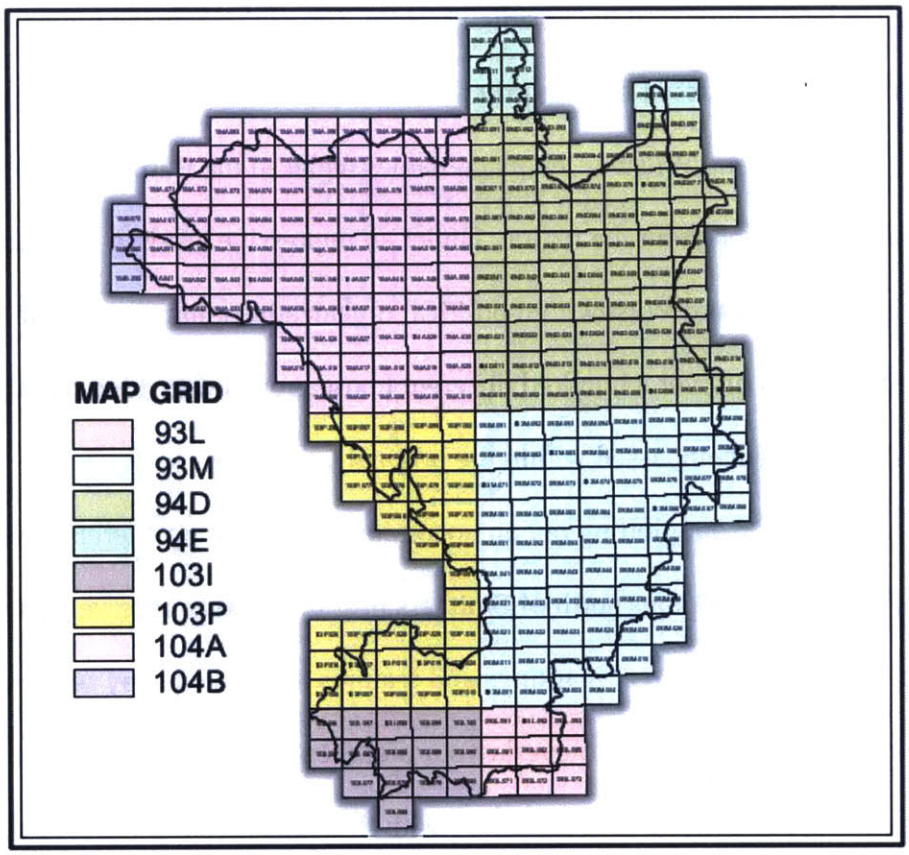

FIG 0.4. Outline of the overall Gitxsan territory claim subdivided by National Topographic System (NTS) quadrants. Modified from Gitxsan Watershed Authorities 2004.

From Rendering Governable to Government Gone

This dissertation proceeds from paradoxes. Countless hours and dollars were spent in the last

4 Elsewhere, I have reflected on the problems associated with the new politics of re-assembly inspired by the Government of British Columbia's comprehensive open access campaigns. See Schilling 2014.

decades of the twentieth century building new economic relationships, technologies of representation, and bureaucratic offices throughout North America's rural resource frontiers, all with the intention of rendering trees and people visible and therefore governable. How, then, are we to evaluate the social effects – momentary, enduring – of these technocratic forms as twenty-first century neoliberalism sloughs them off into seeming obsolescence? How did the tools these experts used to mark their landscapes and render them visible eventually efface the experts themselves? The need to make sense of these contradictions is urgent and palpable in the railroad towns of northwest British Columbia, conjured overnight throughout the twentieth century, hundreds of miles from the nearest metropolis, yet rapidly integrating with far-flung resource geographies. In the vast coniferous forests of western Canada, twentieth-century technocracy remade the world within a matter of decades, legitimating the presence of provincial and federal government officials and displacing the hereditary hierarchies of dozens of different indigenous polities. In *The Intemperate Rain Forest,* Bruce Braun (2002: 3) details the productive effects of these processes by asking "how something called the 'forest' is made visible, how it *enters history* as an object of economic and political calculation, and a site of emotional and libidinal investment." Yet if the central problem of neoliberalism is, as Aihwa Ong (2007: 4) puts it, "how to administer people for self-mastery," to what end do these "investments" obtain when the original goals of technocratic administration, including the production of large cohorts of highly trained administrators themselves, are slowly abandoned by a retreating state? What kind of material residues are left behind as waves of technocracy advance, crest, and retreat?

In British Columbia during the 1990s, proliferating digital maps of traditional territories, biodiversity data, and other kinds of expert-curated "knowledge" seemed to promise empowering new scaffolds for envisioning environmental futures and new forms of rural life. Men and

women trained in GIS mapping, forestry modeling, and other landscape visualization methods seemed poised to reformat regional governance. Whether from positions in government ministries, First Nations representative bodies, or at the interfaces being created as these polities met uncomfortably in courtrooms and community halls, the experts who strove to bring old conflicts into digital media promised a new middle ground in longstanding disputes over resources, rights, and territory.[5] For the First Nations communities and other residents who live scattered throughout the region two decades later, however, much of this promise remains frustratingly unfulfilled. This dissertation is an attempt to track these divergences, and to make sense of the longer histories of technical visualization and media circulation in northwest British Columbia that have grounded – and destabilized – so many claims of expertise throughout the region's contested landscapes.

In British Columbia and elsewhere, policy scholars and anthropologists alike have spent the past decade predicting the future effects of neoliberalism by tracking the rise of corporate power within resource governance processes previously managed by state agencies (Benson and Kirsch 2010; Brockington, Duffy and Igoe 2008; Heynen *et al.* 2007; Li 2014; Matthews 2008, 2011, 2014; Medina 2015). Within the forests of northwest British Columbia, private expertise has been perhaps most visible in the transition away from collaborative land use planning programs towards the range of industry self-reporting practices initiated during the province's "results-based management" regulatory regime (Thielmann and Tollefson 2009). Despite the widespread devolution of monitoring tasks to timber companies and other corporate actors, however, the weight of anthropological attention being paid to those aspects of governance has caused many scholars to neglect the human links and paper trails connecting emergent neoliberal

5 Like so many others who have discussed the political and epistemic disjunctures informing settler-indigenous environmental conflicts (Callison and Hermida 2015; Conklin and Graham 1995), I am indebted to Richard White's (1991) formulation of the "middle ground" as both contact zone and terrain of mutual incomprehension.

forms of land management and the more centralized institutions of earlier technocratic regimes. This dissertation seeks to take stock of the subtler legacies of the move towards digital technologies of landscape representation in different scenes of technocratic planning. Building on ethnographic engagements with the researchers, mapmakers and technicians tasked with calculating and justifying new tree harvesting metrics and community land use plans, this dissertation aims to recognize the complicated and at times contradictory legacies of British Columbia's brief experiment with what both anthropologists and policy makers have occasionally called "knowledge-based governance."

In a diverse array of recent anthropological scholarship, the term "knowledge-based governance" has been mobilized to describe how profound shifts in legal and bureaucratic regimes brought on by indigenous land claims (Gibbs 2009), intensified border policing (Garelli and Tazzioli 2013), and transitions to market capitalism (Petryna 2004) have been effected and legitimated by new arrangements of expert institutions, state actors, and claims to knowledge (Fortun and Fortun 2005). Outside anthropology, the term has had an even more diverse career, emerging in the language of urban planning, environmental policymaking, government training programs, and even primary school accreditation and assessment manuals. Wherever it appears in print, however, invocations of "knowledge-based governance" index particular kinds of promises. Whether marshaled to mark an institution's self-serious commitment to informed decision making or deployed to critique the political pretensions of reifying datasets, the term offers a vision of a future in which outcomes will be traceable back to specific analytical processes, and where accountability will be built into deliberation itself.

Promises of "knowledge-based governance" do more than simply describe how the work of experts articulate with political processes, however: taken up within periods of transition and

uncertainty, promises of informed decision-making can rend or refashion the fabric of social life. Adriana Petryna (2004) invokes "knowledge-based governance" to describe the conditions of possibility for "biological citizenship" in post-socialist, post-Chernobyl Ukraine. Citizenship status, rights, livelihoods, and identity claims, all based on technical knowledge about radiation exposure, became for Petryna's interlocutors a mode of transcending the loss of socialist support infrastructures and the suffocating imposition of new market relations. Knowledge – even uncertain knowledge, "non-knowledge," or the corrupting knowledge of state-appointed experts – became for Ukranians a scaffold for building new lives amidst Chernobyl's detritus.

As it had in Ukraine, the stability of these scaffolds in British Columbia has depended largely on the technological resources different experts mobilized as both the documents and landscapes through which they worked were rapidly changing form. In some ways, the rationales invoked during these processes mirror the basic objectives of "techno-politics" itself. By tracking how such relationships emerge and decay, however, subtle differences emerge. Timothy Mitchell (2002) argues that concerted efforts to reorganize political institutions to concentrate decision-making power with small cadres of technical experts – a form of rule Mitchell and others describe as "techno-politics" – often manifest as spatial processes, reminding us that "[t]he twentieth century's new regime of calculation did not produce, necessarily, a more accurate knowledge of the world, despite its claims, nor even any overall increase in the quantity of knowledge. Its achievement was to redistribute forms of knowledge, increasing it in some places and decreasing it in others" (92). The actual, lived experience of these processes, however, depends hugely on the historical dimensions under which reorganization unfolds.

A Brief History of Technocracy in Northwest BC

In geographically immense resource peripheries like the Canadian north, expert-driven visualizations of space have anchored the rationales behind a broad range of settler calculations and government interventions since the 19th century.[6] Projected ore tonnages; timber harvest volumes; dam-generated kilowatt hours; protected species population estimates. Attaching visual metrics to sparsely populated regions has the effect of packaging rural entities as objects of interest and control and affixes a sense of tangibility to rural landscapes seemingly too vast or too alien to otherwise comprehend (Augé 1995; Messeri 2010). Even in my own attempts at synoptic description (particularly during my visits with friends and family members outside Canada), I invariably resort to framing the landscapes of northwest British Columbia through ponderous cartographic comparisons. For instance: west of the Rocky Mountains and north of Highway 16, the northernmost route linking eastern Canada to the Pacific coast, only a handful of small towns interrupt the nearly 300,000 square kilometers of evergreen forests before the Yukon border. Aside from the villages of Stewart (population: 494) and Dease Lake (population: 303), no single permanent settlement surpasses two hundred and fifty people in population throughout the entire region, an area nearly as large as all of Germany (Census Profile 2011).

When pressed to explain who, or what, bears the greatest responsibility for managing these sprawling landscapes, many of the environmental scientists I met in the northwest decried the eroding standards of government stewardship in the province with stories tinged with of outrage and nostalgia. Positioned by my interlocutors as a cheerfully naive American observer, I was often encouraged to view my immersion in Canadian partisan grudges through the lens of "war on science" led by the then-Conservative government of Canada. I was also made to

6 Although the term "resource peripheries" has begun to be used more widely among North American social scientists in recent years, the originators – and still the chief proponents – of the term are Canadian economic geographers and rural sociologists (Hayter, Barnes and Bradshaw 2003; Petrov 2007).

recognize how the separation between federal and provincial jurisdictions over environmental science and management throughout British Columbia had shaped the different fronts of the "war." Unlike the comparatively weak state government institutions with which I was familiar in the United States, BC's provincial ministries wield spectacular power to designate timber harvest levels, regulate mining activity, and police oil and gas development on public lands; such complex – and consequential – responsibilities more frequently fall to federal agencies in the US. In British Columbia, the provincial government is also far and away the largest single land owner, holding over 94% of its roughly 945,000 square kilometers as "Crown land," compared to the paltry one percent of land area controlled by the government of Canada (chiefly in the form of railroad right-of-ways and Aboriginal reserves).[7] By comparison, only the state governments of New York and Alaska own more than fifteen percent of the states they manage. Taken together, all fifty American states' holdings still comprise less than the total area of BC's crown land.[8]

Maps and politics are inseparable in towns throughout British Columbia, populated as these places are by foresters and forestry scientists whose careers are predicated on stats-backed promises of sustainable gains and dependable returns. Such a correlation would be taken for

7 These numbers warrant some explanation. Despite various Canadian provincial governments' tremendous monopolies over land ownership in BC and in several other provinces (including in particular Newfoundland and Labrador on Canada's east coast), the federal government remains the largest landholder in the country as a whole thanks to its sprawling tenures in Yukon, Nunavut, and Northwest Territories. For a more detailed breakdown of Canadian land ownership statistics, see https://cfs.nrcan.gc.ca/statsprofile. Accessed 18 May 2015.

8 Of the 768,900 square kilometers of state-owned land in the US, 428,000 square kilometers (roughly 56%) is in Alaska. For a recent and comprehensive breakdown of state and federal land ownership statistics, see Gorte *et al.* 2012. Even the considerably more expansive American federal lands (more than three million square kilometers, roughly half of which is in Alaska) fail to surpass the jurisdiction of BC's province-spanning dirt ministries, broken down as American federal land is among seven separate agencies. This includes the Bureau of Land Management (BLM), The United States Forest Service (USFS), the National Park Service (NPS), the National Wildlife Refuge system (NWR), the Army Corps of Engineers, the United States Armed Forces (in the form of military bases), and the Bureau of Indian Affairs (or BIA, which manages the delivery of services on American Indian reservations). It certainly bears mentioning that government-owned lands in the United States change hands constantly, and the boundaries and jurisdictions are often subject to small changes from one year to the next.

granted in any so-called "resource town," particularly in a region dominated by public land. The scale of forestry operations in northwest British Columbia, however, quickly translates provincial squabbles over allotments and modeling algorithms into triggers for geopolitical confrontation. Yielding as many as ninety million cubic meters of hemlock, spruce, pine, and cedar for foreign and domestic markets each year, the interior of British Columbia has for decades been one of the largest timber producers in the world; the single largest source of lumber the United States; and a major supplier for East Asia as well (British Columbia Ministry of Forests, Mines, and Lands 2010). From its origins as a railroad town in the early twentieth century, the small town of Smithers established itself as an outpost for provincial administrators and researchers during the logging boom years of the 1970s. Working out of small, corrugated metal sheds and Quonset huts clustered near a sawmill on the south end of town, government employees based in Smithers oversaw the technocratic transformation of northwest British Columbia from a territory so "vast" early settlers assumed it would "never be surveyed" (Shand 1898: 501) to the largest single exporter in the Pacific Rim timber trade.

Built up around an old railroad depot set over one thousand kilometers north of Vancouver and just west of British Columbia's coastal mountains, Smithers has for decades served as a regional hub for one of the most prolific timber-producing regions in the world. The meaning of this status as "regional hub," however, has gone through distinctly different phases. Beginning in the 1970s, the expansion of logging in the region brought a wide range of forestry scientists and administrators to Smithers. This early cohort of technocrats was charged with normalizing the forest itself by imposing the system of "sustained yield" forestry across the remote corners of province. Highly trained émigrés from Canada's southern metropolitan centers settled in to life in the northwest even as they helped to redefine the space around them, drafting

new management districts and harvesting rotations atop newly-created landscape classification maps in a concerted push to project timber yields and profits decades into the future.

In the early 1990s, amidst growing protests against the clearcut logging of British Columbia's dwindling groves of old growth trees, the provincial government's presence in the northwest extended further still. Given a mandate to incorporate watershed restoration research and biodiversity management prerogatives into forestry policy by a new conservation-oriented government, dozens of botanists, ecologists, and landscape modelers joined the ranks of conventional foresters already crowded into Ministry offices in Smithers. Trees were more than a cash crop, they argued: ecosystems deserved spokespersons, too. Riding a wave of global interest in science-based conservation generated in part by the UN's 1992 Rio Declaration on Environment and Development, this second generation of technocrats drew heavily on the emerging language of "adaptive management" (Hayer 2003). Taking up the mandate of a newly elected provincial government to argue for more precautionary approaches to modeling forest secession, monitoring ecosystem health, and planning timber harvests throughout the province, Smithers's second-generation technocrats did more than simply antagonize their peers in conventional management. As I show in the following chapter, some new arrivals also lent their expertise to a series of new community-based land use planning workshops, arguing that collaborative venues should replace centralized, government-run conservation and planning boards altogether.

In 2002, part of this wish was granted. Deciding that the transition towards ecosystem-based resource management and locally organized land use and conservation planning had created an unfriendly business climate for logging companies, a new provincial government began dramatically downsizing the institutions responsible for overseeing both phases of timber

technocracy. The central Research Branch of the BC Forest Service was dismantled, and by the year's end, most of the service's regional offices had been closed as well, including the Ministry's northwest headquarters in Smithers. Within weeks of learning of the office's impending closure, government scientists and advocates affiliated with the town's cooperative land use plan (see chapter one) met in order to discuss the fate of the town's "critical mass" of soon-to-be-unemployed environmental scientists. Many were already resisting the government's attempts to reassign them to new positions at Ministry headquarters in Victoria. The group also discussed what might be done to rescue and re-organize the troves of experimental data and technical reports housed at the regional office. Without a dedicated building and staff to manage the material generated by government-funded forestry research projects in the region, they lamented, archived data and decades of accumulated knowledge would be lost as researchers dispersed and old reports were discarded.

All around Smithers, another technocratic history was unfolding in parallel. On March 8th, 1991, dozens of chiefs and other members of the Gitxsan and Witsuwit'en First Nations[9] staggered out of a courtroom in downtown Vancouver, struggling to process the fact that their joint claim to 22,000 square miles of ancestral territory in the northwest had been abruptly

9 Each of the terms used to refer generally to the original inhabitants of Canada and their descendants is problematic in different ways. "Aboriginal" and "Indian" remain common in bureaucratic use (e.g. the federally-run Department of Indian Affairs and Northern Development, now known as Aboriginal Affairs and Northern Development Canada, has for decades administered to all of Canada's reserves, as well as managed the national government's engagements with the Inuit-run territory Nunavut). "First Nations," a term which refers to all non-Inuit, non-Métis indigenous groups in Canada, was brought into common usage at the end of the twentieth century and has become particularly popular in British Columbia. Official band membership issues are typically referred to as "Indian status," although the term "First Nations" has begun appearing more frequently in these contexts as federally registered "Indian bands" change their official names. In practice, many of the Gitxsan, Gitanyow, and Witsuwit'en men and women I worked with used the terms "Indian," "Native," "Aboriginal," and "Indigenous" interchangeably, a fact which I reflect in direct quotations throughout the dissertation. While I attempt to use more specific names and terms wherever possible, I use the term "indigenous" when reflecting on my interlocutor's attempts to generalize their experiences, reflections, and political claims. For more on the contemporary politics surrounding each of these terms, see Fortun, Fortun and Rubenstein 2010.

dismissed.[10] The Gitxsan *adaawk* and Witsuwit'en *kungax* the chiefs had sung for an incredulous judge had brought oral history performance into a Canadian court for perhaps the first time, but had been rejected out of hand as incongruous with the state's standards for legally admissible evidence (Borrows 1999). Yet even after wading through the longest (331 days of testimony) and most expensive (upwards of $25 million in public funds) land claims case in Canadian history, many of the men and women who assembled *Delgamuukw v British Columbia* took only a little time to regroup. Within a year, most of the original claimants had filed a motion to appeal. Some Gitxsan returned to the logging road and railway blockades they had begun staging a few years earlier, when the province had refused to suspend timber harvests on their territories as the trial progressed. When a new, social democrat-style provincial government took power at the end of the year with a mandate to take seriously the ambiguities surrounding an ever-expanding canvas of clearcuts and land claims, First Nations techno-politics entered a new phase: the era of "capacity building" had officially begun.

On the Gitxsan reserves in and around the village of Hazelton, fifty minutes north of Smithers, the sudden influx of grants stimulated an already-growing bureaucratic landscape. A number of Gitxsan-led institutions, including an education society, a forestry consultations group, and a development corporation had already formed during preparations for the *Delgamuukw* trial or were quickly taking shape in the aftermath of the initial decision. The voluminous archive of trail maps, tape-recorded testimonies, ethnographic texts, ethnobotantical notes, and other research materials built up during the decade that the claimants and their collaborators had spent preparing for *Delgamuukw* had become a paper-based infrastructure for

10 Critical discussions of the 1991 MacEachern decision in *Delgamuukw v R.* and its meaning within ongoing struggles for First Nations rights and in law and colonialism at large has occupied dozens, if not hundreds of scholarly books and articles. For a comprehensive overview of the case, its precedents, and the immediate responses of anthropologists, see Culhane 1998. For more recent perspectives on the aftermath of the decision and its appeals, see McCreary 2014; Napoleon 2013.

Gitxsan-led technocratic work on the territories. Armed now with Global Positioning System (GPS) navigation devices and Geographic Information Systems (GIS)-based computer mapping software, Gitxsan representatives purchased computers, expanded their offices, and hired instructors for a small but growing cluster of technical training and certification programs. Young trainees, some barely teenagers when the *Delgamuukw* team had first gone to court, were conscripted to lead the Nation's new institutions and to bring Gitxsan governance into the digital era as their land claim worked its way through Treaty Commission meetings and eventually back to federal court. By the mid 1990s, their growing digital archives created through a new phase of trail mapping and nascent ecosystem-based research brought a handful of Gitxsan into conversation with environmental scientists living nearby, many of whom were then developing GIS maps and models of their own.

Only a few years later, the Gitxsan technical governance project was in disarray. Provincial support for the new offices waned and finally collapsed as the developmentalist Liberal Party won the parliament in 2001. Smithers-based collaborators, once eager to help the new mapmakers incorporate technical idioms into still-forming Gitxsan land management principles, slowly retreated as project funds disappeared and as internal tensions suppressed during the *Delgamuukw* era resurfaced and intensified. The documents and data files that young Gitxsan GIS mapmakers had produced during the brief flurry of institution building succumbed to a range of fates; most were left to fade on the hard drives of antiquated computers stored around the former mapping office. Unlike their former colleagues in Smithers, most of the men and women involved either moved back into logging jobs or left the region in search of new work suitable for their burgeoning technical skills. By the time I arrived in 2012, the Gitxsan Nation's inaugural class of technocrats had dispersed, sent into exile long before reaching critical

mass.

In the following five chapters, I trace how the promise of "knowledge-based governance" in northwest British Columbia established new relationships between people, landscapes, and documents, which have subsequently shaped how rural residents view the possible futures of these places. I argue that proponents of "knowledge-based governance" sought to collapse *all* forms of environmental expertise into the same project of technocratic modernization, promoting GIS-based mapping technologies as a mode of making life predictable by making knowledge visible. In northwest British Columbia, the rapid expansion of clearcut logging during the second half of the twentieth century and increasingly strident calls by First Nations groups for comprehensive land claims forced the region's residents to grapple with a growing range of uncertainties in their daily lives. For Euro-Canadian settlers, not knowing whether a cherished section of forest would be targeted in an upcoming harvest, or a favorite fishing site would be subsumed in a land claim, was compounded by a general lack of understanding about the jurisdictional authorities involved. (For instance, despite repeated assurances to the contrary, many white residents of the Skeena watershed remained convinced well into the 1990s that a successful Gitxsan land claim would involve the resettlement of non-Gitxsan residents and the expropriation of their homes and farms.) As my interlocutors explained to me, white and First Nations advocates alike responded to these tensions by calling out for more detailed spatial renderings of these processes and their possible effects.

Sustained public outcry during this period caused rural technocratic institutions – Treaty Commission mapping divisions, tree growth modeling divisions, geological surveys, and other kinds of planning groups – to swell in number and scope. Like many ambitious projects to stir up wonder and excitement among rural residents upon arrival in the northwest, though, most of

these new institutions began to decay as soon as the attention of their provincial patrons waned and moved on. The calculable certainties they offered remained incomplete; a decade and a half into the twenty-first century, the numbers, maps, and models that had provided the beginnings of answers in the 1990s had been re-purposed and re-posed as increasingly frustrated questions. Development maps and ecosystem models prepared for community land use plans were published only to be starved of meaningful data (see chapter one). An ambitious land use plan for the territory of the Gitxsan Lax Skiik clan, constructed in part by members of the Lax Skiik, was championed in broadly circulating promotional literature as a blueprint for other plans to cover the entirety of Gitxsan territory; it proved to be the only one of its kind (see chapter two). By the time I arrived in the northwest, the slow violence of climate change and the interminable pace of treaty negotiations had left most of the region's residents resigned to negotiating even more dramatic changes on the land, and with technocratic assurances fewer and further between.

Making "Knowledge" Visible

By treating different technocratic regimes' demands for making knowledge visible as a shifting set of challenges for managing material documents, this dissertation aims to raise a number of questions not typically applied to anthropological studies of expertise: How do documents like maps and models facilitate the reproduction of cultural formations (including traditional governance systems and communities of expertise), and how can the practices they engender serve to disrupt lines of social continuity? How do digital tools establish codependencies between weak institutions, and how do these relationships affect how an institution functions after a transition in policy regimes? What happens when some part of these computer-reliant infrastructures begins to fail, and how do these failures impact already-marginal First Nations

communities and experts differently from their non-Indigenous neighbors? The dissertation also explores the residual effects of the programs and careers begun under this banner in the midst of what might otherwise appear to be the boundless expansion of the provincial government's developmentalist agenda.[11] By examining how indigenous experts and forestry scientists' experiences of professional mobility are shaped by different translational challenges and local attachments, we can better hope to make sense of the unsteady conjunctures of digital media, space, and profession that characterize contemporary environmental expertise.

This forthrightness is particularly necessary when discussing what happens when experts travel – an increasingly common occurrence since the demise of knowledge-based governance. "It is crucial," write Wendy Larner and Nina Laurie (2010: 219), "to recognise that the diverse experts who become 'traveling technocrats' are not simply policymakers and technical experts who are trained in elite institutions, then fan across the globe imposing policy recipes as if politics didn't exist and places didn't matter." Indeed, as Petryna (2005) shows in her more recent work, the deliberate pursuit of "ethical variability" has become a major component in the ongoing geographical re-organization of a range of globally dispersed industries (see also Petryna, Lakoff and Kleinmann 2006). As Tania Li (2005, 2007b) has argued in the case of emergent "community"-oriented conservation initiatives in Indonesia, "state schemes" rarely

11 In the years since neoliberalism was first identified as a defining logic in the construction of new economic relationships, modes of governance, and forms of life, geographers and anthropologists of globalization have distanced themselves from earlier, monolithic characterizations of neoliberalism by using temporally and geographically specific cases to differentiate between the wide range of governmental processes and subjective transformations associated with neoliberal theory. Building on her collaborative writing projects with Stephen Collier (Ong and Collier 2005) as well as her own work throughout southeast Asia (Ong 1999; 2006) anthropologist Aihwa Ong calls attention to isolated manifestations of "neoliberal logics" imposed within disparate social and economic systems as examples of a "migratory technology of governing that interacts with situated sets of elements and circumstances" (2007: 5). These interactions, which Ong and Collier call "assemblages," can provide anthropologists of globalization with a medium of analysis in which to assess the radical contingency of multiscalar interactions. "The space of analysis is not already defined by geographical entities," Ong (2007: 5) argues, "but by the space configured through the intersection of global and situated elements. The concept [of the assemblage] bypasses structural analysis, scalar progressionism and predetermined outcomes commonly deployed by political economy. As a field of inquiry, assemblage stresses not structural hierarchy but an oblique point of entry into the asymmetrical unfolding of emerging milieus."

simply succeed or fail, but rather establish new modes of defining and particularizing environmental problems (see also Mukerji 2007). The tendency of some scholars of development to attribute any and all technocratic accounting procedures to hegemonic, place-obliterating renderings in the service of state "legibility" (Scott 1998) has largely failed to illuminate these "messy, contradictory, and conjunctural effects" (Li 2005: 383) and what they portend for future relationships among states, experts, and situated populations.

This so-called "legibility," whether of people, places, or things, is hardly the immediate result of technocractic attention, but is rather the *effect* of numerous sedimented processes, each of which takes up questions of landscape and place in materially constrained ways (T. Mitchell 1999). Indeed, it can be far more illuminating to ask *how* place comes to matter within the context of specific deployments of digital media, or as Timothy Choy casts the question in more general terms, "how particularity comes to work as a mark of expertise" (Choy 2005: 6). Echoing Bruno Latour's (2004b) concern that constructivist critiques of expertise and scientific universalism fail to portray accurately the kinds of knowledge claims relevant to contemporary environmental politics, Choy complains that "the critique of universalism is as dead as universalism itself; it no longer speaks to the configuration of power but instead finds itself echoing the state. More mildly put, an indictment of universalism in expert venues is helpful but not sufficient for the critical analysis of expert politics. That critique – and its valorization of specificity – has already been internalized in those arenas" (Choy 2005: 16).

Examinations of the visual cultures of expertise have struggled to move past these critiques of universalism. Many historians of science have deepened their critiques by emphasizing the particularities of training and disciplinary identity, focusing on the producers of scientific images as convention-bound, institution-loyal practitioners. Drawing on theories of

"trained sight" developed by art historians and psychologists like Ernst Gombrich (2000 [1960]), Erwin Panofsky (1991 [1927]), and Rudolph Arnheim (1954), historians of science began attacking the tropes and conventions of mimetic representation in a wide range of scientific disciplines beginning in the late 1970s (Cambrosio, Jacobi and Keating 1993; Edgerton 1984; Rudwick 1976). Inspired by critical examinations of authorship and narrative form then emerging in literary theory (Barthes 1977; Derrida 1973; Foucault 1977; W. Mitchell 1981; Said 1993; H. White 1973), art historians began to critique landscape paintings, portraiture, and other "naturalistic" artistic forms as tacit vehicles of dominant ideologies and culturally-specific meta-narratives (Alpers 1983; T. Mitchell 1992; W. Mitchell 1986, 1994, 2000). A number of historians of cartography took with gusto to the task of poststructuralist critique, too, insisting that the interpretation of maps and other visual tools of empire-building deserved the same rigorous analysis heretofore reserved for literary texts (Edney 1993; Harley 1988, 1999; Wood and Fels 1992; see also L. Brown 1977 [1949]). By the late 1980s, the convergence of visual culture and the history of science had expanded past its initial inquiries into form and semiotics to explore the material particularities of different image-making processes (Galison 1997; Goodwin 1994; Latour 1990; Lynch 1985; Pang 1994, 1995; see also Crary 1994; Ivins 1969 [1951]). This "material turn" returned a number of scholars' attentions to issues of technique and professionalization that had been increasingly obscured by preceding decades of criticism that had fixated on the so-called "death of the author" (Barthes 1977). Describing the training of scientific artists and image makers as a process of cultivating "epistemic virtues" consonant with the aesthetics, publishing conventions, and social mores of a given period and place, Lorraine Daston and Peter Galison (2008) argue that even "objectivity" itself is best understood as a series of historically specific (and temporary) intersections of practice and form. Eschewing these

implicit nods to zeitgeist, David Kaiser (2005) moves past the institutional determinism of these earlier readings by showing how graphical conventions morphed and stabilized according to the needs of highly localized academic networks and inter-personal relationships.[12]

More so than any other visual artifact of scientific practice, however, maps exist simultaneously as both "representations" of spatial phenomena and as bureaucratic documents. They do more than index their makers' professional lives and institutional ties: as bureaucratic documents, maps also shape how institutions function, and to what ends. Thanks in part to a general reorientation of anthropological attention away from structure and discourse-based theories of agency to the impositions imposed on social life by "non-human actors," paper documents and digital artifacts have begun to take a more central place in ethnographic studies of bureaucratic institutions (Hull 2012a; Gitelman 2014; Riles 1998, 2006). Citing the turn towards materiality in anthropology, science studies, and related disciplines as "part of a general rehabilitation of the artifact in the social sciences and humanities," Matthew Hull (2012b: 253) argues that "[t]he fundamental insight of [recent anthropological scholarship on bureaucratic documents] is that documents are not simply instruments of bureaucratic organizations, but rather are constitutive of bureaucratic rules, ideologies, knowledge, practices, subjectivities, objects, outcomes, and even the organizations themselves." The *limits* of the constitutive powers of documents become particularly clear in the case of marginal expert institutions like those in rural British Columbia. As Hull (2012b) emphasizes, the material form of bureaucratic documents also ultimately constrains where and how their users can mobilize them within broader scales of discourse.[13] "Bureaucratic discourses are no longer understood as semiotic

12 Robert Brain (2008) offers a related critique in his work, arguing that physiological investigations, rather than simply discursive engagement, of so-called "aesthetic feelings," helped inform idioms of utopianism that developed around relationships between scientific and artistic endeavors in the early 20th century.

13 Sheila Jasanoff and Sang-Hyun Kim (2009) downplay the ways in which the materiality of documents constrains discursive scale in their discussion of "technoscientific imagineries," a nation-state-level rendering of ideology which argues that prevailing concepts of risk and "the good society" are primarily products of

constructions ('texts') abstracted or abstractable from their material vehicles – files, forms, reports, graphs, and so forth. … This argument is implicit in the very characterization of bureaucratic forms of documentation as 'documents' rather than as 'texts' or 'representations' to be interpreted" (253-4).

Explaining precisely *how* maps enact these constitutive powers, however, has led many historians of cartography back to the same questions of semiotics, wherein issues of professionalization continue to be overshadowed by attention to the maps themselves. Historians of mapmaking complicated the "material turn" taking place in other disciplines by emphasizing how, once embedded in bureaucratic practice, maps often become a complete substitute for physical engagement with physical landscapes. Explaining the foundational role played by British colonial maps in shaping accounting practices in early twentieth-century Egypt, Timothy Mitchell (2002: 93) goes a step further: "The distance from the field to the map and back again, from the village to the computing office, would come to mark what seemed an absolute gap: the divide between reality and its representation, between an image-world and its object." By harmonizing disparate cartographic practices through global satellite coordination standards, the digital turn has only deepened this divide. "GPS [global positioning systems] should not be seen as simply a tool for making geographic space legible," historian William Rankin (2015: 555) writes. "Rather, GPS became a replacement for traditional space (and time) altogether. Both the spaces of day-to-day experience and the spaces constructed by representational maps were superseded by a space that was more immediately calculable, less historical, and almost perfectly uniform."

The fact that numerous environmental scientists in northwest BC assisted in the

conversations between elite experts and their bureaucratic patrons and spokespersons. For an anthropological critique of Jasanoff and Kim's take on scale, see Tidwell and Smith 2015.

construction of ecological classification systems and have subsequently embedded these standards in a wide range of land cover maps, forest succession models, and planning documents seems to support these arguments. Indeed, the rapid expansion of clearcut logging in the region throughout the last decades of the twentieth century – the transformation that gave shape and urgency to so many different forms of management, activism, and territorial politics still relevant there today – has been presented as merely the logical conclusion of the deployment of discursive technologies meant to normalize the forest as a calculable (and profitable) space (Braun 2002; Prudham 2007). And yet, how such an analysis would weigh the wry detachment with which many of Smithers' formative contributors to the BC Ecological Classification System (Pojar, Klinka and Meidinger 1987) view the constantly-updating system of codes that they helped to produce? How does insisting on reading forest mapping conventions as surveillance technologies help one to make sense of the deployment of BCECS acronyms in Gitxsan-authored land planning documents, or their appearance in other material artifacts of Indigenous sovereignty projects?

The preponderance of deterministic readings of maps as discursive objects have made it remarkably difficult to assess the actual relationships that develop between mapmakers and their media. Despite the incredible heterogeneity of these relationships, scholars have continued to treat both digital and paper maps as texts, made to serve as mediators for phenomenological engagement, and designed to be read through universal grammars. The progenitors of the critical cartography movement focused heavily on the role of mimetic representation in historical transformations of geographical consciousness, and on the concrescence of bounded "geo-bodies" in new strains of nationalism (Edney 1997; Winichakul 1994). In recent years, some of these more deterministic readings have become increasingly difficult to sustain. The massive

increase in civilian uses of GPS tools and GIS mapping programs in the 1990s "further untethered surveying from the geography of national states" (Rankin 2015: 555), and expanded the epistemic distance between the closely controlled military development of GPS technologies and their proliferating applications in science and activism. In calling attention to critical cartographers' obsessive attention to the links between visual representation and state ideology, Rankin (2016: 150-1) echoes Choy's complaint that political actors themselves have long since reconciled themselves to working through decentralized mechanisms of power. "[T]reating geographic knowledge – and power – as a question of representation alone does not cast the net nearly wide enough. Not only have practitioners themselves largely abandoned the stronger versions of cartographic authority, but geographic knowledge as a whole has ceased to be only a representational problem."

Rankin is far from the only scholar to recognize the problems inherent in critical cartography's longstanding emphasis on militarism and statecraft.[14] Historian Denis Wood (1991) has for decades incorporated social constructivist analytics and questions of professionalization into his explorations of cartographic practice. "I imagine those of you who actually make maps do so in the name of science," he teases in a review article. "But this doesn't mean that I can overlook the fact that you also make them in the name of your career, to make a living, or to impress co-workers or colleagues" (78). Geographer Sarah Elwood (2006) further challenges the supposed dichotomy between "co-optation" and "resistance" that historians and social scientists still frequently project onto non-expert users of GPS and GIS tools.[15] Recent research into the

14 A number of these questions are nearly as old as the technologies themselves. The social implications of remote sensing (particularly for privacy, and for tacit acceptance of certain kinds of government surveillance and control) were discussed by geographers shortly after the first satellites were put into orbit, decades before GIS came into widespread use (e.g. J. Anderson 1969). Early critiques of the military control of GPS technology focused on the declassification and sharing of data, on diplomatic tensions engendered by international fly-overs, and on broadening the scope of civilian applications (Dobson 1983; Tomlinson 1988).

15 Geographers Chris Perkins and Martin Dodge (2009) have challenged this dichotomy even more directly by outlining efforts by GIS user activists to bring "secret" images of clandestine government spaces into public

governance and management practices made possible by the exploding use of "volunteered geographical information" has tempered some of the more utopian assertions that the widespread use of civilian GIS and GPS technologies would result in a "democratization of mapping" for marginal communities (Cinnamon and Schuurman 2013; Robbins 2001; Schuurman 2000).

Amongst both the First Nations and white conservation activists throughout the region whose emergence and entanglements with technocracy I outlined in the previous pages, the darker aspects of "democratization" provide topics for loud and vigorous debates. The rapid expansion of online staking procedures for mineral prospecting claims has allowed thousands of individuals to register mineral exploration rights throughout British Columbia – including throughout Gitxsan and Gitanyow (a Gitxsan people with a separate governing structure from the neighboring Gitxsan First Nation) territories – without ever visiting the lands in question (Schilling 2014). Numerous individuals I spoke with during my fieldwork in northwest BC were furious about these developments and the ways that seemingly benevolent "open data" policies were being designed to shift public opinion in favor of expanded mining and forestry development. And yet, these complaints were not usually voiced as defenses of so-called "local knowledge," nor were detractors overly concerned with the hegemony of particular kinds of geospatial grids. Despite a growing awareness that the very designation "local" is the product of globally circulating systems of power and value (Appadurai 1995; Ferguson and Gupta 2002; Walley 2002; see also F. Fischer 2000), geographers and other scholars continue to rely on implicit (and apparently self-evident) demarcations between "uniform systems" and "local knowledge" to structure their explanations of the mediating roles played by spatial technologies in conflicts between indigenous political actors and nation states (McCreary and Lamb 2014; Fox 2002; Steinberg 2009). Because of this, the reciprocal influence between indigenous

circulation.

mapmaking institutions and their tools is too often effaced.

As I show throughout this dissertation, indigenous experts have spent decades adopting and adapting digital mapmaking technologies and technical standards within dynamic political strategies. And yet, the governments of British Columbia and Canada's long-delayed promises of "knowledge-based governance" in environmental management – promises upon which these incorporations have been based – leave many urgent questions unresolved. If First Nations GIS experts "inherited" the same global[16] grid of twentieth-century digital cartography as the government ecologists and land planners with whom they came to collaborate, how did they then populate this grid with "facts" – and who decided what could count as a "fact" within the gridded system? Even more generally: If knowledge-based environmental governance is predicated on certain kinds of technocratic visibility, how has the work required to render "knowledge" visible produced divergent consequences for different expert groups? If the "politics of recognition" has inspired the indigenous residents of settler states to offer both impassioned pleas for legibility (Taylor 1994) and assertions of alterity (Coulhard 2014; Povinelli 2002; Simpson 2007) in equal measure, to what extent are prevailing definitions of what counts as "expertise" shaped by the visual documents they use to articulate these pleas to different audiences?

The Techno-Politics of Recognition

"Paintings by Aboriginal Australians are not immediately recognisable as maps."

– *Helen Watson, on Yolngu bark paintings* (Turnbull 1993 [1989]: 28)

This statement, the first sentence in Helen Verran (formerly Watson)'s contribution to David

16 In Canada, the geospatial coordinates of GPS are often supplanted for positional numbers and quadrants associated with Canada's National Topographic System, or NTS. See Sebert and Munro 1972.

Turnbull's *Maps are Territories, Science is an Atlas*, exemplifies a longstanding impasse in the historiography of colonialism: the visual representation of environmental knowledge, even "vision" itself, many postcolonial theorists would have us believe, is fundamentally an imperial technology, one that can only ever be imitated or appropriated by indigenous actors (T. Mitchell 1989; Pratt 2008 [1992]; L. Smith 1999). Recognition, whether of maps, landscapes, or people, is tacitly understood to be the task of the settler society. This argument is particularly difficult to move past when indigenous-authored documents are provincialized as emblems of otherness. Even after offering a sensitive and nuanced analysis of the roles that bark paintings of ancestral songlines[17] play in mediating Yolngu cosmology, narrative, memorialization, and navigation practices, Verran implicitly reaffirms a Euro-centric conception of maps as disembodied "texts" by attributing songline paintings' constitutive powers to actors outside the documents themselves. "We might say that in a profound way the Ancestral Beings of the Yolngu were mapmakers. They created the landscape and at the same time made the country a map of itself in the knowledge network" (Turnbull and Watson 1993 [1989]: 36).

Despite having done more than perhaps any western scholar to elucidate the internal dynamics and epistemologies of indigenous knowledge practices (Watson-Verran and Turnbull 1995; Watson-Verran and White 1993; Verran 2001), Verran is far from alone in this bias in her early work: the material forms of indigenous representations of territory have long been subjected to an entirely different range of questions than those directed towards the mapping technologies of settler states (Lewis 1998; Mundy 2000; Turnbull 2000; see also Clifford 1997). Often focused on colonial encounters and archaeological discoveries, many of these treatments

17 Songlines are performed engagements with "dreamings," embodiments of ancestral spirits in the physical landscape which some Australian Aboriginal groups have used to recount their cosmologies, social histories, and ancestral connections to particular landscapes. As anthropologists like Elizbeth Povinelli (1995) have argued, songlines can function as both navigational aids and as repositories of oral histories. On a more fundamental level, however, performances of songlines are often understood by the groups who invoke them as "performing landscapes into being" by fulfilling ethical responsibilities to engage with dreamings and interpret their signs.

dwell on the epistemological divides apparently made visible in the material forms of indigenous wayfinding tools (Jolly 2007; Rundstrom 1990; Turnbull 1998; see also Latour 1990; Eglash 1999). By contrast, the cartographic technologies of settler societies are often presented primarily as alienating and disruptive influences on indigenous "concepts of territory" (K. Carlson 2010; Rundstrom 1993, 1995; T. Thornton 2012). In the writings of Mary Louise Pratt, (2008 [1992]) D. Graham Burnett (2001), Greg Dening (1995) and others, surveyors' maps become emblems of colonial mis-recognition – not merely of the diverse understandings of landscape and place held by colonized peoples, but of alterity itself.[18]

Historical analyses of the roles played by indigenous- and settler-authored cartographic technologies in both day-to-day colonial administration and contemporary governance have followed similar lines. As Sioux politician and historian Vine Deloria Jr. argues in his influential manifesto, *Custer Died for Your Sins*, technical questions about territory and resources prefigured U.S. government engagements with American Indians at every level and on every topic, including the most basic matters of human rights. "Land was the means of recognizing the Indian as a human being" (Deloria Jr. 1988 [1969]: 7), he chides. Others have argued that the entire colonial encounter between European settlers and the indigenous residents of North American, indeed the fact of colonial domination itself, was a direct result of the *lack* of pre-existing textual and other material representations of indigenous knowledge about territory (Chamberlin 2004; Harris 2002). And yet as the events of the late twentieth and early twenty-first century have shown, the colonial project of producing visual knowledge on and about indigenous territories never entirely succeeded in keeping indigenous actors affixed to the map, the printed page, or the space in front of the camera (Clifford 1997, 2007; Ginsburg 2002).

18 For a strong defense of the reciprocal dimensions of visualization, see Bleichmar 2009. Helen Verran's (2010) more recent work at the intersection of water management issues in Aboriginal land claims in Australia is similarly effective in viewing state and Indigenous mapping idioms through symmetrical categories of analysis.

As assimilationist policies gradually gave way to the half-measures of multiculturalism in Canada and elsewhere during the 1980s and '90s, some of the indigenous groups and individuals forced to relocate during the twentieth century were invited to participate in this work of visualization. As I discuss in chapters two and four, this work has taken many forms. Cooperative wildlife management projects enrolling indigenous hunting and fishing groups in North America first began to coalesce around new state conservation initiatives during the late 1970s (Berkes 2009). "Traditional use and occupancy" analysis techniques developed for mapping and place-name cataloging expeditions first organized on Inuit territory in the early 1970s soon spread throughout Canada and the United States, and shortly thereafter to indigenous-claimed territories around the world (Chapin, Lamb and Threlkeld 2005; H. Brody 1976). By the 1990s, the proliferation of government programs, tribal initiatives, and independent consulting work conducted under the banner of "traditional ecological knowledge" (TEK) or a variety of other acronyms had generated considerable archives of data, a few of which were articulated directly into adaptive management initiatives and other emergent forms of knowledge-based governance (Houde 2007). Transcripts of interviews and oral histories; ethnobotanical lists and surveys; collaborative analyses of archaeological evidence; video recordings of potlatches, performances, and elders' accounts of historical events; each new document indexed the goals of myriad indigenous sovereignty projects even as it was folded into a new salvage anthropology for the twenty-first century. Above all, though, the global expansion of TEK produced maps: bureaucratically legible, spatially explicit documents of sanitized alterity destined to be managed, or at least collaborated upon, by an altogether new class of rural technocrats: the indigenous TEK worker.

Materializing Indigenous Expertise

Paradoxically, First Nations who have made careers out of TEK work are often regarded as neither "authentically indigenous" nor wholly expert. While the academic literature on TEK continues to grow as the cultural heritage resource (CHR) consulting industry expands throughout North America and contracts new clients among indigenous groups in the global South, the physical and intellectual labor expended by the indigenous groups and individuals engaged in these projects is rarely examined in the same terms that anthropologists have used to discuss other forms of indigenous labor in resource economies.[19] These omissions have been doubly painful, since, as Paul Nadasdy (2005a) argues, the bureaucratic organization of TEK work forces practitioners to either eliminate or self-consciously depoliticize many of their most distinctive knowledge claims in the service of anodyne performances of competency (see also W. Anderson 2009). Critical discussions of resource development and professional training programs in indigenous communities often focus on the social disruptions caused by the travel and relocation demands, racial hierarchies, health hazards, and income inequality characteristic of many kinds of resource industry work.[20] TEK workers, indigenous or otherwise, are only superficially situated within these same discussions, despite the fact that many of these researchers live in dislocated rural communities and face an overlapping range of challenges in their own work. The tendency of applied scholars to frame methodological discussions around the accuracy of cartographic representations of participants' input and the durability of the graphical formalisms involved in map construction reflect TEK experts' continuing struggles to

19 Notable exceptions to this trend include discussions of the effect of contemporary lifestyles and forms of employment on the mechanisms of "knowledge transmission" used by indigenous groups to train youth in hunting, harvesting, and navigation practices. See e.g. Ohmagari and Berkes 1997.

20 The academic literature on indigenous peoples' experience with wage labor in Canada is vast and varied, yet links between forced movement, dispossession of territory and resources, and connections to particular landscapes provide recurring themes. See in particular Bell 2012; Bradbury 1978; Knight 1978; Walia 2010.

have their work recognized in legal and commercial venues.[21] Perhaps because of these anxieties, even critical discussions of TEK work focus on the (often considerable) challenges faced by nonspecialist participants in these projects rather than on the subjective pressures and institutional demands navigated by the researchers themselves (Bielawski 1984; Nadasdy 2003; see also Walley 2004).

Analyzed within the historical and geographical experiences of specific groups, the struggles indigenous TEK-workers have faced reconciling the twinned tasks of translating claims for specific audiences and representing "knowledge" in general highlight a troubling contradiction at the heart of professionalization. Before paper maps came into widespread use among the Gitxsan and Gitanyow First Nations and their neighbors, historical and ethnographic accounts of the political entanglements surrounding performances of knowledge about ancestral territories painted complex pictures of translation and transposition (Marsden 2002). Neil J. Sterritt, a Gitxsan chief and key political figure during preparations for the *Delgamuukw* trial, argues that the links between naming, knowing, and owning land, crystallized in the feast

21 While Paul Nadasdy's (1999) call to examine critically the very concept of knowledge "integration" remains the starting point for many stock-taking reviews and retrospectives on TEK literature in the twenty-first century, many of the articles who cite this article continue to misrepresent Nadasdy's portrayal of bureaucratization as a simplistic "dualism between technical and political agendas" (Bohensky and Maru 2011: 16). Put more simply, many of the articles which begin by citing Nadasdy proceed to describe contemporary TEK-work as a steady progression towards greater integration. The lack of critical attention to the financial aspects of TEK-work raises other kinds of questions. One could plausibly argue that by omitting details related to the organization and funding of their own work, some scholars are deliberately downplaying the significant (and rising) costs indigenous groups must often bear to participate in TEK projects. On the other hand, simply determining who actually pays for TEK-work can be complicated as well. In northwest British Columbia, archaeological overview assessments (AOAs) and map biographies which had previously been funded through the provincial Ministry of Forests and other government offices are increasingly being covered by mineral exploration companies and mine developers, whether through third-party CHR consultancies or direct payments to band councils and other First Nations governance groups to conduct their own studies. Numerous groups have been reluctant to receive money from corporate developers or accept the results of third-party TEK-work, and have opted instead to use band council budgets and private sources of funding to finance their own studies. To be fair, numerous TEK workers and consultancies have expressed anxiety about the financial demands their services place on resource-poor First Nations communities, and several notable companies and researchers have explored this dilemma in both popular and academic publications. (On traditional land use and occupancy studies (TLUOS), see e.g. Tobias 2000, 2010) As in most other internalist "critiques" of TEK, however, these discussions tend to focus on practical strategies and application-specific methodologies for maximizing researcher efficiency and minimizing impositions on interlocutors. For a more theoretical criticism of the costs and burdens imposed by participatory projects, see McCall and Dunn 2012.

performance of a Gitxsan *adaawk*, have been embedded in material technologies since the earliest colonial encounters.

> "For the Gitksan[22] and other Northwest Coast nations, the process of claiming territory is described as "walking the land" or "surveying" it and includes naming mountains, rivers, lakes, and other areas. These names are highly descriptive and reflect a detailed knowledge of the landscape. Once the land was surveyed, the house hosted a feast and announced its claim to the territory and its names. The guest of the host, the chiefs of the other houses, acknowledged the claim to the territory, thereby validating the house's ownership of the territory and completing the process of establishing land tenure. Knowledge of the names of geographical features within the territories and of their historical origins is therefore an element in the proof of ownership within the indigenous legal system. The Gitksan and Nisga'a[23] have described their territory many times, naming its places and identifying its resources to anthropologists, government agents, judges, and royal commissions on Aboriginal matters. As well, they have developed their own documentary record around a variety of petitions, maps, and claims for presentation to government" (Sterritt *et al.* 1998: 12-13).

As the materiality of Gitxsan territory markers shifted first from the sung histories of the Gitxsan *adaawk* into the hand-drawn paper maps used in the first *Delgamuukw* trial, and then into digital polygons and GIS map layers, new kinds of technicians have had to step forward to manage these artifacts. Since the arrival of digital mapping technologies in the early 1990s, managing

22 Sterrit *et al*'s spelling, "Gitksan," is the name of the Nation in the Gitxsenimx dialect of the Western village reserves, as well as the official spelling of the original Gitksan-Wet'suwet'en Alliance whose members organized much of the first *Delgamuukw* land claims case. More recent institutions, including the Gitxsan treaty society, have adopted the spelling and orthography of the Gitxsanimx dialect of the Eastern village reserves. Many of the people associated with the pre-Treaty Society leadership continue to use Gitxsenimx spellings and terms.

23 This Nisga'a First Nation is group whose territory claim, directly to the southwest of Gitxsan and Gitanyow territory, was partially incorporated into land concessions outlined in the Nisga'a Final Agreement of 1998, the first modern treaty signed in British Columbia. As Sterritt and others have argued, however, part of this claim also incorporated large sections of land claimed by the Gitxsan and Gitanyow. See Sterritt 1998.

these artifacts and claiming responsibility for the kinds of knowledge they manifest has meant seeking out sparse sources of technical training and navigating a constantly shifting landscape of software updates, data access rights, and technology availability issues. As managers of documents, if not as official representatives of recognized territories, individual TEK-workers interface with institutional forms spanning a wide range of bureaucratic functions and jurisdictional scales.[24] For the most involved members of these groups, however, managing maps has also meant committing themselves to careers without the benefit of consistent work opportunities on or near their home territories.

Ethnography on the Map and Cartographic Refusal

The Gitxsan experience of the entangled histories of sovereignty and techno-politics intersects awkwardly with a growing body of literature devoted to decrying the neocolonial effects of technocracy in general. The motivations behind this movement are well-founded: increasing frustration amongst cultural anthropologists against the violence done to First Nations groups and other indigenous communities by bureaucratic forms and imposed categories – violence often enacted by well-meaning anthropologists themselves (Kuper 2003; Simpson 2007; Starn 2011; see also Deloria 1988 [1969]: 78-100) – has of late precipitated a resurgence of activism

24 Between different First Nations, the relative power of these forms varies tremendously. Particularly in the provincial northwest, the members of traditional governing entities like the Gitxsan *simgiigyet*, or hereditary chiefs, are not elected to pre-set terms like the members of the 203 federally recognized Indian band councils which oversee British Columbia's small reserves, but are rather elevated to their positions through hereditary lineages managed during ceremonial feasts (Daly 2005). (The number of registered Indian Bands in BC varies. This number is derived from a First Nations Health Council (2010) report which compares the merits of the number offered by various sources.) Whereas band council representatives' jurisdictions cover defined lists of privileges and responsibilities on their minute home reserves, *simgiigyet* assertions of authority articulate a wide range of social, financial, and environmental obligations over vast landscapes. As spokespersons during the logging blockades of the 1980s and '90s often pointed out while asserting the geographical scope of their standing to timber industry officials and provincial negotiators, house group leaders and their wing chiefs are formally charged by the *simgiigyet* with managing the land and resources contained within their house group territory in such a manner that they can provide for their house group members during times of need (Culhane 1998). In practice, the modes of "management" practiced by each house group varies tremendously depending on house members' wealth, levels of formal education, and location relative to their house group's territories.

deliberately pitched outside the ambit of legal and bureaucratic legibility (Coulthard 2014; Simpson 2014).[25] Critics from a variety of disciplines began to deconstruct the policies and rhetoric of "nation-to-nation" engagement almost immediately after the governments of Canada and British Columbia began implementing new reconciliation policies in the early 1990s (Alfred 2001; Alfred and Corntassel 2005; Sawchuk 2001). Critiques published in the wake of the Idle No More protests which spanned all of Canada from late 2012 to early 2013, however, questioned the value of the entire reconciliation project, a project that, Dene theorist Glen Coulthard argues, offers "little insight into how to address the more overtly structural and/or economic features of social oppression" (Coulthard 2014: 34).

These new theoretical commitments have exacerbated the ambiguous status of indigenous-produced maps. Despite the popularity that digital maps have garnered as markers of First Nations territorial presence, the status of the boundaries articulated in these maps has never been fully settled in Canadian law. In the twenty-six years since Gitxsan researchers first used a great paper map of their territories to announce their presence during the beginning of testimony in the *Delgamuukw* trial, many issues of jurisdiction, meaning, and authority remain unresolved. Questions about maps – particularly the digital maps assembled in concert with biodiversity surveys and species inventories during the 1990s – are still often taken as questions about the legitimacy of the social groups and governing entities the maps were originally drawn to represent. As some scholars have pointed out, much of this wariness stems from the omnipresent threat of abrogation. During the *Delgamuukw* trial as well as during subsequent treaty negotiations, Gitxsan representatives were told many times over by government lawyers that any kind of participation in province-run research and planning projects could be interpreted as

25 Outside of Canada, scholars have investigated similar political claims by critiquing state actors' tacit appeals to the so-called "modern constitution," a strategy of reification outlined by Bruno Latour in *We Have Never Been Modern* (1993). See e.g. De la Cadena *et al.* 2015.

recognition of the state, and thus could be taken as grounds for extinguishing their claims (Napoleon 2001).

In recent years, however, this wariness has been redirected away from the British Columbia Treaty Commission and towards the Gitxsan Treaty Society (GTS), a Gitxsan-led bureaucratic institution established in the early 1990s in part to manage the maps produced by *Delgamuukw* researchers. Registered as a civil society organization under provincial law (McCreary 2014)[26] yet charged with representing the Nation in treaty proceedings and with mediating between provincial ministries, corporate developers, and the more than eighty house groups, or *huwilp*, of the Gitxsan Nation, GTS officials regularly found themselves accused by all parties of harboring conflicts of interest.[27] When a Society executive made a unilateral agreement in 2011 allowing for the construction of a controversial pipeline through Gitxsan traditional territory, dissident chiefs responded by staging a public blockade of GTS headquarters (Gitxsan Unity Movement 2012a).

To an earlier generation of *Delgamuukw* researchers who followed the blockade from their new places of work elsewhere in British Columbia, the transformation was bitterly ironic. Twenty years after mappers working for the Gitxsan Strategic Watershed Analysis Team (SWAT – see chapter two) had worked in concert with activists to fight injunctions against Gitxsan-led blockades, their data sat idle behind a Gitxsan-led, Gitxsan-fought blockade of the very office whose legitimacy was forged in these earlier battles. By the time the protesters finally took down their barricades and banners after receiving a promise of a forensic audit of the Society's

26 Both white and First Nations-organized civil society groups have become increasingly central to resource management disputes throughout British Columbia in recent years. For a general overview of these shifts within the context of community forests, see McCarthy 2006.

27 Many of these conflicts date back to the original paper map of Gitxsan *huwilp* boundaries produced for the original Delgamuukw trial in 1987. As legal historian Val Napoleon (2005) has argued, the decision by the plaintiffs to remove or abridge conflicting depositions from house group leaders led to at least one *wilp* being dropped entirely from the formal registry.

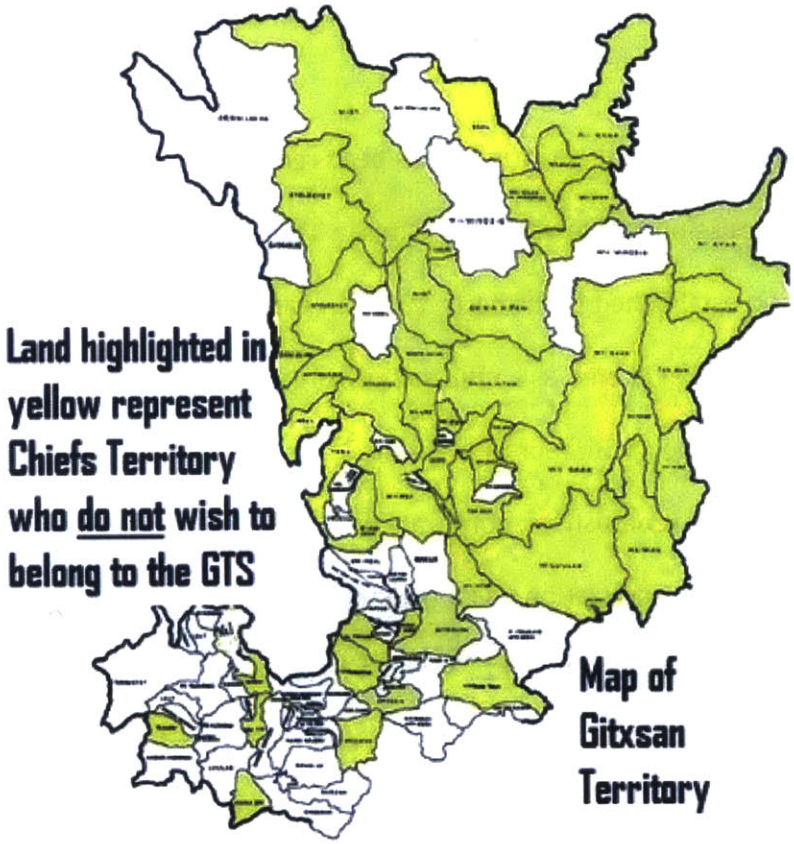

FIG 0.5. Visual depiction of Gitxsan chiefs allied with (white) and against (yellow) the Gitxsan Treaty Society. Small polygons in the image represent Gitxsan house group territories (as cartograhically described during the *Delgamuukw* trial research). Modified from Gitxsan Unity Movement 2012b.

accounting practices six months later, news of Gitxsan political turmoil had reached a national audience. The GTS had lost the confidence of the chiefs of roughly half of the Nation's *huwilp*, and had countered dissidents' attempts to dissolve the Society by rewriting their bylaws to recruit new members from the remaining loyal *huwilp* (Spookw v Gitxsan Treaty Society 2015).[28] Numerous newspaper articles published by dissident chiefs during the blockade and its aftermath broadcast the breadth of their alliance through a color-coded version of the paper map produced

28 Dissident chiefs' attempts to counter revisions to the bylaws of the GTS were rejected in provincial court, despite the agreement of presiding Justice McEwan that forensic audits of GTS accounting practices had revealed alarming irregularities. McEwan even went so far as to admit in his written decision his resignation to the fact that the proposed bylaws would further legitimize the Society by providing it with a dubious semblance of representativeness.

for the original *Delgamuukw* trial: white-colored house territories were for the GTS; yellow remained opposed (Gitxsan Unity Movement 2012b). The geographic boundaries that the founders of the Society had helped to formalize were used to paint visual arguments that the Society had lost its legitimacy (see figure 0.5 above).

Increasing anthropological attention to the politics – but not necessarily the techno-politics – of territorial disputes in Indigenous-settler state relations complicates attempts to make sense of the roles played by maps in this conflict and others like it. In the recent work of Coulthard, Audra Simpson (2014), and others, the thoroughly disenchanted colonial concept of "borders" is being reappropriated – one might say "re-enchanted" – in new and daring ways to assert Indigenous *space* as an inviolable domain, and to challenge the taken-for-grantedness of Canadian and American "nationhood" and the countless other assimilative discursive practices to which Indigenous people in North America are exposed in their daily lives. In Simpson's work among the Mohawks of Kahnawà:ke, this critical reinvigoration of the concept of sovereignty crystallizes in the idiom of refusal: an assertion of political identity that takes form in the refusal of the conveniences and complicities of Canadian citizenship, and the refusal to abet the work of categorization upon which "indigenous elimination" depends. Kahnawa'kehró:non refusal affects not just the status of their reserve territory within the Canadian nation state; it shapes how they travel, how (or if) they vote, and how they articulate with the broader Iroquois Confederacy. In practice, refusal is a multi-scalar phenomenon, even if it pretends to abnegate completely key scales of political discourse.

By refusing the complicities and half-measures of settler states' politics of recognition in favor of new direct action protests and proclamations of uncompromising alterity, Simpson, Coulthard, and the many scholars and activists influenced by their work have helped to

reinvigorate First Nations sovereignty movements with a fervor not seen in decades (e.g. Grande 2004; Kulchyski 2005; LaRocque 2010). Yet by eschewing the mundane practices of research, planning, and administration that comprise the material architecture of techno-politics, the idiom of refusal has also tacitly reinforced a structural relationship between knowledge, power, and expertise that is increasingly becoming outdated. For some, contemporary forms of refusal represent ruptures in historical memory as well. Treated now as outcasts and apostates by the GTS elite, Gitxsan cartographers who were active in the 1990s find in their old maps memories of the unfulfilled promises of knowledge-based governance: species inventories begun, but never updated; predictive ecosystem models assembled to project the longer-term consequences of clearcutting, analyzed only once before being set aside. Environmental data provided imperfect yet tactically useful idioms for land claims researchers exhausted by the mis-recognition offered by the courts. But like the majority of the scientists with whom they worked, cut adrift in the early 2000s by government downsizing and neoliberal reforms, most of these data have been "removed," too, from contemporary representations of Gitxsan territory. What once provided a complex scaffold for emergent forms of life has been purified, re-claimed, and re-enchanted.

Dissertation Overview

The following five chapters of this dissertation are organized into two and a half pairs of essays, each set oriented around a separate legacy of knowledge-based governance. For each chapter describing how the predominately white community of forest ecologists and planners in Smithers struggled with the effects of institutional restructuring, long-term fieldwork, and data dissemination, I devote a corresponding chapter to related challenges faced by Gitxsan and Gitanyow mappers and resource managers. As Marshall McLuhan (with Quentin Fiore 1967),

Canada's original expert on the politics of mediation, reminds us, however, the medium and message of such a contrived structure are not so easily disentangled. Each pair of essays, full of ill-fitting correspondences, deeply personal relationships, and missed connections, mirrors the main methodological challenge which structured my fieldwork as a whole: As in so many other "frontier" communities in western Canada, most of the First Nations people and Euro-Canadian settlers who reside along the tributaries of the Skeena River in northwest British Columbia live their lives in virtual isolation from one another (Bell 2014; Dinwoodie 2002; Furniss 1999; Robertson 2004). Finding commonalities between each community's relationship to contemporary modes of landscape mediation without overly dwelling on a few sites of direct and active conflict has often required me to project potential points of intersection in spaces where actual dialogue is elusive.

The scientists, technicians, and activists with whom I spent most of my time during this period usually imagined themselves as being above the de facto segregation in place throughout rural British Columbia. Most of the board meetings and planning workshops I attended in Smithers began with an invocation of the authority of the Witsuwit'en house group on whose unceded territory the town was built. Many of the environmental planners and scientists I met in Smithers, particularly younger people and mid-career professionals, were eager to detail their participation in community information sessions, teach-ins, and other First Nations-oriented outreach projects. Some admitted to being nervous about the prospect of discussing First Nations politics with an anthropologist, and reminded me that the groups and events they supported were relentless in their gestures of inclusiveness, even as their efforts were typically criticized or ignored by the First Nations groups they struggled to recruit. Whenever local researchers or government scientists organized "community"-wide initiatives like land use plan amendments,

risk assessments, or knowledge trusts, they invited representatives of the Office of the Wet'suwet'en or the Gitxsan Watershed Authority to participate in group discussions. As I often observed, however, these invitations usually were extended only after the scope of a new plan or process had been agreed upon and the terms of reference meant to structure ensuing discussions had already been spelled out. While a handful of individuals were deeply engaged in conversations and processes on both sides (particularly on the matter of knowledge sharing trusts, a topic to which I will return in the concluding chapter), white and First Nations technicians alike complained to me that their interactions with each other too often felt frustratingly formal and inconsequential.

In empirical terms, the dramatic decline in government support for independent research projects since the late 1990s and the cancellation of watershed restoration initiatives meant the near-disappearance of opportunities for Smithers-based ecologists and Gitxsan and Witsuwit'en mappers to apply for shared grants. As piecemeal jobs and research funds emerged elsewhere, erstwhile collaborators simply fell out of touch. Whenever I asked senior scientists and planners active in the region to reflect on their experiences working with First Nations mappers during anti-clearcutting protests and joint forestry research projects during the 1990s, most were far more blunt than their younger colleagues in their assessments of the disconnect that had developed between the two communities since. Some attributed the distance to white activists' impatience with the land claims process. "'What are you going to do? Sit around and wait another thirty years? By then, there'd be no trees left,'" one planner sarcastically pantomimed, reenacting for me the logic espoused by many of her colleagues during the blockades and standoffs remembered now as the "War in the Woods" (see chapters one and two). Others admitted that their ignorance and timidity around "internal" disputes between house groups of

the same First Nation cast a pall over early collaborations, a state of unease which resurfaced time and again as new collaborative endeavors were proposed. "We knew that that stuff was going on, but we knew that we couldn't delve into it, so we didn't," a long-time Smither-based environmental planner admitted to me. "We just hoped it would all work out." As I seek to show in chapter two, many of these disputes are still far from resolved. With a few exceptions, non-First Nations experts, particularly the former government employees and contract workers who dominate regional planning work in Smithers, are still reluctant to get involved in any conflict among their First Nations neighbors, regardless of the roles that their earlier work might have played in structuring how these confrontations unfold.

Ultimately, I decided to convey these ruptures not through post-facto analyses of failed joint ventures, but by attempting to treat each groups' technological histories on their own terms. Read together, these twinned histories echo the feedback and dissonance of parallel conversations, vigorous debates conducted in adjacent spaces, yet often just out of earshot. In some ways, the common characters between the two sides thus become the mapping technologies themselves: handheld GPS devices; survey notebooks; georeferenced polygons and digital elevation models; online data repositories; tree lists, whether as subjects of study, targets of extraction, or discrete monuments of ritualized modification. Convenient as it may be from a textual standpoint, this call-and-response structure is far from perfect. It goes without saying that any direct comparison between the experiences of the two groups forces epistemic equivalences capable of considerable harm. The choice is a paradoxical one: discussing both white and First Nations forms of expertise in the same language implicitly legitimizes Euro-Canadian technocracy as the hegemonic model of rural knowledge production. On the other hand, insisting that these forms of expertise are qualitatively, even "ontologically," different suggests that

indigenous groups have no "institutions" worthy of the name. Insisting on incommensurability also eschews much of our responsibility for analyzing the historical circumstances underlying the unequal successes of these disparate forms.

Chapter Outline & Methodology

In the remainder of this introduction, I will introduce the themes and topics to be covered in the next five chapters, first outlining the aim of each pair before describing each chapter individually. Drawing inspiration from the structuring device David Nye (2003) employs in *America as Second Creation* to pair his coverage of American Indian and Euro-American settlers' accounts of the technological transformations involved in westward expansion, each pair of chapters addresses a separate social, spatial, or digital form that has been reconfigured by the neoliberalization of environmental mapping and research during the twenty-first century. The labels that I use to group and describe these three different forms, "Institutions," "Fields," and "Models," are imprecise: each term invariably reflects the professional bias of one group, or highlights political commitments ostensibly outside the purview of the other. The terms also reflect the methodological choices I made while struggling to assemble my field notes, interview transcriptions, and analyses of media into a single ethnographic text.

As a novice ethnographer who began visiting British Columbia to conduct interviews and participate in mapping projects two years before my dissertation fieldwork began in earnest in 2013, my own (very tentative) claims of expertise often rested on the affordances of digital mapping tools. Beginning with a series of short visits to mineral exploration offices in Vancouver in 2011, my initial attempts to locate the authors of various maps and models relevant to shifting perceptions of Canadian landscapes felt like a doomed quest to track professional nomads.

Seeking out the institutions where new and idiosyncratic cartographic conventions had been established often led me to the websites of government divisions that had been dramatically reorganized or shut down since the maps in question were published, or to the rented office spaces of independent research groups surviving from grant to grant. Committing to any single company or government ministry as a "field site" was beginning to feel increasingly risky.

At the urging of an assortment of mineral exploration industry advocates and conservation activists I met while trying to track maps in Vancouver, I drove thirteen hours north to Smithers. I quickly met a wide range of ecologists, botanists, geologists, and GIS technicians, including several who were members of the Witsuwit'en, Gitxsan, and Gitanyow First Nations, whose territories covered most of the region. Over the course of one year in the northwest, I conducted interviews with over six dozen of these experts and repeatedly accompanied several of them to collect data on forest growth experiments and other field-based trials. I also worked to make sense of the professional communities they had articulated, however fleetingly, through the media they had produced earlier in their careers, a strategy which caused me to make repeated trips to other offices in southern and central BC to meet former colleagues who had participated in earlier iterations of key projects.

As each chapter of this dissertation seeks to argue in different ways, the idioms of "community" articulated in and around these media reflected the precarious and shifting affiliations of the mapmakers themselves. Even as I slowly became a familiar figure in parts of Smithers and in the homes of individual Gitxsan and Gitanyow mappers and activists living in the region, I was struck by the professional isolation, even loneliness, that many of them had come to experience since their institutional identities began to fracture in the early 2000s. Their stories made me acutely aware of the tenuousness of my own place as an ethnographer in the

northwest, as well as how, not unlike my interlocutors, I increasingly relied on the material artifacts of mapmaking projects to inform my sense of continuity with the region's pasts and possible futures. The two objects I described in the first paragraphs of this introduction – the "current and future developments" wall chart I received on my first day in Smithers and the Gitxsan territory map displayed in a mapmaker's living room – signal this reliance. These maps and others like them, with their configurable data layers or their unwieldy physical heft, were to be the sites of my ethnography, as much or more so than the peaks and conifers calling out from the window beside my desk at the community college in Smithers.

Section I: Institutions

"Institutions," the first pair of chapters, focuses on a pair of specific expert organizations: the Bulkley Valley Research Centre (BVRC), and the now-defunct Gitxsan Strategic Watershed Analysis Team (SWAT). The chapters also trace the professional networks and paths of professionalization from which these bodies emerged – and, in the case of SWAT, into which their technicians moved as their organization broke down. Framing mapmaking as an organized, remunerative profession – an *identity*, as opposed to a depersonalized set of practices – certain disparities immediately come to the fore. While Smithers-based ecologists affiliated with the BVRC reflected on government cutbacks in terms of an epochal shift from rigid institutional structures to more agile professional networks, the First Nations technicians most directly affected by the same reforms had yet to experience the professional stability which their government-employed counterparts in Smithers had enjoyed for decades. The widespread availability of contract work in the region, particularly on corporate-led environmental assessment and resource analysis projects, allowed many of the scientists displaced in the early

2000s to maintain their lifestyles. With far fewer work opportunities and only limited, fragile professional networks available to the Gitxsan environmental mapping experts, however, the loss of government research funding was devastating. As I argue in chapter two, the young technicians who took part in the formation of an acclaimed Gitxsan counter-mapping and cartography training program in the early 1990s were freighted almost immediately with the bureaucratic needs and expectations (leading complex timber harvest consultations with the province, primarily) of Gitxsan politicians and other community members who originally supported them. By comparison, the Bulkley Valley Research Centre, formed a decade later, was often described to me as a local haven for well-traveled environmental researchers, a source of stability amidst the new demands and uncertain pressures exerted by the new provincial government's land management regime.

