CHANGES AND IMPACTS TO ABORIGINAL USES ON THE LANDSCAPE:

FOREST CHANGE AND THE LAKE BABINE NATION, NORTHERN BRITISH COLUMBIA

by
Angela Sinclair

THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE
in
NATURAL RESOURCE MANAGEMENT

THE UNIVERSITY OF NORTHERN BRITISH COLUMBIA

ABSTRACT

CHANGES AND IMPACTS TO ABORIGINAL USES ON THE LANDSCAPE:
FOREST CHANGE AND THE LAKE BABINE NATION,
NORTHERN BRITISH COLUMBIA

by Angela Sinclair

This thesis examines aboriginal land uses and how they are impacted by changes in landscape patterns. The research is interdisciplinary in that it combines both social and natural science methodologies. The geographic research area is located in northern British Columbia in a sub-boreal spruce forested environment.

Information on aboriginal land use was acquired through interviews and mapping exercises with land users from the Lake Babine Nation. Data collection focused on activities related to the hunting of large mammals, the trapping of furbearers and the gathering of wild foods. The interview data were combined with ecological landscape information in order to associate the uses with biological landscape criteria. Geographic Information Systems (GIS) were used to create a digital hypothetical landscape called "Resource Use Area I". Disturbances representing the spatial and temporal patterns of conventional harvesting, natural fire and fire-mimicked harvesting, were applied to the landscape with GIS modelling. The model for fire-mimicked harvesting was based on patterns that approximated the spatial and ecological characteristics of natural fire by matching the perimeter to area ratio and by leaving island remnants of original forest within the harvested area. A forest growth model was also applied in order to examine change 120 years into the future. Available land for each aboriginal land use was calculated in the modelling at 60 and 120 years into the future.

The research revealed significant variations in impact between the disturbances. Each of the land uses was affected differently by the disturbances. Examination of the results on the aboriginal use landscape as a whole further showed the landscape-level change caused by the various disturbances. The modelling showed that the conventional harvesting pattern significantly fragmented the landscape, especially in the long-term, and in turn, drastically reduced availability for aboriginal uses. The fire-mimicked harvest pattern, on the other hand, more closely approximated natural landscape evolution and allowed for continued aboriginal uses in the long term. These results are discussed and illustrated by a series of accompanying maps.

TABLE OF CONTENTS

LIST OF MAPS & FIGURES

ACKNOWLEDGEMENTS

The author wishes to express sincere appreciation to the members of Lake Babine Nation for sharing their knowledge and traditions, as well as for their guidance and kindness over the last two years. Thanks is also due to Forest Renewal British Columbia (FRBC) for the funding which made this research possible.

CHAPTER I

BACKGROUND TO THE LAKE BABINE RESEARCH

INTRODUCTION TO THE RESEARCH

PROJECT SCOPE OF FRBC JOINT RESEARCH PROJECT. "The Impacts of Disturbance Regimes on Traditional Use and Cultural Practices of the Lake Babine Nation" was a joint research project of UNBC and the Lake Babine Nation, funded by Forest Renewal B.C. (FRBC). This project examined how changes in the patterns of landscape disturbance processes have affected land use and cultural ecology of the Lake Babine Nation in Northern British Columbia. The project research began in summer 1995 and the first phase was completed in spring 1997.

Traditional aboriginal land use patterns were researched by reviewing existing information and through discussions with community elders, hereditary chiefs, trappers and other individuals. The land use information focused on the location of archaeological/cultural sites and fish camps and activities such as hunting, trapping, and harvesting of edible and medicinal plants within traditionally defined trapline areas. The trapline areas were described and mapped using geographic information systems (GIS). These data were analyzed using GIS modelling to examine change in patterns over time when impacted by natural and human disturbances.

This was a program of joint research with the Lake Babine Nation. The project also aimed at assisting the Nation in obtaining the information it required and to pass on training and skills in the areas of forestry and mapping. The maintenance of a strong working relationship and the transfer of skills and information were integral to the collaborative nature of the project. The Nation was, and continues to be, consulted with regards to the release of general research findings within and beyond the scope of the project. Prior approval also has been sought from the Treaty Office regarding the use of specific project information. Overall research within the Nation was guided by the Office of Hereditary Chiefs with the late Mr. Gordon Joseph as primary overseer. Day-to-day research was guided by the Treaty Office and accomplished with its assistance.

THESIS OBJECTIVES. The above project research also served as the basis of this thesis towards the completion of the Masters of Science Program in Natural Resource Management at UNBC. The objectives of this thesis are to:

- Identify the major traditional aboriginal land uses of the Lake Babine Nation within two resource use areas (traplines).
- Examine the effects of different disturbance patterns on an aboriginal use landscape utilizing geographic information systems (GIS) technology.

- Draw conclusions on the impacts of varying disturbance patterns (conventional harvest, natural fire and fire-mimicked harvest) on aboriginal uses.
- Link the results of the land use research to the community through the examination of the implications for forest management and aboriginal use.

STEPS IN THE RESEARCH PROCESS.

- Reviewed existing land use information and completed a literature review on pertinent topics.
- Conducted two sets of land use interviews for two resource use areas corresponding to native trapline territories.
- Created mylar overlays during the land use interviews to show various activities within the resource use area.
- Created a hypothetical digital landscape called "Resource Use Area I" with GIS, which was based on the interview and other information.
- Developed landscape criteria linking each traditional activity with appropriate ecological characteristics.
- Utilized basic GIS modelling to simulate the changing landscape due to disturbance patterns at three different points in time.
- Calculated the resulting amount of available land per traditional activity.
- Examined GIS findings and drew conclusions.

ACADEMIC FOCUS. This research crosses many disciplines including Landscape Ecology, First Nations Studies, Forestry, Geography and GIS.[1] The research combines the use of both biophysical and traditional ecological knowledge in the data collection and applies them to a hypothetical digital landscape in GIS. GIS as a tool allows this manipulation of a hypothetical landscape to illustrate impacts and change. The resulting digital landscape was based on interview and other scientific data to be representational of an actual aboriginal use landscape.

The interdisciplinary nature of this research presented its own set of challenges and rewards. The most obvious challenge was the inherently political arena of both First Nations issues and the Forest Industry in British Columbia. By using GIS on a hypothetical digital landscape, it is hoped that geographically-specific political issues have been avoided and that confidentiality has been maintained, thus meeting the needs of the First Nation. The obvious reward of interdisciplinary research has been the gaining of knowledge and insight from two very different sources. Both have provided perceptions of the landscape and its resources that combine to create a balanced view of the issues.

---

[1] Geographic Information Systems (GIS) can be considered a discipline as well as a tool due to the widespread offering of academic courses and programs with GIS as their central focus.

The most significant contribution to knowledge surpasses the discipline-specific discoveries of the research and involves the actual nature of the work itself. By combining research methodologies from the social sciences and natural sciences [2], this research has shown that it is possible to accomplish interdisciplinary work in the areas of Aboriginal Land Use and Natural Resource and Landscape Change. This was facilitated by using the landscape as the geographic unit of study and as the central concept that linked disciplines.

GEOGRAPHIC FOCUS. The general geographic study area was the traditional territory of the Lake Babine Nation, which lies in the central interior plateau of Northern B.C. and surrounds Babine Lake. Babine Lake, in the Upper Skeena watershed, is the second largest natural lake in B.C., over 150 km long and 490 km^2 in area. The Morrison, Fulton, Pinkut and Sutherland watersheds comprise the major sub-basins. Surrounding mountains reach up to 1000 metres above the lake surface. The Babine Lake watershed is located in the sub-boreal spruce biogeoclimatic zone. Forests consist of white spruce and subalpine fir, with early seral stages dominated by fire dependent stands of lodgepole pine. The traditional territory of the Lake Babine Nation reaches beyond the two northern arms of Lake Babine, around the Lake on both sides

---

[2] Interview methods were taken from social science approaches while GIS methodology and the analysis of results were rooted in natural science.

and down towards the town of Burns Lake in the south. Figure 1.1. is a study area map showing the traditional territory of the Lake Babine Nation and the resource use areas studied.

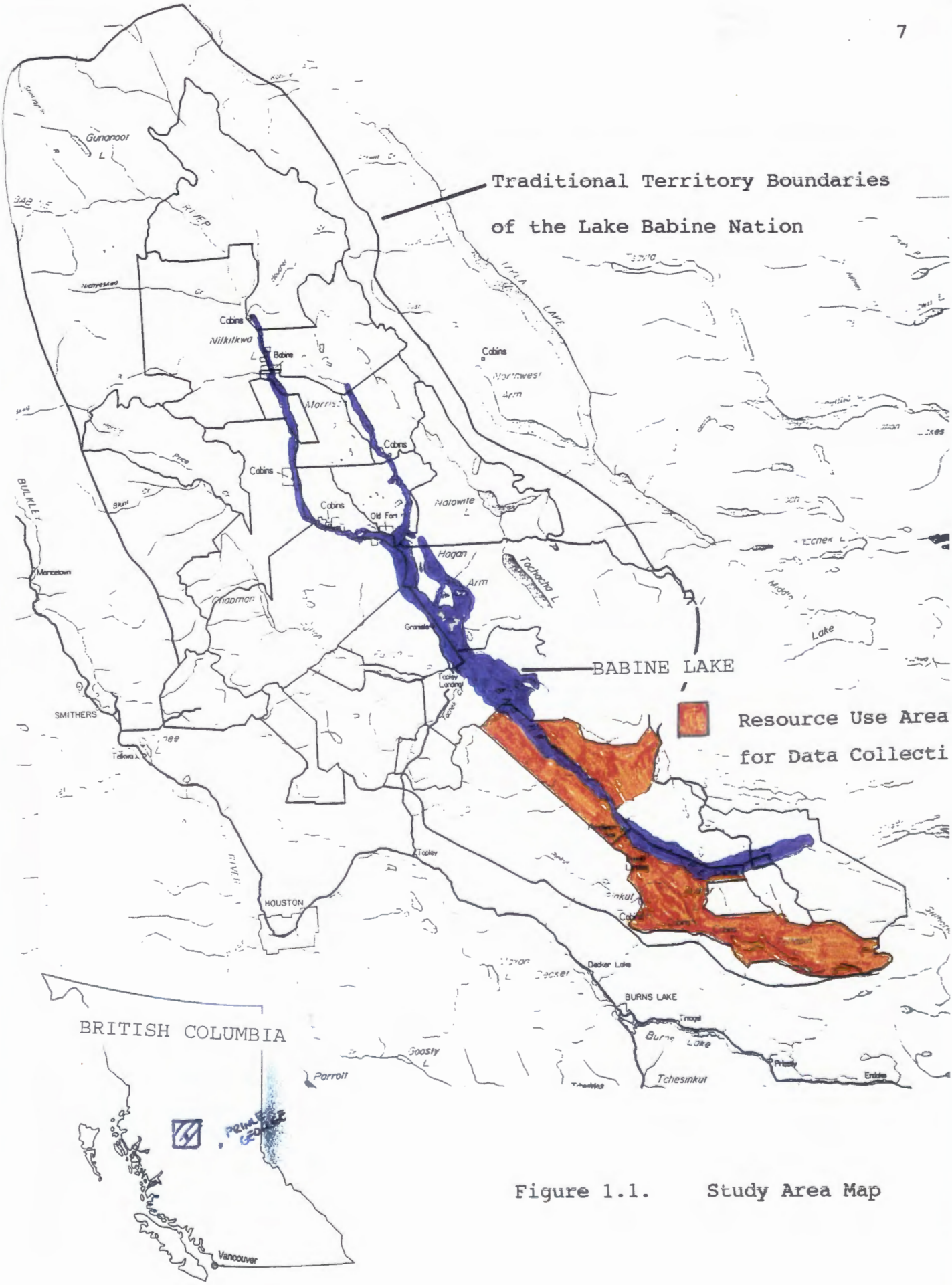


Figure 1.1. Study Area Map

BACKGROUND ON THE LAKE BABINE NATION

CULTURAL OVERVIEW. All research was collaboratively undertaken with members of the Lake Babine Nation and was a mutual learning experience for all involved. The cultural depth and dedication of the Nation to the land as well as their rich cultural traditions helped to illuminate the human side of the research. Much of the ethnographic and general cultural information was acquired through informal discussions with Nation members and hereditary chiefs as well as from the review of secondary sources.

Carrier Linguistic/Cultural Group. The Lake Babine Nation is a Canadian First Nation of Carrier peoples. Carrier peoples speak Northern Athapaskan languages and live in the north central interior of British Columbia. Carrier peoples are grouped together by linguistic and cultural similarities that distinguish them from their neighbours: the Chilcotin, Sekani, Gitksan, Haisla, Bella Coola and Shuswap (Tobey 1980, 413). The Native language of the Lake Babine Nation is Ned'u'ten, and is considered by Lake Babine people to be a Carrier dialect. Certain linguistic research, however, views Ned'u'ten and the neighbouring Wet'suwet'en dialect as a distinct language from the more easterly located Carrier dialects (Pedersen 1993, 4; McMillan 1988, 226).

Clans and the Bah'lats. Lake Babine people are born into one of four matrilineal clans: Likh C'ibu (Bear Clan), Gil Lan Ten (Caribou Clan), Jiln Ts'e Yu (Frog Clan) and Likh Tsa Mis Yu

(Beaver Clan). Clan membership entails certain privileges and restrictions with respect to cultural practices and land use. Each clan has a certain number of "titles" to natural resources and land uses within the territory. Responsibility for the land lies in the hands of the heads of clans, hereditary chiefs and important trapline holders. Traditionally this may have entailed overseeing the burning of berry patches, regulating harvesting and granting land use permissions (Lake Babine Hereditary Chiefs 1996; Mills 1994, 143).

The hereditary chiefs are significantly involved in resource and other major decisions within the Nation. These people have gained one of the limited number of hereditary "names" through inheritance and affirmation by means of the traditional feast, the bah'lats. Holding a name involves particular responsibilities and privileges within a clan. A name also implies honour and respect and is a protected and cherished entitlement.

Traditional law is enacted through the bah'lats (potlatch) which directs the use and exchange of resources (Fiske and Patrick 1997; Hackler 1958; Hudson 1972, 1983; Jenness 1943; Pedersen 1993; Mills 1994; Lake Babine Hereditary Chiefs 1996). Bah'lats is the Babine word for the institution of potlatch which regulates the exchange of goods and titles among the Nation's clans and individuals. This institution traditionally formed the basis of many North American aboriginal societies along the Northwest

Coast. A bah'lats is held to validate important socio-cultural events, such as the gaining of a hereditary name, the settling of a dispute or a funeral. Bah'lats always involve a feast and distribution of goods and money. Under Wet'suwet'en traditional law, for example, any transaction concerning the land, such as "selling" a trapline, is considered binding only if it takes place in the context of bah'lats (Mills 1994, 144). Though outlawed by European authorities from the late 1800s to the 1950s, when the law was revoked, the institution of the bah'lats has survived and enjoys considerable rebirth and influence in societies such as Lake Babine today.

HISTORICAL MILESTONES. In the last two hundred years, the lives of the Lake Babine people have undergone a drastic transformation. Traditionally, First Nations once had a direct and reciprocal relationship with the land. Since European contact, this relationship has been altered and diminished by detrimental policies, practices and social influences. A number of significant events in the recent past have brought the communities of the Lake Babine Nation to where they are today.

European contact - Hudson's Bay Company. European contact with the Carrier to the south and east first occurred when Alexander Mackenzie of the North West Company journeyed from Lake Athabasca to the Pacific Ocean in 1792-93. At the turn of the nineteenth century, fur trading between aboriginal peoples and Europeans

intensified and expanded. Simon Fraser established the first trading post in what became known as New Caledonia in 1805 at Fort McLeod. Soon after, a number of posts were built in the Carrier traditional territories. The New Caledonia fur trading district headquartered its fur trading activities at the Stuart Lake post, now known as Fort St. James, in the Carrier territory. After 1821 and the merger of the North West Company and the Hudson's Bay Company, fort building was renewed in the region. Fort Kilmars (Old Fort) was built in 1822 on Babine Lake, which created greater trade with the Lake Babine people. The Hudson's Bay Company moved the fort northward to Fort Babine in 1836 in an effort to secure a monopoly in the lucrative salmon and fur trade of the Babine Lake area (Morice 1906; Tobey 1980, 418).

Government and Church Influence. After the mid-1800s, the influx of prospectors and free traders reduced the Hudson's Bay Company's control over the resource trade with aboriginal people. The increased European settlement in the area also hastened the spread of smallpox and other diseases, to which aboriginal peoples had little resistance. Increasing dependence on European foodstuffs, hardware and clothing fortified links between the Babine people and the company trading posts while eroding the strength of the bah'lats and other traditional systems. The Roman Catholic church worked hard to further transform Carrier culture and eliminate traditional practices.

In 1884 the Federal government outlawed the institution of the potlatch. Federal Indian agencies were created in the area to enforce this and other federal laws. Government presence severely curtailed resource usage within the Nation. A significant historical change in resource usage resulted from the forcible removal of traditional fishing weirs or "barricades" from the Lake. These were permanent enclosures that allowed selective catchment and release of salmon stocks. Along with the removal of the barricades, the fisheries department enforced laws forbidding the sale or barter of fresh water salmon. This new regulation obviously affected the aboriginal resource use dynamic in the area.

The Indian Reserve Commission established most of the reserves in British Columbia at the turn of the century in order to more easily "manage" the aboriginal populations of the country. Formally, the Lake Babine Band was created in 1957 by the Department of Indian and Northern Affairs with the amalgamation of the Fort Babine and Old Fort Bands. Many of the people of Lake Babine had begun to move closer to the village of Burns Lake in order for the men to work in the sawmills of the area. The amalgamation process formally relocated these people to an unoccupied Indian Reserve adjacent to the village, which became I.R. #27 Woyenne (Pedersen 1993, 39). The relocation of Lake Babine communities exacerbated the severance of strong links to their traditional lands. The fur trade, the reorganization into

bands by the Department of Indian Affairs, amalgamation and separation, and the move to Woyenne Reserve near Burns Lake encouraged alienation from their ancestral lands.

Growth of Resource-Based Industries. After 1860, with mining and settlement in the region, New Caledonia was no longer isolated. The completion of the Grand Trunk Pacific railroad in 1914 brought widespread development pressure. This was most apparent in the forestry sector. The logging industry grew rapidly from the 1920s to the 1940s. Logging of spruce and pine forests in the Babine watershed began in 1950s. Forestry affected the economic lives of local aboriginal peoples, who moved to gain limited employment in the sawmills of the area (Hudson 1983, 132). Rapid development of the forestry sector has led to widespread change in the pattern and intensity of disturbance events within the Babine Lake watershed as well as drastically altering aboriginal access and resource use.

THE NATION TODAY. There are three main Lake Babine communities located on the reserves of Woyenne, Tachet and Fort Babine. Fort Babine is located at the northern tip of the Lake, and Tachet is located approximately at mid-point, near Granisle, at Topley Landing. The largest community is Woyenne, which is adjacent to the village of Burns Lake, approximately 220 km west of the city of Prince George.

Administrative and government responsibilities are divided between the elected Band Council and the Elders' Council. The elected Council comprises a Chief, Deputy Chief and nine councillors. The councillors are elected to represent the various communities of the Nation. Total band membership is currently 1760 people.

The state of First Nation communities in Canada is well known. Many communities suffer from drastically high levels of suicide, unemployment and a variety of health and social problems. The health gap that exists between aboriginals and non-aboriginals may be attributed to the combination of poverty and social distress that results in "lifestyle diseases." "For example, suicide rates and motor vehicle fatalities are at least three times higher among aboriginals than non-aboriginals in Canada; alcohol and drug-related birth defects affect as many as one in five aboriginal children" (Drost, Crowley, and Schwindt 1995, 1). The Lake Babine Nation grapples with many of these problems and attempts to improve the conditions and community life with a variety of social programs and through treaty negotiations.

The treaty process is one of the mechanisms being used by the Nation today to improve its situation. The British Columbia Treaty Process was created in 1990, following the recommendations from the British Columbia Claims Task Force. This process outlines the steps to negotiating modern-day agreements between First Nations and the federal and provincial governments on land and other

issues. The Lake Babine Nation initiated its involvement in the process with a Letter of Intent in December 1993. As of May, 1997, the Nation was nearing the end of stage three of the process, which will culminate in the signing of its Framework Agreement with federal and provincial governments. The next stages involve negotiations of an Agreement in Principle, formal treaty negotiations and finally treaty implementation. The completion of the six stages of the process may take several years. Land issues are central to the treaty process in British Columbia. Research concurrently carried out by the Treaty Office at Woyenne was often quite complementary to this research, which resulted in a close and cooperative working relationship between the Treaty staff and the UNBC researcher.

