

**Ice, Through Inuit Eyes:
Characterizing the importance of sea ice processes, use, and change
around three Nunavut communities**

by

Gita Joan Laidler

A thesis submitted in conformity with the requirements

for the degree of Doctor of Philosophy

Graduate Department of Geography

University of Toronto

© Copyright by Gita Joan Laidler 2007

Ice, Through Inuit Eyes: Characterizing the importance of sea ice processes, use, and change around three Nunavut communities

Gita Joan Laidler

Doctor of Philosophy

Department of Geography

University of Toronto

2007

Abstract

Sea ice is an integral component of life in Inuit communities. It has complex influences on economic, social, cultural, and subsistence activities. Also, due to its influential role in regulating energy exchanges between the ocean and the atmosphere, sea ice is often used as an indicator of climate change in arctic regions. Significant scientific research effort has been focused on determining the potential impacts of global climate change on arctic ice seasonal patterns. Recently, interest in the impacts of climate change on arctic communities, and resulting societal adaptations, has emerged. Sea ice is thus an essential component to include in vulnerability assessments designed to evaluate community-specific implications of climate change. However, in order to undertake such an assessment, we must first understand Inuit characterizations of sea ice and the attributes of ice that most affect their livelihoods and lifestyles.

Inuit have developed an intimate relationship with the sea ice and marine ecosystem through generations of observation and experience. While they have long been able to harvest wildlife and forecast changes linked to ice conditions, little of this detailed knowledge has been documented to appropriately represent this expertise. Therefore, working with Inuit sea ice experts in Cape Dorset, Igloolik, and Pangnirtung, Nunavut, this thesis characterizes the local importance of sea ice processes, use, and change. Employing a collaborative research approach, a combination of participatory methods (i.e. semi-directed interviews, experiential sea ice trips, focus groups) were undertaken in four field seasons between 2003 and 2005.

Results from each community include descriptions of: i) freezing and melting processes; ii) the influences of winds and currents on sea ice; iii) sea ice uses for travel, hunting, and wildlife habitat; and, iv) observations of sea ice change. These results facilitate a comparative regional analysis, with an emphasis on Inuktitut terminology and implications of a changing sea ice environment. Experiences in a cross-cultural, community-based, collaborative research setting also enable an evaluation of the effectiveness of the research approach. This thesis lays the foundation for knowledge-sharing between Inuit and scientists. It is a starting point for attempts to link local and scientific knowledge in a complementary manner.

Dedication

This work is dedicated to the Inuit elders who shared their wisdom and contributed to this project, but who passed away before seeing the results.



In memory of Mosesee Nuvaqiq, Paulassie Pootoogook, Etidlouie Petaulassie, and Iqadluq Nunguisuituq, this work is also dedicated to the future generations of Inuit with whom they wanted to communicate.

Acknowledgements

So many people were involved in the process of conducting this research. I am ever-grateful for the support, teaching, time, and patience I have been fortunate to receive over the past four years.

I wish to thank my supervisors Dr. Vincent Robinson and Dr. Deborah McGregor for providing me the opportunity to pursue this project. I greatly appreciate the independence they have afforded me in learning the research process, as well as the guidance they have provided throughout. They facilitated the research funding, and have continually been patient and supportive. Thank you for all your efforts to ensure the timely completion of this project.

I wish to thank my committee members Dr. William Gough and Dr. Scott Prudham for helping me think in broader geographic and scientific realms. Their expertise has brought important dimensions to this research that complement the guidance of my supervisors.

Andrew Dialla, Pootoogoo Elee, Eric Joamie, and Theo Ikummaq acted as interpreters, guides, assistants, and – most importantly – teachers in Cape Dorset, Igloolik, and Pangnirtung, Nunavut. Their skills and dedication enabled the success of this project, and provide a strong foundation for future collaborations. I cannot thank them enough.

I am very grateful to all those who contributed to this thesis through interviews, focus groups, and sea ice trips. They provided the essence and foundation of the thesis, and I hope I have conveyed their words appropriately. From Cape Dorset, this includes: Kristiina Alariaq, Timmun Alariaq, Atsiaq Alasuaq, Etulu Etidlouie, Ashevak Ezekiel, Matthewsie Joanasié, Sandy Kelly, Mangitak Kellypalik, Eliyah Mangitak, Jimmy Manning, Oqutaq Mikigak, Adamie Nuna, Iqadluq Nunguisuituq, Oqsuralik Ottokie, Aleka Parr, Etidlouie Petaulassie, Qatsiya Petaulassie, Ningeoseak Peter, Paulassie Pootoogook, Mikisiti Saila, Kanayuk Solomonie, Simigak Suvega, and Quvianaqtuliaq Tapaungai. From Igloolik, this includes: Samuelie Ammaq, David Angutikjuaq, John Arnatsiaq, Maurice Arnatsiaq, David Aqiaruq, Zacharias Aqiaruq, Theo Ikummaq, Eugene Ipkanak, David Irngaut, Arsene Ivalu, Enuki Kunuk, Jaipiti Palluq, Nathan Qamaniq, Daniel Qattalik, Levi Qaunaq, Anthony Qrunnut, George Quviq Qulaut, Herve Paniaq, Augustine Taqqaugak, Abraham Ulayuruluk, and Louis Uttak. From Pangnirtung this includes: Joavee Alivaktuk, Levi Evic, Manasa Evic, Jaco Ishulutak, Lazarusie Isulutak, Michael Kisa, Mosese Keyuajuk, Joanasié Maniapik, Manasié Maniapik, Jamesie Mike, Enoosie Nashalik, Manasié Noah, Jackie Nowdlak, Lootie Nowyook, Mosese Nuvaqiq, Joeelee Papatsie, Joanasié Qappik, Peterosie Qappik, Joopa Soudluapik, and Paulosie Veevee. It was an honour to work with all of these people.

