

UNIVERSITY OF MANITOBA

Two Centuries of River Ice Dates
in Hudson Bay Region from
Historical Sources

by Mary A. Magne

A Thesis Submitted to the Faculty of Graduate
Studies in Partial Fulfillment of the Requirements
for the Degree of Master of Arts.

Department of Geography
Winnipeg, Manitoba

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MASTER OF ARTS

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ABSTRACT

This study established annual dates of breaking and freezing of river ice, at selected locations on Hudson Bay for the 18th, 19th and 20th Centuries. Although analogous in many respects to an earlier study undertaken in this field by Moodie and Catchpole, this thesis was innovative in that it derived dates for the Eastmain and Severn estuaries, extended the Albany record into the 20th Century, and combined dates from individual estuaries to obtain mean dates representative of the James Bay region.

The source material consisted of post journals kept by the Hudson's Bay Company during its period of occupation in North America. The method used to extract these dates is termed content analysis. Content analysis enables the extraction of numerical data from a written, spoken, or an artistic medium using the principles of the scientific method.

The unscientific nature with which the post journals were written necessitated establishing not only the reliability of the method but also the validity of the resultant dates. In this respect it was found that content analysis was a reliable method of deriving breaking and freezing dates and that the obtained dates were as valid as those previously obtained from post journals and modern records.

Finally, the dates of breaking and freezing derived by this study provided one of the longest historical records of climatically controlled phenomena in North America.

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This thesis is dedicated to my parents, Ines and Joseph in recognition of a lifetime of support and encouragement.

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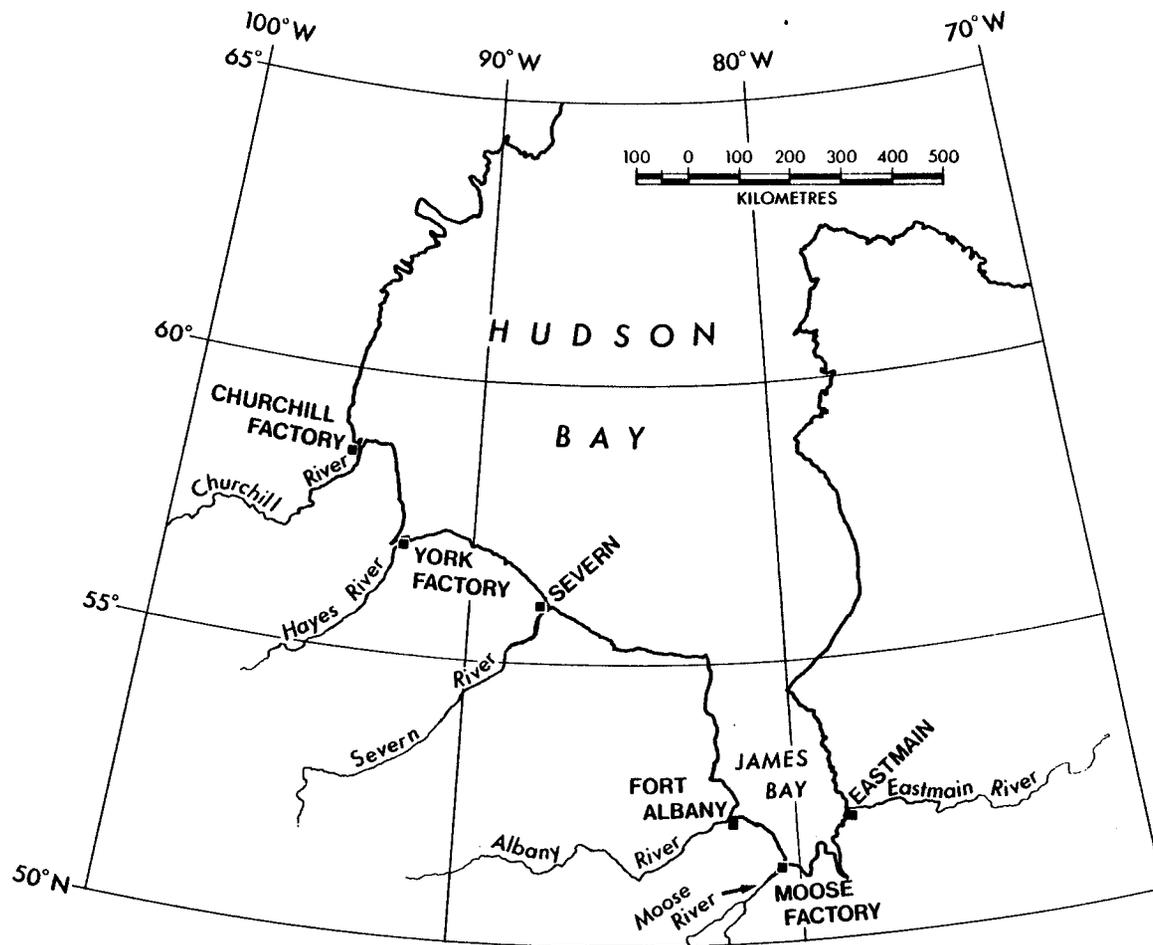
CHAPTER I