In an abstract sense, the term "institutions" refers to both rigid systems and ad-hoc arrangements; physical buildings and virtual meeting spaces. Among the people who used the word in their day-to-day work, the idea might reference to an object of nostalgia or an elusive, perhaps illusory, goal. Even as they bemoaned the shrinking of government research institutions, members of both SWAT and the BVRC nevertheless spoke in nostalgic terms about the comparative stability they experienced during the 1990s. Reflecting on their contemporary positions, members of both groups imagined themselves as occupying a place on a kind of imaginary continuum, a spectrum of stability and influence ranging from precarious isolation to well-funded security. Each of the meanings lent to the term tacitly recognized local communities, their aspirations, and their sense of place and belonging in markedly different ways. The original purpose of the BVRC, as one director put it, was less about achieving a particular political goal or undertaking a specific scientific or managerial project, but rather protecting the region itself

from "the loss of all this critical mass of people that were working in government, [finding] some place for them … to keep functioning in a 'results-based' [regulatory] environment." For former members of SWAT, the struggle to gain standing as individual experts, let alone achieve "critical mass," precluded any attempts to diversify their sources of support for the talented but professionally isolated technicians already living and working on the territories.

In 2002, the closing of Forest Service research offices throughout British Columbia threatened to end the institutional support structure that had for decades allowed environmental scientists to live and work in the rural north – a place where, unlike the neighboring Gitxsan, most of them had relocated by choice. The first chapter of the dissertation, "The Care of Experts: Ecosystem-Based Management and Technocracies in Transition," explores how forest ecologists and planners living in the town of Smithers managed to maintain their livelihoods and build a new sense of collective identity by leveraging the principles of "ecosystem based management" to build new organizations for research and advocacy around the now largely defunct conservationist policies of earlier resource management regimes. Building on a historical analysis of this community's participation in the BC Land and Resource Management Planning process in the 1990s and an ethnographic account of contemporary work at the Bulkley Valley Research Centre (BVRC), I argue that post-deregulation rural research organizations and the informal networks they support exemplify the emergence of a mode of expertise positioned somewhere between formal, government-driven technocracy, on the one hand, and "citizen science," on the other.[29] By examining how transitions in government-authored environmental

29 My exploration of this new mode of expertise draws inspiration from work on "boundary organizations" and "hybrid management" undertaken by Clark Miller (2011), David Guston (2001), and others. I diverge from Miller and Guston's framework, however, in my attention to the far more modest scale of the putatively "local" political interventions and articulations of community put forth by my interlocutors. It is not clear to me yet how the transitional form of expertise I am arguing for here could be made relevant to the comparatively stable nation-state-level and other international environmental management projects that drive Miller and Guston's analyses.

management policies have been presented by BVRC affiliates and supporters as failures of care, I argue that the emergence in the rural northwest of expertise as an oppositional language of ethics and solidarity has largely been effected by former government researchers' incomplete renunciations of their formal ties to government institutions. I challenge prevailing STS and anthropological distinctions between "experts" and implicitly non-specialist "locals" or "residents" by showing how BVRC affiliates' nostalgia for the adaptive management programs of the 1990s has served to embed bureaucratic norms (including those no longer practiced by the current regime) within ostensibly "community-driven" forms of advocacy.

The second chapter, "Expertise in Exile: Gitxsan GIS and the Politics of Professionalization," traces the career arcs of two prominent Gitxsan GIS mapmakers who first came to positions of power and visibility as members of the Gitxsan Strategic Watershed Analysis Team (SWAT). Drawing on interviews and archival sources, I follow their bifurcating careers as a new provincial government sought to undermine the nascent First Nations self-determination movement by withdrawing support for First Nations technical capacity building, a process that eventually drove many would-be mapmakers off their reserves in search of work. These transitions forced Gitxsan GIS experts to craft new professional identities as a means of proving their competence and neutrality, often by distancing themselves from the personal battles and political claims of the groups whose interests motivated their recruitment into technical careers. I argue that scholarly treatments of First Nations capacity-building initiatives focused on technical skill creation have implicitly relied on prevailing STS (and thus effectively Euro-Canadian) models of professionalization and network-building. Too often, these treatments simplistically celebrate individual influence and mobility while ignoring how processes of expert-formation can unsettle local hierarchies and power structures within marginal

communities. Building on earlier anthropological arguments that "Traditional Ecological Knowledge," or "TEK," research and governance programs abet neocolonial strategies of anti-politics and reify problematic concepts of territory and rights (Agrawal 1995; Li 2003; Nadasdy 1999, 2005a), I argue that the processes of professionalization set into motion by these programs have proven even more disruptive to already-precarious forms of life by forcing indigenous TEK workers to adopt normative modes of individual careerism more commonly associated with highly formalized technical professions. Working at immense geographic distances from universities, corporate centers, and, increasingly, the government institutions that provided their initial support, Gitxsan GIS experts' relationships with their maps, once deeply personal and politically interested, have been radically depersonalized by the de-facto conditions of their new – and still limited – professional mobility.

Section II: Fields

"Fields," the second pair of chapters in the dissertation, explores how the brief efflorescence of adaptive management programs and cooperative land planning projects begun in the 1990s transformed regional experts' modes of articulating space in the forest. As in chapters one and two, chapters three and four deal with bureaucratic categories that emerged to great fanfare as vehicles for specific political claims in the early 1990s, but have since been marginalized in both activist discourses and governmental practice. For Smithers-based forest ecologists, the word "field" denotes detached spaces of scientific inquiry, outdoor laboratories scattered throughout the region for generating data about forest growth patterns, tree species succession, and other long-term transformations best quantified (they argue) through repeated visits and systematic observations. For First Nations GIS experts, the word "field" can denote spaces of scientific

inquiry, too; rather than the arbitrary boundaries of experimental grids, however, the space of the field for the Gitanyow mappers I follow in chapter four is delimited by the boundaries established through *Delgamuukw*-era land claims research. Still discussed by both groups of experts as spaces for making visible particular kinds of knowledge about processes of environmental change, the two spaces I explore in these chapters – an experimental forest managed by the BC Forest Service, yet maintained by the BVRC; and a series of transects along the path of a proposed pipeline on an area of Gitanyow territory only a few dozen kilometers away – are now navigated, remembered, and mapped in critically different ways.

By showing how scientific fieldwork forces practitioners to reify certain boundaries even as their technical arguments and political goals change, the second pair of chapters calls attention to the subjective labor required to maintain, as opposed to merely create, the boundaries and markers that define spaces of research. As one of the founders of the BVRC insisted as he decried declining government support for experimental forests at a forestry conference a decade earlier, maintaining the sites and objects of fieldwork means articulating the social histories of these spaces in particular ways, too. "The very nature of long-lived dominant organisms such as trees," botanist Philip Burton (2006) pleaded, "necessitates inter-generational collaboration among forest researchers." Among the Gitanyow mappers and their collaborators, periodically conscripted to produce technical maps of the Gitanyow territories, the myriad obstacles to "inter-generational collaboration" are inscribed on the landscape itself. Particularly as ongoing tree harvests and pipeline construction projects carried out amidst continuing jurisdictional ambiguity accelerate processes of environmental change, efforts to represent knowledge about the territories as the product of continuous observation have made Gitanyow GIS experts ever more reliant on digital databases and corporate funding. By juxtaposing these two different modes of

producing continuity by (re)producing space, "Fields" expands on the institutional histories outlined in chapters one and two to show how the original goals of knowledge-based governance remain embedded in the navigation and observation practices different groups of experts have employed in their efforts to leverage these spaces in new confrontations.

Since it was first established in 1992 by the provincial government as a salve to the anti-clearcut logging protests which swept British Columbia in the late 1980s and early '90s, the Date Creek Research Forest has languished in the twenty-first century due to the provincial government's declining interest in long-term ecological research. Chapter three, "Into the Woods: Placing Science and Making Time in a Post-Disturbance Regime," draws on my explorations of the site with those members of the BVRC who have come increasingly to serve as the stewards and chief experimental users of the Research Forest. I argue that as the meanings of the partial cutting experiment which originally defined the forest (effectively, a test of the economic viability of ecologically sustainable tree harvesting methods) changed and the infrastructure of the Research Forest itself began to decay, Date Creek researchers have begun to position their observations of the consequences of "natural" disturbances to highlight the provincial government's failure to observe and manage its own infrastructures along the temporal scales relevant to forest transformations and climate change. These deliberate reconfigurations of meaning around outdoor laboratories signify a transition in attitudes about individual legacies and professional succession, particularly for environmental scientists supported by government research institutions. By challenging government administrators set on devaluing Forest Service-led, field-based data collection and experimental work, BVRC affiliates seek to reappropriate the outdoor laboratory – and the public land upon which it sits – as a privileged site of knowledge production and political legitimation. Building on Robert Kohler's (2002, 2010) notion of "the

field" of environmental research as a "working environment," I argue that the ad-hoc research groups that increasingly use and maintain long-term forestry experiments seek to render visible the legacies of their scientific labor not simply by "constructing nature" in governable ways (Braun 1997; Castree and Braun 1998; Prudham 2007; N. Smith 1984), but by recursively re-designing the space of the field as a flexible grid capable of generating new questions for local researchers and broader audiences – and, importantly, of deferring answers – about the long-term consequences of prevailing resource management practices.

The fourth chapter of the dissertation, "Transects and Territory: Indigenous Field and Information Sciences in the Neoliberal Era," follows an ad-hoc crew of temporary GIS mappers hired by the Gitanyow First Nation to map the route of a proposed pipeline through Gitanyow traditional territory, a landbase partially recognized in provincial policy by an interim treaty agreement, but still administered by the BC government. I argue that the recent rise in anthropological interest in experience and navigation and the concomitant fetishization of indigenous peoples' "trails" and other seemingly continuous forms of landscape navigation implicitly undermines the different forms of value accumulated in indigenous-led technocratic work (Aporta 2004; De la Cadena 2010; Ingold 2008; Sletto 2009). However partial and delimited, these new zones of political engagement make clear that complex forms of labor are still required to populate with data the technocratic forms of contemporary colonial governance – forms like the transect, an environmental mapping technique used to quantify objects of interest along a discrete linear path. Anthropological critiques of development on indigenous territories tend to conflate any form of indigenous participation in government and corporate projects with the governmentalization of indigenous subjectivities and with a broader resignation to the tenets of neoliberal developmentalism (Li 2010; Pasternak 2015). I argue that it is precisely this

"mediating labor" that allows indigenous mappers to both participate in and reflexively critique the geographical constraints of the provincial government's "land selection" model (namely, the demand that a nation renounce its claims over most of their traditional territory in exchange for broader jurisdictional powers over smaller areas) for negotiating new treaties with First Nations. By presenting an ethnographic portrait of my own participation in a transect mapping exercise, and putting forth the transect as point of condensation for the reflexive labor of mediation, I seek to valorize the mundane practices and partial projects through which this critique is built.

Section III: Models

The final pair of chapters, "Models," focuses on the documents of visual knowledge generated by and for both kinds of fieldwork. Drawing on a long tradition of work in the history and philosophy of science on the relationship between predictive models, theorization, and empirical observation (Cartwright 1983; Hesse 1966; Giere 2004; M. Morgan and Morrison 1999; Kennefick 2000; Winsberg 2010) these chapters examine how debates over theoretical projections and data visualization among both forestry scientists and First Nations GIS experts reveal deep professional anxieties over the future place of human researchers in the field. The questions of continuity probed amidst the fractured institutions and disjointed field sites explored in earlier chapters are taken up again. With their field sites threatened by erasure and their own careers drawing to a close, I ask how these experts have positioned documents of their work in order to intervene in conversations after the social infrastructures of land claims and forestry research have changed completely. How have the digitally reconfigurable layers of GIS-based territory maps and computer-based simulations of long-term environmental change altered the nature and authority of the archives generated by this work? The mutability of these documents

and their associated analytical tools exemplifies the dynamism of the institutions and field sites that they index but cannot fully reconstruct or keep fixed (Gusterson 2005; Kaiser 2000, 2005). As perhaps the most robust legacies of British Columbia's fleeting experiment with knowledge-based governance, the proliferation of these digital artifacts generate new spaces of contestation and investment, even as it threatens to replace entirely the people and places they were created to represent.

Chapter 5, "Aging in Digital: Simulating Succession in the Normal Forest," juxtaposes ethnographic portraits of two different sites of model construction (a largely academic research network, based in part at the Bulkley Valley Research Centre; and the analysis branch at BC Forest Service headquarters in Victoria) to show how the post-1980s "spatial turn" in forest growth simulation and ecological modeling brought different professional communities of forestry modelers into conflict. As academic researchers and government analysts alike reformatted their work to inhabit new GIS mapping technologies and database infrastructures throughout the 1990s, the emergence of spatially explicit datasets and forest growth simulation routines allowed government funders to conflate the numerical outputs of forestry research programs organized under radically divergent epistemic priorities: namely, short-term timber yield versus long-term forest health. Environmental modeling's spatial turn – effectively, the movement away from using models to generate numbers towards the use of simulations to generate representations of space through time – paradoxically has also made both ecologically- and economically-minded modelers dependent on older forms of data collection – processes that the government no longer supports – including the labor-intensive work of physically measuring trees. Government resource management institutions are now transitioning towards the exclusive use of growth models capable of "self-populating" with virtualized data (i.e. large-scale growth

simulations built from data generated by the models themselves, rather than from model-analyzed physically collected measurements). Diverging from a "trading zones"-style rendering of the intercalated dependencies between the theories, tools (simulation algorithms and databases, especially), and professional communities supporting these two kinds of models (Galison 1997: 781-844), I argue that the "evolution" of these models depends less on the *transitions* between theories, tools, and people, so much as on their anticipated *disappearance* (e.g. the non-replacement of government research personnel and the cancellation of data collection programs). Exploring both groups of modelers' attempts to countenance new and uncomfortable legacies for their lives' work, I argue that the so-called "spatial turn" has not only failed to secure the particularity of place for environmental spaces taken up within technocratic forms, but has rendered the numerical outputs of spatial analysis even more resistant to critique.

In a brief concluding chapter, I will take a few steps away from the institutions, field sites, and models of land claims and forestry research to explore how other activists in the northwest are leveraging new legal instruments to resurrect some of the original promises of knowledge-based governance. "Knowledge sharing trusts" created around particular animal species and watersheds in the region have become for BVRC affiliates an exciting new mode for coordinating disparate government, corporate, and academic datasets into large, publicly accessible repositories. Read against the provincial and federal governments' own conservation benchmarks, advocates argue, trust-run data repositories will highlight the managerial failures and intentional blindspots created by the current regulatory regime. Even more optimistically, these trusts have also generated new, if still unstable, points of actual engagement between white and First Nations communities. Among Gitxsan activists in particular, conversations about *re*-politicizing environmental data collected on the territories have begun to offer new angles into a

range of simmering stalemates. While the practical effects of most of the trusts introduced by BVRC affiliates in recent years remain to be seen, conversations that I observed among trust founders over the technical design of new repositories revealed a deep nostalgia for the scientific roles – as explorers, observers, and authors – many felt they were being forced to give up. Conversations about metadata standards were particularly illuminating: A catch-all term referring to descriptive amendments, revision histories, user details, and contextual information attached to individual entries in computerized databases, metadata relevant to environmental research can provide both an organizational structure as well as a space for marginalia and reflection within the otherwise relentlessly quantitative realm of spatial analysis. Formatted according to the changing whims of lapsed conservation initiatives and outdated management boundaries, trust-curated metadata can provide analysts and other GIS users concrete links to earlier regulatory regimes. In other ways, though, the excitement surrounding trusts reflects their founders' resignation to the permanence of new discontinuities in their institutions, models, and field sites. No longer convinced that they will be granted the means to track changes in the land through first-hand observation and research in the field, erstwhile advocates of knowledge-based governance are turning away from their old goals of making knowledge visible toward a new and uncertain politics of perpetual re-assembly.

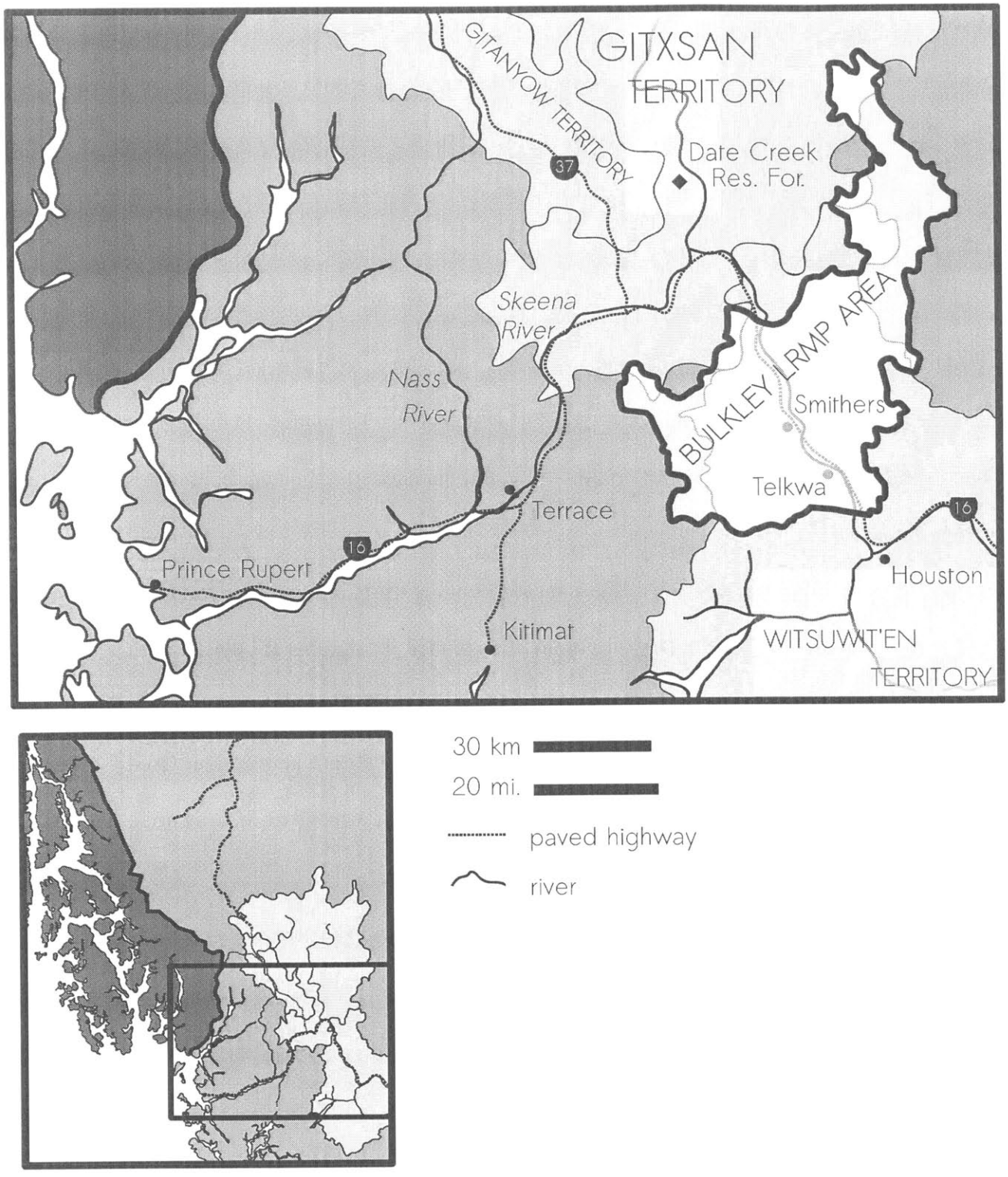

FIG 1.1. Smithers, B.C. and environs. Note the Bulkley LRMP plan area, which overlaps substantially with the Witsuwit'en traditional territory.

Chapter 1: The Care of Experts

Ecosystem-Based Management and Technocracies in Transition

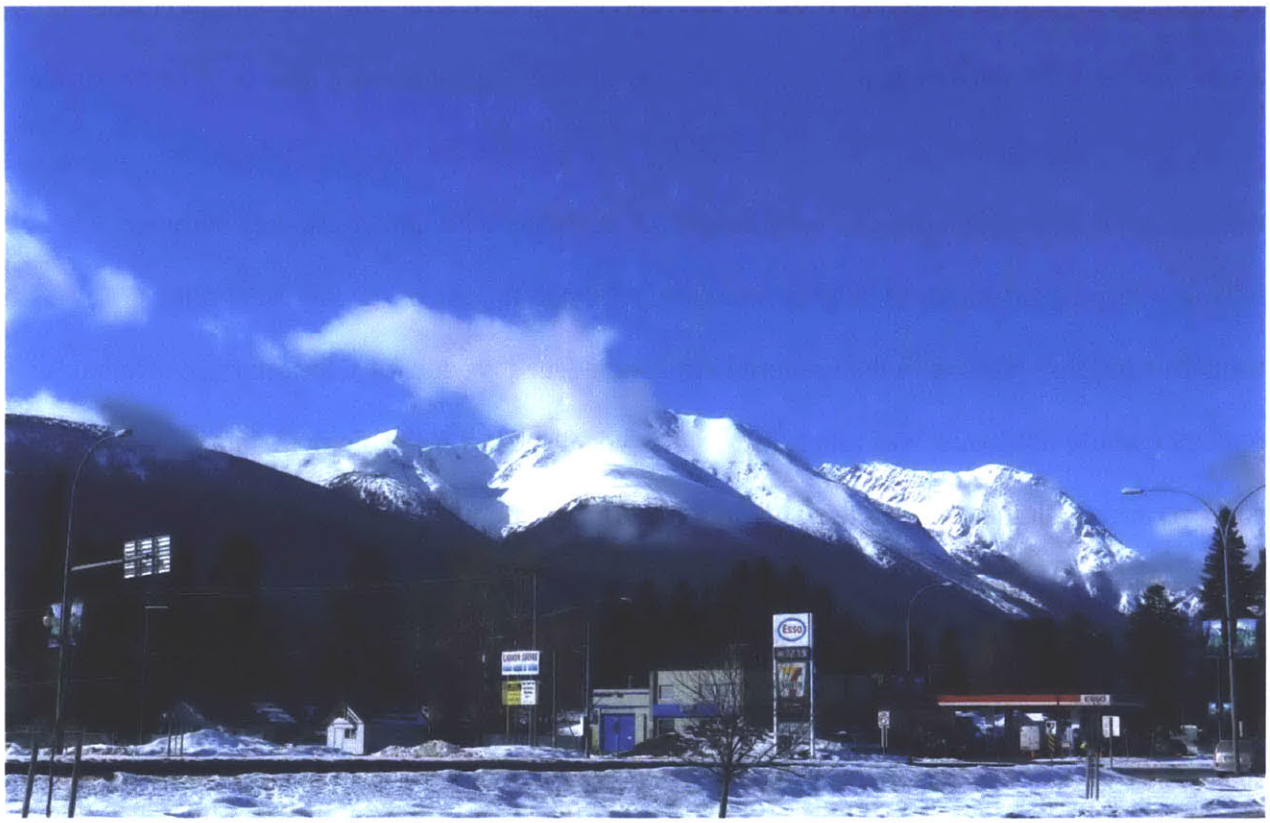

FIG 1.2. Downtown Smithers, B.C. with Hudson Bay Mountain in the background.

"We used to have fact-based decision making. We now have decision-based fact making." A murmur of laughter slowly rippled across the room. Five minutes into his speech, Nathan Cullen[1] had earned the one-liner. Looking out over the dozens of people crowded into the high-ceilinged gathering space of Northwest Community College, Nathan embodied the potent mix of political

1 Nathan Cullen, Doug Donaldson, Taylor Bachrach, David DeWit, Philip Burton, and Irving Fox are all public figures, and thus I am using their real names. All of the other names used in this chapter are pseudonyms.

power and local legitimacy yearned for by so many of the scientists and activists sitting in the audience. Splitting the year between his modest bungalow a few blocks away, near the basement apartment I rented in the small town of Smithers, British Columbia, and his office in the House of Commons in Ottawa, Nathan's position as federal parliamentarian and Opposition House Leader (perhaps the third most powerful politician in all of Canada) was a source of pride for the Smithereens[2] who chatted with him at the weekly farmer's market, curried his input on environmental assessment panels, and planned social events with him at low-key summer festivals. Despite serving as the highest-ranking politician for one of the largest and most productive logging regions in the western hemisphere (see introduction), the source of Nathan's popularity in the northwest was more diffuse. His vocal support for ecological data collection programs and participatory land use planning had long tempered the town's resentment over Smithers' declining status as northwestern BC's administrative center. But as the methodology guiding these programs, ecosystem-based management, or EBM, steadily moved out of provincial policy and into the language of activists' laments, Nathan's role as the champion of Smithereen expertise had grown more complex. Rallying crowds in the northwest increasingly meant drawing dramatic distinctions between the researchers who often filled his audience and the politicians who had apparently left them behind.

None of the speakers at the college that morning were explicitly campaigning for re-election. And yet, both they and most of the audience wore their alliances openly. Like Nathan, two of the other speakers were elected members of the New Democratic Party (NDP), a growing social democratic political party that had overtaken the more centrist Liberals as Canada's part of Official Opposition in the federal elections of 2011 (the same contentious elections which saw

2 Yes, the most widely used demonym for residents of Smithers, BC, is indeed "Smithereen."

the re-election of Stephen Harper and his Conservative Party as leaders of parliament). Along with natural resources manager for the local Office of the Wet'suwet'en First Nation, the mayor of Smithers, and the provincial legislator for the northwest's Stikine electoral district, the four men all traded good-natured jokes about the dysfunction and melodrama making headlines around each other's legislative bodies. Spanning each of the jurisdictions relevant to mainstream Canadian politics, they stood as a reminder that the scientists of Smithers had a friend at each and every level where policy was being made (see also Lahsen 2004). The NDP may have been languishing as the party of opposition in Ottawa and in the provincial parliament in Victoria, where the BC Liberal Party had held power since 2001. In Smithers, however, with its bevy of displaced researchers and citizen activists, the opposition could still hold court.

Rallying the Opposition

The four speakers had been invited for an impromptu summit by the directors of the Bulkley Valley Research Centre (BVRC), an independent research management office that had served as a home base for me in Smithers throughout the year. Positioning itself as a "neutral" space for research, policy conversations, and education and outreach initiatives, the BVRC had become in the decade since its inception a social and professional nexus for dozens of academics, regional NGOs, independent consultants, environmental lawyers, and past and current government employees working throughout the rural northwest. Originally created as a professional stop-gap for Smithers-based forestry scientists after the town's Forest Service district office closed in 2002, the Centre's few full-time staff members had managed to cultivate a critical mass of researchers around the tenets of systems ecology and adaptive land management – the core principles of EBM – by sponsoring research projects, hosting conferences and other events, and

supporting new "knowledge trusts" and other data sharing agreements (see concluding chapter). In their various public guises, BVRC affiliates insisted on their positions as political agnostics. Their influence among individual NDP politicians and their vocal support for prescriptive forestry and fisheries regulations made clear the Centre's continuing commitment to a particular kind of technocratic conservationism. And yet even as their roles as researchers had been realigned, their legitimacy as spokespersons for the Bulkley Valley, as well as their entanglements with the new phase of technocracy that had taken over the province, remained difficult to define.

If nothing else, a friend suggested as we settled into our chairs before the first talk of the morning, BVRC-hosted speeches usually offered a good pep rally for the Centre's friends and affiliates. Already a few days into December, the speakers acknowledged that 2013 had been a very long year. Region-wide protests against a series of oil and gas pipeline proposals had reached a crescendo early in the autumn, after the Conservative Party-led federal government intervened in the work of a Joint Review Panel (JRP) of scientists and bureaucrats who had spent the past year and a half canvassing the province for popular input and technical recommendations regarding the Enbridge Northern Gateway pipeline, the most controversial of four separate pipelines proposed for the region.[3] The panel's recommendations, already discredited in the eyes of most of the audience, were set to be announced in two weeks. Even as the four speakers self-consciously avoided the topic of pipeline protests while passing around the microphone, the broad year-end portrait they painted for the region was replete with dispiriting numbers. The summer run of sockeye salmon had dropped to a record low throughout the surrounding Skeena river watershed, according to fisheries officials and fishers. Thousands of

3 On the participation of local Witsuwit'en First Nation communities in these reviews and protests, see McCreary and Milligan 2014.

Gitxsan and Witsuwit'en fishers who relied on their summer catch to fill their freezers for the winter, several speakers reminded the crowd, had been forced to buy most of their salmon that year from the Nisga'a First Nation in the neighboring Nass watershed.

The early months of the year had been particularly draining. After leading by as many as twenty points in province-wide polls in the weeks before the provincial elections in May, the NDP had suffered a stunning last-minute collapse, leaving their center-right opponents, the BC Liberal Party, in control of the provincial government it had been leading for the past twelve years.[4] Since losing the government to the Liberals in 2001, NDP politicians and supporters had watched as the provincial "dirt ministries" – Energy and Mines; Environment; and Forests, Lands, and Natural Resource Operations, or FLNRO – were reorganized and dramatically downsized, and as the environmental monitoring and data collection programs they had built during the 1990s were dismantled. A more efficient phase of land management would soon be underway, provincial officials declared, with industry self-reporting and periodic audits replacing the painstakingly prescriptive (if still largely pro-industry) policies only recently put in place by the NDP. For many of the environmental scientists in the audience that morning, each new wave of devolution and deregulation, hallmarks of the ongoing neoliberalization of resource extraction industries elsewhere in Canada and throughout the world (see Introduction), had profoundly changed their experiences living and working in the northwest. Partisan loyalties among Smithers-based researchers had hardened when the town's regional Forest Service office closed a year after the initial transition, leaving dozens of ecologists and other forestry scientists scrambling to find new places to work. Thanks in large part to the creation of the Bulkley Valley

4 As left-leaning BC residents are anxious to complain to new arrivals, the British Columbia and center-left federal Canadian Liberal Parties are radically different entities with a long history of antagonism. Whereas BC NDP officials routinely caucus with their federal NDP colleagues, BC and federal Liberals have no such working relationship.

Research Centre that the same year, many had long since found new roles as corporate consultants, university affiliates, and contract-based independent researchers. Still the administrative center of BC's enormous northwest, other provincial offices remained open in Smithers, contracting and re-forming to meet the changing demands of the Liberal government. In the eyes of many of the town's researchers, however, environmental science simply had ceased to be a governmental prerogative.

No longer recognized as formal agents of the state, the many former government researchers in the audience appreciated all the more the speakers' recognition of the projects they continued to pursue from different professional vantage points as their earlier work was undermined or abandoned by the Liberal government. Taylor Bachrach, a young web developer then serving as the mayor of Smithers, began the morning's first speech with a self-congratulatory historical overview of the town's forays into political and legal activism. "The Bulkley Valley has really led the way for so many decades when it comes to community-based resource management," Taylor insisted. "There's a strong legacy of innovative governance systems and collaborative resource management systems … rising out of the conflict in the 1980s around forestry … and the establishment of the LRMP process and the Community Resources Board. I see so many people in this room who have sat on the Community Resources Board at different times." Taylor's invocation of the Bulkley Valley LRMP, or Land and Resource Management Plan, foreshadowed a common theme in other speeches as the morning wore on. Several of the people gathered in the audience had helped to draft the original LRMP document in the 1990s, a multi-year process designed by the provincial government to enlist rural community members in the mapping of new conservation areas and landscape classification units across contested regions of the province. Many others had spent years on the Bulkley

Valley Community Resources Board (CRB), whether during the drafting and implementation of the original plan during the late 1990s, or during the unending search for new enforcement mechanisms after the document was slowly dismantled in the following decade.

Alongside repeated references to the LRMP and the CRB, most of the speakers worked in a few jokes to flag their awareness that they were preaching to the converted. As I scanned the crowd, I saw dozens of people I had met throughout the year: consultants; researchers; environmental planners who sat on the Bulkley Valley Research Centre's board of directors or participated in its various projects. A few hands were raised as the speeches drew to a close, but most of my new friends and interlocutors simply watched and listened. After spending hundreds of hours assembling reports and holding meetings with each of the speakers during the build-up to the JRP, few of them likely expected to hear anything new. No one anticipated that the data collection and monitoring work stipulated in the ecosystem-based management policies of the 1990s would suddenly return. If anything, the speakers aimed only to keep the mounting sense of invisibility shared by their scientist friends from devolving into complaints of helplessness and despair. Correlating the undermined JRP report with a recent spate of confrontations between NDP-backed climate scientists and federal politicians, Nathan cast Smithers itself as a heroic foe of the current regimes in Ottawa and Victoria, and as survivors of a generally hostile attitude towards scientists that seemed to prevail across Canada as a whole. "The rules are stacked right now," he declared, pacing the stage. "If you're a scientist, you are on trial right now, and you have to justify your very existence, and if you should have a voice in how we make decisions about what happens in the real world." If the state no longer cared for its experts, he seemed to ask, how were our experts to care for the land?

. . .

As I left the college with the speakers and a few BVRC affiliates to walk to the Centre for a post-summit lunch, the large crowd of researchers and activists who trickled out of the building alongside us illustrated a demographic paradox: as the presence of provincial government institutions in Smithers steadily shrank through the first decade and a half of the twenty-first century, the number of individual, government-funded scientists living in Smithers has, if anything, increased. Anchored around the BVRC, this self-consciously peripheral cluster of experts and their expanding rosters of independent projects continue to draw more and more researchers to live and work in northwestern BC, despite the fact that the government ministries that still lend form to much of their work have drastically downsized and grown increasingly unstable. Over the course of the year, I had often heard working-class Smithereens derisively refer to these newcomers as "amenity migrants," young professionals who began moving to Smithers in the 1980s intent on building technical careers while enjoying the spectacular mountains, parks, and wilderness areas surrounding the Bulkley Valley (Chipeniuk 2004).[5] For many of these migrants, though, achieving professional mobility meant more than gaining access to far-flung professional networks: it meant crafting the power to remain in place.

Meeting for coffee the following afternoon with Paul and Beth, two unabashed "amenity migrants," we laughed aloud as we recounted together some of the more melodramatic lines from the summit. "They're all nice guys," Beth offered with a smile, trailing off as she struggled

5 Smithers resident and former UNBC professor of Environmental Planning, Ray Chipeniuk's work on "amenity migration" is well known among BVRC affiliates (several of whom thought – incorrectly – that Ray himself had coined the term), whose reflexivity about their own status as "amenity migrants" helped to make many of them richly provocative, if occasionally overly self-conscious ethnographic interlocutors. (For a local profile on Ray himself, see: Amenity man 2007.) While most North American scholars interested in amenity migration have approached its effects as problem of economic geography, municipal planning, and rural sociology, several ethnographies add texture to these analyses. Anthropologist Leslie Robertson (2005) has explored the social ruptures and ethnic and class conflict and alienation induced through the construction of a ski resort in a historic coal mining town of Fernie, British Columbia. For a broader overview of the geography, sociology, and planning literature on amenity migration, see Gosnell and Abrams 2011. See also McCarthy 2008.

to explain what purpose the meeting had served. As the married co-operators of a small consulting company, Beth and Paul had arrived in the north just in time to watch the local Forest Service office begin to contract. Beth's weary appraisal of the meeting found fault not with the speakers, but with her peers in the crowd. "We never really got an answer to Nathan's question," she sighed. "'How do we change?'" For Beth, Paul, and other researchers who have come to rely on the Centre's funding and imprimatur as government support for research steadily dwindled, "change" had come to signify not a transition between states of policy, but a policy state in itself: an orientation towards inevitable disappointment, movement, and perpetual reassembly. As this chapter will show, the BVRC's critical appraisal of the provincial government's respect for ecological science mirrored their mistrust of the government attitude towards ecologists themselves. Among the wildlife biologists and systems ecologists who came together for scenario planning workshops, independent research presentations, and other BVRC-hosted events, "continuity" had long ago ceased to be a matter of institutional overlap or professional hierarchy. For these men and women, continuity was a measure of their commitment to ecosystem-based management as an abstract ideal, a bond articulated through maps, planning documents, and other media from a bygone technocratic era.

Chapter Outline

The early twenty-first century transformation of Smithers, British Columbia, from a regional center for government scientists into a rural hub for independent researchers and self-employed consultants demands new explanatory frames. This chapter explores how the transformation of ecosystem-based management, or EBM, from a research methodology and nascent resource governance framework into an oppositional language of ethics and solidarity has restructured the

meaning of "local expertise" in the neoliberal era. Drawing on emergent anthropological scholarship on environmental expertise, participatory land use planning, and neoliberalism, I argue that individual researchers have sought to cope with increasing professional uncertainty by building new forums for research and advocacy around the now largely defunct conservationist policies of earlier regimes. While numerous scholars have pointed to the disaggregation of expert institutions as a hallmark of neoliberal reform, less attention has been paid to the efforts of displaced researchers to reassemble new networks of influence. Reflecting on my conversations with Pauline, founding director of the BVRC and original member of the Bulkley Valley Community Resources Board (CRB), I will explore how the documents and relationships drawn together during the Land and Resource Management Planning (LRMP) process raised hopes among government critics for a general transition toward a systems-oriented conservationist regime.

These hopes unraveled amidst widespread regulatory devolution and the rise of "results-based" environmental management policies in the early 2000s.[6] As Victoria-based political scientists Tim Thielmann and Chris Tollefson (2009: 119) explain,the Forest and Range Practices Act (FRPA) which took effect in early 2004 transformed the role of ecological scientists in key processes of government assessment. "Under the former legislation," they explain, "[timber] licensees were obliged to conduct an array of site-specific planning and preparatory measures prior to receiving logging authorization. Consistent with the results-oriented approach, the new law, by contrast, allowed licensees to demonstrate that the strategies outlined in their site-specific plans were consistent with the objectives in FRPA or related regulations." With a steadily

6 For a critique of the proliferation of "results-based management" programs in international aid programs, see Eyben 2010. Vincanne Adams (2013) and Lindsay Bell (2016) have made similar points about the strains which the recent rise of "evidence-based medicine" analytics have introduced into the bureaucratic and human relationships governing clinical settings, pharmaceuticals research laboratories, and other health care facilities.

declining cohort of Ministry researchers available to evaluate the plans of licensees, "demonstrating consistency" increasingly entailed articulating vague benchmarks which were difficult for assessors to measure or litigate against (Stem *et al.* 2005).[7] Over the past decade and a half, groups like the BVRC have taken up the legacies of "results-based management" and the enervation of the LRMP process as evidence that the government could no longer be entrusted with the care of participatory forums, data, or even expertise itself. And yet Smithers-based environmental scientists have not disavowed their status as expert spokespersons. Rather than simply emboldening "citizen scientists" or railing against the myopia of the state, they have positioned themselves as compassionate mediators between the loosely defined community of the Bulkley Valley and the new social and bureaucratic forms growing in the interstices of neoliberalism.[8]

Taking inspiration from recent calls to investigate ethnographically the shifting boundaries between science, ethics, and environmental governance (M. Fischer 2003; Fortun 2001; Fortun and Fortun 2005; Jasanoff 2005; Petryna 2003), this chapter sets out to make sense of the social shaping of bureaucratic forms through the personal stories of individuals whose lives and careers have played out among scenes of rural technopolitics. This portrait of the BVRC is also meant to establish contrasts for the following chapter, which focuses on the members of a short-lived environmental mapping group called the Gitxsan Strategic Watershed Analysis Team, or SWAT. Despite comprising over thirty-five percent of the population of the Stikine electoral district in which Smithers is represented in the BC legislative assembly, Gitxsan

7 Within two years, even the provincial government's own independent advisory group, the Forest Practices Board, admitted that, as Thielmann and Tollefson (2009: 119) put it, "forest planning documents approved by the Ministry under this model often disclosed few details about how, when, and where logging would occur, and most did not define forestry outcomes or results that were capable of measurement." See also Forest Practices Board 2006.

8 The credit for this turn of phrase, like so many other angles and insights in this dissertation, is owed to Stefan Helmreich.

and other First Nations people and institutions have only been marginally involved in many of the "community"-oriented research projects supported by the BVRC.[9] This discrepancy is not a simple case of misrecognition or mutual unintelligibility, however. As later chapters will show, many of the BVRC's central advocates have collaborated closely with First Nations communities on research projects and land use plans. Others have even provided expert testimony supporting land claims lawsuits filed by these groups against the provincial and federal governments (Monet and Skanu'u 1992: 105-141). As I will argue in the following chapter, however, the fading of these collaborations reveals dramatic differences in the ways that white and First Nations environmental scientists have been able to translate institutional uncertainties into professional mobility, political influence, and community coherence.

By exploring how the mobile class of experts who call Smithers home has leveraged scientific competencies and institutional connections to legitimate their ties to the region, I seek to raise questions that I will continue to explore throughout the dissertation as a whole. For instance, what does it mean for an independent consultant to use a biodiversity map, a forest succession simulator, or some other forward-looking model of environmental change to claim public land as an object of care? How do the moral claims framing these interventions function to embed new technologies of normalization within landscapes already overdetermined by excessively optimistic management projections? As this and later chapters will show, much of the work involved in defining and deploying new environmental scales and domains of

9 Covering an incredible 150,000 square kilometers, the Stikine district was home to roughly 20,000 people in 2013. Demographic information for each of British Columbia's 85 ridings, or electoral districts, is maintained on the elections.bc.ca website. See http://www.elections.bc.ca/index.php/maps/electoral-maps/. Accessed 4 April 2015. Given the small populations in the immense north and the tremendous influence of the resource industries and interests active in the region, the provincial northwest has been the target of an unending series of redistricting proposals by the provincial electoral commission, Elections BC. The current Stikine District has existed only since 2009, and it is quite likely that it will change significantly in size and shape within the next few election cycles. For several of the proposed re-districting plans, see the official report of Elections BC: http://www.elections.bc.ca/docs/rpt/BCEBC-Prelim/Part%209-TheNorth.pdf. Accessed 4 April 2015.

government jurisdiction has been profoundly transformed by the neoliberal reorganization of British Columbia's resource ministries and other state institutions. And yet, the many environmental scientists, cartographers, and modelers unmoored by government restructuring have not simply ceased to exist.

Particularly for those professionals living in western Canada's rural locales, where career decisions are invariably explained through the twinned lens of lifestyle and "community," the new technocratic forms developed during the 1990s rise of ecosystem-based management powerfully shaped former government researchers' later experiences of professional mobility and influence. By criticizing the government's handling of long-term research sites (chapter three), forestry models (chapter five), database infrastructures (concluding chapter) and land management policies and institutions (this chapter) as willful abnegations of responsibility for social and environmental continuity, BVRC affiliates have framed emergent policy regimes in terms of deficits of data and failures of care. Following them between public speeches, research trips, and two decades of meetings and collaborative endeavors with a shifting cast of government officials, this chapter will begin to reconstruct how these researchers took up the tenets of ecosystem-based management to position themselves as mobile stewards of the future northwest.

Ecosystem-Based Management and the Neoliberalization of Nature

Over the past twenty years, the failed promise of EBM has served as a powerful, if paradoxical, rallying point for the Smithers consulting class. By continually exhorting government officials and local residents to consider in systematic terms the scale and consequences of environmental change, researchers affiliated with the Bulkley Valley Research Centre have managed to validate

their status as experts even as they bemoaned the fading status of the government research programs that granted them their original influence. Numerous anthropologists have called attention to strategic deployments of idioms of "community" as a means of legitimating specific spokespersons and drawing boundaries around resource management disputes (Agrawal and Gibson 2001; Brosius, Tsing and Zerner 2005; Li 2002; Olson 2005). Making sense of the productive tensions between BVRC researchers' simultaneous claims to "expert," "local," and "government outsider" positionings, however, requires a closer look at the political and epistemic history of ecosystem-based management itself. A loosely organized body of scientific theory[10] and a guiding rationale for dramatic policy experiments in both prescriptive, government-driven environmental conservation (Egoh *et al.* 2008 Pitcher *et al.* 2009) as well as participatory land management and planning (Armitage 2005; S. Brody 2003; Daniels, Lawrence and Alig 1996; Kearney *et al.* 2007), EBM has over the past three decades profoundly re-shaped popular perceptions about how environments work and how government institutions should be held responsible for these processes.

The science informing EBM is based largely around the use of complex systems theory to analyze organism- and human-environment interactions. Crawford S. Holling (1973), a Canadian ecologist who pioneered the academic exploration of systems ecology in the 1970s, first used the term "resilience" to characterize the capacity of an environment to maintain certain systemic functions in the face of sudden disruptions and changes in state. As more and more material

10 Much like the original biological, ecological, and anthropological research behind the science/policy nexus now known as "Traditional Ecological Knowledge" (see chapters two and four), the theoretical basis of contemporary EBM was largely developed in marine environments by scientists who struggled to expand the purview of fish stocks management policies beyond their narrow focus on catch volumes and species distributions. See e.g. Barbier *et al.* 2008; Olson 2011; Pikitch *et al.* 2004; Slocombe 1993. More recent scholarship on the implementation of EBM policy frameworks in forest management has emphasized the uneasy coexistence of conservation and development prerogatives in cyclical harvesting methods. See e.g. Franklin *et al.* 2002.

flows, species counts, and state variables were incorporated into these analyses, greater numbers of fieldworkers and mathematicians were recruited to measure, organize, and calculate these values, and the political purview of systems ecology as a whole steadily grew (Ensmenger 2012). Over the past three decades, ecologists have expanded definitions of resilience to include numerical representations of industrial development and other human activities, drawing dynamic concepts of post-harvest succession management, subsystem interaction, and carrying capacity into policymaking arenas in Canada and across the globe (e.g. Berkes, Folke and Colding 2000; Gunderson 2001; B. Walker *et al.* 2004). As the tortured history of the Bulkley LRMP makes clear, however, industry- and government-based resistance to the expansion of these methods, was never far behind.

Since EBM first began to emerge in resource governance programs in North America in the late 1980s, a number of social scientists have grown wary of its proponents' tendency to aggregate human-environment interactions at all scales into perpetual cycles of crisis and risk (Reid 2012; MacKinnon and Derickson 2013). As environmental historians and sociologists have shown, the transition in ecological theory away from models of succession anchored around the improvement of degraded ecosystems into steady-state "climax communities," towards metastability and rupture, mirrored the metanarratives and managerial ideals of late twentieth-century political discourse (Macnaghten and Urry 1998; Worster 1998 [1977]).[11] Even systems ecologists' own narrations of the historical development of their field, Paul Nadasdy (2010: 42) points out, disingenuously contrast "a constructivist account of equilibrium-based ecology …

11 On the antecedents to these links in the art and fiction of nineteenth century North America, see Marx 1964. On ideology and biology in the Soviet Union, see Graham 1977. A number of contemporary ecologists have begun reconsidering more localized formulations of "climax communities" by reexamining transitions between metastable system states (e.g. tropical forests and palm oil plantations) within the framework of resilience theory. See e.g. B. Walker *et al.* 2004.

and a positivist account of non-equilibrium ecology" as a means of discrediting earlier theoretical approaches and downplaying the political entanglements of contemporary systems ecology research (see also Nadasdy 2007).

In their efforts to distinguish resiliency-based methods from the ecological theories informing more centralized technocratic institutions, some proponents of systems ecology have mirrored neoliberal rhetorics by casting the relationship between management and resiliency in almost tautological terms. Generalizing a large number of case studies of environmental management processes into a "handful of heuristics" for would-be EBM acolytes, for instance, ecologist Brian Walker and his co-authors (2006: 13-4) offer the circular appraisal that "pathologies of management occur when the stabilization of key ecological processes for economic or social goals leads to a loss of resilience." Simultaneously ideologically and methodologically bound to far-from-equilibrium models of thermodynamic metastasis and exchange, economic historians like Philip Mirowski (2007) argue, proponents of resiliency theory have also indirectly undermined the practice of fieldwork itself by increasing their use of computer-based simulators and other tools of financial economics.[12] As I show in chapter five, these transitions had immediate practical impacts on environmental researchers reliant on precarious data collection infrastructures, since building system behavior theories models around sophisticated partial differential equations allowed analysts to make progressively more dramatic claims with smaller and smaller amounts of physically collected data (Zimmerman 2008).

In some of the more dramatic criticisms, resiliency theory has been treated not merely as another technocratic "anti-politics machine" (Ferguson 1990; see also Li 2007b) deployed to undermine specific conservation efforts and livelihood strategies, but as a proxy for

12 On the genesis of the theories and analytical tools which prompted Mirowski's critique, see especially Costanza 1992. On ecologists' reactions to Mirowski, see Martinez-Alier 1997.

developmentalist ideology and state domination broadly speaking. By explicitly emphasizing the determinative power of systems over the agency of individual political actors and institutions in NGO-funded sustainable development projects, Michael Watts (2011) argues, resilience theorists and other EBM proponents powerfully reinforce the very same capitalist ideologies and neoliberal policy goals that many of them claim personally to protest.[13] The very term "resiliency," Watts and others argue, implies an arrogant faith in the idea that the earth can be made to "bounce back" from development's demands. Jeremy Walker and Melinda Cooper (2011) go further still, provocatively comparing Holling's strategic institution-building work (including his role in founding the journal *Conservation Ecology*, now re-named *Ecology and Society*, as well as the Resilience Alliance research and policy network) to the free market triumphalism of economist Friedrich Hayek (see also Bakker 2010).

Indeed, I routinely heard "market"-based logics and other economic idioms in the descriptive language of both the champions of EBM I spent time with in Smithers and the government-employed defenders of "results based management" I encountered during my trips to the provincial capital. I was occasionally startled by the pat defenses of free market policies I encountered in BVRC-produced documentation for climate change adaptation workshops held for local school children and other community residents.[14] Over time, however, I came to realize that the tropes which populated many of my interlocutors' fine-grained descriptions of the theory

13 For a somewhat more tempered take on Watts's claims, see K. Brown 2014.

14 At one particularly well-attended "scenario planning" exercise meant to generate timber harvesting policy recommendations for the Nadina River watershed, organizers distributed pamphlets juxtaposeing four speculative narratives depicting different possible effects of climate change in the region. Without explanation, "severe average global temperature increase" was directly correlated to ""increased barriers to international trade" in both of the more catastrophic scenarios, while "free trade" and "minor to moderate average global temperature increase" were linked in the less disruptive scenarios. When I remarked on this to the primary organizer of the workshop, he laughingly explained that he and his colleagues devised subtly different scenarios for each exercise in the hopes that attendees would find them engaging and provocative. For a more general discussion of the increasing popularity of "scenario planning" workshops in participatory forums for environmental policy development, see Peterson, Cumming and Carpenter 2003.

behind their research did not necessarily translate into the slogans through which they framed the broader impacts of their work. The slogans they *did* employ, however, indexed a set of goals and promises which nevertheless reaffirmed the end goals of neoliberalization. Many BVRC-hosted events that I attended throughout the year were explicitly aimed at replacing suspect industry analyses and derelict government functions by "separating values from knowledge," whether to promote open-source forest growth simulators (see chapter five) or to convince provincial officials of the efficacy of new risk analysis models (see conclusion). For a group so powerfully affected by the downsizing of government research institutions, the BVRC's outspoken support for the work of environmental NGOs and private research institutions mirrored its resignation to the inevitable decline of government involvement in ecological restoration and research.[15]

Naturally, the academic backlash against resilience theory has provoked a backlash of its own. As their critics in the natural sciences often protest, the focus placed by geographers, environmental anthropologists, and other political ecologists on slogans, policy statements, and other discursive articulations of systems ecology has often resulted in misleading caricatures of the individual scientists involved in the development and implementation of EBM policies (Armitage 2007; P. Walker 2005). Particularly in North America, critical treatments of resilience theory often over-emphasize the influence of individual researchers and research institutions on politicians, confusing temporary connections to policy-making arenas with actual legislative authority. For environmental scientists struggling to sustain their careers within actually existing developmentalist regimes, these accusations are particularly galling. Many BVRC affiliates openly complained to me that EBM-based policies like those their research had helped to assemble for British Columbia have suffered a seemingly endless string of failures across Canada

15 For analogous reactions among US-based environmental scientists, see Lave, Doyle and Robertson 2010.

in the decade and a half since their original successes, as ambitious new programs were quickly rolled back or simply not implemented after new governments took office. In the eyes of many of the researchers involved in these policies, most EBM programs were doomed from the outset, since the elaborate data collection and monitoring work on which they depended were so frequently downsized or canceled shortly after the programs themselves were approved, leaving only nominal versions of the original policies in place. Perhaps their erstwhile government sponsors knew in advance that this would happen, a few of my interlocutors angrily speculated, and had merely placated environmental scientists and activists by allowing them to draw up elaborate management plans that were designed to fail.

As tempting as it is to draw direct links between the increasing prevalence of idioms of rupture and change in environmental policymaking and the ascendancy of resilience theory in ecological research, the tortured path between the theory and actual implementation of EBM in northwest British Columbia suggests a more complicated picture. By using increasingly comprehensive representations of environmental change to orient what Rebecca Lave (2012b) refers to as the "extramural science" of disparate non-academic institutions around ethical imperatives of regional stewardship, BVRC affiliates have managed to construct new modes of professional mobility that complicate earlier depictions of the technocrat as compradors of capitalism (Gupta 1998; T. Mitchell 2002; Mosse 2004; Scott 1998). In their introduction to a recent special issue of *Social Studies of Science* on "STS and Neoliberal Science," Mirowski, Rebecca Lave, and Samuel Randalls (2010) argue that the expanding influence of neoliberalism within bureaucratic institutions throughout Europe and North America is profoundly reshaping the contexts in which scientific projects are organized, funded, and carried out. As the authors put it, "neoliberal science policy is creating a regime of science organization quite distinct from

the Cold War science management regime" (667).

There are clear problems inherent in attempting to treat "neoliberal science policy" and "Cold War science management" as altogether separate spheres without acknowledging the specific characteristics and causal mechanisms driving the transitions in different disciplines (Kaiser 2013). Still, the demarcation, however simplistic, points to a range of significant divergences. Within many of the research settings theorized by historians and sociologists of the physical and biological sciences, large, well-funded, and highly visible research groups have long provided key models for understanding how scientific concepts are transformed into the micropractices of political regimes.[16] These groups typically retain their influence, cohesiveness, and momentum over years and decades; individual scientists remain in place for long careers; and the availability of financial support for their research remains relatively consistent, even if applicants must occasionally adopt new experimental techniques or re-articulate their main research questions in order to make them seem more applicable to emergent theoretical trends.[17] Even poorly funded laboratories attached to marginalized institutions have been argued to cohere according to individual scientists' preference for stasis and their personal aspirations for upward mobility within their institutions, however embattled these institutions may be.[18] Historical and

16 For an early example of the role of professional hierarchy in "big science," see especially Latour 1988.

17 Although the book makes a more provocative point about how elaborate research programs can come to cohere around "model organisms" (which themselves can change), Robert Kohler's *Lords of the fly: Drosophila genetics and the experimental life* (1994) is perhaps the classic study of an individual academic research laboratory maintaining power and influence through multiple decades of personnel changes, shifting disciplinary trends, and even institutional relocation. Sociologist Karen Knorr-Cetina (2009) makes a similar point about the organization of research group hierarchies and the broader "epistemic cultures" of their founding disciplines in her comparison of biology and physics laboratories.

18 Through more than three decades since university professors and researchers first earned technology transfer and patenting rights with the establishment of the Bayh-Dole Act in 1980, these scholars have decried newfound correlations between patent protections, applied research, and other aspects of commercialization on collaborative research programs, authorship, and tenure promotion policies in science and engineering departments (Berman 2008; Rajan 2006). Naturally, the pressures of commercialization faced by American universities have played out very differently in other national contexts. For discussion of an example from the post-Soviet Russian context, see Graham 1998.

ethnographic studies of generational transitions within large, hierarchically complex experiment groups have explored discontinuities effected by funding cuts, government policy shifts, and infrastructural changes, such as relocation, the obsolescence of research equipment, or the loss of space to competing research groups (Doing 2009; Galison 1997; Traweek 1988). With few exceptions, however, institutional ethnographies have been too limited in duration or scope to capture the complete disintegration of a large laboratory, let alone the wholesale migration of displaced professionals into new corporate, government, or academic roles.[19]

Even as scholars acknowledge in statistical terms the widespread downsizing of government-run research divisions or examine the loss of a particular group within the context of a larger organization, the tendency to focus on institutions as opposed to individual actors has often led to simplified discussions of the professional incentives and social support systems that have allowed individual researchers to conduct their work and extend their political interests.[20]

19 Many examinations of large corporate and government laboratories also dwell on the ghosts of imagined laboratories of the past, where individual researchers enjoyed unfettered access to space, supplies, and other resources, and "pure" research questions supposedly reigned. Mirowski and Philip Van Horn (2005) lampoon this insistence on an idyllic professional past, arguing that "contract research organizations" and other sites of limited-term research have long challenged the influence of universities in terms of their sheer output of publications, patents, policy recommendations. One of the most interesting exceptions to this trend is the work of Hugh Gusterson (1998; 2005), whose more than two decades of ethnographic fieldwork among nuclear weapons scientists at Lawrence Livermore and Los Alamos National Laboratories has allowed him to observe first-hand the myriad effects of the proposed Comprehensive Nuclear Test-Ban Treaty on the organization of work in both labs. While both weapons research group have in fact seen their financial support substantially *increase* since the (as-yet non-ratified) treaty informally went into effect during the Clinton administration, the transition to simulated tests of nuclear weapons and away from the below-ground explosions of actual devices effected a powerful shift within the hierarchy of the lab groups, instilling a sense of a generational divide between earlier testers and the increasingly influential computer scientists whose simulations now stood as the end-goal of lab-wide collaborations. David Kaiser (2011) provides another key counterexample in his study of the out-migration of Ph.D physicists away from their original domains of research and into quantum computing projects in telecommunications and finance.

20 With the exception of a few high-profile facilities like the Large Hadron Collider at CERN, centrally-driven, massively funded scientific projects have recently begun to transition away from site-specific "megaprojects" towards geographically dispersed collaborations between arrays of university groups and corporate research laboratories (Galison 2003; Wray 2006). Examples of cutbacks in the North American context abound. The construction of the Superconducting Super Collider (SSC) in Texas, a high-energy hadron collider originally planned as ring 54.1 miles in circumference, was canceled in 1993 after $2 billion had already been spent on the project. (For a scholarly account of the demise of the SSC, see Riordan 2001.) More recently, NASA's decision to end the space shuttle program without further plans for human-based space exploration have been met with derision and despair by scientists and pundits who decry the transition to robotic space exploration as the end of

As Mirowski (2009; 2013) and others have repeatedly shown, the late-twentieth century ascendancy of neoliberal economic policies in governing institutions and international development organizations dramatically altered the circuits of power through which scientists and other technocrats exercise their influence. And yet as Stephen Collier (2012) argues, many STS scholars who have investigated these transitions continue to focus on the reach and mobility of the "big Leviathan" of the state, often producing excessively monolithic treatments of neoliberalism which mask the dynamism and uncertainty that has come to define professional life for so many individual researchers.[21]

Many in the Smithers "consulting class" experienced the erosion of the dirt ministries not through frustrated mobility or diminished professional expectations, but as a struggle to craft new modes of working in place. For researchers like Pauline, the founding director of the BVRC and the protagonist of the following section, the nature of her work (post-disturbance plant succession and autecology, or the study of the relationship between individual species or organisms and broader environments) barely changed as she left government and began working as a private consultant. Yet as Pauline and other independent researchers began devoting their newfound free time to citizen action groups and expert advisory committees, their claims to

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American scientific dominance. In the US and in Canada, federal support for a broad range of large-scale scientific projects ebbed as the twentieth century drew to a close, causing many of the researchers who began their careers in national laboratories or earned their Ph.D degrees during Cold War spending booms to move into corporate jobs, often in quantitative finance or other domains radically different from their original areas of specialization. A number of recent studies have explored the rise of Ph.D-wielding "quants" in financial economics, particularly in companies involved in high-speed trading (Lepinay 2011; Patterson 2012).

21 James Ferguson has long been critical of grandiose historical theories of neoliberal transformations, arguing with Akhil Gupta (1992: 4) that "spaces have *always* been hierarchically interconnected," and that social theorists should take care to distinguish between broad projects of ideological transformation and class restructuring and more specific deployments of neoliberal "arts of governance" (Ferguson 2009). Geographer Noel Castree (2008: 137) echoes these complaints, pointing to a growing awareness of this distinction among human geographers: "In urban, economic, and development geography … it has become axiomatic among researchers that they are investigating a spatiotemporally variable process ('neoliberalisation') rather than a fixed and homogeneous thing ('neoliberalism')." David Harvey (2005: 21) makes a still more general point in relation to contradictions inherent in the neoliberal ideological project itself, pressing scholars to "pay careful attention … to the tension between the theory of neoliberalism and the actual pragmatics of neoliberalization."

status as disinterested expert mediators complicated their relationships throughout the town and surrounding region. The ambiguity of Pauline and others' positions with regards to the state both mirrors and magnifies the collapse of trust between rural residents and the state as a whole.

Efforts to reconstitute trust amidst periods of rapid environmental change have led to the emergence of altogether novel social forms. Building on the idiom of "reflexive modernization" developed by Ulrich Beck (1992; with Giddens and Lash 1994) and others to describe the emergence of new subjective formations and institutional complicities around ambiguous risks, Kim Fortun (2001) examines how different kinds of spokespersons can emerge from spontaneously organized "enunciatory communities" during emergencies and other critical events. It is precisely during the radical ambiguity imposed by environmental disasters, Candis Calison (2014) argues, that formal institutions come to appear most unstable and illegitimate, thus opening up new spaces for advocacy and governance. Drawing on Jean-François Lyotard's (1984) characterization of the Euro-American subjective experience of "post-modernity," Michael Fischer (1999: 464) echoes Fortun's argument, suggesting that the confluence of technical and jurisdictional uncertainties around environmental risks at the turn of the twenty-first century dramatically revealed the inadequacies of existing forums of expertise and critique.[22] "[E]nvironmental issues have provided the metanarratives of society … increasingly requiring more participatory and decentralized decision making while requiring more sophisticated modeling and regulatory regimes."

Despite their ongoing migration out of the dirt ministries and into a range of non-governmental roles, many of Pauline's colleagues at the BVRC and elsewhere continue to see

22 In her early work, Anna Tsing (1993) directly challenges the unacknowledged Eurocentrism inherent in Lyotard's formulation, arguing that other groups' experiences of the disruptions of the late twentieth century inspired new forms of collective imagination or directly invoked dormant narratives of cataclysm and change.

themselves as spokespersons and stewards of the northwest. Many explicitly put forth their loss of formal attachments, still a considerable source of anxiety among researchers fearful of losing access to their lifestyles and livelihoods, as proof of their impartiality as scientists and of their commitment to the "community" of the Bulkley Valley and its environs. And yet by promoting new participatory planning venues while simultaneously highlighting rural residents' dependency on forms of technical knowledge only a select – if heterogeneous – class of local experts possess, they have wagered their return to local prominence on a series of precarious compromises. As the second half of this chapter will show, Smithers-based scientists' efforts to promote new models of decentralized governance have struggled to acknowledge their own complicity in the ongoing construction of environmental space as an object of technocratic rule. Rather than analyze specific projects and policy documents associated with the drafting of the Bulkley Land and Resource Management Plan and the formation of the BVRC, the following sections will draw on individual researchers' reflections on the roles they and others played in these processes to track the evolution of the positionings their narratives invoke.

The Limits of "Local" and the Struggle to Stay

Compared to the kinds of grumblings one might hear from the rest of British Columbia's four and a half million residents, Smithereens' complaints about government policies are often much more elaborate than grumblings one is likely to find elsewhere in the province. During the 1980s, Smithers became renowned throughout the province for its rising population of so-called "amenity migrants," a mobile class of young professionals who brought university degrees, government connections, and urbane politics and tastes to a region dominated by timber mill towns and small mining camps. I first heard the nickname "Nelson North" applied to Smithers

while sitting in on a meeting of entomologists at the University of Northern British Columbia (UNBC) in the city of Prince George, four hours east of Smithers. The joke paired the highly educated and oft-outspoken activist community of Smithers with the more famous town of Nelson, a hamlet for American draft dodgers and leftist expatriates during the Vietnam War set amidst the ski resorts of BC's southern Rocky Mountains. Separated from Vancouver by a fifteen-hour drive or a notoriously expensive two-hour plane ride, visitors I met in Smithers often spoke adoringly of the town's "quaint" alpine hamlet aesthetic. Smithereens, for their part, rarely missed an opportunity to deride Vancouver's runaway housing prices, or to trade stories of urban rudeness encountered on recent trips to the metropolis.

The few full-time government scientists still remaining in Smithers continue to answer to their superiors at various ministries' headquarters in Victoria, but for most of the year, they are left alone to administer to the many mines, timber supply areas, and provincial parks scattered throughout the northwest corner of the province. Compared to the social atmosphere at the main dirt ministry offices that many of new residents had left behind in Victoria, the friendly egalitarianism that they encountered in and around Smithers came as a relief. As I got to know many of the consultants and scientists over Friday evening happy hours and Saturday mornings at the farmers' market, a number of former government scientists-turned-consultants who had proudly "escaped" the "toxic cynicism" of the provincial capital occasionally shared stories of delayed promotions, badly mismanaged maternity leaves, and other encounters with gender discrimination that precipitated their journeys away from the capital.

While BVRC affiliates often used their work to both celebrate and challenge Smithers's status as an administrative satellite of the Victoria-based provincial government, several of the forest ecologists with whom I worked also leveraged their status as independent researchers and

off-site, adjunct faculty at various universities around the province to craft positions at the boundaries of BC's traditional centers of academia.[23] Pauline's husband Dennis (see chapter three) advised a handful of master's and doctoral students (often in shared office space at the BVRC), all while holding himself at a comfortable remove from the day-to-day politics of the University of British Columbia Department of Forestry. Over the course of the year, I encountered a number of researchers like myself who had come to Smithers as temporary residents after being drawn into the Centre's orbit. Biologists from eastern Canada stopped by for a few weeks to observe a familiar bird species in unfamiliar habitat. Tree disease specialists from Vancouver drove north between semesters to see how a provincially dispersed pest interacted with the kinds of trees growing in the region's coastal, interior, and transitional forests. A number of the people I met had first come to the region as short-term guests, only to decide to extend their stays. Some returned years later for multi-year postdoctoral appointments or, like me, for prolonged bouts of research for Ph.D degrees supervised by advisors at distant institutions. Dividing my time in town between the ramshackle meeting rooms at the Centre's main office and my borrowed cubicle in the Northwest Community College's glistening new LEED-certified building two blocks away, I spent a few days each week meeting with BVRC researchers and affiliates for coffee and talking with them about their lives and their work. Many shared stories about their experiences in other kinds of private and government-driven forestry research, and their anxieties about the provincial government's seemingly endless restructuring. We gossiped about the developing projects and daily dramas at the BVRC, and the broader ambitions of the

23 Numerous academics I met throughout the provincial interior lamented the government's decision to construct the University of Northern British Columbia's (UNBC) main campus in Prince George, a predominately blue collar city which, with a population roughly eight times greater than that of any other BC city north of the Kamloops metropolitan area, serves as the commercial and transportation hub for the provincial interior. Several recently hired professors at UNBC were particularly despairing about the location of the campus, one complaining that the school's proximity to the enormous Prince George sawmill had caused him to develop asthma just months after moving to the area.

Centre's enthusiastic directors.

As my social circles in Smithers steadily widened over the year, I encountered a range of attitudes towards the BVRC and its staff. While most of the people I talked to lauded the Centre as a legitimate and proactive organ of badly needed environmental expertise, a few saw little difference between the Centre's advocates and the more strident activists who had led road blockades and other direct action protests against the local forest industry in the early 1990s. Positioning myself within this polarized landscape proved to be surprisingly straightforward, however: to many of the environmental researchers and pro-industry workers I met during my time in the northwest, I was simply another temporary visitor, little different from the steady stream of visiting scientists who dabbled in local politics. *You're not a local until you've buried someone here,* was a half-joking refrain I often heard, including once while being rebuffed for citing as a "local" a resident who, in the words of my critic, "had only just moved up north in 1978." For some, the end of summer brought relief. A Smithers-born, government-employed sociologist summarized for me the feelings of many of his colleagues as we chatted at "Pints and Politics," a monthly event that brings many of the Smithers consulting class to a local pub to chat informally with the town mayor about local gossip and concerns. "November is everyone's favorite month," he admitted. "That's when you find out who's really here."

Some of Smithers' most celebrated "locals" were scientists who had simply turned down repeated opportunities to move away. Months before the December summit, I joined Pauline, the founding director of the Bulkley Valley Research Centre, for a first-hand look at some of the maps she had helped to construct during her first years as a forestry scientist working in the northwest coast. For several hours, we flipped slowly through stacks of old biodiversity reports in her office, an unassuming room above the garage at the home she shared with her husband

Dennis (the protagonist of chapter three of this dissertation). For a woman who had played as large a role as anyone in keeping intact the Smithers research community after the Ministry of Forests regional office closed in 2002, her self-professed naiveté was disarming. "I didn't even know what the word 'foundation' meant when we started the Research Centre," Pauline insisted. "It just wasn't part of my vocabulary. In Canada, government funded this stuff, right? But they were moving away from that, and they unsuccessfully tried to get industry to do r&d, but it's completely a nonevent in Canada because, you know, 'government does research.'"

Over the spring and summer, I was invited to retrace the migration of institutional memory away from the Ministry office into informal spaces and personal relationships. I visted other home offices around Smithers and the surrounding region, examining maps and sifting through computer databases and filing cabinets with researchers like Pauline as I shared in gossip and observed ecologists and other professionals as they went about their work. Some of my hosts shared long stories detailing their earlier lives and careers; whether I prompted them on the matter or not, all felt obliged to explain exactly how it was that they had wound up living in Smithers. While most had migrated north from Vancouver or west from urban centers in Ontario and Quebec, Pauline was among relatively few BVRC affiliates few who could claim northwestern roots by birth. Growing up in the company town of Kitimat, a three-hour drive west of Smithers on the Pacific Coast, Pauline was a young girl when her father had broken with the American-led Steelworkers Union to lead the formation of the Canadian Association of Smelters and Allied Workers in 1967.[24] Coinciding with the spectacular media attention generated by Expo '67, the World's Fair held in Montreal, the sudden formation of a Canadian-led worker's union at

24 Prior to the construction of the Alcan smelter in Kitimat in the 1950s, nearly all of the aluminum production in Canada took place in Quebec. For a glimpse into the federal reaction to the formation of unions in Kitimat, see Lapointe 1994.

what was then one of the largest aluminum smelters in the world quickly turned Pauline's father into a regional celebrity, as well as a favored target of conservative political attacks. "That kinda influences your attitude about taking charge of your own destiny," she admitted to me, joking that her career decisions only seemed to comprise a broader narrative when she considered them in the light of her father's professional choices.

As a relatively early arrival among the Smithers consulting class, Pauline's personal experiences with earlier government layoffs in the province allowed her to view the 2002 closing of the local Forest Service office in a comparative light. One of the few women to enter the prestigious University of British Columbia forestry program in the 1970s, Pauline spent a formative summer conducting field research in the northwest as she transitioned into graduate study, assisting a Smithers-based botanist with mapping work for what would become a new landscape classification system for the province (Pojar, Klinka and Meidinger 1987). After completing a master's degree in Oregon in 1979, Pauline moved to Smithers with her husband Dennis, a forest ecologist who had migrated to BC from eastern Canada, and they both began working for the provincial government full time.

Two years later, both Pauline and Dennis were left unemployed as both the Ministry of Forests and the Ministry of Environment (Dennis's employer) were reorganized by the government of the Social Credit party, populist conservatives who diminished the role of both Ministries' research divisions after a brief period of rapid expansion (Wilson 1998: 149-82).[25]

25 Although no longer extant, the Social Credit Party, or "SoCred," is widely credited with being the driving force behind the commercial and infrastructural development of the provincial interior during the middle decades of the twentieth century. For more on the Social Credit influence on BC land management and development, see Barman 2007 [1991]: 286-314. Explaining Ministry cutbacks of the early 1980s is not simply a matter of a conservative antipathy towards "big government," of course. Earlier SoCred regimes presided over a series of massive expansions in the scope and size of the provincial Forest Service and, through the system of appointing top Ministry officials, coordinated a close relationship between the Ministry and the logging firms that dominated the province (Prudham 2007). As forestry scientists explained to me, the SoCred-led Ministry saw little need to embellish the sustained yield system of forest management that they themselves had helped to

After the province's industry-friendly land tenure system was challenged by a short-lived NDP-led government in the early 1970s, the Social Credit government sought to blame the growing "Wilderness Movement" throughout the province on the expanded role that the NDP-led Forest Service had accorded to ecological restoration research. "Everyone with minimal seniority got thrown into the street, kinda overnight," Pauline admitted. Like a number of her younger colleagues, she and Dennis took the layoffs in stride. After leaving Canada to travel for several years, they returned to Smithers, where Dennis was soon recruited to begin work as a research scientist for the Ministry of Forests. Soon thereafter, Pauline began receiving offers of consulting work from contacts and friends she had accumulated as a Ministry employee. By the late 1980s, Pauline had begun soliciting contracts for her new owner-operated consultancy, cataloging habitat sensitivity information throughout the area for environmental impact assessments and Ministry reports.

As we talked through the morning, Pauline occasionally gestured over her shoulder to a set of enormous paper maps adorning the pitched ceiling of her office: biogeoclimatic classification system charts (e.g. figures 1.3 and 1.4) and cross sections (e.g. figure 1.5) which she had helped to produce more than thirty years ago during her first summer internship as a forester in the northwest. Around Smithers, coded ecosystem maps like these are a common kind of wall art. For those who can interpret their acronyms and keys, the statistical distributions of groups of tree species denoted by these cascades of colors signify in broad strokes the unfathomably immense landscape of the northwest: magenta for the grand cedars along the coast; teal for the swaths of aspen following the trunks of the region's largest rivers; indigo as the Douglas fir of the coastal mountains gives way to the cyan of the interior plateau's vast

establish in the 1950s.

monotony of lodgepole pine; chartreuse for the alpine tundra which slides lower and lower, off ridges and peaks and eventually into the valleys of the Spatsizi Plateau as the map ranges northward to the Yukon border. Taken into the field, BCGS printouts and overlays on GIS maps provided many of the researchers I worked with throughout the year a way of intuiting our relative position in unfamiliar terrain based on the trees and plant species we observed around us.[26]

Pauline described the fieldwork involved in the construction of the maps as equally grueling and mundane. "It was basically walking fifty meters, putting down a stake, counting trees; walk another fifty meters..." she laughed. "Most of the maps here are way, way out of date by now, of course, but they still have sentimental value for me." By contracting young botanists and ecologists to extend the new classification system across the province, the BC Ministry of Environment exposed environmental scientists moving to the north to a growing discordance between longstanding administrative boundaries and emergent ecological units. As the politics of forestry development grew more fraught in the late 1980s and early 1990s, however, the attachments that Pauline and her colleagues formed with these maps profoundly shaped their roles in the emergence of the Land and Resource Management Planning process, an altogether new domain of environmental governance. Inspired by their experience in the field and by a rapidly growing academic literature on ecosystem-based management, ecologists working in Smithers seized on the new platform as a means of moving EBM research into mainstream environmental politics.