The main natural resource concerns within the Nation involve the environmental consequences of the Bell Mine (copper mine) closure at Granisle, the condition of salmon spawning channels and the rate of logging within the territory. This research will provide insight into forestry impacts on the landscape and hopefully will be helpful in Lake Babine Nation's efforts to become more fully involved in the management of the forest resources within their territory.

CHAPTER II

LAKE BABINE ABORIGINAL LAND USE

ABORIGINAL PATTERNS OF LAND USE

ABORIGINAL ENVIRONMENTAL KNOWLEDGE. Thousands of years of use on a specific landscape results in a level of intimacy and familiarity with the resources, patterns and systems that are found on it. The knowledge gained through aboriginal experience on the land is often referred to as traditional ecological knowledge (Sadler and Boothroyd, 1993). The best known kind of traditional knowledge is the aboriginal local information of animals and land. Information about the natural history of animals and their biophysical environments is acquired through years of hunting and trapping. Knowledge and use of the land and the wildlife that inhabit it is integral to the lives of aboriginal peoples. Animals are used for sustenance as food and clothing and also serve important spiritual and cultural roles for the people.

Traditional knowledge is a cumulative body of knowledge that is handed down through generations. This knowledge usually includes a system of classification, a set of empirical observations about the local ecology and a system of self-management that governs hunting, trapping and fishing (Dene Cultural Institute, 1993, 8).

Experience with the land is also influenced by land ethics and value systems. A land ethic is the conceptualization of and value

placed upon the relationship with the land by an individual or group. The land ethic of many of the aboriginal communities in North America rests on a spiritual relationship with nature. "The people see themselves as a small and very dependent part of a larger web" (Bombay 1993, 15). The retention and use of aboriginal knowledge and land ethics are important as they are a reinforcement of aboriginal identity and can assist in a community's path to development (Sadler and Boothroyd, 1993, 1).

SUBSISTENCE AND A WAY OF LIFE. Subsistence hunting and fishing continue to put food on the table in most Lake Babine households while providing an important reaffirmation of aboriginal identity. Traditional foods make up part of the diet of nearly all people of the Lake Babine Nation. Trappers and individuals who live and travel in wilderness areas may consume larger quantities of traditional foods in a wider variety and more frequently, as a result of convenience and necessity.

Salmon is consumed all year, after being smoked, dried, canned or frozen in the late summer and early fall. Other fish, including char, trout, ling cod and whitefish, supplement the diet when they are in season. Moose meat is slightly less plentiful than salmon, but is consumed at most special gatherings and is considered a welcome bonus to households that can procure it. Bear, beaver and deer are consumed much less frequently. Hunting of moose, bear and deer provides meat that is consumed and hides which are treated

and manufactured into clothing and handicrafts. Trapping of furbearers provides meat, furs for sale and handicrafts. Berries that are used on a regular basis include huckleberries and soapberries. Soapberries are whipped with sugar to create a common local delicacy, which is also served at many bah'lats and special occasions. Dependence on wild food sources is both direct through production, and indirect, through sharing and exchange (Hudson 1983, 10).

The traditional foods provided through these activities serve a vital role in the health of the people as well as in cultural events such as bah'lats. Beaver meat, soapberries, dried fish and other traditional foods are important gifts within the Babine bah'lats. Traditional food sources such as wild plants, fish and game offer complete nutrition and have sustained many aboriginal peoples over thousands of years (Kuhnlein and Turner 1991, 6). Traditional foods are also often much healthier than marketed foods, which are limited in variety and quality in the isolated and low-income areas often inhabited by aboriginal peoples.

Usher (1983, 2) discusses wildlife related values of aboriginal people. Values include that of meats and pelts (consumption); the wildlife experience (sensory); way of life; and option and bequest values (future use). All of these values need to be taken into account when examining the importance of resource use within aboriginal life. Traditional aboriginal activities on the

landscape are a component of life on the land and are essential to cultural identity. Cultural identity, status values and even legal status as aboriginal people are bound up with the use of fish and wildlife for domestic and commercial purposes (Usher 1983, 35). First Nation issues relating to community health and stability, cultural identity, spirituality and economic sustenance are closely linked to the condition of their lands and natural resources. The renewal of aboriginal language and continuation of activities such as dance, song, ceremony, hunting, trapping and fishing is considered by many to be key to the cultural survival of aboriginal peoples.

HISTORICAL RESOURCE USE. In pre-contact times, aboriginal people in this area depended completely on the land for sustenance. In addition to the regular consumption of fish and meat that continues today, a wider range of plants and animals was also consumed. The distribution of settlements at strategic fishing places along lakes points to the predominance of salmon in the historical economy of the region (Hudson 1983, 58). Historically, the collection of plants for consumption and healing was also a very important resource use (Hudson 1983, 65). Beaver was a more dominant meat source prior to the widespread use of moose after its arrival in the region in the early 1900s.

Trading with neighbouring aboriginal groups for a variety of foodstuffs and other materials was common practice. A strong

native trade network existed prior to the involvement of the europeans. Furs, prepared hides and salmon from the interior were traded for such exotic coastal items as seaweed, eulachon oil, shellfish and mountain goat wool blankets. The "grease-trails", named for the eulachon oil carried deep into the interior from the coast, were the major arteries of trade and travel that dissected the region (McMillan 1988, 228). After the arrival of the europeans, aboriginal land use was modified to engage fully in the new fur trade. Beaver, marten, lynx and fox pelts became important commodities for trade. Hunting techniques, living habits, settlement patterns and resource allocation were modified to accommodate fur post location and trade (Tobey 1980, 417).

We know that some aboriginal peoples have traditionally used prescribed fire, possibly to control and/or to alleviate the threat of large-scale fire disturbance or to maintain desired habitat types (Lewis 1982). There is very limited anecdotal evidence that this practice occurred in the Lake Babine region. Other strategies used by aboriginal people to conserve and manage the resource landscapes around them included selective and seasonal harvesting, habitat conservation and maintenance, and the use of diverse resource bases (Kuhnlein and Turner 1991, 21).

TRAPLINES AS RESOURCE USE AREAS

The people of the Lake Babine Nation are active resource users

within their traditional territory. The territory is divided into more than twenty trapline areas; the registered trapline boundaries closely correspond to traditionally defined resource use areas for various clans, families and individuals (Dimitrov, 1986, 78; Hudson 1983, 135). The spatial areas represented by the registered traplines are, however, smaller than the traditional use areas. The smaller spatial dimension can be explained by industrial development, government regulations and the trapline registration process itself.

REGISTERED TRAPLINE SYSTEM. In 1926, the Province of British Columbia enforced the registration of traplines within the province. The stated purpose of this system was to encourage the responsible harvest of furbearers while eliminating the over-harvest of any one species (Harcombe 1984, 7). This regulatory process conflicted with aboriginal patterns of use by establishing strict boundaries between areas and between individuals. The survey maps of the period were also only somewhat accurate, which resulted in inaccuracies in trapline registration. Cultural insensitivity and a lack of clear communication between government officials and aboriginal people at that time exacerbated the inaccurate representation of actual aboriginal land use within the trapline system (Dimitrov 1986, 23).

RESOURCE USE AREAS. Traditional trapline areas used by aboriginal people are based on a sophisticated adaptation to the region's

ecosystem. "This system of adaptation is based on a vast knowledge of land, animal movements, climate variations, as well as hunting and trapping skills" (Dimitrov 1986, 77). Trapping is often perceived differently by aboriginal and non-aboriginal people. For aboriginal people, trapping is often just one of the many activities that make up the complex of bush life; it is not simply a distinct activity (Elias 1991, 142). The activity of aboriginal "trapping" within a trapline necessarily takes advantage of the other resources contained within its boundaries. Trappers will often carry a gun in case a moose is spotted and set fish nets for food and bait for traps. Trapping cabins are used as fishing and hunting stations in the off-season. A trapline is where one hunts, traps and fishes and the right to use the resources of a particular area often coincide with the possession of a trapline (Hudson 1983, 158).

Due to the range of activities carried out within the trapline area, the research landscape will be referred to as a resource use area. Resource use area, in this research, refers to an area in which harvesting takes place as well as to other areas that the Lake Babine people consider culturally significant. By aboriginal or 'traditional' use, this research refers to both the culturally-based aspects of pre-contact aboriginal life and the culturally-modified contemporary practices by which people identify themselves as aboriginal peoples. "Aboriginals are not aboriginal because they hanker after the traditional practices. What makes

them aboriginal is a desire to be what they believe being aboriginal to mean and to explore the meaning and consequences of that identity with others who share it" (Drost, Crowley, and Schwindt, 1995, 84). A reality of modern aboriginal life is a certain degree of assimilation into the non-aboriginal culture and a sense of loss of culture. A certain amount of traditional culture is, however, often retained in knowledge, customs and social structures. Culture is constantly evolving, and is affected by the change around it. 'Traditional' activities in all societies are perpetually reinvented in association with cultural change.

The role and importance of traplines in the support of family and community life are significant. The value of trapping cannot be assessed simply by the level of activity or by the volume of fur sales. The claim to a certain area is every bit as important as the actual use of the territory (Hackler 1958, 39). The right and privilege of passing on a trapline to future generations is highly valued. Traplines also provide a concrete representation of traditional territory and a link to social history, as rights and resource use were and are tied to social structure (Lake Babine Hereditary Chiefs 1996; Hudson 1983, 7).

CULTURAL RESOURCES ON THE LANDSCAPE. From the salmon runs to the pictographs on the water's edge, the culture of the Lake Babine people is based in the land they inhabit. All these things represent who the people of Lake Babine are. The natural landscape

holds an important role in the native definition of place and self through its physical characteristics and uses. Sacred sites and traditional activities are important in the education of younger generations; oral history and tradition are passed on in the continuation of cultural activities and in visits to physical sites.

Archeological & Cultural Sites. The archeological record shows that the Lake Babine people inhabited this specific area for at least 2000 years (Mohs 1976, 15). Archeological remains offer a concrete legacy of the past that help to document the history of the Nation. They are a reminder of the roots of the culture, of their ancestors and hence, of who they are.

A series of archaeological surveys were carried out in the 1970s, providing limited information on lakeshore sites. Sites recorded in these surveys tended to be found on knolls, escarpments on open shorelines, sheltered bay areas, small points of land and areas adjacent to salmon spawning channels. Most sites recorded were ground depressions indicating cache pits, historically used for food storage. The existence of artifacts and pictographs was also noted (Mohs 1976, 4).

While knowledge of archeological sites depends on physical cultural remains and scientific method of enquiry (survey or excavation), other types of sites are also of cultural importance.

Cultural sites support the living culture of the people through their use and very existence. Traditional fishing places are some of the most important cultural sites present on this landscape. Some have been abandoned while others continue to be used actively every summer for salmon fishing. The fishing camps strengthen clan and community by bringing together extended families to work communally. They are an important arena for passing on traditional knowledge and skills about the land and its resources. Plant and berry gathering areas, spiritual locales and sites of historic importance are further examples of cultural resources on the landscape.

RESEARCH LANDSCAPE AND METHODOLOGY

Landscapes are composed of both terrestrial and aquatic environments. The aquatic environment of Lake Babine itself and the surrounding rivers and streams are obviously vital parts of the landscape and influence the total land use of the Lake Babine people. This research, however, focuses exclusively on terrestrial-based traditional activities for several reasons: biological complexity of the lake environment and its key species, to avoid overlap with environmental studies being undertaken within the Nation, and because GIS mapping lends itself more naturally to the mapping of terrestrial environments.

RESEARCH LANDSCAPE DEFINED. Two aboriginal traplines or resource use areas were chosen for the examination of aboriginal land use and change. The chosen areas are defined by registered trapline boundaries and cover a variety of landscape characteristics and traditional activities. They are bounded by several bodies of water and are actively used for hunting, trapping and fishing activities throughout the year by Lake Babine families.

Though interview information was collected for two actual resource use areas, this information was used for generalization only. The interview data on location and type of uses were supplemented with other ecological and biological information and used to create a hypothetical digital landscape ("Resource Use Area I"). The interview data served as one source to assist in the selection of common aboriginal uses in this area and to develop landscape criteria for these.

DATA COLLECTION METHODOLOGY. Preliminary land use information was extrapolated from a number of video-taped interviews with elders and trapline holders. Land use interviews and mapping exercises were also carried out in the summer of 1996 to obtain geographic-specific and more detailed information on the nature of activities within sample resource use areas. Translation between Ned'u'ten and English was provided by the following Lake Babine Nation Treaty Office staff: Norbert Dennis (Ske leelh), Marilyn Alec (Akh ghot), Roger Patrick (Mas c'ibu), Lily Ann Williams and Derek MacDonald.

Land Use Interviews. Land use interviews were conducted with two trapline holders representing two distinct resource use areas. Both of the participants are trapline holders within the Lake Babine traditional territory whose resource use areas are actively used by themselves and members of their families. All interviews were voluntary and carried out with a Ned'u'ten translator trained in research and interview methods. Informed consent was sought prior to the interviews, and confidentiality protocols were observed. The interviewees shall be referred to as Land User "A" and Land User "B" for the purposes of this thesis. The identity of the individuals shall remain confidential within this document.

Geographic information on specific traditional land use activities such as trapping, hunting and the collection of various plants for food and medicinal purposes was required in order to correlate traditional activities to biophysical landscape criteria. The interviews and mapping exercises sought to uncover historical and present traditional activities and their locations. Questions focused on type of activity, duration and location within the resource use area.

The specific information needs were discussed by the interviewers prior to the interviews. The actual interviews were however, conducted without a formal interview guide, so as to maintain a culturally appropriate, flexible and informal atmosphere. The preparation for interviews and mapping work was guided by Norbert

Dennis (Ske leelh). Mr. Dennis is a respected Hereditary Chief as well as a Treaty Researcher. He is fluent in the Ned'ut'en language and served as translator when required. Approval for the conduct of interviews was received from the Office of Hereditary Chiefs of the Lake Babine Nation and from the Ethics Committee of UNBC. Copies of the Informed Consent form for Land Use interviews and the UNBC Ethics Committee approval are contained in the appendices of this thesis.

Upon completion of the interviews, each was translated and transcribed. Confidential copies of the transcribed interview and accompanying maps are kept at the Lake Babine Nation Treaty Office in Woyenne for future use at their discretion. Confidentiality regarding specific sensitive geographical locations within the GIS system and on hard copy maps is protected. Exact land use locations within the resource use areas are not revealed in the GIS modelling and analysis. The information gained was used to generalize aboriginal uses on a hypothetical resource use landscape.

Overlay Mapping. Mylar overlays were created during the land use interviews to show various activities within the resource use area. The interviewees were encouraged in the mapping exercises to take part in the drafting of the overlays with coloured markers to indicate the specific land use areas being discussed. These overlays were created at a 1:125,000 scale with topographic base

maps for each area. These were used to create confidential GIS information layers for reference during the modelling process.

Geographic Information Systems (GIS). After the land use interviews and mapping exercises were completed, the information collected was moved into the digital arena with the use of GIS. This computerized tool allowed us to view a number of sources of information as layers on a digital map. By using digital information, hypothetical scenarios could be applied to Resource Area I. This also allowed the use of generalized information while protecting the confidential and sensitive nature of the data. The use of GIS and the technical methodology is explained in chapter four.

Limitations of the Methodology. The informal interview style did not work as well as expected for a range of reasons. The first barrier was the fact that the interviews were conducted in Ned'u'ten and that translation was required. Cross-cultural interviews requiring interpretation and translation require considerable time. This amount of time is rarely available to researchers on limited time projects. Second, also due to the timeframe available, the interviewers were unable to develop an interview format based on experience. Third, it is likely that the interviewers had differing views as to what information might be most significant. These limitations resulted in the conversations covering a wide range of topics that went beyond the immediate data needs of this research.

A limiting factor in the cartographic representation of land uses is the difference in spatial cognition between cultures and generations. The topographic base maps used did not necessarily represent the landscape in the same way that the interviewees perceived it. The maps lacked native place names, and emphasis on landscape features was topographically-based rather than culturally-based. Landmarks that guide the interviewees through their landscapes were not always indicated on the government maps and even if they were used, the cartographic symbols and names were unfamiliar to the participants. The topographic maps also are necessarily two dimensional, which can further confuse a participant whose experience with the landscape has always been immediate and fully dimensional.

The ability to read and understand cartographic devices such as contour lines and to mentally reconstruct topography are skills that take time to learn, even for those who study and work in geographical fields (Duerden and Johnson, 1993, 728). In addition, cartographic devices are culturally-specific. To expect any person whose experience with the landscape is understood from a different perspective, to interpret specific maps was a faulty assumption on the part of this researcher. If time had permitted, extensive geo-referencing on the ground could have improved the geographic accuracy of the information.

Despite these limitations, valuable information was collected in the interviews, reaffirming the range of activities within resource use areas. The confidential overlay maps offered supplemental geographical information that helped to create and model aboriginal uses on the hypothetical GIS landscape.

LAKE BABINE ABORIGINAL LAND USE INFORMATION

Data collected from the two interviewees and from other discussions with land users within the Nation indicate that traditional uses continue today within the resource use areas. Traditional land use information collected focused on location of activities such as hunting, trapping, edible and medicinal plants, fish camps and archeological/cultural sites. Supplemental information on aboriginal land use among a neighbouring Carrier people was obtained from Douglas Hudson's work (1983).

Resource usage among the Lake Babine Nation is by groups of extended families and follows the seasonal round of trapping, hunting, fishing and gathering. Access to and ownership of land and resources are usually inherited through matrilineal succession and affirmed in bah'lats. Territorial disputes between individual families or clans are also settled via the bah'lats. The hereditary names linked to each trapline or resource use area have historical ties to the management of that parcel of land. All resource management was traditionally the responsibility of the

hereditary chiefs (Fiske and Patrick 1997, 234). Today, registered trapline use is still linked to the traditional system. The authority of traditional laws, with respect to use and management of trapline areas, is still respected (Fiske and Patrick 1997, 239).

Moose are hunted along the rivers and lakes, along the roads and in clearings. Moose are hunted in late summer and fall when they are rutting and more easily spotted. Hunting in general is quite pragmatic; guns are usually carried in the bush and around the fishing camps and even on the lake throughout this time in case a moose is spotted (Land User 'A' 1996; Hudson 1983, 165). Bears are hunted in areas that are known to have good berries in late summer (Land User 'B' 1996). Deer are also hunted throughout the territory, but are not as favoured as moose.

Traps and snares are set along game paths and the routes furbearers travel to water (Hudson 1983, 158). Trappers do not necessarily focus on a single species, rather they opt for strategies to obtain a range of animals within each trapline. Marten, beaver, mink, fox, lynx, muskrat, squirrel and wolverine are common furbearers trapped in this area. Trapping cabins are built at different points on a line to serve as places to rest and eat. Today, due to landscape and economic changes, few trappers are active on their traplines. Those who are sell the furs and

prepare the edible meat, which they either consume themselves or distribute within the community.

The level of some activities has declined with changes in lifestyle and interest. The collection of medicinal and edible plants, for example, is far less than in historical times. Though of less importance for subsistence and healing today, these plants and the knowledge about them remain meaningful to the culture of the people of the Nation. Fishing for salmon and the hunting of moose and bear remain significant activities for food consumption. Methods of collection have changed drastically over the years with the introduction and use of modern equipment and roads, but the central purpose of the activities remains the same: the provision of traditional foods and preservation of culture.

Interviews on trapping tended to gravitate towards the past and present location of trapping cabins and the vandalism and destruction that has occurred to the sites. The land users expressed strong opinions about forest industry impacts on their activities and repeatedly expressed a negative opinion of the industry and its practices. The repeated refocusing of the conversation on adverse logging impacts indicates this to be a priority of the interviewees.

CHAPTER III

LANDSCAPE CHANGE

CONCEPTS IN THE ECOLOGICAL STUDY OF LANDSCAPE

The landscape is the central theme to this research and is the entity and concept that links the various disciplines. It is a term that is often used in general conversation, but whose meaning can vary depending on the context. Landscape, in this thesis, refers both to the spatial and material parts of the terrestrial reality. Svobodova (1990, 7) lists a number of characteristics of landscapes: they must occupy a certain space, they must possess visual forms and patterns, they must be functioning dynamic systems, and they must have passed through a sequence of situations (evolution). A landscape is also a heterogeneous land area made up of repeated interactive and interconnected ecosystems (Forman and Godron 1986, 11). Landscapes can be studied vertically, focussing on their internal biological functions, or horizontally/ecologically, focussing on the macro spatial relations.