INTRODUCTION

The objective of this thesis is to establish annual dates of breaking and freezing of river ice, at selected locations on Hudson Bay for the 18th, 19th and 20th Centuries. The dates are derived from the post journals of the Hudson's Bay Company kept at the trading posts on the estuaries of the Eastmain, Severn and Albany Rivers (Figure 1.1).

Historical sources of climatic data are of substantial general significance. The lack of long-term instrumental records in many parts of North America necessitates examination of indirect evidence to supply information about past climates. The development and disintegration of ice cover on rivers and lakes are precursors of winter and spring and reflect the integrated effects of thermal climatic elements. The dates of breaking and freezing presently being examined thus have a potential for use as indicators of general climatic variations in the past 250 years.

This thesis comprises an expansion in time and space of an earlier study (Moodie and Catchpole, 1975) in which annual dates of breaking and freezing of the estuaries of the Albany, Churchill, Hayes and Moose Rivers were reconstructed from Hudson's Bay Company records. Moodie and Catchpole (1975) had limited access to the journals during the



LOCATION OF STUDY SITES

Figure 1.1

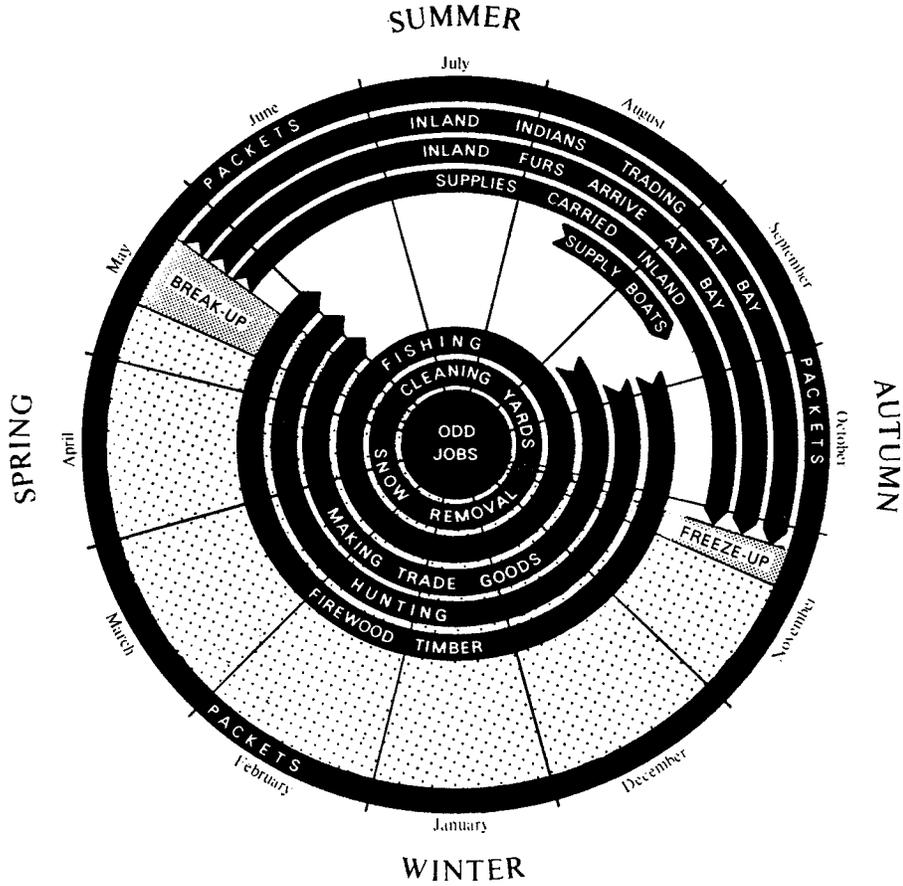
course of their study, since post 1871 records could not be consulted at that time. Recent changes in the archival policies of the Company enabled this study to extend the dates for Fort Albany into the 20th Century. The present study is innovative in that it also derives dates for the Eastmain and Severn estuaries, and in that it combines the dates from individual estuaries to obtain mean dates representative of the James Bay Region. The 250 years record of regional means from the James Bay Region is unique, in terms of its length and continuity, in North American climatic studies.