26 In practice, most BCGS polygons are far too large to aid effectively in on-the-ground navigation. By correlating landscape "types" to geographical areas, however, these abstract maps nevertheless help ecologists and other cartographers to develop an "intuitive" sense of trends and transitions across vast areas of forest.

Re-Scaling Community: The Bulkley Valley Community Resources Board and LRMP

By the early 1990s, logging road blockades led by different branches of a growing forest wilderness movement and other anti-clearcutting protests throughout British Columbia helped the New Democratic Party to win its first provincial elections in two decades. Promising to act as the stewards of an environmentally and economically "sustainable" approach to forestry, newly elected premier Mike Harcourt's ministry appointees set about installing "participatory" land management platforms in the province's most contentious forestry regions. By the end of the 1990s, a series of new Land and Resource Management Plans, or LRMPs, had emerged from the collaborative work of elected teams of community members and government planners.[27] Shortly before government-led planning committees (under the title of the preceding program, the Committee on Resources and Environment, or CORE) were established in 1992 to draft plans for Vancouver Island and for the Cariboo-Chilcotin and East and West Kootenays regions of central BC, the Bulkley Community Resources Board, or CRB, was elected to construct what would

27 The history of the LRMP process deserves its own book, and has already generated a considerable literature among Canadian and non-Canadian policy scholars, several of whom have written entire dissertations devoted to the early stages of the process (e.g. Giesbrecht 2003; Frame 2002; T. Thornton 2002). The initial design and implementation of LRMP processes across the province (including its government-led predecessor, the Commission on Resources and Environment, or CORE) was eagerly hailed as a spectacular success of "democratization," despite the exclusion of First Nations concerns throughout the 1990s and the communication breakdowns suffered by numerous CRBs. For some policy scholars, the mere fact that the process was "completed" and that the resultant LRMPs were then incorporated into provincial land use policy was more important than assessing whether the final plans achieved local consensus or not (Jackson and Curry 2007; see also Bernstein and Cashore 2000). A more recent iteration, the Sustainable Resource Management Plan (SRMP) program introduced by the BC Liberal government in 2002 and led by the newly created Ministry of Sustainable Resource Management (MSRM) has worked to develop land use plans for use by First Nations and other groups (see chapter four), but has been primarily run by smaller (and less well supported) government planners and analysts with minimal public involvement. As political scientist Jeremy Wilson (2001) has acknowledged, most of these processes were flawed from the outset due to the severe constraints imposed by the government planners ultimately responsible for accepting community-produced plans. Legal scholars Tim Thielmann and Chris Tollefson (2009) are among a group of more recent scholars to look past the decline in direct action protests and other forestry conflicts and recognize the lingering sense of alienation most, if not all, LRMP participants have come to feel towards these documents, and to the widespread frustration with the Liberal government's non-recognition of these documents' many non-binding land use recommendations (see also Booth and Halseth 2011; Halseth and Booth 2003).

become British Columbia's first community-authored land management document.[28]

For future members of the Bulkley Valley Research Centre who were already living in the region by 1991, the initiation of the LRMP process was a watershed moment. Hundreds of people attended the first CRB planning meeting in the gymnasium at St. Joseph's Elementary School in Smithers. At the urging of Pauline and Irving Fox, a retired professor of planning and longtime conservation activist in the northwest, dozens of attendees gave short speeches and volunteered for board membership, choosing from a one of brief list of "community values" they would represent if elected to the committee (forestry, fishing, hunting, conservation, or mining, to name a few).[29] For a town strongly divided by differences in profession, class, and birthplace, Pauline reflected, the expansion of clearcut logging throughout the northwest and the widespread circulation of new idioms of conservation had by the early 1990s had created a rare rallying point. "There's always the redneck versus the enviro-people stuff, and the local people versus the urban people, but they were pretty united about the fact that, when the wood ran out, we'd be kinda up the creek."

Pauline's work building ecosystem classification systems during her first stay in Smithers had allowed her to see firsthand the flexibility of the government's resource use and land cover coding schemes. Wary of another transition in government like the one that had prompted her first move away from the northwest, then, she was surprised when none of her fellow board

28 The local genesis of the Bulkley CRB began in conversations between members of other Smithers-based conservation groups in the late 1970s and early 1980s, long before the provincial government first considered opening up the land management planning process to community-oriented groups of non-specialists. After the appointment of the initial CRB group in September, 1991, the board's critiques of the Ministry of Forests-driven Forests and Lands Management Plan (FLMP) program pressured the government to develop an alternative process. The LRMP document alludes to some of these antecedents: see Bulkley Community Resources Board 1998, 22-3. See also Giesbrecht 2003.

29 Irving Fox, the architect of the original Bulkley Valley CRB, deliberately eschewed other CORE and LRMP groups' manner of recruiting representatives based from specific businesses or "sectors," believing that individuals elected based on their "values" would be less beholden to the interests of private entities (Booth and Halseth 2011: 900).

members began negotiations by advocating for the creation of new provincial parks – the strongest form of conservation protection allowable by provincial law. "They all had a reason why they didn't want parks, and each one … was different." Even as she waxed nostalgic about the egalitarian spirit of cooperation between board members of different backgrounds – a dentist, a local hunting guide, and a self-described homemaker, among others – Pauline remembered the personal anxieties they shared while weighing the prospect of banning developmental activities across broad regions, far into an unknowable environmental future. "I was a little bit concerned that we were all just a little too mild mannered," she laughed. "We were all good Canadians." Even those who explicitly aligned themselves with the province-wide wilderness movement were uneasy about dismissing outright the livelihoods of the other members of the board.[30] One participant, for instance, a vocal member of other Smithers-based conservation groups, made his living "building log houses," Pauline admitted, "so he had a lot of respect for people who cut down trees."

As the process wore on and the publicity surrounding the launch of the new board slowly dissipated, the scope of the government's interests in the process became more apparent: while CRB members expected to have a say in the active management of emergent environmental issues, the province was more concerned with achieving consensus on new permanent boundaries for conservation units and parks.[31] The rate of timber harvest in the region, or "annual

30 Arun Agrawal (2005: 95) makes a similar point while discussing the decentralization of forest use law enforcement work in postcolonial India. Whereas the state could mete out harsh fines and prison terms for infractions, community-led councils were more apt to be lenient on rule-breakers "out of the recognition that group members who are punished will remain members" of the council and of the local community.

31 As several of my interlocutors noted, the provincial government, like many governments at the time, was particularly motivated by the influence of the Bruntland Report, "Our Common Future," a treatise on "sustainable development" which the United Nations issued in 1987 (World Commission on Environment and Development 1987). Thanks to the report, the rather arbitrary argument that 12% of a given territory should be protected for ecological conservation was treated (somewhat simplistically) by the incoming NDP government as a mandate for the creation of new provincial parks. As LRMP participants soon discovered, however, ministry planners who facilitated the approval these plans were often more concerned with achieving the province-wide 12% threshold than with focusing conservation efforts on particularly vulnerable or significant

allowable cut," that the government set anew each decade, for instance, was off limits (see chapter five), and would continue to be calculated by a small cadre of industry-oriented Forest Service programmers based in the provincial capital. Ministry officials continued to circulate public discussion documents detailing basic aspects of their rationale for the annual harvest limit set for the region overall (usually on the order of 800,000 cubic meters per year), but even as the LRMP process began taking shape, the maps in Ministry forestry planning documents did not change (British Columbia Ministry of Forests 2001).

For board members and supporters brought to the process by a desire to play an active role in timber management, the revelation was a heavy blow. "There was always this sense that they'd just keep grabbing more and more timber, and everything would become merchantable and then they'd just take it," Pauline explained. "We had so much wild country, you could see this happening." Despite sponsoring a raft of new projects to research the effects of large-scale, sustained yield harvesting, she and others lamented, the NDP was proving to be just as loyal other parties had been in ensuring that the province's timber companies received the allocations they desired.

Along with a growing number of Smithers-based forest ecologists, Pauline had been complaining throughout her career that sustained-yield forestry had become blind to its own faults. Few researchers within the timber industry or the BC Forest Service, she lamented, were willing to discuss with her and other founding CRB members the risks inherent in what political scientist Jeremy Wilson (1998: 79) refers to as the "liquidation-conversion process" of turning dense, lush old-growth forests into regularly spaced, even-aged tree stands that could (ideally) be harvested, *ad infinitum*, at predictable rates. Community anxieties surrounding the long-term

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regions (see also Thielmann and Tollefson 2009: 112-3).

effects of forestry were only deepened by the fact that, as I show in chapter five, ministry planners were rarely allowed to acknowledge publicly many of the ambiguities involved in the tree growth modeling process, let alone allow the public to critique and modify their analyses. "When [the LRMP process] actually happened, people said, 'Oh, we're not going to be able to address the rate of cut … that's not part of the mandate.' But certainly, that was a huge driver for everybody, was the rate of cut. But you know, government: you get to do this, you get to do that. People had this vision that they'd be able to address the rate of cut, but they didn't."

In addition to the bureaucratic constraints ministry planners imposed on their involvement, Pauline reflected, the lack of an independent meeting space constantly reminded the board members of their precarious dependence on government affordances, anxieties that returned in full force during the formation of the BVRC. After spending over a year developing the terms of reference they would use to frame the purpose and structure of the board itself, the group eventually settled into a routine, meeting several times per month to pour over finely detailed maps of the district and debate which of five "resource management zone" designations – protected, settlement, agriculture/wildlife, integrated resource management, and special management – to apply to each area. As their engagement with the province's maps grew more elaborate, their reliance on the technical support of government-appointed planners grew more acute. "There were support people that would do maps – a lot of paper maps in those days," Pauline reminisced. "And you'd say, 'Oh, you wanna find out this,' and they'd print up some vast numbers of maps, and print them off on these giant printers. Lots of colored maps."

Even if Pauline was not producing new maps for the process herself, her technical background enabled her to position herself as a key mediator on the board by asking critical questions of the rotating cast of government researchers who visited the board for consultations.

Hydrologists, botanists, grizzly and caribou biologists, and other specialists joined their meetings for a few hours at a time, each one sharing their research and answering questions about specific regions of the district. By the second year, most of the members of the board had become close friends. As board members grew more engaged with the physical maps of the district, their initial suspicion towards the govenment planners gradually thawed, and they eventually overcame their resistance to the physical space of the Ministry of Forests District Office in Smithers. "We didn't meet there for the longest time because we didn't want to be tainted," Pauline admitted, half-jokingly. "So we met in all these places, but eventually we kinda gave that up and met there because all the maps were there. I remember we were at the library and various things. So that was just a couple years of getting comfortable that the Forest Service wasn't trying to run the process – but of course, they gradually did."

By the middle of the decade, the government's support for a wide range of long-term selective harvesting experiments, stream restoration initiatives, and other new ecosystem-based management-themed projects had seemingly blurred the distinctions between the board's original prerogatives and the dirt ministries' technocratic aims. For seven years, Pauline and the other members of the board worked through different planning scenarios within the space allotted to them, modeling the effects of each proposal on the future populations of particular animal species, the available area of agricultural land, and the rise and fall of predicted timber harvests, then projecting each set of numbers decades into the future. As the plan progressed, they held community feedback sessions to explain the different management scenarios they had experimented with during the previous months. For several years, the board struggled to convince the residents of Smithers and neighboring towns that the project was not simply another government-run endeavor. Pauline kept the group's ministry collaborators sidelined during the

board's open meetings, she admitted, even as they frequently called upon them to answer technical questions. "They would help us with maps and stuff," Pauline joked, "but we would be up there pinning stuff to the wall."

Compared to other LRMP documents begun throughout the province, the detail and specificity of the Bulkley plan starkly reflected a delicate balance of earnest technocratic pretensions and faith in the provincial government. Pauline and other original CRB members I met in Smithers each admitted with weary embarrassment that they had all believed that the Ministry officials in charge of implementing the plan would appreciate their attention to detail, and would recognize regulatory ambitions of the board members themselves. As the final plan was sent to the provincial government for approval early in 1998, the technical meanings and spatial extent of each of the board's five different use designations had been pulled sharply into focus and mapped out with considerable precision (see figure 1.6). Nearly all of the district had been approved for mixed use, while new protected parks were proposed for only five percent of the total plan area. Within the "integrated resource management" areas that took up 64% of the district, a cascade of subdivisions outlined a complex list of subtly different management regimes. Other designations not introduced in the original terms of reference proposed entirely new systems for arranging different forms of use within constrained areas. Descriptions of new "ecosystem network" polygons (see figure 1.7) sketched out intricately organized arrays of habitat migration corridors, intensive forestry development areas, and protected "visual quality" areas (highly visible mountain slopes in close proximity to parks, for instance).

Not all parts of the plan area were subject to such baroque specifications: areas where the board had been unable to reach consensus were marked as "special management zones," listing general provisos constraining how and where certain kinds of development could occur. A

permanent Community Resources Board, refreshed through regular elections, would parse new proposals, and would be consulted by government officials wherever disagreements over implementation arose. With plans for continuous monitoring approved as part of the plan itself, Pauline and others relaxed, fully expecting that the board would be allowed to make regular updates and revisions as environmental datasets expanded and new contingencies emerged.

The Limits of Care in a "Results-Based" Environment: The Collapse of the LRMP

When I joined Beth and Paul early in December, the speeches we had heard the previous morning had put the tortured history of the LRMP back into everyone's mind. Beth was preparing to run in the Community Resource Board elections scheduled to take place in a few weeks. Paul had spent part of the summer building simulators for the board as they worked to assemble a new recreation access management plan for the Bulkley District, and the long hours and occasionally tense negotiations had left him feeling drained. The board still looked to the original plan as its founding document, but after government support for monitoring work and twice-a-decade revisions to the plan were delayed indefinitely in the early 2000s, the group eventually redirected their attention to other, smaller conservation initiatives. When I arrived in Smithers early in 2013, the Bulkley LRMP was still cited around the province as a triumph of participatory planning: of the fourteen LRMPs produced in the province, only the Bulkley plan had won widespread support, and only the Bulkley Valley CRB continued to meet after its plan was approved by the province.[32] Indeed, as my conversations with Beth indicated, the Bulkley CRB was still meeting and electing new members almost a decade and a half later.

32 Several of the fourteen LRMPs were completed by government planners after community board members failed to reach consensus. Numerous groups saw their meetings devolve into acrimony; in one town, the leader of the CRB was burned in effigy after the process fell apart. See Booth and Halseth 2011.

And yet, the plan itself was effectively dead. The intricate management recommendations of the LRMP had been replaced by a new forest management regime in 2004, and the biodiversity objectives structuring the plan's recommendations throughout the district had been voided explicitly by government rulings in 2006 (B.C. Ministry of Agriculture and Lands 2006). By 2013, only the plan's comparatively minute protected areas – the Babine River Corridor, and the Driftwood Canyon and Babine Mountains provincial parks – remained of the LRMP's original land use designations. For many, the transformation belied the failed promise of ecosystem-based management. Although they had not settled permanently in Smithers until after the Bulkley Valley LRMP had been approved, both Beth and Paul had worked as consultants on other land use plans throughout the province before and after they arrived in the northwest. Paul, whose biodiversity models had been repeatedly bowdlerized out of other LRMP documents, often years after the final plans were approved, remained bitter about what he saw as the relentless undermining of the original LRMP process. "The model was set up so that it could have worked. … if they hadn't disemboweled the LRMPs and tried to sweep them to the side because they saw them as interfering with their decision-making, then they could've worked."

Even as the Bulkley LRMP was hailed as a relative victory compared to the tensions aroused by community planning processes elsewhere in the province, the close contacts that Pauline and others had formed with government planners through contracting work, political activism, and other informal associations provided them intimate knowledge of the marginalization of their work. The government's failure to gather the protected species counts, tree growth rates, stream temperature readings, and other ecological data required to update the plan's recommendations had undermined the CRB and transformed the plan into a largely unenforceable document, all without formally abandoning either structure. Across the province,

other LRMPs with detailed biodiversity protection measures were voided, one line at a time, as new policies came into place that obviated the government's earlier commitments to gathering certain kinds of data.[33]

The tense collaborative relationship that the original members of the community resources board had forged with local government planners began to change shape, too, as all of the researchers based at the regional Forest Service office in Smithers were released or reassigned to Victoria. "Everybody's flailing around," Pauline recalled. "Our jobs, our livelihoods, our sense of what we do in Smithers is coming apart, because government is not going to play a role in this stuff anymore." By 2002, most of the regional Ministry of Forests offices around the province had been closed or dramatically downsized. Within the span of a decade, ecosystem-based management had gone from an esoteric scientific philosophy to a central tenet of land management policy in perhaps the largest single forest economy in the world. And yet as soon as its champions had reached positions of power, they were replaced, keeping nominal versions of their policies in place as EBM practices were sent back to the margins of environmental politics.

Re-Scaling Care: Building the Bulkley Valley Research Centre

No longer satisfied with producing documents for what might turn out to be a hollow advisory role, Pauline and several other architects of the original CRB have spent the past decade and a

33 In some cases, the lack of new data also forestalled the provincial approval of LRMPs which had already achieved consensus among community board members. Perhaps the most notable example of this is the Morice LRMP, set in the Morice Forest District immediately southeast of the Bulkley District. After the initial LRMP was sent to the provincial government for final approval in the early 2000s, the onset of a spectacular mountain pine beetle epidemic (see introduction) and the subsequent death of a huge portion of the district's mature lodgepole pine was cited as discrediting the Morice planning committee's stipulations of timber harvesting areas and park boundaries. The plan was finally approved nearly a decade later, despite the fact that no additional ground-based inventory data on the tree cover in the district had been assembled during the interim. See Morton, Gunton and Day 2012.

half working to turn the political marginalization of EBM into an emblem of care and virtue. Within weeks of learning that the regional Forest Service office in Smithers was to be permanently dismantled, Pauline began organizing meetings to discuss the fate of the town's "critical mass" of soon-to-be-unemployed environmental scientists. Many were already resisting the government's attempts to reassign them to new positions at BC Forest Service headquarters in Victoria. The group also discussed what might be done to rescue and re-organize the troves of experimental data and technical reports housed at the regional office. Without a dedicated building and staff to manage the material generated by government-funded forestry research projects in the region, Pauline lamented, archived data and decades of accumulated knowledge would be lost as researchers dispersed and old reports were discarded.

More than any lapsed projects, though, the initial founders of the Bulkley Valley Research Centre feared a rift in the social fabric of the town itself. "Wherever there's a regional office," Pauline explained, "there's this clump, this cluster of consultants partly because you're in tune to what's going on, you get these contracts. But also a lot of spouses are involved, right? A lot of people, one part of the family works in government and ... the other partner's a consultant; they've got the pension and all the health benefits. ... Doesn't matter which partner it is, who's making more money, it's just a nice arrangement for stability. And that's a stay-at-home kind of job, usually." For Pauline, cleverly balanced schedules had also opened time and energy for her to devote her attention to advocacy work, a "hobby" she feared would disappear completely were she and Dennis to take up new jobs in Victoria. "When the land use planning started," she admitted with a laugh, "I had babies, and I really needed to do something other than just be a mom." By the end of 2002, Pauline, Irving Fox, and several of their close colleagues had rented a small office on Main Street in Smithers, and were already applying for private

grants and soliciting new research proposals.

Grasping for new structures of meaning and continuity forced the BVRC's founders to re-cast the vulnerability they suffered as a bureaucratic inevitability. As Pauline grimly acknowledged, several of her friends who worked for the government – her husband included – assumed that such a transition had been brewing for years. "We're always kinda reflecting stuff that happens in the US, to a modified degree, a couple of decades later ... that whole idea that the private sector and the non-governmental sector takes over." Seeing similar changes on the horizon in Canada in the late 1970s, several Smithers-based scientists had already attempted to organize independent research and advocacy groups for civil servants and consultants, but had struggled to differentiate themselves from more aggressive conservationist groups that were already proliferating throughout the province.[34] "[T]here was always this very clear line between environmentalists and resource specialists," Pauline explained as she recounted the rise and fall of the LRMP process. "We didn't go there – it was too political. We had our own definition of what was political and what wasn't political. I don't really understand it anymore, but at the time it was pretty clear: they do their thing, we do our thing."

As they BVRC established itself as a presence in the northwest, the change status of the research reports and policy documents generated by NDP-funded programs offered Pauline and others new opportunities to demarcate their work from the direct-action protests of conservationists who had begun moving to the region since the beginning of the wilderness movement. Even as the decline of Pauline's direct ties to the provincial government made certain ideological distinctions more difficult to sustain, many early BVRC affiliates leveraged the

34 One such research group, the Spatsizi Association for Biological Research, or SABR, was created in the 1980s by Irving Fox, the original architect of the CRB, and Jim Pojar, the ecologist who had hired Pauline for her first summer internship as an ecological mapmaker on the northern coast.

Centre's institutional ambiguity to justify applications to a rapidly diversifying spectrum of research funding organizations. Philip Burton, a former government researcher-turned-biology professor and long-time BVRC board member, insisted that the rise of the Research Centre had helped to transform Smithers from a simple government outpost to a regional center for a complex ecology of disparate institutions. "Let me put it into the institutional culture of the whole Bulkley Valley," he explained when I visited him in his office in the nearby town of Terrace:

> "I remember at one stage we were looking at applying for … a small grant, and the question came up, 'Should this go to the institute, the business, the co-op, or the centre?' It just becomes a different shell within which to run money depending on the varying constraints and … oversight procedures that are required … for dealing with certain kinds of money. So the Driftwood Foundation works for some routes, … the Northwest Institute for Bioregional Research for others, and the Bulkley Valley Research Centre for others. Yet my wife keeps [her consulting company] running if we just want to run it through an ordinary business on a for-profit basis. So to the extent that Ministry of Forest researchers can channel funds through there, it provides a degree of distance and impartiality that if work were only done by the Ministry, the environmentals might not think of it as being completely objective. Likewise, there's the opportunity of what's not always taken or requested for in-house peer-review of methods and results, reports, so from that perspective it provides an institutional shell for a lot of these independent researchers and contractors. And even though we might, you know, call [my wife's] group 'consultants,' in fact, she's very much her own researcher. She's got twenty years of research experience. So the Centre provides a larger legitimate framework within which she can release her reports rather than it being just a consultant's technical report."

As the roster of BVRC affiliates in the northwest grew and their reporting genres and funding sources steadily expanded, Pauline and her colleagues soon began to look past the

decaying LRMP, re-scaling their designs on ecosystem-based management to cover landscapes and processes that escaped the boundaries set for the Bulkley District. "My interests were always much more regional than district," Pauline admitted, reminiscing about her transition away from the Community Resources Board. "It was a whole new thing for me, the 'Bulkley District,' this piddly little thing – and I did coastal forests." After beginning her scientific career helping to build maps of the entire western coast of Canada, reorienting herself toward the vastly smaller (7,600 square kilometer) unit of the Bulkley LRMP "district" demanded re-learning how to appreciate smaller details of ecological classification. She further reminded me that this orientation was reflected in the focus of her consulting work as well. "It was 'Skeena [Ecological Research],' it wasn't 'Smithers [Ecological Research],'" she protested, referring to the enormous Skeena river system, of which the entire Bulkley Valley was but a minute section.[35] "[I]t was kinda a learning process for me to get interested in that area. … When I had worked my dream job, I had basically been [responsible for the region from] Bella Coola up to the Yukon border, so I had a really broad interest in the region, so to get that focus on the Bulkley District – we went over every little speck of land, so I did have a pretty good appreciation for it, but my interests were broader." Expanding and exporting the Bulkley Valley model of technocratic stewardship, then, meant devising ways to embed these earlier interests and attachments into altogether new mediums of care.

Adding It All Up

By 2012, a decade after the Centre first opened, Pauline's calls to broaden the scales of independent research had captured the attention of a national audience. In front of over two

35 Both company names are pseudonyms.

hundred people at "Adding It All Up: Balancing Benefits and Effects of Resource Development," a BVRC-hosted conference held a few months before my arrival, dozens of speakers from throughout British Columbia and Canada presented research and shared stories about the new challenges they had faced in integrating their work over the past decade. "Cumulative effects," the speakers concurred, had become the new watchword, an emerging ethos of computer modeling that extended the analytics of systems ecology dramatically further into the future. Good cumulative effects models would compound the statistical risks and material flows of regional developments with the landscape and watershed transformations projected in climate change simulations. Fragile government research programs like those that had supported the brief fluorescence of ecosystem-based management, however, were not to be counted on. Public and private datasets, speakers from private geographic information systems (GIS) consultancies argued, would have to be correlated and harmonized in dramatically new ways. Contributions from long-marginalized First Nations communities and experts would have to be courted and counted. Old Forest Service experiment sites, like the research forest I explore in chapter three, would have to be revived and expanded to explore urgent questions surrounding new tree diseases and species succession issues. The participatory forums abandoned amidst the collapse of other LRMPs a decade earlier would have to be re-thought, conference speakers insisted, and re-integrated into new modeling technologies (see chapter five).

Throughout 2013, numerous BVRC events hearkened back to the conference. Scenario planning exercises, already a mainstay of both BVRC and government outreach programs throughout the region, began incorporating longer discussions of statistical analysis and climatological variables (e.g. D. Morgan 2009). A one-day risk assessment workshop, for instance, drew over thirty government and NGO fisheries modelers and hydrological experts

from Vancouver and Victoria to the Northwest Community College early in the summer. Even as the many visitors who had also attended "Adding It All Up" happily shared anecdotes from the conference to subtly remind Centre affiliates of the seriousness of their commitment to the region, a number of their Smithers-based counterparts took pains to distance themselves from the visitors in subtle ways. By claiming comprehensiveness itself as the purview of independent science, the BVRC had begun to reverse its relationship with politicians at multiple scales, seemingly conferring legitimacy on the government officials on whom they had once depended for support. All four speakers at the December summit, each of whom had spoken at the previous year's conference as well, cited the large crowds of scientists, activists, and politicians that had traveled to Smithers for the three day event as a watershed moment.

"Five or ten years ago, cumulative effects, you probably couldn't say that within government … same as climate change," one speaker had pointed out that morning, suggesting that the hereditary chiefs he worked with at the Office of the Wet'suwet'en optimistically viewed the new modeling techniques in much the same way that they sometimes spoke of the holistic *yintah* between Witsuwit'en[36] clans and house groups and the animals and landscapes of their traditional territories. "Cumulative effects is the interconnectedness, it is the synergies," provincial parliamentarian Doug Donaldson had offered during his December speech, "and science, the tradition of the science that we practice is not based on this. It's based on reductionism and dualism." If anything, the speakers proclaimed, independent "science in the public interest" (as the BVRC's slogan put it) would demand even more complex organization

36 The Office of the Wet'suwet'en comprises both the council of Witusuwit'en hereditary chiefs and its bureaucratic appendages. Despite the confusing difference in spellings, the Office is not related to the Wet'suwet'en First Nation based in the nearby town of Burns Lake, BC, although the two groups are both represented by the broader Carrier-Sekani Tribal Council. For a more detailed explanation of the origin of these spellings and the affiliations they imply, see chapter two.

frameworks than the crumbling provincial bureaucracies that so many of the scientists in the audience were struggling to leave behind.

Transitions: Inherited Space and The Care of Experts

As her own professional career intertwined with the rise and fall of the Bulkley Land and Resource Management Plan and the emergence and expansion of the BVRC, Pauline's relationship with the maps, media, and policy documents produced amidst these endeavors has undergone constant change. Yet as she and others continually reposition these artifacts to articulate a vision of community relevant to the ambitions of Smithers-based environmental scientists, the differences between their version of technocratic activism and the aims of government science become difficult to define. The laborious work of attaching numbers to rural spaces, and, increasingly, to periods of time, has long provided both an ambit for passionate debate and a structure for many, if not most, of the precious few technical careers available in resource frontiers like northwest British Columbia. Since the beginning of the twenty-first century, the simultaneous remediation and decentralization of ecological science and resource analysis has provoked far-ranging conversations over the personal and professional conflicts that have always inhered in this work, even if the size and dominance of earlier government institutions kept these conflicts hidden from view. Even as provincial institutions distributed data collection and analysis responsibilities among timber company employees, prospectors, and, more recently, contract workers, the dirt ministries nevertheless relied on the documents produced through this work to project knowledge and construct the space of crown land as an object of provincial control (Rossiter and Wood 2005).

By casting technocrats as visitors from afar, most historians and social scientists have had

relatively little to say about how the work of rendering landscapes into documents – and the frustration and disappointment as watching as the power of these documents collapse or change form – shapes the subjective experience of experts who wish to remain in the places they've rendered. Timothy Mitchell (2002), Bruno Latour (1990), Matthew Edney (1997), and others have argued in various ways that the cartographic construction of space has long been the technology *par excellence* used by colonial governments to extend jurisdiction over newly occupied spaces.[37] As Mitchell explains, the construction of dams and railroads in nineteenth century Egypt and the drafting of painstakingly detailed maps of infrastructures and land allotments allowed British colonial officials to create a "paper landscape" (89) which they could administer to from bureaucratic offices in Cairo, Alexandria, and London. Once these representational artifacts were taken up within new accounting practices, administrative experts could then direct their interventions to a singular abstract object – "the economy" – and justify measures of colonial rule as technical matters of economic management (see also Ferguson 1990; Li 2007a).

The simple fact that the documents undergirding these objects were composed by government scientists or by citizen groups reliant on the affordances of policies and political infrastructures does not mean that they continued to be used in the same ways today. By using his examples to ask "what methods of politics and expertise divide the world into metaphysics on the one hand and mere physics on the other," Mitchell (2002: 59) says little about the efforts of untethered experts and other postcolonial administrators to efface or re-position such demarcations within technocratically divided worlds. Arun Agrawal (2005) argues that the retreat

37 As Winichakul Thongchai (1994) argues, even Thailand, a place not subject to colonization, eventually adopted cartographic methods to project its geographical identity, influenced as it was by the border-making technologies in use amongst its colonized neighbors.

of colonial rule and the decentralization of governing functions in forestry-dependent communities in northern India exposed residual subjective formations which proved to be more sympathetic to the punitive systems of the departing British than to the tentative steps towards rural communalism promoted by the emerging Indian state. "Instead of a selective conceptual focus on 'politics,' 'institutions,' or 'subjectivities' as *the* foundation on which to build an analysis of changing environmental relations," Agrawal suggests, "it can be more fruitful to examine how these concepts shape each other and are themselves constituted" (203).[38] Numerous modes of co-influence arise, for instance, from the popular re-appropriation of lapsed colonial policies. By taking up state mandates of forest preservation over and above the more tentative recommendations of newly created local forest councils, Agrawal's interlocutors became "environmental subjects," mistrustful of individual government officials even as they tacitly accepted inherited categories. "'Government employees don't really have any interest in forests,'" his interlocutors protest. "'It is a job for them. For us, it is life'" (2).

Former government employees in Smithers have struggled to reconcile the tensions inherent in the administrative categories they transposed from BC's ministries into their new private and independent work. Working to craft their lives and careers from new positions outside the provincial government, environmental scientists connected to the Bulkley Valley Research Centre often translate their frustrations over the myriad incongruities between ecological and administrative boundaries into an iconoclastic attitude towards the political geography of the province. Particularly among the scientists whose consulting work has kept them in close contact with government ministries, reflecting on past arguments over these

38 Donald Moore (2005) draws a related point from the subjective experiences of landless Zimbabweans, whose interactions with post-revolutionary Zimbabwean state offices were often powerfully shaped by perpetually deferred promises of land ownership.

incongruities often inspired them to hold up the spatialized ecological concepts that orient their work (e.g. watersheds, foraging areas, species distributions, animal migration corridors, etc.) as explicit objects of advocacy.[39] "One thing you should know about me," Beth insisted as she and her husband recounted their own backstories for me in the days following the December summit, "[is that] I'm not a 'boundary' kind of person. I'm not respectful of boundaries … if it ecologically makes sense to draw a line like *this* on a map, I'm gonna ignore that all the district boundaries are like *that*."

Throughout my year in Smithers, BVRC affiliates and former Community Resources Board members constantly invoked for me different political levels and spatial scales only to question their legitimacy under the presiding BC Liberal Party regime. Over time, I began to share many of their anxieties. Establishing local roots, they seemed to suggest, meant championing and caring not just for the forests around Smithers, but for the trees, lakes, and tundra comprising the entire northwest. By funding and publicizing research beyond the Bulkley Valley, the BVRC has allowed researchers to eschew the boundaries of individual LRMPs and provincial forestry districts and project policy complaints across the province as a whole. As subsequent chapters of this dissertation will show, though, each new Centre-supported attempt at re-appropriation has carried along with it some of the baggage of earlier regimes. New hopes often come tethered to the goals of old policies, whether the Centre and its affiliates are busy helping to decouple physical spaces of ecological experimentation from deterministic models of forest change (chapter three), supporting work on new, open source computer simulators meant to challenge opaque government resource analyses (chapter five), or experimenting with novel

39 Celia Lowe (2006) makes a related point about the efficacy of "keystone species" designations and biodiversity conservation programs in shaping the political geography of environmental science and management in Sulawesi.

legal instruments to formalize new research collaborations and data sharing relationships (conclusion).

Busily transposing the theoretical claims and objectives of ecosystem-based management out of old policies and into the explicitly independent realm of cumulative effects analysis, some members of the Smithers consulting class are more willing than others to acknowledge the lingering ties that have allowed them to remain at work in the northwest. Pauline still sees the Centre in pragmatic terms and maintains a low profile at public events. ("Somebody's gotta organize the meetings and that kind of stuff," she chuckled when I asked her about her duties as BVRC chairwoman. "I'll just keep doing it unless somebody brilliant shows up and wants to do it, but nobody wants to do it!") The men and women who comprise the Centre's many networks have internalized the omnipresent threats of funding cuts and policy reversals. The town's "critical mass" of researchers remains impressively intact, even as it becomes increasingly difficult to define.

As the next chapter will show, this critical mass is not to be taken for granted. GIS mapping experts from the nearby Gitxsan First Nation championed ecosystem-based management in their work and drew on the same government funding initiatives for watershed restoration research that supported forest succession experiments and participatory planning processes around Smithers in the 1990s. And yet unlike the amenity migrants who have managed to remain in the northwest amidst the loss of these programs, the limited professional mobility gained by Gitxsan experts has effectively forced them to move south to find work. In the following chapter, I will examine a darker side of rural technopolitics, and attempt to answer how a similar campaign to grow expertise *in situ* yielded not outsiders, but exiles.

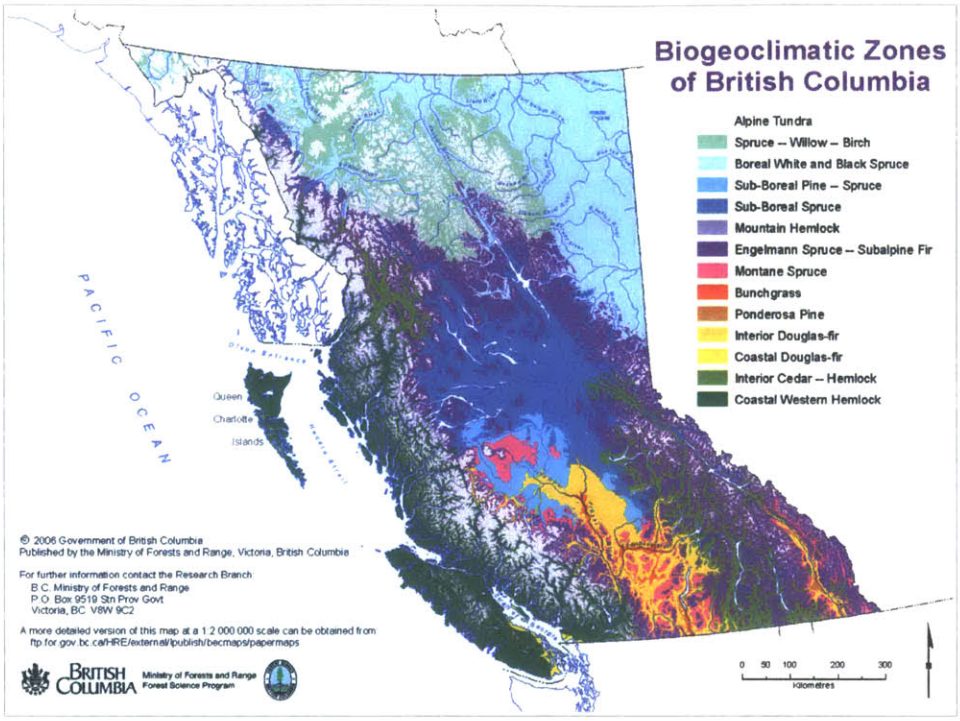

FIG 1.3. Biogeoclimatic Zones of British Columbia. B.C. Ministry of Forests and Range 2006.

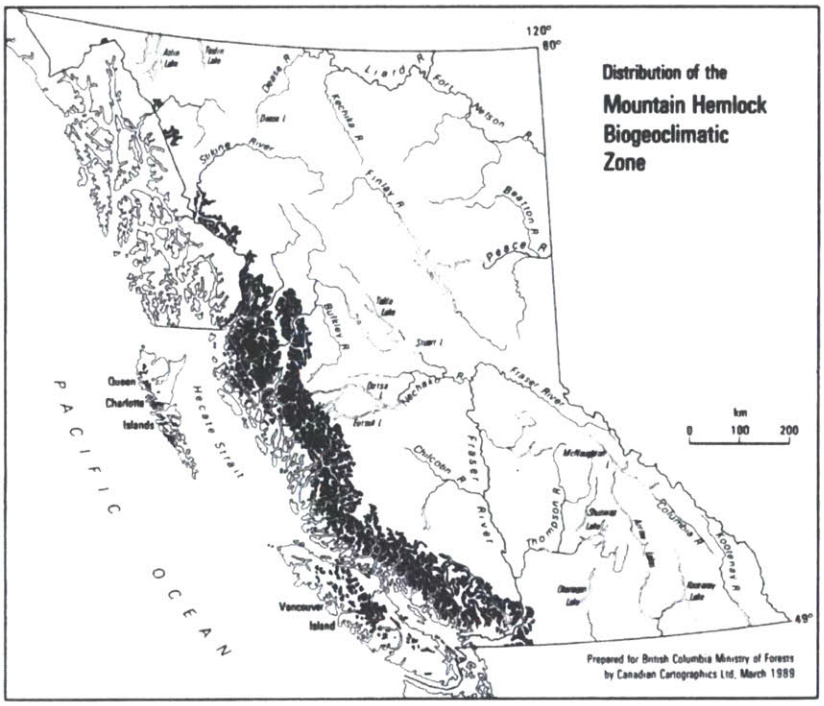

FIG 1.4. Early product of the B.C. biogeoclimatic classification project showing distribution of mountain hemlock-dominant landscapes. Meidinger and Pojar 1991: 115.

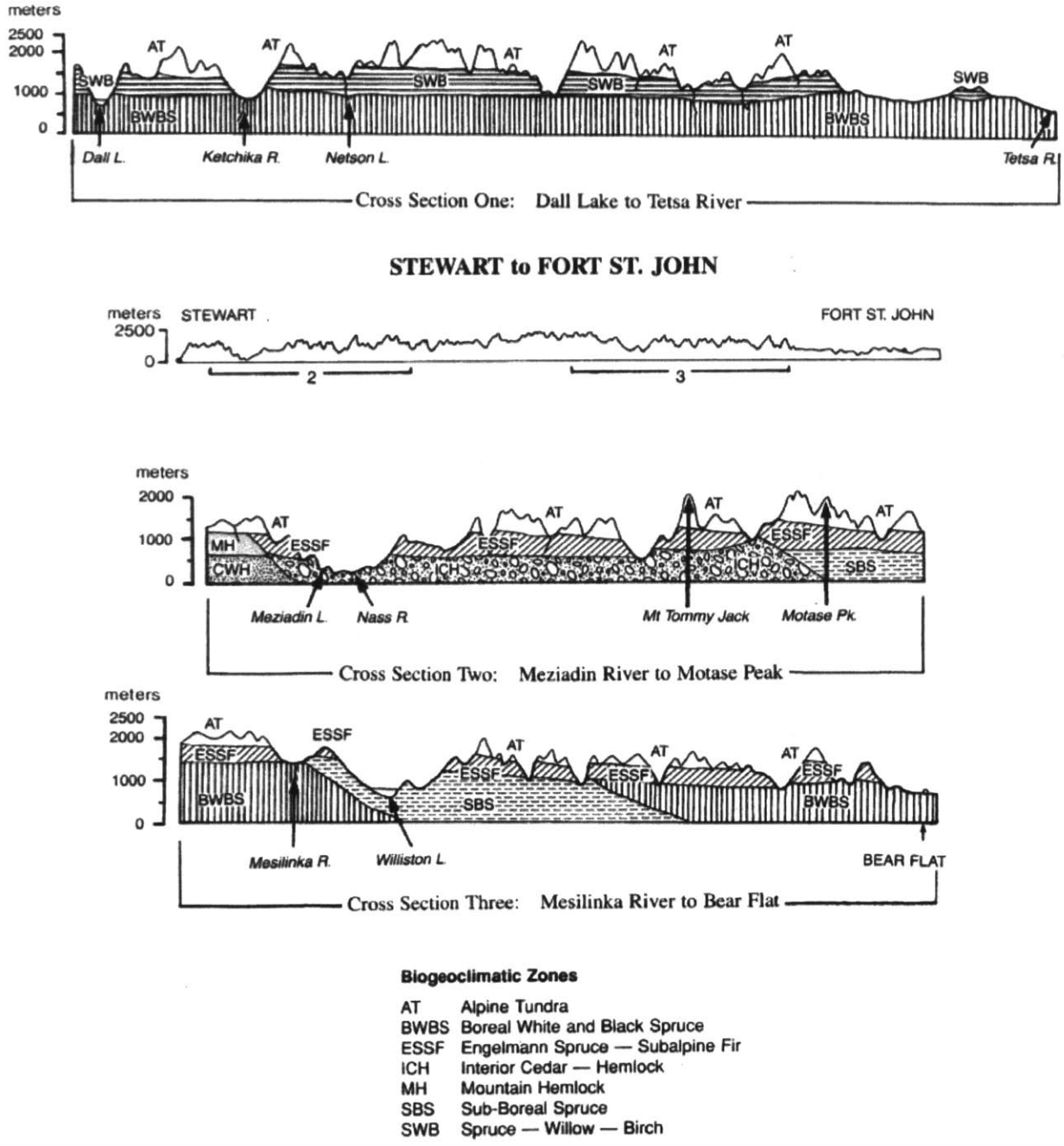

FIG 1.5. Biogeoclimatic zones of British Columbia displayed as a series of latitudinal cross sections across the province. Modified from Meidinger and Pojar 1991: 53.

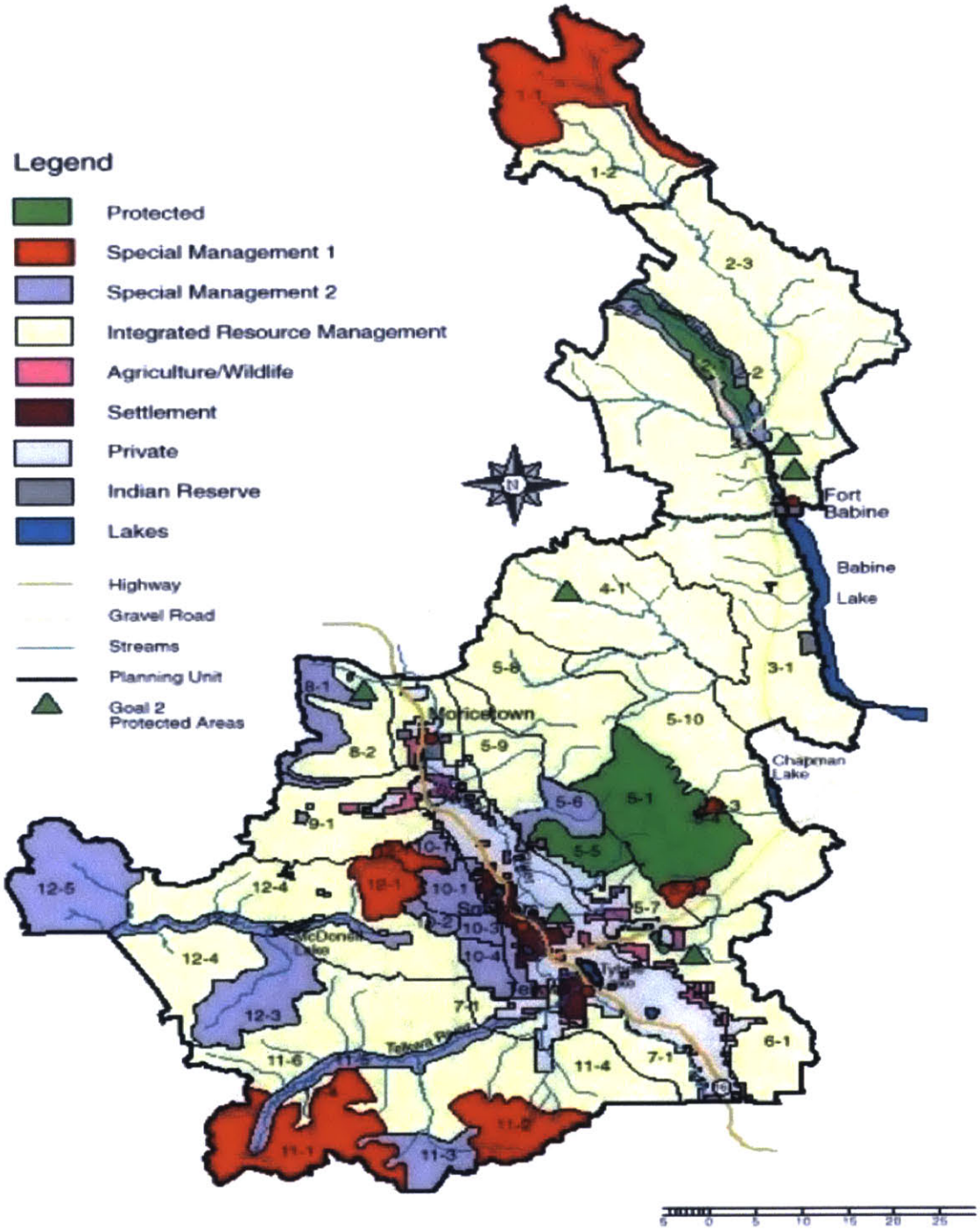

FIG 1.6. Bulkley LRMP plan area color coded by land use designation. Note the preponderance of land classified for (ostensibly collaborative) "integrated resource management." Scale bar is in kilometers. Modified from Bulkley Valley Community Resources Board 1998: 38.

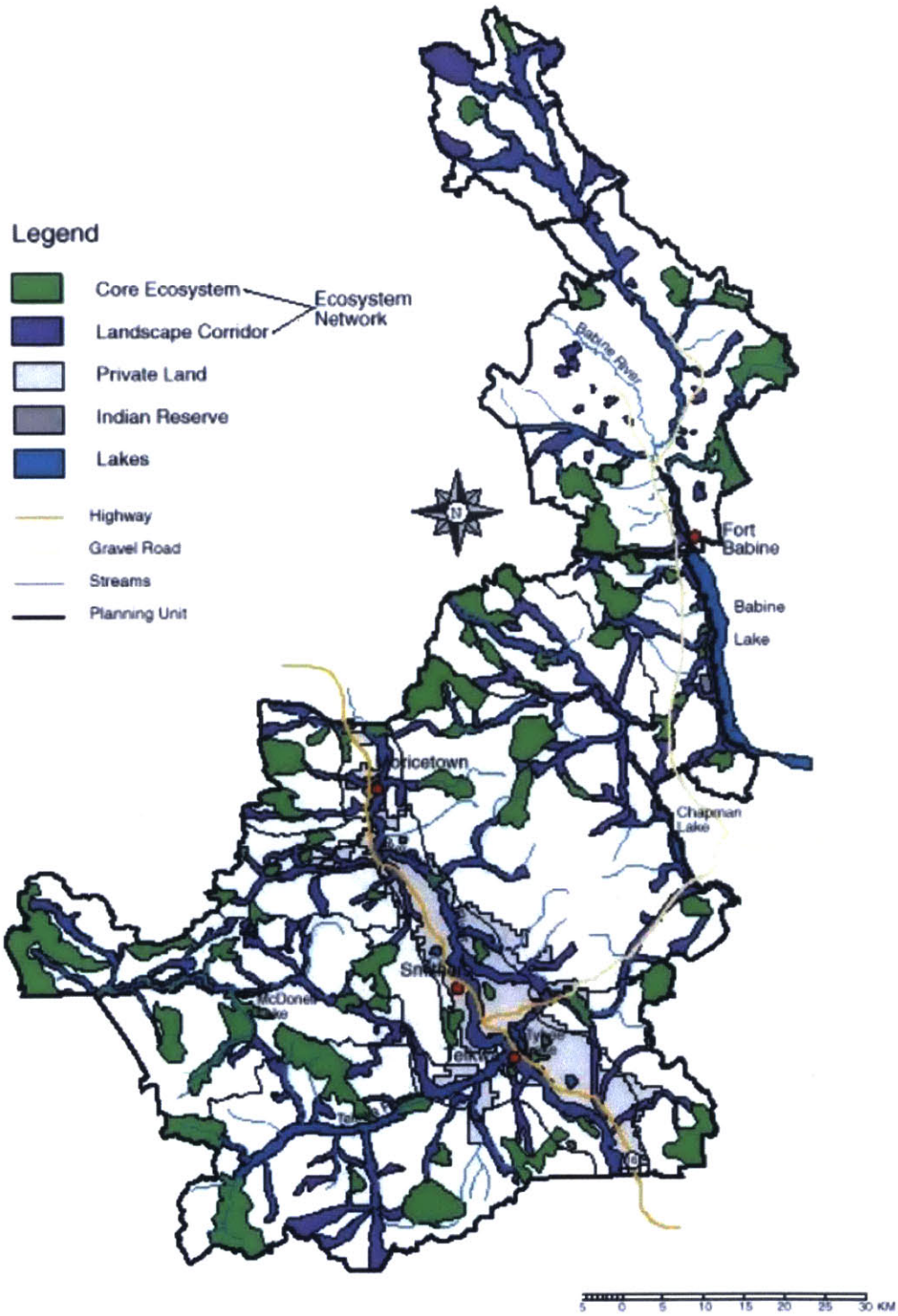

FIG 1.7. Bulkley LRMP plan area depicting ecosystem unit connectivity. Modified from Bulkley Valley Community Resources Board 1998: 46.

Chapter 2: Expertise in Exile

Gitxsan GIS and the Politics of Professionalization

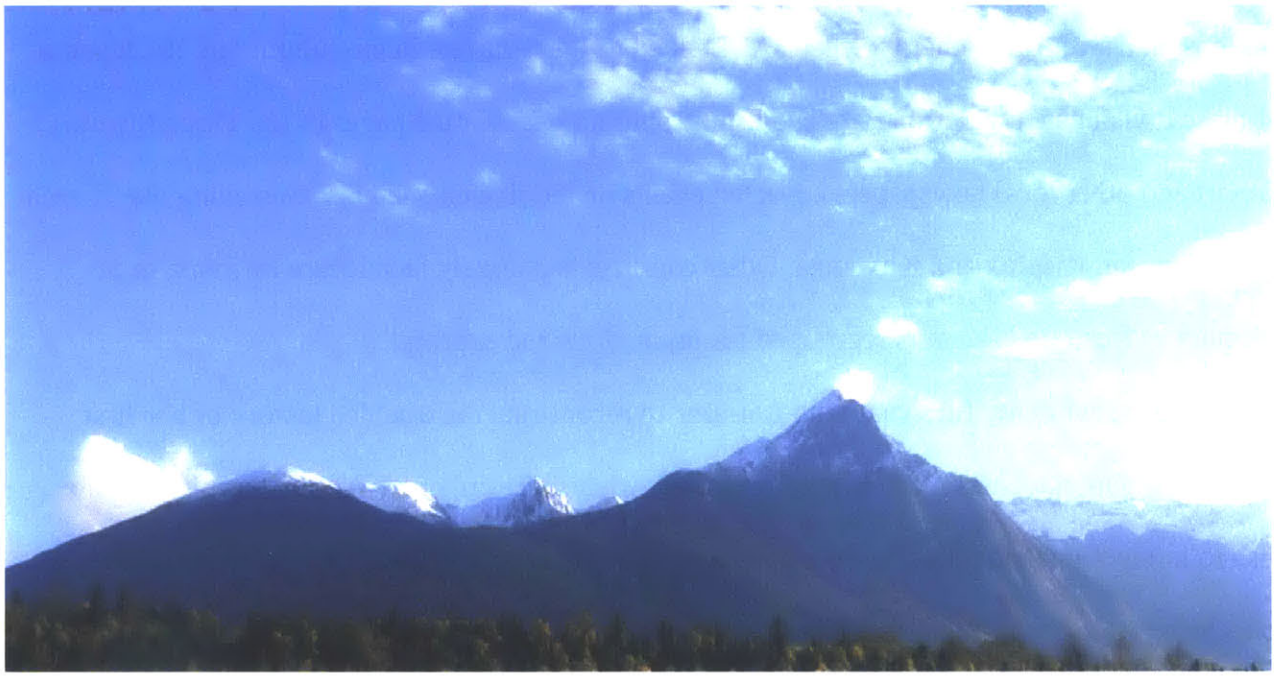

FIG 2.1. Mount Roche De Boule, icon of the Gitxsan territory, from Hagwilget Canyon Bridge.

"You know what? I think people have kinda forgotten about Gitxsan GIS." Lorraine chuckled softly, meeting my apologetic gaze with a resigned smile.[1] She offered her grim assessment as a kind of encouragement: I had come to her to ask, among other things, how to broach sensitive topics in my conversations with Gitxsan hereditary chiefs, clan matriarchs, and other Gitxsan politicians. Two decades earlier, expert trail mappers and geographic information systems (GIS) technicians like Lorraine had helped to formalize thousands of kilometers of intricate house group boundaries throughout Gitxsan traditional territory in northwest British Columbia. In the

1 Russell Collier, Philip Burton, and Don Ryan are all public figures and published authors, so I have chosen to use their actual names. "Mabel" and "Lorraine" are pseudonyms.

years since, these boundaries and the concepts of territory, recognition, and rights which they had helped to enframe had set into motion a profusion of new conflicts. Gitxsan institutions – whether house groups, civil society organizations, or upstart resource management and mapping divisions – had been locked in litigation with the provincial and federal governments, other First Nations, and with each other for years. As I talked to Lorraine late in the summer of 2013, some of these divisions were burning hot and bright, spilling out over the pages of the *Three Rivers Report* and other local newspapers covering events on the five Gitxsan reserves along the Skeena River between Kispiox and Kitwanga. Other conflicts had largely faded from memory, or lay dormant as frustrated litigants regrouped for injunctions and appeals.

I traveled to my first visit with Lorraine to reconstruct the troubled history of her first mapping group, the Gitxsan Strategic Watershed Analysis Team, or SWAT, an organization that rose to international attention in the early 1990s only to disappear from view as the decade drew to a close.[2] Along with Russell Collier, a Gitxsan man and GIS specialist, Lorraine had founded SWAT as an expert representative body for the 22,000 square miles of forests formally claimed by the Gitxsan *simgiigyet*, or council of hereditary chiefs. The *simgiigyet* had initiated their land claim in *Delgamuukw v. The Queen*, the landmark case that the Gitxsan and Witsuwit'en First Nations jointly filed against the provincial government in 1984. By the time the claimants had left provincial courts to appeal to the Supreme Court of Canada, the question of title remained unresolved. Pieces of the jurisdiction they sought had been parceled out amongst an array of new regulatory venues.

Motivated by elders' bitter memories of watching Eurocanadian settlers lay claim to their trees, land, salmon, and minerals throughout the twentieth century, SWAT's official mandate was

2 As both Russell and Lorraine laughingly explained to me, the choice of the name "SWAT" was indeed meant as a tongue-in-cheek reference to the police-related American usage, which had begun gaining currency in northwest BC in the early 1990s thanks to the reality TV show "COPS."

to facilitate "consultation" between Gitxsan house groups and the British Columbia Ministry of Forests. What exactly "consultation" would entail, however, was difficult to define. The BC Forest Service had finally agreed to negotiate approval, or at least provide information, for new tree harvests on Gitxsan-claimed territories while the land claim worked its way through provincial and federal courts. After what had already been more than a decade of highly publicized litigation, SWAT's meetings with Forestry officials were among the government's first major gestures of bureaucratic recognition toward the Gitxsan's longstanding claim to aboriginal title. As Gitxsan representatives mobilized new cartographic categories to navigate the technocratic demands of the consultation process, however, the balance of power between the *simgiigyet* and its new bureaucratic appendages began to change.

Twenty years after the beginning of official consultation and nearly fifteen years after the collapse of SWAT, Lorraine's assessment of the team's impact was bittersweet. "I always thought that if I could heal the land, I could heal the people," she offered as we thumbed through her old field notebooks. As she slowly explained her initial motivation to me, it became clear that her understanding of "healing the land" was already bound up with strategies of confrontation and governance which she had first learned to articulate as a young adult in a short-lived Gitxsan territory management education program. "When I first got into this … I thought, 'Okay, five years, I'm gonna have downward pressure on the AAC,'" she offered with a weary smirk. "But I didn't." The AAC, or annual allowable cut as calculated by the BC Ministry of Forests, was the same brute harvesting metric that anchored the research practices and environmental politics of the independent scientists whose lives and work I explored in the previous chapter. As a leader of SWAT, Lorraine was empowered to couch her assertions of Gitxsan title and political legitimacy within the same numbers and acronyms which gave shape to the political claims of a vocal and

often well-connected class of academics, activists, and government scientists who were moving in increasing numbers to the mountain towns near Gitxsan territory in the 1980s and '90s.

Much like the environmental research and conservation organizations that quickly began taking shape among these new transplants, the creation of SWAT was in part a reaction to the anger and confusion caused by the rapid expansion of clearcut logging in the region during the second half of the twentieth century. For the Gitxsan and other First Nations who cited under-regulated harvests as motivation for land claims against the provincial government, the Ministry's lack of transparency about the scale of these operations offered these groups a constant reminder of the ambiguity of their authority over the land. By the time I arrived in British Columbia in 2012, though, the persistence of disagreements over the management and representation of harvests and other developments underscored the precariousness of the tools and institutions the Gitxsan had built to articulate this authority.

The Loneliness of Networks

This chapter traces the lives and careers of several of the Gitxsan technicians who used these tools and inhabited these institutions. It is a story of both empowerment and displacement, and a reflection on how the pressures of translating interested knowledge between different epistemic orders and bureaucratic spaces exhausts and alienates the individuals who perform this work. This chapter is also meant to be a rumination on the many meanings of "consultation," a nebulous process whose professional participants are increasingly held up as metonyms of "mobility" itself. In the following pages, I will chart the rapid rise and fall of SWAT by outlining the circumstances that shaped the post-*Delgamuukw* "capacity building" phase on the Gitxsan territories in northwest British Columbia. The experiences SWAT members accrued during their

training, their uptake of digital mapping technologies, their enrollment in nascent Gitxsan governance institutions, and their subsequent dispersal have been deeply personal and idiosyncratic. The second half of the chapter builds on these idiosyncracies, and on recent criticisms of structurally deterministic explorations of cultural and professional mobility (Greenblatt 2009; Mavhunga 2014; Sheller and Urry 2016) by exploring how SWAT members crafted their lives and careers amidst this shifting terrain, and how they discovered new forms of agency as indigenous experts. My first portrait explores the beginnings of SWAT from the perspective of Lorraine, a field mapping specialist who continues to live on the Gitxsan territories and who still occasionally conducts environmental mapping projects in the region (one of which I cover in detail in chapter four). The final quarter of the chapter offers one perspective on the subsequent dissolution of the organization through a portrait of Russell Collier's forays into the wider world of professional GIS mapping and indigenous land use planning. Drawing on extensive phone and email conversations with Russell during his time as a consultant working for the Mikisew Cree in northern Alberta, I examine how Russell's attempts to leverage the prestige associated with environmental mapping techniques has helped him achieve a particular kind of legibility away from the Gitxsan territories, even as other forms of recognition escaped him at home.

In much recent scholarship on the disillusion of conventional resource management regimes and the reconfiguration of territorial boundaries between nation states, technical consultants have been heralded as among the chief agents and benefactors of neoliberalization (Ferguson and Gupta 2002; Ong 2008; Petryna 2009; Tsing 2000). Recognized as capable, credentialed experts across variegated political spaces, these individuals are often imagined in the anthropological literature to be almost effortlessly mobile, capable of crafting political ties at

will and moving between states and institutions at little to no costs to themselves. Not all experts lead such charmed lives, however. By examining how the modes and consequences of expert recognition have evolved across space and time for indigenous GIS workers in Canada, professional mobility earned through facility with mapping and modeling technologies has formed a double bind for Lorraine and other founding members of SWAT. Describing the resentment expressed by white Florida residents towards the commercial success of the Seminole people, Jessica Cattelino (2010) uses Gregory Bateson's (1956) figure of the "double bind" to illustrate how achieving the practical means to enact sovereignty has generated new tests of legitimacy and renewed efforts to undermine Seminole practices. These tests are even more disruptive for isolated individuals forced to represent the interests of an indigenous group for government and corporate audiences. Their lonely, often alienating experiences as consultants have differed considerably from the emergent categories of "graduated citizenship" which anthropologists like Aihwa Ong (2005, 2006) have drawn across what they see as increasingly, if differentially, porous boundaries between states and transnational corporate regimes.[3]

For Gitxsan experts who began their careers at the dawn of the indigenous GIS mapping movement of the 1990s, traversing the shifting boundaries between resource peripheries and traditional territories has been neither automatic nor cost-free.[4] In order to enjoy the boundary-spanning mobility and influence seemingly promised by full membership in these networks, many indigenous experts had first to renounce implicitly their debts to the institutions which trained them, and distance themselves from the groups whose political claims motivated their

3 Ong argues that the neoliberalization of immigration policies for workers in technology-producing industries in southeast Asia has introduced new modalities of citizenship, rights, and recognition for the many kinds of professionals involved in this work, and that these changes necessitate new understandings of how entitlements are "territorialized," as well as how sovereignty is articulated over the increasingly (if unevenly) porous territorial boundaries of the nation-state.

4 For a broader perspective on the consolidation of GIS mapping practices on and around indigenous-claimed territories, see Chapin, Lamb and Threlkeld 2005.

recruitment into technical careers. As Russell and Lorraine's experiences of exile make plain, this renunciation is rarely explicit, and it is never clean or complete. By conferring capable users de-facto recognition as experts and offering them platforms from which to challenge the accuracy and legitimacy of government-driven calculations and management operations, mediating technologies like GIS have allowed users partially to change the terms under which they were recognized as individuals by Euro-Canadian society. In any earlier era, when the presence of First Nations individuals within provincial ministries and other spaces of technocratic decision-making was practically non-existent, deferrals of Indigeneity were often seen as necessary steps towards earning a seat at a negotiating table, or a place in a collaborative research project.

The consequences of these deferrals have invariably taken shape on an individual level as well. Given their hard-won technical expertise, their densely situated and self-consciously cultivated Gitxsan identities, and their personal involvements in political disputes across far-ranging scales and venues, Lorraine, Russell, and their SWAT collaborators straddled many of the categories often used by ecologists and anthropologists to describe contemporary political entanglements of indigeneity and expertise. For nearly a decade, they served simultaneously as spokespersons for traditional governing entities, intermediaries between chiefs and technocrats, and translators who painstakingly mapped observations, insights, and strategies into the digital markers of an emergent government infrastructure of environmental management. While many critics of the original *Delgamuukw* decision attacked the provincial court's inability, and unwillingness, to take seriously the epistemic incommensurabilities presented by Gitxsan and Witsuwit'en performances of their oral histories and legal orders (Cruikshank 1992; Culhane 1998; Monet and Skanu'u 1992; Sparke 1998), SWAT representatives explicitly appealed to the

universalist rhetorics of environmental management.

For a brief period, their work served as the most visible face of the broader Gitxsan sovereignty project. Articulated within a historically situated milieu of environmental classification standards, property regimes, administrative practices, and technologies of visualization (detailed in the introduction and the previous chapter), SWAT's vision for a "Gitxsan model" of forest management appealed to a more conciliatory image of ecological restoration. As I will show, Russell and Lorraine quickly developed a savvy relationship with conservationist-oriented media. They circulated beguiling images (such as figure 2.2, a map of the Lax Skiik clan territory depicting critical salmon habitat polygons atop a schematic view of the region's rivers) in GIS industry newsletters, magazine articles, and on First Nations politics blogs. They worked continually to naturalize the larger Gitxsan land claim by constantly referencing their ongoing projects through the territory map produced for the *Delgamuukw* trial (see introduction), whether in GPS user community blog posts (figure 2.3) or in interviews with news outlets eager to attach names, faces, and visual artifacts to the First Nations sovereignty movement (figure 2.4).

Through their public pronouncements and an always-evolving repertoire of GIS-based trail and ecosystem mapping and data collection practices, SWAT's founders sought to materialize an ethics of territorial stewardship capable of harmonizing a multifarious chorus of Gitxsan claims in provincial courts, treaty negotiations, other legal venues. Rather than treating this ethics as an essential and inviolable component of Gitxsan "ontology," however, I have attempted deliberately to eschew direct treatment of the "cultural" concepts from which this ethics is assembled in favor of a longitudinal examination of the lives and careers of some of the key figures responsible for describing, formalizing, and leveraging these concepts in political

confrontations with other indigenous and state institutions.[5] It was through these processes of mediation that Gitxsan experts like Russell and Lorraine, as William Mazzarella (2004: 360) puts it, "grapple[d] with internal indeterminacies as well as external provocations" as they crafted complex arguments for Gitxsan jurisdiction over resources, environments, and lives.

More than two decades after their consultation work began, the many tasks of "translation" have taken a heavy toll on the original members of SWAT. Even the most well-intentioned of their collaborators were often inherently suspicious of the interests and attachments which they saw subsumed within Gitxsan expertise. As I discussed in the introduction, the predominately Euro-Canadian environmental scientists consultants I met in the town of Smithers, roughly one hundred kilometers south of the nearest Gitxsan reserve villages, often glibly switched between multiple registers of idealism, respect, and suspicion when describing to me their engagements with First Nations groups and individuals. They often roundly dismissed the prospect of productive engagement with significant Gitxsan institutions, even while citing specific individuals within these institutions as potential key collaborators. However cynical, these narrow interpellations recognize (and reproduce) a key legacy of institutional precariousness: namely, that the work of mediating cultural forms and seeking recognition within expert institutions is, for indigenous experts, an increasingly alienating endeavor.

Paths of Professionalization

This chapter will explore how the consequences of seeking recognition as an indigenous expert

5 The "ontological turn" in science and technology studies and in the history and anthropology of indigenous experience has produced a considerable literature, and an equally considerable chorus of criticism, in recent years. For the defense, see e.g. Blaser 2014; De la Cadena 2010; Descola 2013; Kohn 2013. For the plaintiffs, see M. Fischer 2014; Helmreich 2014a.

have changed since the emergence of indigenous GIS counter-mapping in northwest British Columbia in the early 1990s. The chapter will chart two Gitxsan mapmakers' experiences with map-making, consultation, and technocratic inter-mediation, both during their time as members of SWAT and in the years of consulting work they have pursued since the team's collapse. The following profiles of two of my primary interlocutors, the co-founders of SWAT, are hardly meant to serve as a typology of the vast range of experiences accrued by indigenous experts working in North America, or even in northwest British Columbia. Nor is this meant to be taken as a diagram of particularly gendered approaches to professional development and alienation: many of the most outspoken Gitxsan activists I encountered throughout my fieldwork were women, and the ranks of traveling Indigenous GIS experts and technical consultants with whom I spoke between 2012 and 2014, like the ranks of the Gitxsan chiefs and other political representatives with whom they occasionally worked, were populated by women and men alike.

While most of our interactions occurred through emails, phone calls, or over charts spread across dining room tables rather than along trails in the forest, the conversations I shared with Russell and Lorraine generally cohered along distinct thematic paths. With Lorraine and her SWAT-trained daughter and sister, I learned how consultation procedures initially took form, and how the team learned to systematize its methods in the field to keep itself agile and responsive in the face of shifting Ministry demands. I also learned what it meant for Lorraine to attempt to continue to work as a mapper on the territories as support from the GTS waned, and as Gitxsan and Ministry representatives began to approach consultation with increasing cynicism and resignation.

My conversations with Russell followed more oblique paths. Often responding to simple questions and prompts via email with long and complex narratives, his reminiscences of SWAT's

place within the broader Gitxsan political landscape were often guarded and vague. While Lorraine's activism and professional outreach work away from the territories largely ended with the demise of SWAT, Russell's professional networks steadily expanded, linking him with audiences, clients, and collaborators throughout North America. A major theme in our conversations, then, became his fluencies with the technologies and formalisms that allowed him to traverse these networks. Like the ecologists whose work I explored in the previous chapter, Russell frequently acknowledged that the significance of this work, whether with SWAT or as a traveling consultant in more recent years, depended upon how it was embedded within other Gitxsan and non-Gitxsan governing institutions. By continually seeking out more stable infrastructures in which to articulate his work, though, Russell resigned himself to professional networks that drew him further and further away from the place he once called home.

Lorraine and Russell were initially charged simply with meeting the Ministry of Forests' demands for consultation, but in practical terms, SWAT quickly took on a more expansive role, building a rival database to match and counter the digital databases which were also only then being created by provincial ministries. Like portrayals of other counter-mapping projects elsewhere in North America published in popular media throughout the 1990s, the dozens of magazine articles and scholarly pieces published about SWAT during its rise to prominence highlighted the organization's innovative design and optimistically celebrated its sweeping potential (see e.g. Convis 2000; Kuin 1998; Lewis 2000; Natcher 2001). Few of these popular narratives, however, directly acknowledged the delicate webs of political support, financial resources, and human labor required to keep the team together and working. As SWAT's media exposure increased, both Lorraine and Russell became minor celebrities in the growing world of indigenous GIS mappers. They shared stories and strategies in GIS training sessions at other

First Nations reserves around BC and Canada. They gave invited lectures to Ministry representatives, academic departments, and environmental conservation groups. As their databases and archives grew, they were called upon to provide expert testimony in parliamentary proceedings over emergent First Nations treaties or to support proponents of new injunctions against consultation-averse logging companies. Almost as quickly as it had arisen, however, the organizational support behind SWAT collapsed, leaving Russell and Lorraine without the provincial funding they required to perform their work. Nearly a decade and a half after they and many of their collaborators had left the region in search of technical consulting work or returned to the dangerous logging jobs they had held before joining SWAT, I joined them in their new homes and offices to see how the shifting fortunes of technocratic recognition had shaped their careers.

Pre-History, Technologically Speaking

The beginnings of SWAT coincided with the emergence of a number of new legal orders and technocratic regimes both within and outside British Columbia. These transformations, several of which I describe in the previous chapter, generated standardized technical languages which fostered new forms of engagement, including tentative collaborations, between SWAT and other government-led management and research institutions.[6] These languages allowed Gitxsan mappers to eschew the polemics of the broader Gitxsan political project while presenting their work to predominately white technocratic audiences. As Russell and Lorraine's accounts of these engagements make clear, the rapidly evolving technological infrastructures supporting the

6 Most academic treatments of these transformations in British Columbia focus on the ways in which technocratic discourses of environmental management "produced" the "nature" that new policies meant to describe and manage. I explore this literature at length throughout the dissertation; see in particular Braun 2002; Wilson 1998. For similar developments in a global perspective, see Agrawal, Chhatre and Hardin 2008.

emergence of GIS mapping techniques were inseparable from the language and work of mediation itself.

As I will show in more detail in chapter four, ethnographic treatments of indigenous counter-mapping projects typically presume that the technocratic apparatus of the state precedes and enframes the "introduction," or "arrival" of digital mapping technologies and competencies in indigenous communities.[7] For early GIS adopters like the Gitxsan and Witsuwit'en, however, transitioning to digital mapping infrastructures at almost precisely the same time that provincial ministries began abandoning their paper maps provided these groups with the rare chance to challenge the terms of their own emerging legibility. At first, SWAT technicians followed the cartographic strategies of the *Delgamuukw* researchers who preceded them, hand-coloring polygons around sensitive areas on the enormous paper topographic maps provided to them (often reluctantly) by the Ministry of Forests. By the time they began using GIS tools to digitally geo-reference these polygons and the territorial boundaries, burial grounds, and other historic sites originally cataloged through research for the *Delgamuukw* trial, the scope of their work had expanded to include a wide range of ecological restoration projects, and their engagements with provincial ministries had grown far more complex.

Agents of the broader Gitxsan political project did not always use GIS technologies in the same ways, however, or for the same reasons. As cooperative management programs and cultural artifact protection laws greatly expanded in scope throughout indigenous-claimed territories in North America over the course of the 1980s and 90s, academic literatures on traditional

7 Some of the geography literature on the digital turn in indigenous mapping, particularly pieces published in the early years of GIS, pushes these anxieties in particularly essentializing directions. See e.g. Rundstrom 1995; Fox 2002. Several scholars attributed these treatments to a broader dissatisfaction among cartographers and geographers with the manner in which the emergence of digital mapping standards were restructuring – and, they believed, overly simplifying – the discipline of map-making. For a review of these complaints, see Schuurman 2000.

ecological knowledge, or "TEK," naturalized epistemic divides between indigenous and Euro-American institutions by framing traditional governance and land management systems as possessing a continuity and legitimacy that bureaucratic organizations lack (Nadasdy 1999). Definitions of TEK mirrored the anxieties of contemporaneous legal tests of traditional use and occupancy, celebrating the continuity and resilience of groups' traditional cultures in specific geographic areas even as band members migrated and indigenous governing bodies grew more heterogeneous and complex. In the decades since the simultaneous emergence of new historical preservation laws and biodiversity conservation policies across Canada helped push TEK into greater engagement with Canadian environmental protection and property regimes, much has been written about how "traditional" and bureaucratic legal orders have progressively re-made one another (Borrows 2002; Marsden 2002; McCreary, 2014; Napoleon 2005, 2013; Overstall 2005; Usher, Tough, and Galois 1992). Relatively little, however, has been written about the ways that the proliferation of TEK and its associated legal apparatuses have re-made the individuals involved in this work.