In each community, an amazing support network grew to facilitate the field research, as well as ongoing and future work. Generous hospitality was provided by Huit Huit Tours, Sherry McLean, Allashuwa Ottokie, and Cheryl and Mike Constantineau in Cape Dorset, the Co-op Hotel, Julie Ross and Chris Hotson in Igloolik, and Auyuittuq Lodge, Trevor and Susan Tetford, and Donald and Meeka Mearns in Pangnirtung. In addition to the Mayor and Hamlet Council in Cape Dorset, local support was provided by Tirak Parr, Art Stewart, Kelly Namunai, Rebecca Hutchings, Keith Wilson, Norman Lockear, and the Hunters and Trappers Association. In addition to the Mayor and Hamlet Council in Igloolik, local support was provided by John MacDonald, Leah Otak, Andre Uttak, Germaine Immaroitok, Rick Doucet, Joel Rose, Brian Kenney, Rebecca Mikki, Nick Arnatsiaq, Brian Fleming, and the Hunters and Trappers

Association. In addition to the Mayor and Hamlet Council in Pangnirtung, local support was provided by Marlene Angakak, Greg Morash, Sakiasie Sowdlooapik, Donald Mearns, Ed Arnott, Dave Goulding, Ooleepeeka Arnaqaq, Billy Eetooangat, Sheena Machmer, Tommy Papatsie, Ame Papatsie, and the Hunters and Trappers Association.

People working for various northern and Inuit organizations also provided invaluable feedback throughout the research, along with logistical support, including: Inuit Tapiriit Kanatami (Scot Nickels and Eric Loring), Nunavut Research Institute (Jamal Shirley, Rick Armstrong, and Mary-Ellen Thomas), Nunavut Arctic College (Susan Sammons), Inuit Heritage Trust (Lynn Peplinski), Nunavut Tunngavik Incorporated (Neida Gonzalez and Philippe Lavallée). Important consultations and collaborations with other academic and government institutions also contributed to the development of this project, including Guelph University (Barry Smit, James Ford, and Johanna Wandel), Ryerson University (Frank Duerden), Canadian Ice Service (Roger DeAbreu and Katherine Wilson), Cryosphere System in Canada, Meteorological Service of Canada Program (Ross Brown, Natasha Neumann, Barry Goodison, and Anne Walker), University of Manitoba (Fikret Berkes), Carleton University (Claudio Aporta), Université Laval (Christopher Furgal), and Harvard University (Shari Fox Gearheard).

At the University of Toronto, I am indebted to Byron Modolfsky and Jane Davie (Cartography Lab), Donna Jeynes and Marianne Ishibashi (Geography Office), Marcel Fortin (GIS Library), Richard Tychansky, Tarmo Remmel, and Hamish Asmath (Mississauga Geography), Bruce Huang and Don Boyes (Geography), and Marianne Douglas (Geology) for their academic and data processing assistance.

Funding for this research was generously provided by: Ocean Management Research Network, Northern Scientific Training Program, Northern Ecosystem Initiative, Cryosphere System in Canada, and ArcticNet Theme 4.2. Scholarships also provided support throughout the duration of this research, including: Ontario Graduate Scholarship, University of Toronto Fellowships, Social Sciences and Humanities Research Council of Canada Doctoral Fellowship, The Donald F. Putnam Graduate Scholarship, Association of Canadian Universities for Northern Studies Canadian Polar Commission Scholarship, Joseph A. May Scholarship, and Society of Women Geographers National Fellowship for Dissertation Research.

To my family and friends who have encouraged me throughout, thank you. I am so grateful to my parents, Chris Laidler and Gail Guy, for supporting me through my loftiest of goals and all related tribulations. To Mom and Garfield McFadyen, many thanks for listening to the ups and downs of the research process and providing helpful feedback. To my husband, Vladimir Ljubicic, I cannot thank you enough for your unwavering support, inspiration, and understanding. You continue to be my rock.

