Ecological and Cultural Research & Monitoring Plan
For Great Bear Lake and its Watershed

Prepared for:
The Great Bear Lake Working Group

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Cover Photos (from top left): The Camsell River; Community of Déline; Andrew John Kenny of Déline, drying fish; Great Bear Lake near Sahyoue; Caribou on Great Bear Lake; Gary Taniton and Lee Tutcho of Déline, water quality sampling.

ECOLOGICAL AND CULTURAL RESEARCH & MONITORING PLAN

FOR GREAT BEAR LAKE AND ITS WATERSHED

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ECOLOGICAL AND CULTURAL RESEARCH & MONITORING PLAN
FOR GREAT BEAR LAKE AND ITS WATERSHED

1.0 Introduction

The Great Bear Lake watershed is located in the Northwest Territories, Canada and lies approximately between 65 and 67 degrees latitude. It is part of the larger Mackenzie River drainage basin which drains into the Beaufort Sea. The total area of the watershed (including its lakes and streams) is approximately 150,000 km^2. Great Bear Lake and its drainage basin span two major physiographic regions, the erosion-resistant Precambrian Shield to the north and east, and the Interior Plains to the south and west. It straddles three land settlement areas, the Sahtu, Deh Cho and Tlicho. The Sahtu Dene and Métis Settlement Area was settled in 1994 and the Tlicho in 2003. The Deh Cho settlement area is currently under negotiation. Sixty-six percent of the watershed is within the Sahtu, 4% in the Deh Cho, 28% in the Tlicho and 2% lies within Nunavut. The drainage basin is characterized by a number of lakes including Great Bear Lake (the largest lake within the borders of Canada), Hottah Lake, Hardisty Lake, Keller Lake, Lac Taché and Lac Ste Thérèse. With a population of approximately 650 residents, Déline is the largest community in the basin.

Great Bear Lake is unique in the world because of its northerly location, massive size (31,000 km^2) and its relatively pristine natural environment. The region surrounding the lake provides habitat for numerous wildlife species, and birds use the region's many lakes, rivers, and wetlands as staging or nesting areas. The lake itself is home to various fish species, and other aquatic organisms. The lake is a precious and essential part of the way of life of the people of the surrounding area, being at the heart of traditions, culture and heritage, and having provided food, water and transportation to the people of the Sahtu region since time immemorial (Hamre, 2002).

2.0 Development of the Plan

In 2000, Raymond Taniton, then Chief of Déline, and David Livingstone, Director, Renewable Resources and Environment, DIAND, discussed the need for better management of Great Bear Lake. Since that initial meeting, the management of Great Bear Lake has become the focus of the attention of several organizations including representatives from the Déline Band, the Déline Renewable Resource Council (DRRC), the Sahtu Renewable Resources Board (SRRB), the Sahtu Land Use Planning Board (SLUPB), DIAND, the Department of Fisheries and Oceans (DFO) and the Canadian Parks and Wilderness Society, Northwest Territories Chapter (CPAWS-NWT). Discussions have addressed the need to protect the watershed, its land, lakes, tributaries and wildlife. In October 2002, a workshop was held in Déline with many of the stakeholders interested in the protection of the watershed. At that workshop, a vision

statement was decided upon: *Great Bear Lake must be kept clean and bountiful for all time*.

The literature survey *What the "White Man" Knows About the Natural History of Great Bear Lake* (Sirois, 2001), State-of-Knowledge Overview, existing scientific knowledge and community concerns have made it clear that additional research and monitoring activities are required to ensure the ecological integrity of the watershed. In order to assess the current state of the natural environment and monitor changes due to natural variability, climate change and human activities, it has become apparent that a comprehensive watershed monitoring plan is required to properly characterize the current state of the environment. A Traditional Ecological Knowledge Report was completed in March 2003 to recognize the traditional role of Déline in understanding and maintaining the land and water resources of the watershed and Aquatic[1] and Terrestrial[2] State of Knowledge Reports were also completed in 2003 and 2004, respectively. All three reports have highlighted knowledge gaps, ecological stressors and the need for research and monitoring in a future management plan.

3.0 Purpose of the Plan

A research and monitoring program is needed provides an information base that is adequate for the maintenance of the ecological and cultural integrity of the GBLW. This plan lays out the basis of such a program.

Great Bear Lake is extremely important to the Sahtu Dene, the Northwest Territories and Canada. The land, water and wildlife of the watershed are vital to the people of Déline: the area supports a diversity of aquatic and terrestrial organisms. The land and water support caribou, musk ox and numerous other wildlife species. Portions of the watershed have been used for thousands of years as traditional hunting, trapping and fishing grounds by Inuit, Dene and Métis.

Future concerns for the lake include maintaining cultural heritage sites and lifestyles and protecting its unique natural environment. Other than the harvesting of fish and wildlife, Great Bear Lake remains largely unaltered by human activity and at present is probably the largest lake in the world to exist in a relatively pristine condition. Although there are not any industrial activities on or near Great Bear Lake, the residents of Déline have raised concerns regarding past mining practices within the watershed. The limited historical mining activities on or near Great Bear Lake have altered the landscape and generated harmful as well as emotional and cultural effects (Livingstone, 2000). There is a need for an ecosystem-based research and monitoring plan to establish baseline environmental conditions prior to further development.

[1] MacDonald, D.D., D.A. Levy, A. Czarnecki, G. Low, N. Richea. 2003. State of the Aquatic Knowledge of Great Bear Watershed. Report submitted to Water Resources Division, Indian and Northern Affairs, Yellowknife, NT.

[2] Macdonald, C.R. 2004. Great Bear Lake. State of Knowledge of the Terrestrial Environment. Report submitted to the Sahtu Renewable Resources Board, Tulita, NT.

Research findings will be used to characterize the current state of the environment, provide a means to better understand the functioning and structure of the Great Bear Lake ecosystem and will also be used to determine if ecological conditions have changed due to climatic variability and/or anthropogenic activities. Research will also characterize the current state of cultural integrity within the watershed, inventory culturally significant sites in the GBL watershed and help in our understanding of cultural integrity and socio-economic health.

The plan will help with better decision-making to protect the environment and Sahtugot'ine culture. It will also contribute to and help coordinate monitoring and reporting in the NWT.

The research and monitoring plan can also contribute to:

- strengthening co-management,
- strengthening the role played by Déline organizations, and
- strengthening respect for and connection with the land, and the roles of the elders in interpreting and transmitting Sahtugot'ine values.

The authors acknowledge that this plan is a framework and should be interpreted in a non-prescriptive manner. It sets general directions only. It has been written in a fairly detailed manner so as to be comprehensive, and to anticipate and prevent future problems, but those implementing the Plan will need the discretion to adapt the Plan's general directions as needed. Further, the Plan should be interpreted in an "adaptive" manner: although a lot of research and monitoring in the GBLW has been conducted, there is much to be learned. Researchers, monitors and Déline will need to adapt as experience is gained and information is collected. This edition of the Research and Monitoring Plan only lays the foundation for the work that will follow.

Co-management will be strengthened because projects will require the cooperative involvement of organizations such as the DRRC, SRRB, SSI, and DLC as well as the Federal Departments of Fisheries and Oceans, Indian and Northern Affairs Canada, Environment Canada, the Government of the Northwest Territories, the fishing lodge industry and non-government organizations such as the Canadian Parks and Wilderness Society.

Déline's role would be strengthened by involving Déline organizations and the community in various phases (development, implementation) of the plan. This would include providing field training for various projects of the plan. There are a number of individuals in Déline whom are already familiar with certain sampling & monitoring techniques. In addition, community members would be involved, where appropriate, in data synthesis and interpretation.

Connection to the land would be strengthened by the stewardship involvement of Déline. Elders and youth and Déline leaders would be invited to participate in field trips to contribute traditional knowledge to the process and to pass on this knowledge to youth

and to people from Government, industry, and citizen groups who are conducting research and monitoring studies in the watershed.