Applied anthropologists, ecologists, and cultural heritage resource managers behind much of the TEK literature have been reluctant to problematize the indeterminacies faced by the indigenous people and groups involved in "TEK work." Indeed, many scholars who have drawn attention to the increasing formalization of indigenous environmental politics over the past three decades have further naturalized these caricatures of expertise by tacitly defining indigenous political actors by their lack of technical training and bureaucratic acumen.[8] This urge to demarcate "science" from "indigenous knowledge," a vestige of foundational debates within the history and philosophy of science, haunts even the most incisive criticisms of bureaucratization

8 For a general critique of the problems inherent in the reification of "indigeneity" within new regimes of environmental governance assembled during the 1990s and early 2000s, see Dove 2006.

(Collins 1985; Feyerabend 1975; Lakatos 1976; Popper 1963). Arun Agrawal (1995), an early critic of the large-scale indigenous knowledge databasing projects organized in the 1990s by the World Bank and other international NGOs, explicitly warned against the dangers inherent in focusing on "knowledge" itself rather than on the sites, circumstances, and subjectivities shaping its emergence (see also Warren, Slikkerveer and Brokensha 1995). And yet, he nevertheless brackets and generalizes indigeneity itself by asking "whether there is anything particularly indigenous about knowledge that has undergone the sanitisation implicit in the movement from particularisation to generalisation. In the very moment that indigenous knowledge is proved useful to development through the application of science, it is, ironically, stripped of the specific characteristics that could even potentially mark it as indigenous" (Agrawal 2002: 292).[9]

While the sheer scale and ambition of the original World Bank databasing projects helped cast numerous early treatments of bureaucratization in monolithic terms, many of the manifestations of TEK-work to emerge since then have taken shape within the cramped quarters of minimally staffed tribal council offices and small environmental NGOs. Since the late 1990s, other scholars have taken up Agrawal's call to examine the lived experiences and technocratic processes through which so-called "indigenous knowledge" comes to be gathered, codified, and operationalized by conducting studies of idiosyncratic, short-lived institutions. Paul Nadasdy's (1999, 2003, 2005a, 2007) work with a cooperative wildlife management program organized by the government of Yukon Territory and the Kluane First Nation tracked the effects of similar

9 To be fair, Agrawal himself is acutely aware of the paradox inherent in the attempt to describe such a move using the received categories of developmentalist discourse. Following Johannes Fabian (1983), he insists that ethnographic fieldwork is responsible for the reification of the intersubjective experience into the "conceptual-theoretical ... category" of indigenous knowledge. "The commensuration between the 'indigenous' and the scientific is established, in other words, by denying culturally produced ways of experiencing time; ways of sharing and experiencing time that underpinned the initial awareness of specific indigenous knowledges and practices" (Agrawal 2002: 294). Such a critique, however, still feels a bit anachronistic, since it fails to account for the several decades of anthropological scholarship conducted in the wake of Fabian's critique, and as I will subsequently show, largely ignores related work undertaken within cultural studies.

processes of abstraction and "integration" over the course of the program's existence.[10] Through several years of meetings and collaborative field visits, Nadasdy observed the alienation and frustration Kluane elders exerienced while attempting to share their observations and beliefs about changes in the local sheep population with predominately white biologists, hunters, and Yukon government officials. Nadasdy repeatedly calls attention to the venues in which these exchanges took place (board rooms, helicopter tours, community meetings) and to the bodily practices and affects – assertiveness and silence, in particular – which shaped different groups' experiences of these spaces.[11]

Among the few participants equally conversant in the languages and affective registers in which sheep biologists asserted their statistics and principles and Kluane elders demurely reflected on their accumulated experience were young Kluane people. Some of those described by Nadasdy were originally conscripted by their band office as "cultural translators" (and often English-Southern Tutchone language translators as well) for individual council meetings or government negotiations, part-time assistants who eventually took on full-time jobs in policy and administration. That the unceasing demands of office work eventually precluded substantial time on the land, Nadasdy (2003: 142) lamented, was a particularly bitter irony: even before their

10 While his long-term ethnographic research methods and his caution with overly general extensions of theory lends Nadasdy's analysis a reassuring measure of detail and circumspection, Nadasdy largely shares Agrawal's fundamental concern with developing a Foucauldian framework for understanding "cross-cultural" projects of knowledge accumulation and administration. While the registers of their accounts may differ, both ultimately ask how the micropolitical procedures of co-management and traditional knowledge formalization produce particular kinds of political subjects. In *Environmentality*, Agrawal (2005) takes a longitudinal lens to the politicization of teak forests and forest users in the Kumaon region of India, arguing that the strict harvesting laws imposed by the colonial state in the early twentieth century, while originally a target of anti-government outrage and resistance during the transition to home rule, soon became an object of nostalgia when the loosening of harvesting regulations led to widespread forest damage and new forms of conflict. Agrawal attributes this subjective shift to the colonial state's success in naturalizing state-approved subjectivities of environmental management through the production of what Agrawal refers to as "environmental subjects." For another Foucauldian treatment of the production of environmental subjectivities in a contested forest, see Kosek 2006.

11 A number of historians of science have invoked the concept of "scientific personae" to discuss the conventions of behavior, speech, and socialization which have shaped the experience of personhood for researchers in various fields and eras. See e.g. Biagioli 1993; Daston and Sibum 2003; Shapin 1991; Wang 2012.

elders had died, the "bureaucratization of the younger generation" of members of the Kluane First Nation had already begun destabilizing the government-driven concept of co-management by casting doubt on younger Kluane participants' legitimacy as possessors of "experiential knowledge" about the land.

Articulating Expertise

When I first read Nadasdy's wistful reflections about young Kluane professionals increasingly visiting their forests and mountains solely for fun and relaxation rather than out of necessity, I immediately yearned for a fuller ethnographic portrait of the rural lives that had been so marked by the strictures of professionalization. In many ways, my own dissertation research became an attempt to produce such a study. Two decades after Nadasdy began his study, however, many things have changed. For both Russell and Lorraine and their Kluane counterparts, the confluence of new technical training programs and emergent forms of bureaucratic recognition for First Nations communities across Canada in the early 1990s seemed to offer a clear path to new levels of self-determination that would have been unthinkable for their elders only a few decades earlier. And of course, two decades after these once-optimistic paths have diverged and grown more obscure, this "younger generation" of translators and assistants filling the peripheries of Nadasdy's ethnography are no longer so young. Many of the elder hunters who greeted Nadasdy on his arrival in 1995 have since died, as have nearly all of the original *Delgamuukw* plaintiffs, many of whom directly facilitated SWAT's emergence as an expert institution. Like many of the forest ecologists and programmers with whom I engage in chapters one, three, and five, the Gitxsan GIS technicians and counter-mapping specialists who took on central roles in the blockades and bureaucratic confrontations in the 1990s are themselves

nearing retirement. Many took up my requests for interviews as invitations to reflect on their lives and legacies. As they lingered over these memories, though, their accounts steadily concretized a temporal framework of arduous professionalization, one built upon transitional events in their individual careers as much as on more broadly shared social phenomena.

The stories I recorded in these encounters also converged on the seemingly ubiquitous challenge each individual faced in reconciling these two registers into narratives of a coherent life. Many of those I spoke with had spent the majority of their adult lives away from the Gitxsan reserves and territories, yet still promoted their work through continual references to the competencies they acquired there. Their legitimacy as indigenous experts in the eyes of their clients, they complained, was as exhausting to frame and renew as the tenuous contracts that funded their work. The question of legitimacy, it seemed, scaled exponentially as their distance from their territories increased.

James Clifford (2001; 2007), borrowing on the concept of "articulation" which Stuart Hall (1986) developed to describe cultural formations which emerged between diasporic communities scattered across the North Atlantic, argues against the false dichotomy which many anthropologists unwittingly reproduce between the "rootedness" of Indigenous groups' experience on the land and the "essentialism" of the representations of these experiences members of these groups crafted and shared away from their territories. Motivated by Clifford (1988; 1997) and by the re-valorization of comparative, multi-sited ethnographic fieldwork by Michael Fischer and George Marcus (1999 [1986]; Fortun 2003; Marcus 1995), articulations of cultural forms and practices of media consumption by groups in diaspora have received great attention by anthropologists and critical theorists for the past three decades (Appadurai 1996; Bhabha 1994; Ong 1999; Sassen 2000). A number of anthropologists have drawn on Clifford's

terminology in recent years, highlighting the roles played by shared experiences of political confrontation, storytelling, resettlement, and trauma in collective identifications with names, territories, and other tribal markers (Goodale 2006; Napoleon 2010b). Clifford (2007: 213) himself, though, notes that many ethnographic depictions of diaspora fall victim to overly-optimistic projections, and that under-examined "[n]egative experiences of exile, alienation from family, despair, loss of language and tradition, endlessly deferred returns, nostalgia, and yearning, are certainly part of the varied experiences of native peoples living in settings removed from their homelands."

That articulation-at-a-distance is invariably treated by anthropologists as a consequence, rather than a cause, of displacement obscures the fact that the work of authoring articulations often falls upon specific individuals or small groups. As Russell and Lorraine's experiences show, these vulnerable individuals are judged – and occasionally judged harshly – by the groups who eagerly burden them with the impossible aspirations of broader political projects. A few anthropologists have recognized the growing imbrication of professional demands and technical conventions within contemporary scenes of indigenous articulation by complimenting Clifford's analytic with the questions and techniques of science and technology studies. Kim TallBear (2013) argues that the contrived narratives and other "false promises" produced through genetic ancestry testing and blood-based group membership thresholds have done much to undermine stories, shared histories, and other foundational forms of collective articulation.[12] Tania Li (2005) and Christine Walley (2003) both worry over the essentializing effects of identity- and community-focused structures of participation that began enrolling indigenous people and other marginalized groups into development and conservation projects in the 1990s. By reducing the

12 For more optimistic readings of indigenous articulations and political performances made through and around technoscientific objects and idioms, see Callison 2014; Farbotko 2010.

collective articulations anchoring broader subjectivities and political claims to whatever fits within the "tribal slot" for participatory development, Li (2000) argues, such comportments often force these actors to trade many of the particularities of their claims for an anodyne politics of universalist progressivism. And yet aside from Walley's interlocutors, whose diversity of opinions and general disenchantment with their earnest NGO collaborators Walley charts out over the course of several years, the subjectivities of the individuals captured in these ethnographic accounts tend to sublimate within the shared goals and narratives authorized by their larger groups.

Rather than the fully formed narratives of cultural identity and belonging that anchor many of these analyses, the scenes of articulation that occupy me here expose the tenuousness of many indigenous experts' relationships to the social and professional groups among whom they live and work. Variable in character and consequence, these partial articulations might be more aptly characterized as what Elizabeth Povinelli (2002: 30) describes as "creative engagements" with epistemic "impasses." In Povinelli's case, the impasses at issue surround "the nonpassage between understanding-based ideologies of justice and subjective-based ideologies of morality" which characterizes the unfolding of Australian multiculturalism. With SWAT, these same impasses are joined by a seeming discord between specific individuals' willingness to defy the conventions of courtroom performance and their eagerness to take up the protocols of digital mapping.

Among the Gitxsan, whose territorial claims occupy twenty-two thousand square miles of northwest British Columbia but many of whom now live in communities throughout western Canada and the United States, the work required to articulate "authentic" connections to the "place" embodied by their house territories is beset by challenges and contingencies. For

individual GIS technicians like Russell and Lorraine and other indigenous experts formally responsible for authoring and formalizing articulations of territorial attachment, the experience of exile has steadily reshaped their relationships to the technologies of visualization undergirding their work. The further the landscapes themselves retreat from view, the lonelier the work of articulation becomes.

Ethnography in/of Exile

As the remainder of this chapter will soon make clear, the people involved in this work move – frequently. Methodologically, then, tracking the diaspora of trained experts on, around, and away from the Gitxsan territories requires attending to the material practices which have allowed "cultural" concepts to move with them. By attempting to define a "location" for SWAT as the original sites of the group's mapping activities, my initial ethnographic methodology ran into a series of dead ends: by 2012, the year my fieldwork began in earnest, few of the team's original founders and collaborators lived near the Gitxsan territories, and those who did had deliberately distanced themselves from the politicians and resource managers with whom they had originally worked. As I learned shortly after I first arrived in Smithers, many of the cartographers and anthropologists enlisted as researchers for the original *Delgamuukw* trial had also long been ostracized from the central leadership of the Gitxsan First Nation, now externally represented by the Gitxsan Treaty Society. Earlier leaders had been forced to fight libel charges and punitive lawsuits, accused by sitting Gitxsan politicians of distorting and damaging the nation's land claims, and of stealing the maps that they themselves created (e.g. Sterritt v. Sebastian 2004). Perhaps unsurprisingly, many of these individuals had chosen simply to move away from the territories and perform consulting work elsewhere in Canada, where the aura of "Gitxsan GIS"

still remained uncomplicated and inspiring.

Performing an ethnography among individual experts, once linked through close personal and institutional bonds, but now leading lives colored by shades of what I am calling exile, posed a range of practical challenges. Throughout, it meant resigning myself to an unending series of awkward impositions and frustratingly partial connections. Several of the former SWAT collaborators with whom I spoke over the course of my fieldwork had not been involved in any counter-mapping projects or GIS work for many years, but nevertheless shared meals with me in their kitchens and living rooms as they answered my questions and pointed me towards the houses, phone numbers, and email addresses where I might find other lapsed mapmakers. Some reflected at length on how their early facility with computer programing had shaped their later careers, often as technicians for environmental assessment consultancies or as operations managers at timber mills. A few of those who still lived on or near the Gitxsan reserves invited me to join them for regular visits or to meet with them during their occasional trips into Smithers, the site of the only major grocery stores and shopping centers within one hundred kilometers of the eastern reserve villages. (One woman was old enough to remember such visits during her youth, when signs of "No Dogs or Indians Allowed" were still displayed in the windows of a few restaurants on Main Street.) Among the others who had left the reserves and were now scattered across the small towns of the vast northern interior, my visits were limited to brief stopovers at their homes and offices during my monthly trips to Prince George, or on my semi-annual journeys between Smithers and Vancouver. A number of SWAT collaborators I never met at all, except in phone calls and through exchanges over email.

Few of those living away from the territories had severed their ties entirely, though. Even among those who had become alienated from mainstream Gitxsan politics in the aftermath of the

collapse of SWAT, nearly all periodically returned to visit family members and attend certain house group feasts. Regardless of their relationships to the people currently in power, though, my questions picked at awkward and sometimes painful memories. Most of my interlocutors were harshly critical of the overwhelmingly expensive treaty process, which they readily complained had reorganized allegiances and deepened longstanding divisions throughout the territories.[13] They complained that most of their original maps and field notes remained inaccessible to them, locked away in the office of the polarizing Gitxsan Treaty Society (see introduction).[14] Several used our conversations as invitations for sustained diatribes against personnel changes and what they saw as institutional corruption across different Gitxsan governing bodies. Others carefully avoided particular subjects and refused to discuss certain individuals by name.

By the time I began sitting down with Russell and Lorraine for face-to-face meetings, I had already completed nearly a year of ethnographic fieldwork in the region. I had grown tired of self-consciously pantomiming the tactical approach of my ecologist interlocutors in Smithers, who solicited individual Gitxsan collaborators while ignoring or downplaying the political pressures shaping their participation in collaborative work. For months, I had been similarly patronizing, delicately sidestepping "internal" Gitxsan conflicts and carefully pruning my questions of antagonizing topics that might provoke memories of old grudges or recent fights. After nearly half a year guiltily trading in vague Gitxsan gossip with other Smithers residents, including more than a few scientists who had collaborated energetically with SWAT and other Gitxsan groups years ago, I resolved to meet the mappers wherever they were, and to attempt to describe their new circumstances from within the fraught and fractured perspectives they had

13 For a forthright discussion of the antecedents of some of these regional divisions and tensions, see Galois 1993.

14 The sensitivity surrounding these original documents is the primary reason that I have chosen to show only a few of the most widely available reproductions of SWAT-produced maps in this chapter. Most of my interlocutors who showed me their personal copies of SWAT-era maps did not wish to have them photographed for fear of legal reprisal from the Treaty Society.

learned to inhabit as their earlier bonds collapsed and changed form.

By the summer of 2013, the simple fact of division among the Gitxsan was inescapable. No honest ethnographic account could hope to redact the banners and barrel fires which stood in front of the blockaded Treaty Society office during the first half of 2012, nor could it fail to acknowledge the arguments and accusations Treaty Society champions had been trading for years with their numerous critics in local newspaper articles and on Facebook, Twitter, and informal news websites and blogs. Nevertheless, I harbored deep practical and professional anxieties: Unlike the great majority of the anthropological work published about the Gitxsan over the previous three decades, my ethnographic forays onto Gitxsan territory in northwest British Columbia were not organized or officially sanctioned by the Gitxsan and Gitxsan-appointed lawyers, politicians, and community organizers representing the nation in their precedent-setting land claims cases of the 1980s and '90s. In order to track how individual mapmakers' skill with cartographic tools facilitated, and perhaps forced, their dispersal, I eventually decided not to seek out the attention or explicit permission of the Gitxsan Treaty Society and approach these current and former mapmakers as both imbricated individuals[15] and as members of their respective house groups and clans.[16]

15 Astute readers will point out that some of the most powerful ethnographic works written among indigenous groups in North America have been semi-biographical treatments of specific individuals. (See in particular Blackman 1992; Bell 2016; Cruikshank *et al.* 1990; Starn 2004) My research is indebted to these and other texts for their intensely personal readings of intergenerational succession, and to Cruikshank's work in particular for examining the roles that individuals play in coordinating broader communal projects of interpretation and cultural performance. Still, I am reluctant to discuss these texts at length here as most of these works, in one way or another, treat cultural belonging as their primary frame of group identification, whereas I intend primarily to focus on how these forms of belonging and identification are crafted around professional practice.

16 Particularly while talking with groups who were in open conflict with the GTS but even in conversation with GTS supporters, I was routinely reminded that the *wilp*, or house group, has always been and continues to be the primary seat of power among the Gitxsan, and that any attempt to represent the interests of a *wilp* by another group without the permission of the *wilp* violates significant aspects of Gitxsan legal protocol. Gitxsan legal theorist Val Napoleon (2010a) has argued that one of the enduring legacies of the *Delgamuukw* research team's focus on the testimony of *wilp* chiefs has been the undermining of the democratic structures which had previously kept in check the authority of individual chiefs. The general valorization of representative forms of politics has rarified decision-making hierarchies and empowered organizations like the GTS to overrule the objections of constituent house groups, Napoleon suggests, a troubling inversion of earlier Gitxsan political and

By urging that we put structures of expert formation more centrally within our readings of mediation and identity politics, I am not advocating for a bland celebration of "hybridity." I remain aware that any historically situated, constructionist reading of indigenous politics and political formations carries considerable risks for the broader Gitxsan community as well (Simpson 2007, 2014; McCreary 2014). My interlocutors in this chapter see themselves as Gitxsan. Most of them have Gitxsan feast names, and many retain band membership through one of the half-dozen Gitxsan reserves. All attend clan meetings, house group feasts, and pole raising ceremonies with the same mixture of pride and boredom that a Euro-Canadian forester might bring to a Canada Day picnic. Nevertheless, accusations of indigenous groups' uses of "strategic essentialism" from incautious academics and from both ends of the political spectrum have deepened many Eurocanadians' cynicism towards aboriginal rights movements and struggles over land claims.[17] Indigenous environmental management organizations and development offices have been particularly vulnerable to anti-essentialist criticisms, as examples of First Nations development organizations and prominent pro-development individuals have fueled critics' attempts to label culturally-framed conservation campaigns as examples of hypocrisy.[18] While it is not my purpose in this chapter to parse or rebut these criticisms, I do want to highlight how the dissolution and destabilization of a number of the Gitxsan resource management

legal orders.

17 Since the term was first popularized in cultural studies in the early 1990s (Spivak 1993), the concept of "strategic essentialism" has led a rather unruly life both inside and outside academia, particularly for scholars seeking to untangle competing definitions and deployments of concepts of indigeneity from within contemporary formulations of environmental politics (Dove 2006; Hodgson 2002). Some of the more severe critiques of the politics of essentialism have been eagerly taken up by conservative critics of reconciliation policies and of the BC treaty process in particular. (For a particularly inflammatory treatise, see Flanagan 2000.) Within the Canadian context, however, scholars have noted that these essentialisms are often proffered in multiple directions, as First Nations groups seek not only to invoke sympathetic ideas of "Indianness" to further their own development and environmental management agendas, but also to perform the social roles projected onto them by their Euro-Canadian neighbors (Furniss 1998).

18 Historians eager to add nuance to essentializing portrayals of the legacies of indigenous environmentalism in North America have been similarly incautious, asserting that pre-contact groups saw moral cosmologies, rather than practical strategies of conservationism, as the drivers of animal population dynamics and landscape health. See Krech 2000. For the myriad protests inspired by Krech's arguments, see Hames 2007; Nadasdy 2005b.

institutions founded during the 1990s has increasingly forced practitioners to defend the claims and performances of these groups even as their individual attachments to them grow more precarious and problematic.

Defining Alterations & Scaling Legibility – Lorraine's Story

Lorraine and I first met in her home next to the Kispiox Forest Service Road, a large, two-story house high on a bluff overlooking the Skeena River and the Kispiox Valley. Unlike several of the other original members of SWAT who abandoned entirely their counter-mapping work after the dissolution of the team, Russell and Lorraine had both enjoyed modest financial success, and their different homes displayed accouterments of middle class art and convenience relatively uncommon in many of the other homes on the Gitxsan reserves. Her eagerness to meet with me despite a series of missed connections and conflicting schedules reflected the generosity with which she had worked with many other scholars over the past several decades. Like Russell, her name frequently graced the acknowledgements sections of books and articles published on disparate research projects conducted throughout the region (see e.g. Berkes *et al.* 1998; Gamiet, Ridenour and Philpot 1998; L. Johnson 1997; Sterritt, *et al.* 1998).[19]

Despite collaborating on linguistic surveys, archaeological digs, botanical succession experiments, and innumerable animal habitat and trail mapping projects, though, few of her academic visitors had sought her out primarily to hear the personal stories she had accrued throughout her professional career. Fewer still were interested in learning about SWAT, a decade and a half after the group's demise. "Yeah, it's been a long time since I talked about SWAT," she

19 Leslie Main Johnson (2010: 185-201), an anthropologist and ethnobotanist at Athabasca University, has collaborated extensively with SWAT members for her research on Gitxsan plant knowledge, language, and landscape perception, and deals far more explicitly than most with the epistemological challenges faced by GIS experts engaged in TEK mapping and cataloging.

laughed as we thumbed through her old field notebooks. "I had this vision of myself retiring until Gitanyow called me again." The Office of the Gitanyow First Nation, a Gitxsan group with separate political leadership, had provided much of Lorraine's contracting work since her departure from SWAT. As was often the case for people living in the region, Lorraine's affiliations with the different First Nations in the area were layered and complex. "[M]y lineage emerges out of Gitanyow. But my Indian status comes out of Gitanmaax. … I've got family in Gitanyow and in Gitxsan."

Like Russell, Lorraine had not grown up on reserve, although she experienced few of the comforts enjoyed by Russell's educated, relatively mobile Gitxsan family. She had learned to speak Gitsanimx̲, the Gitxsan dialect of the eastern village reserves, later in life, slowly formalizing the inchoate sounds of childhood visits to relatives' houses on reserve through deliberate conversations and tutorials with these same elders as she grew up.[20] Sitting across from each other at her kitchen table, we paged through her old field notebooks and laminated checklists. Every few minutes, she would get up and walk to the living room to retrieve a specific map, unfolding it and flattening it out on the broad table to orient old stories and point out the locations of particular dramas. Some confrontations she remembered with a mirthful chuckle: last-ditch efforts to catalog fishing rocks and campsites on the other side of a tense road blockade; surreptitious trips through patches of old-growth to remove timber cruisers' targeting ribbons from the intricately carved and bark-stripped trees the foresters had promised (and forgotten) to leave out of their harvest plans. Other battles had been so contentious and draining that she visibly tired even as she began her accounts.

20 While the Gitxsan Treaty Society has adopted the name, language, and orthography of the Gitsanimx̲-speaking eastern villages (residents of which call themselves "Gitxsan"), speakers from the western villages, populated by those who call themselves "Gitksen," employ the language and orthography of the Gitsenimx̲. As Leslie Main Johnson (2010, 1-7; 219) and Tyler McCreary (2013, x) have both described in detail, the spellings, terms, and orthography employed in written texts have lately followed the standards set by the Treaty Society.

Her memories slowly returning as I asked after small details and flipped through her piles of old maps, she laughed out loud as she recounted the pointed barbs and sarcasm she and her SWAT collaborators had lobbed towards Ministry of Forests officials during their invited lectures at Ministry offices, industry conferences, and academic venues like the University of British Columbia Department of Forestry. Rarely did they miss opportunities to tease registered professional foresters (PRFs) and other credentialed experts, who had only just begun to acknowledge formally the existence of First Nations communities in the forests they allocated for harvest. "We were pretty bold and audacious back then, eh?" she laughed, remembering a specific lecture series meant to introduce incoming foresters to new procedures of First Nations consultation. "We titled our module for UBC foresters, 'Boldly to go where no RPF has gone before.'"

Recalling field encounters and other stories throughout the morning, Lorraine's modesty belied SWAT's brazen, if fading, reputation. As their own reports, parliamentary depositions, and other public talks from the 1990s make plain, SWAT members and collaborators took pride in leveraging the publicity surrounding the *Delgamuukw* land claim to re-frame and critique the consultation process itself. The first stages of engagement between the provincial Ministry of Forests and Gitxsan governing entities, vaguely promised through decades of legal precedents and political pronouncements, had only just begun in the region after a series of Gitxsan-led logging road and rail blockades in the late 1980s forced the province to negotiate with individual clan and house group leaders to regain road access to timber harvesting areas for logging crews kept out by barricaded roads (Glavin 1998; Wild 1993). By the early 1990s, a surge in conflicts between anti-clearcutting activists and the Ministry of Forests inspired by conservationist protests on Vancouver Island and by gestures of solidarity toward the Mohawk communities

involved in the Oka Crisis in Quebec had heightened these longstanding tensions (Blomley 1996). These early engagements, lauded at the time by activists and legal scholars as progressive victories (e.g. Pinkerton 1998), were explicitly meant to compliment and extend the performances of Gitxsan sovereignty that were then taking place in the Vancouver courthouse where *Delgamuukw* trial claimants had been presenting evidence for months.[21]

The work of organizing more mundane assertions of sovereignty, however, meant parsing new and as-yet unstable legal orders for plausible platforms of recognition. One of these orders was ushered in by the establishment of the British Columbia Treaty Commission (BCTC), an independent negotiating group appointed by the provincial government in 1993 to standardize the province's ad-hoc approach to handling a growing chorus of aboriginal land and title claims throughout British Columbia (Alfred 2001; Penikett 2006). The enthusiastic welcome many First Nation groups initially offered the Treaty Commission eventually gave way to cynicism and despair as dozens upon dozens of groups built up tremendous debts to their negotiators and researchers even as only a handful succeeded in ratifying formal treaties with the province (Nelles and Alcantra 2011). By the time most of these negotiations were well under way, though, the BCTC anchored the formation of an entire ecology of expert institutions designed to support the First Nations groups engaged in the treaty process.

Among the *Delgamuukw* plaintiffs, the emergence of the BCTC had helped to occasion the formation of yet another governing entity: the Gitxsan Treaty Society, or GTS. The members of the GTS took over vacuum left from collapse of the Gitxsan-Wet'suwet'en Alliance (GWA), organizing themselves as intermediaries between the Nation's hereditary chiefs, the BCTC, and other provincial institutions. Under the early leadership of Don Ryan, or Mas Gaak, a leading

21 For an irreverent yet comprehensive Gitxsan take on the original trial and its immediate aftermath, see Monet, Skanu'u 1992, 195-210.

figure in the road and railway blockades of the late 1980s and early 1990s, the GTS funded and organized a series of bureaucratic institutions meant to bolster Gitxsan presence in other governance venues.[22] As it quickly became the primary seat of negotiating power on the territories, the GTS sought allies from neighboring conservationist groups and ecological research organizations. Not long after the initial *Delgamuukw* decision was handed down, though, Ryan and his colleagues decided that the Gitxsan Nation deserved an ecological research group of its own.

The timing of Ryan's inspiration was far from accidental. As part of a sustained break between the provincial appeal of the original *Delgamuukw* decision in 1993 and the beginning of the Supreme Court of Canada hearing several years later, Ryan led the newly-formed Treaty Society through a general reorientation towards the structured negotiations of the provincial treaty process (Eichstaedt and Donaldson 1994). Inspired by the conciliatory rhetoric of the newly elected New Democratic Party provincial government, the GTS vocally committed itself to using the lull between the trials to take advantage of new sources of government funding for capacity-building work. GTS leaders and *wilp* chiefs cited an expanded education society, job training programs, and a full-time forestry consultation group as only the first in what they hoped would become a series of Gitxsan-led governance organs to supplement, and eventually replace, the over-extended, federally-funded band councils struggling to deliver social services on the reserves.

In the early years of the transition to a treaty-oriented politics, the synergy between these nascent programs and initiatives (and the periodic blockades that still popped up along logging roads in the territories) attracted a number of Gitxsan men and women who had been too young

22 For an example of Ryan's personal reflections on these transitions, see Ryan 2005.

to participate in the research for the original *Delgamuukw* trial. Lorraine remembered drawing on this excitement when she decided to join the first cohort of the Gitxsan Territorial Management program in 1991, a two-year course on environmental mapping, wildlife habitat assessment, and provincial law. Once the idea of a Gitxsan-led environmental mapping team began circulating among the management program's inaugural graduates, the genesis of the organization was dizzyingly abrupt. Only days after graduating, Lorraine met Don Ryan in the halls of the Treaty Society building, whereupon he summarily invited her to lead the Society's newly created forestry department. The scale of the job was immense: Lorraine was to oversee forestry consultations for the entirety of Gitxsan traditional territories, even as the consultation procedures themselves were only then being put into formation. Russell's formal training, with the GIS mapping program PAMAP, lasted only two weeks, after which Don Ryan recruited him, too, to head the society's GIS mapping department.

Initially, SWAT worked tentatively, building claims from the affordances of a series of historical preservation and heritage conservation laws put into place throughout the second half of the twentieth century. These policies, particularly the Archaeological and Historic Sites Protection Act, introduced in 1960, and the provincial Heritage Conservation Act of 1977, promised indigenous and settler communities alike to demand prospective developers provide prior warning before "altering" sites of "cultural heritage."[23] The acts put forth definitions of "heritage," "historic site," and "alteration," deputized government archaeologists to judge and discipline infractions, and established the year 1846 as the threshold for "historical" status.[24] By

23 Both the AHSPA and the HCA were intended to supplant a patchwork of revisions to the original 19th century Indian Act governing federally-administered reserves, and to haromize amendments to provincial land use policies governing the as-yet unrecognized traditional territories surrounding established reserves.

24 While the province was not formally organized as a British colony until 1858 and did not enter into confederation with the Dominion of Canada until 1871, the signing of the Oregon Treaty in 1846 consolidated British Columbia's southern border and initiated its move towards becoming a formally recognized British territorial entity. For more on the practice and politics of government-led archaeological assessment, see Apland

the 1980s, however, the lack of support for oversight and the final authority of government archaeologists in deciding disputes meant that few First Nations groups had successfully filed any complaints, even as expanding harvesting operations along the coast claimed more culturally modified trees and new hydropower projects submerged untold numbers of riverside grave sites.[25]

In the years immediately before Lorraine helped to form SWAT, however, the legal precedents shaping the province's moribund consultation process began to shift. Partly inspired by amendments to the American Archaeological Resources Protection Act (ARPA) in 1988 and the signing of the Native American Graves Protection and Repatriation Act (NAGPRA) in 1990, the sitting provincial government instituted sweeping revisions to the Heritage Conservation Act in 1996. Whereas under the original act, government archaeologists had only occasionally consulted with local indigenous groups while researching potential "alterations" to historic sites, the revised act necessitated such encounters. Even after the new Act transferred authority away from government archaeologists to First Nations administrators themselves, though, the Ministry of Forests' abrupt consultation demands and unforgiving schedules often made SWAT's participation impossible. After receiving a timber license application for a new harvesting area

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1993. The troubling and rather arbitrary "cut-off" dates for historical standing and other forced tests of cultural legitimacy structuring twentieth Canadian heritage conservation policies have preoccupied industrial and academic archaeologists alike for several decades. While some archaeologists have acknowledged indigenous groups' attempts to subvert these limitations by submerging their claims for recognition within more expansive environmental protection measures, most have argued primarily that the shortcomings of these laws would be best mollified through the increased participation of local indigenous populations in cultural heritage resource management work (Nicholas 2006). For commentaries on the growing entanglement of forestry practice and Canadian and provincial heritage protection laws from the perspective of cultural resource management consultants active in northwest British Columbia, see Budhwa 2005; Klassen, Budhwa and Reimer/Yumks 2009.

25 The creation of the Nechako Reservoir in 1952, which resulted in the forced relocation of the Cheslatta Carrier Nation, was particularly controversial, and is often cited as the primary impetus for the creation of the Archaeological and Historic Sites Protection Act eight years later. At the time, academic archaeologists led the charge: University of British Columbia archaeologists Charles Borden and Wilson Duff cataloged over one hundred camps and grave sites during the year prior to construction of the reservoir dam, but the project proceeded as planned. See A. Carlson 1998. For a general overview of early salvage archaeological work, see R. Carlson 1970.

from the Ministry, Lorraine and her collaborators rapidly investigated the areas for culturally modified trees, trails, old campsites, and other protected markers of "cultural heritage." If they found nothing, cuts proceeded as planned. If they found something that the province decided warranted protection, then the proposed harvest volumes were logged in the surrounding area instead.

The organization of the work almost immediately re-scaled *Delgamuukw* claimants' vast overall vision of territorial sovereignty into the shifting, cumulative units of the province's emergent environmental management programs. Unlike the ongoing appeals to the *Delgamuukw* decision, in which Gitxsan and Witsuwit'en's legal teams focused primarily on the exterior boundaries of the two nations' total claims within the province, Lorraine and Russell's work focused on the watershed units, house groups boundaries, and other regional features which framed most of their individual maps. Basing map construction and consultation demands around house group territories, as opposed to the borders of the overall Gitxsan Nation, meant interfacing between hereditary *wilp* chiefs, clan matriarchs, and other house members, as opposed to the elected bodies of the village band councils or the appointed board of the GTS. They explained their work to individuals and crowds gathered around their computers at the GTS office or, more frequently, over printed maps arrayed atop folding tables at Gitanmaax Hall in Hazelton or other reserve village community centers.

Over the course of hundreds of hours of targeted field sessions and rapid, ad-hoc exercises organized around blockades and other urgent "battles," the group steadily built up a general inventory of "cultural resource" information in an effort to stay ahead of the Ministry's abrupt requests for geo-referenced data on specific forested regions slated for harvesting. The original, passive format that had guided their early confrontations simply did not provide the

team with enough time to visit all of the sites that came up for review. "It was just taking up way too much time, and it was going nowhere and it meant nothing," Lorraine remembered. "It was just dotting the i's and crossing the t's for the province, to go through consultation that led nowhere." Creating maps of their own, then, rather than simply summoning new testimony each time the Ministry was asked by prospective loggers for permission to work in a new area, quickly became the team's primary goal. "In the early '90s, when we first started," Lorraine told me, "before we were involved in GIS, we used to get 1:20k topos or forest cover maps and hand color the polygons. And forestry officials used to kinda snicker at us and say, 'Oh, you've got pretty little maps there.' But they were pretty powerful, actually. They started changing the way forestry officials dealt with us." By the mid 1990s, the team had begun to systematize their own databases from the reference points and observations they gathered through trail mapping sessions and the hundreds of binders full of paper-based archive of *Delgamuukw* research materials and territorial affidavits stored in the GTS office.

Defining Restorations & Disaggregating Units

In 1994, two years after SWAT began its first consultations, these tentative steps towards systematicity were reoriented by yet another change in legal order. Responding to the election of the NDP, a new, social democrat-style provincial government, the Ministry of Forests initiated an unprecedented watershed restoration program called "Forest Renewal BC" (or FRBC). The raft of new management policies was complimented by a generously funded ecological research initiative, an array of grants which prompted Ministry scientists to design experiments to elucidate the long-term effects of logging at a variety of scales. The initiative also sponsored a number of co-management projects (P. Burton 1998), including a study of the effects of forest

canopy shade on the growth of berry gathering sites at various locations around the Gitxsan territories (which subsequently spawned a short-lived berry harvesting co-operative). As I heard several times from both Lorraine and Philip Burton, the government scientist-turned-private consultant who assembled the original proposal, the project provided one of SWAT's first opportunities to collaborate meaningfully with Smithers-based ecologists and botanists. Lorraine reminisced that GIS tools had provided a common ground between the groups, where SWAT analysts were in some respects already more adept than their government and industry collaborators at writing in the DOS coding language required for early GIS data logging interfaces. Working side-by-side, however briefly, with erstwhile-government scientists like Phil also helped SWAT to become even more adept at submerging privileged Gitxsan sites of ambiguous official "historical" status within more robust conservation classification systems. "If you can overlay data for berry areas on forest ecosystem network or hydroriparian zones," Lorraine explained, "then it's already protected and logged, so we don't have to say 'this is our berry area,' [since it's] already established in provincial law."

As the Forest Renewal BC initiative expanded and GIS mapping techniques grew in popularity and sophistication throughout the mid-1990s, a broad class of new landscape classification formalisms and digital data standards soon followed. These standards included laboriously detailed instructions to Ministry officials and their collaborators for taking field measurements, performing calculations, making lists, and defining the attributes of new entries to be programmed into GIS databases. Data standards redefined how these new, geo-referenced units could be compiled and analyzed, and provided a legal language for identifying new protected entities – culturally modified trees, riparian zones, and biodiversity units, to name a few. As I describe in more detail in chapter one, the introduction of digital data standards had

augured a broader transformation throughout provincial ministries away from the field practices, professional hierarchies, and legal regimes associated with paper tools. One ministry at a time, provincial officials were transposing into digital databases the paper records of boundaries, infrastructures, and measurements of environmental change accumulated by government scientists and planners throughout the twentieth century (Bowker 2000a; Edwards 2010; see also Bowker *et al.* 2010).

Throughout my conversations with Lorraine, the categories and terms of these standards constantly emerged, whether in matter-of-fact explanations of the outcomes of a particular mapping project or in her more complicated reflections on the material dimensions of her work on the territories. The morning of our first meeting, before showing me a single map, Lorraine handed me a copy of the laminated checklist which she had developed in conversation with these standards almost two decades ago, a physical document which had proved crucial in helping her to coordinate the work of SWAT's ever-changing roster of field mapping assistants.

Despite the persistence of "watershed units" and other FRBC-authorized legalese in Gitxsan management discourse years after the cancellation of the program itself, though, Lorraine typically shrugged off as "politics" my explicit questions about the institutional pressures that had shaped her day-to-day work with SWAT. "I'm a field person," she insisted. "[Y]ou're always involved in politics and stuff like that, but mostly I spent a lot of my time in the field." While both she and Russell shared duties in leading teams to walk trails and transects, collect data points, and collating them in GIS, the rapid computerization of their work led to a de-facto division of labor which often kept Russell in the office while Lorraine led expeditions on the territories. Building on the mandate of the Education Society that had provided both of them with their original training, Lorraine and Russell routinely organized with other SWAT

collaborators to host GIS analysis and trail mapping training sessions for local Gitxsan youth. For Russell, who often referred to his early students during our conversations, teaching GIS lessons often meant contending with two dozen students crowded around a single computer, and explaining complicated coding practices to teenagers and young adults with little or no prior experience with computers. For Lorraine, whose own mother's early life was shattered by medical malpractice at an aboriginal residential school, trail mapping sessions with teenagers and young adults often meant providing the children and grandchildren of displaced residential school survivors with their first exposure to their families' house territories.[26]

Much like the often ad-hoc, sporadically funded training sessions through which Lorraine and Russell began their own careers, the temporalities of SWAT's projects were also frequently punctuated by the unpredictable demands from government offices or unexpected events in the lives of the team's family members and neighbors.[27] Time and again, the death of an elder completely disrupted a project schedule, as house group members and other relatives temporarily redirected their energies to organizing a commemorative death feast, collecting donations, and handling the transfer of feast names and other matters of hereditary succession.[28] The fact that Ministry demands and funding allotments rendered their professional schedules so tenuous and unpredictable to begin with made these other interruptions even more destabilizing. Lorraine

26 For a sustained discussion of the history of diseases and poorly administered and/or unnecessary medical treatments suffered by the survivors of twentieth century residential schools in British Columbia see Kelm 1999; see also Culhane Speck 1987.

27 On how the rhetoric of developmental economics has "evacuated" imaginings of the "near future" and re-framed perceptions of life events as aberrations, see Guyer 2007; see also Adams, Murphy and Clarke 2009.

28 The prospect of a death in a First Nations community suddenly disrupting plans pre-established plans for business, travel, research, or official meetings was almost treated as a cliché among many of the government officials and company representatives I spoke with who regularly traveled to reserve communities for consultations and negotiations. A number of anthropologists have described the ways in which death suspends quotidian routines in indigenous communities; Hugh Brody's (1981: 72-84) moving, somewhat absurdist account of a Christian funeral on a Beaver reserve in northeast British Columbia performs a brilliant counter move, displaying how the mixture of sobbing, boredom, drinking, and coming-and-going that accompanies the church ceremony renders strange the awkward, dogmatic efficiency and condescending affect of Christian ritual imposed upon the daily life of reserve residents.

readily invoked these layered uncertainties while defending the decisions of several of her family members, who also received their initial technical training as part of SWAT, to abandon counter-mapping work for corporate careers. "The projects are always stop and start, stop and start, and my daughter, my sister, they have families, and they just need steady employment."

Yet the search for steady employment, many SWAT members soon learned, brought with it a wide range of new tests and complicities. As I will show below, Russell's professional networks soon grew to include a broad range of conservation NGOs, government committees, and First Nations management offices. Most of the early SWAT collaborators who followed him away from the reserves, however, took on roles within the logging industry. Speaking to me from her office at a forestry planning and mapping consultancy in a town several hours east of the territories, Mabel, an early SWAT trainee, reflected that the computer training she received from Russell and Lorraine had helped her to move away from the territories, but also effectively removed much of the temptation for moving back home. Her initial sense of moral conflict over working within the forestry industry, she admitted, had long since faded. "The only milestones that shaped where I work and why is opportunities. There weren't a lot of them for someone with my skills. There still aren't a lot," she explained. "I have chosen to stay [away] ... working for a forest consulting organization because I'm paid well, and have had a full time job here for the past ten years." Few of her former SWAT colleagues, she admitted, had been nearly as lucky.

A Fighting Force – Russell's Story

Nearly a decade and a half removed from the collapse of SWAT, Russell's perpetual search for steady employment had brought him into conversation with policy makers and other First Nations activists all across Canada, but it had also drawn him far away from home. Not long

after my arrival in the north, he had begun a job as the consultation coordinator for the Mikisew Cree First Nation in northern Alberta. His brief visits back to his small farm half an hour southeast of Smithers comprised his only chance to spend time with his wife and their two young children. As I busied myself with visits to the homes and offices of other Gitxsan mappers still living in the region, Russell and I connected in other ways. Throughout the summer, I occasionally bought chicken from his family's stand at the weekly farmers' market in Smithers, and I listened to his wife's laments about the strains of living and working long-distance. In our email exchanges, Russell grumbled about the interminably long 1,500-kilometer bus ride between his home and Fort McMurray, the boomtown of the Alberta tar sands and the closest city to the Mikisew Cree reserve. On reserve, though, he admitted, the isolation gave him the time and freedom to craft long, thoughtful, and detailed responses to the questions I began emailing to him during the spring. As my first summer in the northwest wore on, Russell's emails and phone calls steadily filled in a rich, if sometimes angry and elliptical, narrative of the paths he had taken in professional exile amidst the steady dissolution of the Gitxsan Treaty Society's counter-mapping ambitions.

As the summer drew to a close, we finally met in person at Russell's farm to share a meal and scroll through the folders upon folders of new digital maps that Russell had created around Fort McMurray. We toured his fields and chicken pens, and he explained the construction history of his farm house, a modern cabin whose surroundings matched the rugged and ramshackle aesthetics of the working class trailers I lived near in Smithers. The gravel lot in front of the house was decorated with cars, each just a part or two short from being in operating condition. Despite the drudgery of the bus ride awaiting him the next day, Russell exuded a fatherly pride in all of his unfinished projects. The cars, the chickens, the house itself, and the family fixing

dinner inside, all formed a part of the narrative Russell crafted for me of his life as a self-made expert and cultural entrepreneur. "He used to wear this tee-shirt that said, 'If my lips are moving, you'd better be taking notes,'" his wife teased, as I switched on my audio recorder while Russell pointed out different features of their house. Like his accounts of the projects littered around the farm, Russell's re-telling of the story of SWAT lingered over grand plans and unfinished business.

While my conversations with Lorraine often revolved around the usefulness of specific mapping technologies, Russell more frequently reflected on the evolving technologies in which their data were embedded. The materiality of the team's early work was both a domain of new challenges as well as a source of intense pride. Whether in emails or in conversation, Russell never let me lose sight of the fact that the team was primarily producing *digital data* for future maps, as opposed to the individual paper artifacts which earlier Gitxsan mappers had labored over during the land claims research of the 1980s. In an email describing his initial work in the Gitxsan Treaty Society's Technical Department, prior to the creation of SWAT, Russell emphasized the relative novelty of the computer resources made available to him at the outset of his career. "That shop ran an early Unix-based version of ESRI's ArcInfo [a major proprietary GIS program], on Sun OS SparcStations. The shop also had copies of the PC ArcInfo, and I learned them both, picking up Unix systems administration along the way. … Those were the early days of GIS in the community, you have to remember. Very few First Nations at that time had GIS capability; we were one of the early adopters of the technology. It was horribly expensive. I think my office spent $27,000 apiece on 2 SparcStations with ArcInfo installed to each … it was a huge commitment for all of us to make."

Continually looping his reminisces back through the physical devices of his early work,

Russell characterized SWAT's early discussions with hereditary chiefs less as scenes of technical translation between experts and non-experts than as the long-awaited enrollment of individual cartographers within a decades-long conversation between Gitxsan houses and the province. "The hereditary chiefs and clan matriarchs supported this kind of work and this kind of training. Indeed, they felt proud at seeing us all doing this kind of work. In those earlier days, there was a lot of activity from within the communities that my work and my students' work fit into. We were part of a larger dream and it felt pretty good to be of service. The really active community members were the most curious about our work … . Without having the jargon, or the respect of the government-industry folks, they nevertheless [knew] pretty well what they wanted to see achieved. They voted to create us and our work, and they patiently asked questions of us at community meetings. The Education Society work, and the GIS map department work was driven by a combination of response to whatever current battle was occurring, and the longer range vision we were all trying to achieve." The move to digitization, then, was enthusiastically endorsed as a pragmatic tool. Said Russell, "Anybody in the [Gitxsan] leadership or among the tech people could see really fast that this was a useful way of handling more information than one person alone could handle." As the team began constructing and systematizing a comprehensive set of digital maps of the territories, one house group at a time, the tone of their engagements with the province quickly changed.

Russell's interactions with provincial regulators depended not only on expensive computers, monitors, and software, but also on several specialized printers that allowed the group to produce the paper maps - documents that often grounded discussions with individual house groups. "The standard kind of map being produced at that time was printed using a pen plotter," Russell explained as he sketched out the early history of the office. "Everything had to

be formatted with that pen plotter in mind. Filled polygons had to be filled with a pattern of some kind. Partway into the whole treaty negotiating process we acquired a massive electrostatic plotter which could do solid filled polygons, among other things. It weighed I think just over a ton, so once it was in place it didn't move. And it was expensive to operate as well, but we could do long banner maps, and print 4-colour giant maps easily. It put us ahead of pretty much everybody for a while."

The practical demands of assembling reports, exchanging maps with Ministry officials, and supplying navigational charts for collaborators, however, often led the team to rescale their ambitions. Enormous paper maps of territorial boundaries and clearcuts earlier had been useful for asserting presence during land claims proceedings and inspiring indignation among prospective blockaders, Russell admitted. But the steady march towards bureaucratization carried its own material demands. As Russell explained, "[P]rinting ever bigger and bigger maps wasn't all we had to do. We kept getting asked if we could make a smaller, simpler map that could go into a report, or something that could be faxed. So the needs of the negotiating team drove our work."

Russell rarely downplayed the significance of the sheer novelty of SWAT's approach in explaining his personal ambitions during the early years of his career. "The cool factor at being able to work at something that expensive and that advanced was very high, because only government and some industry had the funding to get not just one but two licenses [for the ArcInfo software]," he excitedly recalled. "It signaled to all that we were going to be a force to be contended with." Russell's qualified his fascination with the computer technology he worked with by referring to himself as a "ponytail"-type "geek," a class of tinkerers, he explained, "who tend to get into the graphic design end of things, who are forced into or maybe gravitate towards

social situations where they interact with a lot of other people." That the few GIS specialists who remained on the territories into the 2000s were, as Russell called them, asocial, "propellerhead"-type "geeks" was not unrelated to the general decline in Gitxsan activism, he surmised. In his early emails to me, Russell's account of the genesis of the team echoed Lorraine's insistence on their roles as bureaucratic "translators," but emphasized the excitement involved in being thrust into unexpected managerial roles. "The new job was challenging, because not only were we required to do mapping, we also had to understand what was important to different kinds of map users: lawyers, biologists, hereditary chiefs, and a wide variety of other professional folks. And so I picked up a smattering of all the users' lingo and training."

Russell often expressed bemusement at scholars' and activists' worries over the threat of "epistemological impoverishment" posed by the use of GPS devices and GIS analysis to represent Gitxsan artifacts, historical sites, and land use practices. "One of the questions we got asked a lot was if the technology drove our results, or were we able to resist having our ideas packaged by technology," Russell reminisced while describing the early years of SWAT's rise to prominence. "I actually found that to be a hilarious question. We were taking tools the province provided grudgingly, such as forest cover digital data, with databases attached, and then subverting them for our own ends." Throughout my conversations with Russell, Lorraine, and their collaborators, none showed any self-consciousness over supposedly problematic terminology, either: to them, "data" was "data," whether it encompassed biodiversity indicators, archaeological markers, or personal narratives articulated in pre-*Delgamuukw* affidavits.

In Russell's re-telling, data standards introduced by provincial ministries quickly became handles for subversion, tools which agile field workers could use to transpose their observations into multifaceted legal and scientific arguments against provincial authority and control. "BC

Forests was appalled to find we could do theming that started to get at ecosystem-based management [EBM]. EBM was something they were desperately trying to keep out of discussions and negotiations, to the point where they often refused to admit there was any such thing. … We also could find holes in their regional and landscape planning, because we could find holes in their data."

Much of their advantage, Russell explained, came not only from their facility with the new standards, but from their willingness to physically visit the areas depicted on Ministry maps. Before high-resolution satellite photos became widely available, simply checking the basic accuracy of the ministry's depictions of road locations and old growth blocks with backpack- and hand-carried GPS devices proved to be a rewarding, if time-consuming, confrontational strategy. As Russell bragged to me, "[It] used to really piss them off to find that by ground-truthing the forest cover, we could correct polygon contents and make better decisions with better data." That the tools and data standards of the provincial government's new environmental modeling programs were initially shared with such hesitation meant that SWAT could frame their work as both a compromise with government epistemes and as a unifying gesture of defiance. "I don't think the province or industry realized that if they'd only taken a conciliatory approach," Russell reflected, "and given us an inch here or there, instead of fighting us to the bitter end every step of the way, we'd not have become such a good fighting force."

Much of their early influence, Russell admitted, stemmed directly from the relative novelty of their approach. As other First Nations initiated their own land claims and consultation procedures, the organizational and representational ambiguities facing SWAT multiplied. Despite the thousands of pages of provincial reports and the hundreds of parliamentary hours devoted to instituting forestry consultation procedures and formalizing and revising the processes involved,

government and industry officials continued to be confused by the internal divisions and different institutions on the territories. Other government officials were bemused by the profusion of competing land claims that had emerged throughout the province in the wake of the initial *Delgamuukw* decision. Even advocates of the later treaty process referred to the proliferation of overlapping claims as "boundary chaos" (Olive and Carruthers 1998).[29] Some claims researchers offered stern warnings that the mere suggestion of greed, made visible in provincial maps littered with conflicting markers, threatened to make all claims appear ridiculous, and could turn non-First Nation residents of the province against the treaty process in general. Even regarding communities with long-standing, highly publicized claims like the Gitxsan, confusion over jurisdiction remained a constant theme. "A lot of people don't realize it, even in government," Lorraine complained to me. "They think if they contact the band council, then they're doing consulting." For their part, though, the elected band council members who received these mistaken entreaties did not always take the trouble to remind Ministry representatives that their own jurisdiction ended at the boundaries of the village reserves, overburdened as they were with the day-to-day work of reserve management.

As the *Delgamuukw* appeals wore on, lingering ambiguities over the separation of powers between hereditary clans and house groups and the self-appointed Gitxsan Treaty Society devolved into public disagreements over consultation procedures and development proposals. Influential Gitxsan leaders left the region for bureaucratic jobs and consultancies in Ottawa and southern BC. Throughout the province, government ecologists were steadily "catching up" with

29 Former Gitxsan-Wet'suwet'en Alliance (GWA) leader Neil J. Sterritt, whose research for the *Delgamuukw* trial I discuss in more detail in chapter six, repeatedly called attention to the reluctance of the province to engage with competing claims in a comprehensive manner, particularly regarding the Nisga'a Final Agreement of 1998, which the BC Treaty Commission and other provincial institutions initially celebrated as an exemplary success of the Commission's new reconciliation procedures in spite of the fact that much of the Gitxsan Nation's and nearly all of the Gitanyow First Nation's territorial claims were subsumed within the region claimed as Nisga'a traditional territory. See Sterritt 1998; Sterritt *et al.* 1998.

SWAT's precocious technicians, too, re-purposing still-nascent GIS and ecosystem modeling techniques as "participatory" modes for "community"-oriented Land and Resource Management Planning committees (see chapter one). Wary of abrogating ongoing land claims by recognizing the legitimacy of yet another Euro-Canadian governing entity, Gitxsan representatives refused to participate. By the time the Ministry of Forests suspended its financial support for First Nations consultation work in 2002, many of SWAT's original trainees and collaborators had already left the region to look for work. Weary and defeated, Russell and Lorraine decided to move on.

In Search of Recognition

Following the collapse of SWAT, Lorraine and Russell's careers took markedly different paths. Lorraine temporarily retreated from counter-mapping projects and spent several years taking on other kinds of work before returning in the mid-2000s to oversee occasional mapping projects for the Gitanyow Office of Hereditary Chiefs (see chapter four for an ethnographic account of one of these projects). Russell began a peripatetic journey across western Canada, selling his services as a GIS technician and TEK consultant for First Nations groups and environmental NGOs, many of whom were engaged in forestry-related conflicts of their own. As a full-time TEK worker living away from the Gitxsan reserves and territories, Russell supported himself one project at a time. Like so many technicians throughout North America working at the unstable intersection of policy, environmental conservation, and indigenous politics, Russell divided his time between a wide range of groups, some of whom took opposing stances on the same development campaigns. Each First Nations group with whom Russell worked also faced their own uncertain timelines and sudden gaps in project funding, not unlike the situation at the GTS which he had earlier sought to escape. Few of his "permanent" positions kept him in one location for longer

than a year. Working as the natural resources coordinator for a central BC First Nation, he helped to assemble a database capable of cross-referencing the attributes of new mining and mineral exploration proposals within scalable lists and maps. When the main developer supporting the office sold their prospect to a new group of investors, the funding for the group's environmental management work left with them, and Russell's salary disappeared. Other engagements were even more limited in scope. With numerous coastal First Nations groups already embedded in longstanding relationships with international conservation NGOs like Greenpeace and the Sierra Club, Russell's GIS and GPS training sessions typically lasted only a few weeks or days.

Initially, working with Vancouver- and Victoria-based environmental restoration consultancies and cultural heritage management groups seemed to promise Russell greater certainty in terms of paychecks and project timelines. In practice, however, these industries were also dominated by short-term contracts and a precarious reliance on a few highly sought-after streams of core funding.[30] But while the financial uncertainty characteristic of his time working with Gitxsan organizations remain relatively unchanged, Russell's expanding networks provided him with something he claimed that his Gitxsan employers had long refused to provide: recognition of himself as a skilled professional. In Russell's often elliptical re-tellings of the

30 "Core funding" is a term one hears invoked frequently when working with NGOs. Organizations receiving core funding draw most or all of their support for salaries, rent, and other operational overhead costs from a single primary source, often a large annual grant from a government ministry (as in the case of SWAT) or a major philanthropic foundation. Ostensibly, this arrangement makes a small institution less dependent on the success of individual grant proposals for their day-to-day operations. As many NGO affiliates working in northwest BC will agree, though, this stability often only lasts as long as the political party who provided the initial funding remains in power – a particularly risky proposition in BC, considering the frequent and dramatic swings in provincial politics. Many organizations, including the Bulkley Valley Research Centre (BVRC) discussed in chapter one, have abandoned core funding models in favor of recouping overhead costs from individual project grants. While BVRC officials boast that the model has successfully forced the Research Centre to pursue aggressively a more ambitious range of proposals, it poses considerable challenges for organizations based in communities with limited access to the trained personnel capable of navigating these bureaucratic networks in an unending search for funds. The decline in core funding-based environmental organizations is a key attribute of the ongoing neoliberalization of environmental management across North America, and BC in particular: by offloading still more bureaucratic responsibility onto the recipients of government funding, the increasing precariousness of core funding-based independent research further empowers those who already possess the fluencies, contacts, and acumen to engage governing institutions by themselves.

split, it was primarily his own rising fame as an Indigenous GIS expert and his increasingly assertive demands for commensurate pay that finally completed his break with the Gitxsan Treaty Society. "I'd say that developing a professional identity has been instrumental in kicking me out of the nest so to speak. To more than a few influential leaders in my home communities, [I'll] never be more than the junior GIS mapper I started out to be," he lamented. Away from the GTS and the territories, he explained, the basic terms of professional recognition were cynical, but more straightforward. "I wasn't charging very much and learned that to be considered professional, I had to charge the going rate for this kind of work. I hiked my day rate from $200/day to $350/day and right away found that people's estimation of me went up."

Still, Russell often felt conflicted about serving simultaneously as a mapping technician and as a personal mediator between his consultancies' directors and the First Nations communities paying for the work he performed. His reflections on the time he spent with EnviroShare,[31] one of his earliest engagements with remote consulting, reflected a lingering sense of awkwardness. "I can't say that I was probably the ideal [EnviroShare] employee," he admitted to me as he reminisced about his first years after SWAT. "[T]hey get a … big chunk of money through grants to do stuff, then charged a fee for service to deliver it, which people I talked to in the different communities I was responsible for kept hammering me about, asking me about. 'Don't you guys get big chunks of money to deliver this stuff? Why are you asking for money for it then?' So it caused some ethical difficulties."

Despite often being forced to occupy an awkward intermediary position between the organization and the small First Nations communities where he conducted much of his work, working for EnviroShare quickly thrust Russell into other, grander mediating roles between

31 A pseudonym, with apologies to the eponymous environmental management system of Hall County, Georgia.

corporate developers and the federal and provincial government. Shortly after joining, Russell helped the organization assemble a comparative report on the effects of newly emergent forestry certification programs on indigenous resource rights and political mobilizations, a task he later reprised during a brief stint as the national aboriginal advisor to the Canadian Boreal Forest Advisor (R. Collier and Hobby 2010). His affiliation also allowed him to devote more time to refining, adding materials to, and participating in the Aboriginal Mapping Network (AMN), a website and online community he had helped to develop with EnviroShare.[32] The website aggregated map construction methodologies, first-hand accounts and discussion boards regarding ongoing counter-mapping projects, job postings for GIS technicians, and links to new online atlases assembled by First Nations groups and other indigenous offices. Through the site, Russell's name reached an even more dispersed array of indigenous groups. Hailed as a senior authority by indigenous counter-mapping groups throughout North America, Russell was invited to conferences, policy meetings, and training sessions as the proliferation of free and open source GIS software drew hundreds of new mappers to counter-mapping work.

As had been the case when he first joined EnviroShare, Russell's roles as an intermediary in high-level discussions of policy and technique were invariably accompanied by the more mundane work of enrolling individual communities to participate in externally-organized TEK projects. After leaving EnviroShare, Russell spent a year as an interview data collection assistant and GIS mapper for a Vancouver-based cultural heritage resource consultancy. Like most other traditional land use mappers working at the time, his work consisted primarily of assembling map biographies: interviewing elders, fixing lines and icons to correspond with their stories of their experiences on their territories, and collating the results to produce a visual plots of

32 For an early history of the Aboriginal Mapping Network, see B. Johnson 1999.

indigenous groups' collective presence within particular regions.[33] After that, he spent a year providing technical support for an ecological services consultancy involved in reclaiming a mine in central British Columbia. Returning to the northwest shortly thereafter, Russell began his own consulting company and took on contract work on GIS mapping projects, nascent aboriginal land use plans, and resource management proposals. According to Russell, his decision to build his new farm, cabin, and office over 100 kilometers southeast of Gitanmaax, the nearest Gitxsan reserve, was not meant to put distance between himself and his former employers, but rather to better accommodate his growing roster of contacts at First Nations resource management offices and environmental NGOs across the province and country.

The lingering frustration he expressed while discussing his transition away from SWAT, though casts this distance in less neutral terms. Reflecting on the celebrity he enjoyed from his association with the *Delgamuukw* appeals and with SWAT, Russell occasionally referred to his Gitxsan identity in coldly instrumental terms. "[T]here has been some magic in the "made in Gitxsan" label," he explained during one of our early email exchanges. "[M]y part in mapping for the fabled Gitxsan-Wet'suwet'en Land Claims court cases … in the second stage and the appeal … lends a certain shine to [other projects], because they have a real, live Gitxsan mapper, one of the best in the country, at their service for a contracted chunk of time." That it had become easier for Russell to be recognized as Gitxsan by *non*-Gitxsan groups said much about the burdens and disappointments that had freighted his earlier work. The pride of recognition Russell expressed as we scrolled through folders of new maps he had created during his most recent consulting work often came interspersed with subtle criticisms of his former patrons. "Other,

33 In their review of recent scholarship on anthropological scholarship on indigenous mapping, Chapin, Lamb, and Threlkeld (2005, 624) have called attention to the near-monopoly that "map biography" techniques have assumed over the field since their development with the Inuit Land Use and Occupancy Project in the 1970s. See also Usher, Tough, and Galois 1992.

non-Gitxsan, communities … welcomed me with an enthusiasm that astonishes me. They are more ready to accept me and my growth than my home communities ever have."

By seeking out recognition for his technical skills and defining his success on the breadth of his professional networks, Russell largely succeeded in insulating himself from the many local skirmishes which have characterized the Gitxsan sovereignty struggle since the 1980s. He was also not alone in expressing this sense of deferred allegiance. Mabel, the SWAT trainee-turned-forestry technician who spoke with me from her office three hours east from the Gitxsan reserves, responded bluntly to my questions about the recognition she has enjoyed since leaving SWAT. "I have not heard from anyone and have never been called upon by any Gitxsan group to lend my expertise," she explained to me during an email exchange. Like Russell, the fading of her connections to the GTS and the other management offices on the reserves had pushed her towards other kinds of groups and networks to assuage her sense of uselessness and alienation. Still, her early experiences had made her wary. "I have never worked for any first nation [*sic*] organization as a GIS analyst (directly)," Mabel told me over email. "However, I have taken on contracts with [another First Nation office in central BC]. I believe that because I myself am also first nation (although from a different nation) [I] am more trusted." The roots of this trust, Mabel suggested, emerged from their closeness to the marginalization she had faced as an early opponent of provincial mandates, as well as their safe distance from the particular pressures and jealousies she faced while learning her craft.

The precariousness of these early scenes of professionalization alternately inspired solidarity and alienation among the few who successfully leveraged these experiences into technical careers. All of the members and collaborators of SWAT with whom I spoke expressed

considerable pride about the meagerness of their initial credentials. Unlike many of the other Gitxsan who assisted him with mapping projects, though, Russell had spent time in university before returning home to work on the territories in the 1980s, and he had continued to pursue post-secondary credentials since leaving the region again in the early 2000s. Early into our first email exchanges, he directed me to the master's thesis (R. Collier 2012) he had recently written as part of an environmental education and communication degree.[34] Built around a series of oral history interviews and linguistic explorations with Gitxsan friends and family members, the thesis highlighted Russell's acute reflectiveness about the mapping methods he had helped to develop throughout his career. The language of the thesis also repeatedly emphasized Russell's conviction in his own uniqueness as a "cultural translator," a man who had been "trained in two worlds" and could pass effortlessly through the liminal spaces between traditional governance and provincial technocracy. And yet even amidst his obvious enthusiasm for the somewhat essentialized processes of "translation" he defines in his text, his conversations with elders reveal a man resigned to navigating these liminal spaces alone.

Departing from Russell's house after our first face-to-face meeting, only hours before he was set to board the Greyhound bus back to Fort McMurray, I felt weary under the weight of his stories. Even after talking for nearly five hours, though, Russell had found his second wind. As I gathered my things, he outlined plans for us to reconvene as soon as he returned home for his holiday vacation in December, and he even tentatively strategized how, together, we might "sidle up" to certain Treaty Society officials over the course of the winter to gather "their version" of the story of SWAT. As he had done all year, he again offered long lists of names of people working throughout the province – NGO affiliates, environmental scientists, government

34 Given Russell's status within the counter-mapping community, even his master's thesis received media attention. See Delisle 2012.

officials, other First Nations mapmakers – who had joined him at various stops in his professional travels, and who could add texture and perspective to his narrative of exile. "I know how the research process works," Russell assured me. Fact-checking. Story triangulation. Multiple return-visits and endless follow-up questions. As he walked me down his porch steps and back to my truck, Russell promised to be prepared. "These kinds of things only begin to make sense over time. I'm still learning that myself."

Given to a Name

Months later, three days before Russell's scheduled bus ride back home from Alberta, a friend in Smithers forwarded me a link: a Facebook page had been set up to collect donations for Russell's wife. The previous night, midway through the annual Christmas party on the Mikisew Cree reserve, Russell had collapsed and died on the dance floor. By the following afternoon, his family's initial call for a small, informal memorial service later in the spring had given way to preparations for a large, formal funeral and a death feast hosted jointly between multiple Gitxsan houses, the likes of which had become increasingly rare in the years since Russell's departure. For a single night, the posthumous culmination of Russell's perpetually deferred return collapsed his disparate networks into a single room. Treaty Society executives, members of the provincial and federal parliament, dissident chiefs, and many of SWAT's scattered original members crowded into the feast hall for hours upon hours of meals, performances, speeches, and exchanges of gifts.

As attendees returned to their dispersed homes and institutions in the following days, some offered eulogies for additional audiences. People who had not spoken to Russell for years penned thoughtful editorials for blogs and local newspapers. Months later, Nathan Cullen, the

Smithers resident, federal parliamentarian, and leader of the opposition in the House of Commons of Canada whom we met in in the previous chapter, offered his tribute in a nationally televised session of parliament.[35] Referring to Russell as "one of British Columbia's foremost aboriginal land use planners, a cultural translator between his ancient Gitxsan heritage and his knowledge of modern science," Cullen acknowledged Russell's ties on reserve even as he interpellated him within the professional networks that had drawn him away from home. Former collaborators around Smithers offered similar thoughts in research meetings and chance encounters with each other throughout the winter, citing the persistence of Russell's memory throughout the region as proof that his influence had never left. Recognized as Russell's recent interlocutor, I was pulled into some of these conversations as well. People in Smithers and around the reserves who had been vaguely aware of my research expressed sudden interest in the histories I was struggling to reconstruct. They asked after the tenor of the many stories Russell had shared with me during his final year, and wondered aloud what might have happened if he had ever decided to move back to the region and work with the Gitxsan full-time.

With Russell gone, my already-precarious fieldwork methodology took different turns. I brooded over the uncomfortable fact that I had crowded into the final meal Russell had shared with his family, a nosy anthropologist eager to unsettle painful memories yet largely oblivious to the quiet, difficult work he had been doing for years to repair these broken bonds. Reading again and again through our voluminous email exchanges in the following months and reflecting on Russell's personality and legacy in long and occasionally tearful conversations with people on and off the reserves, I gradually discovered a more patient man than the one I had first captured in my daily annotations. One story in particular stood out: Responding to a cluster of questions I

35 Nathan Cullen's tribute to Russell Collier in the House of Commons. YouTube video clip. https://www.youtube.com/watch?v=cJeS43rfyMQ. Accessed 19 December 2014.

had asked about the unraveling of SWAT's GIS training exercises as the funding for the team collapsed, Russell offered a long and personal story, the relevance of which I only began to grasp in the months after his death. My fixation on the dynamics of technical training that I saw at the root of SWAT's capacity building project, Russell had suggested gently, had caused me to miss key aspects of the longer-term processes in which these exchanges were embedded and understood. Reflecting on his own Gitxsan name, Russell drew analogies to the long-term grooming process through which *wilp* chiefs and clan matriarchs prepared their young successors for the leadership roles they would eventually assume within their house groups and clans. "My name is Hli Gyet Spaiyt Sagat," he told me. "It means 'The Man Who Comes Down From The Sharp Pointed Mountain.' It's a local landmark in the Gitsegukla Valley.'" Having grown up off the reserves, Russell had neither a feast name nor a baby name when he was given to the name Spaiyt Sagat in his mid-thirties. The name itself, too, was a new invention. He was to be its first holder.[36] In Gitsanimx, the name was a triple pun. The first two meanings of the name, he explained dryly, were fairly straightforward: among his family and house group, he was already known as the "mountain man," the mapmaker who led different groups into the hills to mark trails and gather data. As with other Gitxsan men his age, he was also known for retreating to the mountains while mulling over life transitions and important decisions ("to seek visions or whatever," Russell joked).

The third part of the name referred to the end of the journey: the return. "Coming back down," Russell chuckled, shaking his head. "'You will spend most of your life trying to grow into it,'" the chief of his *wilp* had told him during the naming feast, Russell remembered to me

36 When Russell received the name in the late 1980s, the invention of new names was a rare event. In recent years, however, the practice of inventing new names has become far more common, although the lack of authority held by these names in the feast hall continues to make them somewhat undesirable for most Gitxsan. On the relationship between feast names and Gitxsan social hierarchy, see Daly 2005: 194-210. On the politics of names among other neighboring First Nations within the broader Tsimshianic language family, see Roth 2001.

over two and a half decades later. "'And it's only later, when it's towards the end of your life, that you'll finally understand what we meant when we gave you to that name, what we intended for you.'" Russell paused, as if allowing me time to feel the weight of these painfully ambiguous expectations. Was his ongoing story of professional exile part of his time in the mountains? A prelude to his necessarily deferred return? The words of his chief offered nothing, simply the promise of time to work and wonder: "'What you'll do in the meantime is up to you.'"

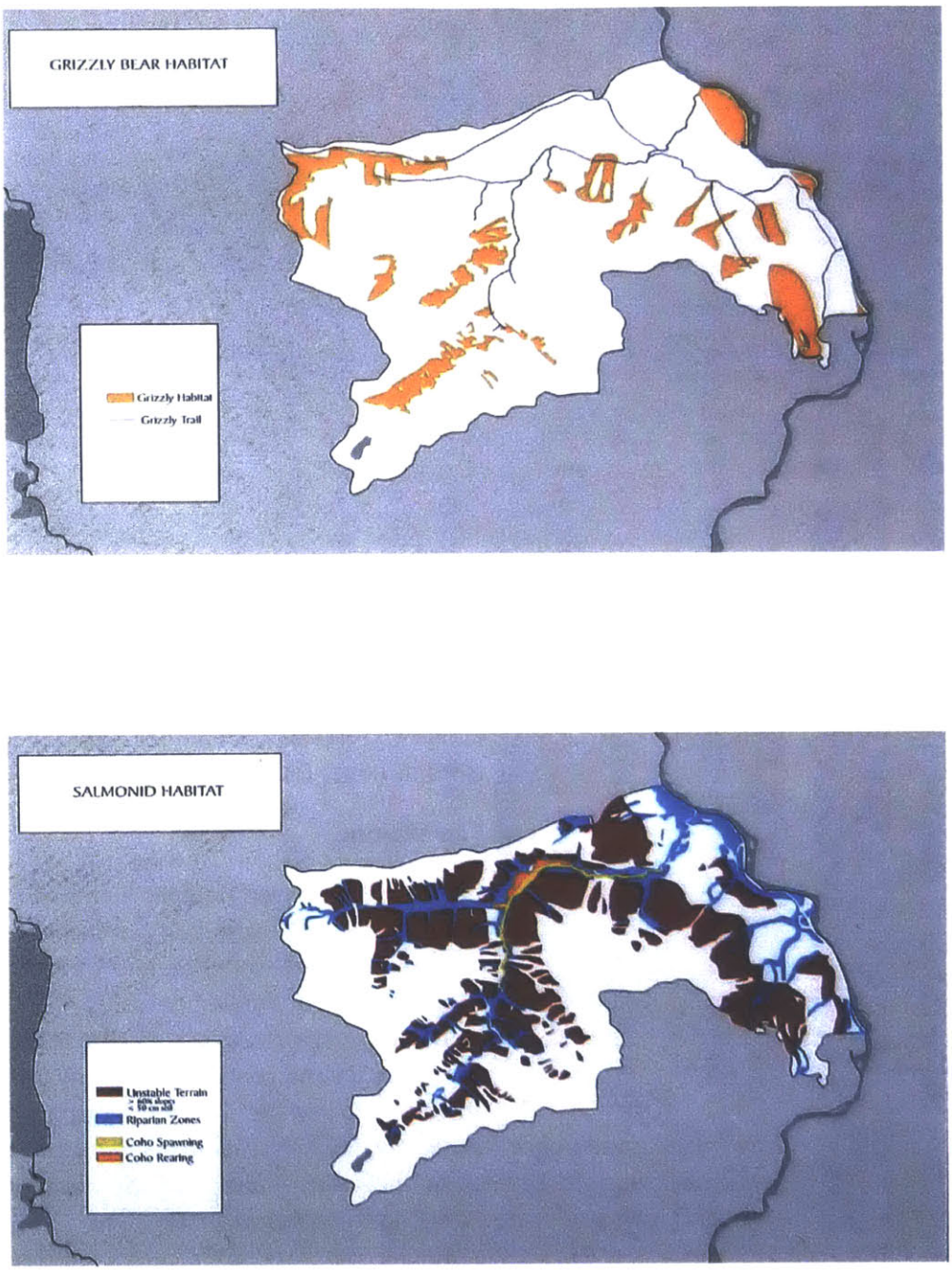

FIG 2.2. Habitat polygons mapped by SWAT for different species in the Lax Skiik house group territory. The aggregated map (bottom) was supposed to serve as the basis for an ecosystem based management (EBM) plan for the Lax Skiik territories. Modified from Gitxsan Strategic Watershed Team 1999.