By examining change at the ecological landscape level we are afforded an integrated view of the complexity of the relationships between process, land and people. At both the micro and macro levels of a landscape, processes affect each other. The interconnectedness of processes on the landscape can be extended to include human activities. Human interaction with the land can

be better understood if examined under a landscape framework. Landscape ecology, which focuses on patterns and processes of interaction and change at this level, is the conceptual basis for this research.

LANDSCAPE ECOLOGY. Landscape ecology is a holistic scientific discipline that examines the cause and effect patterns on a landscape (Forman 1995; Barton 1994; Vink 1983). The term was coined by German geographer, Carl Troll in 1939. The emergence and more widespread availability of aerial photographs at the time, demonstrated a landscape view of the land and apparently led to Troll's use of the term in his studies (Forman 1995, 20). Troll's study of the landscape merged geography and biology and required an awareness of the interconnectedness and mutual dependencies within a landscape. He defined the discipline as the study of the physio-biological relationships that govern the different spatial units of a region. In landscape ecology, the focus is on three characteristics of the landscape: structure (the spatial relationships), function (the interactions between spatial elements) and change (the alteration in structure and function over time) (Forman and Godron 1986, 11).

DISTURBANCES. Disturbances are the natural and human-induced agents that cause change on a landscape. These include windstorms, fire, insect and disease outbreaks, forest harvesting and others. Disturbances usually kill or remove significant biomass from a

plant or plant community and alter the pattern of variation in the structure or function of a system (Forman 1995, 38). Disturbances range from the large scale like fire, to the very small scale like the burrowing of rodents in forest soils.

Disturbances may also interact more complexly with each other across the larger landscape. For example, aging stands will become susceptible to infestation by bark beetles, but are also more likely to burn, which in turn reduces pest infestation (Alverson, Kuhlmann and Waller 1994, 47). "Disturbance is so pervasive in forest habitats that many tree species depend on the conditions created by them to initiate or complete their life cycle" (Alverson, Kuhlmann and Waller 1994, 45). For example, seedling establishment is enhanced by rotting logs, old stumps and coarse woody debris left behind after disturbance. The trees and snags remaining post-disturbance increase structural complexity as they are incorporated into the subsequent stand and are used in regeneration (Hansen et al. 1991, 383). Absence of disturbance can result in reduced growth efficiency by increasing competition among trees (Waring 1985, 212). Disturbances are a natural part of the evolution of landscapes and are vital to the proper functioning of forest ecosystems. By maintaining structural complexity, disturbances also promote plant and animal diversity (Hansen et al. 1991, 382).

Today, natural disturbance has been largely affected and/or

patterns. Patterns are connected spatially and temporally. They are repeated over the landscape and determine its heterogeneity. If the patterns on a landscape are disrupted so significantly that they become fragmented, the ecological processes of the landscape may be disrupted to a point that they can no longer function together. The fragmentation of a landscape has ecological effects on patch size and number, connectivity and species movement (Forman 1995, 413). Vegetation and forest structure are central to wildlife habitat as they are related to food and shelter. These aspects are also what we change the most in forestry and other resource developments.

Wildlife have basic resource requirement "packages", that is, a group of specific resources found together on the landscape. The basic package for most wildlife is composed of energy, nutrients, water, temporary shelter, habitation, anti-predator cover and space. Natural succession after disturbance results in a certain level of predictability in the pattern of availability and frequency of occurrence of these packages on the landscape (Harcombe 1984, 114). Human-induced disturbance and the possible accompanying fragmentation alter this pattern of availability and hence reduce suitable wildlife habitat. As the rate of fragmentation relates to the ability of a landscape to sustain particular wildlife populations, it follows that it also relates to the availability of land for aboriginal uses.

IMPACTS AND CHANGE ON THE ABORIGINAL USE LANDSCAPE

Because of the interdependence between land, culture and society, First Nations communities are especially vulnerable to changes on the landscape. The impact of disturbances, forestry in particular, on the viability and success of aboriginal resource activities is a major concern of local communities. The change in landscape patterns can have severe impacts on furbearing species, large mammals and aquatic species. The size, location and health of wildlife populations respond to these drastic landscape changes. Aboriginal traditional uses have had to be adapted and continue to diminish due to these ecological changes.

Furbearers. Trappers and their traplines are impacted both biophysically and socio-economically. Reductions in suitable habitat for target species results in fewer and lesser quality animals. Socio-economic impacts range from the loss of income to the loss of ecological knowledge and skills associated with the activity. Changes resulting from industrial forestry are also accompanied by vandalism by hunters and other non-aboriginal recreational land users who have gained access to the area. Logging activities can also dissect trails within the bush, disrupting trapping areas.

Current forestry policies call for consultation with aboriginal trappers and the protection of registered trapline sites. In practice, however, the involvement of registered trappers in the planning process has been limited. Trappers are often suspicious

of forestry company activities and are very guarded about the release of specific trapline information. There is a definite lack of trust between the forestry companies and the trappers, which is rooted in a history of poor or non-existent communication. The past incidences of destruction and apparent disregard for the protection of the traplines do not create an open arena for communication. Most aboriginal trappers are left with very little recourse should their trapping rights be eliminated in favour of an alternate use for lands on which they trap.

Large Mammals. The riparian areas around Babine Lake and its rivers and streams offer food and shelter for foraging ungulates such as moose. The distribution, abundance and quality of foraging species such as moose are strongly influenced by landscape change. Changes in landscape-level availability and access to broad-leaved plants and other forage biomass, resulting from silvicultural treatments, affect the quality of resulting habitat. Lake Babine people perceive that there has been an adverse impact on moose abundance within the traditional territory. They have also raised questions regarding the health and meat quality of the animals.

Archeological Sites. Resource development near Babine Lake has adversely affected the archeological quality of the area. Large tracts of land have been disturbed by forestry, mining and

recreation developments, which have also carelessly wiped away

much of the archeological evidence.

Berries And Edible/Medicinal Plants. Silvicultural treatments involving the use of herbicides, such as glyphosate, can leave residues on consumable plants and berries (Coxson 1994, 6.9). The removal of "competing vegetation" in reforestation efforts may also interfere with the growth and abundance of non-tree species plants used by aboriginal people.

Both resource use areas examined in the interviews with Lake Babine land users have been affected by forestry and other developments. Logging access roads dissect both areas and extensive logging has occurred within their boundaries. A provincial park within the boundary of one of the resource use areas has resulted in increases of non-aboriginal recreational land users. The growing popularity of the lake as a prime recreational fishing area has led to the growth of fishing lodges and boat traffic on the Lake.

The landscapes in question have evidently been impacted by disturbance-based change. By modelling different types of disturbance on the landscape, this research examines the changing patterns and resulting available land for these activities in the future. By using computerized mapping technology (GIS) we are able to model this change on a landscape and visualize its impacts.

CHAPTER IV

MAPPING AND MODELLING WITH GIS

USE OF GEOGRAPHIC INFORMATION SYSTEMS (GIS)

WHAT IS GIS? GIS are computer-based systems that can visually display, edit and analyze geographically referenced information. A GIS goes beyond the use of hard copy maps and even computer-based maps by its ability to analyze information. Associated technologies include remote sensing techniques and global positioning systems (GPS). Both of these can provide data for the computer-based analysis of GIS. All of these technologies are steadily becoming more accessible to communities and organizations due to reductions in price and improvements in user-friendliness.

GIS play a central role in the coordination, visualization and modelling of information collected by this research. GIS are interdisciplinary tools that store and analyze a variety of information layers. The combination of these data generates multidimensional and dynamic perspectives that promote effective visualization of Lake Babine Nation lands, impacts and future changes in resource usage. Technical expertise was contracted to assist in the development and execution of the GIS phase of the project. Pearson Farnsworth, a student and GIS technician, was contracted to the project from October 1996 to April 1997.

GIS AS TOOLS FOR FIRST NATIONS. The Assembly of First Nations estimated that at least sixty aboriginal communities in Canada were engaged in GIS work in 1995 (Bird 1995, 23). With the popularity of the technology, this number has most certainly grown considerably in the last two years. In B.C., where the treaty process, land claims and forestry issues are at the forefront of First Nations' agendas, GIS have acquired the reputation of being indispensable tools. The Nisga'a (Naas Valley), Gitksan (Hazelton) and Wet'suwet'en (Moricetown) are but a few of the Nations in Northern B.C. that have active GIS programs. The Lake Babine Nation has identified mapping issues and GIS acquisition as priorities. Involvement in this project with UNBC has brought many land-based issues to the forefront and heightened interest in exploring the potential applications of an in-house GIS.

Mapping archaeological sites and modelling archaeological potential are two avenues for the technology that are available to aboriginal communities. The location of sites is important in cultural education and archaeological preservation efforts. By combining traditional knowledge and technological methods, the identification and mapping of sites are facilitated. Remote sensing further enhances the use of GIS in archaeology by allowing the repeated study of a fieldwork area within its much larger surroundings. By supplementing or replacing the costly use of aerial photos and intensive field digs, archaeological research is brought within reach of more communities and into the hands of the people concerned.

GIS allow for the incorporation of traditional territory boundaries into representations of the landscape. Place names in the aboriginal language can be preserved on maps and even recorded to audio on certain computer systems. The anthropological value of place names is significant, in that they may function as maps themselves, pinpointing by recalling the features surrounding them or the human uses they had (Ryden 1993, xi). Place name map layers are an important educational tool in the First Nation curriculum. The permanent record of these places in the aboriginal language ensures the transfer of knowledge from one generation to the next. GIS have also proven to be good educational tools for teaching environmental interactions and change on the landscape. The visual quality and the non-static interface encourages youths to explore the environmental issues that are affecting their traditional lands. This teaches and prepares the new generation of aboriginal people to protect and responsibly manage the lands which they may inherit.

Today, resource information comes from a wide variety of sources. GIS allow for the integration of these different sources into a compatible format. Forest cover information, traplines, traditional uses, waterways and wildlife habitat can be overlaid on different map layers in GIS in order to facilitate integrated resource management. Short- and long-term resource development plans can be easily displayed and updated with this technology. This allows for more informed stewardship of the land base and

better communication with various resource authorities and organizations also involved in the area. GIS can greatly enhance a First Nation's ability to manage and steward the land. Maps that illustrate the landscape from a variety of perspectives are useful management tools. This aspect of GIS complements the current situation of many First Nations who are attempting to balance both traditional values and socio-economic realities in the management of their lands. The maps and knowledge resulting from a Nation's use of GIS also become vital tools in contemporary disputes over land ownership, access and use rights. The presentation of maps that clearly show boundaries of the claim area of a Nation and possible scenarios on the landscape can assist in land claim negotiations.

The wide applicability of GIS technology for many groups, including First Nations, has made it extremely popular. This may be part of the reason why many systems are being purchased and not used to their full capabilities. It was estimated at a recent GIS industry conference that 80% of the GIS obtained by First Nations groups are not being fully utilized (Poole 1995, 18). Any group that is contemplating purchasing a GIS for some or all of the above applications should weigh several factors first. Factors include such things as price, ease of training, integration with other applications, maintenance and support, system capabilities and the specific needs of the organization. To keep the knowledge that is gained in the community, adequate funding also has to be

put aside to train local people. Training community members not only strengthens community development and environmental stewardship, but also helps to ensure the confidentiality of sensitive data. Additional measures such as controlled-access software may also be required to safeguard sensitive information.

Traditional territory boundaries are defined by the naturally occurring features of the landscape combined with anecdotal history of the area. Local aboriginal history records the legal principles of land tenure, transfers and successions (Lake Babine Hereditary Chiefs 1996). These histories define the aboriginal territory. These stated boundaries, however, often do not correspond to other government-determined boundaries and hence are not recorded on most maps.

The historical landscape can be preserved with applications in archaeology, education and historical demarcation. The contemporary landscape is confronted with many issues such as land claims and resource usage, for which GIS are also applicable. Overall, GIS technology is an area that can benefit many First Nations in Canada and abroad.

REPRESENTING ABORIGINAL USES ON THE LANDSCAPE. The information collected in the land use interviews and mapping exercises with Lake Babine users was studied in order to choose locally prevalent aboriginal activities for inclusion in the GIS component of the

research. In order to protect confidentiality, simplify technical requirements and to increase the scientific validity of the research, the interview information was used in conjunction with forest attribute data and wildlife habitat information and applied to a hypothetical digital landscape (Resource Use Area I).

The challenges of mapping aboriginal uses are numerous. Confidentiality issues, the gradual loss of traditional ecological knowledge and differences in spatial cognition (landscape interpretation and the reading of maps) all affect the quality of information that can be collected and then represented on maps. Historical remains of aboriginal maps show a different perception of the landscape (Marozas 1995; Duerden and Johnson 1993; Brody 1988). Information content on aboriginal maps historically focused on function and cultural importance, emphasizing features that helped communicate the purpose of the area. Work has been carried out that involves alternate spatial representations of the aboriginal landscape (Brody, 1988; Aberley 1993; Duerden and Johnson 1993). The geographic component of the research carried out for this thesis, however, remains within the boundaries of conventional spatial (that is, topographic) representations of the landscape.

MODELLING DISTURBANCE IMPACTS ON ABORIGINAL USES

The GIS models applied in this research are predominately spatially-based supplemented by basic ecological modelling

information. There is an unlimited level of complexity that can be achieved in GIS modelling if the research, time and resources permit. Due to the spatial nature of this research and the fact that GIS was only one of several methodological tools used, the decision was made to limit the models to manageable, applicable but basic spatial models. Models were designed by the project GIS technician, Pearson Farnsworth, to represent the spatial impacts of disturbances on the landscape and basic forest growth into the future. They should not be mistaken for complex growth and yield, harvest simulation or fire ecology models. The GIS modelling component entailed the development of a hypothetical digital landscape (legacy forest), the application of disturbance patterns, the application of a forest growth model, and the calculation of land use availability for traditional activities as determined by related landscape criteria.

DATA SOURCES. The sources of digital data included the Ministry of Forests' forest inventory data and digitized information from the land use interviews. The digital data available from the Ministry for the Lakes District allowed for the acquisition of an extremely broad range of geographic information and allowed analysis for a wide geographic area. These data were provided free of charge in the spirit of cooperation between the Ministry and First Nations. The use of existing digital data saved considerable time and resources in the development of the map layers. The GIS lab at the University of Northern B.C. provided the hardware, software and

lab time required. The forest cover inventory supplied by the Ministry of Forests, Lakes District was delivered in PAMAP format. Because of this, all initial data maintenance and verification were done using this software.

Modelling was accomplished by using both PAMAP and ARC/INFO GIS software packages. After PAMAP manipulation, the dataset was exported in a generic vector format with associated DBASE IV attribute data tables. These exported files were then transferred to the UNIX environment and loaded into ARC/INFO. The spatial disturbance models are natural disturbance (natural fire pattern), conventional harvesting and fire-mimicked harvesting. Impacts were applied throughout a 120 year timeframe and results interpreted at years 0, 60 and 120.

Resource Use Area I was identified and split from the district mapset. Once this area was captured in raster and vector format, all subsequent and pertinent spatial and attribute data were intersected with this polygon to form the different layers of information. The landscape unit in this analysis is therefore the resource use area which is composed of over 26,000 hectares of forest and is intersected by a portion of lake.

Traditional land use activities from the interview maps were digitized in ARC/INFO. The location of traplines, berry picking areas, moose, deer and bear hunting points, as described by the

land users, were taken from these overlay maps. Archaeological and fish camp sites were also digitized from these overlay maps. All this information created a confidential information layer that was used, in conjunction with the other ecological information, to determine suitable criteria for the land use availability modelling. The information layers that are utilized for modelling are hypothetical creations based on actual interview and ecological information. The spatial dimensions of Resource Use Area I relate to an actual trapline boundary in the traditional territory. The scale of the landscape is quite small for the study of certain biological landscape functions and patterns, however, it was deemed to be sufficient for the purposes of this research on aboriginal uses.

DEVELOPMENT AND APPLICATION OF THE MODELS

The Legacy Forest Dataset. Since the Resource Area I digital landscape was created using current geographic and ecological data, recent disturbances influenced its composition. For this reason it was necessary to create a pre-logging landscape, referred to as the "legacy forest" to represent a digital natural landscape prior to disturbance. The forest cover inventory supplied by the Ministry of Forests provided reasonably up-to-date (1995) forest cover information for the landscape and a basis for creating the legacy forest. The age class structure of the forested polygons and their spatial characteristics such as patch size, numbers, perimeter to area ratios, and juxtaposition (the

geographic locations in which they exist in the landscape) were originated from this inventory. The creation of a digital legacy forest landscape was vital to the modelling process, as it served as a baseline upon which change could be measured.

The legacy forest was created with backward projections on the spatial forest inventory. Concepts from Delong's recent work in the area (1997) assisted in this process. The process involved looking for very old (over-mature) stands as well as stands that were in the age class of 0 to 60 years of age. Stands older than 60 years of age were deemed to be naturally occurring (escaped logging), while stands between 30 and 60 years were believed to have been logged or affected by from some type of disturbance. When analyzing these stands it was important to note their shape and position relative to each other. In most cases these stands were of similar shape (square) and quite close to one another, indicating harvesting.

Stands that were determined to have been recently disturbed were classified using primary and secondary species information, site types and relative locations. The stands were then "aged" and their associated attribute tables reconstructed to match the characteristics of the older, closely-related stands. This process generated a more spatially heterogeneous landscape matrix and was felt to be a good representation of the forest prior to logging and fire control. The mean age class structure of this landscape

increased dramatically from the age class structure of the 1995 inventory supplied by the Ministry of Forests. The legacy forest dataset was overlaid on the spatial boundaries of Resource Use Area I and formed the baseline for the modelling. Figure 4.1. shows Resource Use Area I as a legacy forest. The age class structure of the legacy forest is defined by a colour legend. The predominant age class in this undisturbed forest landscape falls within the 81 to 120 year range.

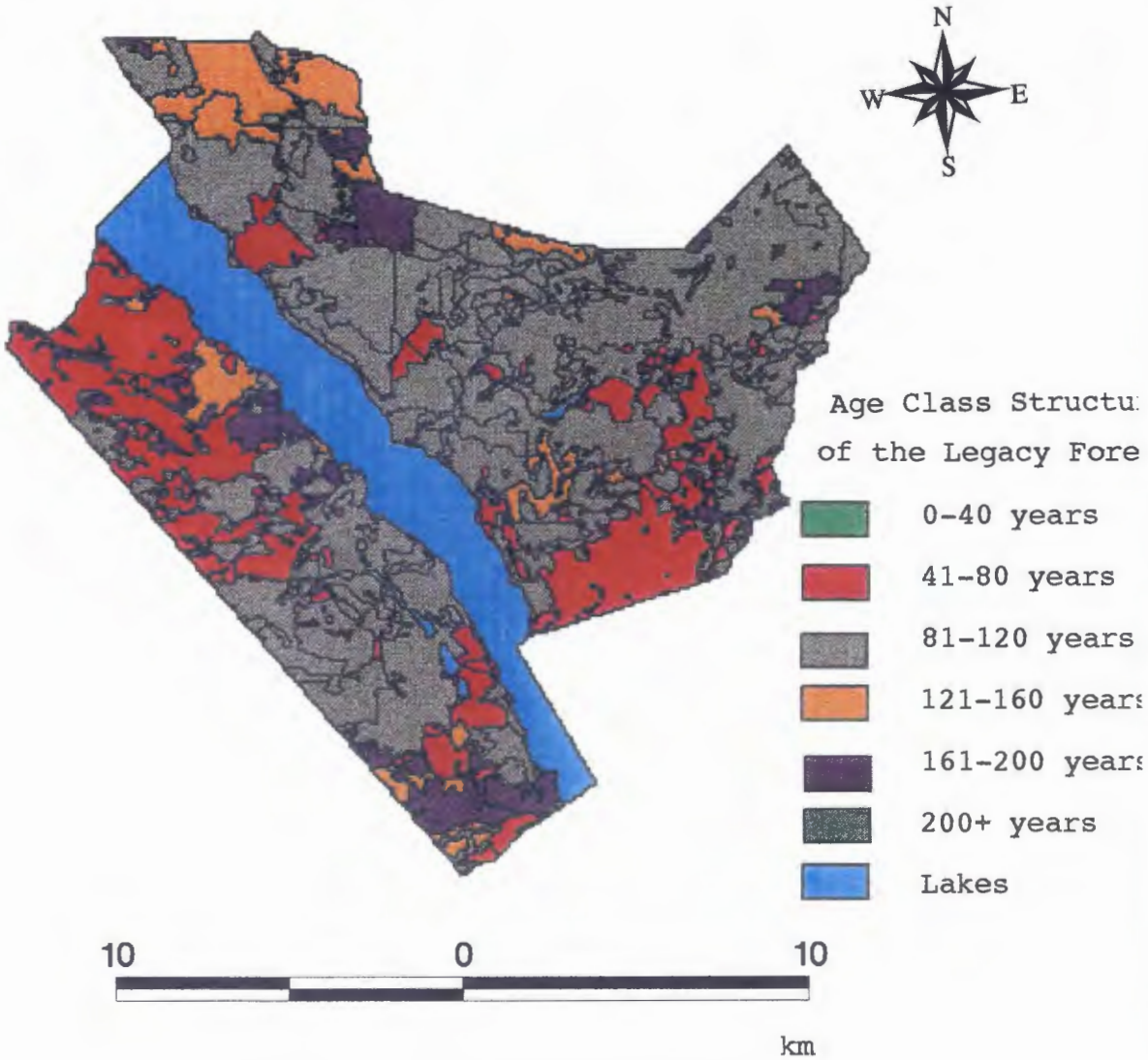


Figure 4.1. GIS Hypothetical Digital Landscape Legacy Forest in Resource Use Area I

Disturbance Models. Three separate scenarios were developed and used to disturb the legacy forest landscape. Spatial representations of conventional harvest, natural fire and fire-mimicked harvest scenarios were created and used to disturb the landscape. The time scale used in this modelling exercise was 120 years where availability of landscape resources for traditional aboriginal activities was quantified at 60 years and 120 years into the future after initial and subsequent disturbances were applied. All three scenarios were developed with equal total areas.