4.0 Objectives and Goals of the Plan

Objectives:

a. In the short to medium term (1 to 10 years), initiate research that will establish a sound foundation for a basic aquatic and terrestrial research and monitoring program in the GBLW, focused on the maintenance of the ecological and cultural integrity of the watershed. Wherever feasible and relevant, design the research and monitoring program to include control sites in Protection Zones and monitor the ecological and cultural integrity of Protection Zones as well as the GBLW as a whole. In the longer term (10 or more years), adapt, refine, strengthen and broaden this research and monitoring program. Current objectives include the following:

   i. collect and analyze information to establish current (including baseline) environmental conditions of the GBLW;

   ii. acquire a better understanding of climate change and the effects of long-range transport of atmospheric pollutants on the GBLW;

   iii. better understand ecosystem functioning through scientific and traditional ecological research;

   iv. document culturally significant sites in the GBLW and in Protection Zones (including places, trails, grave sites, archaeological sites, etc.); and

   v. document elders' place names and stories and the oral histories associated with the sites identified under iv above.

b. In the short to medium term (1 to 10 years), continue research that will build on our baseline cultural information, and establish a sound foundation understanding and monitoring cultural integrity and socio-economic health.

c. Déline organizations and individuals play an increasing and ultimately central role, wherever possible, in GBLW research and monitoring:

   i. In the short and medium terms (1 to 10 years), measurably increase the role that Déline plays in GBLW research and monitoring.

   ii. In the long term (10 or more years), Déline residents and organizations should be fully involved in GBLW research and monitoring.

   iii. Wherever feasible, incorporate training for Déline residents in GBLW research and monitoring projects.

   iv. Wherever relevant, involve Déline elders as research collaborators and trainers.

v. Link Déline schools, school kids, teachers and elders to the research and monitoring program wherever opportunity allows.

vi. Use the research and monitoring program to aid in the transmission of Sahtugot'ine culture from the elders to the younger generations — both in the schools and on the land.

Goals:

- Promote community-based watershed monitoring programs (aquatic and terrestrial).
- Integrate scientific information with Sahtugot'ine knowledge throughout plan development and implementation.
- Encourage the broader research and monitoring community to conduct studies on Great Bear Lake.
- To work with the community to create a research centre (e.g. Déline Knowledge Centre) which could provide research and education opportunities.
- Acquire a better understanding of climate change impacts on the watershed as well as the effects of long-range transport of atmospheric pollutants.
- Better understand ecosystem functioning through scientific and traditional ecological research.
- Contribute towards the management (decision-making) of the watershed.
- Review traditional and past scientific reports to establish appropriate indicators of ecosystem health.
- Encourage better communication and the sharing of information generated from past research and monitoring projects, for instance hold a results-based workshop every two-three years, or as required, in Déline.
- Present options for community training opportunities.

5.0 Structure of the Plan

The Great Bear Lake Working Group draws on the local traditional knowledge of the people of Déline and the expertise of many experienced researchers for advice on what is needed to protect the lake and its resources. Déline and the researchers understand that there are benefits of linking similar projects together to share resources and to cooperate in sampling opportunities for projects that require similar types of work. For example, during the summer of 2004, two field study projects (fisheries and water quantity) were co-located in McTavish Arm, enabling the sharing of Déline community resources. There are many opportunities to combine research efforts and form linkages throughout the implementation of the plan in order to reduce costs and coordinate activities in specific areas. To address this, the GBL Working Group has suggested assembling potential research and monitoring projects into five inter-related groups of projects which were presented during a community workshop in Déline. The five interrelated projects are as follows:

i. a research vessel-based research and monitoring program, which would do a circuit of GBL and undertake an integrated ecological and cultural integrity research and monitoring program;

ii. Déline-based research and monitoring;

iii. projects in each of the arms of GBL that cannot (primarily because of the timing of the needed work) be achieved via the vessel-based research and monitoring program;

iv. projects that are focused on those parts of the watershed away from GBL; and

v. several "stand-alone" projects.

The above groupings of research and monitoring projects are meant to help address funding and human resources limitations that exist. One grouping is not necessarily more important than another. The groupings also facilitate training initiatives for the people in Déline and provide the opportunity for elders to accompany sampling teams in order to pass along traditional knowledge of Great Bear Lake and its lands and to observe sampling techniques. This exchange of information is a major achievement that has developed since the formation of the Great Bear Lake Working Group.

This Research and Monitoring Plan has been divided into eight different research areas:

- **Terrestrial Research & Monitoring;**
- **Water Quality Research & Monitoring;**
- **Water Quantity Research & Monitoring;**
- **Permafrost Research & Monitoring**;
- **Fisheries Research & Monitoring;**
- **Aquatic Ecology Research & Monitoring**;
- **Neh Karila K'ets'Edi Research & Monitoring;**
- **Cultural Research & Monitoring; and**
- **Economics Research & Monitoring**

What follows is a general description of research projects that are designed to provide important baseline information on the Great Bear Lake watershed. The projects have been provided by researchers who are familiar with Great Bear Lake and incorporate many of the concerns voiced by residents of Déline at community workshops.

Any funding (industry, academia and government) of research and monitoring in the GBLW should consider the projects identified in this plan and demonstrate a clear link to the maintenance of the ecological and cultural integrity of the GBLW. Communication with the community of Déline and coordination, where possible, with other research and monitoring projects are essential.

6.0 Research and Monitoring Projects for Consideration

6.1 Terrestrial Research and Monitoring Plan

The review of the status of the terrestrial environment identified several areas where more information is needed to understand the fundamental nature of the watershed. This information is vital in understanding the structure of the environment to be able to monitor changes that may occur from stresses like environmental change, habitat loss through increasing development, or overharvesting. Although basic information is available for major species such as caribou, muskox, marten and waterfowl, there are dozens of mammal, bird, invertebrate, and plant species on the land surrounding Great Bear Lake for which there is no basic information on numbers and distribution. Also, information on the physical environment has been developed solely from remote sensing and satellite imaging and needs to be verified on the ground.

6.1.1 Objectives

- To establish a baseline to assess the diversity of wildlife throughout the watershed prior to any new developments, including tourism,
- To study the current health of the ecosystems and wildlife populations in the watershed,
- To inventory the landcover within the watershed, which will be used to measure changes over time to wildlife habitat,
- To document subsistence, resident, non-resident, and commercial harvest of wildlife, including fish,
- To establish a baseline of natural occurrences of known toxic elements, such as mercury, and significant mineral deposits of economic importance that may be a major influence upon the area.

6.1.2 Knowledge Gaps and Action Plans

(I) *Baseline inventory and monitoring of wildlife species in the GBL watershed.*

Introduction - The main goal of this inventory is to determine a current 'snapshot' of species distribution, composition, and relative abundance throughout the GBL watershed prior to any new developments, including tourism. The main goal of monitoring is to document any changes in populations over time. Wildlife diversity is an important indicator of the ecological integrity of the watershed and of its overall health.

Large Mammals
Two of the species in this section, boreal woodland caribou and grizzly bear, have already been extirpated in some parts of Canada. In the NWT, boreal woodland caribou are considered Threatened [COSEWIC; status pending final decision of Aboriginal Working Group]] and therefore,

warrant both research and long-term monitoring. Grizzly bears are considered Special Concern [COSEWIC] in the NWT; however, since 1996, grizzly bears have been extensively researched through the West Kitikmeot-Slave Study and therefore, warrant long-term monitoring only.

Barren-ground caribou have been extensively researched since 1996 under the Draft Co-Management Plan for the Cape Bathurst, Bluenose-West and Bluenose-East Caribou Herds and therefore, warrant long-term monitoring only. Muskox studies are recommended, since muskox hunts have the potential to be one of the key elements of Déline's growing tourism business and muskox populations appear to be expanding in both numbers and range within the Great Bear Lake watershed

Large mammal studies should include: aerial population surveys (to determine relative abundance and distribution), fall composition surveys (to determine number of bulls, cows, yearlings and calves), spring recruitment surveys (to determine the number of calves that survive the first year), productivity surveys (to determine birth rates), and range use/movement surveys for:
Barren-ground caribou (monitoring only)
Boreal woodland caribou
Muskox
Moose
Grizzly bear (monitoring only)

Small Mammals/Furbearers
Although wolverines are list by COSEWIC with a Special Concern status, they have been extensively researched through the West Kitikmeot-Slave Study and therefore, warrant long-term monitoring only.