The utility of an historical source as evidence of climatic change is dependent on its scope in time and space and also upon its sensitivity to climatic stimuli. There exist many types of environmental evidence, but their reliability as climatic indicators is dependent upon their ability to be direct, precise, and accurate. The written historical evidence contrasts with many types of environmental evidence in its ability to discriminate between years, months and even days. In so doing, it is capable of giving a comparatively detailed picture of climatic change as opposed to the crude resolution of almost all environmental evidence.

Documentary records kept at daily intervals are capable of yielding information comparable to instrumental observations. The Climatic Research Unit, University of East Anglia (1977) notes: "Historical data are invariably more precisely dated than proxy environmental data; and the meteorological and climatological information obtained from historical sources are generally more direct and precise than those from proxy sources. Where it is available historical data provides the skeleton for the flesh of proxy material" (Climatic Research Unit, 1977, p. 4-5).

The daily records kept at the Hudson's Bay Company posts during the settlement period in Canada provide such a source of evidence. The terms of the founding charter, established in 1670 and maintained until the sale of the land to the Dominion of Canada in 1870, gave the Company sovereign power over the vast area of Rupert's Land and trade monopoly over Hudson Strait. The territorial organization of the Company was reflected in its record keeping, thus the day-to-day records of the individual trading posts provide an important information base for geographical investigation (Moodie, 1977). The journals were not written with scientific objectivity and systematization, but they do contain frequent descriptions and references to environmental phenomena. Since water travel was fundamental to the life and economy of the fur traders, their journals are highly descriptive of the processes of break-up and freeze-up. The breaking of the river marked the beginning of the trading season and the arrival of provisions. Freeze-up was the closing of the season, when trading parties should have reached home, and the posts made ready for winter's onslaught (Figure 1.2; Richard Ruggles, 1971).

When efforts are made to extract scientific information from written historical sources, a major problem is the highly subjective nature of the records. The Hudson's Bay Company post journals may abound with descriptions of freeze-up and break-up, but they are written with all the biases of untrained diarists. If derived data are not to reflect these biases, some means must be developed whereby the data are arrived at objectively and the reliability of the method and validity of the resultant dates can be tested.



SEASONAL ACTIVITIES AT HUDSON'S BAY COMPANY POSTS
(RUGGLES, 1971)

Figure 1.2

The general method devised to alleviate these problems of interpreting written accounts is termed content analysis. Basically, content analysis involves a systematic search for information in written documents, conducted using the principles of the Scientific Method. Content analysis endeavours to yield quantitative data from qualitative sources. The method of content analysis used in this thesis is essentially the same as that employed by Moodie and Catchpole (1975), though it has been adapted to the special geographical circumstances encountered at Severn and Eastmain.

The structure of this thesis is as follows. Chapter II will consider the general nature of historical evidence of climatic change, and of the sources utilized. Chapter III examines the methodology by which the data are derived and tested. Chapter IV presents the results, and the summary and conclusions are given in Chapter V.

CHAPTER II

HISTORICAL EVIDENCE OF CLIMATIC CHANGE

The ultimate objective of this chapter is to identify the sources of the data derived in this research. These sources comprise historical documents and are, therefore, a type of evidence of climatic change which has not been extensively used in North America. It is appropriate, therefore, to commence with a discussion of the general nature of historical evidence of climatic change.

2.1 Role of Historical Evidence in Pre-Instrumental Period

Standardized meteorological observations only cover a short time span and, as a result, the more long-term climatic fluctuations and trends have not been measured directly. If the time scale is lengthened to include earlier centuries, the direct instrumental record does not exist. Thus in North America and Europe the emergence of standardized observations commenced in the mid and late 19th Century, and a global network of observations was established only in the 20th Century.