Scenario One - Conventional Harvest

The conventional harvest scenario was developed in the context of general operational requirements and the current regulatory environment for forest harvesting activities. Hypothetical clearcuts that were created under this model were generally less than 80 hectares in size and were aggregated into a clump arrangement as is done in conventional harvesting operational plans. Once these polygons were created and arranged, they were applied to the landscape. The initial clearcuts were applied in three rotations, at impact (year 0), at 35 years and at 75 years. Clearcuts were digitized on-screen with Arcview 2.1 GIS desktop software. Stands of late age classes and volumes were targeted and used substantially as in typical forest management planning. Figure 4.2. shows the applied disturbance on the landscape.

Scenario Two - Natural Fire

Natural fire modelling was accomplished using a raster modelling approach. Fuel loading, proximity to water bodies, slope and crown closure were the main criteria for the natural burning of the landscape. A random point on the landscape was chosen as the ignition point and the fire spread from this point. It is important to note that this model was allowed to run without intervention or suppression by humans. This disturbance was initiated at year 0 and no later natural fire disturbances were created for the remainder of the 120 years. This area of B.C. is known to have recurring large-scale natural fire disturbances approximately every 140 years. Figure 4.3. shows the spatial pattern of the natural fire disturbance. Notice the irregular edge and the island remnants within the perimeter of the disturbance that escaped fire. These are vital to natural landscape evolution.

Scenario Three - Fire-Mimicked Harvest

This human-induced disturbance mimics natural fire disturbances in that it matches the perimeter to area ratio that natural fire creates. Since this is a harvest-based activity, the pattern was, however, applied in the most valuable stands containing mature timber. The disturbance areas were digitized as two large areas with many larger remnant islands within their boundaries. The perimeter to area ratio was much greater than the conventional clearcut scenario in total, but did not reach the ratio that the natural fire regime created. The disturbance pattern was applied

at impact (year 0) and second large cut applied at 75 years. Figure 4.4. shows the spatial pattern of the applied disturbance. Though not quite as irregular and infrequent as the natural fire pattern, the fire-mimicked harvest pattern drastically differs from the conventional harvest pattern both spatially and temporally. Notice how remnant islands were left within the perimeter of both irregular large-scale cuts to mimic natural disturbance.

Initial and subsequent disturbance patterns were applied to the legacy forest landscape within Resource Area I as described above. The landscapes were then updated with a simple forest growth model in order to project the post-disturbance landscape into the future.

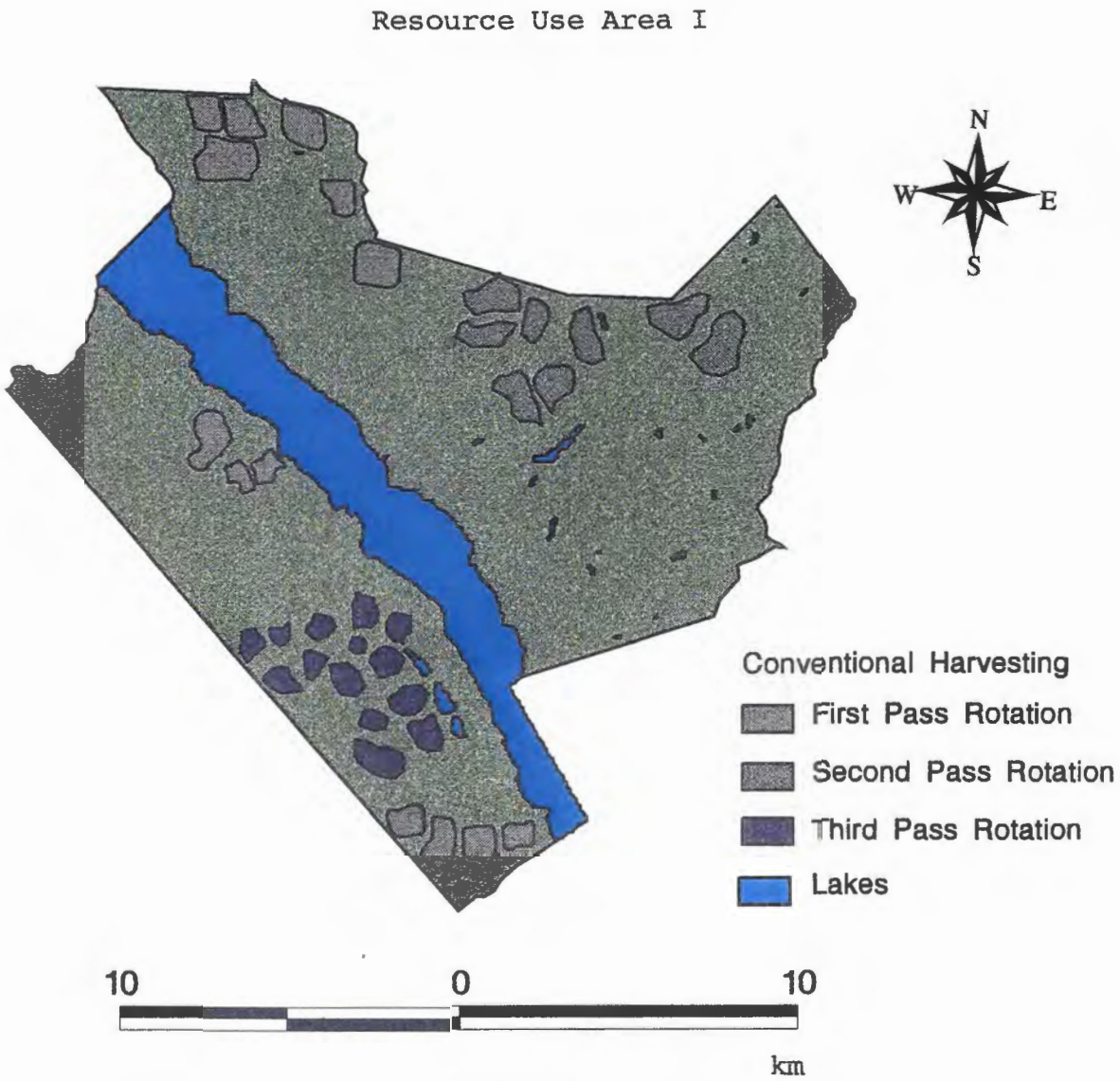


Figure 4.2. GIS Disturbance Pattern for Conventional Harvesting

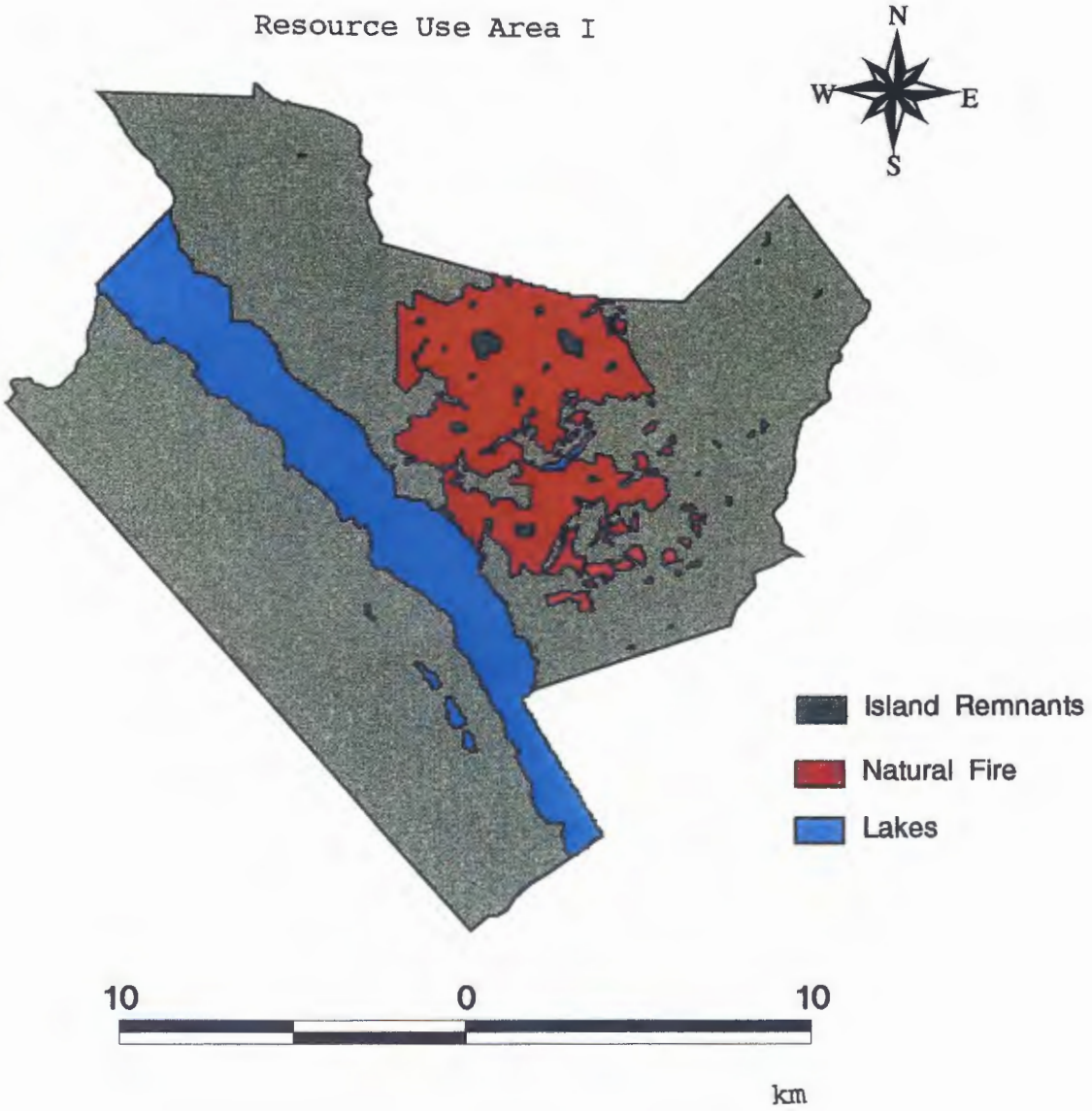


Figure 4.3. GIS Disturbance Pattern for Natural Fire

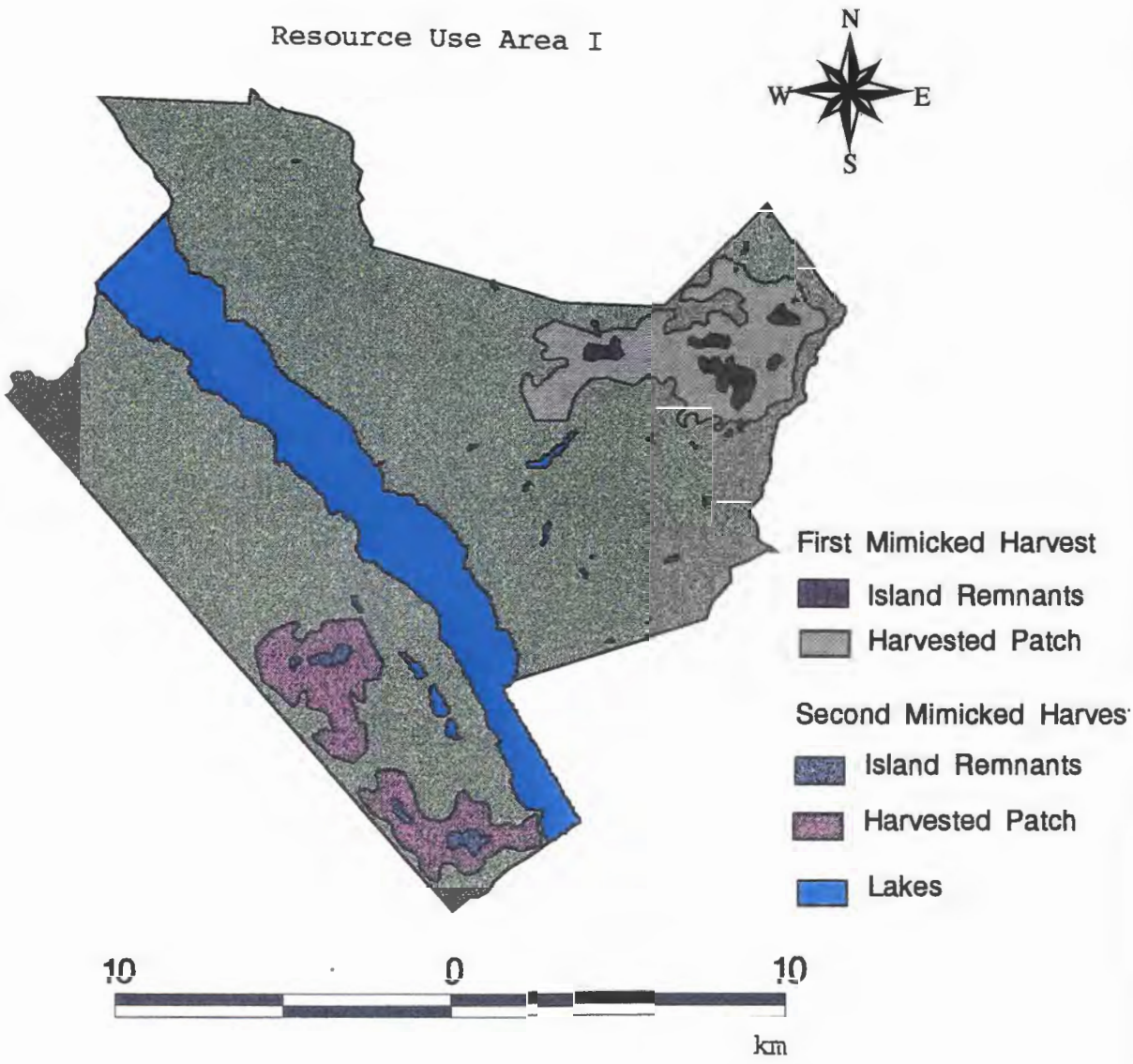


Figure 4.4. GIS Disturbance Pattern for Fire Mimicked Harvesting

Forest Growth Model. A forest growth model was then applied to the resulting landscape. This model grew the forest within the landscape forward in time through the use of a simple stochastic growth algorithm. The growth model projected the landscape to 60 years and 120 years post-disturbance so quantitative analysis could be performed for land use availability. The growth model was based on common forest succession knowledge for lodgepole pine as it relates to understorey growth. A random variable was added to the forest growth algorithm to improve the age class distributions and to make the distribution and variation in growth more realistic. This random variable added a fire probability to stands over 150 years of age, creating random fire-based regeneration in the growth model. The development and application of these modelling approaches was accomplished by the GIS technician, Pearson Farnsworth.

Land Use Availability Models. The calculation of land use availability for traditional activities was based on related landscape criteria. The criteria were determined by conglomerating the interview information, overlay maps, archival information, ecological forest information and biological information on wildlife habitat. The combined information sources facilitated the selection of representational aboriginal uses and the determination of corresponding landscape criteria. The aboriginal land uses in the modelling were based on moose habitat and black bear habitat availability (hunting), pine marten habitat

availability (furbearer trapping), and berry picking sites. Features or points relating to these uses as uncovered in the interviews and mapping exercises were analyzed using raster modelling. Simple point-in-polygon approaches were also used to determine the average set of landscape criteria, including mean forest cover type, associated with each activity within the legacy forest.

Hunting Areas. Two models deal with the hunting aspects of the research: moose and black bear. Both of these species are significant to aboriginal land use in the area.

The model to determine land availability for moose took into account the following points. All identified moose hunting points were found to be very close to water bodies of significant size; therefore presence of aquatic feeding areas was deemed important. Adequate forage and cover for the species were the other fundamental habitat determinants chosen for this species (Demarchi 1983, 3). Criteria chosen for identifying appropriate moose areas in the landscape therefore included aquatic feeding areas, early seral stage stands (usually less than 25 years of age) and adequate cover surrounding these feeding areas. Seasonal variations in ungulate habitat suitability were not factored into this model. Within the model, aquatic feeding areas were indicated by buffering water bodies with a 300 metre edge. Another factor considered in the model was perimeter to area ratio. This factored

into the selection of forage areas because of the edge required for anti-predator cover. The substantial home range of the species also needed to be accounted for in spatial configurations.

Technically, the moose habitat model was devised by visiting each polygon of the landscape that was not a water body and choosing a point within in. The distance to the closest water body and the distance to the closest early seral stage was then determined for each point. These distances were recorded for subsequent processing. A query function was used on the distance values to determine if there were adequate resources (aquatic feeding and early seral vegetation) to form a travel corridor between them. It was important that the animal did not have to cross a large opening to access these areas at any time since moose will not venture more than a few hundred metres into open areas to get to cover or food sources. Once these corridors were determined, the sum of the corresponding and connecting suitable land base area was taken.

The black bear model also involved travel corridors, but of upland sites. Dense cover of mixed wood in low lying areas and the presence of denning sites for winter were the determining criteria. The scale of Resource Use Area I was somewhat constrained by its size, with respect to bear modelling. The large habitat range of bears usually calls for a larger scale regional modelling base, that was not available in this research.

Technically, the bear model was first initiated by buffering all areas of disturbance by 1000 metres and giving them a time of impact attribute. Suitable low-lying mixed wood stands on the landscape were identified and flagged. At 60 years areas where logging had not occurred in the past five years were deemed temporally suitable for bear habitat. Low-lying mixed wood denning sites within the acceptable temporal ranges were located. If there were any forest openings (disturbance) aged between 5 and 30 years, these areas were identified as areas for potential foraging for berries, grass and forbs. All these areas were intersected to find land that would be suitable for black bears.

Furbearer Trapping Areas. The trapping model was based on land use availability for pine marten habitat. Pine marten was selected as the indicator species for trapping since it is commonly trapped in the research area, as are lynx, fox, and beaver. Pine marten was also identified by the interviewees as a species in perceived decline and as one that caused much concern.

Marten are generally associated with climax coniferous forests and their decline is often attributed to logging activities or fire (Soutiere 1979, 850; Stordeur 1986, 25). Marten tend to favour uncut forest landscapes with significant cover. Cover and amount of available forage for prey relates to habitat availability for marten as they hunt for voles and other small animals (Stordeur 1986, 17-18). Spatially, marten also require a home range size of

a minimum 3 km^2 for breeding. Contiguous tracts of habitat that allow dispersion and interbreeding are therefore required for suitable habitat.

The criteria used to find suitable land for marten included appropriate crown closure, age class and contiguous area. Specifically, potential habitat areas were required to be forest stands of a coniferous canopy species, usually lodgepole pine. Furthermore, stands needed to be composed of late seral stages of more than 140 years with crown closures of more than 80%. To accommodate the contiguous home range required for suitable habitat, all suitable polygons found were dissolved of their inner boundaries (aggregation of similar polygons) and areas of less than 3 km^2 were then deleted.