Table of Contents

<u>TITLE</u>	<u>PAGE</u>
Title page	i
Abstract	ii
Dedication	iv
Acknowledgements	v
Table of Contents	vii
List of Tables	xiii
List of Figures	xv
List of Appendices	xx
1. Introduction – Learning about sea ice, through Inuit eyes	1
1.1 Inuit, sea ice, and scientists	1
1.2 Global to local and back again, the politics of sea ice and climate change	2
1.3 Rationale	6
1.3.1 <u>Inuit Qaujimajatuqangit as a Nunavut priority</u>	7
1.3.2 <u>Addressing research gaps</u>	9
1.3.3 <u>Moving towards research partnerships</u>	10
1.4 Thesis statement	10
1.5 Thesis goals	10
1.6 Thesis objectives	11
1.7 Communities involved	11
1.8 Thesis outline	14
2. Literature Review – Inuit and scientific perspectives on sea ice, a starting point	18
2.1 Inuit and sea ice	20
2.1.1 <u>Inuit sea ice expertise</u>	20
2.1.2 <u>Inuit sea ice use</u>	23
2.1.3 <u>Inuit observations of sea ice/climate change</u>	26
2.2 Sea ice and climate	29
2.2.1 <u>Sea ice formation and decay</u>	30
2.2.1.1 <i>Freezing processes</i>	30
2.2.1.2 <i>Ice formation</i>	32
2.2.1.3 <i>Sea ice dynamics</i>	33
2.2.1.4 <i>Melting processes</i>	35
2.2.2 <u>Sea ice around Baffin Island</u>	36
2.3 Monitoring and modeling	40
2.3.1 <u>Monitoring sea ice variability and change</u>	40
2.3.2 <u>Modeling sea ice in climate scenarios</u>	41
2.4 Linking expertise	44
3. Methods – Undertaking cross-cultural, collaborative, community-based research	51
3.1 Collaborative research approach	51
3.1.1 <u>Research phases</u>	53
3.1.1.1 <i>Literature review and familiarization</i>	53
3.1.1.2 <i>Relationship-building</i>	55
3.1.1.3 <i>Preliminary community visits</i>	56

<u>TITLE</u>	<u>PAGE</u>
3.1.1.4 <i>Field work trips</i>	57
3.1.1.5 <i>Data collation</i>	57
3.1.1.6 <i>Analysis and conclusions</i>	57
3.1.1.7 <i>Reporting back and knowledge-sharing</i>	58
3.2 Philosophical underpinnings	58
3.3 Research methods	64
3.3.1 <u>Preliminary community visits</u>	65
3.3.1.1 <i>Cape Dorset</i>	67
3.3.1.2 <i>Igloolik</i>	67
3.3.1.3 <i>Pangnirtung</i>	69
3.3.2 <u>Field research trips</u>	70
3.3.2.1 <i>Semi-directed interviews</i>	71
3.3.2.1.1 Participant selection and numbers	71
3.3.2.1.2 Interview protocol	72
3.3.2.1.3 Participatory mapping	76
3.3.2.2 <i>Experiential sea ice trips</i>	79
3.3.2.3 <i>Focus groups</i>	80
3.3.3 <u>Data analysis</u>	83
3.3.3.1 <i>Transcript analysis</i>	83
3.3.3.1.1 Conceptual modeling	85
3.3.3.1.2 Explanation/synthesis	87
3.3.3.1.3 Community comparisons	87
3.3.3.2 <i>Map analysis</i>	88
3.3.3.3 <i>Focus groups and terminology review</i>	89
3.3.3.4 <i>Methodological analysis</i>	90
3.4 Communication Strategy	91
3.4.1 <u>Interim reports</u>	91
3.4.2 <u>Informal meetings</u>	91
3.4.3 <u>Radio shows</u>	92
3.4.4 <u>Posters</u>	92
3.4.5 <u>Information pamphlets</u>	92
3.4.6 <u>Results summary reports</u>	93
3.4.7 <u>Public meetings</u>	93
3.4.8 <u>Maps</u>	94
3.4.9 <u>Copies of audio/video tapes and transcripts</u>	94
3.4.10 <u>Website</u>	94
3.4.11 <u>Informal communication</u>	94
3.5 Knowledge representation	95
4. Results - The importance of sea ice processes, use, and change around Cape Dorset	97
4.1 Importance of sea ice	97
4.2 Sea Ice processes	99
4.2.1 <u>Freezing processes</u>	99
4.2.1.1 <i>Near shore freezing</i>	99
4.2.1.2 <i>Open water freezing</i>	102
4.2.1.3 <i>Sea ice thickening</i>	103