Small mammal studies should include: winter track counts, fecal counts (e.g., hares), live trapping/mark/release (e.g., voles), and aerial lodge counts (e.g., beaver). Species should include:
Marten
Wolves
Wolverine (monitoring only by carcass collection)
Beavers
Hare (snowshoe and Arctic)
Voles/Lemmings

Many of these small mammal/furbearer studies would be good community-based monitoring projects, especially for school involvement.

Birds
Three bird species have been listed by COSEWIC: Eskimo curlew (Endangered), peregrine falcon (subspecies *anatum*) (Threatened), and

short-eared owl (Special Concern) and therefore, warrant both research and long-term monitoring.

To date, there is very little documentation on bird species distribution, composition and relative abundance in the GBL watershed. Studies for songbirds, shorebirds, and raptors should include: recording bird observations, avian population monitoring, migration monitoring, breeding bird inventories and banding stations. Specific waterfowl studies would include: systematic aerial reconnaissance, breeding pair, brood production and staging surveys of dabblers and divers, and banding stations.

More information is required for the following:
Scaup
Songbirds (passerines)
Shorebirds
Peregrine falcon *anatum* subspecies
Eskimo curlew
Short-eared owl

Amphibians
As amphibians have both an aquatic and terrestrial life stage, they are widely considered to be sensitive environmental indicator species. Some scientists have referred to amphibians as the 'canaries in a coal mine', a reference to their potential value as indicator species of environmental decline.[3] To date, little to no research has been done on amphibians in the Sahtu (Sensitive status in the NWT); therefore, basic occurrence, abundance and distribution studies would be required for:
Frogs (boreal chorus, wood and northern leopard)

Invertebrates
Butterflies and moths have two main life stages – larval and adult. Both stages rely on distinct food plants, which make them vulnerable to change or loss of suitable habitat. To date, little to no research has been done on invertebrates in the NWT which gives them a designation of "Undetermined status"; therefore, basic occurrence, abundance and distribution studies would be required for:
Moths/Butterflies
Dragonflies
Spruce Budworm

It is recommended that the studies collect and establish baseline conditions, in identified areas in each of the three ecozones in the GBL

[3] Canadian Endangered Species Conservation Council (CESCC). Wild Species 2000: the General Status of Species in Canada. Ottawa: Minister of Public Works and Government Services Canada.

watershed, including Sayoue/Edacho, against which future changes could be compared.

ENR and/or SRRB and/or Ducks Unlimited Canada and/or Canadian Wildlife Service and/or Canadian Parks and Wilderness Society would be involved with training and supervision throughout the life of the projects. Responsibility for many of the projects would be turned over to the community as skills are mastered.

Project Description: The basic project would inventory and monitor barren-ground caribou, muskox, marten, scaup, one representative songbird (1), one representative shorebird (1), and frogs. Caribou and waterfowl are very important subsistence species to the community of Déline, as determined by the Sahtu Settlement Harvest Study. Economically, muskox (licensed outfitting) and marten (trapping) are very important to Déline or have the potential to be. Frogs, shorebirds, and songbirds are sensitive indicator species of environmental change. This project is considered to be the minimum required to begin the process of determining the status of key terrestrial species. An enhanced program would be to inventory and monitor the species listed above in each of the categories: large mammals, small mammals/furbearers, birds, amphibians, and invertebrates.

Sampling Frequency: One-time sampling every five years is considered to be the basic level of effort required to generate the needed data (basic), while annual sampling for 5 years with long-term sampling every five years after the completion of initial baseline collection (better), and annual sampling indefinitely (best) will provide more detailed and precise data.

Project Timeframe: It is recommended that both caribou and muskox are surveyed over the short-term (1-2 years), while marten, scaup and frogs should be surveyed over the medium term (5-6 years). Both the warbler and sandpiper should be monitored over the long-term. Other agencies [e.g., Canadian Wildlife Service] are expected to also be conducting similar surveys of these species.

(II) *Baseline inventory to determine the current health of wildlife populations.*

Introduction - The main goal of this inventory is to determine a current 'snapshot' of species physical condition (health), including documenting diseases and parasites, throughout the GBL watershed prior to any new developments or tourism opportunities. Currently, little is known about how pathogens affect wildlife populations and how these pathogens are affected by changes in the ecosystem, particularly in the GBL watershed.

A project to build community capacity in monitoring wildlife health was begun in Déline and other Sahtu communities in 2004.

The Wildlife Health Monitor program provides for collection of a standard suite of biological samples from harvested barren-ground caribou from the Bluenose-West and Bluenose-East herds. The samples allow monitoring of body condition, pregnancy, contaminant levels, parasites, and disease occurrence. These are key components for long-term monitoring of the overall population health of barren-ground caribou herds. Samples are sent to the Western College of Veterinary Medicine in Saskatoon for analysis. Training in sampling procedure was and will continue to be provided for community members.

Community members will report any diseases, parasites, and abnormalities that they find in the wildlife species harvested throughout the year. Database of parasites and diseases would be designed and updated regularly by community members.

Project Description: Annual sampling of opportunistic and planned collections for 5 years with long-term sampling every five years after the completion of initial baseline collection (basic), annual sampling of targeted populations indefinitely (better), annual sampling of all species (best).

Project Timeframe: It is recommended that this project continue to be conducted in the short term (annual samples) and long term, with additional species targeted..

(III) *Inventory of landcover within the GBL watershed.*

Introduction - A variety of factors contribute to the decline of wildlife species, with the most important being habitat loss or fragmentation. Presently, the distribution and status of plant species is very general in nature and is not suitable for monitoring the status of the species. The main goal of this inventory is to determine a current 'snapshot' of the landscape/vegetation, including berries, medicinal plants and invasive species, throughout the GBL watershed prior to any new developments or tourism opportunities, allowing for monitoring of changes over time. As well, the landcover inventory can be used as an important predictive tool, by using habitat preference, when trying to determine possible key areas for wildlife species.

The study would build on existing data already collected by ENR and DUC by using Landsat Thematic Mapper satellite scenes. Up to six bands of information are combined to produce spectrally unique signatures,

which can then be classified using helicopter field verification (ground-truthing).

Continued mapping of seismic lines, including age, width and re-growth, also provides important information about land use practices in the watershed. Currently, seismic information is five years or older before released by the NEB.

Permanent monitoring plots need to be established as part of a strategy to understand the growth and succession patterns of different forest types, to monitor changes on the landscape over time that may be linked to climate change and patterns of wildlife movements, to verify land and ecological classification systems, and for habitat analysis. Permanent monitoring plots and timber cruising would include:

- Measure the height, age, health and other characteristics of the same trees periodically.
- Regeneration and mortality of trees, and other stand characteristics, such as ground vegetation, soil type and coarse woody debris, are measured and monitored in the plot.

Another monitoring project, which will be able to provide important habitat information, is the National Forest Inventory being conducted by the Canadian Forestry Service across Canada.

Project Description: The basic study would be to complete satellite classification every ten years with annual mapping of forest fires and seismic lines, including permanent monitoring plots to document changes that may be kinked with climate change and providing an inventory of berries, medicinal plants and invasive species (basic); the better study would be to complete satellite classification (with intensive ground-truthing), random permanent monitoring plots (10), and timber cruising every ten years with annual mapping of forest fires and seismic lines; the best study would be to complete satellite classification (with even more intensive ground-truthing), random permanent monitoring plots (20), and timber cruising every ten years with annual mapping of forest fires and seismic lines.

Project Timeframe: It is recommended that the survey and plots be established in the medium term (3-5 years).

(IV) *Subsistence, resident, non-resident & commercial harvest of fish & wildlife.*

Introduction - The main goal of this inventory is to continue to document the harvest of wildlife, including fish, in the GBL watershed by beneficiaries, non-beneficiaries, and non-aboriginal hunters. The data

collected provides information on harvesting in order to ensure effective management of wildlife and fish in the Sahtu and signifies the importance of wildlife and fish for environmental assessments.

The study would continue, indefinitely, to document and summarize harvest data reported by beneficiaries in the Sahtu Settlement Harvest Study, as well as residents, non-residents and commercial hunters through ENR surveys. Community members would continue to provide harvest data to trained community interviewers. Lodges and outfitters could use guide-conducted surveys or have guest questionnaires to document sport fishing harvest; non-resident hunter harvest reporting is mandatory in the NWT.