Berry Picking Areas. Berry picking sites were identified based on amount of clearing, site type and stage of succession. Suitable sites were chosen as being less than 20 years of age with a sandy soil or sandy/loam soil type. A simple logical query was applied to identify the polygons matching these characteristics.

The calculation of available land for aboriginal use, based on the criteria as explained above, was performed on all the post-disturbance digital landscapes. The available land for each traditional activity was calculated using a land use matrix

database that counted pixels with appropriate biological characteristics remaining at each time point post disturbance.

CHAPTER V

IMPACTS AND ISSUES

RESULTS AND THEIR INTERPRETATION

The application of the models to the hypothetical digital landscape yielded a variety of results that merit discussion. Each of the disturbance patterns affected the landscape in a different manner. The landscape affected by the conventional harvest disturbance pattern became quite fragmented, especially in the long-term. The natural fire pattern significantly disturbed the landscape in the short-term, but the landscape evolved to near its original state over the 120 year period. The fire-mimicked harvest pattern closely approximated natural landscape evolution with less fragmentation on the landscape than conventional harvesting. Further to the overall impacts of the disturbances, the manner in which the selected species and accompanying activities responded to disturbance-based landscape change varied significantly.

Table 5.1 shows the percentage of available land per activity that is calculated by dividing the amount of land remaining at each time point by the total available land area of the legacy forest (26,097 hectares). The modelling results for marten seemingly show that, compared with the other disturbances, conventional harvesting leads to the highest available percentage of land at impact. By year 120, however, all disturbances are quite close in their resulting percentages. The percentage results for berries

also show conventional harvesting to be preferable at impact with over 99% of the landscape meeting the criteria for berry availability. Again all three results taper down to nearly identical levels by year 120. Moose results, however, show natural fire as the preferred disturbance for this activity. Moose habitat was drastically altered by conventional harvesting and nearly extinguished by year 120 with only 0.2% available land remaining. Bear results also overwhelmingly showed natural fire as the preferred disturbance, with the landscape bouncing back to 100% availability by year 60. For both moose and bear, fire-mimicked harvesting came close to approximating natural disturbance in terms of future land availability. Possible reasons for these responses are discussed in the following section.

Table 5.1. Numeric Modelling Results for Land Availability Post-Disturbance

	Marten	Berries	Moose	Bear
Conventional Harvest (year 0)	11.0%	99.6%	10.2%	66.3%
Conventional Harvest (year 60)	22.9%	24.5%	13.1%	44.7%
Conventional Harvest (year 120)	27.0%	14.4%	0.2%	33.3%
Natural Fire (year 0)	4.9%	49.7%	31.0%	68.3%
Natural Fire (year 60)	14.6%	29.7%	26.4%	100%
Natural Fire (year 120)	22.9%	15.9%	16.6%	100%
Fire-Mimicked Harvest (year 0)	4.2%	55.6%	20.9%	76.0%
Fire-Mimicked Harvest (year 60)	19.6%	22.4%	15.6%	76.0%
Fire-Mimicked Harvest (year 120)	23.6%	15.0%	9.5%	82.6%

AVAILABLE LAND FOR TRAPPING POST-DISTURBANCE. Figures 5.2, 5.3 and 5.4 are the resulting GIS landscape maps showing available land for trapping post-disturbance. As mentioned, the trapping model criteria were based on land use availability for pine marten habitat. The maps show increasing availability over time for the species in all disturbance scenarios. Though availability is reduced in all scenarios at impact, the landscape seems to recover at a similar rate regardless of disturbance type. These particular results do show marginally higher availability with conventional harvesting (figure 5.2.). This outcome, however, needs to be interpreted with care because of scale issues.

The landscape scale of the modelling may have been too large to capture accurate results for this species. The marten's small home range (3 km^2) makes it more susceptible to fragmentation at a smaller scale than the given digital landscape. The introduction of a random variable in the forest growth model also affected the results by not creating large unrealistic areas of older age classes, a preferred marten habitat. A preliminary run of the models achieved these types of results which were questioned and re-assessed. The improved age-class representation in the growth model improved the validity of the research and made it a truer representation of a real forest. In addition, the digital landscape used in the modelling process did not account for road

construction and silvicultural practices associated with harvesting that also impact trapping.

Analysis of these results led to the conclusion that marten are affected by disturbance more temporally than spatially. In the long term, trapping was less affected by the pattern of disturbance than by the time required for the landscape to recover. In the context of the overall aboriginal use landscape, this is a factor that needs to be considered in managing the rate of change on the landscape.

Figure 5.2. Available Land for Furbearer Trapping* after Conventional Harvest Disturbance over 120 years

Available for Aboriginal Land Use of Furbearer Trapping

Disturbance applied to Legacy Forest at impact, 35 and 75 years.
Available Land for this use in Legacy Forest = 10.95%
GIS Model based on habitat suitable for pine marten.

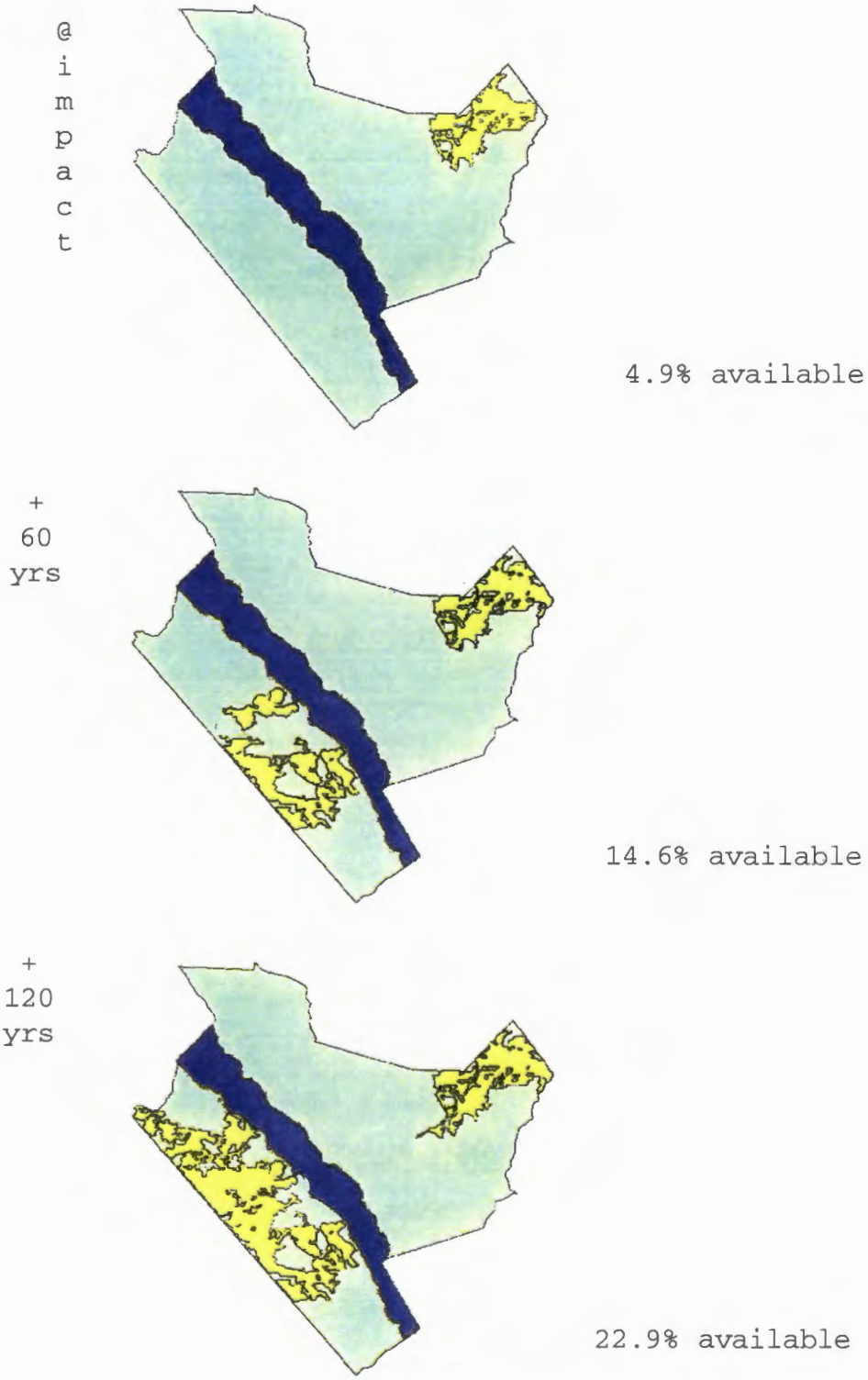


Figure 5.3. Available Land for Furbearer Trapping* after Natural Fire Disturbance over 120 years

Available for Aboriginal Land Use of Furbearer Trapping

Disturbance applied to Legacy Forest at impact only.
Available Land for this use in Legacy Forest = 10.95%
GIS Model based on habitat suitable for pine marten.

Figure 5.4. Available Land for Furbearer Trapping* after Fire Mimic Harvest Disturbance over 120 years

Available for Aboriginal Land Use of Furbearer Trapping

Disturbance applied to Legacy Forest at impact and 75 years.
Available Land for this use in Legacy Forest = 10.95%

AVAILABLE LAND FOR BERRIES POST-DISTURBANCE. Figures 5.5, 5.6 and 5.7 are the resulting GIS landscape maps showing available land for berries post disturbance. The maps at impact show high levels of availability across much of the landscape in all three scenarios, especially in conventional harvest. A notable feature on the maps is the different shape of the available land. In the conventional harvest scenario (figure 5.5.), the available land at 120 years is in the form of small blocks across the landscapes. This differs from the more contiguous irregular pattern of availability resulting from the other scenarios. Overall these maps simply show that berry availability changes over time. They are most available immediately after a disturbance and are quite abundant in the clearcut areas and in the fire patterned areas (natural and mimicked) in the short term. Their availability in the future will likely continue to follow this trend regardless of disturbance type.

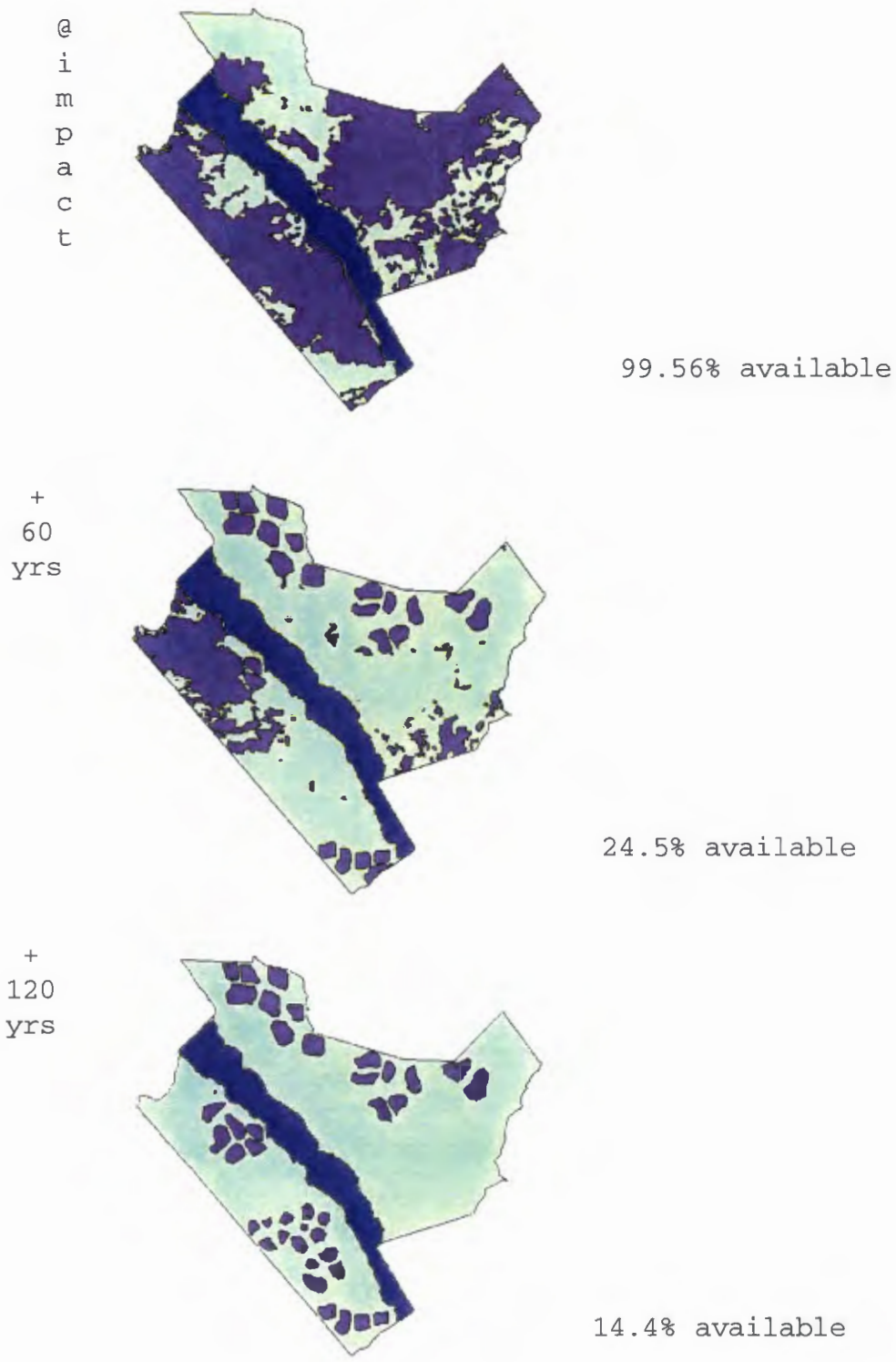


Figure 5.5. Available Land for Berry Picking after Conventional Harvest Disturbance over 120 years

Available for Aboriginal Land Use of Berry Picking

Disturbance applied to Legacy Forest at impact, 35 and 75 years. Available Land for this use in Legacy Forest = 63.6%

Figure 5.6. Available Land for Berry Picking after Natural Fire Disturbance over 120 years

Available for Aboriginal Land Use of Berry Picking

Disturbance applied to Legacy Forest at impact only.
Available Land for this use in Legacy Forest = 63.6%

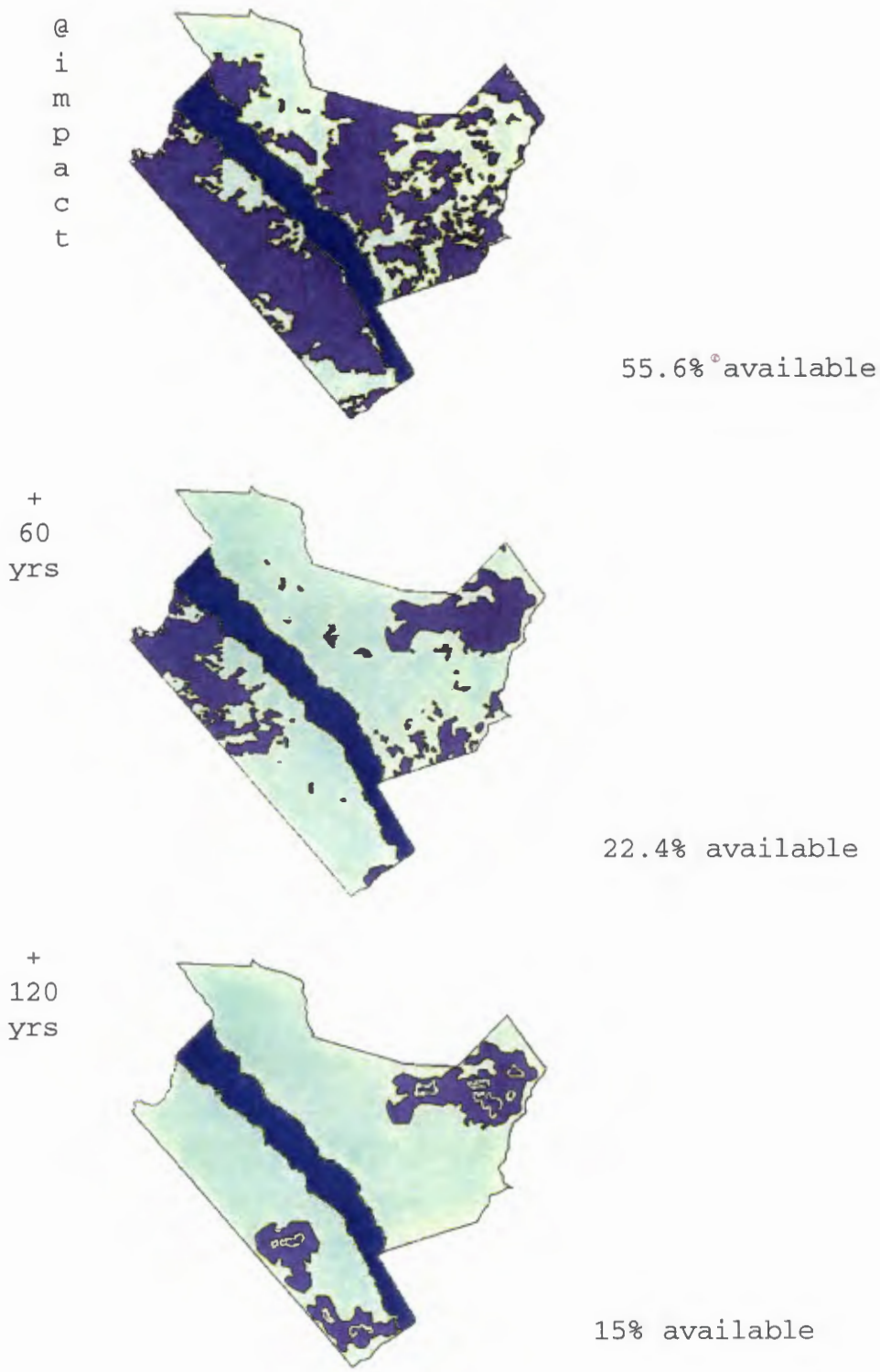


Figure 5.7. Available Land for Berry Picking after Fire Mimic Harvest Disturbance over 120 years

Available for Aboriginal Land Use of Berry Picking

Disturbance applied to Legacy Forest at impact and 75 years.
Available Land for this use in Legacy Forest = 63.6%

AVAILABLE LAND FOR HUNTING POST-DISTURBANCE. Figures 5.8 to 5.13 inclusive, are the resulting GIS landscape maps showing available land for hunting post-disturbance. As discussed, the hunting of large mammals such as moose and bear is an important activity for the Lake Babine people both for sustenance and as a cultural activity.

The most striking results regarding moose availability are illustrated by the maps in figure 5.8. (conventional harvesting). The reduction of available land over time is dramatically illustrated with the final map showing less than 1% available at 120 years. Overall, all three scenarios show a reduction in available land over time, despite an initial rise in availability at impact caused by the disturbances. Disturbance in general provides preferred habitat for moose in the short-term by providing early seral stages of vegetation. Fire is the best disturbance for creating seral shrub ranges and for expanding grassland environments, creating modified plant communities suitable for ungulate habitat (Demarchi 1983, 12).

Though disturbance, including forest harvesting, may provide ecological patterns that support increased moose populations in the short-term, the number of moose available for aboriginal harvest may still vary. The fragmentation of the landscape in the long-term also severely interrupts travel corridors required by moose and reduces suitable habitat over time. Moose populations

are also influenced by road access and increased hunting pressure in the region by non-aboriginal hunters.

With respect to bear habitat availability, the maps in figure 5.12. show how natural fire disturbance is the preferred scenario for continued availability. Figure 5.11. shows how the conventional harvest scenario goes against the trend of increasing land availability over time. The main conclusion drawn from these maps is that fragmentation resulting from the conventional harvest pattern, adversely impacts availability for this activity. With increased return intervals of conventional harvesting spread out across the landscape, black bear habitat could become more fragmented and possible travel corridors could be interrupted.

The fire mimic harvest disturbance pattern (figure 5.13.) closely approximates the patterns of natural fire (figure 5.12.) and results in landscapes that are quite supportive of bear habitat. As mentioned, the scale of the modelling was somewhat constrained in the case of bear due to their extensive habitat range that expands far beyond the size of the chosen resource use landscape. Though the modelling results shows a landscape to be suitable for bear, it does not imply that the landscape is covered with the species, who may only occasionally cross a portion of it for food or shelter. A further limitation of the bear model in this research is the absence of other developments that affect its habitat. Increased occurrence of encounters with humans due to

road access into a habitat disturbs bear populations through poaching, accidents and the disturbance of dens and feeding areas.