<u>TITLE</u>	<u>PAGE</u>
4.2.1.4 <i>Tidal cracks</i>	106
4.2.1.5 <i>Floe edge</i>	108
4.2.2 <u>Melting processes</u>	111
4.2.2.1 <i>Snowmelt</i>	111
4.2.2.2 <i>Water accumulation and drainage</i>	112
4.2.2.3 <i>Break-up</i>	114
4.2.2.4 <i>Cracks/leads</i>	114
4.2.3 <u>Wind and current influences on sea ice</u>	114
4.2.3.1 <i>Prevailing winds</i>	115
4.2.3.2 <i>Influence of wind on ice conditions or movement</i>	117
4.2.3.3 <i>Tidal cycles and currents</i>	118
4.2.3.4 <i>Current and tidal influence on ice conditions or movement</i>	120
4.3 <u>Sea ice use</u>	124
4.3.1 <u>Travel</u>	124
4.3.1.1 <i>Dangers in sea ice travel</i>	124
4.3.1.2 <i>Evaluating sea ice safety</i>	127
4.3.2 <u>Hunting</u>	134
4.3.2.1 <i>Conditions</i>	134
4.3.2.2 <i>Locations</i>	136
4.3.3 <u>Wildlife habitat</u>	136
4.4 <u>Observations of change</u>	141
4.4.1 <u>Floe edge</u>	142
4.4.2 <u>Weather</u>	144
4.4.3 <u>Timing of freeze-up</u>	145
4.4.4 <u>Timing of break-up</u>	147
4.4.5 <u>Ice thickness</u>	148
4.4.6 <u>Wildlife</u>	149
5. Results – The importance of sea ice processes, use, and change around Igloolik	151
5.1 <u>Importance of sea ice</u>	151
5.2 <u>Sea Ice processes</u>	153
5.2.1 <u>Freezing processes</u>	155
5.2.1.1 <i>Near shore freezing</i>	155
5.2.1.2 <i>Open water freezing</i>	155
5.2.1.3 <i>Sea ice thickening</i>	156
5.2.1.4 <i>Tidal cracks</i>	158
5.2.1.5 <i>Floe edge</i>	161
5.2.1.6 <i>Moving ice</i>	163
5.2.2 <u>Melting processes</u>	167
5.2.2.1 <i>Snowmelt</i>	167
5.2.2.2 <i>Water accumulation and drainage</i>	169
5.2.2.3 <i>Break-up</i>	171
5.2.3 <u>Wind and current influences on sea ice</u>	171
5.2.3.1 <i>Prevailing winds</i>	171
5.2.3.2 <i>Influence of wind on ice conditions or movement</i>	172
5.2.3.3 <i>Tidal cycles and currents</i>	176

<u>TITLE</u>	<u>PAGE</u>
5.2.3.4 <i>Current and tidal influence on ice conditions or movement</i>	178
5.3 Sea ice use	183
5.3.1 <u>Travel</u>	183
5.3.1.1 <i>Dangers in sea ice travel</i>	183
5.3.1.2 <i>Evaluating sea ice safety</i>	190
5.3.2 <u>Hunting</u>	197
5.3.2.1 <i>Conditions</i>	198
5.3.3 <u>Wildlife habitat</u>	201
5.4 Observations of change	207
5.4.1 <u>Floe edge</u>	208
5.4.2 <u>Weather</u>	209
5.4.3 <u>Timing of freeze-up</u>	211
5.4.4 <u>Timing of break-up</u>	213
5.4.5 <u>Ice thickness</u>	214
5.4.6 <u>Wildlife</u>	214
5.4.7 <u>Moving ice</u>	216
6. Results – The importance of sea ice processes, use, and change around Pangnirtung	217
6.1 Importance of sea ice	217
6.2 Sea Ice processes	218
6.2.1 <u>Freezing processes</u>	219
6.2.1.1 <i>Near shore freezing</i>	219
6.2.1.2 <i>Open water freezing</i>	221
6.2.1.3 <i>Sea ice thickening</i>	222
6.2.1.4 <i>Tidal cracks</i>	224
6.2.1.5 <i>Floe edge</i>	226
6.2.2 <u>Melting processes</u>	227
6.2.2.1 <i>Snowmelt</i>	227
6.2.2.2 <i>Water accumulation and drainage</i>	229
6.2.2.3 <i>Break-up</i>	230
6.2.3 <u>Wind and current influences on sea ice</u>	231
6.2.3.1 <i>Prevailing winds</i>	231
6.2.3.2 <i>Influence of wind on ice conditions or movement</i>	232
6.2.3.3 <i>Tidal cycles and currents</i>	236
6.2.3.4 <i>Current and tidal influence on ice conditions or movement</i>	238
6.3 Sea ice use	242
6.3.1 <u>Travel</u>	242
6.3.1.1 <i>Dangers in sea ice travel</i>	243
6.3.1.2 <i>Evaluating sea ice safety</i>	247
6.3.2 <u>Hunting</u>	257
6.3.2.1 <i>Conditions</i>	258
6.3.3 <u>Wildlife habitat</u>	262
6.4 Observations of change	266
6.4.1 <u>Floe edge</u>	266
6.4.2 <u>Weather</u>	269
6.4.3 <u>Timing of freeze-up</u>	271