Non-standardized weather observations using obsolete instruments, exposures and methods were made much earlier in parts of Western Europe but the oldest continuous sequences of these data extend back only to the late 17th Century (Manley, 1959). These unstandardized observations have been adjusted to correct for variations in instrument design,

type of exposure, etc. and have been reduced to continuous sequences of homogeneous monthly means of temperature and rainfall, extending over 250 years in various parts of Western Europe. To the modern meteorologist these records of mean temperatures and rainfall amounts may appear to be remarkably long, but to the climatologist studying climatic change, they are brief, encompassing but a small fraction of the climatic changes that occurred since the retreat of the ice sheet and since man's colonization of this planet.

Research into past climates serves not only to elucidate the past, but also to provide a base against which models and theories of future changes can be tested. This data base may also provide insights into the variability, recurrence interval and periodicity of modern climatic fluctuations. Consequently, there is a pressing need for evidence of climatic changes in the pre-instrumental period.

2.2 Indirect Evidence from Pre-Instrumental Period

Two types of data sources exist to extend the record of climate into the pre-instrumental period:

- i. Historical sources comprising written records and qualitative descriptions of weather and of physical, cultural and economic factors that respond to weather;
- ii. Proxy sources comprising various natural indicators of weather and climate.

Historical data from journals, manuscripts, and other documents can provide information on the character of the climate during the historical past (Lamb, 1963, 1967, 1968, 1976*; Le Roy Ladurie, 1971; Catchpole and Moodie, 1978). Although comparable in many respects to proxy data, the ability of historical sources to be more direct and

specific enables them to be superior in quality. Le Roy Ladurie emphasizes this by noting, "In the 'short-term' chronology such as is involved in the study of one century...the usual methods of palaeoclimatology, based on the very long term and even geological time, are inadequate. Finely graded observations and annual series are needed. But most of these are derived from archives and thus are in the historian's province." (Le Roy Ladurie, 1971, p. 269).

Practically all types of written sources have been used to derive information about past climates and this usage is by no means restricted to the factual accounts which might, at first sight be expected to be alone capable of yielding information. Imaginative and effective use has been made of ancient fictional sources, such as Chinese poetry written during the early dynasties (Chu K'O-Chen, 1976). Even more modern fiction has been used for a similar purpose, and inferences about weather and climate have been drawn from Shakespeare's plays and Dicken's novels (Lamb, 1972).

However, the historical evidence that has provided the greatest wealth of information comprises a miscellany of factual sources in which are recorded descriptions of weather phenomena or of environmental, economic or cultural phenomena which are influenced by weather and which, through their variations may provide direct evidence of climatic variation.

Perhaps the oldest factual historical sources are available in China. Chu K'O-Chen (1976) has shown that Chinese phenological records encompassing several centuries can be derived from these sources, including dates of snowfall, first appearance of frost, freezing of rivers, blossoming of trees and flowers and the migration of birds,

Fujiwhara (1921) using Buddhist documents maintained at the Suwa

Temple obtained freeze-up dates for Lake Suwa as far back as the 15th Century. He used these data to relate freeze-up to the tertiary variation of solar harmonic activity. Arakawa (1954) using the same data was able to deduce secular climatic changes. Arakawa (1954) derived dates of first or earliest snow covering of Edo (now Tokyo) from historical sources written during the Tokugawa period (1603-1868) and compared these data with the dates obtained from the Central Meteorological Observatory Tokyo (1876-77 to 1954-55).

To obtain an indication of climatic change in the Northern Hemisphere for the last 1000 years, Lamb (1968) has used European manuscript sources to derive indices of winter severity and summer wetness during the past millenium.

2.3 The Hudson's Bay Company Archives as Historical Sources

The European colonization of Canada occurred within the past three centuries and there is therefore a severe temporal limitation to historical evidence in this country, and in North America as a whole. Notwithstanding this limitation, Canada is endowed with an historical source which promises to serve as a valuable repository of information on climatic conditions during the past 250 years. This is the collection of papers in the Hudson's Bay Company Archives (Catchpole and Moodie, 1978) and in view of their importance, it is appropriate to present a general historical background of these archives.