FIG 2.3. Screenshot of webpage displaying ESRI's interview with Russell collier and their coverage of the SWAT-produced document, "The Gitxsan Model." Modified from Convis 2000.

Tweeten

+1

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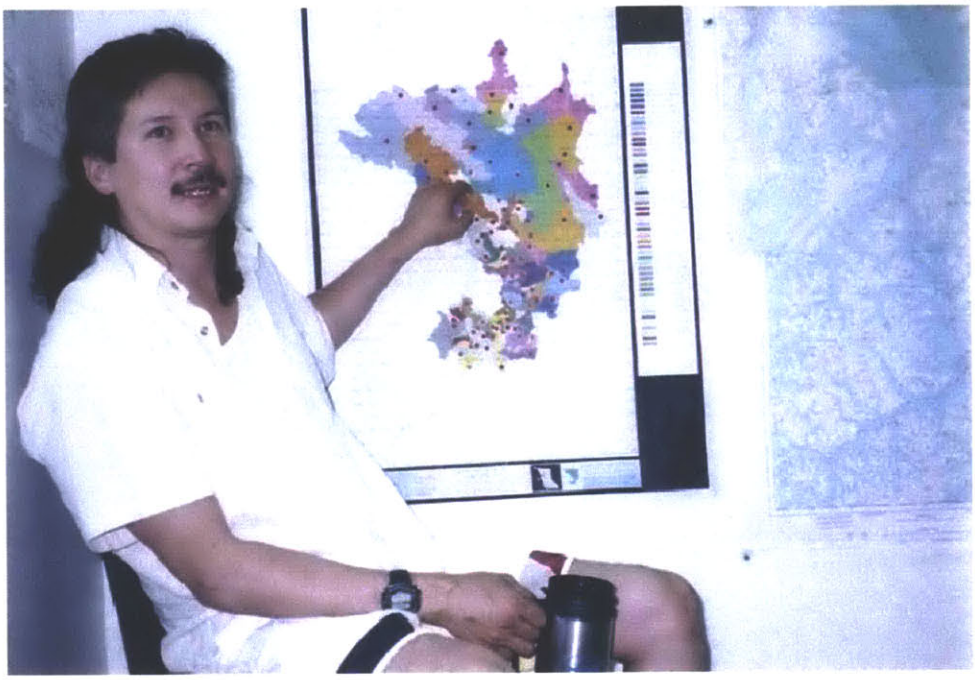
CORRESPONDENT FRANK KUIN > BRITISH COLUMBIA > GITXSAN INDIANEN WINNEN SLAG BIJ STRIJD OM LAND IN WESTELIJK CANADA

Gitxsan Indianen winnen slag bij strijd om land in westelijk Canada

01/08/1998 · 4 REACTIES



Een lid van de Gitxsan bevolking toont het gebied waarop de inheemse groep aanspraak maakt.

Tot voor kort trokken de indianen aan het korte eind in de strijd om de eigendomsrechten van land in Canada. Een uitspraak van het Hoogerechtshof over de Gitxsan bevolking heeft daar verandering in gebracht. "De indianenoorlogen duren nog altijd voort, al voeren we ze nu in de rechtszaal."

FIG 2.4. Screenshot of Dutch language environmental political blog displaying Russell Collier describing ongoing mapping projects on Gitxsan Traditional Territory. Modified from Kuin 1998.

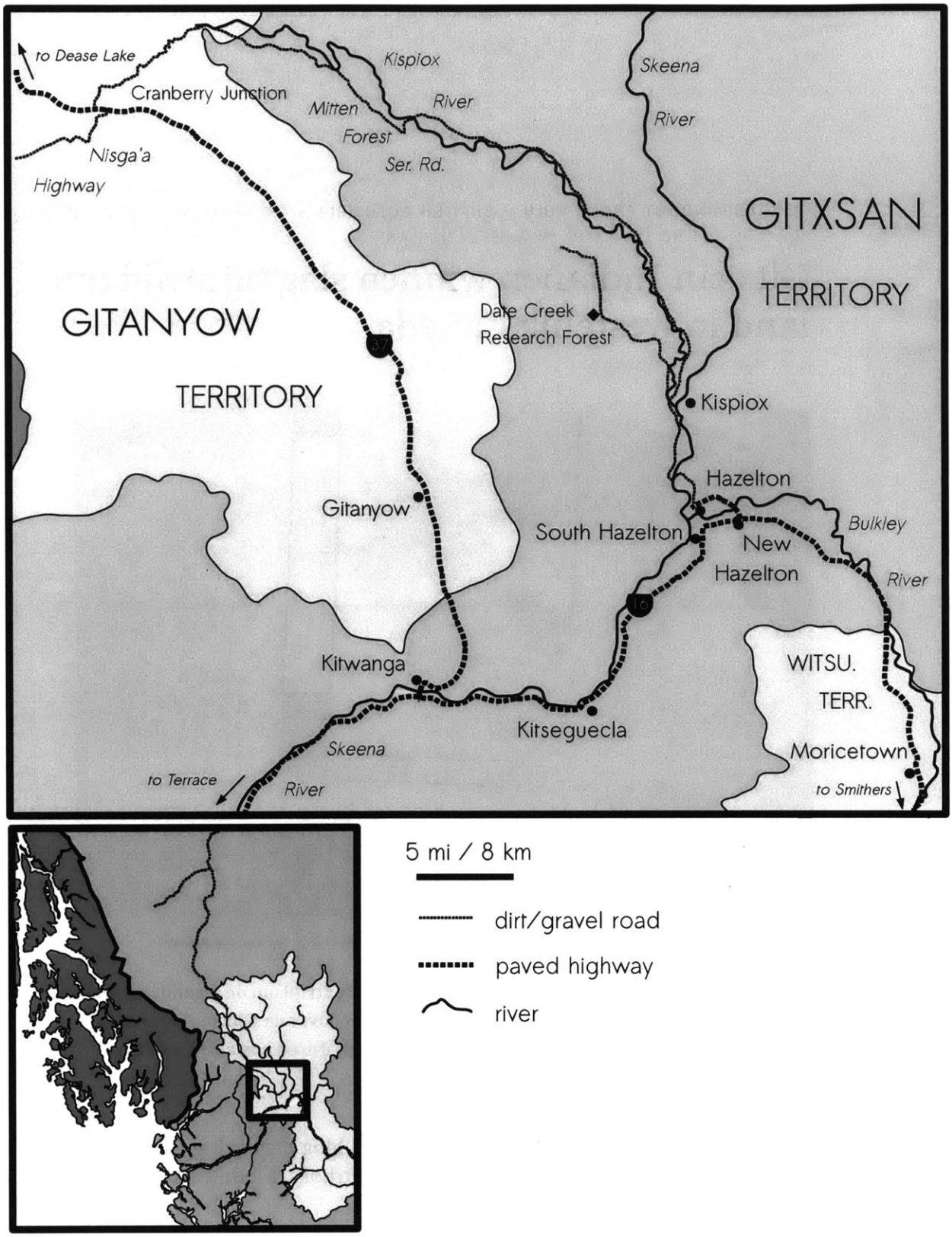


FIG. 3.1. Date Creek Research Forest, Cranberry Junction, Gitxsan villages, and environs.

Chapter 3: Into the Woods

Placing Science and Making Time in a Post-Disturbance Regime

She was out on assignment, working in the field – it was the exclusion of intimate involvements that made a place a field and the line between the two was marked by a taboo that she could not cross except at the risk of betraying her vocation.
– Amitav Ghosh (2005: 95)

FIG. 3.2. Dennis cuts through a treatment unit on a recently renovated boardwalk trail.

The Road to Date Creek

After six hours climbing through the Date Creek Research Forest, measuring trees and taking notes, it was time to go home. My recently-sprained ankle was throbbing. Anand's hands were swollen with mosquito bites.[1] Kristen, in her early thirties already the most experienced of us three assistants, carefully picked dozens of tiny thorns from her lower arms, and winced as she stretched. Even Dennis, a senior research scientist in the British Columbia Ministry of Forests, Lands, and Natural Resource Operations (FLNRO), the original founder of the Research Forest, and the stalwart leader of our ad-hoc measurement group, admitted he was eager to rest his legs during the hour and a half-long drive back to Smithers. Ready to dispense with our heavy rain gear and escape the muggy June heat, we tossed our equipment into the bed of the truck and settled into our seats for the bumpy ride along the maze of rutted Forest Service roads back to the highway. Over the course of the summer our truck had shared these narrow logging roads with geese, wolves, and on two unsettling occasions, families of bears. As we began our drive south on this particular midsummer afternoon, though, we encountered a different kind of fellow traveler heading north: another truck.

Huh. What do you think he could be doing way out here? Dennis wondered aloud as we approached.[2] Lifting his faded brown Forest Service cap to wipe away the sweat collecting along his creased brow, Dennis's thick gray mustache rustled as he spoke. The rest of the group remained quiet. As we rolled towards the truck on the one-lane road, the other driver slowed to a stop and pulled aside to allow us room to pass. Dennis and the other driver rolled down their

1 All of the names provided in this chapter are pseudonyms.
2 Wherever quotations are used in the text, paraphrased statements are depicted in italics, and tape-recorded direct quotations are depicted between quotation marks in non-italicized font.

windows, greeting each other with cautious smiles. *Hello!* Dennis offered. The other driver, an elderly First Nations man, nodded awkwardly in return. *So what brings you out here this afternoon?* Dennis asked. The other man smiled, and nodded again. *Just comin' to check things out, you know. Just goin' for a drive.* Kristen, Anand and I, still silent, looked on from inside the truck. Dennis flashed another smile and waved the other driver on. *Okay, well, have a good day.* Nodding yet again, the man rolled up his windows as he slowly drove away. As Dennis steered our truck back onto the rutted gravel road, we traded a few ideas about what the man was *actually* doing so close to the Research Forest. Was he collecting firewood? Scouting for moose? Gathering huckleberries? Was he lost? The main branch of the Date Creek Forest Service Road links the Kispiox Valley to the Cassiar-Stewart Highway, the only north-south route through the entire northwestern corner of British Columbia. Once on this branch, we invariably tuned our truck's CB radio onto the local frequency, listening for warnings of oncoming logging trucks descending south from new cutblocks further north along the Skeena River. The side road we were on, though, only went to the research forest, a mostly flat, trail-less, four square kilometer expanse of old- and second-growth transitional forests. Where was this man going?

While nobody made the point explicitly, our guesses reflected a vague, perhaps embarrassed, unease that the man and his truck were somehow out of place. It didn't particularly matter that the Research Forest, like 95% of the province of British Columbia, falls on "Crown land," which is owned by either the provincial or federal governments and is meant to be accessible to the general public (through a set of long-challenged colonial-era policies still known as the "free entry system").[3] The four of us, three whites and a Hindu man originally from

3 The complicated legal status of Canada's Crown Land, including the procedures required to develop it, the "rights" of early Euro-Canadian settlers to pre-empt it, and the challenges First Nations groups have faced while attempting to occupy, use, and reclaim it is the subject of a larger number of books, and indeed, is a theme which, implicitly or explicitly, binds together every chapter of this dissertation. For a detailed discussion of the historical roots of the "free entry" system, see Dickerson 1992. For a discussion of the links between Free Entry

Bangladesh, also didn't remark on the fact that our encounter took place just a few kilometers from the entrance to Kispiox Village, one of half a dozen Gitxsan and Gitanyow First Nations reserves in the area. I didn't learn until much later in the year that the bridge to Kispiox Village, the same bridge we passed each day next to the entrance to the Date Creek Forest Service Road, was the site of the first major Gitxsan anti-logging blockade in 1988 (Glavin 1998; Blomley 1996).[4] The Kispiox blockade ended after a day-long standoff between Gitxsan chiefs and loggers brought hundreds of Royal Canadian Mounted Police to the village, but it also helped to open up a northern front in the "War in the Woods." Initially begun on Vancouver Island as a series of blockades and protests against clearcutting in old growth rainforests, the "War" generated international attention which catalyzed other kinds of demonstrations against the seemingly unchecked power of the provincial timber industry.[5] The Gitxsan were the first of more than two dozen First Nations groups in British Columbia who eventually organized timber blockades on public roads as assertions of tribal sovereignty. They eschewed southern Canadian activists' universalizing laments over the destruction of "pristine wilderness," attacking the management of northern logging operations as the illegal expropriation of their rightful resources.

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and other historical developments in property law and expropriation in former British colonies, see Buck, McLaren and Wright 2005.

4 As I discuss in the introduction and in chapters two and four, many Gitxsan people link the impetus for these blockades not simply to the white-led conservationist movements on Vancouver Island, but to a much longer, richly narrativized history of Gitxsan protests against colonial rule. For examples from a timeline authored by representatives of the Gitxsan Treaty Society, see Gitxsan history of resistance, N/d.

5 Geographers and environmental historians alike cite the "War in the Woods" of the 1990s as a major turning point in Canadian environmental politics. Thanks largely through their strategic uses of popular media coverage of the confrontations on Vancouver Island and of other nonviolent protests throughout the province, blockade participants simultaneously presented old-growth forests as problematically commodified objects (e.g. within globalized systems of unequal exchange) and as sacred spaces "beyond politics." For a detailed examination of how the restructuring of the Canadian timber industry and shifts within global markets shaped the "War," see Hayter 2003. For a general summary of the confrontation and of the policy shifts that followed from it, see Salazar and Alper 2000. *Sustaining the forests of the Pacific Coast: forging truces in the war in the woods*. Vancouver, BC: University of British Columbia Press.; For critical readings of the political metaphors and tactics used on both sides of the debate see Wilson, 1998; Braun 2002.

Other predominately white residents of the Skeena region and the nearby Bulkley Valley framed their anxieties not as battle of "nature" versus industry, or of Aboriginal land claims versus white settler encroachment, but as problems of technical representation. While southern and coastal regions of the province had contributed to an immense timber economy since the early twentieth century, industrial-scale logging had only begun in the northwest in the 1970s. For the ecologists and environmental activists who began moving to the northwest from Vancouver and eastern Canada during this period, the visibility of the changes wrought by ever-expanding harvests was unsettling. The seeming incalculability of it all, though, provided the rhetorical framing for a regional call for action. By the early 1990s, several dozen residents of the Bulkley Valley successfully re-directed provincial fears of new Gitxsan-led blockades into support for the nascent Land and Resource Management Plan (LRMP) movement. As I described in the opening chapter, the structures of landscape representation introduced by LRMP organizers gave Smithers-based ecologists access to new idioms for articulating arguments against clearcutting, and for anchoring their research to emergent regional governance projects. As the 1990s wore on, other regionally active groups of forestry scientists leveraged these same provincial anxieties to legitimize and gain increased visibility for a class of representational forms of a much more modest scale: the individual tree stand.

As the representational frames in circulation among Smithers-based forest ecologists gathered political saliency during the late 1990s and early 2000s through the institution-building work described in the opening chapter, scale itself became a powerful legal and rhetorical tool.[6] If the landscape-scale polygons generated through the LRMP process offered a system for

6 Particularly within political ecology, much has been made of cultural geographers' use (and abuse) of the concept of "scale" as both an actor-category and analytic in recent years. My purpose here is not simply to reprise these well-known accounts of how ecological scales are produced and promulgated, but to show how the meanings attributed to such productive work change over time as orienting questions and measurement practices shift. For a critical review of some of these conversations, see Neumann 2009.

assessing forests for metrics of biodiversity, visual quality, and soil retention over and above the financial value of their individual trees, however, stand-level ecologists and alternative siviculturalists practiced a subtler politics. A "stand" of trees is defined as a group of trees of similar species composition, typically substantially less than one square kilometer in extent. As my interlocutors at Date Creek were quick to point out, such dimensions made possible an altogether different form of analytical practices within the forest. By carefully measuring and modeling how specific trees in differently managed stands grow, practitioners of silviculture have for centuries dictated forest use laws around the world and provided technical credence to state- and corporate land management policies (a history I will briefly outline in chapter five).

By building critiques of emergent policies into stand-level computer models of tree growth, however, a number of British Columbian silvicultural researchers began to eschew the "community values"-based rhetoric of the LRMP movement to more directly undermine the most sacred – and most seemingly apolitical – of the rationales used to justify large-scale clearcutting: the data-backed promise of efficient timber harvests and dependably high yields. Following examples set by the US Forest Service amidst other anti-clearcutting protests then raging throughout the American Pacific Northwest, the British Columbia Ministry of Forests offered to fund large-scale studies of selective harvesting and other alternative silviculture systems in the Skeena region, as well as in a number of other particularly turbulent regions throughout the province.[7] Dennis and a small group of other Smithers-based Ministry researchers responded by proposing the creation of the Date Creek Research Forest in the Kispiox Valley – right in the heart of the Gitxsan Nation's traditional territory.

My conversations with Kristen and Anand often drifted to First Nations politics and the

7 The literature on these recent experimental forests is large and diverse. A few examples include: Franklin 1989; Hansen *et al.* 1995; McClellan *et al.* 2000.

demonstrations against the proposed oil, bitumen, and natural gas pipelines that were bringing hundreds of residents onto the streets of Smithers and the nearby Witsuwit'en village of Moricetown throughout the summer. Despite this, they were, like me, still only beginning to learn many of these earlier stories.[8] The broader history of the region was not lost on Dennis, though. He and his wife Pauline, the ecologist and community activist we met in chapter one, had already spent decades challenging their colleagues to engage more actively with Gitxsan, Gitanyow, and Witsuwit'en people and governance groups throughout northwestern BC. Pauline had served as an expert witness on behalf of both the Gitxsan and Witsuwit'en during the landmark land claims trial, *Delgamuukw v. the Queen,* the first legal judgment to recognize standing for First Nations chiefs as governing entities, and the first to recognize Aboriginal title within Canadian common law.[9] Dennis had consulted with the leaders of four Gitxsan house groups while formalizing the initial plans for the Date Creek Research Forest in 1990, and he and the senior members of his team continued to provide these groups with research updates at occasional community meetings in Kispiox Village. During this chance encounter on the road, Dennis had been cheerful and polite. He didn't suggest to us that the man *shouldn't* have been on that road, or that he was actually worried about what the man was up to: he simply started a conversation inside our truck about how it was odd for the man to be out there at all. As we timidly traded theories, though, the sense of awkwardness lingered.

In chapter one of this dissertation, I explored how Bulkley Valley Research Centre (BVRC) members positioned field-based environmental science, cumulative effects modeling, and "open data" ethics as a means of legitimizing local political actors in shifting debates over

8 For a discussion of anti-pipeline protests from the standpoint of ongoing Witsuwit'en struggles for sovereignty, see McCreary and Milligan 2014.

9 The legacy of the *Delgamuukw* decision is addressed at length in another section of the dissertation. In the meantime, for a comprehensive account of the Canadian government's many and various attempts to deny legal standing to First Nations leaders, governing entities, and institutions, see Culhane 1998.

environmental management. This chapter examines how thirteen years of regulatory devolution and government contraction have forced BVRC researchers to contend with the precariousness of the physical space of their experimental work. Since the founding of Date Creek in the early 1990s, the focus of Dennis's partial cutting experiments has diverged. In publications throughout the 2000s, his group shifted away from early questions about post-clearcutting succession dynamics to examine how emergent tree diseases, pest outbreaks, and other climate change-related effects have begun to unsettle the predictive models of conventional silviculture. The political orientation of their motivating questions changed as well, as they moved from tracking deliberate, ostensibly "human" changes in the forested landscape, to measuring the succession effects of marauding beetles, fungi, and other agents further removed from human intervention.

In this chapter, I argue that, as the meanings of their original experiment changed and the infrastructure of the Research Forest itself began to decay, Date Creek researchers began to position their observations of the consequences of "natural" disturbances to highlight the incommensurability between the temporalities of bureaucratic transitions and forest change. Even as the experiments there began to fade from provincial awareness, self-consciously "local" experts like Dennis continued to devote their careers to using the space to undermine Ministry claims of synoptic knowledge and control. In the following pages, I will briefly outline how the outputs of long-term silvicultural research have been taken in up in far-ranging confrontations over the local meanings of development and ecological transformation. Returning to Date Creek, the chapter then charts how Dennis and his different collaborators have sought to negotiate these legacies: first as they worked to promote the research forest itself as a space of exploration and inspiration; and later as they focused on building a distributed network of programmers and ecologists, each one devoted to establishing a science of tree growth prediction rooted in the

ecological theory of disturbance dynamics. Walking the forest for a summer with Dennis, Anand, and Kristen, I draw upon their stories, behaviors, observations, and lessons to begin to assemble a picture of how they distinguish their work from other ways of measuring changes in the forest, and how they seek to make visible the trees, marks, structures and temporalities which I often failed to notice or imagine on my own.

Measures of Precariousness

As Smithers-based researchers learned throughout the early 2000s, access to forest laboratories and mastery over models is no guarantee of political recognition. In the wake of the mountain pine beetle epidemic (see chapter five), many of the project organizers affiliated with the Bulkley Valley Research Centre (BVRC) sought to use their new positions to speak out about the ways government restructuring had left the region vulnerable to the effects of climate change. Most of those who studied the beetle agreed that they had mushroomed in number because northern winter temperatures no longer dropped low enough to control their populations. The destruction the beetles had wrought across hundreds of thousands of square kilometers of forest revealed that the province could no longer afford to treat the timber harvested from these regions as a dependable, predictable resource. The political hysteria surrounding the epidemic had been used by the province to justify a state of exception, a blanket excuse for expanded logging quotas in hastily defined "salvage areas." The new salvage area maps included within their boundaries broad regions that had been only lightly affected by the beetle, or where few pines grew amidst many other tree species (Pynn 2011a, 2011b, 2011c).[10]

10 For the law itself, see Forest Act 2016, Chapter 157. Available at: http://www.bclaws.ca/civix/document/LOC/complete/statreg/--%20F%20--/Forest%20Act%20%5BRSBC%201996%5D%20c.%20157/00_Act/96157_03.xml#section14.1. Accessed 12 July 2014.

The maps also included vast swaths of landscape within traditional territory claims of dozens of different First Nations, including the Gitxsan's claim to the entire Kispiox Valley. While the mountain pine beetle had wrought havoc throughout the Bulkley Valley, the epidemic had barely brushed the Kispiox Valley. Sheltered by the damp climate and a profusion of other tree species dominating the region, the few lodgepole pines scattered throughout Date Creek were barely affected, even as the beetles pushed west along the Skeena River. When scientists affiliated with the BVRC spoke out against the ecological merits of salvage logging, many of them positioned the BVRC and its related institutions as new forums for environmental governance (Lindenmayer, Burton and Franklin 2008). Landscape-level models of post-pine beetle forest change produced by BVRC researchers and affiliates played a key role in informing these protests, particularly as institutional restructuring forced individual modelers to find new spaces from which to personally advocate for their models. If the provincial ministries were unwilling to help northern communities plan for an uncertain future, they argued, then altogether different configurations of data, governance, and expertise would have to emerge to guide the way.

With few exceptions, the Gitxsan house groups in the Kispiox region and the Witsuwit'en groups in and around Smithers have not participated in these projects or played active roles in the formation of these institutions. Many remained mindful of government lawyers' attempts in earlier proceedings to abrogate territorial claims by equating their collaboration in scientific projects and participation in resource management studies with their nation's complicity with Canadian sovereignty. Others resented the condescending structure of expert-driven "consultation" and the limited "stakeholder" roles offered to them by the groups conducting studies on what they saw as their own land (Nadasdy 2003). Many Smithers-based experts

leveraged the technical models produced at Date Creek and elsewhere to gain visibility for their complaints against salvage logging and their pleas for more expansive environmental stewardship. Drawing on the new institutions and personal connections formed around independent research projects, many researchers worked to credit the authorship of these claims to a rural public who felt they had been left adrift after a decade of government restructuring. The Gitxsan and Witsuwit'en men and women who lived in the region were looped in with this public in ways with which they did not always agree. As the presence of researchers throughout northern BC rapidly expanded during the last decades of the twentieth century, the stewardship claims of the Gitxsan and Witsuwit'en became increasingly submerged in a profusion of new models and institutions which white residents sought to use to speak about the regional landscape on their behalf.

The tone of our brief encounter on the road to Date Creek spoke to this pattern of mutual mis-recognition. Less than twenty five years after Gitxsan intransigence had helped create the impetus for the Research Forest in the first place, the presence of an unassuming First Nations elder there felt like an aberration. Simultaneously Crown land, outdoor laboratory, and traditional territory claimed in different parts by the Gitxsan houses of Wii Eelast, Delgamuukw, Ma'uus, and Kliiyem Lax Haa (Coates *et al.* 1997: 2), visitors to Date Creek waded through multiple registers of rules of access: most of them tacit; many of them now conflicting; all of them hierarchically intertwined.[11] Prior to the proclamation of British colonial rule over the region in the 19th century, visitors to Gitxsan house territories sought explicit permission from the chiefs of

11 As James Ferguson (2006: 176-193) has repeatedly argued in his critiques of globalization theory and of ways of writing about the expansion of neoliberal economic policies, regardless of the proliferation of ontologies of territory, spaces are and have always been hierarchically intertwined, whether through unequal trade relationships, legacies of colonial subjugation, or discontinuities of development. See also Ferguson and Gupta 2002.

these territories (Sterritt *et al.* 1998, 98-131).[12]

Few visitors nowadays think to seek such permissions, but many celebrate the almost total lack of provincial restrictions on travel within Crown land. The few written signs scattered within the forest simply proclaim the existence of ongoing research trials (figure 3.3). They carry no explicit prohibitions other than "Do Not Disturb," assuring viewers that "Results will guide Forest and Range Management." Designed to remind visitors of the policy implications of Date Creek's silvicultural experiments, the signs almost seem to confer upon visitors the privilege of witnessing the very production of political legitimacy. In a liberal democratic resource state like Canada, respect for – and trust in – forestry science had for decades been simply assumed, since governance *of* the forest depended on the generation of knowledge *about* the forest. You are entering a laboratory, a sacred space; the signs seem to call out: tread lightly.

When I first arrived in British Columbia for research in 2011, I was powerfully drawn to these kinds of rural laboratories, whether geological exploration field sites, research forests, archaeological digs, or insect collection areas. On my first trips north of Vancouver, I began to spot the colored ribbons, reflective field vests, and other tell-tale signs of science-in-the-bush whenever I ventured off the highway. At archaeological overview assessment sites around proposed road construction projects near the northern BC city of Prince George, these signs and markers might only be present for an afternoon, or however long it takes a group of contractors to walk lines through an area, visually inspect the trees and ground along their paths, and articulate a reasoned judgment against the likelihood of a more substantial search uncovering "cultural heritage resources" there (see chapter four).[13] Against a backdrop of orange field vests

12 For a more general discussion about First Nations' strategies for governing space and territory, see Harris 2002.

13 Archaeological overview assessments (AOA) and archaeological impact assessments (AIA) undertaken in British Columbia must follow strict baselines stipulated by the provincial Ministry of Forest, Lands, and Natural Resource Operations. (See the Ministry webpage for details on these operations: http://www.for.gov.bc.ca/archaeology/docs/impact_assessment_guidelines/assessment_and_review_process_par

and government trucks, field workers entered the forest to make maps, lending formal visibility to the presence – or, more importantly, the absence – of protected artifacts like ancient hunting tools, cache pits, and intentionally modified trees. At long-term experiment venues like the Date Creek Research Forest, formalisms are produced not merely to mark space, but to make visible the passage of time.[14] By projecting decades' worth of possible futures onto regional landscapes, government-managed silviculture experiments offered to rural residents and prospective developers a plausible horizon of expectation articulated through data-driven images of environmental change.[15]

As Dennis and others frequently reminded me, the institutional precariousness of their work meant that any of the projections put forth by these experiments were inevitably contingent and incomplete. Since the first long-term experiments began in the Date Creek Research Forest in 1990, a number of websites, databases, and informal catalogs have been established by Dennis and others to collect the aggregated output of the experimental work undertaken there.[16] Given the erratic turnover among the dozens of researchers who have visited the forest during this period, even Kristen and Anand's most exhaustive attempts to map the locations of individual research plots within the forest yielded at best a partial sketch. On the basic maps we take with us into the forest – paper marked only with crude shapes denoting treatment unit boundaries and roads, with dotted lines around the initial removal areas – the locations of a few of these plots are

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t2.htm. Accessed 21 July 2014.) See also: Northern archaeology. *Northword.* September 24, 2007. Online at http://northword.ca/october-2007/northern-archaeology. Accessed 21 July 2014.

14 In multiple works throughout his career, Bruno Latour cites "inscriptions," the paper (and, increasingly, digital) artifacts of laboratory-based observations as both the singular outputs of experimental research as well as the vehicles of technocratic authority. Latour (1990) also repeatedly explores the links between print-making technologies and conventionalized inscriptions within the framework of what he calls "immutable mobiles" defining "formalism" less as a stand-alone product of scientific knowledge production than as a process in itself, as "*the acceleration of displacement without transformation*" (53).

15 On the genealogy of the concept of "horizons of expectation," see Koselleck 1985.

16 The public versions of these lists, like that on the official Date Creek Research Forest website (https://www.for.gov.bc.ca/rni/research/date_creek/DCStudies.htm. Accessed 26 March 2014.), tend to be outdated.

marked (see figure 3.4). Most are not. Even along the Forest Service road to Date Creek, several other government-run long-term experiments offer similarly ambiguous clues. Some are marked with fading metal signs describing a decades-old trial study in clearcut-based tree growth ("That's *hard* silviculture – plantation, even-aged management, which trees are best. It's an experiment by geneticists," Dennis once volunteered as we passed by one such sign (figure 3.5) near the southern entrance to Date Creek). Others are denoted only by a brief flourish of pink, blue, or orange ribbons (see figure 3.6). A researcher might easily walk an entire summer among these nested experiments without knowing anything of who first planted each stake and tied each ribbon, or why.

The scattered array of overlapping experimental plots I entered twenty-three years after the founding of Date Creek mirrored the palimpsest of geographies in which the Research Forest itself was embedded within the Kispiox Valley.[17] That each ribbon-marked area denoted the site of delicate manipulations and prolonged, systematic observations did little to keep their boundaries distinct, even as ecologists, biologists, and other scientists worked in and among the plots to observe phenomena spanning a wide range of temporal and spatial scales. Exploring the professional identity crises which reshaped various disciplines of field biology between the nineteenth and twentieth centuries, historian Robert Kohler invokes a range of heuristics and metaphors to describe how different communities of scientists approached and policed the often-ambiguous boundaries between the spaces of laboratories and field science.[18] Ultimately, Kohler argues proponents of ecology and field-based biological studies resigned themselves not to challenging the hegemony of laboratory practice, but to using their work to champion the value

17 Lisa Messeri (2011) describes the simultaneity of concepts of territory invoked by users of the same space (and particularly by scientists and non-specialists) as a "double exposure."

18 Kohler 2002. Discussing the social politics of these demarcations, Kohler draws heavily on the work of sociologist Thomas Gieryn (1983), whose concept of "boundary work" was originally addressed to the longstanding problem in the philosophy of science of distinguishing between "science" and "non-science."

of longitudinal studies, "natural" variability, and "real-world" experience.[19]

By essentially taking at face value what each community defined as an "experiment," however, Kohler avoids explaining how the transposition of laboratory practices from bench tops to forests implicated field biologists in broader dialogues on the worth and meaning of these evolving experimental spaces.[20] For Dennis and his group, the meaning of "experiment" was a moving target, an orientation toward the forest and its trees that shifted in tone as their definitions of "disturbance" expanded and their target audience dispersed.

Covering four square kilometers of the Kispiox Valley, the largest experimental plot encompassed the entire research forest itself and included all of the smaller experimental plots within it. And yet, even at the broadest scale, the distinction between "field" and "laboratory" was far from clear. The impetus to create the Date Creek Research Forest was structured by a proposal to compare the growth rates of trees subject to partial cutting to the mountains of measurements already taken by provincial silvicultural researchers working on unharvested stands and post-clearcut plantations. Shade modulates tree growth, as Dennis acknowledged throughout his published work, but the conventional wisdom motivating the province's initial move to clear-cut harvesting in the mid-twentieth century simplified this relationship to near-caricature. In some of the competing models I will explore in chapter five, all of the simulated trees growing beneath the upper canopy simply "die," leaving a simplified, even-aged forest to maximize its coverage across a re-planted cutblock. The grand experiment inaugurating Date

19 As Kohler and others make plain, of course, each of these "values" bears the mark of historical construction and contingency. See Kohler and Kuklick 1996. For a contemporary analysis of the political stakes of similar demarcation strategies, see Cittadino 2004; Lave 2012a. As others have argued, the design and organization of field research stations was also in many cases driven by researchers' desires to maximize their access to summer holiday destinations and various middle class leisure pursuits. See Pauly 2000.

20 In the seventh chapter of the book, "Nature's Experiments," Kohler (2002: 212-51) does discuss how the emergence of glaciology and other disciplines provoked debates over the accuracy of existing observational practices, but he says little about the broader political roles played by the scientists engaged in this work.

Creek asked more complicated questions about the links between light and life, including how *gradients* of brightness produced by overstory shade influence growth and inter-species competition among the younger trees below. As beetle-killed pines opened holes in managed forests throughout the 2000s and turned simplified plantations into pockmarked, complex stands, the bluster behind growing salvage logging campaigns lent these comparisons greater urgency. What began as an experimental comparison between levels of manipulation and human-induced structure was re-framed as a physical model of "natural" change.

Long before Dennis and his group began to position Date Creek as a simulator of future natural forests, though, they spent months identifying the operational variables that would be imposed on their experiment by the topography of the initial installation. Selecting a broad and relatively flat swath of transitional forest which had somehow evaded logging companies working their way north through the Skeena watershed in the 1970s and '80s, the founders proposed to establish a series of sixteen "treatment" units (see figure 3.7). The founders described the structure of the experiment as follows:

"Two levels of partial cutting were used and compared with both undisturbed forests and clearcuts. In the light partial cutting treatment, approximately 30% of the stand volume was removed by cutting either single stems or small gaps (3–10 trees). In the heavy partial cutting experiment, approximately 60% of stand volume was removed, The cutting pattern utilized both large gaps (0.1-0.5 ha[21] in size), evenly distributed across the treatment units and either single trees or small gaps in the forest matrix between the large openings. With the exception of scattered residual deciduous trees (most trembling aspen and paper birch), all stems were removed in the clearcut treatment units. There were four replicates of each of the four treatments, organized in a randomized block design; treatment units were approximately 20 hectares in size. The intent was to create four differently structured stands that would provide a

21 Hectare, or 0.01 square kilometers.

wide variety of environmental conditions both between and within treatments" (The Date Creek Silvicultural Systems Research Project, N/d.).

Dennis and his early collaborators treated the "field" produced through these tree-removal "treatments" as a massive physical simulator, a model of the forested landscapes across all of the province's mapped ICH-MC2 climatic zones ("interior cedar-hemlock, moist-cold, second subdivision"; or in the parlance of conventional British Columbia silviculture, "site index 20").[22] Each "removal area" opened a hole in the canopy of a slightly different size, apertures which were coded into SORTIE-ND computer simulations (see chapter five) as sources for vectors of sunlight (for an schematic illustration of one such "gap," see figure 3.8). Each opening also produced a separate gradient of potential "fields" for smaller-scale experiments, whether on the decay rates of rotting logs; bird and rodent habitats preferences; competition between lichen species; and other ecological problems. Within patches of heavy shade under towering old-growth groves of cedar and hemlock, mycologists marked out plots to track changes in fungi on the "untampered" forest floor.

Most of Dennis's structural language obviated these smaller scales by classifying phenomena within the framework of the initial Date Creek shade and succession experiment as a whole. To the variegated domain of trees underneath the main canopy, anomalies in even-aged plantations and statistical remainders within most intensive management systems, Dennis proposed a name: "secondary structure" (Coates *et al.* 2006). By the time I visited the forest in 2013, the term had become ubiquitous throughout Canadian forestry research and management

22 The biogeoclimatic ecosystem classification (BEC) system was developed in British Columbia between 1950-75 as a means of providing Ministry silviculturalists and other government and academic environmental scientists which a standardized language for grouping sites and regions across the province according to the kinds of vegetation found there. As I describe in chapter one, several residents of Smithers participated in these foundational studies prior to moving into forestry consulting or other Ministry work. For a historical discussion of the creation of the BEC system, see Pojar, Klinka and Meidinger 1987.

bureaucracy. Within the space of his model, the term helped smaller trees to become visible. Outside in Date Creek, they were often all one could see.

The analytical work required in order to build up a complete SORTIE succession model of a multi-species, multi-generational tree stand demands expertise in computer programming (typically in the statistics-friendly coding language *R*, or GNU S). As I will explore in the fifth chapter, members of Dennis's group focused on assembling, testing, and "validating" new SORTIE simulations throughout the long winters between summer field seasons, weathering confrontations with other groups of Ministry-based programmers whenever Dennis travels south to Victoria. The work of collecting the data required to feed a SORTIE model, however, is more inclusive, since measuring trees requires little beyond the ability – and willingness – to follow instructions, operate a compass, and read numbers off a tape measure while fighting through thickets of spruce and bogs filled with spine-covered shrubs. Over the course of the summer of 2013, Dennis had decided to take a complete basal area plot of the research forest as a whole – effectively, an estimation of the density of growing wood as a function of the volume of the entire study region. While Dennis's group had performed a similarly ambitious set of measurements using a "fixed radius plot" method a few years earlier, our group set out to repeat this calculation using "variable radius" method (both methods will be explained shortly), the first time the method had been used to measure the entire forest since experiments were formally initiated in 1990.

In the two and a half decades since its inception, Date Creek had become home to dozens of additional experiments covering everything from post-harvest soil disturbances to bat habitat and foraging behavior. Given that the very creation of the forest was motivated by Dennis's argument that properly managed partial cutting could compete with the long term timber yields

of conventional clearcutting, measuring the overall change in basal area remained central to the identity of the project as a whole. As encroaching pine beetles and other harbingers of climate change caused Date Creek ecologists to re-conceptualize the forest as a simulator of impending uncertainty, however, what these measurements implied about intensive forest management was steadily changing.

A Witness on the Land

The growing precariousness of government-run, long-term experiments like those in place in the Date Creek Research Forest highlights a shift in how resource states like Canada are drawing on their scientific classes to make visible their power and promise. Whether or not research is conducted in publicly accessible areas (let alone outdoors, on public land), the generation of factual knowledge through the collective observation of scientific experimentation has, according to historians Steven Shapin and Simon Schaffer (1985), been a fundamental component of liberal democracy since the founding of the British Royal Society in the seventeenth century. In *Leviathan and the Air-Pump,* Shapin and Schaffer explore the spectacle generated around Robert Boyle's vacuum chamber experiments and his ensuing argument with Thomas Hobbes. In Boyle's schema, the unaided visual observation of his experiments by a court of non-specialists, each one a "modest witness," represented the emergence of an altogether different sphere of public discourse. Ostentatiously disavowing the rhetorical arguments more commonly treated by other British natural philosophers of the period as the proper medium of philosophical "experiments," Boyle implored each viewer to come to their own conclusions about his arguments based on what they themselves saw. Boyle encouraged each witness to feel

as if he[23] were an equal participant in the creation of knowledge itself, albeit without, as Hobbes warned, any of the formal tools required to analyze the visual rhetorics framing the experiment itself.[24]

With forest growth trends and species changes only immediately visible in the slowly accreted measurements of generations of visiting researchers, the layered plots of long-term experiments I negotiated at Date Creek recast this analytical challenge as a moral conundrum. In *We Have Never Been Modern*, Bruno Latour (1993) returns to Shapin and Schaffer's text, arguing further that the very concept of modernity rests on the figure of the modest witness and on the distinction between "natural" and "social" domains made manifest in the structural organization of the space of experimental demonstration. "Natural" phenomena are isolated so that they can be "socially" observed and agreed upon. As Latour argues in his later work, the experimental apparatus itself quickly disappears in this arrangement, allowing technocratic spokespersons to engage in politics on behalf of "nature," as if "nature itself" were authoring their pleas (Latour 2004). In precarious, long-term experiments, the boundaries of an observation are rarely so self-evident. For Dennis and his group, enough time had passed since their previous round of measurements that the new political imperatives that the BVRC had attached to their research in the intervening years pervaded their awareness as they worked. As the modalities of "disturbance" that structured their observations steadily expanded to include the peripheral

23 Shapin and Schaffer make repeated reference to the fact that women were excluded from the Royal Society and from observing experiments with Society members. In *Modest_Witness@Second Millenium,* Donna Haraway (1997) takes more seriously these procedures of exclusion, arguing that the the gendered segregation of the experimental hall did not simply define the Society as an elite, all-male institution, but rather defined gender itself as a marker of who was and was not capable of observing and legitimating the production of factual knowledge.

24 In recent years, historians of science have sought to contextualize the ways in which experimental demonstrations appeal to different forms of "visual rhetoric" by attempting to explore links between observation, argumentation, and epistemology across a broad range of historical settings. See Daston and Lunbeck 2011; Canales 2010.

effects of anthropogenic climate change, keeping these phenomena visible meant redefining the scope and meaning of their experimental plots with each new round of measurements (see e.g. Rheinberger 1997).

Along the road to Date Creek, the visible apparatus of the interdigitated succession experiments spread throughout the forest offered a clear political message during the logging confrontations of the early 1990s, a promise that the insights of forestry research would transcend ideological divisions between First Nations groups and white residents over proper land use in the northwest. As countless historians and social scientists have argued in the years since *Leviathan and the Air-Pump* and *We Have Never Been Modern* were first published, all manner of projects in "modern" governance relied on similar arrangements for producing "facts" and projecting voices of authority (Braun 2002; Haraway 1997; T. Mitchell 2002). As the population of independent and academic researchers visiting the forest began to outnumber the Ministry scientists with whom Dennis had first collaborated, though, the performance of experiments – any experiments – in the face of the Ministry's declining investments in research was put forth as proof of different forms of commitment and care. As I observe in chapters one and five of this dissertation, both celebrations of and challenges to the infrastructures of intensive forestry management made similar appeals through varying media, with parties on both sides articulating claims of stewardship through carefully constructed datasets and simulators. Experimental evidence in hand, resource state technocrats and would-be local defenders alike declare what anthropologist Stefan Helmreich (2009) calls the "sovereignty of science": that the voice of technoscience, indeed, the will of *nature*, should be as audible as the human voices declaring the law of the land.

As our encounter on the road suggested to us, though, even physical signs demarcating

the spaces of expert knowledge production can go unnoticed if the individual experts who tend to these spaces cease to be bolstered by other kinds of political support. Particularly in an area beset by overlapping territorial articulations of reality and conflicting management jurisdictions, such signs can also just as easily be ignored. While sociologists of science acknowledge that technocratic networks invariably require care, attention and upkeep maintain to maintain their epistemic force, Latour's emphasis on the agency generated by the circulation of formalisms downplays the legacies of these institutional ruptures. In an early essay, he chides his colleagues for ignoring the significance of immutable mobiles, observing that "[t]he earlier we go back in history of science, the more attention we see being paid to the setting and the less to inscriptions themselves" (Latour 1990: 48). Once formalized, expertise becomes placeless, without histories or corruptible archives to confound its designs on power. Although a range of recent ethnographic work has helped to remind us that expertise has not completely usurped all other ideologies of environmental governance in the contemporary era (Coronil 1997; Lansing 2007 [1991]; Rappaport 2000 [1968]; Walley 2003), most of the scientific organizations imagined in these accounts are powerful institutions capable of bending political discourse to match their message, tone, and meter. The "obligatory passage points" of expert adjudication theorized by Michel Callon, John Law (1982), and others instantiate a hierarchy not only of power, but of the legitimacy of different groups' claims to knowledge (Latour 1987, 1999). The title of Timothy Mitchell's (2002) book puts the point succinctly – experts don't merely influence public projects: they *rule*. And yet on the road to Date Creek, as I watched a truckload of scientists quietly confront their own precariousness, I couldn't help but wonder where this power might have shifted.

Returning to Smithers after a day in the Date Creek Research Forest is typically so

uneventful that even a non-event like our brief roadside encounter hovered in my memory for weeks. After our embarrassed speculations gave way to other topics of conversation, I quietly imagined what the old man must have thought about *us*, a Forest Service truck full of awkward thirty-somethings and their gray-haired spokesperson, staring him down as if he were crashing an exclusive party. Aside from hanging a few ribbons and nailing a handful of metal tags on seemingly random trees scattered throughout the forest, what were *we* looking for out there, anyway? For several months, our small crew of researchers and helpers had been traveling to the area every few days from over one hundred kilometers away to count and measure trees and collect other data to feed into a complex ecological succession model more than twenty years in the making. The Research Forest existed largely for the production of this model, and the model was produced to project the future of the forest. As Ministry restructuring ruptured the lines of successional continuity within Dennis's group and eroded the visibility of the forest laboratory as a representational space, uncomfortable questions came to the fore: What difference did it make to have a few visitors wandering through the woods if the real experiment was taking place in a bank of computers back in Smithers? To what democratic process could nonspecialist residents hope to bear witness within this forest laboratory, if the politically mediated patterns of succession developed there could only be viewed as shifting polygons on a computer screen?[25]

25 Numerous scholars have asked what the emergence of computation and virtual visualization tools means for Shapin and Schaffer's (1985) articulation of the links between experimental demonstration, witnessing, and governance. Donald MacKenzie (2004) puts the question most directly, suggesting that the impenetrability of computer-based proofs renders impossible Shapin's (1991) search for "trustworthy agents," but that the pragmatic response of programmers to this impossibility produces its own governing effects. Hugh Gusterson (2005) suggests that the "virtual witnessing" of digital simulations of nuclear weapons tests, the present-day analog of earlier physical tests, removes much of the chastening emotional force provided by a first-hand encounter with a nuclear explosion. For a more general theoretical treatment, see Woolgar and Coompans 2006.

Peripheral Visibility

Cloistered as it is amongst the unmarked back roads of the vast Skeena watershed, I had long taken it for granted that the Date Creek Research Forest was *supposed to be* obscure: visible to those with Ministry maps and silvicultural research questions, but, to the rest of the local populace, effectively hidden in plain sight. It hadn't always been that way, though. Launched in 1992 to considerable public interest, the forest attracted a steady stream of visiting tour groups, often led by Dennis himself. "Early on, when Date Creek first went in, we had a mind boggling number of tours," Dennis reminisced to me. Politicians from Europe. Groups of children from nearby schools. At the height of the War in the Woods, the leaders of Greenpeace and the Sierra Club took time away from a meeting elsewhere in the Kispiox Valley to join Dennis for a personal tour. In Dennis's estimation, the attention of these visitors did more than simply validate the research program he and his collaborators had proposed at the outset. The politicians, activists, scientists, and students who made the trek out to Date Creek were led through the forest while learning about experiments on selective logging, multi-tree species growth systems, and the links between harvesting techniques and habitat viability for a range of forest animal groups.

Dennis reasoned that the Research Forest had played host to "quite a cross-section of society. And that wide cross-section of society asked a wide range of questions, but just about all of them asked two questions, and they were: one, what will [this forest] look like in fifty years? And: what … if you had done something different [during the establishment of the initial treatment units]?" As Dennis told me multiple times, the consistency of these questions proved pivotal in his conceptualization of the entire program "[W]e couldn't answer either of those questions with any of the stuff we'd set up, so that's how we got into models. We decided we needed to add a modeling component to our research program." After discovering the original

version of the SORTIE succession model on a visit to a private forest ecology research center in the eastern United States, Dennis decided to import the model to Smithers and begin the work of reprogramming it to fit the purposes of his experiments at Date Creek. Originally developed to simulate ecological effects of wind damage in complex deciduous forests, Dennis and his group spent the late 1990s parameterizing the SORTIE succession model for the transitional coniferous forests of northwest BC (Pacala, Canham and Silander 1993). By virtualizing the patterns of growth and succession measured within Date Creek and linking them to broader transformations across the sprawling Canadian north, the model gained increasing visibility in publications and among collaborative networks of disturbance ecologists even as Date Creek itself began to slide into obscurity.

Much of this transformation came about due to the success of the protest movements that had spurred Date Creek's creation. Over the course of the 1990s, the New Democratic Party provincial government introduced a range of land use reforms; greatly expanded the land area protected within the provincial park system; and reorganized the Ministry of Forests to give it greater powers of prescription and oversight over commercial timber harvesting (Tollefson 1998). Anti-clearcutting blockades, marches, and leafleting campaigns, the defining features of early '90s environmental politics in the province, gradually subsided, and forestry conflicts quietly slipped out of the headlines. By the mid-1990s, Gitxsan administrators had largely abandoned their own direct-action protests to focus their efforts on ongoing provincial and federal appeals to the initial decision in the *Delgamuukw* trial. In 1994, the Gitxsan-Wet'suwet'en Education Society secured support from the Ministry of Forests for their own watershed mapping and timber modeling projects (a story which provides the subject for second chapter of this dissertation). These funds also supported a number of collaborative projects with

regionally active government scientists, including several multi-year studies of post-fire succession dynamics in berry gathering areas and other Gitxsan harvesting sites.[26]

Despite the hype and publicity surrounding the commencement of these projects, the collaborative relationships they called into being proved to be short-lived. During the Ministry reforms that saw the downsizing of the provincial Research Branch and the closing of the Smithers regional office in 2002, these joint projects were summarily dropped. The province scaled back its support for the salaries, traveling costs, and other research expenses of the newly trained Gitxsan ecologists and GIS experts who had initiated the studies. As their opportunities to participate in new projects disappeared, their earlier roles as collaborators began to fade from the memories of other researchers as well. By the time I arrived in Smithers in 2013, other than the people who had worked directly with the Gitxsan, I met relatively few people there who remembered the sophisticated Gitxsan watershed management plans produced during the burst of mapping activity that followed the initial *Delgamuukw* decision. More than a decade removed from the last of these collaborations, most of the Smithers-based ecologists I spoke with dismissed the idea that any Gitxsan might be interested in a long-term forest ecology study, whether it was pitched on their traditional territory or not. As one research opined, *Why would they care about what's going on out there? They're probably just happy that it's something other than clearcutting*.

The more I learned about the historical circumstances which led to the creation of the Date Creek Research Forest, the more our encounter on the road began to feel vaguely like a missed connection, a chance crossing of paths between two erstwhile partners now steadily marching towards mutual incomprehension. (As we will see in the following chapter, when I

26 As I show in chapter two, Gitxsan berry harvesting sites have been subject to a range of published studies. See e.g. C. Burton 1999; P. Burton 1998; Trusler and Johnson 2008.

return to the forests north of the Kispiox Valley with an ad-hoc team of mappers from the neighboring Gitanyow First Nation, random encounters with white travelers inspired even more intense bouts of bemused speculation.) In the case of the Research Forest, though, the steady transition away from grounded collaboration was marked by a deliberate shift towards promoting SORTIE-ND, and away from publicizing the physical space of the forest itself. Dennis's promotional campaigns and education programs continued on for several years before his research group's mounting exhaustion and local communities' waning interest eventually slowed the flow of public visitors to a mere trickle.[27] By the time I visited in 2013, the wooden boardwalk leading to the original interpretive trail had begun to rot, and the information signs and picnic tables near the trailhead were slowly disappearing behind a growing wall of saplings (figure 3.9). While hundreds of early visitors had asked what the forest might look like after half a century of growth and change, few outside the immediate forest ecology research committee had thought to come back to check on its progress two decades later.

A Walk in the Woods

My first formal invitation to accompany Dennis out to Date Creek came less than one week after I had first introduced myself to the local research team. For several days after arriving in Smithers, I had been hanging around the cramped and cluttered Bulkley Valley Research Centre, pestering the young research staff with trivial questions and plying them with coffee. I collected stories about what had drawn them from such disparate places (Alberta, Germany, Seattle, Bangladesh, and Toronto, to name a few) to conduct research in a small town fifteen hours' drive

27 During my months in Smithers, I met relatively few people outside of the BVRC who had ever heard of the Date Creek Research Forest, but I did encounter a handful of twenty-somethings who vaguely remembered their elementary school field trips out to the forest many years ago, most of whom were surprised that the forest was still an active research site.

north of Vancouver (and four hours from the nearest university). Anand, a postdoctoral research and computer programmer, had just arrived in Smithers by way of Winnipeg, Vienna, and Bangladesh, each step in his career pulling him further and further away from his original training in agricultural science. Kristen, a recent masters' grad with experience in community ecology, had lived throughout western Canada after leaving her home near Seattle a decade earlier. Far more experienced than either Anand or me in navigating the dense forests of northwestern BC, Kristen joined the Date Creek crew between stints at nearby soil sampling surveys and other labor-intensive field projects which she helped manage throughout the summer. As the three of us shared our respective back-stories over the course of my first weeks in town, my initial uneasiness about inserting myself into what I assumed was a small and exclusive research group setting faded. Measuring trees would be tiring work, they warned me, but anyone capable of using a tape measure and walking through the bush was welcome to come along. They certainly weren't going to turn down free labor. To most of the group members, I was merely another of the BVRC's visiting scholars, one in a long line of summer students who wanted to spend a few months in the north while the days were long and the hiking trails into nearby mountains were free of snow.[28]

As I slowly became a regular fixture on trips to the research forest over the course of the summer, daily field preparations gradually settled into a familiar pattern. Group members email out weather reports the night before, offering their own predictions of the likelihood of serious

28 Numerous anthropologists and other scholars have called attention to the ways in which the dramatic differences between the seasons in the far north privileges summer visitors and leads to partial, and problematic, ethnographic accounts of the lives lived in these places. In *Hunters and Bureaucrats*, Paul Nadasdy (2003) repeatedly emphasizes that his mid-winter arrival greatly endeared him to his future interlocutors in the Kluane Lake region of Yukon Territory. Journalist Charles Wohlforth (2005) makes a similar point about visiting biologists and ecologists, arguing that those who visit northern Alaska only during the warm summer months are often regarded as vacationing interlopers by the residents of the regions under study, as well as by the scientists who work through the winter.

rain. Despite sitting a mere sixty miles northeast of Smithers, the air above Date Creek holds sway to an entirely different combination of weather formations than those governing the Bulkley Valley, be they masses of warm rain moving up from the coast along the Skeena River valley, or sudden squalls of early snow traveling south along the Kispiox.[29] Mosquito jokes are traded, with older members of the group bravely insisting that they never even notice the bugs until after the mid-June hatch, when all agree that emerging swarms render the backcountry unbearable even under the protection of head nets and thick clothing. A last-minute cancellation prompts a burst of emails and text messages out to a range of stand-by field workers and friends of the Centre. (I quickly learn that four workers – two teams of two – are required to make the three hour round-trip drive worthwhile for Dennis's group.) My invitations out to Date Creek often came the night before a planned trip, when another researcher's child care plans hit an unexpected snag, or an injury sustained by a group member on an earlier trip lingered, simpering in protest at the prospect of another day fighting through the bush.

The following morning, the day's group assembles in the small gravel driveway in front of the Centre, a two-story bungalow half a block off Main Street. In some ways, the scene resembles that of any other group of scientists preparing themselves for a day walking lines, marking space, and measuring objects in an outdoor laboratory. Waiting for Dennis to arrive in whatever Forest Service truck he is able to borrow for the day, we rummage through the Centre's plastic bins of field supplies, a collection of protective gear and measurement tools which might be drawn on in any given week by the Centre's affiliated biologists, ecologists, archaeologists, or

29 Long before climate change scientists became preoccupied with the complex weather patterns along BC's northwest coast, the provincial government devoted significant attention to assessing the links between weather patterns and the volume of annual salmon migrations from the Pacific Ocean into the Nass, Stikine and Skeena Rivers and their related watersheds. Since the World War II, both the provincial and federal government have supported a range of climatological research projects focused on the interplay between shifts in coastal currents and related changes in precipitation and air temperature throughout the transitional forests surrounding these waterways. See Beamish 1993; Brett 1951.

even visiting geologists. Pencils, markers, and neon-colored plastic tape. Aluminum clipboard cases and waterproof paper. Heavy canvas field vests with reflective stripes and multitudes of velcro-sealed pockets. Measuring tape in multiple formats, including large-handled rolls for measuring lines of sight dozens of meters from targets, and narrow metal bands adorned with sharp hooks for wrapping around tree trunks and digging into bark. Bear spray. Regulars in the group swap second-hand stories about bear confrontations from summers past, chuckling through familiar rumors that bottles of bear repellent are far likelier to be discharged accidentally against another person than into the eyes of a charging animal.

On my inaugural trip with the research crew, Dennis devoted our first hour in the forest to explaining to me and Anand (whose earlier research covered managed forests in eastern Canada and central Europe) how to decide which trees were "in" and which were "out" of our measurement plots. The eventual goal for the summer's measurements is a revised basal area calculation: an estimate of the volume of wood per square kilometer contained in the overall forest. As we will see in the second half of this chapter, the government's own timber supply analysts rely heavily on basal area plots to estimate the volumes of wood growing in different parts of British Columbia. Rather than continually re-measuring the same marked trees contained within provincially maintained permanent sample plots scattered throughout Date Creek, however, our group builds a new grid of *variable* radius plots to compare against the Ministry's fixed radius plot calculations. Determining which trees count as "in" in a variable radius plot is a bit like deciding which celestial orbs' gravitational pull matter most at a particular point in outer space: while all stars, planets, and nebulae exert *some* pull on an object placed at a given point, a handful will pull much, much harder than all the others. For an astrophysicist short on time and with a lot of galaxy to cover, these are the bodies she'll measure.

Unlike permanent sample plots, which mark all trees measuring over a particular size found growing within a certain radius threshold and then follow their growth over time, variable radius plots (known colloquially as "prism plots," for reasons I'll explain below) selectively measure trees by correlating size and distance from a point, then averaging the measurements for each point across a large grid of points. The end result is a statistical measure of the density of wood across the entire grid, typically given as cubic meters per hectare. These are the numbers contemporary loggers use while viewing forested landscapes. Depending on the cost of building new roads into a potential cutblock, 400 cubic meters per hectare might be good enough to open a new mill and establish a new rural town. Trying to expand the cut, another mountain range away and a decade later, 200 cubic meters per hectare might mean the same mill loses its financing and closes down.[30]

Against these blunt figures, younger trees become pesky obstacles. Whereas a mature spruce over half a meter in diameter might bring a dozen cubic meters of wood, and an old-growth giant twice as thick might yield as much as fifty cubic meters, a twenty-year old tree ten centimeters in diameter – barely wide enough for a single two-by-four – might yield less than a hundredth of a cubic meter; far less, of course, after bark, scraps, and sawdust fall away as the tree is processed into dimensional lumber. This calculative rationality allowed Weyerhauser, Canfor, and other logging giants to plan their northward push into the interior of British Columbia during the last decades of the twentieth century, financing a string of some of the world's largest lumber mills based on provincially authored predictions of tree growth and yield.[31] For grossly simplistic numbers like basal area plots, smaller second-growth trees simply

30 The complicated links between financial modeling and associated large-scale project planning, possibly the most immediate sources of public controversy in the BC timber industry, fully deserve their own separate treatment. In many ways, this work is older than silviculture itself, having been one of the first targets of net-present value calculations as early as the late 18th century. See Scorgie 1996.

31 The expansion and abrupt closure of sawmills throughout BC interior plateau appears to run in cycles, although

fall out of our calculations: if the loggers won't take them, we don't count them – at least not yet.

Marking each new plot center with a long, thin metal wire called a "pigtail" and adorning its curled end with a bright pink plastic ribbon, we take turns standing at the center and surveying the trees around us. Big trees close to the plot center are clearly "in." Smaller trees further away, clearly "out." Those in between are sighted against a displacement prism, a refractive lens encased within a relascope, a surveying instrument developed for timber inventory work in Austria during the 1960s (Avery and Burkhart 2001: 236-7; see figure 3.10).[32] Seen through the lens of the relascope, the width of an offending trunk is compared to a particular interval painted along an edge of the prism, the first step in a visual algebra required to determine which of the thousands of trees in an acre of transitional forest is large enough to "count," and which can be safely ignored (for a schematic illustration of this process, see figure 3.11). For the trees still "too close to call," one person quickly wraps a tape measure around the trunk while another trudges out from the plot center, unwinding a second tape measure as she walks. With the diameter and distance from the plot center in hand, we consult a table of distance/diameter ratios. Five centimeters too far – it's "out." Diameter's two centimeters past the minimum – call it "in."

Even as I became more adept at imagining different successional timelines as we moved

all of the analysts I spoke with in Victoria agreed that the present milling capacity greatly exceeds the wood likely to be available within the next four decades. Inevitably, though, the openings of enormous mills make international headlines, whereas closures are treated as surprises. A few examples: Associated Press 2004; Richter and Sysoyeva 2013; Harvey 2013.

32 Like many other silviculture research groups in British Columbia, the Date Creek researchers possess a relascope from the original release, and handle the half-century old instrument with extreme delicacy, gently placing it back in its crumbling leather case between each use. From our waterproof GPS devices to our "rip-proof" urethane waders, nearly all of the other instruments and material tools required for timber cruising and mensuration now highlight their appropriateness to the harshness of work in the bush. Adaptive, durable, and ultimately disposable, the emerging aesthetic of "tough tools" for work in "field sites of the twenty-first century" reflects a key divergence from the classist and colonialist distinctions between laborers and "gentlemanly scientists" which marked the field sciences of the 19th and early 20th century, including the large-scale experimental designs and specimen gathering work which accompanied colonial expeditions outside of Europe. (For a classic account of the material culture of these refined expeditions, see Pratt 2008[1992].) As the longstanding prevalence of expensive, fragile relascopes in timber mensuration work attests, however, the combination of limited resources and idiosyncratic proclivities for particular devices has preserved vestiges of earlier material cultures of field-based experimentation.

between plots, I often struggled with the most basic aspects of physical navigation. Learning to walk lines with a forester can be an awkward and uncomfortable process for contemporary hikers accustomed to entering forests on well-marked trails. The soft crunch of moss compressing underfoot provokes memories of sternly worded park signs warning visitors against straying carelessly off paths into "fragile ecosystems." The general lack of established walkways also serves to make visitors particularly dependent on their maps and other way-finding tools. Even in a comparatively small twenty-hectare treatment unit, erratic intrusions of dense new growth disrupt lines of sight, allowing even an experienced forester to become disoriented moments after looking away from their tree cover map and compass. Other than in the airy openness underneath the remaining patches of old growth, sound is quickly swallowed up. In most spots, the thick canopy obscures the sky, often rendering our GPS receivers unreliable.

In order to be able to navigate quickly between grid points, Anand and I, like other naïve recruits who came before us, were taught a range of skills and tricks. "It's very hard to make sure that everyone who comes in here to mark trees and take readings receives the same level of training," Dennis complained as he patiently guided us through each step. With each poorly tied ribbon and misplaced tag, he reminded us, the likelihood diminished of other groups of researchers being able to return to an archived grid point for follow-up measurements years later. After a quick refresher lesson in compass use, Dennis's first instructions to me involved a deconstruction of my gait: Take long strides, and count every other step. After taking a compass bearing, gazing directly along the designated vector, and, picking a tree or some other object roughly twenty meters away (assuming I could see that far within a particular stand), walk straight for it. Climb over deadfall, wade through bogs, tiptoe amongst patches of devil's club,

but unless the path becomes completely impassable, never leave your imaginary line.[33] Only after marching at least half the anticipated distance between grid points should I bother to scan along my path for the next yellow tag.

That such a careful training of the body should be necessary within a space already marked by grids and pictured in maps perplexed me for weeks as I observed and emulated the behaviors of the researchers I accompanied to the forest.[34] Certainly, adopting tricks for staying "on the line" clearly shortened the time required to move between plot centers, and it gave me confidence that I could quickly find my way back to the nearest road if I were I to get separated from the team. After several months of periodic visits to Date Creek, I had slowly learned to count paces even while conversing with my fellow field workers, and to follow straight lines with more or less evenly-spaced steps without constantly stumbling. Even so, as I learned to spot grid point signs from further and further away, my marching skills grew to feel less and less useful. It gradually became apparent, though, that Dennis saw our exercises against a far broader continuum of tree counting practices, from the painstaking permanent sample plot measurements he had helped coordinate during his early years with the Ministry of Forests to the quick-and-

33 Numerous anthropologists and historians of science have called attention to the ways in which the haptic dimensions of field-based scientific work cause researchers to obsess over learned strategies of bodily comportment as a means not merely of navigating, but of making foreign terrain feel more familiar. The influence of these techniques is particularly profound in the work of imperial cartographers, especially in places where techniques of "self-discipline" were often equated with proxies of physical infrastructure (see Burnett 2000). More recently, scholars have extended their discussions to cover related questions regarding the computer-assisted navigation of virtual worlds and the robot-led exploration of inhospitable environments like the surface of Mars or the bottom of the ocean. See Daston and Galison 2007, 363-416; Helmreich 2009; Turkle 2009.

34 While physically grueling fieldwork rarely allows foresters to forget the bodily demands of their science, Natasha Myers (2008) has suggested that bodily practices like hand gestures and even dancing can form a critical component of experimental technique in some of the most ascetic realms of laboratory science. Whether mimicking a folding protein with a bent torso or stacking fingers to emulate interdigitated molecular strands, the molecular biologists Myers follows in her work employ a range of not-exactly-formal devices to orient themselves inside and around their objects of study. Joseph Dumit joins Myers (Myers and Dumit 2011) to put forth a more comprehensive theory of "performative articulation," exploring similar forms of "body-work" employed by geologists and seismologists who employ three-dimensional visualization and manipulation to observe, "grasp," and "explore" structural faults.

dirty timber cruising counts he had performed for corporate clients during his first consulting jobs in the late 1970s. For a forester with nearly four decades of experience in the field, even one with a bent towards ecology like Dennis, the bodily skills learned through years of walking, counting, and measuring one's way through forests were among the few techniques that remained stable amidst a steadily changing array of boundary laws, mapping technologies, and inventory policies.

Yet even as I was adapting myself to what seemed to be a carefully disciplined manner of walking through the forest, the archaeologists and Gitxsan trail mappers I worked with elsewhere chided my enthusiasm with disciplinary bias and outright disdain. *Doesn't matter who they are, foresters have no bush sense whatsoever,* I heard multiple times throughout the year. *Now, an archaeologist, on the other hand,* that's *somebody that can't just walk* around *an obstacle just because it looks like it'll be a tough slog going through it. When we say we're going to walk lines every twenty meters, we* have to *space our lines exactly twenty meters apart. No cheating.* Throughout the year, as my fieldwork exposed me to other mapmakers with their own peculiar ways of looking, walking, and mapping in the forest, I tried to shrug off these barbs as professional myopia, prejudices shaped by the idiosyncratic demands of different kinds of jobs in the field (De Certeau 1984). Walking lines with a Gitxsan trail expert, crucial findings – rodent dwellings, bear scat, decades-old charcoal, the rare and valuable arrowhead – might disappear under foot. An entire week-long trail mapping project or archaeological assessment might be for naught if a hurried pace or wandering path caused one to miss relevant artifacts within a delimited study area. In silvicultural studies, our arguments were assembled through aggregation. At Date Creek, no matter how many details we noticed as we walked, our primary objects of study, during the basal area plot at least, were countable at a distance. We grouped and coded our

findings on simple charts, well aware that consistency outranked precision in our task's hierarchy of virtues. Walking lines between each repetitive plot, we comported ourselves accordingly.

The progression of days changed our rhythms, too. On late summer trips, after a few hours of self-consciously fumbling through relascope sightings and tree trunk measurements, Anand and I would quickly forget the seeming arbitrariness of our task and settle into a routine. We guess which trees will be "in" as we approach a still-to-be-marked plot center, then swiftly move in a clockwise circle around the pin, calling out only numbers and species names, occasionally grumbling about the "near misses" which sit a bit too far, or measure a bit too small, to count as "in" the plot. In the fifty meters between each grid point, we count our steps, challenging each other to maintain an even stride while walking in as straight a line as possible, whether lilting across beds of sphagnum moss or climbing over the trunks of wind-thrown hemlocks. As the weeks go by, we get better at noticing the small blue ribbons tied in branches along the lines of the grid. We begin to see the yellow metal plates denoting grid points from further and further away (figure 3.12), and learn to intuit where plates have fallen or been torn away by falling branches. Planning our routes in expanding loops around the truck, we push towards goals of greater efficiency. We fall into a relentless rhythm: moving, counting, and moving again. Seven grid points before lunch time. Eight more before calling it a day.

Wary of the numbing allure of speed and efficiency on new recruits to the measurement crew, Dennis encourages us to slow down and learn as we work. Without having to punch a clock in front of a company supervisor, we can afford to be more careful than the average corporate timber cruiser, the field-based tree counters who collect data for inventory calculations performed by timber harvest license holders. Rather than simply counting as "in" an even fifty percent of all of our ambiguous relascope sightings (a common time-saving practice of corporate

timber cruisers), we measure every marginal candidate. Even as the backlash against Ministry cutbacks in the late 2000s began to cast doubt on all aspects of provincially-run forestry observation and analysis work, corporate cruisers and government contractors continued to assign labels of spruce and pine so haphazardly that most of the government analysts I spoke with in Victoria applied an error range of over fifty percent in their estimates of species compositions in certain areas of the province. As we make our way through each treatment unit over the course of the summer, the Date Creek researchers I worked with allowed themselves to second-guess each other when determining tree species. Time and again, Dennis unfolded his hunting knife to peel back bark in search of a hemlock's rich red outer cambium. He slowed down the other, more experienced team members to point out the small, round whorls of bark on a mature lodgepole pine, the rectangular scales of the Engelmann spruce, and the long, narrow blisters bulging under the skin of the subalpine fir.

Compared to the narrow focus of corporate timber cruisers, entering the forest with the Date Creek research team turns even an operation as mundane as collecting numbers for a basal area plot into a broad lesson in disturbance ecology. Given the shifting cast of characters who assist with data collection each summer, and the diversity of technical (and, often enough, non-technical) backgrounds they bring with them to their work, even the most elementary topics of plant biology and forest succession turn into subjects for patient explanation and demonstration. Walking lines with Dennis, we learn the Latin names for a dozen species of moss, trunk-clinging lichens, shrubs, and the trees themselves. The common English names, he occasionally forgets. After yet another misstep in a bog earns my grasping hand a palm full of spines courtesy of the omnipresent devil's club, Dennis calls out its Latin name with a wily grin over his shoulder: "*Oplopanax horridus*!" A week later, my hand still red and swollen, the name echoes in my head.

Along roadsides, boardwalks, and neglected trails, Dennis calls our attention to the clusters of saplings clamoring for space in the narrow bands of sunlight let in through small openings in the canopy. More than two decades after the creation of the original treatment units, skid trails, or paths carved between the older trees by "skidders" – tractors charged with dragging the logs out of each removal area – gradually become visible between the towering trunks of 150-year old hemlocks as winding paths thick with young spruce.

While walking through the oldest of the old-growth sections (charmingly referred to as "antique forest" in the Date Creek literature), Dennis points out a streak of blackened wood poking out from long scar in the trunk of a massive cottonwood or western redcedar.[35] *This one was big enough to survive the fire that created this forest.* The new bark we touched along the outsides of these scars, Dennis explained, had had nearly a century and a half to recover from the fire that swept though the Kispiox Valley in 1855, not long after the first European explorers arrived in the Skeena region in 1832 (Parminter 1983; Sterritt, Marsden, Galois, Grant, and Overstall 1998, 194-242.). The fire destroyed much of the spruce, birch, and fir trees that dominated the valley prior to the nineteenth century, opening up broad swaths of valley for aggressively colonizing coniferous species like western hemlock. According to Dennis and other forest ecologists who have examined similar fire scars throughout northern British Columbia, this fire was but one small part of a series of forest fires which burned through tens of thousands of square kilometers during a long stretch of dry summers during the 1850s and '60s (Agee 1993; Arno 1980). Dennis occasionally reminded me of the scale of this transformation when our conversations drifted to the vulnerability of intensively managed, even-aged stands to fire and disease. Depending on what tree species and growth patterns succeeded the trees destroyed in

35 For a more detailed discussion of one of the earliest studies of historical health indicators at Date Creek see Goward, Diederich and Rosentreter 1994.

these fires, much of the resulting forest was left vulnerable to large-scale fires and pest outbreaks. In other words, the fact that so much forested land had been effectively cleared and re-fertilized all at once by the great fires of the mid-1800s created a fire-prone forest, leading eventually to the establishment of obsessive fire suppression policies during the early years of the provincial Forest Service.