Project Description: the minimum effort required to address this gap is quarterly reporting of subsistence, non-resident and commercial harvest. An enhanced level of the project would be monthly reporting of subsistence, resident, non-resident and commercial harvest, and mandatory monthly reporting of subsistence, resident, non-resident and commercial harvest.

Project Timeframe: This project should be conducted over the short-term (1-2 years) to provide the information quickly.

(V) *Inventory natural occurrences of elements and significant mineral deposits.*

Introduction: The main goal of this inventory is to compile the location of natural occurrences of economically important elements and mineral deposits in the GBL watershed. By mapping these geologic and geomorphologic occurrences, preparations for future developments can be made, i.e., determine which habitats and associated wildlife should be studied/monitored. Baseline and long-term monitoring plots can be placed near mineral rich areas prior to development.

The study would build on existing mineral deposit and geologic (era and rock type) mapping[4] conducted by RWED and Geological Sciences Canada. Another possible study would be to determine naturally occurring elements/minerals in the main water bodies throughout the watershed.

Project Description: The smallest allowable project to provide the necessary data is to compile the information from the GNWT and the federal government to identify potentially developed areas in the

[4] A Guide to Mineral Deposits of the Northwest Territories, October 2001. Government of the Northwest Territories, Department of Resources, Wildlife and Economic Development, Minerals, Oil and Gas Division.

watershed. More advanced projects would include ground surveys and detailed mapping of the deposits.

Project Timeframe: This project should be conducted over the long term (6-10 years).

6.2 Water Quality Research and Monitoring Plan

Great Bear Lake is one of the world's largest freshwater bodies and the largest lake within the borders of Canada. The lake is unique because of its size, northerly location and natural environment. Great Bear Lake and the watershed lakes and streams remain largely unaltered by human activity and at present, is probably the largest lake in the world to exist in a relatively pristine condition.

The waters of Great Bear Lake are central to the life of the aquatic community in the lake and the protection of the quality of those waters is a major objective of the Great Bear Lake Watershed Management Plan. The aquatic community of Great Bear Lake relies on the maintenance of water quality within certain limits for optimum habitat, and deviations from those limits will reduce the diversity and integrity of the fish community and other aquatic life. Water quality parameters generally include temperature, oxygen, pH, conductivity, plant nutrients, chlorophyll, suspended solids, metals and possibly the presence of contaminants. The source of the water to the lake is from 6 major river systems and a large number of smaller rivers that only drain to the lake during spring run-off. The monitoring of the surface waters of the lake and the quality of the water flowing into the lake will help to ensure that the quality of the Great Bear Lake aquatic environment is maintained for the long-term.

The work outlined takes a broad perspective on water quality. On the detailed level, the water quality around the community is included as an important aspect to research and monitor.

6.2.1 Objectives

- To establish a water quality baseline on Great Bear Lake's major tributaries and the lake prior to any new exploration and/or development,
- To determine seasonal patterns in water quality in Great Bear Lake as they relate to the normal, healthy functioning of the lake,
- To begin a long-term water quality monitoring station in the vicinity of Déline to assess trends which could be associated with long-range inputs, localized inputs, and/or climate change,
- To obtain water quality measurements for the lake as a whole (summer) and to integrate those values with satellite and other monitoring approaches,

- To collect water quality data from other watershed streams that are important to the community for water and food,
- To collect water quality data to support and augment any fisheries and/or ecological research within watershed.
- To assess water quality downstream from the abandoned mine sites in the Camsell River watershed.

6.2.2 Knowledge Gaps and Action Plans

(I) *Baseline water quality of major inflows to Great Bear Lake.*

Introduction: Great Bear Lake has distinctive features such as the world's largest mass of cold fresh water, very clear waters, low nutrient levels, and relatively simple food web. Water quality should be considered an indicator of ecosystem health to ensure the ecological integrity of the lake. Without protecting water quality, the overall features and ecological integrity of Great Bear Lake cannot be protected.

The two main inflows to the lake are the Camsell River and the Johnny Hoe River, which together occupy approximately 30% of the total drainage area. The Sloan and Whitefish Rivers are also important tributaries of the lake. The Whitefish and Johnny Hoe sub-basins are very important subsistence fishery areas for Déline. Smaller tributaries to the lake include the Dease and Haldane Rivers, both of which drain into the Dease Arm. Presently, there is no water quality monitoring being conducted on inflows to Great Bear Lake.

The Camsell River originates in the north central Northwest Territories at Sarah Lake and drains an area of approximately 31,100km^2 (Hydat, 2002). The river travels 240 km in a northwesterly direction passing through numerous lakes including Faber, Rae, Hardisty, Hottah, Grouard, Clut and Balachey before emptying into Conjuror Bay of the McTavish Arm of Great Bear Lake. The Camsell River is the largest tributary to Great Bear Lake, contributing approximately 18.5% of the inflow to the lake. The long-term water quality station, Camsell River at the Outlet of Clut Lake, (65º35'N/117º45'W) now discontinued, was active from 1969-1999 and provided baseline water quality data for physical parameters, major ions, nutrients, cyanide and total metals. The station was established to collect baseline water quality information against which future changes can be compared. The Camsell River site provided useful water quality information on the inputs from the largest sub-basin within the GBL watershed.

The second largest tributary, the Johnny Hoe River, is located on the south side of Great Bear Lake. From its headwaters near Willowlake River, it flows north for approximately 150km to its mouth at the south end of McVicar Arm. Keller Lake, Lac Ste. Thérèse, Lac Taché and Tseepantee Lake are the largest lakes in

the Johnny Hoe drainage basin. Water quality data on the Johnny Hoe River are limited; a monitoring site was operated by Environment Canada from 1969-1975.

It is recommended that all major inflows to Great Bear Lake be monitored to establish or build upon water quality baseline records. Monitoring the Haldane, Sloan, Whitefish, Johnny Hoe, Dease and Camsell Rivers will provide useful information on the nutrients, metal concentrations and other inputs from their respective sub-basins. Baseline conditions can be established and site-specific objectives can be developed prior to any development activity to ensure the highest level of protection for the aquatic environment.

Flow data exist for the Haldane, Sloan, Whitefish, Johnny Hoe, Camsell and Great Bear rivers. The relationship between water quality and quantity data on these rivers can also be investigated.

Sample Analyses. Water samples will be collected and analyzed for physical parameters (pH, turbidity, conductivity, total and dissolved suspended solids, temperature and dissolved oxygen), major ions, nutrients and metals.

Physical parameters, and major ions are important to provide basic background information on water quality and are useful for the interpretation of other results. Field measurements will be undertaken with a water quality data instrument called the Hydrolab^{TM} Datasonde 4A. Measurements of nutrients are a measure of the overall productivity in a waterbody which important for Great Bear Lake considering the relatively low nutrients which limit the growth of fish and other aquatic organisms. Metal analyses will describe the levels of trace metals in water as well as provide information about the underlying geology of an area that could be of significant mineral deposits of economic importance. Establishment of baseline levels is important prior to any level of development.

Project Description: For the basic level of project, it is recommended that at least one sample from three major inflows representing each ecozone of the watershed (Camsell River, the Haldane River and either the Whitefish or Johnny Hoe River) be collected for each portion of the water-year (spring freshet, summer recession and winter baseflow) or season (spring, summer, winter and fall) to determine seasonal variability. It is recognized that this monitoring frequency will not provide complete representation but it should allow representative sampling at each stage of the hydrologic cycle. It is also recommended that the monitoring program be carried out for at least five complete years, at about the same time each year, to establish a baseline against which future changes could be compared. The regular sampling will also help to address annual variability.

A more advanced water sampling project would be to collect samples every two months from all the major inflows for a total of five years. This would provide an excellent baseline on the long-term seasonal variability in water quality

parameters. The best levels of sampling would be to collect the full suite of analyses monthly in the six major river inflows for a total of five years. All water quality monitoring would be linked with fisheries and other types of research on GBL and within the watershed.

Project Timeframe: This project should be started in the short term (1-5 years).