Incorporated in 1670, the Hudson's Bay Company was the longest lived of the chartered joint stock companies. The terms of the founding charter, which remained unchanged until the sale of the land to the Dominion of Canada (1870), gave the Company trade monopoly and sovereign

power over Hudson Strait, and any territory discovered in trading through that strait. During the first two centuries, the Company ruled over Rupert's Land and adjacent territories. By the mid 1800's, the Company's trading area encompassed almost all of mainland Canada and in the west stretched from the Arctic Circle to San Francisco Bay.

The attention of the Company was primarily focused on the fur trade. Colonization and other enterprises were considered only when they were deemed beneficial to the trade. Mercantile occupation was thus the dominant character over much of the Canadian interior for 200 years. Nevertheless, the far reaching plans of the Company required that detailed information about all aspects of the natural environment of its land be examined and recorded. Records were to be kept not only in North America but also in London, thus ensuring their preservation. Included is a vast array of documents such as account books, post journals, ships' logs, explorers' journals and general correspondence books. For purposes of environmental reconstruction the post journals, account books and ships' logs are of principle value, primarily because of their fullness and regularity. Ray (1975) for example, has demonstrated the utility of the account books in discerning changing faunal resources which supported commerce. Of particular importance to the present study are the post journals. These journals not only comprise one of the most complete of the Company's records, but have been found to embrace long periods and vast areas for which instrumental observations and descriptive accounts of environment would otherwise be lacking. In all, 210 journals are preserved and while most are very brief, five include over 100 years of record and 14 have over 50 years. The earliest settlements were located on the estuaries draining into

Hudson Bay, the natural outlets to the fur trade, and it is these posts which furnish some of the longest records.

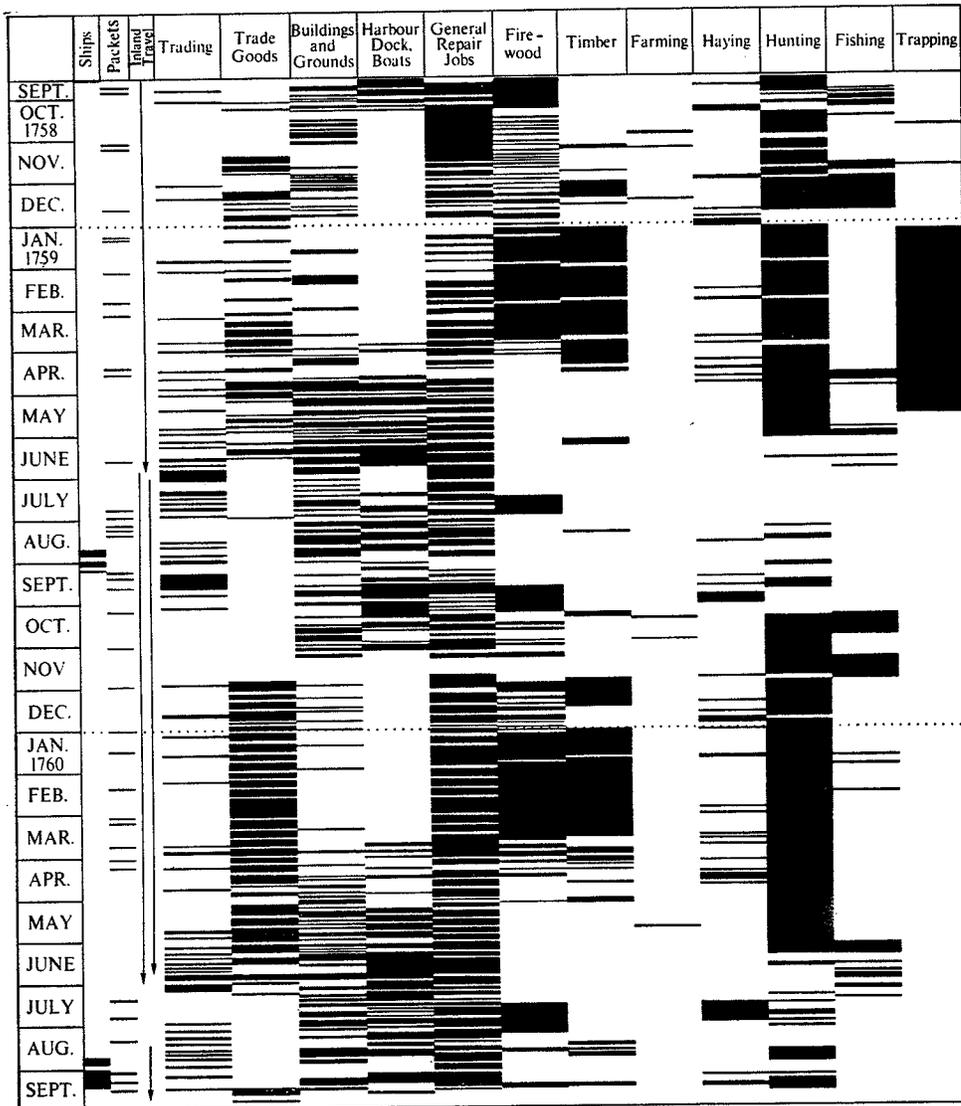
The documents are in the form of daily journals, kept in accordance with the Company's requirements for record keeping at all overseas settlements. Instructions on the content and organization of these journals was specific, as witnessed by the following letter from the Governor of London to a post factor in Rupert's Land in 1814:

The [post] Journals are to contain nothing but a plain & simple memorandum of Fact...Among the circumstances which are always to be noticed in the Journals is the weather & progress of the Season: - the date of the freezing of the lakes & river, the chief falls of snow & their depth, the greatest thickness of the Ice, the commencement of thaw; the breaking up and clearing away of the Ice, the commencement of vegetation; the opening of the leaf of the most remarkable trees; the flowering of any remarkable plant...the ripening of any kind of native fruit, & of any species of cultivated produce, the commencement of frost in the Autumn & fall of the Leaf...The observations are not to be considered as a matter of idle curiosity; but may be of very essential use.

(Hudson's Bay Company Archives, Provincial Archives of Manitoba, A6/18; fols-211-13)

Climate was perhaps the most important physical element affecting the routine at each post. The impact of seasonal changes in the trade was of particular significance (Figure 2.1). Mobility over long distances was the key to the economic occupation of the west. Since water travel was the primary means of transport, the yearly events of freeze-up and break-up of the rivers was of utmost importance. Break-up marked the beginning and freeze-up the end of the principle trading period. Attention was thus focused on the short summer period.

The journals were not written with scientific objectivity, yet the importance of these two natural phenomena is indicated by the regularity with which they are described.



DAILY ACTIVITIES AT YORK FORT,
 SEPTEMBER 1758 TO SEPTEMBER 1760
 (RUGGLES, 1971)

Figure 2.1

2.4 Use of Post Journals in Study of Freeze-up and Break-up.

The climatic significance of these journals was first demonstrated by MacKay and Mackay (1965) in a study of dates of freeze-up and break-up of the Churchill and Hayes Rivers. MacKay and Mackay presumed these dates reliable enough to enable the derivation of a regression equation to establish the relationship between air temperature, and freeze-up and break-up dates.

Moodie and Catchpole (1975) subsequently devised a method for extracting the dates of first breaking, first partial freezing, and first complete freezing, with a certain amount of scientific rigour. The dates commencing in the 18th Century were obtained for the posts located on the estuaries of the Churchill, Hayes, Albany and Moose Rivers. These dates were found to be comparable in accuracy to the information available from the present network of Canadian stations observing break-up and freeze-up.

The research presented in this thesis expands spatially and temporally the work of Moodie and Catchpole (1975) utilizing the information available in the Hudson's Bay Company post journals. The specific data sources for this study are the daily journals kept at the Hudson's Bay Company posts located on the estuaries of the Eastmain, Severn and Albany Rivers, during the following periods:

- i. Fort Albany 1871 - 1921 and 1938 - 1940
- ii. Eastmain 1743 - 1760 and 1893 - 1921
- iii. Fort Severn 1760 - 1897 and 1929 - 1940

For Eastmain House and Fort Severn the time span is in excess of 100 years, whereas in the case of Fort Albany the record is over 50 years. By combining the results from this study with the antecedent work (Moodie and Catchpole, 1975) the record for Fort Albany is extended to 200 years.

This provides the longest climatological record in Canada.

The continuity of these records is disrupted in certain cases, for various reasons. In some cases, significant gaps exist in the journal record, and in other cases when the journals are intact, they are incapable of yielding the dates under investigation.

CHAPTER III

METHODOLOGY

The use of historical documents for the purpose of reconstructing past climates is hindered by their inherent subjectivity. It is imperative that a methodology be developed to derive data objectively. Further, it is necessary to test the reliability of the method before implementation.