<u>TITLE</u>	<u>PAGE</u>
6.4.4 <u>Timing of break-up</u>	271
6.4.5 <u>Ice thickness</u>	273
6.4.6 <u>Wildlife</u>	274
6.4.7 <u>Multi-year ice</u>	275
7. Analysis – Inter-community comparison of sea ice processes, use, and change	277
7.1 Importance of sea ice	277
7.2 Sea ice processes	278
7.2.1 <u>Freezing processes</u>	279
7.2.1.1 <i>Near shore freezing</i>	279
7.2.1.2 <i>Open water freezing</i>	280
7.2.1.3 <i>Sea ice thickening</i>	282
7.2.1.4 <i>Tidal cracks</i>	283
7.2.1.5 <i>Floe edge</i>	284
7.2.1.6 <i>Moving/multi-year ice</i>	285
7.2.2 <u>Melting processes</u>	287
7.2.2.1 <i>Snowmelt</i>	287
7.2.2.2 <i>Water accumulation and drainage</i>	288
7.2.2.3 <i>Break-up</i>	290
7.2.3 <u>Wind and current influences on sea ice</u>	290
7.2.3.1 <i>Prevailing winds</i>	290
7.2.3.2 <i>Influences of winds on sea ice</i>	292
7.2.3.3 <i>Tidal cycles</i>	293
7.2.3.4 <i>Current and tidal influences on ice conditions or movement</i>	293
7.3 Sea ice use	296
7.3.1 <u>Sea ice travel</u>	296
7.3.1.1 <i>Dangers in sea ice travel</i>	297
7.3.1.2 <i>Evaluating ice safety</i>	301
7.3.1.3 <i>Hunting in each community</i>	303
7.4 Observations of change	306
7.4.1 <u>Indicators of change</u>	306
7.4.2 <u>Implications of change</u>	311
7.4.2.1 <i>Floe edge</i>	312
7.4.2.2 <i>Weather</i>	313
7.4.2.3 <i>Freeze-up timing</i>	314
7.4.2.4 <i>Break-up timing</i>	315
7.4.2.5 <i>Ice thickness</i>	316
7.4.2.6 <i>Moving/multi-year ice</i>	317
7.4.2.7 <i>Subsistence and commercial harvesting</i>	318
7.4.3 Considerations for assessments of change	321
8. Analysis – Linking Inuit and scientific sea ice expertise	326
8.1 Evaluation of collaborative research approach	326
8.1.1 <u>Preliminary community visits</u>	326
8.1.2 <u>Semi-directed interviews</u>	329
8.1.3 <u>Participatory mapping</u>	333
8.1.4 <u>Experiential sea ice trips</u>	337

<u>TITLE</u>	<u>PAGE</u>
8.1.5 <u>Focus groups</u>	339
8.1.6 <u>Communication strategy</u>	341
8.2 Community perspectives on working with researchers	348
8.2.1 <u>Previous community experiences with researchers</u>	349
8.2.2 <u>Life experiences</u>	350
8.2.3 <u>Methods of sea ice investigation and knowledge acquisition</u>	355
8.2.4 <u>Goals in investigating or using sea ice</u>	358
8.3 Linking Inuit and scientific expertise	363
8.3.1 <u>Overcoming skepticism and misunderstandings</u>	363
8.3.2 <u>Local concerns with collaboration</u>	364
8.3.3 <u>Effective communication</u>	367
8.3.3.1 <i>The role of the interpreter</i>	367
8.3.3.2 <i>Concepts in Inuktitut</i>	368
8.3.3.3 <i>Sea ice terminology</i>	369
8.3.3.4 <i>Visual aids in communication</i>	370
8.3.3.5 <i>Multiple components to a communication strategy</i>	371
8.3.3.6 <i>Communicating to a broader audience</i>	372
8.3.4 <u>Appropriate topics</u>	373
8.3.5 <u>Rigorous research</u>	376
8.3.6 <u>A long-term process</u>	378
9. Conclusions - Moving forward	382
9.1 The importance of sea ice processes, use, and change	382
9.2 The relevance of sea ice to human and animal activity	384
9.3 Collaborative research	385
9.3.1 <u>Working together</u>	385
9.3.2 <u>Linking Inuit and scientific expertise</u>	387
9.4 Future research directions	388
9.5 Community vulnerability or resilience?	390
Bibliography	393

List of Tables

<u>TITLE</u>	<u>PAGE</u>
Table 1-1: Guiding principles of <i>Inuit Qaujimagatuqangit</i> .	8
Table 2-1: Summary of observed sea ice changes, and related implications, from communities around the Baffin Island region.	28
Table 2-2: Polynya types and descriptions.	34
Table 3-1: Summary of participatory methods employed in northern research involving Inuit communities.	66
Table 3-2: Outline of research visit timing, and duration, in each community.	66
Table 3-3: Summary of map sheets used in interviews in each community.	77
Table 3-4: Overview of experiential sea ice trips undertaken in each community, whereby the research trip # refers to the research trip numbers and dates outlined in Table 3-2.	79
Table 3-5: Outline of focus groups participants, timing, and location in Cape Dorset and Pangnirtung, whereby the research trip # refers to the research trip numbers and dates outlined in Table 3-2.	82
Table 4-1: Summary of predominant directional and seasonal winds around Cape Dorset, and their related influences on sea ice.	115
Table 4-2: Summary of sea ice-related exposure and associated risks for community members in Cape Dorset, including some methods of minimizing these risks.	125
Table 4-3: Summary of observed indicators and associated changes around Cape Dorset. The number of observations refers to the number of interviewees that mentioned this change.	143
Table 5-1: Summary of predominant directional and seasonal winds around Igloolik, and their related influences on sea ice.	172
Table 5-2: Summary of sea ice-related exposure and associated risks for community members in Igloolik, including some methods of minimizing these risks.	184
Table 5-3: Summary of observed indicators and associated changes around Igloolik. The number of observations refers to the number of interviewees that mentioned this change.	208
Table 6-1: Summary of predominant directional and seasonal winds around Pangnirtung, and their related influences on sea ice.	232
Table 6-2: Summary of sea ice-related exposure and associated risks for community members in Pangnirtung, including some methods of minimizing these risks.	244
Table 6-3: Summary of observed indicators and associated changes around Pangnirtung. The number of observations refers to the number of interviewees that mentioned this change.	267