(II) *Great Bear River Seasonal Variability.*

Introduction: The only active water quality monitoring site in the watershed is located on Great Bear River. Water quality at *Great Bear River at the Outlet of Great Bear Lake* has been monitored since 1969 (to present). Two to six samples have been collected by Environment Canada each year (depending on funding resources for that year). Samples are analyzed for routine parameters including pH, conductivity, turbidity, total dissolved & suspended solids, major ions, nutrients and metals. Community members have expressed concerns that the current sampling program at this site is inadequate to properly monitor the quality of water of Great Bear Lake. It is recommended that the monitoring frequency at this site be augmented. Additional sampling will help improve our knowledge of seasonal variability as well as to enhance the existing baseline. Given the long-term monitoring program at this site, site-specific water quality objectives could be developed prior to any development activity which will ensure the highest level of protection for the aquatic environment.

Project Description: The basic plan for monitoring water at the outflow to Great Bear Lake is to augment the current monitoring to ensure that sampling takes place in all four seasons. An enhanced plan would be to augment the current monitoring plan to sampling every two months while the best plan would be to conduct monthly sampling. The costs are relatively inexpensive and can be largely conducted by members of the community of Déline.

Project Timeframe: This project should be started in the short term (1-5 years).

(III) *Monitoring of baseline water quality in Great Bear Lake offshore of Déline.*

Introduction: The physical and chemical features of water, also known as "water quality" are the major determinants of the abundance and composition of aquatic life in Great Bear Lake. Great Bear Lake has very clear waters because of the low concentrations of essential plant nutrients such as phosphorus and nitrogen. Because of this, Great Bear Lake is more vulnerable to over fishing that the West Basin of Great Slave Lake where nutrient concentrations are higher, microscopic plants more abundant, and more food available for fish to eat. It is very important to obtain better information on the water quality of Great Bear Lake. This will allow researchers to better understand the factors limiting plant and animal, including fish, growth and abundance.

While Great Bear Lake is a healthy lake with naturally low concentrations of plant nutrients, dissolved salts, and a near-neutral pH (acidity) this could change through a variety of mechanisms. One mechanism is long-range atmospheric transport of phosphorus, nitrogen, sulfur, and other compounds. A second mechanism is through localized inputs into the lake from various human activities including sewage and industrial releases. While both of these activities currently are minimal on Great Bear Lake, it is important to establish baseline conditions as development in the north is expected to grow markedly over the decades. For example, if nutrient levels began to increase, microscopic algae could become more abundant (chlorophyll levels become higher) and the water less clear (Secchi disc readings become lower). Oxygen levels in deeper waters could also decrease as productivity increases in the surface waters.

Many aspects of water quality vary seasonally with seasonal variations in temperature and light. Oxygen concentrations vary with temperature, lake mixing, and lake cover. Plant nutrients also cycle as they are reduced in concentration with plant growth and then increase as dead material decomposes. Therefore, it is desirable to measure water quality on a seasonal basis. It is proposed to establish a "Master" station which will continually monitor many of the water quality parameters through time.

The vicinity of Déline is selected as a Master station for the long-term monitoring of lake water quality because travel distances to the Master station will be short, allowing for frequent and relatively inexpensive sampling in comparison to more remote sites. Second, while Déline is small, the community size will change over the decades and this increase could potentially affect Great Bear waters through the release of various effluents and discharges into the lake.

Sample analyses. A Master station would be established offshore near Déline. This station would form the focus of water quality monitoring and would be linked to aquatic biology studies and to tributary sampling. Water quality measurements would include Secchi disc depth, a Hydrolab cast, and water quality sampling with depth. The number of depths would depend upon water column depth. A minimum of two depths would be sampled for water quality as in "baseline water quality inflows" with the exception of major ions and metals, which would be sampled only once.

Project Description: The basic levels of sampling required to obtain the necessary data is to collect samples from three depths, four times a year for a total of five years. An enhanced sampling program would provide sampling quarterly, with an increase in sampling frequency to bi-weekly during the open water season. The best sampling regimen would be to collect samples at several depths monthly, with an increase in the frequency to biweekly during the ice-free season.

Project Timeframe: This project should be started in the medium term (5-10 years).

(IV) *Spatial variations in water quality in Great Bear Lake.*

Introduction: Great Bear Lake is a large lake with five major arms and a central area. There are numerous tributary inflows, which bring essential plant nutrients and salts into the lake. The shallow waters are probably the most important areas in the lake for plant and animal growth, including fish. The microscopic plants, which form the base of the food web, are believed to grow slower in deeper, offshore waters.

There are two aspects to measuring spatial variation of water quality in Great Bear Lake including a general survey of the physical and chemical features of Great Bear Lake waters is required to determine inshore-offshore differences in these features, and the effects of tributary inputs on the water quality of the major arms of the lake. Such a study would be linked with tributary studies, aquatic biology studies and studies of the heat budget of the lake.

A second way to obtain information on water temperature, chlorophyll concentrations, movement of river plumes, etc. is through satellite images. The images only provide a picture of the upper few meters of the water but do provide a detailed picture of the entire lake. Satellite images could be used to investigate how these features of the lake change through the ice-free season. Such images also could be used to investigate how freezing and thawing occurs and when.

Project Description: The basic project required to collect the necessary information on physical and chemical characteristics would include the collection of three to four samples in each arm of Great Bear Lake during open water season in one year. The studies could be combined with other projects examining fish or other aquatic resources. The enhanced version of the project would include a survey of two to three arms and the offshore areas of Great Bear Lake in one year, followed by surveys of the rest of the lake in the following year. These surveys would be conducted in conjunction with some analysis of satellite images taken during the same time period. The most advanced version of the project is a comprehensive survey of the entire lake in midsummer in a single year with the use of satellite images to provide information on temperature, chlorophyll, river inflows, etc. in other times of year. The satellite images would be verified or ground truthed, with real data. In later years, this could be expanded to sampling in three time periods.

Project Timeframe: This project should be started in the short term (1-5 years).

(V) *Baseline water quality of lakes and rivers in the Great Bear Lake Watershed.*

Introduction: In addition to Great Bear Lake and the tributaries flowing into it, there are numerous smaller lakes and streams in the watershed. For example, there are a series of lakes within the Johnny Hoe River system, including Lac Ste. Therese where the fish have high mercury levels. This river system is one of the traditional fishing areas for the people of Déline, however fishing in this area has now declined because of the mercury problem. Mercury levels are lower in Kelly and Mahony lakes, and also in the Great Bear Lake drainage basin. Few studies of the water chemistry of these lakes within the drainage basin have been conducted. For example, Environment Canada made water chemistry measurements in all three lakes in 2002.

Baseline water quality studies are desirable on the lakes and tributaries within the Great Bear Lake drainage basin. These studies will establish conditions prior to continued development. Such studies would be integrated with aquatic biology and fisheries studies on these lakes. Data collected during these studies could be used to help explain why mercury levels are in fish in some lakes and not others.

Project Description: The basic levels of project required to obtain the necessary information from these lakes would be to sample three to five lakes or streams that have been identified by the community as traditionally important. Three sets of measurements would be collected from each site per year. A better project would be to collect water quality measurements at least once in the summer in major lakes or streams. Samples would be collected at two depths, with bathymetric mapping of the larger lakes. The best projects would include water quality measurements at two depths at least once for the major water bodies in the watershed, with bathymetric mapping of the water bodies.

Project Timeframe: This project should be started in the medium term (6-10 years).

(VI) *Water Quality at Abandoned Mine Sites in the Camsell River Basin.*

Introduction: Protection of surface water quality and maintaining the integrity of the aquatic ecosystem is a primary concern of Northerners. Residents of Déline have raised concerns regarding past mining practices in the Camsell River basin. These concerns stem from the silver and other base metal mining activity in the area that took place intermittently from the 1960s until closure of the last mine site in 1985. The mine sites were abandoned without proper decommissioning, remediation or long-term monitoring plans to ensure that the sites were not negatively affecting the receiving environment. Contamination from past mining activities and the potential for contamination entering the Camsell River concern the people of Déline. In addition to the physical hazards on site, people are concerned about water quality and potential impacts to fish and wildlife that have unrestricted access to these abandoned mine sites.

Mine site runoff can result in significant adverse impacts to aquatic ecosystems. Downstream water quality such as pH, major ions and concentrations of certain metals can be affected by how the land is used. Monitoring water quality at abandoned mine sites is important to determine potential impacts from the abandoned mines on the local area and downstream receiving aquatic environment.