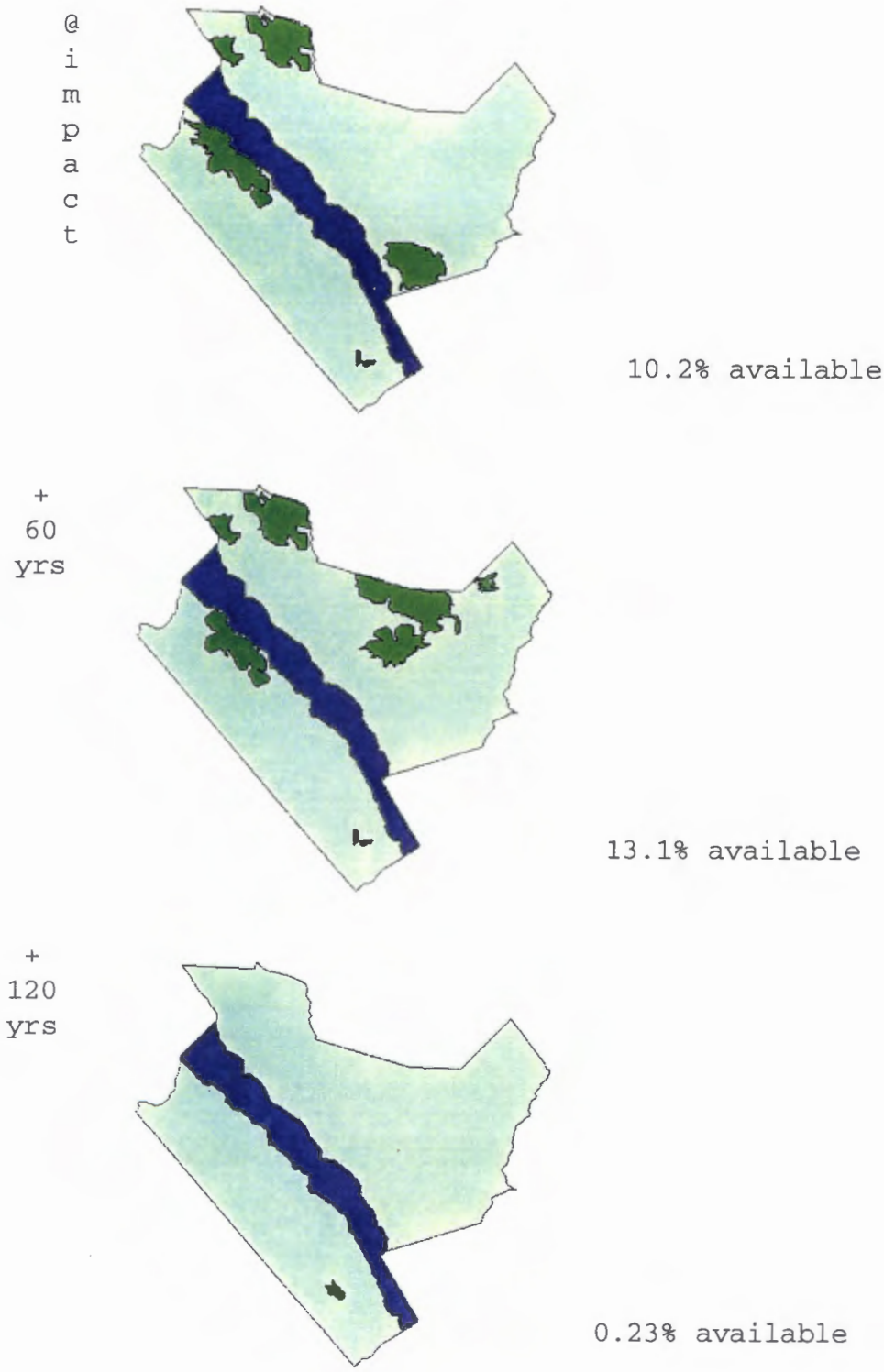


Figure 5.8. Available Land for Hunting Moose after Conventional Harvest Disturbance over 120 years

Available for Aboriginal Land Use of Moose Hunting

Disturbance applied to Legacy Forest at impact, 35 and 75 years. Available Land for this use in Legacy Forest = 5.3%

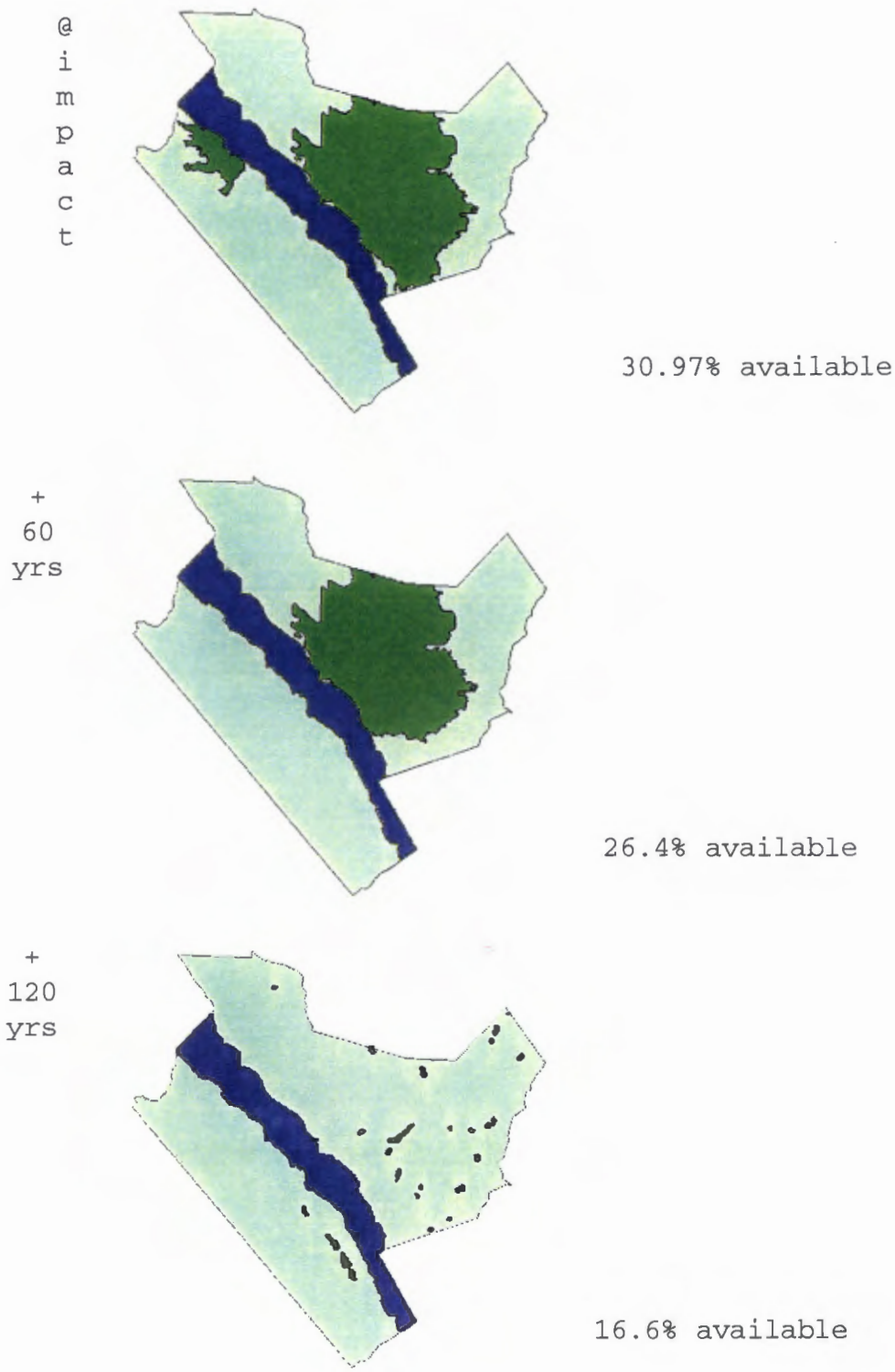


Figure 5.9. Available Land for Hunting Moose after Natural Fire Disturbance over 120 years

Available for Aboriginal Land Use of Moose Hunting

Disturbance applied to Legacy Forest at impact only.
Available Land for this use in Legacy Forest = 5.3%

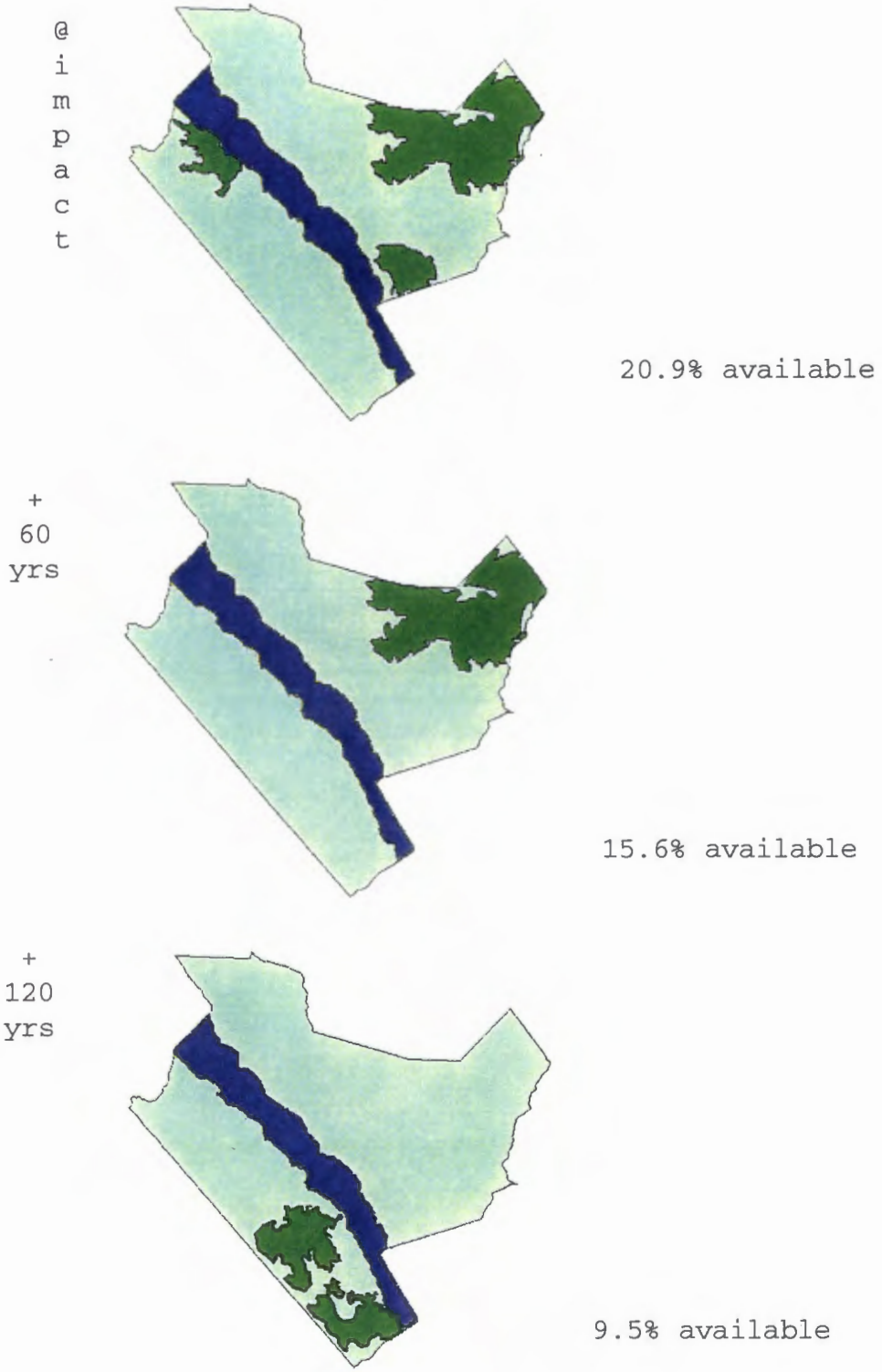


Figure 5.10. Available Land for Hunting Moose after Fire Mimic Harvest Disturbance over 120 years

Available for Aboriginal Land Use of Moose Hunting

Disturbance applied to Legacy Forest at impact and 75 years.
Available Land for this use in Legacy Forest = 5.3%

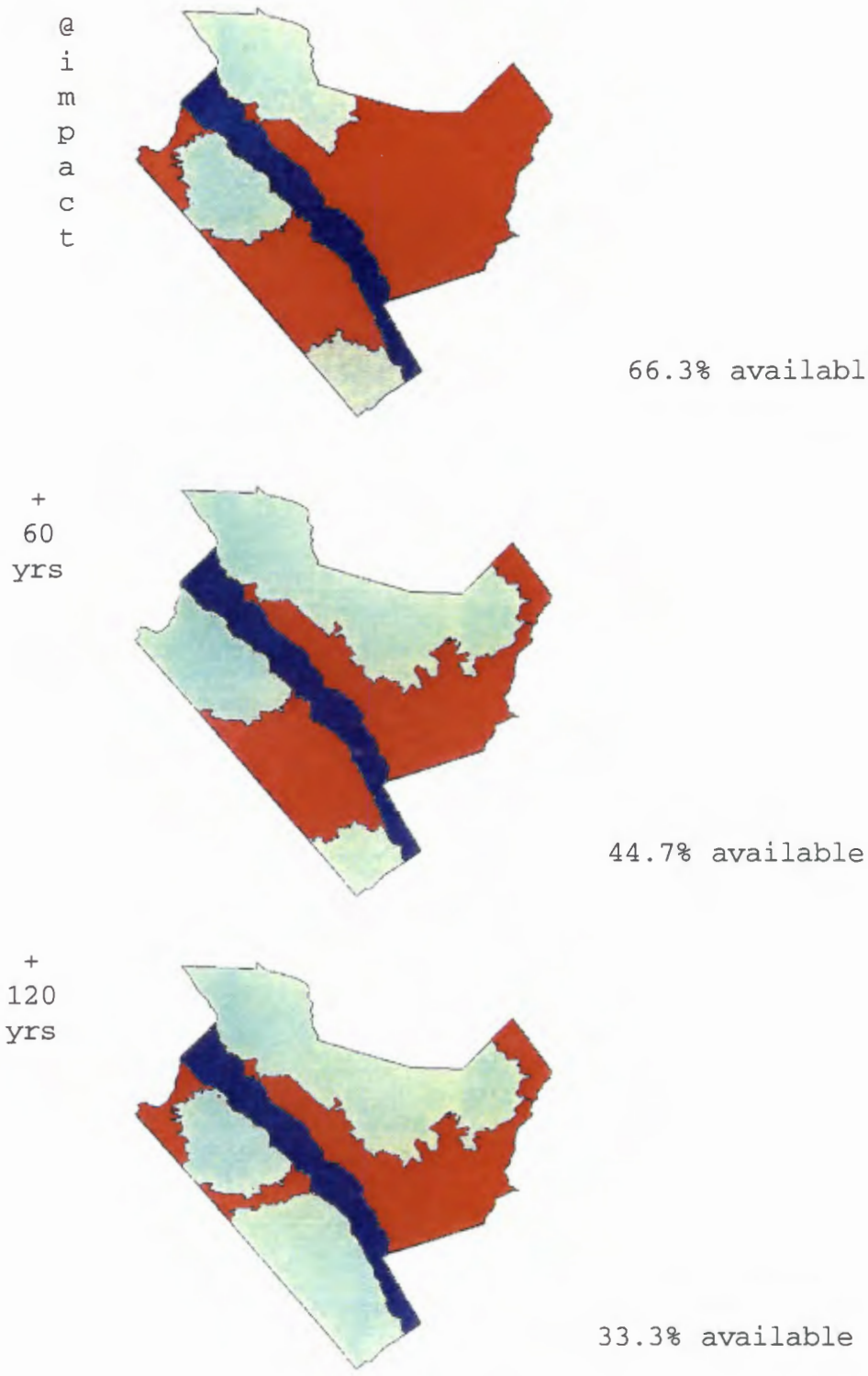


Figure 5.11. Available Land for Hunting Bear after Conventional Harvest Disturbance over 120 years

Available for Aboriginal Land Use of Bear Hunting

Disturbance applied to Legacy Forest at impact, 35 and 75 years. Available Land for this use in Legacy Forest = 100%

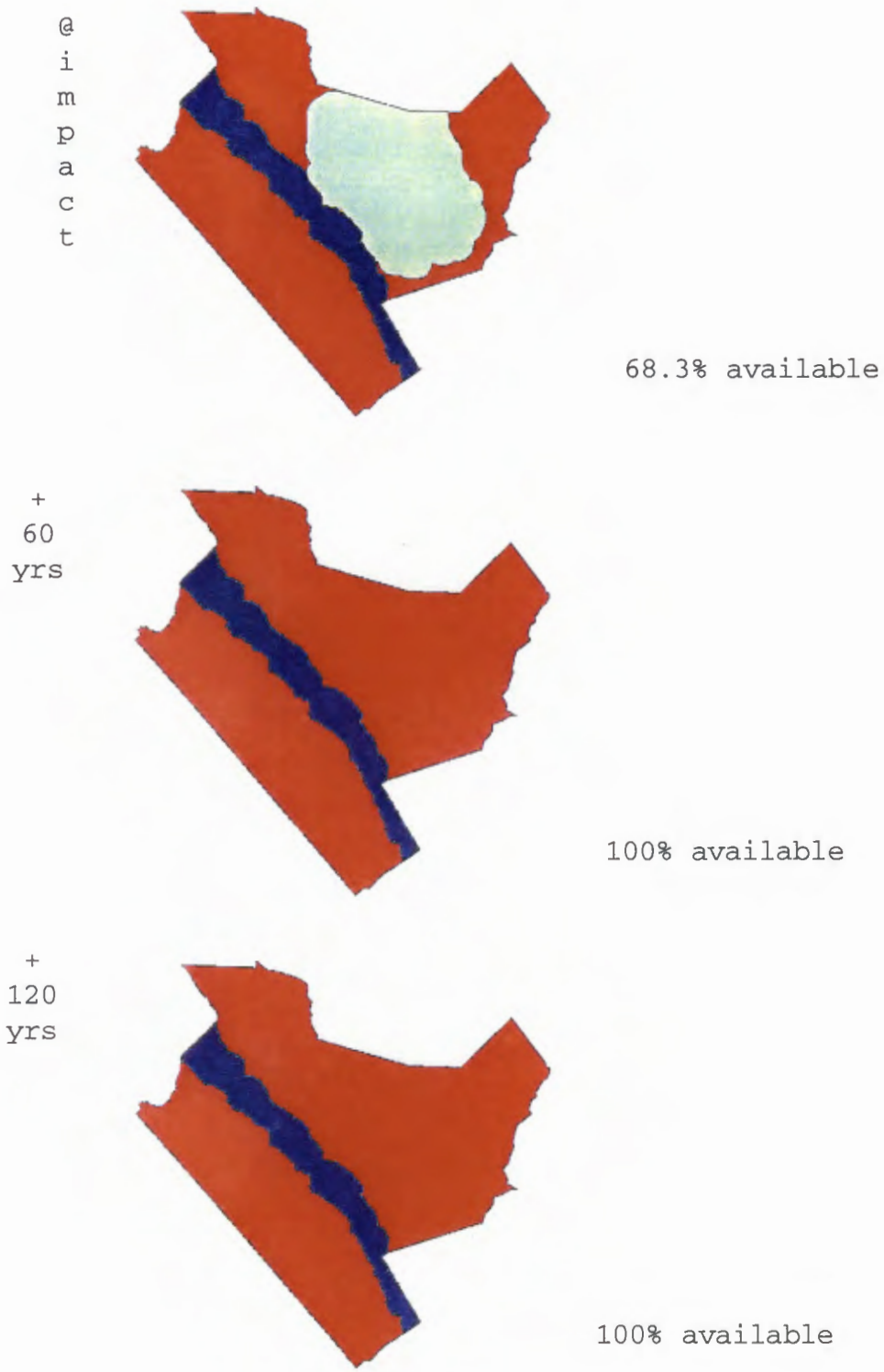


Figure 5.12. Available Land for Hunting Bear after Natural Fire Disturbance over 120 years

Disturbance applied to Legacy Forest at impact only.
Available Land for this use in Legacy Forest = 100%

Figure 5.13. Available Land for Hunting Bear after Fire Mimic Harvest Disturbance over 120 years

Available for Aboriginal Land Use of Bear Hunting

Disturbance applied to Legacy Forest at impact and 75 years.
Available Land for this use in Legacy Forest = 100%

Response to change can also be illustrated in the form of bar charts. Figure 5.14. shows the changes in availability in this format. The rate and direction of change is different in each case. Some of the more notable features of these charts are described below. The data relates to the numeric findings listed in Table 5.1.