<u>TITLE</u>	<u>PAGE</u>
Table 7-1: Comparison of Inuktitut terms related to sea ice freezing stages, in each community.	281
Table 7-2: Comparison of Inuktitut terms related to tidal cracks, in each community.	284
Table 7-3: Comparison of Inuktitut terms related to the floe edge, in each community.	285
Table 7-4: Comparison of Inuktitut terms related to moving or multi-year ice, in each community.	286
Table 7-5: Comparison of Inuktitut terms related to sea ice melting stages, in each community.	289
Table 7-6: Comparison of Inuktitut terms related to the influences of winds on sea ice, in each community.	292
Table 7-7: Comparison of Inuktitut terms related to the influences of currents on sea ice, in each community.	295
Table 7-8: Summary of ice conditions used for different types of marine mammal hunting, in each community.	304
Table 8-1: Summary of the strengths and weaknesses of various communication methods used in the overall communication strategy.	343
Table 8-2: Overlapping Inuktitut and scientific terminology for sea ice (based on the closest approximations of meaning).	370

List of Figures

TITLE	PAGE
Figure 1-1: Map showing the location of communities involved in this research project.	12
Figure 2-1: Map of Inuit regions and communities in Canada.	19
Figure 2-2: Scientific characterization of sea ice formation, decay, and dynamic processes.	31
Figure 3-1: Overview of the collaborative research approach, employed in this project, including the various research phases and the general timeline of research.	54
Figure 3-2: Preliminary community visit to Cape Dorset.	68
Figure 3-3: Preliminary community visit to Igloolik.	68
Figure 3-4: Preliminary community visit to Pangnirtung.	69
Figure 3-5: The number of people interviewed, and the total number of interviews conducted, in each community.	72
Figure 3-6: The interview setup in Cape Dorset (a), Igloolik (b), and Pangnirtung (c).	74
Figure 3-7: Garmin GPSMap 60C was used to track the sea ice routes traveled throughout all research trips (left). In order to maintain effective AA battery life the GPS was kept inside my parka for warmth, and an external antenna was attached to the top of my hood (right) to ensure clear reception.	80
Figure 3-8: Focus groups held in Cape Dorset (a, b) and Pangnirtung (c, d).	81
Figure 4-1: Conceptual diagram of freeze-thaw processes, interactions, and terminology based on interviews conducted in Cape Dorset.	100
Figure 4-2: Photos of early near-shore freezing, including: <i>qinnu</i> (a), <i>kuiviniq</i> (b), <i>sijja</i> (c), and <i>sikuliaq</i> (d).	101
Figure 4-3: The freezing process, gradually extending away from shore, November 23, 2004, Cape Dorset.	102
Figure 4-4: Photos of sea ice thickening, including: <i>sikuaq</i> (a) and <i>nigajutaq</i> (b).	103
Figure 4-5: Photos of <i>qanguti</i> on the ice surface (a), and close up (b).	104
Figure 4-6: Photos of ice that is becoming landfast, including: <i>sikujuq</i> (a) and <i>tuvaq</i> (b).	105
Figure 4-7: Photos of different types of tidal cracks, including: <i>nagguti</i> (a), <i>ajuraq</i> (c), and <i>qullupiarniq</i> (c).	107
Figure 4-8: Key <i>naggutiit</i> (plural for <i>nagguti</i>) in the Cape Dorset area.	107
Figure 4-9: Photos of the floe edge, and ice formations/dynamics along the floe edge, including: <i>sinaaq</i> (a, b), <i>uiguuq</i> (c), and <i>uqaqtuq</i> (d).	109
Figure 4-10: Maps showing the approximate location of the <i>sinaaq</i> around Andrew Gordon Bay (a) and Cape Dorset (b).	110
Figure 4-11: Key <i>aukaaniit</i> around the Cape Dorset area. These areas wear out earlier than others in the melt process, and can thus be dangerous to travel near or around.	112
Figure 4-12: Photos of early melt processes, including: <i>immatinniit</i> (a), <i>qalluit</i> (b), and <i>qillait</i> (c).	113