The Silver Bear minesites include 4 abandoned mines that are located approximately 270km northwest of Great Slave Lake. The nearest community is Gameti, located 170km south, while Déline is situated 250km west near the outlet of Great Bear Lake. Terra, Northrim and Norex mines lie within the Camsell River watershed, which drains an area of approximately 31,100km^2 (Hydat, 2002). The Camsell River, the largest tributary to Great Bear Lake, flows into the southeast corner of the McTavish Arm (Conjuror Bay) and contributes approximately 18% of the flow to the lake. Terra, Northrim and Norex are approximately 12km upstream from Great Bear Lake. Smallwood mine is located on Smallwood Lake, east of Great Bear Lake. Smallwood Lake drains southeasterly into a series of large lakes.

Project Description: The main focus of the study is to determine metal concentrations at various locations at each mine site including tailings containment areas, seepages from waste rock piles and drainage from mine adits and to determine whether contaminants are migrating into and potentially impacting the local area and nearby water bodies. Current water quality conditions of the Camsell River will be established. This program has been coordinated with monitoring at other abandoned contaminated and waste sites in the Great Bear Lake Watershed, where economically and logistically feasible.

Project Timeframe: This project was started in 2002.

6.3 Water Quantity Research and Monitoring Plan

The hydrologic regime of a watershed is a product of topography, geology, elevation, climate, permafrost conditions, drainage area, the presence of lakes and vegetation cover. Given the size and diversity of the Great Bear Lake watershed, the physiography varies from one area to another. There are three terrestrial ecozones surrounding the lake: Taiga Plains, Taiga Shield and Southern Arctic. It is important to establish baseline conditions in each ecozone in order to characterize the hydrology and to attempt to understand the potential impacts of change, whether natural or human-induced.

6.3.1 Objectives

- To establish a baseline of the existing flow regimes in order to characterize the hydrology of the watershed.
- To establish a research and monitoring plan that will use both existing and new sites to improve hydrologic and climatic records.
- To promote efficient and effective research and monitoring within the basin focusing on components of the water balance, such as precipitation, evaporation and runoff.

6.3.2 Knowledge Gaps and Action Plans

(I) *Hydrometric record within the Great Bear Lake watershed*

Introduction: Since the early 1960s, hydrometric data have been collected from select locations in the Great Bear Lake watershed. A few tributary streams were monitored between the mid-1970s until 1992. In all, nine stations have operated within the basin with records ranging from six to 43 years. At present, however, only three stations are operating: the Camsell River at Clut Lake, Great Bear Lake at Hornby Bay and Great Bear River at the outlet of Great Bear Lake. Given the diversity of the landscape around Great Bear Lake and the paucity of hydrometric gauges, differences in hydrologic characteristics of inflows to the lake are not currently being monitored. Although the historical records available for certain sites are helpful in characterizing hydrologic regime, the data records are relatively short and therefore have limited statistical value. They also fail to provide information regarding current conditions. In order to obtain data representative of inflows to Great Bear Lake, more hydrometric stations should be installed at a variety of locations around the lake.

Project Description: To quantify the larger inflows to Great Bear Lake, it is recommended that sites with historic data and with reliable locations be re-established. These include the following: Haldane River, Sloan River, Johnny Hoe River and Whitefish River. These data would add to those currently available for the Camsell River and Great Bear River outflow. This would require several site visits per year, including following break-up and freeze-up to check stations and equipment. This work is best conducted by the Water Survey of Canada, Environment Canada, Yellowknife office and should only be considered as long-term in duration (10+ years).

Project Timeframe: This project should be started in the short term (1-5 years).

(II) *Small basin hydrology in the GBL watershed*

Introduction: In order to characterize the hydrology of tributaries to Great Bear Lake, the water balance of three small basins representative of the three ecozones

surrounding Great Bear Lake should be established. The collection of precipitation, evaporation, runoff and meteorological data are required. Establishment of small basin hydrology allows for a better understanding of the potential impacts of change within these basins.

Project Description: The project requires the establishment of water level and climate stations at sites within three small basins representing the three ecozones in the Great Bear Lake watershed. It would be beneficial to co-locate these sites with those identified in project (a) for potential logistical and information overlap. Site visits would be required at least three times per year. This project should be conducted over a medium duration (5-10 years).

Project Timeframe: This project should be started in the short term (1-5 years).

(III) *Historical climatic and hydrologic conditions*

Introduction: In the NWT, instrumental hydrometric and meteorological records are relatively short (often <50 years), particularly in the more remote regions, like the GBL watershed. Records of this length are a poor basis for the detection of environmental change and are unlikely to capture the annual and seasonal extremes that characterize hydrology and climate of a region. Results from tree ring studies can help to place current hydrologic and climatic fluctuations into a long-term context and can assist in environmental management and impact assessment decision-making. One of the knowledge gaps identified includes historical hydrometric data for the lake and its watershed. This information can help to assess current conditions in respect to historic conditions and allow for speculation into rates of change in the watershed. Dendrochronology is the dating of past events through the study of tree rings. For example, it enables the reconstruction of climatic histories with an annual resolution. The technique can extend climatic and hydrological records as much as 300 to 400 years. Tree ring widths are precisely measured and are used to indicate growing parameters like the availability of heat and water.

Project Description: The project to establish a hydrometric and/or climatic history within the watershed includes conducting tree ring analysis on the east half of the GBL where geological and topographical conditions are favourable for the study of tree rings. One visit in mid to late summer per year for two or three years would be adequate. This project should be conducted over a short term duration (1-5 years). It forms part of larger collaborative project initiated in 1999 by Environment Canada, University of Regina and Indian and Northern Affairs Canada that is focused on providing a longer perspective on hydrology and climate within the NWT.

Project Timeframe: This project was started in 2004.

(IV) *Snow and ice conditions in the Keith Arm*

Introduction: Snow depth and density records are important hydrologic data for they provide an idea of the amount of water available for runoff during spring melt. Long-term changes in the amount of snow received annually and in ice thickness could be indicators of climate change. Changes in snow volumes and ice thickness can have significant impacts on a variety of components of the ecosystem, including fauna and vegetation. In addition, if there is a trend to earlier break-up and later freeze-up, this means that there is a longer open-water season. This could affect water temperature which has potential ecological implications. There is also community concern regarding changing snow and ice conditions.

Project Description: The project involves conducting snow surveys and taking ice measurements at three sites on the Keith Arm with up to three visits per winter. Observations of ice conditions can be made from Déline and coordinated with satellite imagery and air photos. More in depth studies could include more measurements in the Keith Arm to improve precision, with a greater number of visits per winter. This project should be conducted over the long term (10+ years).

Project Timeframe: This project should be started in the short term (1-5 years).

(V) *Snow and ice conditions in the Great Bear Lake watershed*

Introduction: This project is an extension of that described in project IV. Further information of snow and ice conditions in the Great Bear Lake watershed should strengthen our understanding of hydrologic and climatic conditions in the region. It also provides information with which to assess change. The collection of snow volume data in tributary watersheds would be a necessary component of water balance calculations discussed in project II.

Project Description: The project involves conducting snow survey and ice thickness measurements at sites in the watershed. These sites could include the gauged Camsell River site, Haldane River, Johnny Hoe River, Whitefish River and Sloan River. One set of measurements would be conducted per site per winter. This project should be conducted over the long term (10+ years).

Project Timeframe: This project should be started in the short term (1-5 years).

(VI) *Rate of evaporation in the Great Bear Lake watershed*

Introduction: A major component of the water balance in any watershed is the loss of moisture by the process of evaporation. Evaporation rates may potentially influence water levels on Great Bear Lake more than tributary inflows, therefore it is important to understand evaporation's impact in order to manage the lake

appropriately. It is important to develop baseline information in order to understand impacts of development and climate change (e.g., changes in duration of open water, water temperature and water levels can affect evaporation rates). Various estimates of the rate of evaporation from the watershed exist but these are general estimates based on modelled values.

Project Description: The project entails establishing a climate tower on an island in the Keith Arm to measure evaporation. In addition, cables will be floated in the water to measure surface water temperatures. The project should be conducted over three years, with two visits over the summer and one in the winter.

Project Timeframe: This project was started in 2004.