For marten, the availability increases in the long-term in all three disturbances. The closely matched bars in the chart show that all three achieve approximately the same level of availability at the 120 year time point. In the case of berries, the chart shows a downward slope indicating reduced availability in the long-term. The significant feature of this chart is the extremely high level of availability with conventional harvesting at impact. The moose chart shows a drastically shorter bar for conventional harvesting at all three time points, that can be interpreted to represent an overall lesser quality landscape when affected by this disturbance. For bear, the bar representing changing availability with conventional harvesting is of interest, as it goes against the natural trend of increased availability over time.

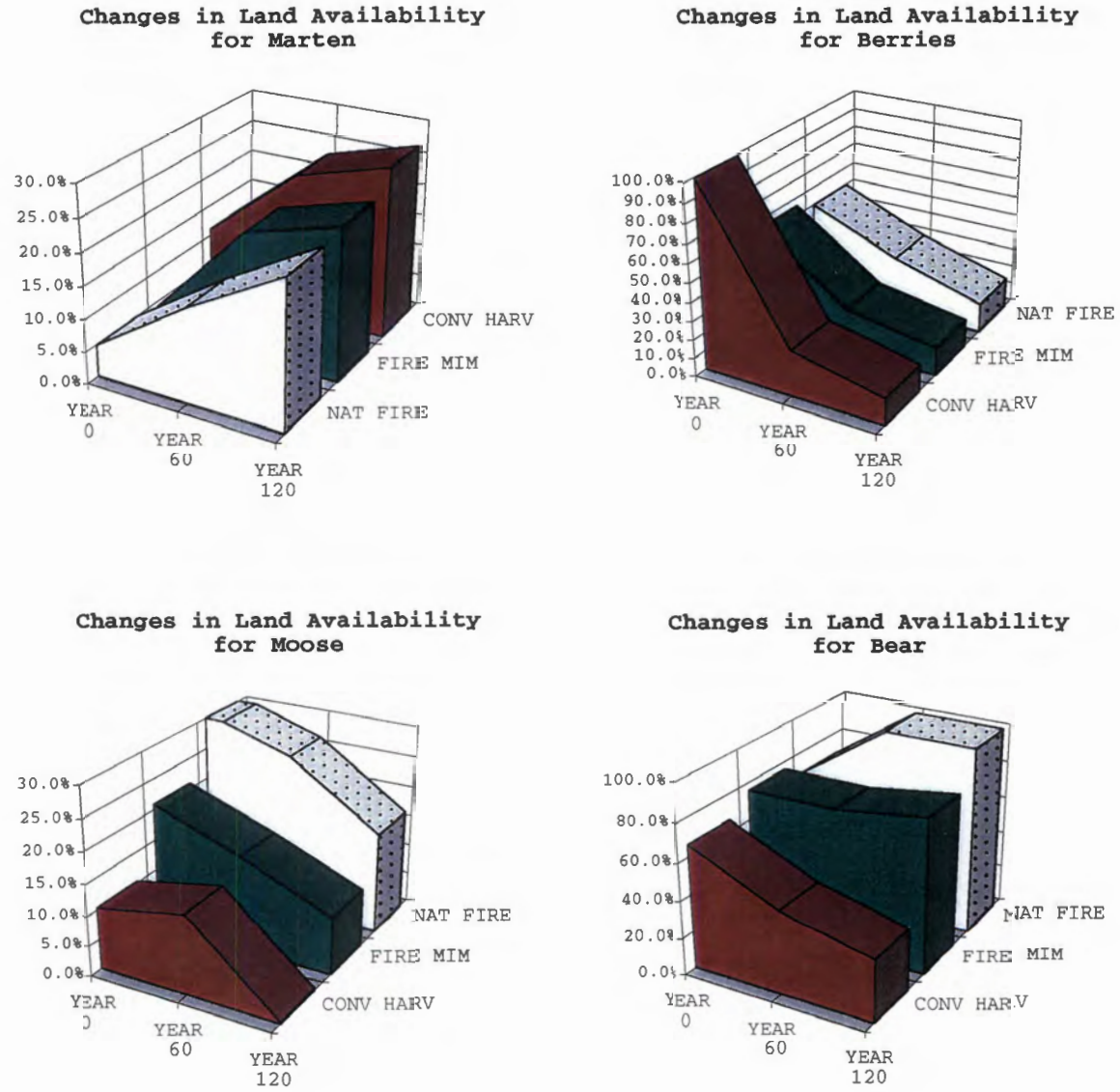


Figure 5.14. Changes in Land Availability as Depicted in Chart Format

COMPOSITE AVAILABLE LAND FOR ABORIGINAL USES. Figures 5.15 to 5.18 inclusive are a series of composite maps that summarize all the activities together on the landscape. By viewing the total aboriginal use landscape as a whole, the cumulative impacts of disturbance-based change are illustrated. Figure 5.15. (conventional harvesting) shows a drastically more fragmented landscape with several unusable areas showing around small patches of available land. Though all of the uses are still present on the landscape, the available areas are smaller and further apart. Figure 5.17. (fire-mimicked harvesting) shows a series of landscapes that are closely related to a natural evolution as in figure 5.16. (natural fire). Larger patches and adjoining uses characterize these landscapes.

Figure 5.18. is a comparison of the available land for aboriginal uses post-disturbance at 120 years. This gives a striking visual summary of the possible landscapes of the future. The future aboriginal use landscape affected by conventional harvest disturbance is very fragmented and less desirable for aboriginal uses. The centre map is a natural landscape of the future, as affected by natural fire. The fire-based landscape of the future illustrates one possible version of natural change. The landscape is, however, fully available for the entire spectrum of uses. The fire-mimicked harvest landscape is an attempt to approximate this pattern and the map shows a close match, with most of the landscape available for use.

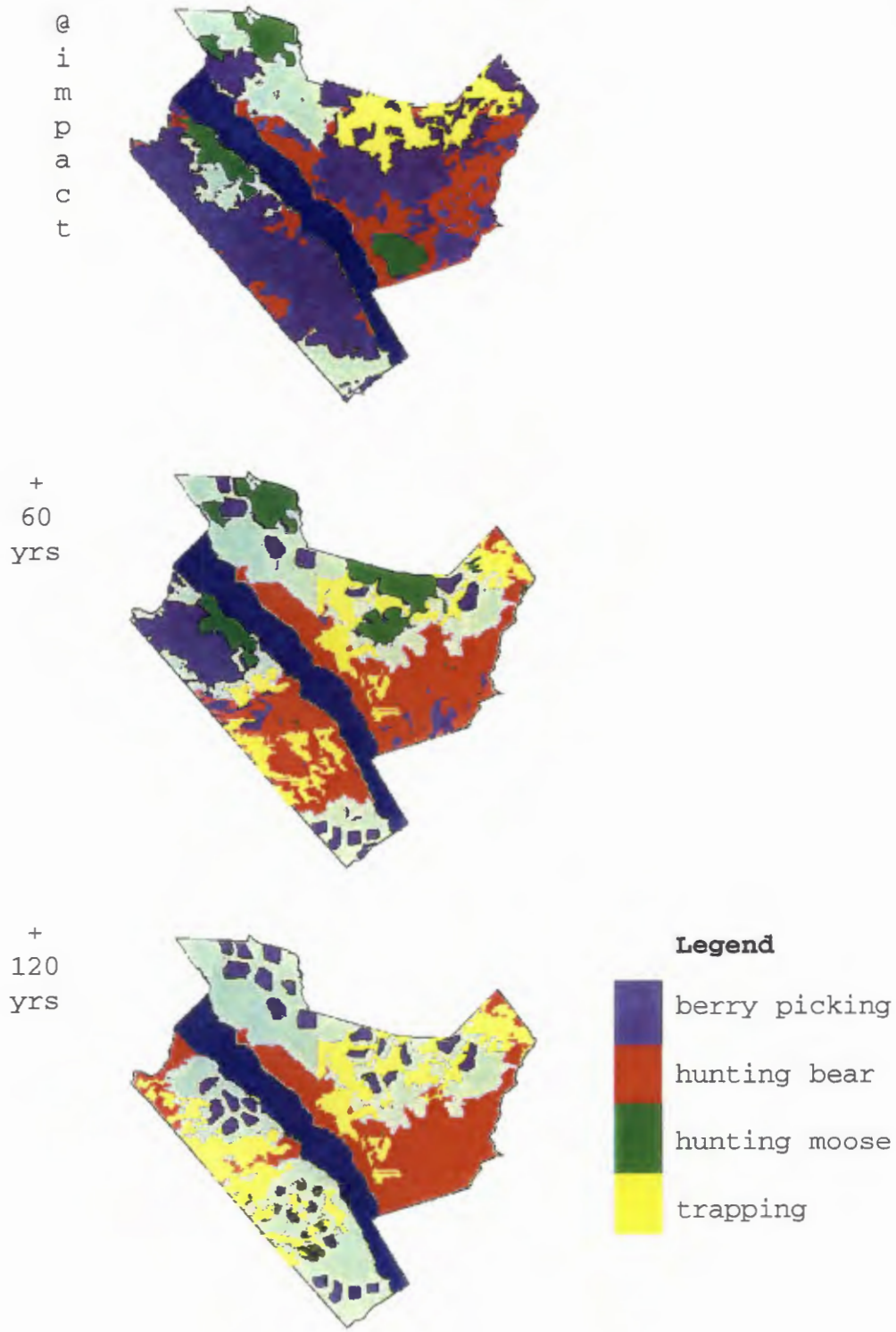


Figure 5.15. Composite Available Land for Aboriginal Uses after Conventional Harvest Disturbance over 120 years

Disturbance applied to Legacy Forest at impact, 35 and 75 years

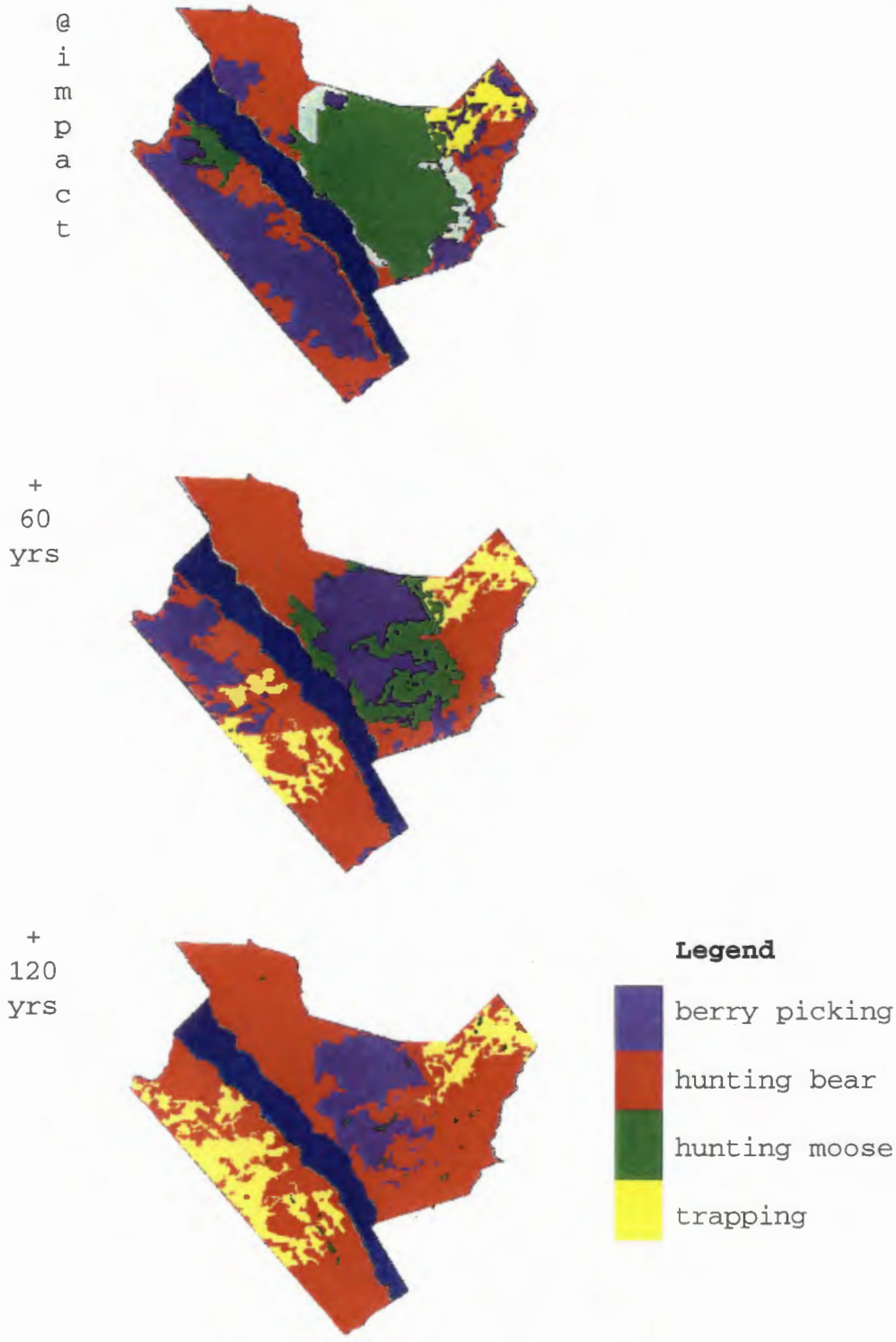


Figure 5.16. Composite Available Land for Aboriginal Uses after Natural Fire Disturbance over 120 years

Disturbance applied to Legacy Forest at impact only.

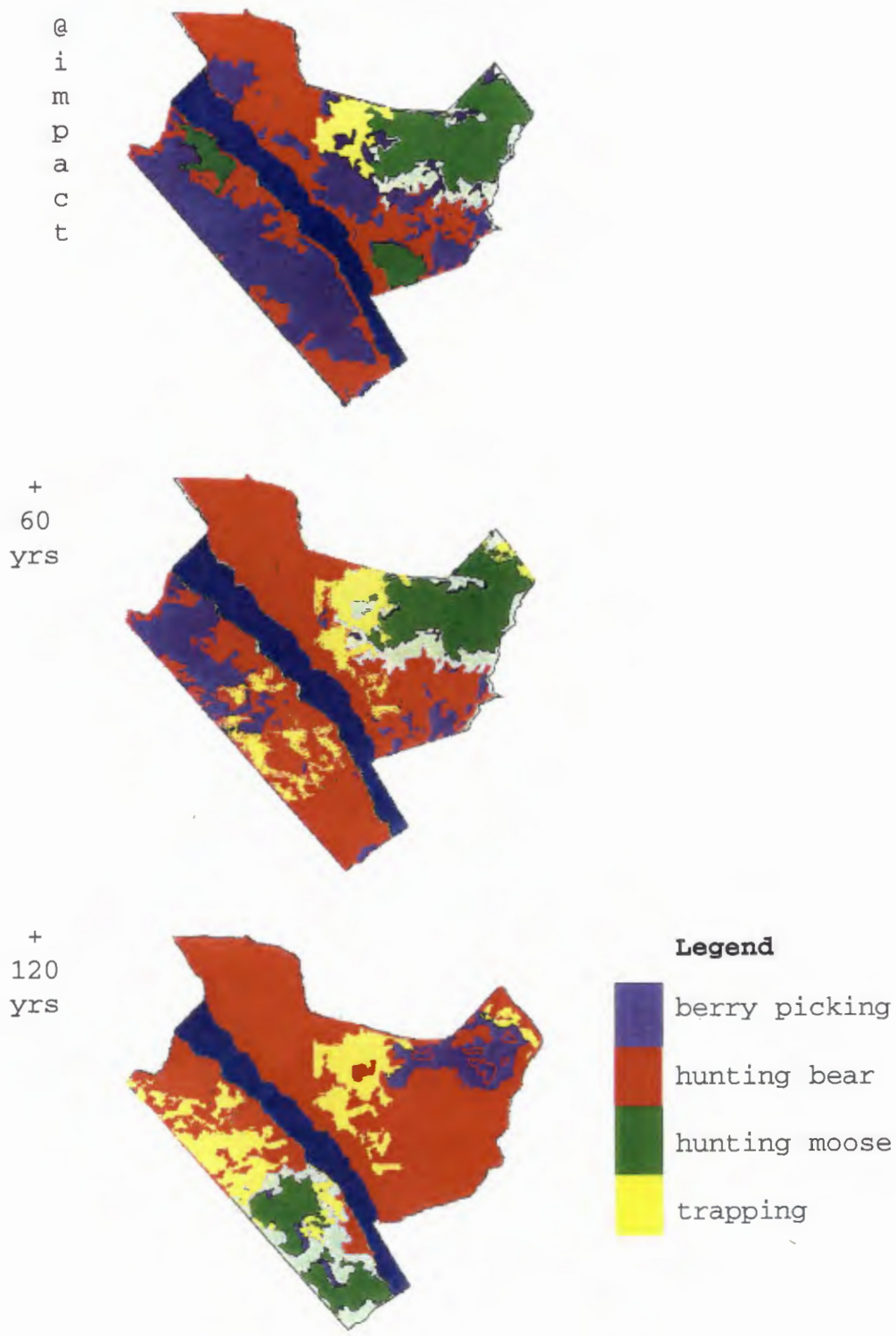
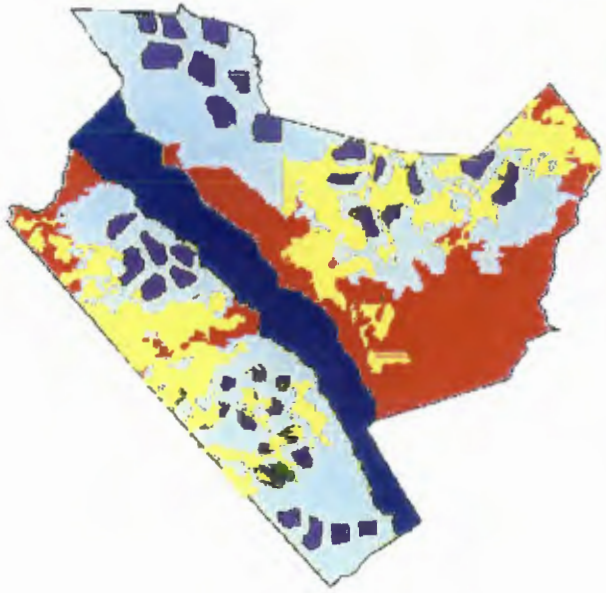
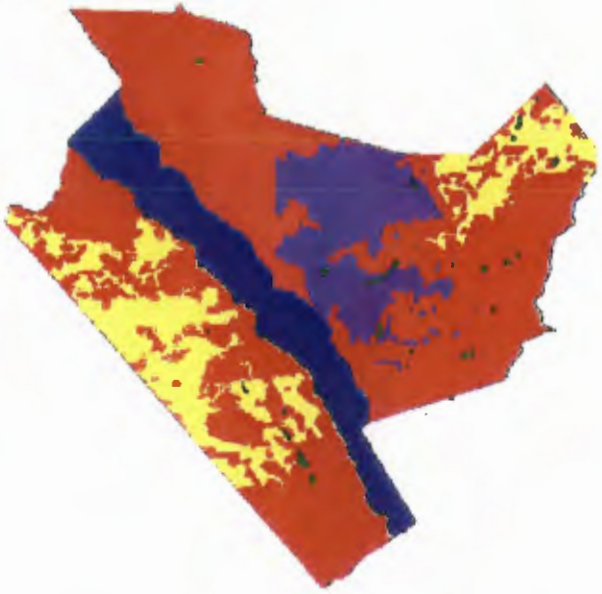


Figure 5.17. Composite Available Land for Aboriginal Uses after Fire Mimic Harvest Disturbance over 120 years

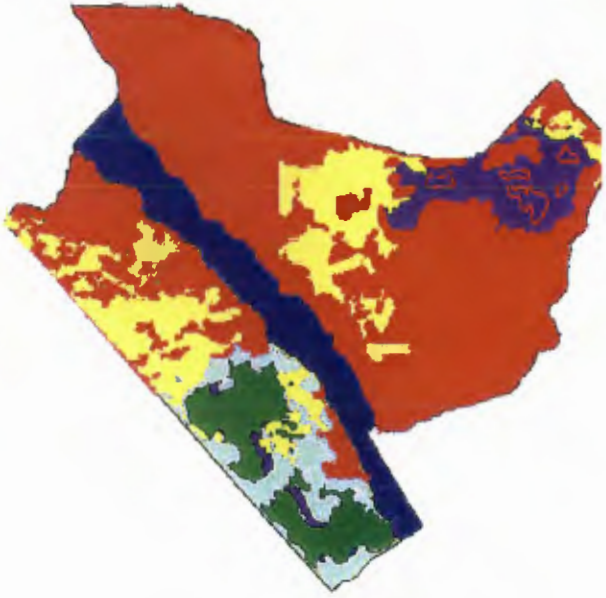
Disturbance applied to Legacy Forest at impact and 75 years.