<u>TITLE</u>	<u>PAGE</u>
Figure 4-13: Conceptual model of the influences of winds on sea ice formation, movement, or decay based on interviews conducted in Cape Dorset.	116
Figure 4-14: Conceptual model depicting the influences of currents and tides on sea ice formation, movement, or decay based on interviews conducted in Cape Dorset.	119
Figure 4-15: Maps showing prominent <i>saqvait</i> around Chorkbak Inlet (a) and Cape Dorset (b).	121
Figure 4-16: Maps of common travel routes near Cape Dorset (a) and Andrew Gordon Bay (b).	128
Figure 4-17: Atsiaoq Alasuaq uses his harpoon to test the <i>uiguaq</i> at the <i>sinaaq</i> . It is the most important tool to ensure that the ice is thick and stable enough to support travel (either on foot or by snowmobile).	130
Figure 4-18: Snowmobiles (left) are now the most common method of sea ice travel, but many elders expressed that they felt safer when they used to travel with dog teams (right).	133
Figure 4-19: Hunters wait and watch for seals at a <i>saqvaq</i> nearby Cape Dorset (left). Boats are often used to retrieve seals from open water (right).	135
Figure 4-20: Maps showing common seal hunting areas around Cape Dorset (a) and Andrew Gordon Bay (b).	137
Figure 4-21: Maps showing common walrus hunting areas around Salisbury Island (a) and Cape Dorset (b).	138
Figure 4-22: Summary of the timeframes used in interviews when discussing observations of sea ice change.	142
Figure 4-23: Delineation of the changes observed in <i>sinaaq</i> location over the past ten years.	143
Figure 4-24: Summary of the changes in freeze-up and break-up timing observed in Cape Dorset.	146
Figure 4-25: Atsiaoq Alasuaq checks his seal net in a <i>nagguti</i> . This is one way that hunters are always aware of, and evaluating, ice thickness.	148
Figure 5-1: Conceptual diagram of freeze-thaw processes, interactions, and terminology based on interviews conducted in Igloolik.	154
Figure 5-2: Photos of early open water freezing and sea ice thickening, including: <i>qinu</i> (a), <i>sikuaq</i> (b), <i>nigajutaq</i> (c), and <i>nigajutaviniq</i> (d).	156
Figure 5-3: Photos of <i>niuma</i> (a) and <i>niumakjuaq</i> (b) on the ice surface.	157
Figure 5-4: Photos of ice that has become landfast (i.e. <i>tuvaq</i>) (a) and has snow accumulation (i.e. <i>apulliq</i>) (b).	159
Figure 5-5: Photos of different types of tidal cracks, including: <i>nagutti</i> (a), <i>quglukniq</i> (b), and <i>aajuraq</i> (c).	160
Figure 5-6: Map showing different crack formations, including <i>naguttiit</i> , <i>qugluknniit</i> , <i>napakkutiit</i> , and <i>quppirniit</i> .	160
Figure 5-7: Photos showing a fall (a) and spring (b) floe edge.	162
Figure 5-8: Maps showing floe edge variations (a) and approximate position of key reefs (b).	164
Figure 5-9: Map (a) and photos (b, c) depicting the position and views of <i>Agiuppiniq</i> .	165
Figure 5-10: Photos showing 'dirty' (a) and 'clean' (b) <i>sikutaq</i> .	166

<u>TITLE</u>	<u>PAGE</u>
Figure 5-11: Photos of snowmelt conditions on the surface of the sea ice, including: <i>nilaruqtuq</i> (a) and <i>ijaruvaujat</i> (b).	168
Figure 5-12: Photos of water accumulation and drainage, beginning with <i>immaktinniit</i> (a) and <i>puktailaq</i> (b) and leading to water accumulation (c) before the formation of <i>killait</i> (d).	170
Figure 5-13: Conceptual model of the influences of winds on sea ice formation, movement, or decay based on interviews conducted in Igloolik.	173
Figure 5-14: Conceptual model depicting the influences of currents and tides on sea ice formation, movement, or decay based on interviews conducted in Igloolik.	177
Figure 5-15: Map showing key <i>aukkarniit</i> around Igloolik and within <i>Ikiq</i> .	179
Figure 5-16: Photos showing various aspects of the <i>aukkarniq Aukarnarjuq</i> , from afar (a), up close (b), the process of <i>ukpittuq</i> (c), and the <i>kaniq</i> (d).	180
Figure 5-17: Photos showing how rough ice can lead dangerous travel when snow accumulates and thins the ice underneath (a), or when currents are funneled under the ice (b).	188
Figure 5-18: Areas that wear out early in the spring (<i>aukkarniit</i>), usually found near polynyas or narrow areas where the currents are strongest.	189
Figure 5-19: Areas along the shoreline can wear out earlier due to the heat from the land and potential freshwater influence from runoff or rivers; where they start breaking up can make it challenging to cross from ice to land.	189
Figure 5-20: Photos showing that overlapping sea ice is safer (a), and the extensive use of sea ice around Igloolik makes it hard to delineate particular routes (b).	193
Figure 5-21: Photos showing the use of a harpoon to test the ice for safety (a), and that when unsure, the ice should not be driven on (b) and should be tested constantly.	194
Figure 5-22: Photos showing seal breathing hole hunting (a), as well as a ringed seal (b), bearded seal (c) and walrus (d) breathing holes.	199
Figure 5-23: Summary of the timeframes used in interviews when discussing observations of sea ice change.	207
Figure 5-24: Summary of the changes in freeze-up and break-up timing observed in Igloolik.	212
Figure 6-1: Conceptual diagram of freeze-thaw processes, interactions, and terminology based on interviews conducted in Pangnirtung.	220
Figure 6-2: Photos of near-shore freezing conditions, including: <i>qainngu</i> (a) and <i>sijja</i> (b).	221
Figure 6-3: Photos of open water freezing conditions, including: <i>qinnuaq</i> (a) and <i>sikuaq</i> (b).	222
Figure 6-4: Photos of various stages of sea ice thickening, including: <i>sikurataaq</i> (a), <i>qanngut</i> (b), <i>nigajutaq</i> (c), and <i>tuvaq</i> (d).	223
Figure 6-5: Photos of different types of tidal cracks, including: <i>nuttaq</i> (a), <i>nagguti</i> (b), and <i>aajuraq</i> (c).	225
Figure 6-6: The location of various tidal cracks in Cumberland Sound.	225
Figure 6-7: Spring <i>sinaaq</i> at the mouth of Pangnirtung Fiord in May, 2004.	226
Figure 6-8: Variations in the position of the <i>sinaaq</i> in Cumberland Sound.	227