Small Change

After fighting our way through another stand of twenty-foot tall saplings, Dennis stops and points to the ground. *Those big spruce aren't the only things that grew up here after the skidder came through,* he says. Crouching on the ground now, we peer closely at a dense carpet of tiny green trees, toy-sized miniatures of the fast-growing spruce we had just passed through. *These little guys are spruce too, and they might be just as old as the ones growing in the middle of the trail.* Dennis peers up at the canopy again. *Or maybe they're only five years old. Hard to tell.* Confronting the taller juvenile spruce that sprang up along skid trails and other patches of light throughout the forest, Kristen, another ecologist and Date Creek regular, had taught me early on to estimate the age of fast-growing trees by counting the major branches jutting out at semi-regular intervals along the trunk. *One major branch per year,* she assured me. *It's easy to count them when each branch is a foot apart like they are on the trees in these skid trails.*[36]

Simple visual heuristics like this provided one more reference point as I slowly learned to read the temporal registers of the forest in the same ways the other field workers did. Twenty year-old spruce saplings. Antique old growth. Hundred-fifty year-old burn marks next to twenty-

36 Several ethnomethodologists have explored the use of visual heuristics, ideal-typic models, and learned techniques of differentiation which are central to contemporary field research in biology and ecology. According to these scholars, learning to recognize separate species of plants and animals, develop authoritative counts, and delimit spatial and temporal areas of study all depend on the trained application of highly formalized techniques. See Rudwick 1976; Lynch 1985; Law and Lynch 1990.

three year-old gouges cut by passing skidders, numerous on the lower trunks of the large trees along now-covered skid trails. By taking pains to help me learn to see so many aspects of succession in action, Dennis, Anand and Kristen revealed much about their own positions within the Research Forest. For Kristen, each lesson on species differentiation and age class identification bespoke her breadth of experience with an ever-changing slate of projects. Throughout the summer, Anand was beginning to establish himself at the Bulkley Valley Research Centre by using his expertise with other succession modeling programs to test and refine specific aspects of SORTIE.[37] In the forest, his observations on the growth stages of the trees we measured echoed the focus of his current postdoctoral appointment at the BVRC – a collaborative study how each model depicted particular features of secondary structure. Well aware of the months of data-entry work which awaited him in the coming autumn, Anand was also the group's strongest advocate for consistency in our measurement reporting techniques. While Kristen and Dennis lined the margins of their tables with idiosyncratic observations, Anand's notebooks remained clean and precise. After four decades in the forest and another two decades building plots in SORTIE, the languages and examples Dennis drew on shifted constantly. Rich anecdotal descriptions of specific tree stands visited over successive years. An odd growth feature (a bifurcated base below a fused trunk, for instance) parsed through the resolutely empirical lens of conventional silviculture. Ecological modeling concepts and statistics to explain perceived correlations between trees sizes and other growth trends within a specific plot.

During the years he spent collecting data for what would become a major study of the correlation between shade gradients and tree growth rates in complex forests (Coates and Burton

37 An earlier example of this comparative work can be found here: Hawkins *et al.* 2012.

1997), Dennis shared space in the Date Creek with groups studying growth dynamics in more minute "disturbance regimes," such as the pygmy forests underneath our feet, or the lichens crawling up the trunks of mature trees. Peeling away a small clump of moss with his boot, Dennis assures us that if we return to the same spot a few years hence, the new divot will be full of inch-tall saplings, just like those growing in great clusters on either side of the skid trail. *These long-term experiments are tricky, though*, Dennis admitted. *Some of the students who studied tiny saplings like these didn't stick around long enough to see them get swallowed up when the moss came back in.* In order for the new trees to have any hope of remaining, they need to grow fast enough, or in great enough numbers, to keep the disturbed moss from reclaiming its old domain. Critical mass.

The other long-term experiments Dennis refer to often appear, like these carpets of tiny spruce saplings, directly beneath us as we stand to rest between plots. Once we notice the first orange ribbon staked at knee height, we gradually learn to scan around our feet for others, each denoting the corner of a research plot. Succession experiments focused on shrubs and saplings occupy four square meters of forest floor; those focused on moss and lichens, a single square meter. Larger "woody debris" plots can span up to twenty-five square meters, in which rotting trunks, branches, and other pieces of wind-throw and deadfall are marked with a profusion of blue ribbons, each denoting to returning researchers which pieces to measure and which they can safely ignore. In the woody debris plots, these numbers help the ecologists who record them to decide how quickly dead material in a given area will rot. Among the shrubs and lichens, other ecologists from the Bulkley Valley Research Centre or plant biologists visiting periodically from other Candian universities may measure a single plant over many years, tracking its patterns of response to changes in light, climate and the composition of the plants in its immediate

surroundings. A number of plots throughout the various treatment units in the forest see research groups returning each year, some forming long-standing collaborations with Dennis and other BVRC affiliates. Many other plots are long abandoned, still growing and changing within their grids of marked, rusting stakes, but simply forgotten as degrees are earned, papers are published, or particular research questions shift or lose funding.

Like our roving group, none of the other researchers active in the forest content themselves with collecting figures from a single plot. With their own simple maps in hand, they work their way between plots scattered throughout Date Creek, collecting measurements to be calibrated later against location-dependent variables. Encountering an old, fragile stem crushed beneath the boot of another wayward researcher, a shrub specialist moves to other stems in other plots, balancing the bad data point against dozens of unmolested figures. As data tables grow over summers and between years, and as species counts and dimensional figures make their way into SORTIE and other ecological modeling programs run by the provincial ministry (see chapter five), data points denoting individual crushed stems are swarmed over by tables of measurements built up around shifting mosses, retreating lichens, and the myriad other minute dynamics that signify changes along the simulator's virtual forest floor. In the square meters- to hectare-sized expanses of sunlight opened up in the canopy during the initial partial cutting treatments, forest ecologists like Dennis perceive longer-term dynamics at far larger scales. New openings for sunlight to reach the leaves of shorter stems that had previously been obscured by the thick canopy of mature overgrowth. New paths for wind; new vulnerabilities for wind damage. A rush of new shrubs, lichen, and other undergrowth in and around the removal area. Stems quickly sprouting up from patches of dirt exposed where logging crews tore away mature shrubs and ground up old blankets of moss. If the inspiration for bringing SORTIE to Date Creek was

Dennis's inability to answer guests' questions about what the research forest would look like fifty years on, twenty years' experience navigating both the model and the forest had made it impossible for him to look at Date Creek without immediately imagining how its different parts might evolve.

Going Home

By the end of September, snow had crept down from the peaks around the Kispiox Valley and had left its first dusting on the roofs and roads of Smithers. The aspen trees around the Bulkley Valley slipped from green to yellow to leafless within three short weeks; from one week to the next, the days grew shorter by half an hour. Kristen had moved on to her other projects, and was soliciting volunteers to help her collect the final soil samples of the season before the changing weather rendered inaccessible her primary field site, a second-growth forest 200 kilometers southeast of Date Creek. In a small upstairs office at the Bulkley Valley Research Centre, Anand had already been busy for weeks, tabulating the hundreds of pages of hand-written notes and figures recorded on our trips. By winter (or rather, the season recognized on calendars throughout the northern hemisphere, not the region's nine months of snow bracketing August and June), he would be ready to begin the first full-scale calculations with the data collected throughout the summer.[38]

Hemmed in by days of freezing rain, Dennis and I made our final field trip of the year together in early October, aiming to pick up the last few prism plots that had been missed in other sections and begin a survey of wind damage which he and Kristen would conclude the

38 Writing on the material culture of fieldwork and experimentation characteristic of 19th century geology, Martin Rudwick (1996) makes the provocative claim that scientists working in temperate regions actually benefited from long, winter-induced pauses between summer exploration seasons, arguing that geologists forced to spend months indoors used the time to develop more sophisticated theories to guide their summer prospecting work.

following year. *Too bad we didn't bring along a bottle of Scotch to toast the end of the field season, huh?* Dennis smiled. As we finished the final plot and returned to the truck to store the fragile relascope and exchange clipboards, Dennis coached me through the methods that would guide our next count. *First things first, you gotta determine whether a downed tree is actually windthrow or whether it just fell down on its own. Wind isn't the only thing that kills trees out here, you know.* We take a few steps into the treatment unit closest to the truck. Rotting hemlock trunks are strewn everywhere. *Anything with moss on it was probably knocked down in the big windstorm a few years ago. We don't need to worry about those – we're just looking for the new stuff.* Previous years' measurements are spray-painted and tagged. Flipping to a printout in his clipboard, he locates our unit. *At this heading, this big guy should be already marked. There it is: number 115. Let's keep moving.* Eyes fixed on our compass, we wind north and then south through our treatment unit in fifty meter increments, measuring trees that fall across our narrow line, leaving the others to be conjured by the windthrow simulation subroutine in SORTIE. Without the fanfare or epistemic closure of a transition in paradigms, one experiment ends. Another begins.[39]

As we hoist each other up and over downed trunks (see figure 3.13) and wade through the bogs and thickets separating each clearing, Dennis's reminiscences morph into wistful speculation. We wonder together about succession patterns within the Kispiox Valley, and the future shape of clearcutting along the Skeena. We guess about the likelihood of hirings and firings in research offices in Smithers and Victoria, and think out loud about how other forest ecologists in Canada and elsewhere might eventually adapt, replace, or simply forget about

39 On how the beginnings and endings of experiments express themselves in different "genres" of epistemic closure, see Galison 1987. Rebecca Lemov (2015) has also discussed the effects of personnel changes and institutional instability on issues of closure and continuity in large-scale social science research. See also Edwards 2010.

Dennis's own published work on the relationship between shade levels and growth dynamics in temperate forests. Dennis muses at length about the changing fortunes of other senior researchers who, like him, are nearing retirement, and about the impending loss of their accumulated knowledge and skills as the Ministry refuses to hire new researchers to replace them. We both worry after the fate of his experiments in Date Creek, and about the new generations of forestry researchers who may or may not choose to devote time, money, and energy to maintain its intricate plots. "It could be tremendously useful for some graduate students in the future if some university professors know it exists. There's a lot of old experiments … that are well taken care of for ten or fifteen or twenty or twenty-five years, and then they kinda fade away."

While Bulkley Valley Research Centre officials revel in their relative independence, at the far north of the provincial government's "radar," discussions about distance take on an altogether different tone when the future of the research forest is put into question. "We're a five and a half hour drive from Prince George. We're a really long way away from Vancouver. There's a lot of places that university professors can send their students that are a lot closer than here, and we've had students come up over the years. But it'd be pretty hard to have somebody come up, to be here." As Dennis matter-of-factly reminds me, with sufficient time, the boundaries of the Research Forest could simply fade from provincial management maps, leaving its carefully tended stands of hemlock and cedar trees open to roving logging crews. More than once, Dennis despairs about the imminent retirement of his chief collaborator. "[T]here's little doubt that [the Ministry is] not going to replace both of us. They might replace one of us. And even right now I'd say that's unlikely. So if we're both gone, there's isn't going to be anyone to go out there and keep things going. It's as simple as that."

Driving towards the bridge to Kispiox village on our way back towards Smithers that

night, we encounter no other drivers. As we cross onto asphalt and begin winding our way towards Hazelton and highway 16, Dennis reaches for the transmitter of our CB radio to let the Smithers dispatcher know that we are in for the evening. Off the Forest Service road, along the banks of the Skeena, Gitxsan men in tall gaiters cast lines into the river while others with long-handled nets and gaff hooks wait downstream. The autumn run of coho salmon has just begun. In Moricetown Canyon, half an hour out of Smithers, all eyes are on the river, too. Witsuwit'en fishers line gangplanks along the walls of the canyon, gaffing fifteen pound coho as they struggle to leap their way up and over the cascading falls. Smithereens and Moricetown residents mingle along the sides of the highway, leaning out the windows of parked cars to watch the action in the river below. No one looks up as our truck rattles past.

FIG. 3.3. BC Forest Service signage, visible from road, denoting boundaries of Date Creek Research Forest.

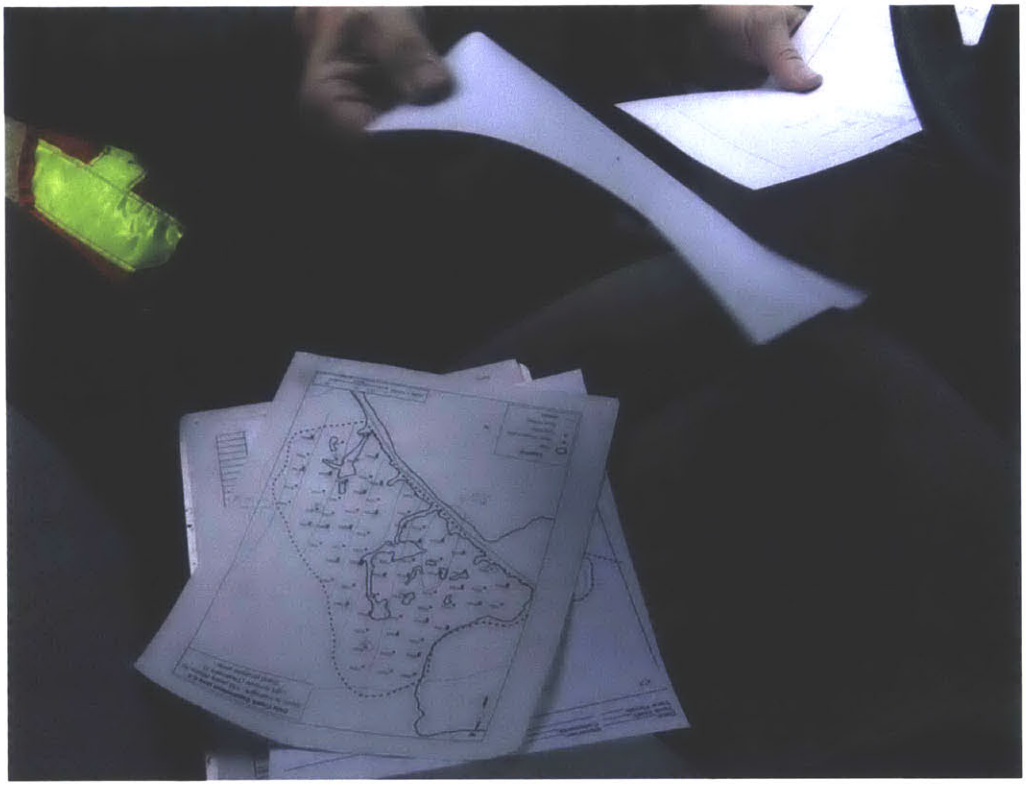

FIG. 3.4. Basic paper field map for Date Creek Research Forest treatment unit (30% removal area). Dotted lines denote boundaries of treatment unit; numbered dots denote grid points (i.e. locations of prism plot measurements); solid lines denote gaps/removal areas; penciled lines denote completed paths walked by measurement crew.

FIG 3.5. Informational sign outside BC Forest Service-run conventional silviculture experiment site near Date Creek Research Forest.

FIG 3.6. Unidentified experimental plot markers.

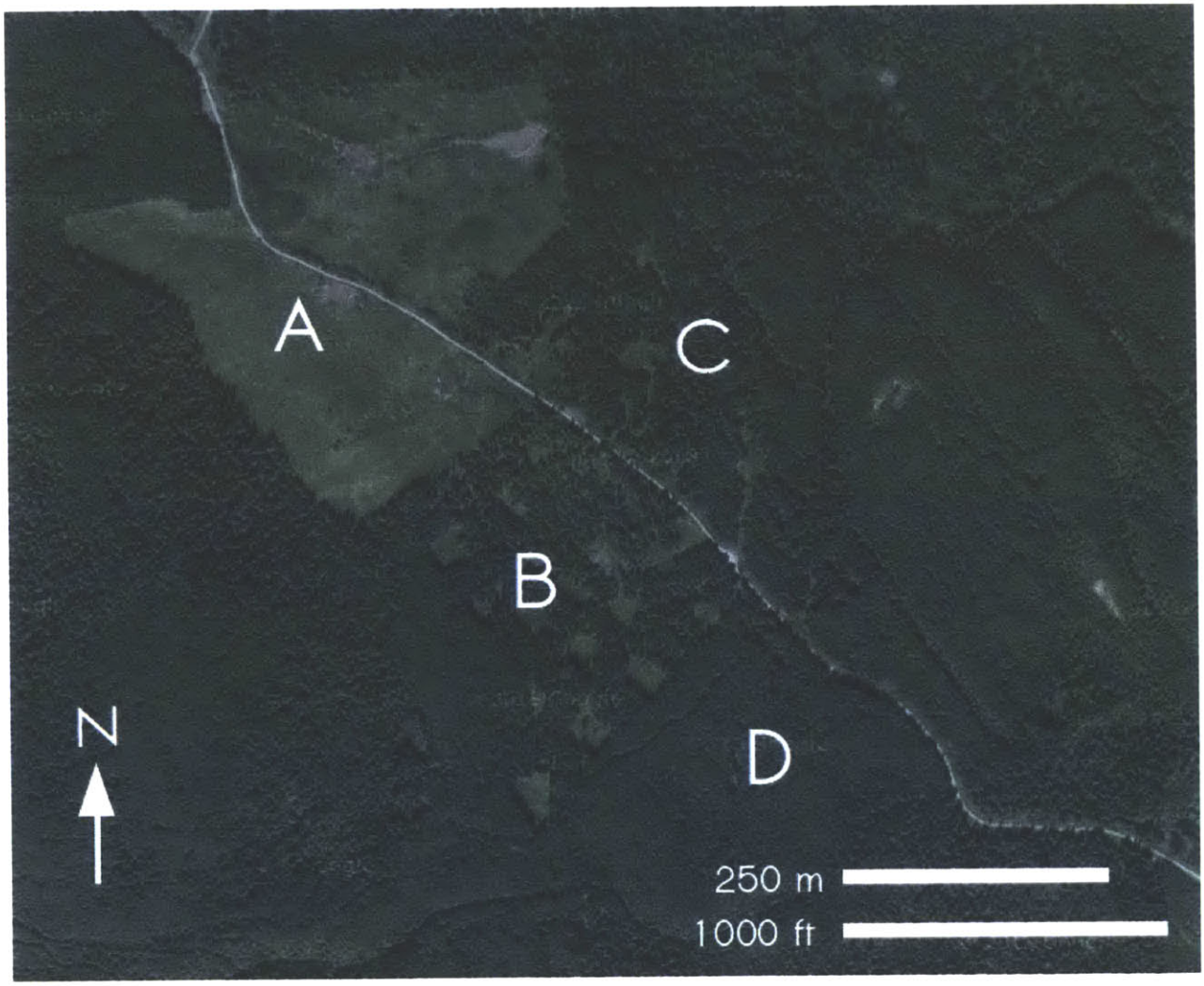

FIG 3.7. Satellite photograph of Date Creek Research Forest ca. 2016 (25 years after initial creation of treatment units). The different removal areas are labeled by letters: A. clearcut; B. 60% removal; C. 30% removal; D. 0% removal/control unit. The pale line winding through the center of the image is the Kispiox Forest Service Road. Satellite imagery © Province of British Columbia.

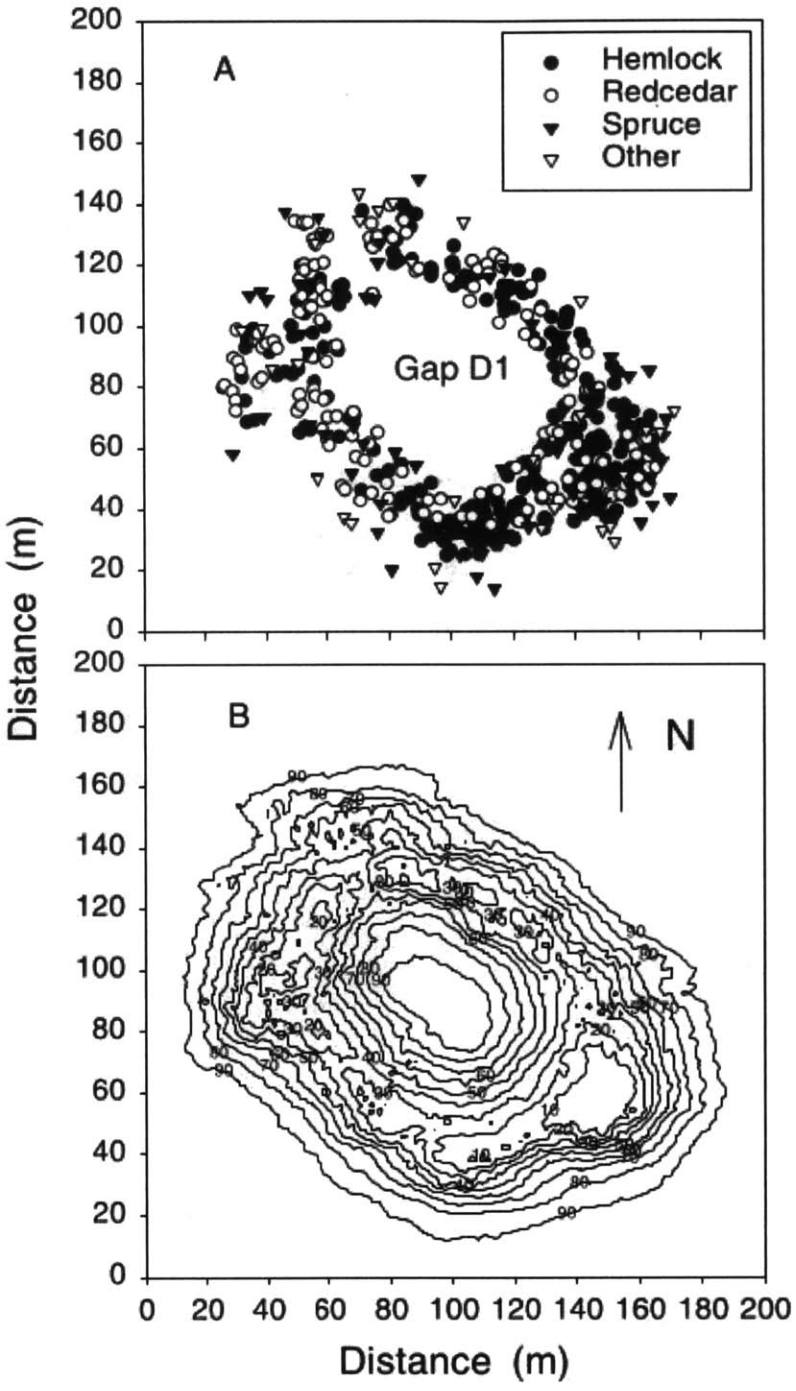

FIG 3.8. Schematic diagram of tree stem location (A) and light distribution (B) relative to a 0.33 hectare gap, as modeled in SORTIE-ND. Numbers in (B) denote extent of shading; area outside polygon devoid of trees. Figure modified from Canham et al. 1999, 1782.

FIG 3.9. Date Creek Research Forest informational sign near entrance to boardwalk trail.

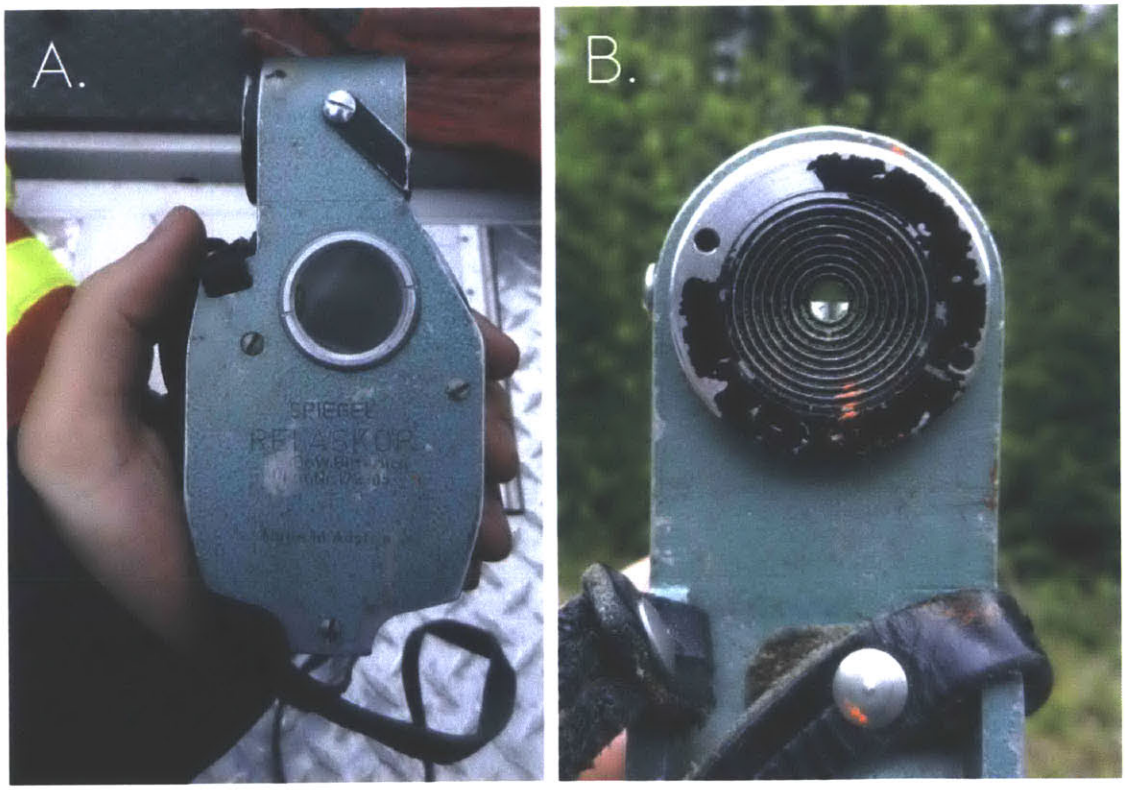

FIG 3.10. Spiegel Relascope, seen from the side (A) and through the viewing aperture (B). The prism used for sighting trees is just visible through the eyepiece.

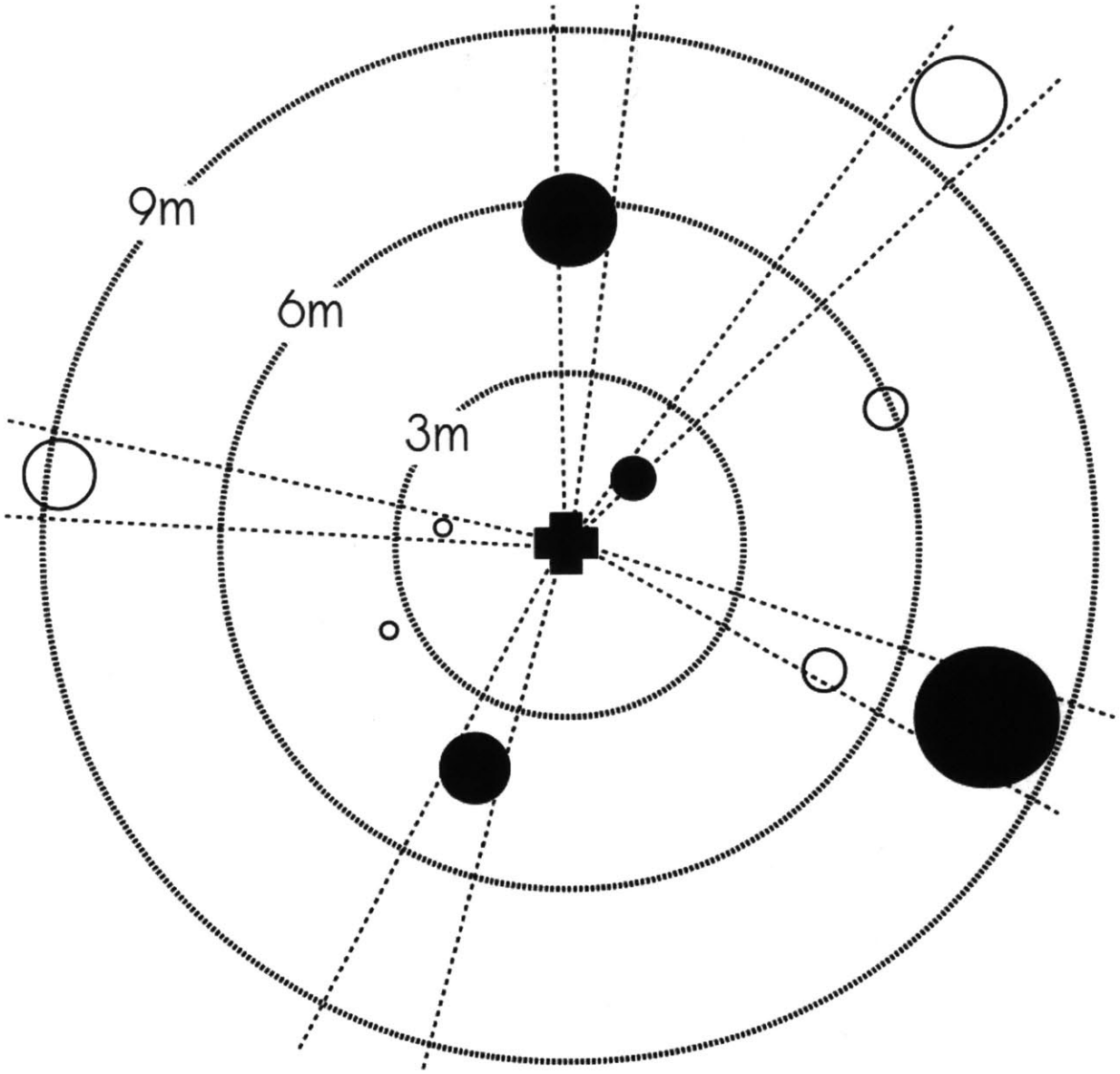

FIG 3.11. A schematic depiction of a prism plot. The cross denotes the center of the survey, and the concentric, finely-dotted lines denote three meter distance intervals from the plot center. Based on the prism used for this particular survey, each tree stem depicted by a darkened circle would be counted as "in" (and thus its diameter would be measured and recorded), and each stem depicted by an empty circle would be counted as "out" (and would thus be ignored).

FIG 3.12. A typical grid point label.

FIG 3.13. A particularly daunting series of obstacles within the windthrow study area.

Chapter 4: Transects and Territory

Indigenous Field and Information Sciences in the Neoliberal Era

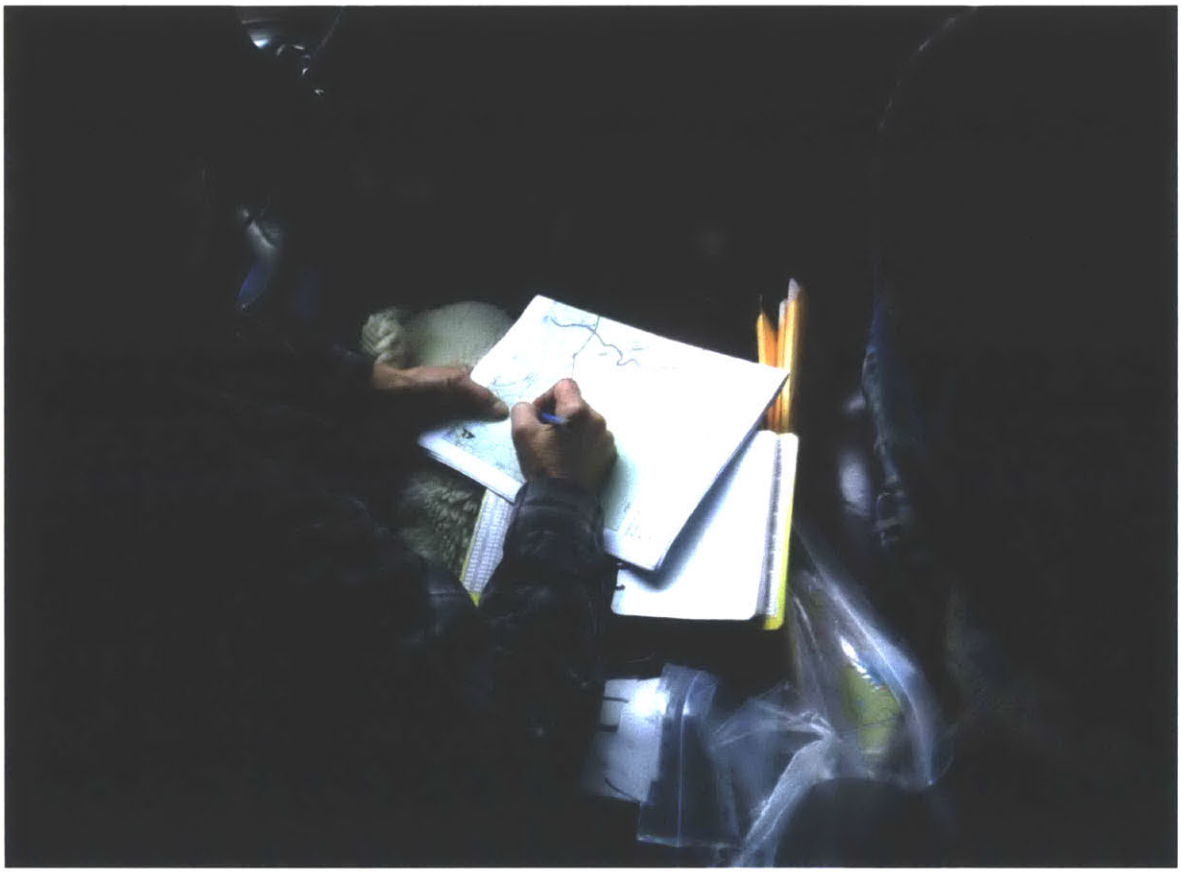

FIG 4.1. Lorraine annotates a topographic map in preparation for a transect walk.

In the two decades since the British Columbia Treaty Commission began standardizing negotiation protocols around First Nations land claims, the scope and structure of mapping and environmental fieldwork on traditional territories has undergone continuous change. Numerous First Nations individuals who participated in counter-mapping and resource co-management

projects set into motion by land claims litigation throughout western Canada during the 1990s have since built careers as GIS experts and traditional land use consultants (Nadasdy 2003:142-143). After the government of British Columbia drastically reduced funding for First Nations-led mapping and environmental monitoring work in the early 2000s (see chapter two), many of these people were forced to seek out new modalities of engagement and alternative sources of financial support. Many also began learning to navigate the conflicts inherent in accepting corporate funding to challenge corporate plans. This has been particularly true for the fraught negotiations surrounding several separate oil and gas pipelines currently proposed for construction through central BC, massive engineering works which could potentially span hundreds of kilometers and cross the boundaries of dozens of contested traditional territories (McCreary and Milligan 2014). Even as these new infrastructures grow in scale, however, the fieldwork required to weigh their potential effects increasingly has been subject to displacement and rupture.

Over the past half decade, the diversification of First Nations defensive fieldwork strategies has entered a new phase. Weary of divisive and overwhelmingly expensive treaty negotiation protocols that have as yet generated only two comprehensive agreements, nearly two dozen First Nations groups across British Columbia have begun constructing new Incremental Treaty Agreements (Government of British Columbia n/d).[1] Typically comprising a combination of short-term revenue sharing agreements and collaborative roles (alongside government planners) in the production of new resource management and access plans, interim agreements have generated mixed feelings among First Nations communities (Alcantra 2013; Barker 2009). While some community leaders welcome the increase in timber and mineral production royalties and the simplification of consultation procedures, others complain that the agreements serve only

1 The Nisga'a Final Agreement was generated under a legal protocol separate from the BC Treaty Commission process. See Blackburn 2005.

the interests of capital, securing for developers certainty over land access in the short term even as the environmental consequences of new developments and more substantive matters of First Nations rights and recognition are perpetually deferred (Blackburn 2005; McCreary 2014; Pasternak 2015). And yet as both sides acknowledge, the work of tracking and projecting the effects of new projects must proceed.

In much the same way that anthropologists have long invoked "trails" both as specific, identifiable routes across landscapes and as metaphors of distance, time, knowledge, and interconnection (Aporta 2004; L. Johnson 2010; Ridington 1992; Rosaldo 1980), the *transect*, a scientifically freighted, ostensibly disenchanted emblem of landscape description, has come to serve as a point of condensation for a precarious yet vital range of First Nations practices, policies, and shared experiences. For mappers and ethnographers alike, the word "transect" carries multiple meanings. In First Nations resource management offices and treaty research centers where field data are compiled into diverse maps and arguments, the transect is merely an environmental mapping technique, a mode of navigating space along straight lines while enumerating particular kinds of objects and measuring their distance from an axis of travel (see figure 4.2). Designed to catalog both statistically significant distributions of plant species and animal activity as well as isolated remnants of human use and occupation, the increasing uptake of transects and other landscape surveying techniques in recent decades by First Nations mappers and resource managers mirrors the statistical revolution which transformed ecological and archaeological field practice in the second half of the twentieth century (Goodwin 1994; Hurst 1978; Lynch 1985). Taken up as scaffolds for new classification systems designed by cartographers based in marginal First Nations management offices, transects have offered purchase for indigenous experts struggling to exert their influence within the evolving

bureaucracies of federally managed reserves and traditional government institutions.

The transect also offers an alternative approach for addressing the often overlapping challenges of resource conflicts and "cultural salvage," particularly in regions where earlier trails no longer exist. Throughout northwest British Columbia, including the traditional territories of the Gitanyow First Nation where the fieldwork for this chapter was based, the rapid expansion of forestry during the second half of the twentieth century destroyed many of the original trails and culturally modified trees which served as legal and symbolic anchors for emerging land claims and self-government efforts (Nicholas 2006). As numerous First Nations groups formed strategic (and often contentious) alliances with environmental advocacy groups in an effort to push land claims into other legal domains, their reliance on data from biological and ecological field mapping projects steadily grew (Braun 2002; Wilson 1998). Despite these developments, however, First Nations-led fieldwork and data analysis has yet to receive the sustained attention from anthropologists or other scholars of science, technology, and society (STS). Early critical discussions of emerging intersections between indigenous politics and technocracy centered primarily on the fears of reification provoked by ambitious "traditional ecological knowledge" databasing projects (Agrawal 2002) and the ambiguities of intellectual property claims set amidst indigenous legal orders (Downes 2000; Greene 2004).

Within the legal and technical domains relevant to First Nations territorial politics (see literature review below), however, the tenuous recognition accorded to the data gathered for these processes reflects tensions and ambiguities beyond the pressures which have always surrounding indigenous sovereignty claims. STS investigations of field biology and ecology research have shown that fierce debates over observation and extrapolation techniques, database assembly, and other mundane fieldwork practices have provoked far-reaching anxieties among

many kinds of environmental scientists working under neoliberal regimes and public-private collaborations (Fortun and Fortun 2005; Lahsen 2005; Lave 2012b). As First Nations GIS specialists and other indigenous experts struggle to coordinate complex mapping projects amidst the uncertainties and limited affordances of new interim agreements, these anxieties are compounded by the growing sense that more permanent guarantees of self-determination are forever slipping further into the future.

By focusing on how technoscientific objects like the transect have facilitated the ongoing spatial and temporal reorganization of First Nations resource politics, this chapter is meant to provoke reflection on indigenous experts' contemporary experiences of professional mobility and discontinuity. The material constraints and epistemic reorientations engendered by indigenous experts' resignation to uncertainty and complicity have become a constitutive feature of the work of mapping, and of the increasingly fractured terrain of indigenous territorial claims. This process has also transformed the temporality of ethnographic engagement with First Nations mapping projects. When I joined a mapping group on the traditional territories of the Gitanyow First Nation several days after their project had begun, I feared that I would be lost playing catch-up, and that my engagement with the field of their work would be trapped *in media res*. As I quickly learned, however, the project, like many others, had no clear beginning or end for them, but was rather defined by a series of markers denoting the limits of what they could accomplish in a given day. Once the team located a section of their intended path, they chopped the work up into segments. In practical terms, working through transects made my own participation expendable, since any new assistant could simply take over where I left off. The territory maps and artifacts produced through these exercises have had profound consequences on the legal, political, and social lives of the people interpellated by them. And yet, the identities and

narratives tethered to these maps continue to be as disparate and undecidable as "the field" probed and passed through by so many humble transects.

From Trails to Transects

The remainder of the first half of this chapter examines how the fallout from contemporary treaty processes has shaped First Nations articulations of territory in emergent legal and environmental confrontations. Following a discussion of Hugh Brody's influential trail mapping work among the Beaver Indians in the 1970s, the second half of the chapter draws an ethnographic portrait of transect mapping around a current pipeline proposal to show how the original tools of early traditional use and occupancy studies have been reconfigured as concepts of territory and professional circumstances have changed. In the autumn of 2013, the Gitanyow Office of Hereditary Chiefs (GHC), a governing body and research center based in the Gitanyow First Nation reserve village of Kitwanga, received a small grant from the TransCanada Pipelines Corporation to research an alternate path for a natural gas pipeline that TransCanada hoped to build through the Gitanyow traditional territories in northwest British Columbia. The long, kinked route traced out on the territories by the small group I accompanied was not in itself a transect, but, mirroring the surveying techniques of the pipeline builders who might eventually be following in our wake, comprised a chain strung together of short, straight lines. The right to propose an alternative path was a key part of the new consultation process formalized by the Gitanyow Strategic Land and Resource Plan (SLRP), a document produced in collaboration between the GHC and the BC Forest Service.[2] Set against the Gitanyow SLRP, our small

2 In 2010, the British Columbia Ministry of Forests and Range was combined with departments of several other provincial ministries to form the BC Ministry of Forests, Lands, and Natural Resource Operations, or FLNRO. For brevity, I use "Forest Service" to denote both the pre-2010 Ministry of Forests and FLNRO.

transects became partial rasters, discrete segments of territory which, taken together, began to suggest images and arguments that would be used to describe the state of the landscape as a whole. Lorraine,[3] the Gitxsan/Gitanyow[4] woman and renowned GIS expert who led our project, had spent more than two decades assembling maps from rushed expeditions and incomplete datasets. As my conclusion shows, despite her tremendous agility, Lorraine's strategies for defining and engaging with "the field" of her work nevertheless reveal critical expectations and dependencies at the heart of the broader Gitanyow political project.

As the relationships between First Nations, the provincial government, and prospective developers have changed over time, Gitanyow mappers like Lorraine have negotiated competing pressures to represent their territories as both bounded, autochthonous spaces and as "working environments" of scientific knowledge production (e.g. Fearnley 2015; Kohler 2012).[5] Maintaining a productive tension between these characterizations has required indigenous experts like Lorraine – people whose experiences of indigenous identity are inextricable from their technical professions – to emphasize the iterative nature of their work and the fragile contingency of the diverse institutional relationships that support it. This has occurred even as many anthropologists have sought to provincialize the role of "science" in indigenous politics and governance by emphasizing the seeming immediacy of indigenous groups' experiential engagements with the landscapes they claim as ancestral territories (e.g. Ganapathy 2013; Larsen and Johnson 2012). Recent scholarship has challenged positivist and humanist biases within both anthropology and international law by calling attention to a wide range of concepts of agency, causality, and sentience at play among the inhabitants of these places (Alberti, Fowles, and

3 All names in this chapter are pseudonyms. Quotations depicted in italics are paraphrased from notes and memory; quotation marks denote verbatim transcriptions of field recordings and recorded interviews.

4 The Gitanyow are a Gitxsan people with separate political organization from the Gitxsan First Nation.

5 Robert Kohler (2012) uses the term "working environment" to call attention to the labor issues and professional contingencies which have shaped scientific fieldwork throughout the twentieth century.

Holbraad et al. 2011; De la Cadena 2010; Kohn 2013; Povinelli 1995). By exploring how the form and practice of the transect allows First Nations mappers to embed long-term political goals within precarious collaborations with government institutions, I offer one possible path of critical engagement into emergent debates around the "ontological politics" of indigenous forms of life (Bessire and Bond 2014; Fortun 2014). The Gitanyow First Nation's experiences with government-organized resource planning and treaty negotiations show how formalized representations of landscapes can both help and hinder indigenous experts struggling through the ambiguities and double binds of territorial politics. Rather than simply reproducing hegemonic representations of colonized territory, I argue that the practices of transect mapping undertaken by Gitanyow mappers and their collaborators extend key anti-colonial projects even as they necessarily defer other critiques and strategic goals.

In the twenty-three years since the United Nations Rio Declaration on Environment and Development made the category of "indigenous knowledge" into a term of international law (Agrawal 1995; Dove 2006; Sillitoe 1998), anthropology has seen a range of debates over the technoscientific transformation of indigenous territorial politics. Claudio Aporta and Eric Higgs (2005) have taken Inuit wayfinding as an example of an indigenous practice transformed by the generational rifts and changing habits laid bare by the increasing use of Global Positioning Systems (GPS) technologies in the far north. Bjørn Sletto (2009) calls attention to an even broader range of social processes involved in contemporary forms of participatory mapping, chiding earlier treatments for "reifying material and discursive forms of domination operating through Western projects such as development and global environmentalism" (443) while missing key "negotiations of power, identities, and authenticities implicated in community-based productions of spatial representations" (444). In *Indigenous Experience Today*, contributors

identified a broad range of technologically-mediated "negotiations" underpinning contemporary forms of indigenous life, from "the emergence of larger-scale 'tribal' and 'Native Alaskan' social formations … bound up with liberal multiculturalism and governmentality" (Clifford 2007:210) to observations of climate change entangled in "circumpolar networks" of academic glaciologists and indigenous activists (Cruikshank 2007:356). Turning from the micro-practices of territorial politics to the persistence of bureaucratic norms entrenched by decades of strategic advances and retreats, Tania Li (2010) has surveyed the fraught marriage of sustainable development and indigenous participation since the Rio Declaration by arguing that the "communal fix" imposed upon indigenous legal formations has facilitated new modes of land dispossession even as it galvanized resurgent articulations of indigenous collective identities.

Tim Ingold shares with numerous other anthropologists an anxiety over the complicity of anthropologists in colonial transpositions of indigenous concepts of territory into Western languages of space and power (Hirtz 2003; Rundstrom 1995; Wolfe 1991). "[T]he more one reads into the land," he cautions, "the more difficult it becomes to ascertain with any certainty where substances end and the medium begins" (Ingold 2008: 8). In their rush to produce synoptic portraits of landscapes and their inhabitants, Ingold and others argue, anthropologists and other scientists have favored discretely organized lines of inquiry, and have often eschewed the idiosyncratic forms of navigation, wayfaring, and storytelling through which individuals and groups have come to know their environments. For the people who live in "the field" of anthropological work, "quotidian life is experimental through and through" (Ingold 2011: 15) and its study demands attention to the embodied knowledges unique to particular locales.

In his recent work, Ingold's longstanding emphasis on embodiment and experience has transitioned into a nostalgia for the holism of trails, navigation, and other continuous forms of

human-environment interaction. Rather than explicate how the shape of these interactions has been influenced by specific confrontations and material histories, however, Ingold locates this transformation in the postmodern rupture of a particular narrative form: the line. "Once the trace of a continuous gesture, the line has been fragmented – under the sway of modernity – into a succession of points or dots" (Ingold 2007: 75). For Ingold, the "fragmentation" of the line introduced by mapping clashes with the boundlessness of "life" and its "meshwork of habitation" (103). In his earlier work, Ingold (2000) recognizes the inevitability of rupture in the practices and social relationships linking people with particular landscapes. "Skills are not transmitted from generation to generation," he argues, "but are regrown in each" (5). But by contrasting the ambiguities and fissures of "postmodern" representation with the immediacy and – importantly – *continuousness* of embodiment, however, Ingold tacitly endorses a troubling assertion: namely, that it is merely technologies of representation, and not actual forms of indigenous life, that have been subject to rupture and disintegration in the contemporary era.

By focusing on the interrelations between the place-based practices inherent in any mapping activity and the mediative work required to transform maps into mappings (and mappings into maps), this chapter explores how Gitanyow mappers negotiate the contingencies and paradoxes of fieldwork. For GHC contractors and technical staff, producing maps over the past two decades has exposed them to a widely varying range of provincial governance regimes, and to shifting languages for discussing landscapes in terms of place-based rights and resources. As any field mapper will readily agree, "synoptic representation" means altogether different things in concept and in practice. Lorraine (a Gitxsan/Gitanyow woman) and Alan (a white man), two field workers who have spent decades walking the land and watching it change, are acutely aware of the limitations of their maps. The dynamism they observe as they walk on the territories

on various short-term mapping projects, year after year, energizes their work as a whole, and yet, they both understand that the institutions they work with trade in static signifiers.

Lorraine and Alan both exhibited tremendous skill as they deciphered traces of animal activity, overgrown hunting trails, and subtle changes in vegetation amidst tangled undergrowth and maintained our bearing through miles upon miles of nearly featureless tree stands. And yet, the exhaustive deliberateness, even awkwardness, of transect mapping constantly reminded me that mapping is *not* a "quotidian practice." As we moved and mapped together, our work regularly drew upon our individual skills and experiences, but always in highly selective ways. This does not mean that the work of mapping is altogether separate from, or unimportant to, the daily lives of the white and Gitanyow people who comprise GHC-supported mapping teams. Gerry, the Gitanyow man who eventually joined our group, was neither expert nor novice. Superficially, his participation was a remnant of long-standing "capacity building" initiatives meant to encourage the hiring of Gitanyow people for work on the Gitanyow territories. Primarily oriented toward unskilled jobs that would otherwise be performed by migrant contractors or underemployed whites in surrounding communities, GHC jobs optimistically promise the dual benefits of a modest wage and an expanded sense of investment in the landbase and infrastructures overseen by the Gitanyow Nation's traditional government. Joining us in the field at precisely the same time that revelations regarding TransCanada's clandestine surveying activities were beginning to inspire loud denunciations across the region (see below), Gerry undertook the mundane labor and tacit activism inherent in the job without questioning directly the broader rationale of the project. Yet by entering the territory with experts long practiced at building maps and databases from the contributions from temporary assistants, Gerry's labor added new marks to a field long defined and sustained largely by these partial connections. Equal

parts sanctuary, workplace, and imperfect laboratory, the linked chain of forest transects we walked together kept the politics of pipelines in our peripheral vision even as we steadily trained our sights further and further ahead.

Territory without Guarantees

While colonial dispossessions of indigenous territory anchor a wide range of contemporary political claims across western Canada, the legal strategies different groups have pursued to challenge and reformat these dispossessions have followed divergent paths. Like most of the dozens of other bands and First Nations groups who entered into treaty negotiations with the province under the aegis of the BC Treaty Commission (BCTC) beginning in the early 1990s, the Gitanyow energetically began the treaty process only to watch their work devolve into arguments with the province over the participation of hereditary leaders (versus elected band councils) and disagreements with neighboring groups over the positions of external boundaries. The root of these impasses, Gitanyow negotiators argued, was the hegemony of the "land selection model," the province's preferred method for separating claims into small subregions in order to translate broad questions of use and access into more localized issues of land ownership (Devlin 2009). Despite following BCTC protocol by filing a transparency agreement, a negotiation framework, and a mapped statement of intent for their claim during the mid 1990s, nearly all of the claimed Gitanyow traditional territory was absorbed within the Nisga'a Final Agreement in 1998, the first comprehensive treaty to emerge from the new process (Sterritt 1998; Sterritt, Marsden, and Galois et al. 1998). After complaints to the province went unanswered, Gitanyow representatives sued the government and the Treaty Commission for failing to negotiate in good faith (Krehbiel 2004). By the end of the decade, negotiators had suspended their work with the BCTC to focus

their efforts on writing a Gitanyow constitution and earning provincial recognition for the document (Gitanyow Hereditary Chiefs 2008; Peeling 2004).

In the twenty-first century, the seemingly unending wait for a definitive answer to the "land question" has pushed First Nations representatives towards a growing range of Incremental Treaty Agreements and interim strategies (Aboriginal Affairs and Northern Development Canada 2008). By the time I met her in 2013, Lorraine had also retreated from the confrontational tactics that characterized her years working with the Gitxsan Strategic Watershed Analysis Team (see chapter two), the GIS mapping group created in the wake of the 1991 *Delgamuukw* trial decision to oversee Gitxsan consultations with the BC Forest Service (L. Johnson 2000). Working in the perpetual shadow of the treaty protocol forced Lorraine to decouple her mapping work from the expectations of recognition and sovereignty that shaped Gitxsan and Gitanyow activism throughout the 1980s and '90s. The financial support for her work with the GHC, once drawn primarily from government grants, increasingly was coming from corporate budgets for environmental assessment work around proposed mines, energy infrastructure projects, and tree harvests. More quickly than many other Nations who entered treaty negotiations in the early 1990s, Gitanyow leaders resigned themselves to probing the efficacies of partial recognition. By 2012, the Gitanyow Hereditary Chiefs had established an interim Recognition and Reconciliation Agreement with the province, greatly expanding their jurisdiction over forestry management decisions on their territories, and deepening their engagement with government land use designations and formalisms which they had begun incorporating into their own territory maps in the early 1990s (Clogg 2012).

In keeping with the skepticism surrounding other Interim Treaty Agreements, public support for the new agreement was muted (e.g. Meissner 2012). Frustrated by the slow pace,

enormous costs, and relative inefficacy of the standardized treaty process, First Nations representatives have long criticized the provincial government's efforts to structure their adjudication of claims around the exclusive use and ownership of autochthonous territories. The peculiar colonial geography of British Columbia's federally managed Indian Reserves complicates these attempts, however. Surveyed and circumscribed by a series of appointed commissioners during the decades before and after British Columbia's entry into confederation with Canada in 1871, the hundreds of minute reserves where most of the province's indigenous populations lived by the middle of the twentieth century were designed to recognize each groups' identification with particular landscapes, even as reserve residents were cut off from the continuity of their seasonal rounds by settler encroachment. Each reserve, geographer Cole Harris (2011) observes, was localized around whatever the reserve commissioner at the time deemed to be each group's "village sites, cultivated fields, and favourite places of resort" (41).[6] Ironies abound: As Harris (2011:87-89) argues, the provincial government's stated dedication throughout the late 19th and early 20th centuries to preserve the geographical continuity of aboriginal communities was undermined by the reserve commissioner's explicit interest in driving First Nations people *off* their reserves in search of wage labor in the young province's rapidly expanding resource industries. This tension has shaped First Nations politics since the end of the nineteenth century. "A common view," historian Rolf Knight (1996[1978]) writes, "is that whatever wage labour Indian people were involved in during this period, they were tied to their own locales: that they were an inward-looking people, rich in their own customs but unknowledgeable about events of the larger world. Considering their work related travels one may wonder about this" (14).

6 Harris contrasts this with reservations in the western United States, where many indigenous groups were forcibly relocated to comparatively large areas of land, albeit often in marginal, arid regions. See Biolsi 2005.

The invention of new categories of indigenous space and the hardening of correlations between identities and locales has been energized by the use of new media technologies by a growing range of officials, travelers, and activists. Even those who wielded maps, surveying equipment, and other tools with the best of intentions have wrought far-ranging consequences on the groups they sought to depict (Bryan 2011; Palmer and Rundstrom 2013). Writing from the perspective of an active negotiator for a Coast Salish group on Vancouver Island, anthropologist Brian Thom (2009) charged the static "ethnographic maps" produced by reserve surveyors and contemporary use and occupancy research teams with subverting the "ideas and practices of kin, travel, descent and sharing [that] make [Coast Salish] boundaries permeable" (179). Julie Cruikshank (2010) identifies similar subversions at play in colonial encounters along the southeast Alaska coast, a few hundred kilometers northwest of the Gitanyow territories. Juxtaposing different narrative forms generated around sites of scientific work set in indigenous territories, Cruikshank shows how the initial process of deciding what to include in depictions of landscapes authorizes who can speak, and what can be said, in later re-tellings. By the mid-twentieth century, the increasing formalization of scientific and legal histories of the northwest had greatly narrowed the ways in which indigenous residents could describe for government audiences their connections to these places. For the would-be owners and managers of newly recognized territorial entities, historian Keith Carlson (2011) argues, expectations of exclusivity ingrained by the spread of rights-based discourses have changed how many of them judge the legitimacy of maps, stories, and other representations of contested landscapes. Paul Nadasdy (2012) echoes similar worries among the Kluane First Nation, arguing that the treaties produced under the Yukon Umbrella Agreement fixed ideas about spatial boundaries among neighboring First Nations, hardening relationships into a state of suspicion approaching ethno-territorial

nationalism (see also Moore 2005). Dene theorist Glen Sean Coulthard (2014) goes further still, arguing that decades of legal confrontation throughout western Canada have effected a near-total "reorientation of the meaning of self-determination … [and] indigenous struggle from one that was deeply *informed* by the land as a system of reciprocal relations and obligations … to a struggle that is now increasingly *for* land, understood now as a material resource to be exploited [...]" (78).

Among the Gitxsan, whose participation (with the neighboring Witsuwit'en) in the watershed land claims case, *Delgamuukw v. The Queen*, first established recognition for indigenous governing entities and oral histories within Canadian law, the production and circulation of territory maps has been particularly disorienting. Advocates involved in *Delgamuukw* pre-trial research (Overstall 2004) openly lament the effects that the court recognition of individual house chiefs has had on earlier practices of collaboration and joint decision-making on the Gitxsan territories. Shortly after the federal appeal to the second *Delgamuukw* decision in 1997, geographer Matthew Sparke (1998) argued that the maps produced by the plaintiffs had failed to enact a new narration of Gitxsan and Witsuwit'en nationhood precisely because the claimants had had "to place native people and spaces within the overarching cartography of the country" (463). Val Napoleon (2003) a Cree woman and researcher and advocate for the Gitxsan, argues further (with fellow trial researcher Richard Daly) that Gitxsan people "now understand and describe themselves according to *Delgamuukw* – through the legal arguments, the transcripts, the commissioned evidence, three levels of court decisions, and the experience itself" (117).

The pervasive adoption of legal discourses of ownership and property among the descendants of the original *Delgamuukw* claimants mirrors subjective realignments among other

First Nations communities engaged in different stages of treaty negotiations (Egan 2013; Nadasdy 2002; Overstall 2008).[7] As Lorraine admitted, the surge of enthusiasm that brought her and others into technical mapmaking in the 1980s and 1990s has largely given way to apathy and cynicism, in part because many of the original leaders of the movement have since dissociated themselves from mainstream Gitxsan politics. Critical discussions of the uptake of concepts of territory in other contemporary venues of indigenous politics are similarly despairing. Tyler McCreary, Tania Li, and others have called attention to how diverse indigenous political actors have unwittingly facilitated the re-colonization of contested territories by settler regimes, allowing formalized registers of "traditional knowledge" to function "as an anchor for a field of governmental inquiry and action" (McCreary and Milligan 2014:115), often by helping to restrict sovereignty claims to a "delimited geography of tradition" (McCreary and Lamb 2014:595; see also Bryan 2011; Wainwright and Bryan 2009). By rendering the ecological prerogatives of indigenous sovereignty claims into discrete series of technical puzzles and managerial problems, Li (2007a) argues, state officials transfer jurisdiction over matters of territory out of the courts and into the waiting hands of scientific experts and state institutions, rendering identity-based claims into empty polemics (see also Ferguson 1990).

In the wake of their 2012 Recognition and Reconciliation Agreement, the Gitanyow Hereditary Chiefs produced a set of finely detailed maps of old growth forest management areas, animal habitat, and other conservation zones in collaboration with the provincial Forest Service. Taken as mere technocratic artifacts, this mass of new maps holds much in common with the objects of Li's critique. And yet, the "depoliticization" of indigenous claims is more than simply a discursive, technocratic process. Lorraine's experiences make plain that indigenous experts can

7 On the problematic role of property discourse in the preparation of the Gitanyow constitution, see in particular Overstall 2008.

be deeply invested in producing technical renderings that open up critical avenues of action and critique often forestalled by identity-based claims to sovereignty. As Li insists, the work of "rendering technical" invariably takes place within a broader assemblage of political activity and conversation. In the final months of 2013, shortly after Lorraine finished the project, the GHC put their new maps and accompanying shapefiles online, supplementing them with court transcripts and other historical documents outlining the Gitanyow Chiefs' struggles with the province over the weight and structure of its consultation procedures (Gitanyow Hereditary Chiefs n/d). The GHC added their own polygons to the maps, too, derisively depicting the pitiful extent of the regions that the province offered the Gitanyow during earlier stages of "land selection"-style treaty negotiations that they had been engaged in for nearly twenty years. They also added Gitanyow Office logos to each map, and replaced many of the colonial era names for mountains, rivers, and other features with Gitanyow markers and Gitxsanimx language place names. That such an substantial archive of information exists now, ready to hand, belies the days when activists had to conjure excuses to visit regional BC Forest Service offices to steal copies of basic paper maps of forest cover and proposed clearcuts (Glavin 1998). And yet, the competition for space on the maps between provincial and Gitanyow logos and names echoes the awkwardness of a decades-long struggle to come to terms with the epistemic consequences of their collaborators' best intentions.

Digital Maps and Energy Dreams

The history of First Nations mapping activities in northern British Columbia is intimately related to the province's history of pipeline development. In 1978, anthropologist Hugh Brody (1981)

moved to a Beaver Indian (Dane-zaa[8]) reserve near the town of Fort St. John to assist them in documenting their use and occupancy of land in the region prior to the planned construction of the Alaskan Natural Gas pipeline. Hired by the Union of British Columbia Indian Chiefs to assemble maps depicting the group's subsistence activities throughout the region, Brody drew on his own experience as a government consultant in the High Arctic, adopting the novel mapping methods which he had recently helped to pioneer while assembling the first comprehensive maps of Inuit territory in Canada (H. Brody 1976).[9] The maps that Brody produced for the consultation process were not depictions of territorial boundaries, but rather charts of movement, work, and constant adaptation. Many of the Beaver men and women Brody encountered on the reserves had been relocated there less than two decades earlier. They still drew heavily on the income they earned from fur trapping on their families' registered traplines, and on the hunting rights they had earned with the establishment of Treaty 8.[10] While certain elders played central roles in Brody's study, the younger men who led many of the hunts in which he participated became key sources for Brody's maps and anecdotes as well. At times, they directly criticized Brody's unconscious assumption that the methods and motivations behind their own hunts were somehow less legitimate than their fathers' had been.

Still, Brody recognized a troubling paradox in identifying indigenous groups by their adaptive skills rather than on the attributes of their cultural ephemera. "There is a difficult

8 The seven Indian Reserves (which all now identify as First Nations) Brody identified as Beaver Indian groups in 1978 now use multiple different spellings (Dunne-za, Dunne Tsaa, etc.) to designate their collectivity. The term "First Nations," a consciously adopted term referring to all non-Inuit, non-Métis indigenous groups in Canada, and was not in common usage at the time of Brody's fieldwork.

9 For a genealogy of use-and-occupancy mapping methods that emerged from the Inuit project, see Chapin, Lamb, and Threlkeld 2005.

10 The only First Nations groups within British Columbia covered within the 18th-19th century system of numbered federal treaties, the Dane-zaa and their neighbors northeast of the Rocky Mountains have not taken part in BCTC-led treaty negotiations which have dominated provincial interactions with other First Nations groups for the past three decades.

tension," he writes, "between insisting, on the one hand, that Indians are surprisingly flexible, and saying, on the other hand, that they are now economically and socially threatened as they have never been before" (H. Brody 1981:248). Brody's image of the frontier, a liminal zone enmeshed with aspiration and latent conflict, remains prescient and insightful nearly four decades later. Though hired only to produce maps in consultation for a single proposed pipeline corridor, Brody's monograph, *Maps and Dreams*, forebodes of a future in which rising oil prices and expanded transport infrastructure would bring far more prospectors and developers to the region, and introduce changes far more expansive than those that the Beaver were already struggling to contest (see also Mason 2013).[11] By the time I set out with Lorraine and her colleagues onto the Gitanyow territories in late 2013, natural gas produced in northeast British Columbia had become one of the province's most valuable export commodities, a source of fees and royalties that by 2006 was providing over $2.6 billion in annual provincial revenues (Ministry of Energy and Mines 2012:2).[12] With the aid of a new, 48-inch diameter pipeline to connect these growing gas fields to the port city of Prince Rupert, the province argued, producers would enjoy direct access to the tremendous energy markets of East Asia. Advocates for the Beaver's claims against the Alaska Gas Pipeline proposal pioneered the consultation process in the late 1970s, generating a new class of regulatory forms in the process. Among the Gitanyow and the other First Nations groups whose territories would be bisected by the new pipeline, re-

11 The proposed Alaska Gas Pipeline which originally brought Brody into contact with the Beaver has been been abandoned and re-imagined multiple times since the late 1970s as contracts changed hands, sources and markets reconfigured, and different prospective routes encountered new forms of opposition. The route along the Alaska Highway, in discussions for over forty years by this point, has also faced opposition from proposed routes through the MacKenzie River Valley in the Northwest Territories and through the Alaskan Mountain Range to Valdez, Alaska, the current endpoint of the trans-Alaskan oil pipeline. In its most recent iteration, TCP, the proposal's latest proponents, put forth yet another set of plans for a route along the Alaska Highway to a distribution station in Calgary, Alberta, before a drop in gas prices in 2014 led the company to suspend its bid.

12 Thanks to the development of hydraulic fracturing techniques and other shale gas extraction methods, natural gas development within the Peace region expanded so quickly in the first years of the twenty-first century, that in 2013, the provincial government created an entirely new ministry, the Ministry of Natural Gas Development, to manage the legal and bureaucratic consequences of its growth.

inhabiting these forms four decades later has meant articulating their connections to landscapes within an altogether different professional world.

While the cumbersome strictures of Treaty 8 have for decades forced Dane-zaa representatives to advocate for their changing needs and interests within an increasingly archaic framework of traditional rights, persistent ambiguities surrounding the contemporary BC treaty process have left Gitanyow planners to construct interventions in a state of constant contingency. Many of the mapping techniques that Brody helped to develop have since become embroiled within the professional politics of private consultancies and in struggles for power between and within First Nations communities. Even among the neighboring Gitanyow, Gitxsan, and Witsuwit'en, use and occupancy projects have been put towards radically different ends, depending on the larger political and economic goals of their sponsors (McCreary 2013:143-182).[13] Numerous First Nations groups have succeeded in training local residents to conduct interviews, survey field sites, and populate GIS databases, whether by installing them as assistants within consultancy-led mapping projects or applying for government grants to support cartography training programs and other "capacity building" initiatives (Dunn 2007). Still, the high costs and often elusive benefits of such projects have inspired backlash in a number of First Nations communities. Thanks partly to prolonged over-exposure to cartographers, treaty lawyers, and anthropologists (Kuper 2003) over the intervening years, the cautious optimism which Brody attributed to his Beaver interlocutors has largely given way to resignation and cynicism among many of the First Nations groups still engaged in consultation and mapping projects (Bell 2012; see also Li 2000). Amidst a clamor of consultancies competing for contract work as mediators

13 McCreary worked primarily with the Office of the Wet'suwet'en, the Carrier-Sekani Tribal Council, and the Skin Tyee First Nation, the latter of whom used developer-supported studies specifically to challenge anti-development protests.

for First Nations engaged in development proposals, treaties, and land claims, some groups have grown skeptical of the complicities inherent in collaboration, and have criticized their chiefs and other leaders' willingness to accept developer support for new projects (Veltmeyer and Bowles 2014). Wary of skeptics pressing in from both sides, many corporate-funded indigenous mapmakers have learned to approach "the field" of their work with sovereignty aspirations held firmly in check.

Helpers and Helicopters

It was only half past six in the morning, but already Alan, Lorraine and I had been up for hours. The fire we had built to stave off the mid-autumn chill was dying down; the generator whined, charging our lanterns, satellite phones, and GPS devices. Anxiously, we plotted the day's route on an enormous paper map spread out atop Lorraine's firewood box, comparing its roads to the positions of the pixelated brown lines winding through a stack of satellite photos (figure 4.3). As Alan read through the markers along our day's path and Lorraine keyed the numbers into her GPS device, the three of us traded morose jokes. With Indian[14] status through a Gitxsan reserve, maternal lineage in Gitanyow, and a host of family members and previous mapping projects spread across both territories, Lorraine's two decades of experience as a GIS expert had made her a familiar face among developers and activists alike. The GHC's decision finally to accept TransCanada support was simply strategic, she assured me; the maps we had driven out to the field to validate, a tentative route sketched by the two full-time scientists at the GHC office, was a kinked path, oriented primarily through clearcuts and other previously developed areas, and

14 "Indian" remains the term denoting legal status and recognition used by the federal Department of Indian Affairs and Northern Development (DIAND) to refer to non-Inuit, non-Métis indigenous people in Canada. An individual's legal Indian status is transferred paternally and is tied to a specific federally administered reserve.

curving away, as much as possible, from old-growth management areas and water sources. Set against a backdrop of maps and datasets which Gitanyow officials compiled with British Columbia Forest Service officials in preparation for their own Reconciliation Agreement, the alternate pipeline route proposed by the GHC challenged TransCanada's definition of "path of least resistance." The nearly seventy-kilometer route proposed by TransCanada, itself a small yet unavoidable section of a planned 1,400 kilometer extension of the company's nation-spanning network of pipelines, offered a straighter path with minimal elevation gain, hewing closer to the rivers and lakes feeding into the Skeena, Nass, and Cranberry Rivers draining the Gitanyow Territories. The data we collected as we walked would offer the Gitanyow a technical base for confronting the pipeline proposal. If construction impacts were deemed too severe for even the least vulnerable swaths of the territory to sustain, Gitanyow advocates would stand a far greater chance of halting the project entirely. Once added to the GHC's database, however, our data would also serve other ends. With a tentative counter-proposal already assembled from databases decades in the making, Lorraine was entering the field to gather new data for confrontations to come.

As I drove west to meet Lorraine and Alan at their campsite the night before, I had crossed through the territories of three different First Nations that would be bisected by the proposed pipeline. In keeping with their divergent bureaucratic histories, representatives of each group had encountered the TransCanada proposal in radically different ways. Members of the Office of the Wet'suwet'en,[15] whose territories encompassed the town of Smithers where I lived, had spent the past several years leading a province-wide protest against a contemporaneous proposal by the Enbridge corporation to build a bitumen pipeline across their territories. Their

15 Like the Office of the Gitanyow Hereditary Chiefs, the Office of the Wet'suwet'en houses both the bureaucratic structure and council of chiefs for participating Witsuwit'en house groups.

approach to the TransCanada proposal had been similarly blunt. After the company submitted their initial environmental assessment report with the province in 2014, the Office immediately followed suit with a submission to the same office, insisting that the TransCanada report had failed to account for outstanding Witsuwit'en claims to aboriginal rights and title (Office of the Wet'suwet'en 2014).

The stance of the Gitxsan First Nation, Gitanyow's neighbors to the east, remained opaque and inconsistent. During early negotiations with the Enbridge Corporation, members of the Gitxsan Treaty Society[16] had signed a unilateral agreement with the company, inspiring a series of lawsuits and a six-month long blockade of their headquarters by Gitxsan chiefs who opposed the pipeline (Canadian Press 2012). Two years later, Treaty Society executives spontaneously evicted Enbridge and TransCanada surveyors from their territories for violating Gitxsan territorial sovereignty (Posadzki 2014). As with other confrontations between the Gitxsan, the provincial government, and prospective developers over the past two decades, residents of the Gitanyow reserves apprehended Gitxsan responses to TransCanada's work in multiple registers. The night before I joined Alan and Lorraine, residents of the Gitxsan reserve of Kispiox Village had held a meeting to discuss the unexpected discovery of TransCanada surveyors and survey markers on Gitxsan territory near the reserve, a clear violation of the province's consultation protocol. The overcrowded meeting, which drew numerous white environmental activists from the nearby town of Smithers, inspired another round of angry denunciations of the Gitxsan Treaty Society, whom many assumed were complicit in the new developments.

16 At the time, all members of the Gitxsan Treaty Society were self-appointed. Membership has since been extended to the chiefs of all Gitxsan house groups, albeit in a controversial manner designed in part, critics allege, to further marginalize dissenting house groups. See *Spookw v Gitxsan Treaty Society* 2015.

With a smaller population, land base, and operating budget than either their Gitxsan or Witsuwit'en neighbors, the Gitanyow Nation's initial response to the TransCanada proposal was circumspect. Working within the spatial structure of their recently adopted Strategic Land and Resource Plan (SLRP), Gitanyow staff scientists began negotiations by proposing an alternative path for the pipeline. On the maps we brought with us into the field, the simplicity of the projected route belied the diversity of materials which had been assembled to construct the new SLRP maps (figure 4.4). In the weeks before we entered the field, managers at the GHC office had sifted through an unruly archive of discarded treaty charts, land management polygons, and GIS shapefiles generated from species counts, habitat corridors, and other datasets assembled by provincial foresters and other government analysts over the past several decades. Lorraine speculated about the negotiations behind the project with a mixture of pragmatism and resignation.[17] *Who knows what will happen?* she admitted. *If something happens, it'll be better to have our path on the books, too.*

Disengaged from the day-to-day politics at the GHC but a long-time friend and ally of the Nation's chief, Lorraine was often the Office's first choice to lead mapping projects on the territories, particularly in cases where funding was scarce but the consequences of mismanagement were severe. Since learning of TCP's grant earlier in the summer, she had struggled to coordinate the people and resources she knew would be needed to map out the entire line quickly enough to challenge TCP's own proposed route. Her long-promised helicopter service, a common feature of remote field mapping campaigns throughout the province and a basic necessity along several of the most rugged patches of the GHC's proposed path, kept being pushed back, as TCP introduced a steady stream of bureaucratic hurdles. As I drove up to the

17 "Resignation" is increasingly seen as a deliberate outcome of corporate-led disenfranchisement and token accommodation of affected communities. See Benson and Kirsch 2010.

campsite the previous afternoon from the town of Terrace, a regional hub of 12,000 people roughly 200 km south, Lorraine had explained that they hoped to spend my first day with the team flying the length of the proposed route scouting for potential landing sites (level clearings on mountain tops, sandbars in rivers, etc.). With this information in hand, they would then divide the remainder of the route into walkable segments, maximizing the team's logistical efficiency while reducing Lorraine's exposure to the steep inclines that challenged her ailing knee. By the time I arrived at the camp, a few kilometers north of Cranberry Junction, plans were still in flux. Throughout the evening, Lorraine argued over her satellite phone with a company representative who suddenly announced that each member of her team would have to complete an unpaid, day-long safety course back in Terrace before being allowed to board a TCP-rented helicopter. Meanwhile, the few pilots based in the region were steadily being lured away to other jobs.