The method of content analysis used in extracting river ice breaking and freezing dates from Hudson's Bay Company post journals has been described elsewhere (Moodie and Catchpole, 1975). This method is applied without any general modifications in the present study, in order that the data derived in this thesis will be homogeneous with the previously published data. Specific modifications are required however to accommodate the unique physical conditions in the estuaries of the Eastmain and Severn Rivers, and it is these modifications which will be expounded upon.

This chapter initially describes and tests the method employed in obtaining the historical dates. Subsequently the techniques used to test the validity of the resultant data are presented. The discussion will commence with an explanation of content analysis and its appropriateness to historical investigations.

3.1 Content Analysis

The highly subjective nature of written historical sources poses a major problem when they are used for deriving scientific information. Content analysis was originally developed in the social sciences, as a method for obtaining information with scientific precision from such sources. Content analysis is "any research technique for making inferences by systematically and objectively identifying specific characteristics within the text" (Stone, 1966, p. 5.). It is distinguished from classical procedures of historical investigations in that the inferences are derived by standard procedures, arrived at by formulating propositions controlled by both the historical content, and contemporary standards. In this way, any reader furnished with the same evidence, rules and procedures, should make similar judgements about the inquiry.

In simple language, content analysis can be conceived as the application of the scientific method to the interpretation of information that is written, spoken or that is displayed in any artistic medium. If a written document is to be interpreted using content analysis, then either the whole, or a sample of it may be examined. The part to be examined is systematically subdivided into passages (coding units) and each of these is scrutinized separately. Depending on the nature of the method, coding units may be whole chapters, separate pages, paragraphs, sentences or even phrases. The information that is to be sought is classified into categories and rules are established (coding rules) for the identification of the occurrence of particular categories within coding units. Methods are then developed for enumerating the frequency of occurrence of each category.

Testing is an essential part of content analysis and is carried out at two levels. Both the reliability of the method and the validity of the resultant data must be tested. The reliability of a method is determined by the degree to which it yields similar results when applied by different researchers. However, reliability does not guarantee accurate results. Validity testing is required to establish that the data derived using the method of analysis are true measures of the phenomena they are intended to measure.

A primary strength of content analysis is its ability to yield numerical data from qualitative sources. The significance of this is three-fold:

- i. it enables more precision in measuring the standards and norms of past observers;
- ii. it facilitates comparisons between the standards and norms of the past and those of the present;
- iii. it permits the establishment of testing techniques and allows for the application of methods of quantitative analysis.

Unless past observations are measured, tested and compared to their modern counterparts, they cannot be assessed properly and their value remains speculative.

3.2 The Method

The objectives of this research are to extend in time and space the historical records of river ice breaking and freezing dates derived by Moodie and Catchpole (1975) and to amalgamate individual records into long-term regional means.

The journals examined for this undertaking are housed in the Hudson's Bay Company Archives in Winnipeg. Prior examination of these

Archives, identified 210 post journals preserved from posts scattered between Labrador and the Rocky Mountains. The journal records for most of these posts are very brief, but 14 were kept for more than 50 years and five lasted over 100 years. The journals which endured for long periods were kept at main depots and important posts where few interruptions in journal-keeping occurred.

The journals maintained at the posts on the Eastmain and Severn Rivers were selected for use in this research as both contained close to 100 years of record and were also in spatial proximity to sites previously selected for analysis (Moodie and Catchpole, 1975). The decision to extend the Albany dates from 1871 rested on the longevity of the records. The Albany journals are the longest post records maintained by the Hudson's Bay Company.

All direct and indirect references to ice and water conditions documented in the journals between the months of March to June and September to December were transcribed, along with the dates of entry. Direct references are actual references to ice and water conditions; while indirect references concern activities such as navigation, which are influenced by these conditions. These descriptions were used to trace the progress of the breaking and freezing processes from initiation to termination. The following passage from the Eastmain journal of 1759 is an example of a transcription for the freezing process:

October	28	"Some small Ice driving in the River"
	31	"Much Ice along Shore & in the River"
November	1	"Much Ice driving in the River"
	2	"Much Ice driving in the River"
	3	"Much Ice in the River"
	4	"Much Ice in the River"
	5	"The river all most fast from Side to Side"
	6	"The river all fast above the House"
	7	"Some holes in the River"