<u>TITLE</u>	<u>PAGE</u>
Figure 6-9: Map showing the location of various <i>aukkaturliit</i> that open up earlier than other areas in the spring time.	228
Figure 6-10: Photos of water accumulation on the sea ice, including: <i>ikiartirtuq</i> (a) and <i>puttaijuq</i> (b).	229
Figure 6-11: Conceptual model of the influences of winds on sea ice formation, movement, or decay based on interviews conducted in Pangnirtung.	233
Figure 6-12: Conceptual model depicting the influences of currents and tides on sea ice formation, movement, or decay based on interviews conducted in Pangnirtung.	237
Figure 6-13: Key <i>saqvait</i> located around Cumberland Sound.	239
Figure 6-14: Common travel routes used around Pangnirtung, and in Cumberland Sound.	249
Figure 6-15: <i>Qainngu</i> is often used to access Cumberland Sound in the spring once the ice has broken up, and the mouth of Pangnirtung Fiord is open. Shown here, this ‘ice ledge’ near the mouth of Pangnirtung Fiord was still travelable on May 24, 2004 when Cumberland Sound was open water.	249
Figure 6-16: Joavee Alivaktuk testing the consistency and thickness of the ice with a harpoon in December, 2004.	251
Figure 6-17: Joanasie Maniapik with his snowmobile and hunting gear. The small boat on top of the <i>kamotik</i> is useful for seal retrieval but also for safety purposes should his machine go through the ice. It also holds other safety and emergency gear inside.	255
Figure 6-18: Dog teams used to be the main means of winter transportation, now they are not commonly used, and tend to be maintained for tourism or sport hunting purposes.	255
Figure 6-19: A glimpse of a polar bear in Pangnirtung Fiord during a sea ice trip on May 24, 2004.	260
Figure 6-20: An example of hauling up the long line used for turbot fishing in Cumberland Sound.	260
Figure 6-21: Overview of some key fishing areas in Cumberland Sound.	261
Figure 6-22: Summary of the timeframes used in interviews when discussing observations of sea ice change.	267
Figure 6-23: Delineation of the changes observed in <i>sinaaq</i> location over the past twenty years.	268
Figure 6-24: Summary of the changes in freeze-up and break-up timing observed in Pangnirtung.	272
Figure 7-1: Matrices of Inuktitut terminology showing the number of unique and overlapping sea ice terms for freezing processes, in each community.	280
Figure 7-2: Matrix of Inuktitut terminology showing the number of unique and overlapping sea ice terms for tidal cracks, in each community.	283
Figure 7-3: Matrix of Inuktitut terminology showing the number of unique and overlapping sea ice terms for floe edge, and related dynamics, in each community.	284
Figure 7-4: Matrix of Inuktitut terminology showing the number of unique and overlapping sea ice terms for moving or multi-year ice, around each community.	286

<u>TITLE</u>	<u>PAGE</u>
Figure 7-5: Matrices of Inuktitut terminology showing the number of unique and overlapping sea ice terms for melting processes, in each community.	288
Figure 7-6: Matrix of Inuktitut terminology showing the number of unique and overlapping terms related to the influence of winds on sea ice, in each community.	291
Figure 7-7: Matrix of Inuktitut terminology showing the number of unique and overlapping terms related to the influence of currents and tides on sea ice, in each community.	294
Figure 7-8: Summary of sea ice and related changes observed in each community.	307
Figure 7-9: Summary of observed freeze-up and break-up timing changes, in each community.	309
Figure 8-1: The number of people previously involved, or not, in research in their communities.	350
Figure 8-2: The number of people who have seen, or used, satellite imagery of ice conditions.	356

List of Appendices

<u>TITLE</u>	<u>PAGE</u>
Appendix 1: Common, scientific, and Inuktitut names for wildlife species	413
Appendix 2: Glossary of scientific sea ice terminology	414
Appendix 3: Map sheets covering the Cape Dorset area	416
Appendix 4: Map sheets covering the Igloolik area	417
Appendix 5: Map sheets covering the Pangnirtung area	418
Appendix 6: Preliminary community visit summary – Cape Dorset	419
Appendix 7: Preliminary community visit summary – Igloolik	421
Appendix 8: Preliminary community visit summary – Pangnirtung	423
Appendix 9: Interview participants in each community	425
Appendix 10: Semi-directed interview guide	428
Appendix 11: Information pamphlet	433
Appendix 12: Consent form	435
Appendix 13: Satellite imagery used in interviews	436
Appendix 14: Cape Dorset Inuktitut Terminology	443
Appendix 15: Igloolik Inuktitut Terminology	452
Appendix 16: Pangnirtung Inuktitut Terminology	462
Appendix 17: Compilation of interim research reports for each community	471
Appendix 18: <i>Sinaaq</i> (floe edge) approximation in the Cape Dorset area	486
Appendix 19: Travel routes in the Cape Dorset area	487