Lorraine had also spent several minutes on the phone the previous night checking in with the GHC about the status of their ongoing search for a field assistant. *Sounds like they found a guy*, she had relayed to Alan and me, returning to the fire after finishing a call. *An older guy, I guess, but he should be up here and ready to go at 5am tomorrow. I really hope he works out.* That night and for the next several days, Lorraine's anxious optimism turned into a regular refrain. *I can't do this project by myself. I really hope he works out.* Since returning to work on the Gitanyow territories a decade earlier, Lorraine had overseen a series of mapping projects with an ever-changing roster of field assistants, untrained helpers recruited by the GHC through online ads, Facebook posts, bulletin board announcements, and word-of-mouth calls around the reserves at Kitwanga and Gitanyow village. The people who responded to these ads, Lorraine explained, were often older men, motivated to engage in physical, outdoor work, yet still looking for part-time employment. *Most of the people who* are *motivated here have full-time jobs*

already, Lorraine mused sardonically, *so we're looking at a pretty narrow slice of the population.*[18]

Training the new arrival would occupy Lorraine's chief assistant for most of the next two days. Alan, a white man and registered professional biologist (an "R.P.Bio," in provincial parlance) based near the predominately Gitxsan town of New Hazelton, often worked for the Gitanyow office, assembling wildlife population projections, leading mapping exercises, and offering his signature to technical documents requiring the certification of a provincially-registered scientist. This week, Alan was to serve as our chief navigator, keeping Lorraine on the path of the GHC's proposed pipeline route by roving ahead and calling out waypoints and markers as we walked through the forest, leaving her free to keep her eyes on the ground. Over the past decade, Alan had met and managed a revolving cast of temporary assistants, too, training them on the fly to navigate, observe, take notes, or log GPS waypoints on whatever device they had managed to borrow from the Gitanyow Office for the day. On this project, like many others, the GHC could only afford to hire Alan for the first few days of fieldwork before transferring his responsibilities to a lower-paid Gitanyow assistant. For his part, Alan had no qualms with the arrangement or with the GHC policies that prioritized the participation of local Gitanyow over white labor. He simply offered a chorus to Lorraine's anxious refrain. *I just hope this guy works out. It'd be a shame for me to spend two days training him only to have him bail on Lorraine as*

18 Lorraine and many other Gitxsan men and women I worked with complained to me that few of the young people they encounter on the reserves have any interest whatsoever in exploring, let alone working on, the territories, a change in attitude that Lorraine, like others of her generation, tended to attribute to the twinned evils of "Facebook and x-box." My own observations were no doubt colored by a sampling bias, though, as I spent relatively little time around younger Gitxsan men and women, and the few that I did meet were actively engaged on the territories, building trails, trapping, and even living full-time in strategic cabins. Regardless, a number of other scholars have picked up on these generational anxieties and explored them in detail, whether in the context of young peoples' expectations to be paid for participating in co-management conversations or the challenge of creating inducements for young people to participate in environmental education programs (Lowan-Trudeau 2012).

soon as I leave.

At a quarter past seven, the fire by now completely dead, the sound of a vehicle came crawling up the hill through the narrow path to our campsite. Moments later, led by the flapping wings of scattering grouse, an old GMC Suburban lumbered out of the poplar grove and nosed up next to Lorraine's camper. From the passenger seat, a tall, grey-haired Gitanyow man stepped out, hastily stuffing canteens, a sweater, and bags of food into a small backpack before bidding his driver goodbye and turning to greet us. Smiling apologetically, Gerry admitted that he'd started off with the wrong directions to our meeting site, then had to turn back to Kitwanga, over seventy kilometers south, when his driver reminded him that he'd left the house without packing any protective clothing. Reaching into his backpack with a sheepish grin, he pulled out a heavy pair of bright white and neon yellow reflective overalls. *Couldn't find my hunting pants either, so I had to bring these. Worked as a flagger for a highway crew this summer. Better than nothing I guess.*

The tension of the early morning quickly fading, the four of us returned to the map to explain the purpose of the project and to sketch out the day's route for Gerry. As Alan pointed out each kilometer marker, road crossing, and incline, Gerry nodded along, occasionally asking after the names of particular roads or rivers. "I didn't realize there were so many roads up in here," Gerry offered, gazing at the maze of tiny dotted lines extending off the highway and the main Forest Service roads linking the region to the coast and to the Kispiox Valley. "Oh fuck, there's roads all over the place in here," Alan chided. "All over the place." One of the main challenges of working with such complicated maps, Alan explained, was that so many of the roads depicted on them had long since been decommissioned, and the other, more recent roads had not yet been incorporated into the primary government shapefiles used by the GHC to

compile their maps. "I wish they would've made the lines thicker," Alan joked as Gerry squinted at different labels and markings. "The guy was really cheap on the ink on this one." As we quickly realized, Gerry's experience hunting bear and moose and picking mushrooms around Cranberry Junction had given him a profound knowledge of how to move through the region, but like Alan, his awareness of the state of the area's roads and bridges was embedded in memories and anecdotes. Pouring over the map together, they slowly updated each other's mental inventories with stories.

His eyes roving along the thick red line marking the GHC's proposed pipepline route, Gerry gently chimed in with Gitxsan and settler-authored place names as Alan described the landscape along the path. "I knew lots of moose used to be in there, eh? Quite a bit. Used to see them all in there." Lorraine murmured a courteous agreement, still absorbed in programming additional waypoints into her GPS. As he pointed to differently shaded lines and colored areas along the route, Lorraine slowly explained the GHC's system. "That's Gitanyow's land use plan, and that's an old growth management area," she offered, following Gerry's roving finger with her eyes. "Oh yeah, there's some pretty old growth in there," Gerry agreed, remembering a particular mushroom gathering excursion and struggling to recall the name of the outlet creek that had led him there. Lorraine remembered the landscape around the grove, too, but in more immediate terms. "The only trouble is, we can't get in here without a helicopter," she laughed. Together, Gerry and Alan pieced together recent histories of infrastructure development across the territories. The destruction of a bridge along a branch of a primary forest service road had kept most hunters out of one particular region for over a decade. Moose scared away by the development of the original power lines next to Highway 37 several decades earlier had moved in, displacing the resident caribou. Now that the old line was being decommissioned, the corridor

along its path was "greening up" with dense second-growth spruce forests. A new transmission line with a much wider "right-of-way" was being cleared along a new path; many of the moose had begun to move back.

Training in Transit

At 8am, the GHC finally relayed the news from TransCanada: no helicopter for today. Alan and Lorraine swiftly assembled a new set of waypoints covering a relatively flat section of the route that Lorraine had hoped to save for the end of the project. A broad swath of twenty-five and fifty-year-old second growth timber set within a five kilometer gap between active logging roads, the route promised few interesting finds. Alan offered more hopeful angles: with few clear landmarks and a profusion of small trees and other dense undergrowth disrupting their lines of sight, he suggested, this kind of second-growth terrain would force Gerry to hone his navigation skills quickly. *Won't we just be using the GPS the whole time?* Gerry asked, cautiously. "As soon as you jump in the bush, you're using your compass," Alan explained, as the dense overgrowth in the region often made GPS devices unreliable. Our devices were meant solely for marking finds and waypoints along each transect, and for periodically confirming their position on the paper maps we carried in our packs.

For temporary assistants like Gerry and me, knowing that our observations could not easily be repeated kept us focused on our work, even we struggled simply to find our way through the forest. The only markers we encountered as we walked were the neon pink ribbons left behind by TransCanada surveyors who had been cutting new trails through the area ("Illegally," Lorraine sighed) the previous week. With little rise or fall in the land to help orient us after the initial climb up from our parking site, Alan tacked constantly between compass,

navigation target, and folded map. Anything an approaching pipeline construction crew encountered after we left would either be destroyed or displaced, he and Lorraine pointed out. However unimpressive our finds proved to be, "the field" we captured in our notes and maps would offer a critical historical perspective on the region if TransCanada's plans came to pass. As we groped our way forward, most of the few points of orientation we encountered were long-abandoned roads (figure 4.5) or enormous right-of-way paths cleared for other recent infrastructure projects (figure 4.6). At each encounter, Alan pointed out the discrepancy between the precise location of the intersection depicted on the map and the position he measured with his GPS device. As the province recommissioned these roads during the lead-up to pipeline construction, Lorraine complained, inaccuracies would invariably cause disagreements; we might as well start noting them now.

As we stopped for a moment to note the site of our day's first kilometer marker, Alan explained that he was going to take over navigation duties for the morning to make up for the time we had lost waiting for news of the helicopter. In the meantime, Gerry and I were to stay close to Lorraine, observe her observations, and relay her detours and pauses back up ahead to Alan. Moving swiftly, Lorraine offered tutorials over each pile of droppings and every stripped patch of browse and claw-torn tree stump (figures 4.7 and 4.8). Most variations of scat we encountered, Gerry and I could place from our own experience following deer and other animals through the woods. At a glance, though, Lorraine could tell how old a pile of droppings were, what season they had been left behind, and what the animal that left them had been eating at the time. Walking ahead, Gerry shared anecdotes from his fur trapping experience in the mountains further south, helping me to spot holes in rotting logs that had likely been dug out by weasels. Calling Lorraine over to investigate each of find, she would tell us what kind of weasel had

likely made the hole, and when.

As lunchtime approached, Gerry and I were both quickly learning how to distinguish badger dens from bear diggings. We fanned out, ten meters on either side of Lorraine, and stared at our feet as we trudged forward through the brush, calling out to Lorraine to inspect our "finds" as the three of us followed the booming beacon of Alan's voice leading on ahead. Encouraging our attempts to describe verbally our observations as we walked instead of calling her over each time our eyes caught something promising, Lorraine coached us along with questions and clarifications. As I shouted out a description of a large hole in a tree stump and estimated the size and shape of the splinters littered around its base, Lorraine affirmed my guess even as she continued to push her way through the undergrowth. "Yep, that sounds like a bear," she shouted back, "and I'm gonna record it as such." When Gerry asked how she accounted for signs she couldn't quite place, Lorraine was straightforward in her modesty. "If I think it's really important," she offered, "then I take pains to describe it." She showed him her field notebook, already filling up with rows of check marks next to coded category headings, each one corresponding to a few dozen different kinds of frequent finds. Flipping several pages forward, she showed a tightly packed column of descriptive notes and short-hand reflections next to a corresponding list of spatial coordinates. Gerry nodded in polite approval.

Throughout the first morning, Lorraine continually apologized that she had invited me to accompany her on such a "boring" project. The premise of the GHC's proposed route, she reminded me, meant that the goal of the team, whether we liked it or not, was to find "nothing," or rather, nothing that the Gitanyow chiefs couldn't bear to lose in the event that the TransCanada proposal was approved. Gerry admitted that when he had signed on to help, he had expected to find more "cultural stuff," too. Most of the marked trees, hunting trails, and camp

sites that had once existed in the area, Lorraine lamented, had been destroyed during the first years of logging on the territory, decades before such artifacts were protected by provincial law. The few that remained were marked and coded as small orange polygons on the maps we carried, but, by design, few of these polygons sat anywhere near the land we would be crossing as we worked. This did not mean that the tangled thickets of second-growth trees growing in the wake of these removals were devoid of value. Dense, new forests provided food and shelter for moose and other animals evading humans through the short autumn hunting season. While the towering cedar groves and lush moss beds of British Columbia's coastal old growth forests offered stirring symbols for activism throughout the 1980s and '90s (e.g. Braun 2002), the day-to-day realities of ecological conservation had grown somewhat less romantic in the intervening years. Coding the notes she had accumulated over the day's walk back at camp each evening, Lorraine explained that our rather mundane finds, once numbered, generalized, and extrapolated along the path of the route, would help GHC staff scientists to question and improve upon the habitat polygons and other conservation shapefiles the office shared with the province.

Gerry was far from critical or suspicious of the technical designations that Alan and Lorraine invoked to describe the different areas we visited. As we stopped for lunch, though, the personal stories Gerry shared took on a cheerfully conspiratorial tone: Which neighboring white and First Nations groups had been venturing into the area to poach moose to sell back at home; Which Gitanyow families had likely helped the poachers to perform their work without getting caught. Reclining on fallen hemlocks as we rested in the first patch of old growth we encountered for the day, he pointed out places where he and friends had located treasure troves of pine mushrooms during the 1990s, when wild-picked specimens were fetching over $100 per pound from wholesale buyers working out of garages and backyards in Kitwanga. He laughed as

he described the circuitous steps he and his fellow pickers had taken to cover their tracks from their finds, admitting that anyone caught out in the forest with a GPS device in those days was liable to be followed and harassed by other pickers.[19]

After breaking for lunch (figure 4.9), Alan invited Gerry to take up his compass and begin leading the way. Gerry moved slowly at first, constantly referring to Alan's GPS and Lorraine's GIS-enabled iPad (figure 4.10) to determine how far he was straying from the route as we walked, before gradually picking his bearings based on targets further and further away. As Lorraine and I set to work a dozen meters behind, I probed for her thoughts on Gerry. *He seems to be learning fast, which is great,* she offered. With Alan's contract set to expire in two days, Gerry's competence could determine the success or failure of the trip. As they gently reminded me, though, "competence" in the field was not something one could predict based on credentials and qualifications alone. Struggling to read a label on Alan's map during our lunch break, Gerry admitted that he was illiterate. Lorraine and Alan took the revelation in stride; both later acknowledged to me that most of the GHC recruits they took on as temporary assistants were older men with very little formal education. Some of them, like Gerry, took to the work with gusto and good humor, patiently absorbing lessons and sharing stories as they worked. Some resented the long hours and grueling pace, or bristled at the hierarchies implicit in the division of labor that project leaders like Lorraine employed to keep the team moving swiftly.

After almost twenty-five years bringing novice field mappers into the forests of northwest BC, Lorraine could decipher immediately whether a new recruit would take to the technical tasks

19 Gerry and Alan swapped anecdotes throughout the day about some of the dangerous situations they had each encountered over the years during visits to "the zoo," a large, caravan-style encampment of transient mushroom pickers that emerged along Highway 37 near Cranberry Junction each year. Recounting accidentally stumbling onto frenzied activity around a prized mushroom patch during an early moose hunt, Gerry laughed out loud as he described how he and his hunting companion were chased away from the site by white pickers with shotguns bared.

each project required. Assessing how new assistants would manage the exhaustion, vulnerability, and other emotional stresses of fieldwork, however, was less automatic.[20] After walking beside her all morning, I did not need to be reminded that Lorraine couldn't possibly observe, take notes, and navigate simultaneously if she hoped to cover more than a few hundred meters per day. Even a master of multi-tasking would be foolish to work alone here, a nearly homogeneous, overgrown stretch of second-growth timber almost completely devoid of established trails. The steady stream of bear-splintered logs we had been stepping over for hours made clear our dependence on one another, a dependence we tacitly noted in jokes about the utter impossibility of landing a medical evacuation helicopter anywhere near our current route. When Gerry learned that I would be leaving the group a few days later, too, he quietly admitted that he was only just beginning to realize how crucial he was to the fate of the project. And as Lorraine subtly reminded him, his mere presence in the field was almost as important to her as his navigational skills. As we walked late into the afternoon, half-serious jokes about encountering bears on our route became slightly more serious jokes about bears wandering into the camp at night. Sleeping alone in a deserted camp a few days hence was not something Lorraine was looking forward to. "I'm getting too old for this!" she admitted with a laugh. At Gerry's suggestion that she bring a dog up to camp to warn her of approaching animals, she laughed again. "Yeah, to scare me all night with his barking!"

As we returned to camp late in the afternoon, Lorraine's easy rapport with Gerry made

20 Anthropologists of the Canadian north have long been interested in how the physical and emotional demands of hunting, travel, and isolation have shaped different First Nation communities' understandings of the tensions between individualism and interdependence. For a review of this literature, see Ridington 1988. Recent changes in corporate-led training regimes around resource development work in remote rural areas have recast some of these issues in dramatic ways. As Lindsay Bell (2014, 157-90) and Tyler McCreary (2013, 218-56) have described for the Northwest Territories and northern British Columbia, respectively, the mineral exploration and mining training camps and other professionalization programs which have come increasingly to replace more conventional forms of social assistance in rural First Nations communities are often expressly oriented at cultivating the "values" and "emotional skills" required for extended work in the field.

plain her long experience easing the anxieties of new mappers, still uncertain of their place in the field. At fifty-three years old, Gerry was a few years younger than Lorraine. Both had granddaughters who were in their late teens, and family members scattered across the Gitxsan and Gitanyow reserves. During their first hours getting to know one another, they discovered a few common friends, but spent more time listening politely to each other's stories than reminiscing about pieces of a shared past. Gerry timidly inquired several times about Lorraine's knowledge of the Gitsanimx language, and listened intently as she explained the family dramas that had forced her into English-language schools. Members of neighboring communities with divergent histories, Gerry and Lorraine communicated across a professional divide rather than a generational gulf. Like many other people who grew up on the reserves, Gerry had spent much of his life working in a string of sawmills, pulp mills, and other timber processing facilities along the Skeena River. Much of the work had been so boring, he admitted, he had occasionally walked out on the job, returning later when other walkouts opened up new positions. He preferred driving skidders out on the territories, maneuvering through groves while dragging logs from tree-falling crews to loading sites. Lorraine nodded along with Gerry's stories. As a teenager, Lorraine offered, she had worked as a bucker for local logging outfits, too, hewing freshly fallen trees into the rough logs that skidder drivers like Gerry pulled out of the forest. As she transitioned into full-time mapping work in her twenties, she remained sympathetic to the allures and hazards of industrial labor.

She admitted to me later that she was pleased to hear Gerry reflecting on the day's mapping work as a more engaging contrast to the drudgery he had endured as a millworker. The tone of his reminiscences, though, had left her wary. The physical endurance acquired through logging work translated well into the demands of transect mapping, and many of the young men

and women she taught to map and navigate during her time with the Gitxsan Strategic Watershed Analysis Team (see chapter two) freely moved between the two domains as work opportunities emerged and disappeared. The revolving, if narrow, door between industry and activism on the territories heightened tensions around development controversies, she admitted to me, since new projects and proposals so often found members of the same families and house groups entangled on opposing sides. Lorraine had learned to avoid feasts with her own Gitxsan house group when she knew that confrontations were imminent. Approaching her projects one transect at a time, the iterative nature of her work matched the circumspect tone she adopted while musing about her maps' possible consequences. "For me, it's just little pieces," she insisted as we drove back to our camp for the night. "I'm not part of these house groups, so I'm not involved in the decision making with what happens to the data. I can give my suggestions … and I do give my recommendations all the time when I'm putting this data together." Freed of the burdens of governance but enmeshed in the unending politics of data assembly, working in the field somehow offered Lorraine both a zone of engagement and a space of escape.

Despite her central role in the GHC's response to the TCP pipeline proposal, Lorraine approached the controversy surrounding the project with an air of wry detachment. As we encountered roughly cut trails, flashes of neon marking tape, and other signs of TCP surveyors' recent presence in the field throughout the day and into the week, the four of us traded weary jokes about how enraged pipeline opponents would be to realize how much the company had accomplished before formally earning Gitanyow consent for their work. Lorraine knew that the TCP crew was spending more on their work each week than they had allotted for the entire Gitanyow project, but such a discrepancy was a common feature of corporate-funded transect work. We speculated together about what might happen now that the company's clandestine

surveys had been brought out into the open during the meeting that had taken place the previous night in the Gitxsan reserve at Kispiox Village, just a few kilometers south of the Date Creek Research Forest. Longtime residents of the Kispiox valley and the Kitwanga reserve an hour to the west, respectively, Lorraine and Gerry regaled each other throughout the day with pieces of gossip they had heard from friends and family members. They laughed, uneasily, that the story had already become national news. Gerry observed that his friends' accounts of the meeting had not quite matched up with the depiction he had heard on the CBC radio broadcast during his drive up to the campsite that morning. He wasn't sure which of his sources was more trustworthy, he joked, but for the time being, he would give his friends' re-tellings the benefit of the doubt.

Impacts and Imperfections

In April 2015, a year and a half after Lorraine concluded her fieldwork on the territories, the Gitanyow Hereditary Chiefs finally voted to endorse the TransCanada project (Fee 2015). If the project is endorsed by the remainder of the First Nations whose territories lie along the proposed pipeline path and construction proceeds, the GHC will receive annual payments, job training programs, and continuing support for environmental mapping work. While the initial public response to the agreement has been quiet, GHC emphasis on support for technical work is consistent with an overall shift in Gitanyow political strategy. On the GHC website, accounts of earlier lawsuits against timber companies and other developers operating without permission on the Gitanyow territories are followed by links to documents generated by the new Strategic Land and Resource Plan (Gitanyow Hereditary Chiefs n/d). Explicitly organized as a coherent timeline

of Gitanyow opposition, both kinds of documents position iterative, long-term fieldwork as evidence of the Chiefs' rejection of the colonial ideology of the land selection model. Whether each related mapping project was conducted in defiance of, or in collaboration with, state and corporate interests and support, the timeline suggests, the documents certify the GHC's belief in their right to engage, in whatever terms available, with the totality of the territories outlined in the initial Gitanyow land claim.

Citing the Strategic Plan as a way to integrate the results of Gitanyow-collected fieldwork with Forest Service data archives, however, the TransCanada agreement belies the degree to which new, much-heralded government-First Nation collaborations like the SLRP are built upon the expectation of developer support. The continuing decline of provincial support for fieldwork on traditional territories has forced the Gitanyow Office to form new alliances in order to support the work required to refine landscape designations and update old polygons as animal populations move and disperse (Stueck 2011). Beset by new institutional co-dependencies, changes in the material practice of fieldwork and information management forecast significant consequences. Without the means to establish a network of grid points to which mappers like Lorraine might return for new measurements every few years, ad-hoc transect mapping expeditions allow the GHC to observe long sections of land in quick bursts, and to record agile datasets that can be re-compiled as new needs and challenges arise. Yet by relying on such an iterative system, the GHC has in some ways traded their reliance on continuous trails and fieldwork sessions for an increased dependency on continuous relationships with specific personnel. As she explained to me while compiling her field notes every evening, Lorraine perpetually compares trends that emerged in her notes with observations from nearby transects she had walked in previous years. Despite the sophistication of her coding systems, though, she

cannot not make the terrain that emerges in these pictures evolve under some guiding principle, even if her accumulated experience helps her to predict general shifts in forest health and animal distribution with impressive accuracy. Officially, she can only watch, write, and compile reports, adding to an interlacing archive of transects stored at GHC headquarters. As Lorraine prepares to retire, it will take less experienced mappers far longer to translate the marks of the archive into nuanced pictures of territorial change and workable inputs for Gitanyow governance.

By treating transects and territory as mutually constitutive elements of Gitanyow political practice, I have sought in this chapter to underline some of the ways that the contingencies of fieldwork expose connections between daily life, technocracy, and contemporary forms of indigeneity. As we worked our way across the territories, rising public debate over the broader pipeline project hovered overhead. And yet, our manner of speaking kept its forebodings at a comfortable remove. The language of data points and extrapolation metrics we employed as we worked offered a means of temporarily depoliticizing our descriptions of the territories, even as Lorraine steadily repackaged our experiences there into the discrete observations and numerical arguments which the Gitanyow Chiefs would use to structure their eventual response to the TransCanada proposal. Immersed in the exhausting satisfaction of her work, the field became for Lorraine both laboratory and sanctuary, a place where changes could be pondered and conflicts deferred.

To imply that the depoliticizing effects of cartographic representation effects a permanent state of domination ignores the dynamism – and patience – of indigenous legal strategies (McCreary and Lamb 2014). As the heterogeneous nature of fieldwork makes clear, technoscientific media like the GIS maps Lorraine compiled from our transects are not readily reducible to developer prerogatives or state demands for legibility. With so much of the field

already defined by transmission lines, logging roads, dams, and old clearcuts, one might ask, what new knowledge can First Nations mappers hope to produce by re-describing these altered landscapes? Through more than two decades of work throughout the Gitxsan and Gitanyow territories, Lorraine has seen the ambitions of many former colleagues collapse under these contradictions. Yet she has also learned that questions of continuity often simply cannot be taken head-on. As she patiently listened to my restless worries over the likely "impact" of our work on the overall pipeline proposal, her modesty belied a broader conception of the place of Gitanyow territory in Gitanyow forms of life. The data she compiled at her laptop each evening conveyed only slices of the whole, Lorraine insisted. Nearing the end of a long career spent assembling arguments from outdated maps and imperfect datasets, she was well aware that one could hardly predict how her work might be read in the future. The challenge in the meantime is to find the strength to keep walking.

The Road to Cranberry Junction

By the end of our second day in the field, the topography of our path had tilted sharply. A succession of steep ridges broke up the featureless monotony of the previous day, but the new terrain carried hazards of its own. While scrambling to the top of an outcropping for a view of the path ahead, Alan punctured his thumb on a splintered branch, leaving Gerry to manage the compass alone for much of the afternoon. Lorraine began the morning by stumbling over a grounded hornets' nest, awaking a small swarm that stung her on her hands and face. Toward the end of the day, I tripped over a wayward root while picking my way down a short slope, aggravating an ankle I had sprained at the nearby Date Creek Research Forest (see chapter three) only two weeks earlier. Only Gerry had managed to survive unscathed, although the day's

constant climbing had left him utterly drained. Piling into Alan's minivan at the end of the walk to begin the long, winding drive back to camp, Lorraine jokingly offered morose predictions about the injuries we were likely to sustain as the week went on. Her frustrated calls to the GHC had yet to earn a clear answer about our long-awaited helicopter, she reminded us. We had better start getting used to all of this climbing, since the flat sections of the path were becoming fewer, and less accessible, as we worked.

As we rounded a sharp curve hemmed in on both sides by tall, yellowing aspens, half a dozen kilometers from the highway, our helicopter finally arrived. There it sat: parked in the middle of a dip in the logging road, set between a gravel pit and a small clearing (figure 4.11). Its rotor blades lay still, with no pilot or passengers in sight. As Alan slowed to a stop, Lorraine laughed. *That's probably the one we were supposed to rent today,* she mused. Strange as it was to see a helicopter parked in the middle of a road, none of us were particularly surprised. A pair of helicopters had been hovering over the Cranberry Junction region for the past two days. One carried a team of TCP surveyors; the other, "some nature photographers," Lorraine informed us. (With relatively few pilots available in the region, she explained, the GHC had gotten a fairly good grasp of each pilot's upcoming schedule as they argued with TCP representatives over the terms of their own rental.) After a few minutes of waiting, Lorraine reached over from the passenger seat and tapped on Alan's horn. Three people, a middle-aged man and two women, emerged from the clearing. Large cameras dangling from their necks, the women waved cheerfully and jogged back to the helicopter, settling into their seats as the pilot set the rotors back into motion. Leaning out of the windows of the van to take pictures of the spectacle, we waved back, then looked at each other and shrugged.

Dust and leaves buffeted Alan's windshield as the helicopter slowly lifted into the air. As

we rolled up our windows and watched it rise and turn south, Gerry chuckled. *Wonder what they're thinking up there, a couple of Indians and a couple of white guys in a busted up minivan out here in the middle of nowhere. Hiding drugs or poaching moose or something, eh? Probably wondering about that one really good.*

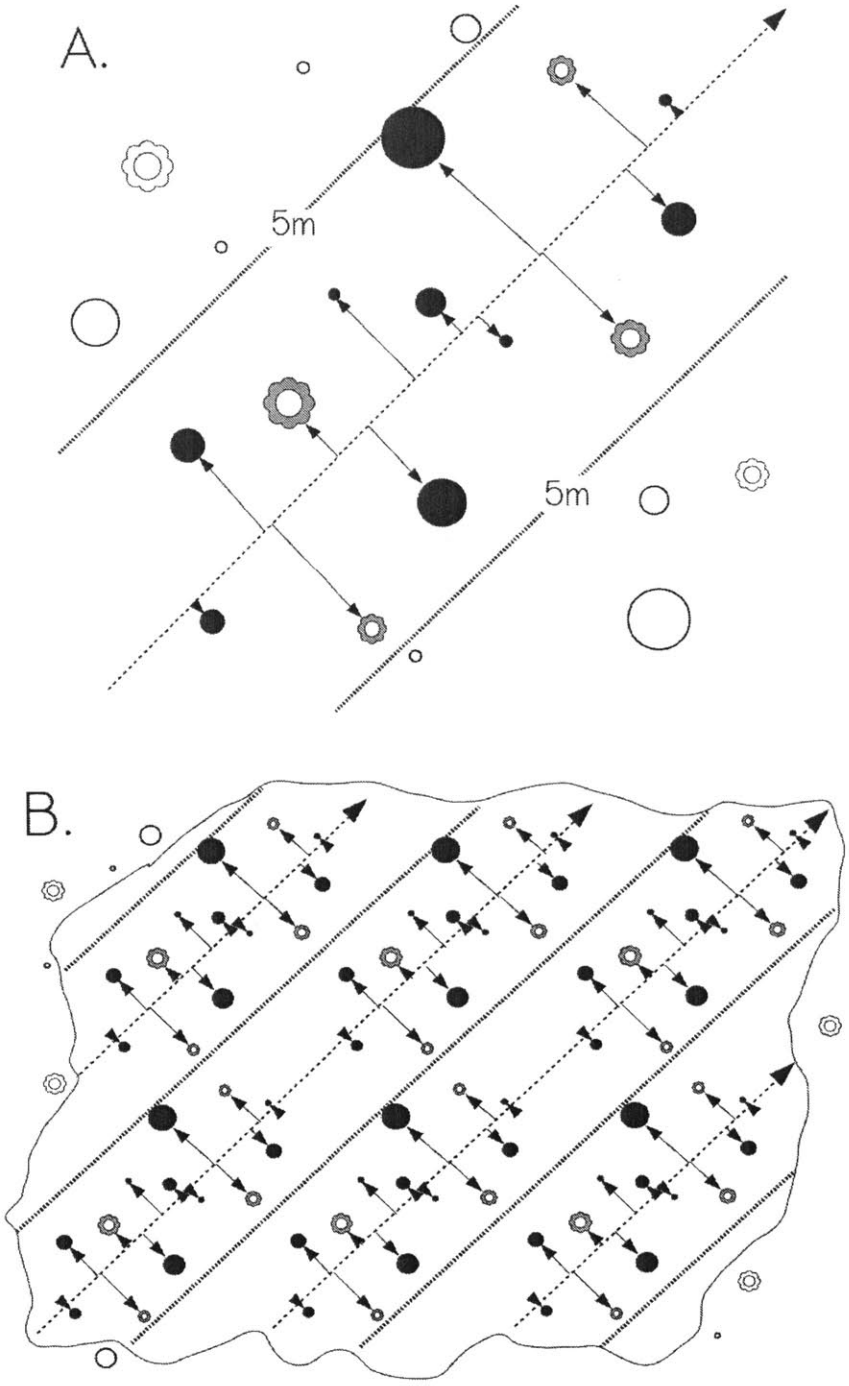

FIG 4.2. Schematic diagram of a single transect line (A) and a broader research area subdivided by multiple parallel transects (B). The dotted arrow denotes the direction of travel, and the darkened circles and flower icons denote objects counted within the transect study area (defined in part by their distance (solid arrows) from the transect line). In both cases, non-shaded objects outside either the single 10 meter-wide study area (A) or the broader research area (B) would not be counted.

FIG 4.3. Early morning map discussion at camp.

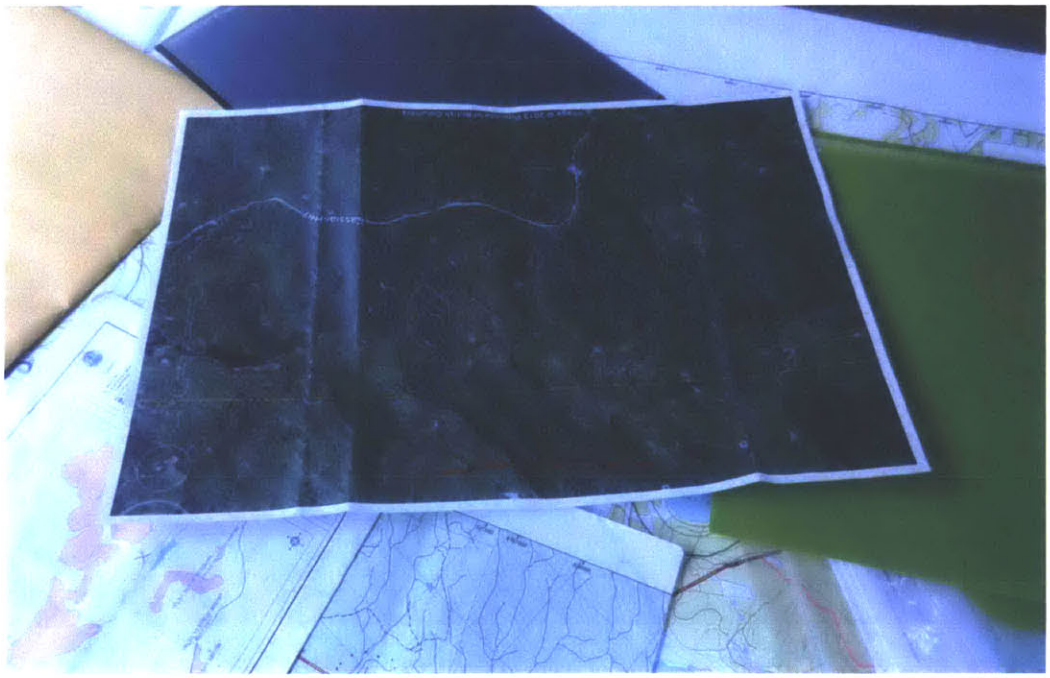

FIG 4.4. Satellite photos and Forest Service tree cover charts arrayed atop the GHC's 1:50k-scale route map.

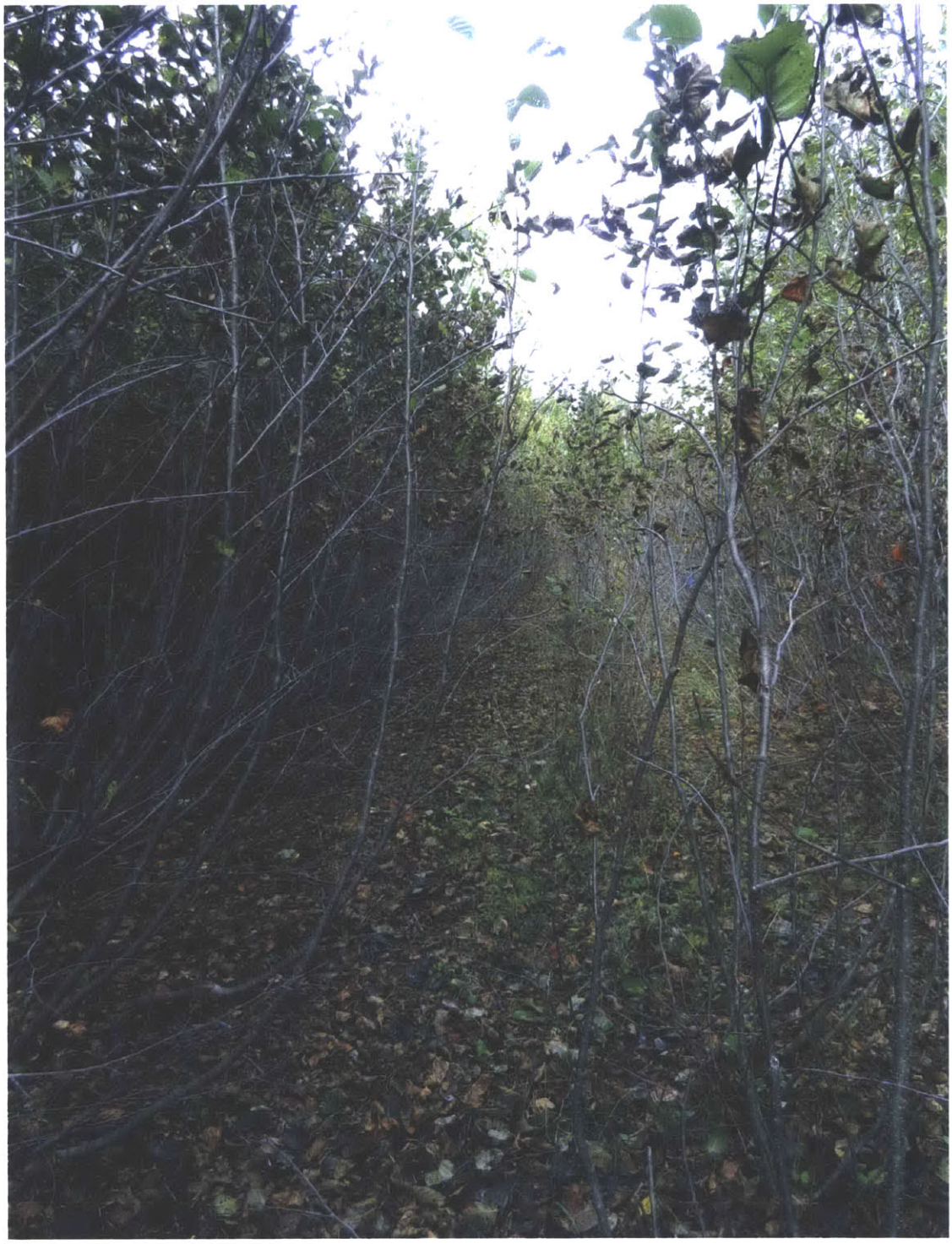

FIG 4.5. A decommissioned logging road, overgrown with saplings.

FIG 4.6. A 100 m wide right-of-way through Gitanyow territory cleared for the Northwest Transmission Line. The preponderance of post-clear cut second-growth forest (the shorter, multi-colored tree stands, versus the darker areas along the far ridge) throughout the region becomes visible immediately when seen from above.

FIG 4.7. "Bear diggings."

FIG 4.8. A wayward moose antler, with GPS device nearby for scale.

FIG 4.9. Alan stops for lunch.

FIG 4.10. Alan and Gerry confirm our position on a georeferenced map of the study area, uploaded onto a GPS-enabled iPad which we carried into the field during the early stages of the project.

FIG 4.11. The elusive helicopter, with Alan's minivan in the foreground.

Chapter 5: Aging in Digital

Simulating Succession in the Normal Forest

FIG 5.1. Mountain pine beetle-killed Lodgepole pines near Smithers, B.C.

Scrolling through a sprawling table of acronyms, Anand[1] *clicks on an icon labeled "ICH-MC2" (or "interior cedar hemlock, moist-cold subzone 2," in the parlance of the British Columbia ecosystem classification system). In cells scattered throughout our spreadsheet, precise values for half a dozen variables spring into place. Over the rest of the afternoon, Anand painstakingly inputs thousands of tree stem measurements from the paper worksheets he and I filled out during summer visits to the nearby Date Creek Research Forest. Elsewhere in the spreadsheet, tree stem measurements compiled by different groups working*

1 Dennis, Anand, and Arnold are pseudonyms. All other names given in this chapter are real.

at Date Creek since early 1990s spool out over hundreds of pages. With his parameters finally set, Anand opens a new terminal and enters a command to set the day's first test simulation in motion. A flock of small windows suddenly opens on Anand's monitor, each bearing a set of axes ready to track the progress of a different tree species and growth parameter projected by the model (see figure 5.2). *Scattered points suggesting steeply rising lines march across each graph, gradually leveling off as the young trees in Anand's test simulation reach maturity.*

A three-dimensional visualization of the simulation wouldn't be much more exciting than the numerical outputs we're staring at, *Anand assures me. A skilled programmer familiar with the SORTIE-ND simulator and many of its better-known competitors, Anand would most likely dismiss the sight of virtual tree crown icons competing for space and other visual outputs of forest succession modeling as a meaningless drain on his computer's processing power. Deprived of visual heuristics, Anand uses a language rich with tropes of physical observation to narrate the changing forest sketched out in his growing graphs. At the origin of each axis, every tree stem begins as a seed or sapling, defined by their distance from a gap in the virtual canopy of the mature trees around them. As the rising new cohort of second-growth timber slowly closes out holes in the canopy, the forest floor dims. Young upstarts in mixed species stands rise quickly before slowly giving way to the spatial demands of their more aggressive neighbors. Growth slows. Undergrowth simplifies.*

Few people experience time quite like a forestry scientist. What to the average hiker, hunter, or logger might appear a picturesque landscape is to a forester or ecologist a four-dimensional tableaux, replete with enticing possibilities and emerging risks, all unfolding more gradually than most humans have the means to see or catalog. Precisely how the forestry scientist interprets and intervenes in this tableaux, however, depends considerably on what kind of catalog she makes. The field notes above hint at the various worlds shaped by the affordances of one such catalog, a forest growth and succession simulator called SORTIE-ND developed in part by ecologists and programmers based at the Bulkley Valley Research Centre. Working within the space of the

model, Anand and other modelers imagine more than virtual trees growing and dying. Within the space of the model, colleagues age. Field sites disappear. Compared to digital tree stands cycling through hundreds of simulated seasons, the entire architecture of government science begins to feel like a fleeting, insubstantial thing.

For forestry scientists practicing their trade in British Columbia over the past three decades, the proliferation of computer-based simulators has transformed the way they experience time. Management policies based on simulation results have radically altered the forests in the world, giving rise to new simulations to contest the value of these changes. Data describing these changes, either measured from new trees or simulated directly from still more simulators, co-mingle in disparate archives, ready-to-hand for other modelers and planners eager to fold them into economic models, or to tile their projections through space and time. All the while, archives, forests, and the scientists themselves continue to age, unsure of what will come along to replace them, or when.

In order to examine how the rise of forest growth simulators has changed how forestry scientists contend with so many tracks of time, one might first acknowledge the epistemic values and disciplinary schisms that helped to set these arguments in motion. "You gotta make a distinction between people that went to forestry schools and people that went to Harvard. Between people that are in ecology and evolution programs versus people that are in forest ecology, forestry. Big, big difference." Dennis, a senior forest ecologist with the British Columbia Forest Service and a key figure in several independent research institutions based in the sparsely populated northwest of the province, required little prompting to see the foresters' battle between dread and optimism as the product of social pressures. A longtime proponent of replacing clearcutting with selective tree removal techniques and of modeling tree harvests as

merely another form of ecological "disturbance," Dennis was one of many disaffected researchers I spoke to during my time in British Columbia who questioned the long-term wisdom of the province's "sustained yield" forest management system. "[P]racticing foresters who have come through that same type of training as the growth and yield researchers... – very timber oriented, very production oriented – have this worldview that has at its core this notion that, 'well, that's just an unusual event, that's just a rare thing.' … 'All the trees are blowing over?' ... [I]t's always 'We'll fix it, and then we're right back to the good yields.'" No matter the issue, Dennis explained, conventional forestry analysts framed their calculative interventions against the idealized experimental system known as the "normal forest." The computer models and data archives of conventional forestry were not research tools so much as routes, Dennis lamented, "'right back to management making everything better.'"

Experimental systems (Rheinberger 1997) like the "normal forest" do not simply shape the "epistemic things" one can find in them, or the kinds of questions one can employ them to ask: experimental systems also shape the professional lives of the people who spend their careers developing tools to explore them. My concern in this chapter is not with the development of forest ecology and industrial forest management, or silviculture, as scientific disciplines per se. Rather, I will explore how the professional lives and emotional investments of individual modelers involved in each discipline have changed as forest succession simulators have facilitated the transposition of forestry expertise into new domains of environmental governance. In this chapter, I trace a long-running debate between the creators of two competing forest growth simulators. Tree and Stand Simulator (TASS), a proprietary model developed by members of the British Columbia Forest Service for predicting growth and yield in intensively managed (i.e. clear-cut and artificially planted) tree stands has been under development by a

dedicated team of government programmers and forestry scientists since the early 1980s. SORTIE-ND, an open-source model introduced a decade later to project post-disruption succession dynamics in complex forests, has been refined by a disparate network of government and academic ecologists, including in particular the members of an independent research group based in a small town in northwest BC.

In the years since the government of British Columbia dramatically reorganized its Ministry of Forests (the original source of financial support for SORTIE-ND, and still the home of the TASS group) in 2002, both groups have seen their access to empirical data change dramatically. Regional Forest Service offices throughout the province began to close, leaving SORTIE's original developers in the rural northwest struggling to find new institutional frameworks, experimental spaces, and funding sources to support their research and livelihoods (see chapters one and three). Even among forestry researchers closely connected to provincial land planning processes, governmental reorganization has had far-reaching effects on the way they approach their simulators. As I will discuss in detail below, the collapse of government support for on-the-ground tree measurement work deprived TASS modelers of access to the new data they required to to meaningfully refine their simulator.

In both cases, recent changes to forestry fieldwork, archive management, and other material practices abetting model construction, testing, and refinement have done more than simply change the numerical inputs used to feed either simulator. As climate change-related tree diseases and pest outbreaks (see figure 5.1 above) began to decimate Lodgepole pine tree stands throughout the interior of British Columbia shortly after the reorganization of the Ministry of Forests in 2002, the kinds of problems government officials and environmental researchers put to TASS and SORTIE began to change dramatically, too. The few TASS programmers to survive

Ministry downsizing warily simulated new forests for pest-devastated regions, suddenly reliant on "imputed" tree growth data simulated from decades-old surveys. Meanwhile, the SORTIE-ND developer network steadily enrolled more university researchers, private consultants, and marginalized government planners, all eager to pursue a growing range of questions about forest growth and change outside the normative assumptions of conventional silviculture.

For members of both groups, deciding how to both maintain their livelihoods while keeping their models relevant has meant making difficult compromises. TASS has maintained its place as the privileged tree growth simulator for government resource planners in one of the largest timber economies in the world, even as infrastructural changes have eroded its accuracy and reliability. SORTIE-ND, once hailed as a bridge between academic research into climate change-related forest species succession and economically-driven timber growth and yield modeling, has been shunned by government planners even as its applications have diversified and its popularity among university-based ecologists has grown. As the leaders of both groups near retirement, seeing their intellectual legacies tethered to such unstable research objects has forced programmers on either side to re-evaluate their epistemological investments in the norms and forms of contemporary forestry science.

Rather than hailing forest succession models as what Landström and Whatmore (2014) describe as "vehicles of expertise" between disparate domains of research, policymaking, and participatory planning, this chapter will examine how different modeling groups have responded to the pressures of recontextualization and the fraying of their connections to human data collectors and physical field sites. I argue that debates over the legitimacy of new applications of competing computer simulations – often articulated through generalized anxieties about the legitimacy of simulation as a substitute for experimentation – reveal new discontinuities and

zones of competition facing environmental scientists in the neoliberal era. This is particularly true in fields where the retirement of senior researchers and the loss of financial backing have thrown into doubt the terms of membership within an expert community, or even the continuing existence of the community as a whole (see Graham 1998). The reproduction of cultures of expertise particular to government modelers and small-town ecologists alike are exercises in agility and ambiguity. Among forestry scientists active in contemporary British Columbia, surviving these exercises often means articulating their simulators – for many, their life's work – within research programs and resource management processes increasingly removed from their direct influence or control.

Experimenting on Time

Computer-based models and simulations have often served as vehicles for professionals to work out and worry about their epistemological investments in specific theories and methods (Galison 1996; Gusterson 2005; Lahsen 2005; Kennefick 2000). Many of these crises emerge directly from the way simulators mediate individual researchers' relationship with time. Even as they promise to amplify productivity by compressing into computer clock cycles the months and years required to set up and carry out long-term experiments, simulators nevertheless mark and manage time for their creators in ways that often escape full notice. On a day-to-day basis, time spent compiling code, populating databases, and debugging algorithms gradually changes the meaning of research simply by diverting scientists' attention from other tasks associated with experimentation and writing. Over the course of years and decades, however, simulators shape their creators' experience of time in still more profound ways by attaching their names and reputations to code-bound processes and software versions that age and decay far faster than

humans do.[2]

Discordant temporalities between human researchers and infrastructures of research have framed anthropological investigations into the organization of professional hierarchies and the broader processes shaping the reproduction of cultures of expertise (Doing 2009; Gusterson 1998; Rabinow 1996, 2008; see also Guyer 2007). In her investigations of the lives and work of scientists based at large American and Japanese high energy physics laboratories, Sharon Traweek (1988, 1992) has shown how intricately the career aspirations of individual physicists are indexed to, and in many ways limited by, the services lives of particular pieces of equipment. Despite their apparent ability to move through space and cross institutional boundaries, computer models pose their own indexing problems as well by serving as vehicles for professional norms and techniques of governance. The divergence of temporalities between careers and computer models is particularly palpable for forest ecologists and other silvicultural scientists amidst a general shift towards contract-based research organizations and the rapid devolution and deregulation of resource management institutions (Lave, Mirowski and Randalls 2010; Mirowski and Van Horn 2005). As I have argued throughout this dissertation, these divergences have preoccupied forestry researchers already struggling to design new field sites and institutional forms capable of outliving the trees that occupy their studies (Kimmins 2002).

In her introductory chapter to *Simulation and its Discontents*, a volume of essays about the professional and epistemological perils created by the increasing dependency on computer simulations felt in various fields of research, Sherry Turkle (2009) reflects on the anxiety

2 In their introduction to a recent special issue of *Social Studies of Science*, Emma Kowal, Joanna Radin, and Jenny Reardon (2013) make a closely related point about the divergent temporalities affecting the use and management of putatively ageless frozen indigenous biospecimens by aging scientists. To better cope with the practical and epistemic consequences of this divergence, the authors suggest modifying the concept of "co-production" to be more attentive to the temporal unfolding and otherwise "abductive" dimensions of the kinds of social compulsions and techno-legal justifications called into being by the persistence of research objects.

associated with both quotidian and career-spanning temporal scales. The exploding complexity of simulators and their associated forms of screenwork (e.g. Boyer 2013) has initiated new divisions of labor amongst scientists who formerly "did it all," Turkle laments, but now often spend "more time debugging than working on design" (Turkle 2009: 21). Extrapolated out to the timescales of scientific careers and generational transitions, however, Turkle's wistful reflections sometimes become entangled with the more general angst of her interlocutors, for whom the inexorable transition towards simulation-based research practice has long since become a proxy for the alienating effects of contemporary society. "Across disciplines," she warns, "there is anxiety about the retirement of senior colleagues: they are seen as special because they were in touch with a way of doing science and design that was less mediated, more direct" (6).

When read alongside the histories of disciplines where changing environments and shifting government policies have fundamentally altered researchers' access to the physical space of their experiments, the nostalgic fantasies described by Turkle take on new meanings. In 1992, nuclear weapons scientists working at Los Alamos National Laboratory conducted their final physical tests before the U.S. government's de facto ban on nuclear weapons testing went into effect. As Los Alamos scientists transitioned to conducting tests entirely within the space of elaborate computer simulations, Hugh Gusterson (2001) argues, many senior lab members were deeply frustrated by the reorganization of roles around test events and the rising prestige associated with computer programming work. As new hierarchies around simulation-based tests formalized and hardened, many of Gusterson's long-time interlocutors wondered aloud how the remediation of weapons design work would affect the moral judgment of their younger colleagues. By witnessing first-hand the awesome destructive power of their bombs in periodic underground tests, senior lab members insisted, they had developed a sense of caution that

shaped their dealings with the military officials responsible for actually using these devices. Even as they designed new simulators and pedagogical methods to "qualify" subsequent generations of weapons scientists, however, Gusterson argues, a process of "scientific involution" was already underway, as the theoretical innovations of senior lab members "simultaneously matured and withered away" (Gusterson 2005: 75).

Gusterson's use of Clifford Geertz's rendering of "involution" demonstrates how swiftly political exigencies like the Comprehensive Nuclear-Test-Ban Treaty can disrupt trajectories of discipline development and conceptual "revolution" (Galison 1997; Kuhn 1962; Lenoir 1997). Even if the secrecy and controversy surrounding nuclear weapons research makes Gusterson's example an exceptional one, though, the fears of erasure and illegitimacy he describes echo throughout other historical and sociological analyses of scientific training and generational succession within technical institutions (Kaiser 2005; Mody and Kaiser 2008). Whether articulated through shared knowledge of a common research object (Creager, Lunbeck and Wise 2007; Kohler 1994; Traweek 1988) or a carefully controlled language of visual observation and representation (Goodwin 1994; Lynch 1991; Rudwick 1976; Wise 2006), the rules and standards of membership surrounding expert communities remain vulnerable to disruptive technologies and the vicissitudes of history.

For forestry scientists working in British Columbia, the rising importance of computer-based forest growth and succession simulators in both academic research and government planning has intensified these vulnerabilities. Many of these new pressures are the result of what Paul Edwards (2010) describes as "data frictions" between bodies of information from disparate fields brought together in new collaborative research endeavors. Climate science projects in particular continue to generate new demands for "interoperability among data, tools, and

services" (Edwards et al. 2011: 667), Edwards and his co-authors argue, making participants – "expert" or otherwise – in large-scale modeling projects ever more dependent on the metadata and other technical standards used to federate and navigate the massive databases required to feed these simulators (see also Borgman, Wallis and Mayernik 2012). As "interfaces" (Edwards et al. 2011: 669) proliferate between disciplines and their associated practical techniques, epistemes, and memory practices (Bowker 2005), however, new collaborators have struggled to devise new forms of boundary work to sustain the internal coherency of their fields and affiliations (Gieryn 1983).

Ever since the mediating roles of models and analogical language first came under scrutiny in philosophical debates over the relationship between tools and deductive reasoning (Duhem 1954; Hesse 1966; Netz 1999; Wartofsky 1966), critical analyses of modeling and simulation have moved steadily away from their original fixations on the representation of "reality" (Cartwright 1983; Giere 2004; Psillos 1999) and the policing of distinctions between scientific experimentation and theory-building towards more open-ended questions about the embedding of simulators and modeling logics in an ever-expanding range of research applications and governmental processes (Knuuttila, Merz and Mattila 2006; Lenhard, Küppers and Shinn 2006; MacKenzie 2006; M. Morgan and Morrison 1999; Sismondo 1999; Svetlova and Dirksen 2004; Winsberg 1999). Whether by asking broad questions about "how the scientific community constructs computer simulation as an epistemically and pragmatically useful methodology" (Dowling 1999: 261), or unpacking the tinkering, improvising, and equivocating required to construct functioning models and simulate multiscalar processes with limited computer resources (Kennefick 2000; Sundberg 2009; Winsberg 2010), though, the pragmatic emphasis of much of this recent work belies the anxieties that continue to color the lives of

professional model-builders.

While different disciplines have long used exacting definitions of the tools, techniques, and deportments proper to legitimate "observations" to demarcate scientific ways of seeing from popular visualization practices (Daston and Galison 1992; Daston and Lunbeck 2011; Pang 1994, 1995), computer-based models have defined the boundaries of their relevant expert communities through a far more ambiguous set of language games (M. Fischer 2013; Kelty 2005). As Naomi Oreskes, Kristin Shrader-Frechette, and Kenneth Belitz (1994) warn, the bulk transposition of terminology from field-based experimental practice into discussions about simulations implicitly privileges the individual observer and author as the responsible authority for all of a model's subsequent claims. "What we call data," they argue, "are inference laden signifiers of natural phenomena to which we have incomplete access" (642).[3] Deborah Dowling (1999) echoes this point, suggesting that for many computer scientists and their collaborators it is "commonplace to present the output of a simulation as 'observations,' 'samples', and 'data'" (265). By adapting logical terms like "validation" and "verification" from the language of physical experiments, authors of simulators in the physical sciences have resuscitated long-running debates over the moral responsibilities inhering in claims of scientific proof, and provoked new concerns over the legal ramifications of proposed nuclear waste disposal sites and other ambitious technical projects planned around assurances provided by computer simulations.

Different fields have responded to the crises spawned these transpositions of language in a variety of ways. The rise of Monte Carlo simulations in the 1960s first as addenda to, and in

3 Writing about the circulation of misleading terminology around geological models built to support the proposed Yucca Mountain nuclear waste disposal site in the 1980s, Oreskes, Shrader-Frechette, and Belitz (1994) argue that the legalistic use of words like "validation" and "verification," while common practice among modelers working to improve the statistical accuracy of their projections, can have disastrous consequences when this language is taken up by government officials attempting to promote controversial projects. See also MacKenzie 2001.

some cases as wholesale replacements for large-scale physical experiments precipitated identity crises for particle physicists accustomed to anchoring their claims in the de facto authority of large research groups and enormous particle accelerators (Galison 1996). Anxieties related to language have been particularly acute within environmental research and the life sciences, where computer simulations built up from metaphorical descriptions of cellular reproduction and other physiological processes have shaped debates about the meaning of "life" (Keller 2002) and served as latent tropes for everything from Christian theology, race, and gender (Haraway 1976, 1997; Helmreich 1998) to transcendental signifiers and logocentrism (Kay 2000; Rheinberger 2015).

Critical analyses of modeling within the environmental sciences have explored similar issues around freighted language and individual researchers' anxieties over authority and positioning (Hayles 1996; Lahsen 2005; Petersen 2012). Much more frequently, however, simulations in ecology and related fields of research are problematized primarily as mediating devices in policymaking arenas, whether between scientists and government officials or between experts and non-specialists (Bocking 2004; Lahsen and Nobre 2007; Landström and Whatmore 2014). Particularly as government agencies begin to build new risk assessment, disaster preparedness, and environmental management programs around the current and anticipated effects of climate change, models and simulations are being mobilized to tie together and ever-expanding array of industries, advocacy groups, and regulatory institutions (Callison 2014: 201-42; Lane, Landström and Whatmore, 2011). Among developers of general circulation models of meteorology, the sheer number of stakeholders involved and the scale and diversity of datasets contributing to each model has generated an ever-increasing number of sites of political investment and epistemic translation (Edwards 2010; Lahsen 2005; Lenhard 2007). At each new

site, however, questions of professional identity and continuity have grown more complex.

Modeling the Revolution from Below

While historical and sociological studies of the use of simulations in finance and economic policy have typically emphasized the influence and exclusivity of the cadres of modelers associated with financial markets and state planning (Callon, Millo, Muniesa 2007; MacKenzie 2006; Mirowski 2002; Van den Bogaard 1999a, 1999b), the modeler-as-technocrat that emerges in recent critical accounts of environmental management institutions is a noticeably humbler figure. Unlike their counterparts in economic planning, the producers of ecological models are just as likely to be attached to academic institutions, adaptive co-management groups (Armitage, Berkes and Doubleday 2007; Wolenberg, Edmunds and Buck 2000), community forestry initiatives (McCarthy 2005), environmental NGOs (Saberwal 1999; Sandker *et al.* 2010), and other "boundary organizations" (Miller 2001) involved in conservation science and resource management. Whether and how these groups challenge the logic of sustained yield forestry and other prevailing land management paradigms is not always easy to discern. In British Columbia, the stakes associated with these new institutional positions has been complicated by the fact that government-sponsored grants and contracts remain a primary source of financial support for all of these institutions, even as government investments in forestry science have dropped precipitously over the last decade and a half (Thielmann and Tollefson 2009).

Critics of devolution rightly have presented the reorganization of forest management expertise in British Columbia as part of a long-term government strategy to cut rural services and privatize BC forests (Haley and Nelson 2007; Penn 2011; Hayter 2003). In the midst of these transitions, however, some modelers have taken advantage of their positional ambiguity to

devote greater attention to simulation problems that previously fell outside the purview of conventional forestry. Much of the ensuing "revolution from below" was facilitated by changes in the architecture of computer-based environmental modeling. The emergence of Geographic Information Systems (GIS) mapping tools initiated an epochal shift in forest growth and succession simulation work. Prior to the early 1990s, timber yield forecasts were computed by specialists processing field data through linear models.[4] Within a few years, most of these specialists had been replaced by more diverse groups of programmers capable of correlating on-the-ground measurements with particular landscapes and growth factors tied to actual geographical coordinates. Spatially explicit forest growth simulations soon provided prospective model-builders with new means of challenging the logics of sustained yield by providing a shared space in which the economic and ecological effects of different forest management paradigms could be examined side by side.

By the mid-2000s, a steadily growing number of spatially explicit simulators were being used by independent, academic, and corporate forestry research groups throughout British Columbia to explore complex, multi-generational forests and other ecological dynamics which government modelers largely ignored (Bugmann 2001; Liu and Ashton 1995; Welham, Seely and Kimmins 2002; e.g. figures 5.3 and 5.4). While some used recently developed visualization technologies to illustrate simulations of individual tree growth (Ancelin, Courbaud and Fourcaud 2004; Kimmins *et al.* 2010, 59-78; e.g. figures 5.5 and 5.6), others worked to link individual tree, tree stand, and landscape-scale simulations into comprehensive planning tools. A few of these

4 Since the introduction of computer modeling techniques into forestry analysis in the late 1960s, numerous books, articles, and Ph.D dissertations have been written proposing new growth factor equations and model refinements, yet within the field of conventional silviculture, relatively few of these publications have seriously called into question the biological rationale for treating individual trees as isolated systems. For a particularly influential review of linear programming techniques in operation as the field moved towards spatial modeling techniques in the mid-1990s, see Zeide 1993.

projects, such as the ecological modeling language SELES (Spatially Explicit Landscape Event Simulator), helped to bring sophisticated ecological concepts into mainstream planning by offering proponents of conventional growth and yield metrics a virtual space in which to mimic government-style sustained yield simulators alongside peripheral models of complex ecological processes (Fall and Fall 2001; see figure 5.7).[5] Others bridged succession simulators with carbon sequestration models, offering climate scientists and silvicultural experts the chance to engage in a shared multi-scalar space (Kirschbaum 1999; Seely, Welham and Kimmins 2002; see also Winsberg 2010, 72-92). Emboldened by their technical innovations, a few of these developers began to leverage their models to lobby government officials to promote alternative silvicultural methods through new forest tenure laws and harvesting regulations (Puettmann, Coates and Messier 2009).

Challenges to sustained yield forestry policies are almost as old as silviculture itself (Wilson 1998). Whether critiquing the vulnerability of intensively managed forests to pests, fire, and diseases (Gadgil and Bain 1999; Lindenmayer, Burton, and Franklin 2008; Nepstad *et al.* 2001; see also Nikiforuk 2011) the destruction of old-growth habitat and the implicit devaluation of non-timber forest uses (Braun 2002; Prudham 2005); or the precariousness of forestry-dependent rural communities (Halseth 1999; Peluso 1992; Prudham 2007), opponents of plantation-style forests and clearcut logging have long cast conventional silviculture as emblems

5 Working in southern British Columbia in the mid 1990s, Andrew Fall developed an ecological modeling language called SELES (Spatially Explicit Landscape Event Simulator) as a computer science Ph.D project. Fall then spent the next decade helping other programmers to apply SELES to linked simulations of harvesting methods and animal habitat change in emergent Land and Resource Management Plans throughout the province (see chapter one). As Fall's experience consulting with the Ministry demonstrates, not all ecology-based models have been spurned by FAIB programmers and analysts. In recent years, SELES-based models also served as a platform for negotiations over harvest allocations on the islands of Haida Gwaii, where representatives of the Haida First Nation group had successfully lobbied for a far greater role in the timber supply analysis process than had ever been awarded to any group outside the Ministry. With the help of Ellen, a FAIB researcher who temporarily relocated to the islands to facilitate negotiations, the SELES-built tree growth models were explicitly used as a tool for conflict resolution between island residents and the Weyerhauser forest products company (personal communication, Andrew Fall).

of technocratic over-simplification (Scott 1998: 9-52.). When one examines how actual models and modelers interface with state-led timber planning processes, however, a more complicated picture emerges. When I began corresponding with BC Forest Service programmers in 2013, more than a decade had passed since the replacement of the Forest Practices Code, a prescriptive set of forest management laws installed under a comparatively progressive provincial government in the 1990s. The new policy framework privileged industry self-reporting and replaced most of the province's on-the-ground tree inventory work with automated satellite surveillance systems (Howlett, Rayner and Tollefson 2009). Much of the analytical work – aerial photo interpretation and wildfire and pest tracking, in particular – that had previously been performed by permanent staff had since either been automated or assigned to contract workers.

Whether positioned inside the shrinking provincial Forest Service or in the competing and complimentary institutions proliferating outside, simulator-focused forestry research communities have spent the past decade and a half struggling to remain relevant and viable. By the time I began visiting Victoria, BC, in 2013, only a few of the programmers working directly on the Tree and Stand Simulator, or TASS, the BC government's main forest growth simulator, remained full-time employees. The lead developer of TASS prepared to retire in 2014, yet there was no indication that the Forest Service planned to hire or promote a full-time replacement. As the second half of this chapter will show, the manner in which TASS programmers embedded their model within government planning has made them vulnerable to ever-increasing pressures on the provincial government's resource management ministries to reduce staff and automate analytical processes.

Despite far-ranging changes in the technocratic infrastructures of forestry planning in British Columbia, TASS programmers have resolutely resisted government attempts to transpose

and recontextualize their simulator to fill the gaps in these new processes. This is not to say that TASS developers' commitment to the original purpose of their model has caused them to ignore theoretical developments in forestry science. Indeed, successive versions of the simulator developed over the past decade and a half have begun to incorporate some of the key frameworks of ecology-style succession models, including attention to the smaller trees and other "secondary structure" characteristic of multi-generational forests (figure 5.10). As I will explain shortly, however, their resistance has been chiefly to new operational pressures, including in particular the provincial government's increasing reliance on "imputation" for generating tree growth data, the likes of which BC Forest Service employees formerly collected in the field.

As the name implies, imputing data within a forest growth model refers to a process whereby the characteristics of specific trees within a particular section of landscape are not physically measured before being incorporated into the model, but rather simulated *ab initio* based on data obtained for "similar" sections of forest "nearby." In the view of TASS's developers, imputation undermines their credibility as experts and perverts the original design of their simulator by cutting off its access to meaningful data. By auguring TASS's claim to legitimacy through its connection to physical fieldwork even as the Forest Service moves towards fully automating its timber inventory and harvest planning system, TASS developers have wagered their return to influence on an increasingly risky gambit.

The manner in which TASS developers have faced their uncertain futures contrasts markedly with the strategies employed by differently-positioned developers working in the province, particularly the programmers and forestry scientists associated with the forest succession simulator SORTIE-ND. As I discovered while interviewing and working alongside both groups in 2013 and 2014, conflicts between the two have been heightened by SORTIE

developers' recent attempts to market their model to provincial planners as an alternative tool for predicting forest growth and yield – heretofore the exclusive jurisdiction of TASS. Originally adapted from an independently designed simulator used to project tree species distribution changes following destructive windstorms, SORTIE-ND was taken up in the mid 1990s to model the long-term results of a series of small-scale alternative harvesting experiments undertaken in the Date Creek Research Forest in northwest British Columbia (see chapter three). Since the closure of the regional Forest Service office in the nearby town of Smithers, BC, in 2002, development of SORTIE has primarily been overseen by members of the Bulkley Valley Research Centre (BVRC), a small, politically active organization composed of former government scientists, part-time consultants, and a handful of postdoctoral scholars and visiting researchers (see chapter one). As the SORTIE-ND developer network expanded from its base at the BVRC to include over two dozen academic, government, and private forestry scientists and ecologists across Canada and the United States, the range of questions to which the model has been addressed has steadily grown.

The fact that senior developers like Dennis have encouraged collaborating researchers to adapt SORTIE-ND to new applications suggests that they are coming to terms with new, and perhaps more ambiguous legacies for themselves as modelers and scientists. By presenting their simulator as both a stage for exploring ecological theory as well as a tool for predicting timber yields in increasingly uncertain times, SORTIE developers like Dennis have leveraged their heterogeneous institutional positions to engender a kind of professional continuity that many of their colleagues in the forestry science community are struggling to obtain. According to some of the modelers more embedded within government forestry planning, however, the line between agile multi-functionality and dilettantism is a fuzzy one. Whereas TASS programmers and other

full-time analysts working for the Forest Service are often pushed by provincial officials to offer extremely optimistic yield projections, experimental simulations in SORTIE have been debated and celebrated in academic journals even if their projections are sometimes dourly pessimistic. The consequence of this heterogeneity poses ecology-based model developers with a double bind (M. Fischer 2007; Fortun and Fortun 2005; see also Bateson *et al.* 1956): their reluctance to commit to the contradictory demands attending more formalized government positions has enabled them to pursue epistemic continuity for their work and helped them to improvise professional attachments even as it promises to keep them marginalized from the mainstream of technocratic planning. In the second half of this chapter, I will turn to a series of ethnographic accounts of model-building with TASS and SORTIE developers to examine in more detail how each community has confronted the demands and paradoxes of recontextualization.

Heavy Lies the (Tree) Crown

"I told [Dennis] fifteen years ago... he came asking for advice at one point – the one and only time – and I said, 'Well, you get yourself ingrained into the timber supply arena, you become essential.' And somehow, for some reason, that hasn't happened. I don't know why."

Arnold, one of the few senior researchers remaining at the Ministry of Forests capital headquarters when I met him in 2013 and a chief architect of TASS, chose his words carefully. The leader of one of the Ministry's longest-standing computer simulation research groups, Arnold's methods were occasionally criticized among academic modelers and independent contractors, particularly those working in the rural north. A few modelers took issue with the fact that TASS was designed exclusively for post-clearcut plantations, although most admitted that six decades of sustained yield forestry in British Columbia had rendered plantations nearly

ubiquitous throughout the province. Some complained about the TASS group's longstanding refusal to share the source code behind the model, despite publishing extensive documentation about its evolving features. Most programmers simply admitted to being jealous of the group's standing and influence within provincial decision making.

The circuits of introduction through which I came to know Arnold shared much in common with the social webs into which I had ingratiated myself around the Bulkley Valley Research Centre in Smithers. Several of Arnold's closest friends were, like Dennis, former senior government researchers who had retired or migrated into new roles as consulting scientists in oversight groups and NGOs. Unlike Dennis's work with SORTIE, however, Arnold and the TASS group were still very much a part of the provincial government. Whereas the forest ecologists affiliated with the BVRC were only able to devote a portion of their time to developing SORTIE amidst the other research and administrative responsibilities they faced at their regular jobs (often at provincial government offices in and around Smithers, or at the University of Northern British Columbia in the city of Prince George four hours east), the process of refining, testing, and running TASS had been for decades a full-time job for a small team of people working together at Forest Service headquarters in Victoria.

Originally set apart from the day-to-day work of timber supply analysis as an independent group within the Ministry's prestigious Research Branch, the TASS group was integrated into a planning division called the Forest Analysis and Inventory Branch (FAIB) after the closing of the Research Branch in 2010. Like many of downtown Victoria's thousands of other disgruntled and displaced civil servants, Arnold and his friends routinely commiserated about administrative pressures and restructuring campaigns over Friday evening beers in the bars along Wharf Street. Whereas the weekly happy hour in Smithers had often led to loud manifestos in support of new

local governance initiatives percolating at the BVRC, Arnold's friends preached to a different kind of choir. With the remaining staff of British Columbia's so-called "dirt ministries" shrinking every year and new amendments to the Forest Act perpetually reducing FAIB's influence over the practice of forestry in the province, the researchers in Arnold's circle dwelt on former glories.

To Arnold and the other TASS modelers working in Victoria, the worth and meaning of any tree growth model was inseparable from the programmers, data archives, and other institutional infrastructures through which these simulators were built. Arnold had personally dedicated much of his career to assembling a massive archive of growth conditions measured in permanent sample plots, or marked clusters of trees (see discussion below), in replanted clearcut areas. "Some of it came from France, New Zealand, America, across Canada in some cases, depending on what species. Anything we could get our hands on, anytime somebody would give us data, we took it." As Arnold explained to me, "When I came on [as a new member of the TASS development group], it was a couple thousand ... When I shifted to more of a leadership role, we'd gotten more than 16,000 permanent sample plots together," roughly one third of which had been gathered from a "grid" of installations across British Columbia.

The TASS group interpreted its tremendous archive of measurements according to an idealized experimental system known as the "model forest." In the lexicon of quantitative silviculture, model forests are composite objects projected from the averaged dimensional measurements and other characteristics of a dispersed array of thousands of eighth- to quarter-acre-sized[6] clusters of trees positioned at random points throughout a specified geographical area. Describing the provincial plot array as a "grid," Arnold admitted that the Ministry's original

6 The size of a permanent plot varies between different provincial and national forest management jurisdictions, partly due to variances in tree species between locales and partly due to arbitrary conventions established by different forest service-type groups throughout the twentieth century. In British Columbia, the Ministry of Forests guidelines for timber cruising defines permanent plots at 0.12-0.25 acres.

goal in establishing the plots, namely, to encompass a broad distribution of forest "types," had proven to be more of an aspiration than a statistically rigorous reality. And as Arnold frequently reminded me, the quantity of information contained within a particular plot varied. "If we get a hectare sized plot, we're lucky. … Sometimes it's just what they call 49 tree plots – seven by seven, right?"[7]

Even as the spatial constraints of new plots remained idiosyncratic, government foresters prided themselves on other elements of methodological consistency. Over the second half of the twentieth century, establishing and maintaining each of the province's thousands of plots and returning to them to conduct measurements for provincial-scale forest inventory estimates became a central responsibility for new hires at the Ministry of Forests.[8] Theoretically, each forest type was supposed to vary according to latitude, elevation, annual precipitation, and a list of other defined factors. But as Arnold wryly explained, "even the [plots] that have been measured historically in BC are all purposively chosen. Somebody called it a 'drive-by inventory,' or 'drive-by monitoring,' which is close to the road in normal stands." As he explained the painstaking methods whereby researchers mapped and measured such plots over the course of multiple decades, Arnold was consistently circumspect. "There's all kinds of problems with the permanent sample plot: it *is not representative* of the forest. That's the number one thing. It's not statistically based. It can't be. It's gotta be biased."

Bias notwithstanding, Arnold asserted that the Ministry's ability to collect information in bulk was, for decades, a defining feature of its claim to authority. As many of the older Ministry researchers I met in Smithers and Victoria were eager to remind me, the "model forests" which

7 One hectare (a 100 meter by 100 meter square, or 0.01 kilometer squared) is equal to a little less than two and a half acres.

8 Many forest service jurisdictions maintain their own standards for permanent plot analysis. See e.g. Curtis and Marshall 2005.

shaped and were shaped by developments in TASS were first produced not within the space of the model, but through the material practices of plot construction, surveying, and repetitive measurement. Foresters building new permanent sample plots would begin their work by locating a section of forest somewhere in the province and cataloging it according to a system of geographic and climatic classifications (Pojar, Klinka, and Meidinger 1987). After placing a metal stake at the "center" of a new plot and marking the stake with a colorful plastic ribbon, they would then choose which trees close to the center of the plot were large enough to warrant inclusion in a calculation of wood density for that particular forest type, marking each selected tree either by spray painting large digits or nailing a small, numbered tag into each trunk.[9] After dutifully recording the diameter, height, and distance from the plot center of each of the labeled trees, the forester made judgments about the climate, precipitation, slope, shade levels, and soil quality characteristic of the area, then moved on.