6.4 Permafrost Research and Monitoring

Permafrost is a major feature of the northern terrestrial environment and is susceptible to disturbance, whether natural or human-induced. Permafrost is defined as ground, whether soil or rock, that has remained below a temperature of $0^{o}C$ for more than one year. Ground ice is the frozen water present within the soil and can occur in a variety of forms. Permafrost is considered to be discontinuous over the GBL watershed, however it could be considered to be continuous in the northern region. Where permafrost is present, the ground ice content varies significantly; in bedrock areas, it is virtually non-existent, whereas in unconsolidated material or peatlands, it is likely high (>15%). Changes in the state of permafrost could have an impact on the flow of surface water into Great Bear Lake and could potentially release material into the lake.

6.4.1 Objectives

- To monitor the extent of permafrost in the Great Bear Lake watershed.
- To monitor ground temperatures in areas of permafrost over time.
- To determine the ground ice content of permafrost at representative locations in the Great Bear Lake watershed.
- To determine the effects of changes in permafrost over time.

6.4.2 Knowledge Gaps and Action Plans

(I) *Baseline soil temperature conditions at Déline*

Introduction: Changes in snow depth affect ground temperature regime (i.e., permafrost). Thawing of ice-rich permafrost may result in slumping of slopes, changes in vegetation, changes in drainage patterns, and ground instability. Thawing permafrost may also release materials into the surface waters. Infrastructure related to in-ground waste storage may be affected by changes in ground temperatures.

Project Description: The project will establish a monitoring plot near Déline where active layers, soil temperatures and snow depths will be measured. These measurements could be carried out in conjunction with other measurements of snow cover and depth. These measurements would be conducted twice per year. This project should be conducted over the long term (10+ years).

Project Timeframe: This project should be started in the short term (1-5 years).

(II) *Baseline soil temperature conditions in the Great Bear Lake watershed*

Introduction: The rationale for this study is the same as the previous study, however the study would extend to several sites within the watershed.

Project Description: The project will establish monitoring plots at other sites in the watershed where active layers, soil temperatures and snow depths will be measured. These measurements could be carried out in conjunction with other measurements of snow cover and depth. These measurements would be conducted twice per year. This project should be conducted over the long term (10+ years).

Project Timeframe: This project should be started in the short term (1-5 years).

6.5 Fisheries Research and Monitoring Plan

The distribution, status and general biology of the fish in Great Bear Lake and the watershed are not well enough understood to be able to protect the resource, or to understand the impact of changes in the environment. Demands and stresses on the fish stocks in Great Bear Lake and the lakes and streams of the watershed are likely to increase with new economic initiatives such the start-up of additional lodges and outfitters, and the possible effects on fish habitat and water quality in relation to climate change, hydroelectric and hydrocarbon development. Species such as lake trout, whitefish, herring (cisco) and grayling continue to have nutritional, social and cultural significance to the residents of Déline as traditional foods. Outfitting and guiding for anglers also provides income in the community and in the lodge industry. In order to maintain these fisheries at optimal levels, up-to-date information is required on the general biology, stock structure, distribution and movements of fish in the lake and watershed, and on the numbers harvested by residents of Déline and by tourists.

Although biological assessments are currently being conducted for lake trout stocks in the Keith Arm area, biological data has not been collected in most areas of Great Bear Lake since the early 1980s. Since this time there have likely been changes in the population characteristics of fish from these areas of the lake, and there have been improvements in techniques for assessing fish populations. The Department of Fisheries and Oceans and SRRB have recently initiated studies to update this information. Similarly, little information is available on the biology and movements of both harvested and forage

fishes for many of the lakes and rivers within the Great Bear Lake water shed and where studies have been done they are out of date.

Harvest information from lodges on Great Bear Lake and outpost camps requires updating from the previous study which ended in 1990 and fisheries managers need an update on what the sport fishery is harvesting from lakes and streams in the rest of the watershed. As well, co-managers have little information on the extent and impact of unguided anglers on Great Bear Lake fish stocks. Subsistence fish harvests were determined over a 3 year period as a component of the Sahtu Harvest Study administered by the SRRB but additional research may be needed before "the Sahtu minimum needs level" can be determined. Also, there is no track of commercial fishing that may be occurring at present.

To manage lake trout and other species on Great Bear Lake the catch by various fisheries (subsistence, sport and commercial) and the resilience of the stocks involved must be determined. Biological assessments by DFO are currently underway for the Keith Arm fish stocks and the above-mentioned subsistence harvest study was recently completed by the SSRB. However, knowledge of the total harvest is of major importance, especially in this area of the lake where fish stocks support more than one type of fishery. When "Basic Needs Levels" are set for Sahtu beneficiaries of the claim, harvest statistics for all users; the food fishery; guided and unguided sports fishers and any commercial fishing activity will be required by co-managers to allocate the resource.

6.5.1 Objectives

- To monitor the harvest of fish by all user groups; subsistence, sports and commercial,
- To prioritize species and water bodies/areas of Great Bear Lake for study based on results of harvest studies and literature review,
- To monitor population abundance, catch rates and biological characteristics of harvested and unharvested fish stocks in GBL and the GBL watershed,
- To compare genetic relationships among fish from different locations to determine stock structure,
- To document the morphological variation of the major fish species (identification of different morphotypes within species),
- Determine movement patterns and critical habitats of (migration timing and location) of migratory fish species,
- Identify and characterize critical fish habitat; spawning, rearing, overwintering areas, migratory corridors, and
- Determine mortality rates of fish released in the sport fishery.

6.5.2 Knowledge Gaps and Action Plans

(I) *Numbers of fish harvested from GBL & watershed: Guided Anglers.*

Introduction: The last harvest study of guided anglers was completed in 1990 and is due for an up-date. The goal for Great Bear Lake is to manage for a very high quality trophy fishery; therefore, considering the low productivity of the lake, harvest levels need to be maintained at relatively low level. Catch and possession limits for lake trout are legislated at conservative levels and quotas have been recommended for each of the areas fished by sports lodges, except for the Keith Arm. Until reassessed, these quotas should not be exceeded if a high quality fishery is to be maintained or in some cases rebuilt. The fishing lodges have supported conservation on Great Bear Lake; they claim to be more conservative in their harvest than the recommended and/or legislated requirements in order to protect the fish stocks, which are basic to the success of their businesses. Both resource managers and lodge management need to periodically assess the results of their conservation efforts. Additionally, catch and possession limits should be reviewed once again to ensure they support the goal of high quality sport fisheries on Great Bear Lake.

Project Description: This project will update the catch, release and harvest statistics and biological information on fish caught by lodges and outfitter anglers on Great Bear Lake using a guide conducted survey, sampling to determine the size composition of trout retained for shore-lunch and a recording of the number of trout over 9 kg (20 lb) caught, kept or released in the fishery.. The survey should be conducted each season for three years in a row each decade. The surveys would be extended to further years if lodge management doesn't get the participant rate up to 60%.

Project Time Frame: It is recommended that this study be initiated in the short term (1-5 years).

(II) *Numbers of fish harvested from GBL & watershed: Unguided Anglers.*

Introduction: There are unknown numbers of anglers who travel to the lake by aircraft or jet-boat who sport fish unguided on the lake. Some of these anglers are beneficiaries of the Sahtu claim while others are residents of the NWT, elsewhere in Canada and possibly from other countries. Although their numbers may not be great and it appears they do not harvest a great number of fish compared to other users, it is still necessary to account for this portion of the total harvest, particularly since most unguided anglers fish close to Déline in what is likely the most heavily exploited area of the lake.

The GBL special sport-fishing license was designed to provide statistics on the numbers of unguided anglers using the lake or at least intending to do so. To date, statistics have not been made available to managers.

Déline feels a lack of control and even a lack of knowledge regarding this group of anglers. Likewise, the SRRB, the GBLWG and DFO are as much in the dark regarding this group of resource users.

Project Description: This gap in harvest information needs to be addressed in two ways. 1. License statistics for Great Bear Lake need to be examined to see if they are useful in tracking the number of unguided anglers using the lake. If addresses and phone numbers are available information on harvest could be estimated from a mail out or phone survey. 2. A boat from Déline would be used to survey anglers in the Keith Arm of the lake through monitoring patrols. Surveys would be conducted in July and August on an annual basis with periodic winter surveys when the ice road is in place. A pilot study was conducted during the 2004/05 fishery.