Scenario 1: the future aboriginal use landscape in 120 years after CONVENTIONAL HARVEST
result: fragmented landscape with many areas unsuitable for use



Scenario 2: the future aboriginal use landscape in 120 years after NATURAL FIRE
result: natural evolution and a fully restored landscape



Scenario 3: the future aboriginal use landscape in 120 years after FIRE MIMICKED HARVEST
result: almost fully restored landscape with many useable areas

Legend

- berry picking
- hunting bear
- hunting moose
- trapping
- not useable

Figure 5.18. Comparison of the Available Land for Aboriginal Uses Post-Disturbance at 120 years.

IMPLICATIONS FOR FOREST MANAGEMENT

This research into disturbances, the landscape patterns they create and the impacts on aboriginal forest uses is relevant to both ecological and socio-economic aspects of forest management. Achieving balance between the various demands on a forest is the key to effective forest management. The forest ecosystem and the cultural values of the people both need to be protected.

ECOLOGICAL IMPLICATIONS.

The GIS modelling in this research illustrates the landscape level implications of various disturbance patterns. In order to maintain a landscape that is ecologically functioning and available for aboriginal use, patterns of conventional harvesting should be avoided. The landscape scale of this research allows for a good visualization of the effects of fragmentation. The maps show that natural fire disturbance leads to a completely functioning landscape well into the future. This, of course, makes sense because this is how these forests have evolved for thousands of years. The fire-mimicked patterns give results that approximate this natural trend while allowing for economic growth in forestry.

Experiments in alternate harvesting patterns, such as the fire-mimicked patterns, are important contributions to the preservation of forest health at the ecological landscape level (Franklin and Forman 1987; Hansen et al. 1991; Delong 1997). It is possible to mimic the irregular mosaic-like spatial patterns of natural

disturbance as well as leave behind snags and debris that mimic the structural patterns of them. Disturbance-based patterns, such as fire-mimicked harvesting, provide an alternate view and a way to incorporate landscape level processes into forest management.

SOCIO-ECONOMIC IMPLICATIONS. The socio-economic implications within forest management relate to both the public and political pressures for responsible forestry and the protection of aboriginal uses. Increasingly, socio-economic concerns are being incorporated into resource management decision-making. Forests need to be managed in order to provide for a number of uses, including timber, recreation, wildlife and aboriginal uses. This research provides a representation of alternative forest uses on a landscape. This information and the manner in which it was collected can serve as an example of traditional land use research. Land use information, including aboriginal uses, is a vital part of an effective resource management decision-making process.

Meaningful involvement of First Nations in the industry is the first step towards ecologically responsible forestry that supports aboriginal uses now and in the future. A major challenge to the forest industry has been the creation of management structures that provide for meaningful participation by First Nation communities. One such mechanism under the Forest Practices Code of B.C. is the protection of "cultural heritage resources." Cultural

heritage resources are defined as a practice, object or site that is important to a group of people, like a First Nation (Forest Service of B.C. 1996). In theory, sites are to be recorded through traditional use studies and incorporated into forest management plans of companies working in the area. The Forest Service then, in theory again, works with First Nations and forestry companies to protect these sites. In practice, this level of cooperation and openness is still a very distant reality. This research provides a guide and an incentive to carry out and map cultural heritage sites and other aboriginal uses on a landscape.

IMPLICATIONS FOR FIRST NATIONS

ABORIGINAL LAND USE IN THE FUTURE. The composite maps showing aboriginal use availability on this landscape link the forest management issues to specific First Nation issues. An understanding of the impacts on the landscape allows First Nations an informed voice regarding the management of the resources within their traditional territories. Land use and landscape change information acquired during this research can be used in long-term resource management that satisfies economic, ecological and cultural needs of First Nations. A society with a profound dependence on a set of resources for its future and present well-being has a strong self-interest in managing those resources in the best way possible (Freeman and Carbyn 1988).

Today, many First Nations, including the Lake Babine Nation, are restoring their control of, and relationship with, their natural environments and the resources within them. This recovered responsibility is accompanied by tremendous economic and cultural challenges. The forestry sector is particularly so, with resources that have been mismanaged for decades and with complex political and legal issues that surround land tenure. First Nations involved in forestry must not only navigate political and industrial standards, they must also define successful and sustainable management strategies that meet the economic, social and cultural needs of their membership. This research and its findings will hopefully also be a contribution to these efforts.

RECOMMENDATIONS FOR FURTHER STUDY

This project represents the first formal attempt at mapping traditional aboriginal uses by this Nation and a significant learning curve was faced by all involved. This project examined landscape level processes and traditional land uses within two constrained areas in the Lake Babine watershed. There is a strong interest at all levels of the Nation to expand this research into several other traplines in the traditional territory. More in-depth interviews supplemented by geo-referencing activities are suggested. The research should strive to include archeological sites and the cataloguing of food and medicinal plant use, which were only briefly addressed in this research.

Due to its interdisciplinary nature, this thesis has touched upon a number of areas that merit further investigation. Further work on aboriginal activities, aboriginal land use mapping, GIS, landscape level interactions in forestry, and alternative forest harvesting methods and patterns, are all areas that could benefit from more specific continued research. The information gained in this research has, however, contributed to all of these fields and to the combined interdisciplinary practice.

CONCLUSION

This research and GIS modelling have allowed the visualization of a typical forest and the accompanying aboriginal uses at a landscape level. The results have clearly illustrated the level of impacts associated with various disturbance patterns and their compatibility with traditional aboriginal uses on this landscape. They have shown that specific activities respond variably to disturbance-based change on the landscape. They have also shown that the aboriginal use landscape as a whole is further affected by disturbance-based change both spatially and temporally. Conventional harvesting is shown to drastically fragment the landscape, especially in the long term, leaving a mosaic that is much less favourable for aboriginal uses in the future. Fire-mimicked harvesting on the other hand, provides a future landscape that is much closer to one created by natural disturbance and to which adaptation by wildlife and plant species is facilitated. This is turn, translates into possible continued aboriginal use.

The maintenance of an ecologically functioning forest landscape that is able to support traditional aboriginal uses, timber, recreation and wildlife will benefit all stakeholders long into the future.

Appendices

INFORMED CONSENT

Summer 1996

Land Use Interviews and Mapping

Impacts of Disturbance Regimes on Traditional Land Use and Cultural Practices of the Lake Babine Nation

Joint Research Project of the Lake Babine Nation and University of Northern BC (UNBC)

I, _____, have agreed to be in this research study on Impacts on Traditional Uses within my trapline area. I understand that one UNBC student and a Treaty Researcher will be present during my interview.

I understand that my participation is voluntary and that I will not be paid for interviews. I may decline to answer any or all questions and may withdraw from the interview at any time without any penalty. I consent to have the interview taped and a confidential copy of the transcribed interview kept at the Treaty Research Office in Burns Lake.

Maps and other information resulting from these interviews will be used for the purposes of this project only. Confidentiality regarding specific sensitive geographic locations will be protected on both computer (digital-GIS) and hard copy maps. If I should have any questions about the research I can contact the Treaty Research Office in Burns Lake.

_____ _____

Participant's Signature Date

_____ _____

Interviewer - UNBC
Angela Sinclair

Date

_____ _____

Interviewer - Lake Babine Nation
Norbert Dennis, Hereditary Chief (Ske leelh)

Date

UNBC Research Ethics Committee
Certificate of Ethics Approval

Name of Researcher: A. Sinclair

Title of Research Project: "Impacts of Disturbance Regimes on Traditional Land Use . . ."

I certify that this project was given ethics approval by the UNBC Research Ethics Committee

Signed: _____ **Date:** 26 Aug 96
Dean of Research and Graduate Studies

SELECTED BIBLIOGRAPHY

Alberta Society of Professional Biologists. (1986) Native People and Renewable Resource Management: 1986 Symposium of the Alberta Society of Professional Biologists. Edmonton, Alta.

Aberley, Doug. (1993) Boundaries of Home: Mapping for Local Empowerment. Gabriola Island, B.C.: New Society Publishers.

Alverson, William, Walter Kuhlmann, and Donald Waller. (1994) Wild Forests: Conservation Biology and Public Policy. Washington, D.C.: Island Press.

Barton, Nina. (1994) Landscape Ecology, Ecosystem Management and Landscape Design: Theory and Application to Forest Planning. Victoria, B.C.: Ministry of Forests B.C.

Bird, Beverly. (Winter 1995) "The Eagle Project: Re-mapping Canada From an Indigenous Perspective." Cultural Survival Quarterly 18: 23-24.

Bombay, Harry. (Spring 1993) "Many Things to Many People: Aboriginal Forestry in Canada is Looking Toward Balanced Solutions." Cultural Survival Quarterly 17: 15-18.

Brody, Hugh. (1988) Maps and Dreams: Indians and the British Columbia Frontier. Vancouver, B.C.: Douglas & McIntyre.

Carrier Linguistic Committee. (1973) Hanuyeh Ghun Utni-i (Plants of Carrier Country, British Columbia). Fort St. James, B.C.: Carrier Linguistic Committee.

Choices: Native Perspectives on Forests and Forestry. 4 (1996) Vancouver, B.C.: Forest Alliance of B.C.

Coxson, Darwyn. (1994) "Ecosystem and Community Health of the Nat'oot'en First Nation - Co-management Alternatives for the Babine Lake Watershed." Unpublished Proposal, University of Northern British Columbia, Prince George.

Delong, Craig. (1995) "Ecosystem Management in Sub-Boreal Plateau Landscapes: Lessons from Wildfire." Unpublished Paper, University of Northern British Columbia, Prince George.

Delong, Craig. (1997) "Ecological Characterization of Forest Island Remnants Left by Wildfire." Master's thesis, University of Northern British Columbia, Prince George.

Demarchi, D.A., B Fuhr, and B.A. Pendergast, et al. Wildlife Capability Classification for British Columbia: An Ecological Approach for Ungulates. Victoria, B.C.: Ministry of Environment, Lands and Parks, 1983.

Dene Cultural Institute. (1993) "Guidelines for the Conduct of Participatory Community Research." In Traditional Ecological Knowledge and Environmental Assessment, edited by Barry Sadler and Peter Boothroyd. Hull, Que.: Canadian Environmental Assessment Research Council.

Dene Cultural Institute. (1993) "Traditional Ecological Knowledge and Environmental Assessment." In Traditional Ecological Knowledge and Environmental Assessment, edited by Barry Sadler and Peter Boothroyd. Hull, Que.: Canadian Environmental Assessment Research Council.

Dimitrov, Peter. (July 1986) "An Investigation of the Carrier Sekani Registered Trapline System." Unpublished Report, Prince George, B.C.: Klarion Enterprises for Carrier Sekani Tribal Council.

Drost, Helmar, Lee Crowley, and Richard Schwindt. (1995) Market Solutions for Native Poverty: Social Policy for the Third Solitude. Social Policy Challenge Series #11. Ottawa, Ont.: C.D. Howe Institute.

Drushka, Ken, Bob Nixon, and Ray Travers, eds. (1993) Touch Wood: B.C. Forests at the Crossroads. Madeira Park, B.C.: Harbour Publishing.

Duerden, Frank, and Valerie Johnson. (1993) "GIS and the Visualization of First Nations Land Selections." GIS'93 Proceedings. Vancouver, B.C.

Einbender, LeGrand. (1990) "Social Forestry in The Navajo Nation: Implications and Opportunities for Multiresource Management." Master's Thesis, Northern Arizona University, Flagstaff.

Elias, Peter Douglas. (1991) Development of Aboriginal People's Communities. North York, Ont.: Captus Press.

Fiske, Jo-Anne, and Betty Patrick. (1997) "C'iz dideen khat, When Plumes Rise: The Way of the Lake Babine Nation." Unpublished manuscript, Burns Lake, B.C.: Lake Babine Nation.

Forest Service of B.C. (1996) "Workshop on the Forest Practices Code for First Nations." Documentation from workshop. Victoria, B.C.: Forest Service of B.C.

Forman, Richard, and Michel Godron. (1986) Landscape Ecology. New York: John Wiley & Sons.

Forman, Richard. "Ecologically Sustainable Landscapes: The Role of Spatial Configuration." In Changing Landscapes: An Ecological Perspective, edited by I.S. Zonneveld and Richard Forman. New York: Springer-Verlag, 1990.

Forman, Richard. Land Mosaics: The Ecology of Landscapes and Regions. Cambridge: Cambridge University Press, 1995.

Franklin, J.F., and Richard Forman. (1987) "Creating Landscape Patterns by Forest Cutting: Ecological Consequences and Principles." Journal of Landscape Ecology 1: 5-18.

Freeman, Milton, and Ludwig Carbyn. (1988) Traditional Knowledge and Renewable Resource Management in Northern Regions. Edmonton, Alta.: Boreal Institute for Northern Studies, University of Alberta.

Gillis, Anna Maria. (September 1990) "The New Forestry: An Ecosystem Approach to Land Management." Bioscience 40: 558-562.

Hackler, James C. (1958) "Factors Leading to Social Disorganization among the Carrier Indians at Lake Babine." Master's thesis, San Jose State College, San Jose.

Haines-Young, Roy, David Green, and Stephen Cousins, eds. (1993) Landscape Ecology and GIS. London: Taylor & Francis.

Hammond, Herb. (1991) Seeing the Forest among the Trees: The Case for Wholistic Forest Use. Vancouver, B.C.: Polestar Press.

Hansen, A.J., T.A. Spies, F.J. Swanson, et al. (June 1991) "Conserving Biodiversity in Managed Forests: Lessons from Natural Forests." Bioscience 41: 382-392.

Harcombe, Andrew. (1984) Wildlife Habitat Handbooks for B.C.: Problem Analysis. Kamloops, B.C.: B.C. Ministry of Environment.

Hudson, Douglas R. (1972) "The Historical Determinants of Carrier Social Organization: A Study of North West Athabascan Matriliny." Master's thesis, McMaster University, Hamilton.

Hudson, Douglas R. (1983) "Traplines and Timber: Social and Economic Change among The Carrier Indians Of Northern British Columbia." Ph.D. diss., University of Alberta, Edmonton.

Hunter, Malcolm. (1993) "Natural Fire as Spatial Models for Managing Boreal Forests." Biological Conservation 65: 115-120.

Jenness, Diamond. (1943) The Carrier Indians of the Bulkley River: Their Social and Religious Life. Bulletin 133, Washington, D.C.: Bureau of American Ethnology.

Kellehear, Allan. (1993) The Unobtrusive Researcher: A Guide to Methods. St. Leonards, N.S.W., Australia: Allen & Unwin.

Kimmins, Hamish. (1992) Balancing Act: Environmental Issues in Forestry. Vancouver, B.C.: UBC Press.

Kuhnlein, Harriet, and Nancy Turner. (1991) Traditional Plant Foods of Canadian Indigenous Peoples: Nutrition, Botany and Use. Philadelphia, Pa.: Gordon and Breach Science Publishers.

Lake Babine Hereditary Chiefs. (1996) Unrecorded discussions with Band members and Hereditary Chiefs. Woyenne I.R.#27, Burns Lake, B.C.

Lake Babine Land Users. (1996) Unpublished confidential land use interviews conducted by Angela Sinclair and Norbert Dennis. Woyenne I.R.#27, Burns Lake, B.C.

Lake Babine Nation.(1993-1996) Annual Reports. Burns Lake, B.C.: Lake Babine Nation.

Lake Babine Nation (1995) "The Ned'u'ten Treaty; Amalgamation Process, What Does this Mean for You?" Information brochure. Burns Lake, B.C.: Lake Babine Nation.

Lewis, Henry. (1982) A Time for Burning: Traditional Indian Uses of Fire in the Western Canadian Boreal Forest. Edmonton, Alta.: Boreal Institute for Northern Studies, University of Alberta.

Marozas, Bryan. (1995) "Enhancing Tribal Integrated Resource Management Plans by Integrating Traditional Knowledge with Geographic Information System Technology." GIS'96 Proceedings. Vancouver, B.C.

Maser, Chris. (1994) Sustainable Forestry: Philosophy, Science and Economics. Delray Beach, Fla.: St. Lucie Press.

McMillan, Alan D. (1988) Native Peoples and Cultures of Canada: An Anthropological Overview. Vancouver, B.C.: Douglas & McIntyre.

Merriam, Gray. (1994) Managing the Land: A Medium-term Strategy for Integrating Landscape Ecology into Environmental Research and Management. Toronto, Ont.: Ontario Ministry of Natural Resources, Forest Research Institute.

Mills, Antonia. (1994) Eagle Down is Our Law: Witsuwit'en Law, Feasts and Land Claims. Vancouver, B.C.: UBC Press.

Mohs, Ann, and Gordon Mohs. (1976) Babine Lake Archaeological Survey Project. Victoria, B.C.: Heritage Conservation Branch, Resource Information Centre.

Morice, Adrien G. (1978) [1906] The History of The Northern Interior of British Columbia. Smithers, B.C.: Interior Stationery.

Morice, Adrien G. (1910) "The Great Dene Race." In Anthropos 5, 113-142; 419-443; 643-653; 969-990.

Mullett, Donald. (1982) "Trapping Versus Logging: A Trapper's Legal Position Based on Biophysical, Socio-economic Impact, and Remedies Elsewhere." Bachelor's thesis, University of British Columbia, Vancouver.

National Aboriginal Forestry Association. (1993) Forest Lands and Resources for Aboriginal People. Ottawa, Ont.: National Aboriginal Forestry Association.

Natural Resources Canada. (1995) The State of Canada's Forests, A Balancing Act. Ottawa, Ont.: Natural Resources Canada.

Notzke, Claudia. (1994) Aboriginal Peoples and Natural Resources in Canada. North York, Ont.: Captus Press.

Pedersen, Niels. (1993) "Moulding of Ethnicity among the Contemporary Babine Indians of Interior B.C." Master's thesis, University Of Copenhagen.

Poole, Peter. (1995) Indigenous Peoples, Mapping & Biodiversity Conservation. Biodiversity Support Program, USAID.

Poole, Peter. (Winter 1995) "Guide to the Technology (Geomatics)." Cultural Survival Quarterly 18: 16-18

Ryden, Kent. (1993) Mapping the Invisible Landscape: Folklore, Writing and the Sense of Place. Iowa City: University of Iowa Press.

Sadler, Barry and Peter Boothroyd, eds. (1993) Traditional Ecological Knowledge and Environmental Assessment. Hull, Que.: Canadian Environmental Assessment Research Council.

Slim, Hugo, Paul Thompson, Olivia Bennett, and Nigel Cross. (1995) Listening for a Change: Oral Testimony and Community Development. Philadelphia, Pa.: New Society Publishers.

Smith, Peggy, Grant Scott, and Garry Merkel. (1995) Aboriginal Forest Land Management Guidelines: A Community Approach. Ottawa, Ont.: National Aboriginal Forestry Association.

Soutiere, Edward. (1979) "Effects of Timber Harvesting on Marten in Maine." Journal of Wildlife Management 43: 850-860.

Stordeur, L. A. (1986) Marten in British Columbia with Implications for Forest Management. Victoria, B.C.:B.C. Ministry of Forests and Lands.

Svobodova, Hana. (1990) Cultural Aspects Of Landscape. Wageningen, Netherlands: Pudoc.

Tobey, M.L. (1981) "Carrier." In Subarctic Vol.6 of The Handbook of North American Indians, edited by June Helm. Washington, D.C.: Smithsonian Institute.

Usher, Peter. (1983) The Value of Wildlife in Northern Canada. Ottawa, Ont.: P.J. Usher Consulting Services.

Vink, A.P.A. (1983) Landscape Ecology and Land Use. London: Longman.

Waring, Richard, and William Sclesinger. (1985) Forest Ecosystems: Concepts and Management. Orlando, Fla.: Academic Press.