Until recently, many government-run permanent plot measurements followed a predictable schedule. A decade after first establishing a new plot, a forester would dutifully return with a map and compass (and, increasingly, a GPS device). Aided by the ribbons, tags, and paint left behind by her predecessor, the forester would locate the center of the plot, then begin to hunt for each faded paint marking and tag, occasionally wandering in circles in search of old tags obscured by newly grown moss or sheared away by a fallen tree. Clipboard in hand, the forester then measured the new heights[10] and diameters of the still-growing labeled trees. Back at her

9 The first measurement relevant to permanent sample plot (PSP) analysis is the "diameter at breast height," or DBH, which is measured using a measuring tape specially converted to display diameter (effectively assuming a perfectly circular trunk). For the Canadian laboratory forester, "breast height" means 1.3 meters above the "site of germination" (a point above the roots colloquially defined by some foresters as the lowest spot on the trunk through which one can pass a chainsaw without clogging it with dirt). In the US, South Africa, and several other countries, this figure rises to 1.4 meters. For a forester in the field, "breast height" is taken as the height of a pre-cut stick held at some arbitrary point above the ground, or as often as not, the spot on the tree "eyeballed" to sit roughly breast-height above the splays of the root system as it joins the trunk with the soil.

10 Timber cruisers uses a variety of tools and methods to measure tree heights, few of which actually require them to leave the ground to acquire their data. As of 2016, nearly all inventory specialists remaining in BC use laser

office, the forester would tabulate the measurements in a spreadsheet, comparing each number to earlier figures obtained at the same plot. Twenty years, thirty years, forty years later, foresters returned to each plot, repeating the same measurements and collecting new iterations of data. At the end of each round of measurements, the spreadsheets were filed away, sometimes in Victoria or in other regional offices of the Ministry, within larger archives with data from hundreds of other permanent plots. More frequently, as the researchers who performed the original measurements retired or left the Ministry for new positions in industry or academia, the data they gathered slowly fell into obscurity. As a number of recently retired foresters admitted to me, career-spanning datasets of permanent sample plot measurements were often simply discarded as computers were moved, files were destroyed, and senior personnel were lost or replaced.[11]

Over almost five decades of coordinated modeling work and permanent sample plot measurement, the TASS group progressively refined a succession of new versions of the program.[12] Building on the basic model developed throughout the 1960s and '70s by original TASS group leader Kenneth Mitchell during his work at the Canadian Forest Service, Yale, and the University of Idaho, a dedicated group of programmers steadily incorporated more and more structural precision into the simulator as they processed an ever expanding archive of data from thousands of permanent plots. As a directional light model, weather and temperature simulators, and fine-scale slope emulators entered the program throughout the 1980s and '90s, virtual tree stem locations were moved, and virtual crowns grew and changed shape in TASS projections. Two floors above the TASS group in the Forest Service building in downtown Victoria, Ministry silviculturalists used these projections to build new theories about the upper limits of growth

height finders. See Williams, Bechtold and LaBau 1994.

11 Rebecca Lemov (2015) discusses similar material losses and re-scalings in the context of the denouement of Cold War-era sociological research.

12 Some of these refinements have been documented in publications authored by programmers within the group. See Di Lucca 1999.

rates for the new forests manually being re-planted in old clearcuts. Periodically, the Silviculture Branch would translate these correlations into published recommendations, prescribing to corporate and government foresters new techniques for planting, spacing, trimming, and harvesting trees.[13] Under Arnold's direction, TASS group members kept collecting data from permanent plots, tirelessly tinkering with the model to improve the precision of its projections as the government optimistically promised corporate timber license holders ever greater growth rates and harvest allocations.[14]

Sketching out different growth and yield curves on white boards and napkins as we talked, Arnold slowly taught me how to explore the virtual space of a TASS model. "The whole idea is modeling crowns," Arnold explained to me while we poured over a series of sample growth curves in a meeting room near the TASS group's cubicles (see figure 5.8). "Anything that doesn't see any open sky directly above just stops growing and dies. It's a simple equation." In the three-dimensional space of the model, the crowns act as polyhedra of opacity, blocking incoming light from a simulated sun, the movement of which is conditioned by separate algorithms for seasonal variations, latitude, and topography (figure 5.9). Together, this light model interacts with simulated tree crowns to produce virtual shadows, which in turn modulate

13 The relationship between the TASS modeling team and the Silviculture Branch of the BC Ministry of Forests/FLNRO has a long and acrimonious history, perhaps best embodied by internal disputes between the two divisions over the efficacy of "partial thinning" techniques as a means of increasing overall yield. Representatives of the Silviculture Branch argued that pruning branches from growing trees (i.e. "thinning" the canopy) would allow more light to reach the forest floor and thus strongly increase tree growth rates and overall timber yields compared to stands which had not been intensively thinned. TASS managers strongly disagreed, arguing instead that the data to support the correlation between thinning and increased yield simply didn't exist. As the current leader of the TASS group explained his group's position to me, "You're just wasting money and you're making the stands worse. Because extra growing space, branches get big, wood gets weaker, and you end up generating pulp wood." In the end, the TASS group won the argument simply by refusing to change the growth algorithms in their model. For a more general discussion of thinning, see Puettmann, Coates, and Messier 2009: 21-22.

14 James Scott (1998: 294-299) discusses the misleading yields obtained from "experimental plots" as just one of a number of misleading metrics imposed on agriculture and silviculture throughout the quantitative turn of the twentieth century. Closer to the "growth and yield" community, many forest ecologists have also long critiqued the unrealistic assumptions that shape idealized timber yield projections. For an extensive review of technical critiques within the disciplines of silviculture and ecology, see Puettmann, Coates, and Messier 2009.

the growth rate of the stand as a whole (figure 5.10). "It's basically a crown simulation model at its core. In a spatial, three-dimensional computer space, the trees are established, each of which is then assigned … a trajectory upon which it grows based on field data … and the best trees, the 'site trees,' grow along a 'site index curve.' And that's just a model of dominant height growth, which has been in the literature for centuries – or a century and a half, at any rate. … Now, trees depart from that trajectory if they get under certain stressed conditions, but that's the driver." With each four- to eight-decade cycle of simulated growth, TASS modelers digitally harvest these stands, and calculate the merchantable volume of each tree trunk within the plot to reveal an ideal yield for each topographic unit and its corresponding site index.

Through several decades refining TASS predictions against a sprawling archive of model forest measurements, Arnold had developed a keen sense of the limitations of his simulator. But he had also cultivated an abiding faith that TASS's inaccuracies could be kept in check through the patient vigilance of an expert modeler. "TASS is calibrated to a biased database," Arnold admitted while sketching a sample growth curve. "Philosophically, [the growth rates projected by the model are] just highly likely higher than what is happening in the forest in general, and you don't know how much higher. So we calibrate to the data we have available, then provide a knob to turn things down." In TASS, this "knob" came in the form of an "operational adjustment factor," a system-wide variable that Arnold and other TASS programmers could manipulate to deflate the model's projections by an arbitrary percentage. But without a team of modelers to keep a deft eye on new field data and a hand on the knob, Arnold's colleagues lamented, the projections they authored could become meaningless – or worse yet, misleading.

An Experimental System on Autopilot

As of 2016, the Forest Service remains the primary storage space for archives of permanent sample plot measurements taken throughout the province. The work required to bring these datasets together, though, had always been a personal endeavor. When I began corresponding with TASS programmers in 2013, the work of building the archives was being undertaken by a steadily dwindling number of individuals. Over the course of three decades, the TASS group had accumulated these archives by visiting regional offices, contacting retired foresters, and hunting through filing cabinets and decommissioned computers around the Forest Service headquarters in downtown Victoria. While their compilation efforts were initially motivated by their desire to continually optimize the model, broader shifts within the Forest Service soon complicated these ambitions. Government-run plot measurement work steadily declined throughout the 1990s, and in 2002, and the imposition of a remote sensing-based virtual inventory and surveillance system almost completely halted all field-based data collection. In the rush to make provincial forests legible to the Ministry's new virtual inventory and satellite surveillance system, TASS modelers and a wide range of other Forest Service researchers began to approach the group's permanent sample plot data archives less as the material for building silvicultural tools and refining theories than as empirical evidence that their status as experts was endangered.

As remote sensing technologies took on more expansive roles in Ministry planning and analysis work during the early 2000s, the technological apparatus which remote sensing experts developed to stabilize and elucidate fine-scale mechanisms of forest growth had grown increasingly at odds with the phenomena they were meant to to help TASS programmers capture and project.[15] While forestry-oriented remote sensing and automated data processing initiatives

15 Or as historian and philosopher of science Hans-Jörg Rheinberger (1997) might put it, the scale and structure of the new technical objects generated by automated analysis began to obscure the epistemic things that the TASS group had built their reputations by modeling.

are increasing in sophistication and scope, some large countries, including the United States, have maintained the majority of their field-based inventory infrastructure and personnel, reserving remote sensing technologies for large-scale, "strategic" mapping projects and surveillance work (Heath, Domke and Nichols 2011). "Most places, like in the states, where they've got more of a ground-based, operational inventory, they've got a tree list," Arnold explained to me while lamenting recent shifts in Forest Service policy. "We don't have that here." Soon after the new virtual inventory system came into effect, Arnold and his colleagues were asked to compensate for the system's lack of fine detail by simulating plausible "tree lists" for new forest cover polygons from old permanent sample plots scattered throughout neighboring regions. Through a Euclidean process of "imputation," many long-ignored archives of sample plot measurements took on new life within the provincial forest inventory. Given the haphazard way in which the plots were originally established, however, new polygons might be dozens, even hundreds, of kilometers away (not to mention decades removed) from the sites from which their tree lists were imputed. Simulated tree lists in hand, Arnold and his colleagues begrudgingly began to run their invented numbers through TASS. Topographic information, species compositions, and climatological data have faded from the new simulations, even as the virtual inventory's timber yield projections have grown more and more detailed.

The epistemic challenges posed by simulators operating in isolation are radically compounded when these tools are embedded within other automated systems of analysis (Edwards *et al.* 2011), or when their outputs must be integrated with other simulated data to project multi-scalar changes in complex environments (Winsberg 2010). As I describe in more detail elsewhere (Özden-Schilling N/d), the march towards total inventory virtualization has become a source of constant anxiety for analysts and programmers throughout the Forest

Service. The TASS group, previously responsible only for translating post-cleartcut inventory data into growth and yield projections for the Ministry's comprehensive harvest forecasts, has become particularly nervous. Arnold himself expressed alarm at Ministry officials' eagerness to virtually generate inventory information by feeding virtualized data into TASS. "[T]heir inventory is very high level. It's not designed to drive a model of TASS," Arnold explained. "It's a strategic inventory, it's not an operational inventory. It's not designed to do what they now want to do, which means that all they have on a polygon is species, age, basal area,[16] and crown cover. … All they do is increment the age, and hope the dynamics are crude … They just don't have the data to drive a more elegant model."[17]

During the decade TASS researchers had spent developing the current version of the simulator, the size of the group had been cut by two thirds. The group's former institutional home, the Forest Service Research Branch, had been closed entirely in 2010, with its few remaining staff reassigned to other applied groups within the Forest Service "to 'focus' their research," as one programmer derisively put it. From his office in downtown Victoria, Arnold had witnessed firsthand the imbrication of TASS within and among the changing roster of overlapping models and analytical processes deployed by Forest Service planners. His group had played a critical role in crafting centuries-long, multi-scalar plans for optimizing timber production in one of the largest single forest economies on the planet. By providing precise theoretical benchmarks for every harvestable tree stand in the province, Arnold had helped shape the forest itself, even if he occasionally had to battle the government's own silviculturalists in

16 "Basal area" refers to the estimated volumetric density of timber growing within an area of land (500 cubic meters per hectare, for instance).

17 As Stefan Helmreich (2014b) has shown, numerous other kinds of scientists (including, in Helmreich's case, oceanographers, mathematicians, and other scientists involved in climate change modeling) have increasingly had to use simulated "data" as a proxy for field measurements, particularly in arenas where issues of site access and the demand for attention to morphological complexity render certain forms of experimental "observation" impractical.

order to put his model's precepts into action. For the past decade, he had pushed back against proposals to use TASS to generate virtual inventory numbers to replace the field measurements that the Service was no longer collecting. And yet as he retired in 2015, he could only watch as simplified substitutions of the archive he had spent his entire career collecting and refining crudely replicated themselves throughout the province.

Simulating Succession in the Gig Economy

Outside the provincial capital, modelers contemplate the legacies of their simulators in more idiosyncratic terms. As I described in chapter one, the transition towards contract-based research across Victoria's dirt ministries affected full-time researchers in the provincial capital very differently than the way it restructured the lives of ecologists working in the small northwest town of Smithers, BC. The realignment of government divisions and entire ministries in Victoria following the 2002 provincial elections displaced hundreds of scientists, but most remained in the region, thanks in part to the creation of new auditing institutions like the Forest Practices Board (Hober 2001). After the regional Forest Service office in Smithers closed in 2002, the comparative lack of skilled jobs in the rural northwest forced many trained scientists to leave the region entirely or to find work as part-time consultants. A number of long-term projects initiated by government researchers stationed in the northwest were simply abandoned amidst these transitions. Some were picked up and refashioned by scientists affiliated with independent groups like the Bulkley Valley Research Centre, whether as new field sites and data sources for botanical, biological, or ecological fieldwork or as venues for emergent community-based conservation initiatives (see chapter three). Struggling as they were to refashion their careers in the wake of the regional office closure, perhaps it is unsurprising that SORTIE-ND developers

quickly learned to promote the model for wide range of applications.

Each new audience, however, posed their own criteria of legitimation. Even within the academic domain of forest ecology, the theoretical framework which Dennis and his collaborators developed for making sense of the forest succession dynamics they observed at the Date Creek Research Forest and modeled in SORTIE-ND was initially met with suspicion and disbelief. "Gap dynamics" theory was originally developed to explain how particular microclimates emerge, and how shade, moisture, and soil compositions shift as minute "natural disturbances" within an unlogged forest (typically a fallen tree or broken branches) open space for light to pass through a heretofore closed forest canopy.[18] Treating deliberate tree removal processes within the same explanatory framework, Dennis and his early collaborators proposed to use SORTIE-ND to combine the fine-grained analysis practiced by academic ecologists with the rough metrics of industrial logging (Coates and Burton 1997).

A subdiscipline developed in the 1980s to track disturbance dynamics in tropical ecosystems, gap dynamics had never before been used to project the growth of trees within temperate forests, let alone simulate the effects of logging. The editors of the journals to which Dennis sent his initial studies rejected the premise outright. "'It's completely inappropriate!'" Dennis imitated for me in mock outrage, reminiscing about the rude welcome he received during the early years of his research career. The breadth of SORTIE's appeal to modelers throughout the forest ecology community and its generativity in helping disparate researchers design to avenues of inquiry soon helped to soften this skepticism.[19] By the mid-2000s, Dennis and his original team had built up an informal network of SORTIE collaborators throughout North

18 For a survey of the field prior to the extension of disturbance theory to temperate forests, see Pickett and White 1985.

19 For a discussion of the place of model-based improvisation in policy discussions, see Landström, Whatmore and Lane 2013.

America and Europe through the model's source code distribution website. The use of gap models for studying temperate forest succession dynamics grew to be accepted by other scientists within the forest ecology research community, gradually at first, but in increasing numbers as collaborators published articles on new modeling applications and SORTIE-related research trials in increasingly prominent academic journals (see e.g. Martin, Canham and Kobe 2010; Papaik, *et al.* 2010; Vanhellemont *et al.* 2011).

Despite the lack of visual outputs within the model-building interface itself, early developers soon learned to take advantage of SORTIE's flexibility to explore an increasing range of successional processes, harvesting programs, and forest diseases. Anand, a modeling specialist who joined the BVRC as a postdoc shortly before my arrival in Smithers in 2013, patiently led me through a series of model-building demonstrations even as he was learning to adapt his prior modeling expertise to meet the demands of his new supervisors (one of which I describe in the opening pages of this chapter). Anand's constant movement between theoretical improvisation and local problem-solving played out within the space of the model. On different days in front of the computer, rainfall and temperature sat or swayed according to Anand's whims. As he pushed and probed different aspects of the model throughout the autumn, his simulations grew more complex. Drawing on long conversations with botanists at the BVRC and other collaborators in the SORTIE developer network, Anand began to test amendments to a model subroutine for *Dothistroma* needle blight, a fungal disease that began killing large numbers of Lodgepole pines throughout British Columbia in the mid-2000s.[20] Narrating the scatterplots of a *Dothistroma* simulation for me one afternoon, Anand pointed to an inflection point in one graph as the point at

20 While the mountain pine beetle received far more attention during the early 2000s, many practicing foresters took the large scale of the *Dothistroma* needle blight, as well as its simultaneity with the beetle attack, as evidence of a sea change in the correlation between climate change and tree pathology. For a historical account of the *Dothistroma* blight in the province, see Welsh, Lewis and Woods 2009.

which half of the model's pine trees lost their needles and began to die. On another afternoon, a mountain pine beetle pest subroutine swiftly killed an even greater percentage of virtual pine. Mimicking the armies of new loggers brought into beetle- and *Dothistroma*-affected forests by a raft of controversial salvage harvesting policies in the late 2000s, Anand introduced a new and expansive clearcutting algorithm to simulate the creation of vast new canopy gaps within the space of the model. Watching as the scatter plots changed and grew, we imagined new roads opening up and dead pine disappearing (along with thousands of healthy neighboring trees). Exposed to new sources of light, the cycle of growth began again, but more slowly this time, without the decaying pine logs left behind to feed new arrivals.

While the empirical datasets used to refine TASS were drawn from thousands of dispersed permanent sample plots, SORTIE developers' focus on idiosyncratic forest clearings and their scattered work and travel schedules meant that their data collection efforts were more localized and sporadic. But whereas the TASS development group spent their time almost exclusively behind their desks in Victoria and were reliant on datasets sourced from other offices, most of the modelers in the SORTIE network also spent considerable time in the field gathering their own data. Throughout the previous summer, Anand and I had helped each other learn the messy and monotonous work of counting and measuring trees. Joining Dennis and other members of an ad hoc team of researchers affiliated with the BVRC, we spent five months making bi-weekly trips to measure sample plots in the Date Creek, one hundred kilometers north of the town of Smithers. Our main purpose for the summer was to check the progress of the original selective harvesting experiment for which the research forest had been established in 1992: after creating clearings of different sizes in a gridded pattern throughout Date Creek, Dennis and his collaborators had spent the next two and a half decades conducting periodic

surveys to measure the growth rates of various species of trees as a function of their distance from each clearing (see chapter three for a more detailed explanation). Over the course of the summer, Anand and I familiarized ourselves with the wide range of more recent, smaller-scale experiments scattered throughout the forest as we helped the group complete one more survey.

When I returned to Smithers in December after spending part of the autumn conducting fieldwork in offices around the provincial capital, Anand had been working for months, formatting the measurements we had gathered together during the previous summer into the tabular inputs required to generate a new SORTIE simulation. Relieved at the temporary respite from the crush of binders, charts and cubicles that had faced me during my visits to the crowded floors occupied by the Forest Analysis and Inventory Branch at the Ministry of Forests tower in Victoria, I typically found Anand working on a single desktop PC in a small, spare office on the second floor of the BVRC's modest bungalow, with Hudson Bay Mountain peering in through his westward-facing window. A recent addition to Dennis's small research group, Anand's explorations of SORTIE and his painstaking work familiarizing himself with the programming language R (or Gnu S) found him regularly drawing upon the experience he had developed with other tree growth models and statistical analysis programs. *The beta version of SORTIE I used during my first postdoc didn't model the seed release process very well*, Anand explained when we first discussed his earlier research, *but the new version of the program appears to be working much better for that. No model is ever perfect.*

As Anand had learned firsthand, one's professional mobility as a forestry scientist could expand quickly as one developed fluency in more modeling languages, but demonstrating commitment to a particular model, even temporarily, could come with hidden costs. A product of elite academic forestry programs in Austria and Eastern Canada, Anand ingratiated himself with

Dennis and his new colleagues at the BVRC by throwing himself into grueling, repetitive data collection work. By autumn, he was pushing the development of SORTIE by continuously running trial simulations to isolate and critique different stages of the model's growth and succession algorithms. But by joining the group, Anand slowly realized, he had also unwittingly picked up a number of adversaries simply for pursuing research questions which challenged the tenets of sustained yield silviculture. *The last time I gave a talk in Alberta,* he told me, *a government forester criticized me for mentioning "secondary structure." "That's just a political term," he told me. I was not expecting that.*

Politicizing Succession in a Changing Forest

Within the space of the model, the politics of "secondary structure" calculations seem innocent enough. During our summer visits to the research forest, I had spent considerable time counting and cataloging many of the smaller trees typically ignored or discarded by clear-cut logging crews, and Anand had simply incorporated them into his simulation routines to whatever extent the model allowed. If the SORTIE group's approach to modeling trees was as subversive as Anand's critic suggested, its subversiveness was rooted in this patient attention to decimal points and remainders, whether in the forest growing at Date Creek or among the scatter plots growing on Anand's computer screen.

For conventional forest growth modelers, however, technical criticisms of sustained yield management could be difficult to distinguish from blatantly personal attacks. Moving away from the precise simulations of uniform, post-clearcut plantation forests offered by TASS to ecology-based models capable of projecting succession dynamics in complex, multi-generational stands required more than simply revising the government's attitude towards fieldwork and planning. It

required persuading provincial analysts that the shift to new idioms for describing forest change could replicate the outcomes – dependable tree growth figures and maximum long-term timber yield – offered by the permanent plot, the site index, and the linear optimization model. For the modelers who had built their careers establishing this experimental system, imputation and automation had already cast doubt on their futures as Forest Service researchers. The prospect of being further undermined by an academic model was doubly difficult to bear.

Describing to me his early involvement with the development of SORTIE-ND and the Date Creek Research Forest in the early 1990s, Philip Burton was quick to eschew the particularities of TASS and SORTIE to focus on the pressures exerted by their respective venues of development and application. A co-founder of both the Bulkley Valley Research Centre and a professor of ecology based in the nearby town of Terrace, Philip's prior experience with ecological modeling work in American research universities and in the Canadian Forest Service had made him wary of leveraging new models to gain standing in political debates. "This has been the battle that [Dennis] has been facing, with getting SORTIE simulations accepted in terms of their growth and yield projections. People are willing to give it the benefit of the doubt when it comes to successional or species composition changes, but because so much has been invested – three decades, five careers – into TASS … and its very minute tree crown dissections and elegant … bole taper[21] equations, they're not willing to give up on the fact that most forests – all but the most intensively managed forests – are not in fact single species, single aged plantations that those models work very well for. But we try really hard, even if the biology doesn't warrant it, to knock the aspen and birch out of the spruce and the pine and Douglas fir plantations; to even knock out the hemlock and subalpine fir that comes in naturally, too, even though those can

21 Effectively, the change in shape of a tree's trunk between its crown and base.

be perfectly good crop trees." Philip saw TASS less as an individual growth simulator than as a dogmatic component of the "normal forest" itself. "When it comes to growth and yield, we're often managing our forests to conform to the model assumptions rather than being willing to improve our models to represent the real forest."[22]

Reflecting on the marginal status of SORTIE-ND and its network of developers within provincial timber supply analysis, Dennis was diplomatic. "There's no doubt in my opinion that if you clear-cut, create full open conditions, plant one or two species, TASS is by far the best model we have for projecting those results. Absolutely." Dennis reminded me that such a qualified compliment was not meant as faint praise: provincially-active logging companies had been clearcutting since the Forest Act Amendment Act had laid the groundwork for sustained yield management in 1947 (Archibald 2011). When replanting obligations began to be devolved to corporate tenure holders in 1982, companies had little incentive to replace harvested stands with more than one or two species of trees (Eng 2010). Still, echoing Philip Burton's concerns during a conversation we shared while traversing a second-growth section of Date Creek, Dennis bemoaned the circular reasoning used to justify the model's implementation. "To kind of a perverse extent, because we could only model single-species, even-aged stands, we tended to plant and manage single-species, even-aged stands. Because that's what we could model."[23]

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22 Donald MacKenzie (2006) offers a nearly identical argument about the performative effects of the Black-Merton-Scholes options pricing formula in contemporary financial markets. Canay Özden-Schilling (2015, 2016) complicates MacKenzie's (and by extension, Burton's) performativity thesis by calling attention to the broad range of engineers and other actors without formal economics training needed to design economic principles into physical, "market-based" infrastructures like contemporary electric grids. For an early discussion of performativity, see Butler 1993.

23 Drawing a dramatic distinction between experimentation and simulation, Sherry Turkle (2009) echoes similar anxieties about the "performativity loops" facing researchers whose reliance on modeling tools dulls the insight of their observations. "An experiment, in real terms, turns to nature ready to be surprised. But if experiments are done 'in simulation,' then by definition, nature is presumed to be 'known in advance,' for nature would need to be embedded in the program" (40). Despite the incredulous tone that Turkle attaches to this proposition, numerous historians of science have long argued that the "embedding" of "nature" into computer simulations, theoretical formalisms, and other experimental apparatus often takes place through gradual shifts in the meanings attached to conventions of representation (Giere 2004; Kaiser 2000; Kennefick 2000; Oreskes,

At precisely the same time that the government of British Columbia began devolving and disassembling its forestry research infrastructures, an enormous outbreak of mountain pine beetles in the center of the province began to cast a harsh light on the limitations of TASS's performative powers. Peaking in numbers and geographical spread between roughly 2003 and 2009, the beetles affected over 100,000 square kilometers of forests, killing tens of millions of mature Lodgepole pine trees – one of BC's most important commercial species (Axelson, Alfaro and Hawkes 2009). Beset by overly optimistic simulators and a recently shuttered data collection program, government planners spent the decade scrambling to salvage the dead wood before researchers could properly assess the effects of these efforts on the health and productivity of the forest as a whole.[24]

The unprecedented scale of the mountain pine beetle attack – and the equally unprecedented scale of the provincial response – meant that the baroque simulators used to process remote sensing data into inventory numbers and harvesting quotas were based on a number of suddenly very inaccurate assumptions about how the trees within a "normal forest" grow and die. In Dennis's estimation, the relative stability of the Ministry over the preceding decades had fostered an institutional reliance on overwhelming exceptional problems with enormous stores of "normal" data. "The glitches now with TASS are whether or not some of these assumptions behind survival rates are actually occurring – it has pretty optimistic survival rates – and twenty years ago, we were probably getting those survival rates. But now with climate change, various things have been happening, we're not, in a lot of cases. With what's

Shrader-Frechette and Belitz 1994; Rudwick 1976) have argued, however. As David Kaiser (2000, 2005) has repeatedly argued, the deployment of graphical formalisms can often accrue associations of "realism" and verisimilitude as theoretical tools are passed between different lab groups, disciplines, and generations of researchers.

24 As subsequent research proved in great detail, the scale of provincial salvage logging efforts seriously misrecognized the actual dynamics affecting beetle-killed tree decay. See P. Burton 2010; Kurz *et al.* 2008; Lewis and Hartley 2006; Lindenmayer, Burton, and Franklin 2008.

going on today, the TASS people need to be a little more open … they come from a culture of using really, really tight data, lots of really carefully controlled data from plots that have been followed carefully over time. If something happens to one of those plots, they throw the plot out." In the sprawling beetle-affected forests of the provincial interior, few of the permanent sample plots which remained as the beetle retreated could still pass TASS's exacting standards.

During the height of pine beetle outbreak, Dennis brought new forms of attention to the SORTIE developer network by giving dozens of talks to different audiences around Canada, both within the Ministry and as a Ministry representative speaking elsewhere. Early into this work, he grew alarmed that so many politicians seemed to be obsessed with the idea that the forests were "dead." "Listening to them, you'd think that everything north of Hope [a small town at the edge of the Vancouver metropolis, in the Fraser Valley] looked like the surface of the moon. And that's simply not true." Speaking in his office at the University of Northern British Columbia in the neighboring town of Terrace, Philip agreed, noting that the bright red needles of recently attacked pine trees produced a media-ready visual effect, generating horror while overstating the scope of the infestation. "It simply isn't as dramatic after the needles have fallen. You see the green between the gray."

> "That was a basic tenet that a lot of people had around 2000, 2001, 2, 3 – the faster we clear-cut it, the better, because that's the only way we can save it. Because it's all dead. But the thing is, it wasn't all dead… There was a lot of green trees in a lot of these stands, and clear-cutting them and starting over again just made midterm timber supply worse. And so I spent a lot of effort saying, 'The issue here isn't how fast we clear-cut and how fast we salvage, the issue is the mid-term timber supply. What in the heck are we going to log thirty years from now?' … if you accept that premise … that there's something like three or four million hectares of our twenty-two million hectare operable landbase where

> we harvest trees, where fifty percent or more of the stand are dead overstory pine trees, with a variety of other tree species of various sizes and spatial compositions mixed in there, we have no idea how to model the growth of those things over time. But SORTIE would do a really good job of that. But I've still been unable to get powers that be in Victoria to use SORTIE to model these stands. There's just some sort of institutional, cultural... barrier that I don't understand."

Within SORTIE-ND, dead yet still standing pine became windbreaks for secondary structure. Fallen needles opened broad swaths of canopy, letting in sunlight to areas which had previously languished in heavy shade. Winter snow piled higher, unobstructed in its path between the sky and the forest floor. Underneath the snow, saplings and berry bushes escaped the winter ravages of foraging animals. Over time (between five and fifty years, depending on topography and wind exposure), dead pines fell, leaving rotting logs to feed new growth. Projecting beyond the gruesome swaths of red and gray depicted by provincial-scale mountain pine beetle population models, the secondary structure populating Dennis's model – the future forest, forty years and more hence – was not impoverished, but flourishing.

Still technically an employee of the Forest Service and yet distant from the timber supply planning processes taking place at Forest Service headquarters, Dennis nevertheless frequently framed his research into disturbance dynamics and tree diseases as "outsider" interventions into prevailing modeling orthodoxy. As much as he enjoyed working at the margins of provincial control, though, the distance between Date Creek and BC's academic centers forced him to rely heavily on the expertise of other Smithers-based forestry researchers as he built up the new model from Date Creek-sourced data. Dennis often bemoaned this responsibility to me while explaining the logistical challenges he faced in attracting, training, and maintaining a critical

mass of research assistants in Smithers. Even during my brief time in Smithers, individual researchers came and went, leaving in their wake a scattered array of replicated datasets and new indexing systems throughout the Centre's computer hard drives. In Dennis's group's archives at the Bulkley Valley Research Centre, tables of old measurements coexisted alongside field reports from far more idiosyncratic experiments. The trading of tables between generations of group members only further blurred the boundaries of Date Creek's amorphous archives.

Even as the SORTIE developer community expanded its geographical scope and accumulated new research topics and institutional connections, however, Dennis insisted that perhaps the model's most significant impact was the continuity it offered to the projects and personnel affiliated with the original Date Creek Research Forest. In chapter three, we saw how long-term experiments and remote field sites like Date Creek often follow the career arcs of their aging senior researchers, slowly fading into invisibility as their caretakers move or retire, often after waiting for years in the false hope that the Forest Service would hire new researchers to replace them. Like many of the other Smithers-based researchers whose work I followed in chapter one, however, Dennis had spent much of his career creating space for experimental research at the margins of provincial control. While Dennis rarely played a visible administrative role in the profusion of conservation initiatives, knowledge trusts, and other collaborative endeavors that emerged from the BVRC, he routinely advocated for expansions in the province's community forest programs. Yet by continually returning to the SORTIE developer network to cultivate links with new researchers and institutions, Dennis betrayed an awareness that the fate of his remote research community would not be decided on local terms alone.

Becoming Essential or Getting by: Two Routes to the Digital Afterlife

Moving back and forth between Smithers and Victoria, the similarities between Dennis's and Arnold's worlds might strike one more forcefully than the differences each group of modelers took pains to proclaim. Both men were senior Ministry researchers who had begun their careers in university forestry programs, and both decided to specialize in modeling and simulation work as career opportunities arose. Perhaps most significantly, both Dennis and Arnold had devoted their careers to specific research *objects* – tree growth models and forest succession simulators – even as the real-world environments and government policies with which these objects articulated had begun changing rapidly as they both neared retirement. Arnold was keenly aware of the influence and the relative safety he had earned through his willingness to embed TASS within the heart of the BC Forest Service's sustained yield system. Dennis's experience with regional office closures, contracting work, independent collaborations, and the proliferating institutional ecologies of the rural northwest (see chapter one), however, had made him reluctant to attach his work to a singular governmental function, no matter how powerful.

Generating meaning through environmental modeling work often means articulating with localized sites of investment and attachment even while scanning the horizon for broader applications and more expansive political labels further afield (see Lahsen 2004). During our final fieldwork sessions together in the autumn of 2013, Dennis reflected that building a legacy through his published work and the expansion of the SORTIE developer network had helped to soften his frustrations over the Forest Service's unwillingness to prop up the fading infrastructure supporting the Date Creek Research Forest where he had spent so much of his career. "There's a lot of old experiments in forests that are well taken care of for ten or fifteen or twenty or twenty-five years, and then they kinda fade away," Dennis admitted. "The worst kind [of experimental forest] is the one that's been in the ground for twenty years, and people have gone out and

measured [the trees], and all the data's in a filing cabinet, right? So, we've published a lot."

For government modelers like Arnold, accustomed to playing a central role in timber supply analyses for the entire province, treating academic articles as a suitable legacy for a simulator represented a failure of ambition. By eschewing the constraints of centralized planning in favor of a heterogeneous and geographically dispersed assortment of applications and collaborative projects, SORTIE developers antagonized some of their counterparts in government for what the latter saw as a basic misunderstanding of the realities of bureaucratic integration. As my conversations with Arnold drifted back towards his history of confrontations with the SORTIE development group, Arnold strained to be polite. "There are choices in their model that we disagree with, but modelers disagree." Most of the technical differences Arnold listed for me were trivial: TASS programmers incorporated measured tree height information more directly into their growth equations, whereas SORTIE programmers deduced height from measured diameters; tree crowns, modeled as three dimensional polygons in both programs, took on slightly different shapes and sizes as they grew. Still, the comparative paucity of the archives used to fine tune these parameters occasionally brought others' institutional prejudice out in full force. As one TASS programmer complained to me in a moment of bitterness, "For [Dennis], if he gets it published, that makes it true."

For Arnold, the key differences between the models lay not in their assumptions, but in the kinds of labor devoted to fine-tuning these assumptions over time. "Any model that you go through is an iterative process: fitting functions, putting them into the system and testing to see if it's working right, because any recursive relationship can go off into hyperspace." Without more testing and "validation," Arnold argued, it would be impossible to know whether or not a simulation constructed in SORTIE-ND could accurately project growth conditions in the "real

world." "It's nothing that we have fought against," Arnold insisted. "If they come to us and say, 'What do you think of using SORTIE in timber supply?' … basically all I would say is, 'I'd like to see some validation work, but if you feel like you want to have a go at it, give it a try, at least on a sensitivity analysis basis."[25]

As Arnold began his first years of retirement and Dennis diversified his energies around Smithers in the years since I first met them both, the likelihood of SORTIE taking on a central place in British Columbia's timber supply planning process has grown dim, although not necessarily because of the government's continuing hostility to disturbance ecology as a planning framework. Rather, for modelers like Dennis, the goal of "becoming essential" to government practice is increasingly seen as an illusory one. Some of Dennis's more skeptical collaborators were explicit in viewing government entreaties as professional traps, where paradoxical compromises like imputation attend each new stage of influence. "I warned [Dennis] several times" Philip Burton complained to me from his office at the University of Northern British Columbia. "You don't want to become a modeler because then you'll be expected to and almost pressured to be defending your model and to modify it to do everything that anybody wants you to do. So use your model for a specific set of questions, and then let it go. You don't want to be known as the defender of SORTIE."

And yet by choosing to align their legacies as scientists with a simulator, a socially promiscuous and reconfigurable research object, Dennis and other SORTIE developers have nevertheless found ways to get by. They continue to place side bets on expanding their influence through publication networks, and they have come to play meaningful roles in the maintenance

25 "Sensitivity analysis" refers to a model-testing process which seeks to determine how much the relative levels of uncertainty of different inputs and components of a model contribute to the overall uncertainty of the general outputs of the model itself. For numerical models, sensitivity analysis is often accomplished through a combination of variable isolation, linear regression, and partial differential equation analysis. See Saltelli and Annoni 2010.

of rural research forests and in the growth of new independent institutions like the Bulkley Valley Research Centre. Their archives remain distended, partial, and vulnerable to the redundancies and formatting frictions caused by constant changes in personnel, whether at the BVRC office or in the academic departments linked together in the SORTIE developer network. For better or worse, they cannot look upon British Columbia's normalized forests or the government's dauntingly (if misleadingly) precise timber yield forecasts as the products of their own labor and genius. Being able to live and work in a small town like Smithers often means accepting these kinds of limits, many of Dennis' collaborators reminded me from time to time. This does not mean all of SORTIE's future generations of developers will be similarly constrained, of course. Forests and simulators are still four dimensional tableaux. Neither they nor their modelers remain static for long.

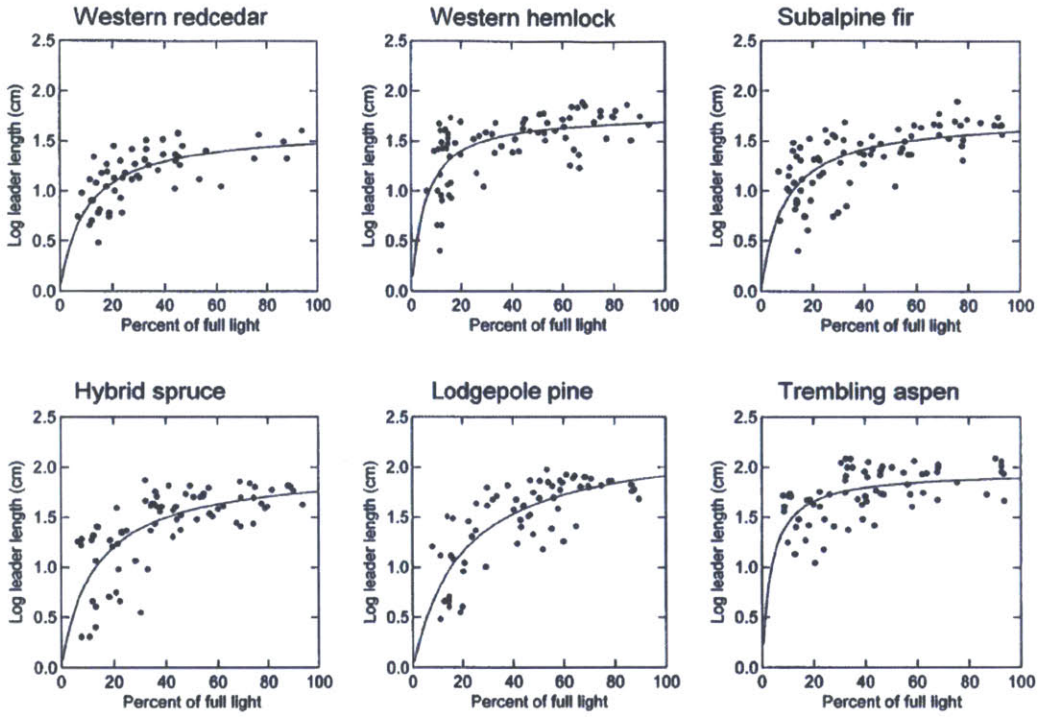

FIG 5.2. Simulated growth figures for multiple tree species as a function of canopy coverage (i.e. sunlight access). Modified from Canham *et al.* 1999.

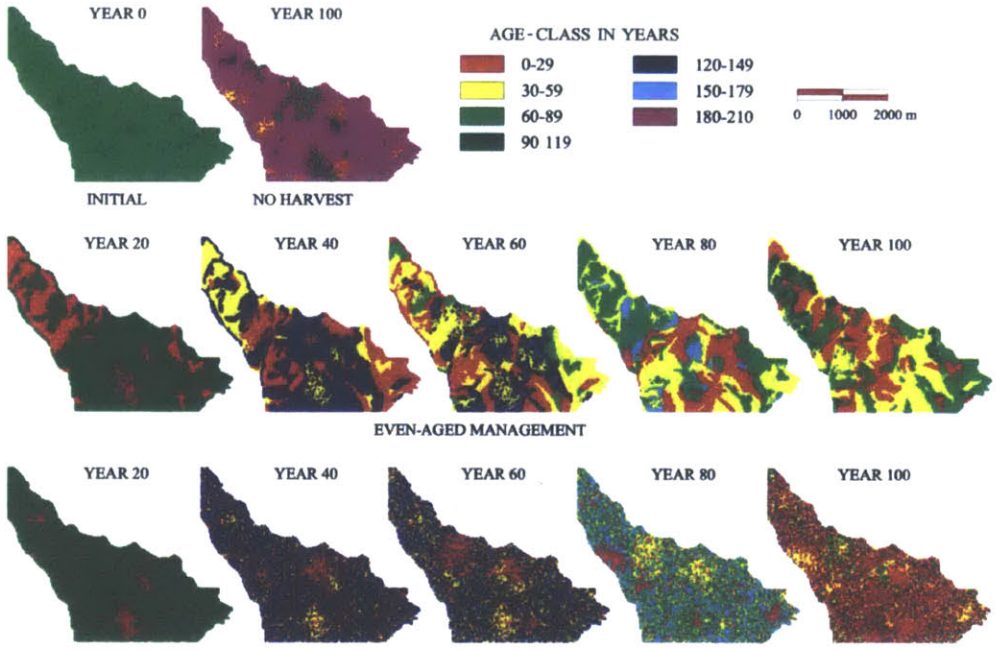

FIG 5.3. Example LANDIS simulation results showing changes in age class mixing for three different forest management scenarios. Modified from Gustafson *et al.* 2000.

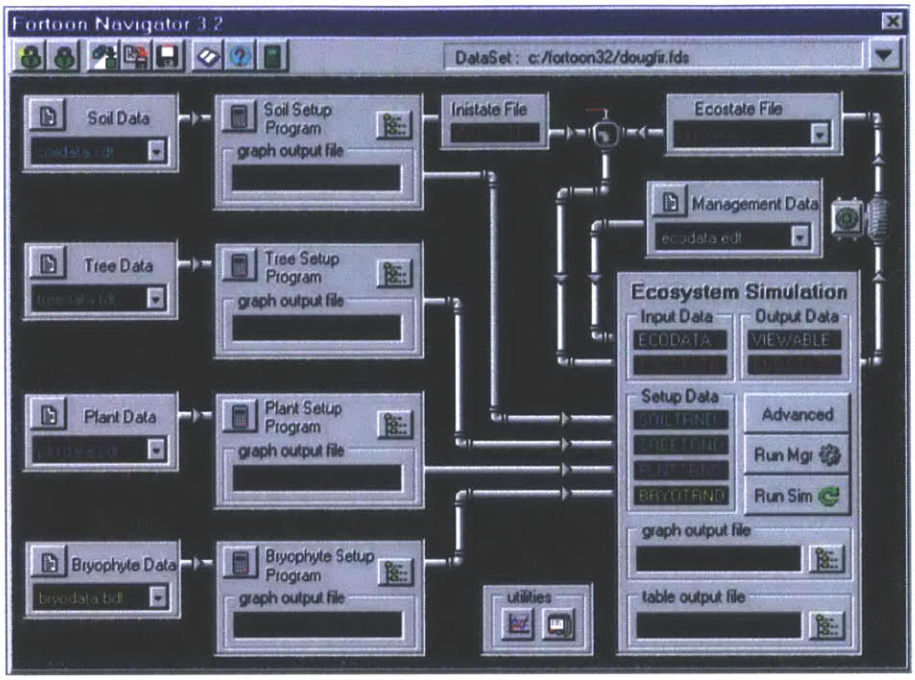

FIG 5.4. Early graphical user interface for FORECAST, a multi-scale ecosystem simulation program developed at the University of British Columbia Forestry program. The dialogue boxes on the left are used to input data tables, and the dialogue boxes in the center of the image are used to load specific simulation algorithms for each class of data. Image modified from FORECAST Ecosystem Model N/d.

FIG 5.5. FORCEE individual tree simulator visualization on simulated topographical unit. Modified from FORCEE Individual Tree Model N/d.

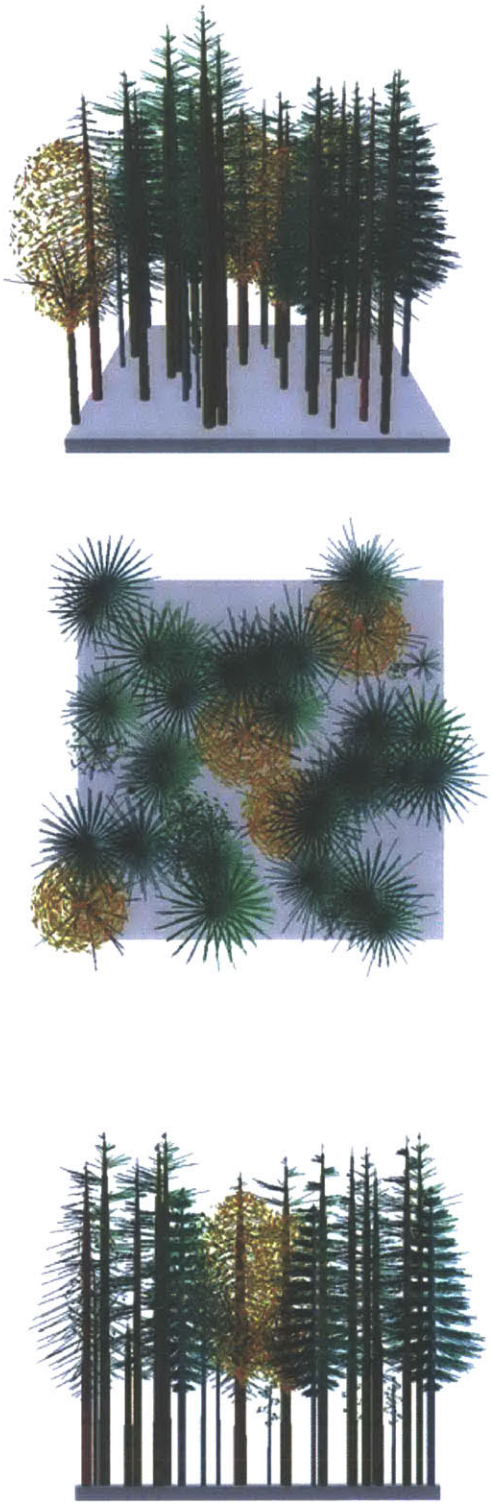

FIG 5.6. Visualization of Stand Visualization System, an individual tree- and stand-level modeling program developed by the Pacific Northwest Research Station of the US Forest Service. Image modified from USDA Forest Service N/d.

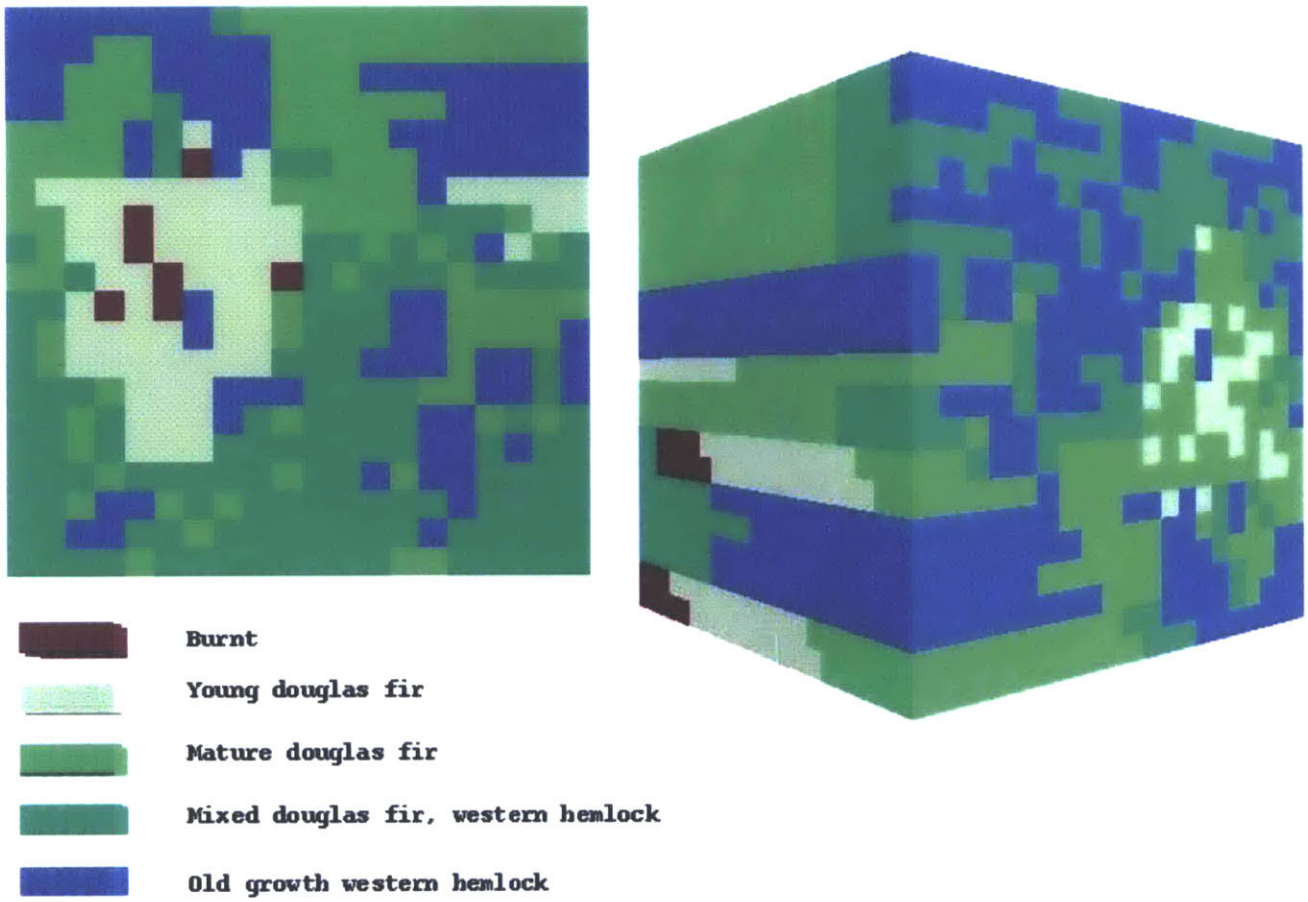

FIG 5.7. An early visualization experiment with SELES (Spatially Explicit Landscape Event Simulator), an environmental modeling language developed by Andrew and Joseph Fall (2001). In this visualization, the simulated temporal evolution of a low resolution two-dimensional forest cover map (on left) is creatively displayed as a cube (on right) in which each interval along the vertical axis represents a separate moment in time. Image modified from Carpendale *et al.* 1996.

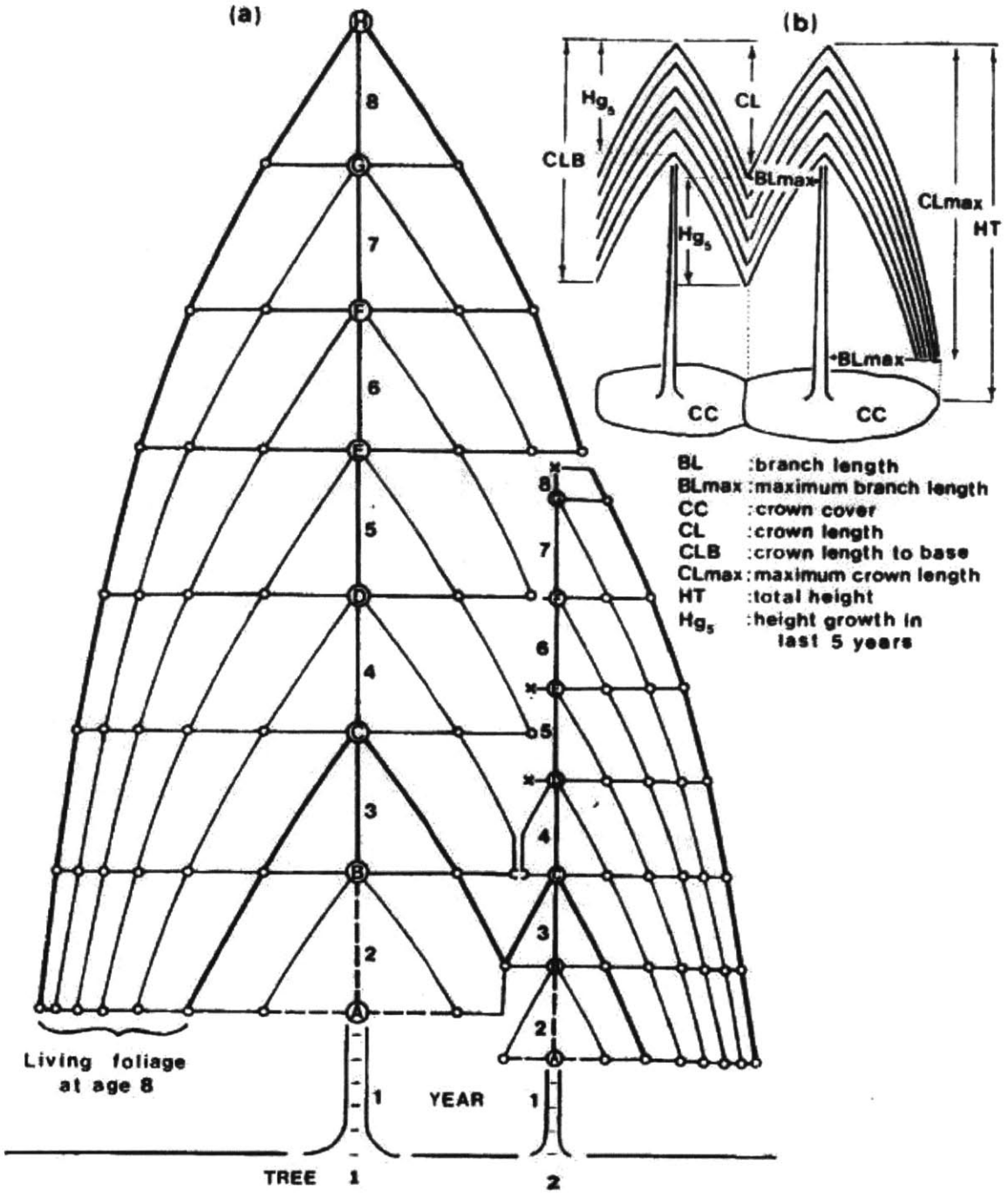

FIGURE 3. *Inter-tree competition showing (a) the method by which a relatively vigorous tree overtops a slow growing competitor, and (b) the variables that characterize the crown.*

FIG 5.8. An illustration of the kind of tree crown growth and inter-tree competition modeled by TASS and other tree- and stand-level simulators. Modified from B.C. Ministry of Forests and Range N/d.

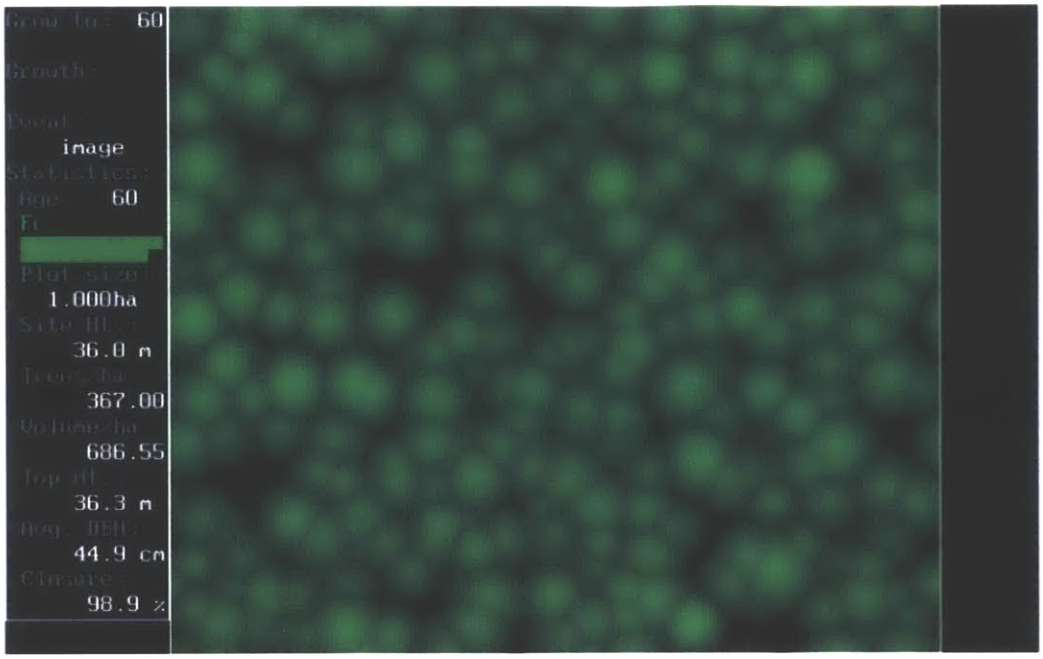

FIG 5.9. Early graphical user interface for TASS. Spherical figures on right are simulated tree crowns. Numbers on left are average characteristics (tree height and diameter, uniformity of canopy closure, etc.) for the stand as a whole. Modified from B.C. Ministry of Forests and Range N/d.

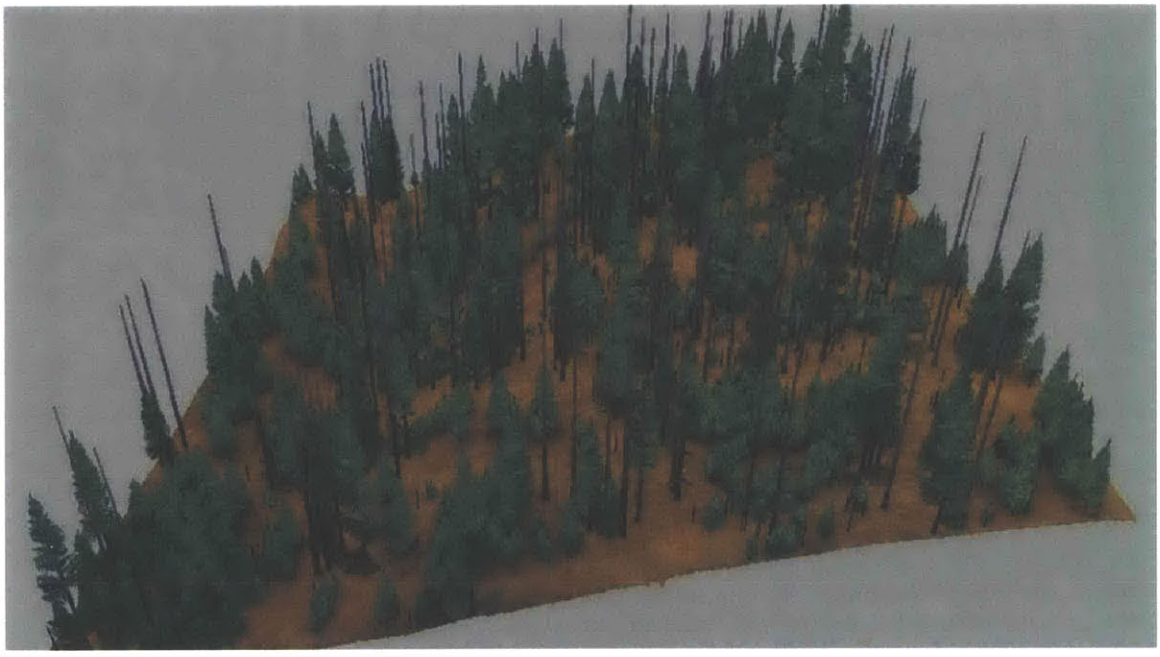

FIG 5.10. Visualization of a TASS-simulated mixed species tree stand on a simulated topographical unit, including standing fire-damaged and pest-killed trees. Modified from B.C. Ministry of Forests and Range N/d.

Postscript

Data, Time, and Trust

"Nobody should have to fly anywhere for these meetings," Nigel insisted, to the rueful laughter of the small group of biologists, computer programmers, and conservation activists assembled around the table.[1] "If anybody has to fly anywhere, this is going to take years!" Just a few minutes into the second meeting for the Bulkley Data Trust, most of those in attendance still didn't even know what a "trust" *was*, but they did know that they didn't want the government of British Columbia to know what they were up to for a few more months. For the second time that summer, we were gathered together in the cramped kitchen of the Bulkley Valley Research Centre. For hours, we had been discussing how to gather, store, and distribute dozens of different datasets related to the movement of salmon through the region's rivers. Simply agreeing on an initial list of the *kinds* of data to be gathered by the trust had taken several hours: stream temperature and clarity; salmon counts; the density of logging roads around streams and especially around salmon spawning areas; local grizzly population figures; soil compaction and erosion around new logging sites; each new angle steered the discussion to other factors that the trust had yet to consider.

All agreed that the provincial and federal governments could no longer be trusted to manage – let alone share – these data appropriately. Even as evidence accumulated that Pacific salmon populations were plummeting, federal and provincial fisheries biologists were still being

1 All of the individual names listed in this chapter are pseudonyms. "Bulkley Data Trust" is a pseudonym, too.

laid off in droves, maintaining the downsizing trend begun in the "dirt ministries" by the center-right B.C. Liberal Party immediately after they took office fifteen years earlier. And yet as we drifted further into debate over which companies' and organizations' datasets to go after first, nobody had bothered to share their thoughts about what exactly it would mean for an "independent" group to take over the management such a broad body of knowledge.

Humble roots and ambiguous means notwithstanding, knowledge sharing trusts are increasingly being enlisted in northwest British Columbia to perform governance functions that are no longer – or never were – performed by the formal offices of the state. Among the diverse group of trust proponents I came to know in Smithers, most were established professionals who had resigned themselves to the idea that the surge of support for collaborative land-use planning which had temporarily transformed rural B.C. in the 1990s would not soon be repeated. Whether drawn up by white conservationists in the comparatively wealthy Bulkley Valley or anti-corruption activists living on nearby Gitxsan reserves, each of the nascent trusts I encountered in the region were designed to mollify the uncertainties of policy changes and government turnover by replacing ministry functions with locally-controlled data distribution infrastructures. After spending several months following Smithers-based trust proponents between their work with the Bulkley Data Trust (BDT) and their other spaces of paid work and activism, however, I began to see knowledge sharing trusts not only as instruments of a future-oriented techno-politics, but as instruments of nostalgia as well.

Like many new forms of environmental governance to emerge in developmentalist states in recent decades, proponents of new data-sharing and coordination mechanisms often defend their creations by invoking "transparency" as an end in itself (Cinnamon and Schuurman 2013; Fortun and Fortun 2005; see also Beck 1992; Callison 2014). As government-led environmental

data collection programs in Canada steadily decline for want of funding, however, contemporary conversations about "transparency" often transition quickly into complaints about privately funded researchers' reluctance to fill the gap. "On the coast, we've had huge trouble getting access to company data," one Smithers-based landscape modeler complained to me shortly after we began attending BDT meetings together. "It's ridiculous. Operating on public land, and you can't get the data?" Acquiring useful data, of course, is only part of the problem. Even as they struggled to compel would-be developers to publicize their private data as a public good, most BDT members were already looking further ahead, anxiously debating how best to encourage future database users to view their hard-won datasets in cumulative terms.

What exactly "transparency" might come to mean for researchers working in a trust-based governance regime was an open question as well. Among the disparate experts to join early planning sessions for the BDT, I witnessed numerous potential answers to this question worked out within conversations about metadata, or the organizational codes that determine how users of a database search for new data, and how they perceive each dataset's history of compilation and revision. Even as they discussed potential metadata standards for the datasets they sought to acquire for the trust, BDT meeting attendees invariably reflected on their personal pasts and futures as environmental scientists in the region as they articulated what kinds of narratives different standards might promote. More immediate events colored these reflections. The proposed Enbridge Northern Gateway Pipeline in particular cast a shadow over all of my conversations with BDT proponents over the course of the year (McCreary and Milligan 2014; Veltmeyer and Bowles 2014). Conservation activists throughout western Canada had been galvanized by the Conservative federal government's decision largely to ignore the findings of the enormous Joint Review Panel (JRP) convened to study the potential impacts of the pipeline

(see chapter one). Increasingly urgent attempts to find more robust institutional forms reflected more than shared frustration over the perceived betrayal of government science and public feedback processes, however. As BDT members explained how specific, often far earlier, political confrontations and policy changes had shaped their own personal histories and professional goals as researchers in rural B.C., each new exhortation of "democratized science" and "transparency" seemed to belie a common desire to escape altogether the turbulent temporal rhythms of Canadian resource politics.

In small towns throughout North America's resource frontiers, the embedding of modest data sharing programs in social and professional life raises a number of questions that constructivist critiques of databasing work have largely avoided. As government-run databases for biodiversity information, so-called "Indigenous Knowledge," and other kinds of digitized spatial data began to expand in the 1990s, critics wondered aloud what kinds of politics new combinations of state prerogatives, formalized collection practices, and formatting conventions would yield (Agrawal 1995; Bowker 2000a; Dove 2006). Whether focusing on the potential loss of what Geoffrey Bowker (2000b: 739) describes as the "irreducible ontological diversity" of plant and animal species information or "threats" to "epistemological diversity" in Indigenous representations of space and territory, early scholars were concerned primarily with the dynamics of translation, standardization, and above all the centralization of control undergirding new environmental management processes (Agrawal 2002; Houde 2007; Nadasdy 1999; Rundstrom 1995). Thanks to a rapidly devolving regulatory landscape, however, some of these fears now seem misplaced. Relatively little attention has been paid to what has happened as large-scale databases have been phased out of state land management policies and relegated to the margins of independent advocacy and contract-based environmental research. Exploring the concepts of

scope and purpose articulated around new hybrid databasing initiatives and legal forms like the BDT can tell us much about the kinds of local authority and technocratic power that some politically active scientists no longer believe they possess.

That day in the BVRC kitchen, the task of explaining how the new trust would actually work fell to Nigel, an environmental lawyer and activist who had moved to region in the 1980s. Whether one wanted to mobilize a knowledge sharing trust as a simple data aggregation mechanism, a public information portal, or a proactive government watchdog, Nigel offered, the trust itself was little more than a legal agreement between parties with competing interests that a common store of information would be handled in a consistent manner. Even if policymakers and company officials could hide behind vague numerical benchmarks and other legerdemain as they went about their usual business, parties to a trust could only gather data and report. Rules for membership, reporting, and access would be agreed upon in advance and spelled out in a "terms of reference" document, so that private developers, NGOs, and government institutions would be obliged to contribute and publicize new datasets gathered in the region regardless of the consequences for a given project. Most importantly, unlike the Forest Service protocols and other environmental management policies with which they articulated, trusts could not simply be canceled at will. "When you're an executor of a will," Nigel patiently explained, "you can't just say, 'Oh, Sheila's a druggie, let's not give her any money.'" The trust was different from a technical advisory committee, too, where individual members could easily lobby government policymakers towards specific ends. Everyone around the table had participated on such committees before, and memories of bitter arguments had left them yearning for the relative certainty of more binding legal forms.

Like the motley group of independent and government researchers arrayed around the

table beside him, Nigel was resigned to the fact that many new conservation laws were being in written in ways that government ministries might struggle to enforce. By using a knowledge trust to make public disparate data sets relevant to northwest British Columbia's rapidly declining salmon populations, the group hoped to make visible not only data itself. The group planned to cast a light on a range of legal promises to gather salmon-related information that provincial and federal ministries had not fulfilled for several years. Many of the water quality metrics written to regulate pollutants in the nearby Skeena River, for instance, were tied to numerical benchmarks which the federal Department of Fisheries and Oceans no longer assessed.

When we first met in 2013, Nigel was also quietly sketching out designs for a trust with activists from the nearby Gitxsan First Nation. As I discussed in the Introduction, many Gitxsan had grown increasingly alienated from the leadership of the Gitxsan Treaty Society (Gitxsan Unity Movement 2012a, 2012b; Spookw v. Gitxsan Treaty Society 2015). In the months before I arrived in the northwest, a number of individuals had approached Nigel after discovering that, individually, they lacked the legal standing to request technical information about proposed developments on the territories claimed by their traditional clans and house groups. Emboldened by Nigel's successes with conservationist groups elsewhere in the province, dissident chiefs hoped to bind Treaty Society executives to contribute developer reports to their database by building on the affordances of environmental protection and public disclosure laws not normally leveraged against First Nations civil society groups.

Exactly how "binding" any new trust agreement would be, of course, varied with the policies within which it was articulated. In academic journals focused on environmental politics and First Nations law, Nigel himself had published eloquent examinations of the strengths and weaknesses of the trust model within different regulatory regimes. In northwest BC, he had

already helped to establish several data sharing trusts to coordinate monitoring activities in the nearby Babine River watershed. Each of Nigel's trusts confronted a power asymmetry by calling attention to loopholes and gaps of logic in existing policies, often through references to more robust conservation policies established by previous governments that were no longer in place. And yet by structuring a shared archive through a common genealogy of policy claims, each trust also promised a kind of social continuity for the researchers who participated in its articulation and management.

The friendships I slowly formed with the Bulkley Data Trust group and their colleagues throughout Smithers made plain the personal entanglements which shaped the trust and brought it into being. Rural research could be a lonely affair, they admitted to me; whether one worked within or outside the government's ministries, the sheer distance between northwest BC and the provincial capitol in Victoria meant that researchers were often the only visible signs of government authority in the region. Perhaps unsurprisingly, BC foresters were among the earliest adopters of GIS mapping tools among forestry divisions worldwide. When these already-strained researchers began to get laid off, those who remained struggled to manage and organize the voluminous stores of data generated by their departed colleagues' work. "One of the tricks of having a large enough government agency is that you have legacy just by overlap of people," a landscape modeling expert offered when we first met at a trust meeting. "Whereas now with the downsizing of government, you're losing that legacy, which then requires you to have these huge metadata structures to keep that institutional memory alive."

This facile conflation of metadata with social memory was a recurring theme in many of my conversations with Smithers-based environmental scientists. A catch-all term referring to descriptive amendments, revision histories, user details, and contextual information attached to

individual entries in computerized databases, metadata relevant to environmental research can provide both an organizational structure as well as a space for marginalia and reflection within the otherwise relentlessly quantitative realm of spatial analysis (Edwards *et al.* 2011). The watershed-spanning erosion tables which Nigel occasionally brought to our meetings for reference were liberally annotated by former government employees. Sections gathered at different times were formatted according to the changing whims of lapsed conservation initiatives and outdated management boundaries. For analysts and other GIS users, these metadata helped them to imagine their contemporary consulting work through the language and policies of earlier regulatory regimes.

As much as metadata provide fodder for epoch-spanning narratives within individual datasets, however, they become particularly critical when disparate datasets are combined. With the proper standards in place, a company would be legally obligated to include numerous specific attributes of information normally omitted from "public disclosures." Designed in reference to a common spatial grid, standards also force different contributors to format their data into GIS-ready numerical tables and shapefiles. Considering how many developers still satisfy public disclosure requirements with only printed numbers on paper sheets, proponents of trusts often cite their demands for digital accessibility as perhaps their most powerful legal tool.

Tess, the database manager for the trust, was responsible for actually designing these metadata standards. She occasionally complained to me that her colleague's aspirations were built, at least in part, on a fantasy, an imagined past where government scientists had had the support, mobility, and social continuity to transcend the reductive confines of bureaucratic accounting and archiving. Tess had moved to Smithers in the 1990s to work as the government's GIS coordinator for the entire northwest quarter of the province. The work brought her into

regular contact with a bewildering assortment of mineral prospectors, forestry companies, First Nations resource managers, and conservation groups active throughout the area. This capaciousness led many of her collaborators to view her work through a nostalgic – and, in her eyes, frequently unrealistic – lens. "If you have [Tess] in Smithers, you don't need this big metadata structure and big record," a member of the group suggested to me, "because everyone goes to her."

The notion that a single, heroic individual could synthesize the region's rapidly dissolving environmental monitoring programs into a comprehensive whole belied each group member's ambivalent feelings about their own fraying institutional ties. Whether organizing research activities for First Nations land claims, applying for grants for bear population monitoring programs, or modeling the spread of forest diseases, each person who attended BDT meetings had come to know the other members of the group by working together on other modest initiatives. Jumping from project to project in rural British Columbia's expanding "gig economy," they had all performed their work within a wide range of professional positions and temporary appointments over the past decade. Indeed, three of the attendees who gathered together with us in the kitchen that morning were active government employees who had had to take vacation time from their ministry jobs in order to join the group. Tess and several others had spent years working for the provincial government before entering the private sector. Each person was a regular fixture at community outreach workshops, whether providing maps and models for scenario planning exercises or offering informal public lectures on their research.

While several of them had participated in marches and direct action protests earlier in their lives, the men and women who attended the initial meetings for the BDT no longer bore much resemblance to the people who had chained themselves to tractors in old growth forests in

the early 1990s, or to any of the other popular archetypes of British Columbian environmental activism. All of the people in the meeting had been involved in some way with a number of conservation and community-based planning initiatives that the previous provincial government had begun and the current government had canceled or de-funded. In different ways, they had all come to work in the northwest because the transition towards "knowledge-based decision making" in British Columbia's forestry and fisheries policy during the 1990s had promised the possibility of technical careers in rural places (see chapter one). Even if they held drastically different notions of institutional allegiance than the earlier generations of researchers and technocrats that they had followed on their journeys north, they shared with these people a similar inviable faith: that data, once properly organized and publicly shared, could speak for itself. "As we all know," one of the computer programmers proclaimed half-jokingly, "once you have more information, the choice becomes more obvious."

Today, over three years since the group began meeting, it is still unclear whether or not the Bulkley Data Trust will be successful. Other than one representative from a local conservation NGO, none of the initial members had had much previous experience working with salmon before, but their agility soon helped them to make allies with local fishers and biologists. In the language of a recently written yet poorly enforced salmon conservation policy, Nigel and Tess found robust legal justifications for some of the trust's data collection demands. Still, as of today, none of the corporate developers or commercial fishers active in the region have signed on to contribute their datasets to the trust. Most appear to be waiting until the next provincial election cycle, Tess admitted to me, to see if the new salmon policy will be phased out entirely (a likely event, provided the current, center-right governing party maintains its majority).

As the working group waits for new data to arrive, the months that Tess spent uploading

information from decades of government-run projects has allowed them to admire an archive already assembled – an archive in which several of them, thanks to earlier work connected to watershed restoration research, already play starring roles. Through descriptive metadata, these researchers have returned to explore these past lives; bit by bit, Tess and Nigel have helped them to structure their old work to imagine continuity with an uncertain future. In a new era of environmental governance less likely to be shaped by government-collected data than by the gracious contributions of private research, knowledge sharing trusts may yet forge new paths of political influence. How they will shape the memory of what came before remains to be seen.

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