Project Time Frame: It is recommended that this study be initiated in the short term (1 -5 years).

(III) *Numbers of fish harvested from GBL & watershed: Food fishery harvest (Déline and other Sahtu communities).*

Introduction: The objective of this study is to provide co-managers with harvest estimates for the Keith Arm and other arms of the lake as well as inland lakes and streams and to identify "basic needs levels" as required by the land claims agreement. This project would entail a continuation of the SRRB harvest study or similar study.

Project Description: This project has been described under the project for the harvest study data in the Terrestrial Research and Monitoring Plan. The basic requirements of the project are to have quarterly reporting of subsistence, non-resident and commercial harvest. Improved plans would increase the rate of reporting to monthly levels of all forms of harvest

Project Time Frame: It is recommended that this study be initiated in the short term (1-5 years).

(IV) *Numbers of fish harvested from GBL & watershed: Commercial Fisheries.*

Introduction: There are presently no regulated commercial fisheries in the GBL watershed. If they do occur, co-managers need to know when, where and how much fish of each species is being harvested by this sector. If unregulated trade is occurring, co-managers need to know if the harvest is being recorded under the food fishery. The objective of this project is to provide co-managers with annual harvest statistics if regulated commercial fisheries or unregulated trade occurs in the watershed.

Project Description: If organized commercial fishing is initiated within the watershed, a field technician(s) from Déline would be contracted to monitor the fishery for at least the first two years. In subsequent years, log book program for fishers that would provide catch and effort information would be implemented. It requires a willingness and capacity to fill out log books on fishing actions. A technician would run the program and compile and summarize data collected. Biological samples of the catch, including length, weight and aging structures would be collected as well. A biologist would be needed to support and administer the program and analyze and interpret the resulting information.

Project Time Frame: It is recommended that this study be initiated at the outset, whenever a commercial fishery begins.

(V) *Population abundance and biological characteristics of fish in GBL & watershed.*

Introduction: Until recently there were no studies on the biology of fish stocks in the Keith Arm area of Great Bear Lake and the last studies of fish stocks in other arms of the lake were carried out in the early 1980s. Updated biological information is required for all areas of Great Bear Lake in order to adequately manage fish stocks and determine sustainable harvest levels.

The Department of Fisheries and Oceans, with support from the SRRB and Déline RRC, is currently collecting biological data on all fish species in the Déline area of Keith Arm with a focus on lake trout. This research has been intensive and multi-year in nature in order to gather accurate information on the stock size and status of trout in this previously unassessed arm of the lake. Although the research in the Déline area is extremely valuable, it is also limited since this is just a small portion of the lake. Further data should be collected from lake trout in other areas of Keith Arm and Great Bear Lake since different stocks of lake trout are likely to occur in this areas and since it is expected that future outfitting in Keith Arm may need to be carried on outside of the special harvesting area near the community of Déline. A study by DFO and the SRRB to update biological information on fish stocks in the McVicar, McTavish, Dease and Smith Arms was initiated in 2003.

Very little biological information has been collected on subsistence fisheries in the watershed and what has been colleted is out of date. The exploitation of fish, particularly in small inland lakes, is an important stressor on stocks. In order to measure the impact of subsistence fishery harvest on fish stocks in lakes and streams, studies are needed to determine basic biological information about the fisheries in the watershed. In addition to harvest, managers need information on the species composition of the catch (what kinds of fish are being caught), the catch per unit of effort (CPUE - a measure of how good or poor the fishing is) and the size and age composition of the fish being harvested in lakes and streams other than Great Bear Lake.

The project objective is to determine the population abundance and biological characteristics of fish stocks in Great Bear Lake and the watershed.

Project Description: Researchers would use gill nets, seine nets and electrofishing to capture a representative sample of fish species of various sizes/ages in a given area. Sites selected for study would be chosen in consultation with the community of Déline. The following information would be collected from captured fish:

- CPUE (number of fish caught/species/unit of net/time period)
- Fork length, total weight and aging structures
- Sex, maturity, gonad weight and fecundity
- Stomach contents
- Muscle samples for contaminants, stable isotopes and genetic analyses
- Model data to estimate population abundance, mortality and recruitment and develop biological indices of growth rate, age and size at maturity, age and size structure, and fecundity.

The basic project needed to collect the necessary information would involve the collection of the above detailed biological information over a consecutive 5 year period for each arm of GBL or water body within GBL watershed. This could be followed by more basic sampling of biological information (catch rates and possibly length, weight, age) on a continuous basis by locally trained field monitors. A more detailed sample could be collected once every 5-10 years thereafter. The highest priority species are lake trout and whitefish, while others, such as lake cisco and grayling are a lower priority over the short term. For all of the above described actions it would be preferable to collect information from all arms of Great Bear Lake simultaneously, rather than staggering data collection across years.

Project Time Frame: For Great Bear Lake, it is recommended that research on lake trout and lake whitefish take place over the short term (1-5 years) while information on other species (cisco and grayling) is required over the medium (5-10 years) and long term (all other species). For species in the lakes and rivers of the watershed, data are required on the harvested species in the short term (1-5 years), while other species should be assessed in the long term (10+ years).

(VI) *Structure of the fish stocks in GBL & watershed*

Introduction: The stock structure of lake trout and other harvested species within Great Bear Lake and the watershed is unknown. .A major impediment in the management of the lake trout populations in Great Bear Lake is the lack of information regarding the distribution of fish within the lake. The major question is whether there are several individual populations of trout in the individual arms of the lake, or whether there is just one population distributed through the lake.

The question has significant implications for establishing the catch limits and the conservation of trophy-size fish.

The Department of Fisheries and Oceans is currently collecting genetic tissue samples of all species in conjunction with their population assessment work on Great Bear Lake. These samples can be used to analyze the genetic structure of various species within the lake. They have also issued tissue sample kits to lodges on the lake in an effort to collect tissue samples from shore lunch trout that can be used for genetic analysis. To date they have managed to collect a small number of trout samples from each area with which they have conducted a pilot analysis of the mitochondrial DNA. Larger sample sizes and further lab work using microsatellite DNA are in progress.

Project Description: The basic project plan is to collect 100 tissue samples from each major stock of harvested fish within the lake or watershed. Microsatellite DNA would be analyzed in the fish samples and results would be used to model stock structure and migration patterns within a given water body or area. The enhanced level of this project would be to collect and analyze a larger number of samples (200) from each of the harvested stocks as well as spawning aggregations. Tissue samples could be collected as part of any studies involving biological sampling of fish populations (e.g., knowledge gap IV)

Project Time Frame: It is recommended that the data for this study are collected in the short term (1-5 years) for lake trout, the medium term (5-10 years) for whitefish and in the long term (10+ years) for lake cisco.

(VII) *Variation among lake trout,lake cisco and lake whitefish stocks.*

Introduction: Research by DFO and/or traditional knowledge indicates that lake trout, lake cisco and possibly lake whitefish in Great Bear Lake exhibit considerable phenotypic variation and may be comprised of more than one form. This situation has also been observed in other large lakes such as Great Slave Lake and the Laurentian Great Lakes however the variation has been extinguished in these more southerly populations due to overexploitation. Experience from these other large lakes has shown that, in both lake trout and cisco, some types are more vulnerable to fishing than others and that in restocking and rehabilitation efforts, some types seem to recover their abundance more readily than others.

Although Great Bear Lake is located further north it shows many parallels with the southern Great Lakes. The presence of within species variation in Great Bear Lake adds an element of risk to managing the fishery since productivity and resilience to harvesting may vary among types. The documentation/preservation of natural variability is an important consideration in the conservation of these species. Furthermore, we need to gain an understanding of the productivity, relative abundance, and habitat requirements of different morphotypes and we

need to know if distinct types represent ecologically, and or reproductively isolated (genetically unique) populations.

Project Description: The project will document the morphological variation within lake trout and cisco species (and possibly lake whitefish) in Great Bear Lake using body measurements from digital images of fish taken in the field. Additional measurements and counts may also be collected from fish heads if retained. The research will identify key characteristics that will allow resource users to identify putative types. The measurements will be conducted from a one time collection of 100 digital images (and fish heads, if available) per species from each arm of GBL and at spawning grounds as they are identified through migration studies and TK. A one time collection of 100 whole fish/species near the community of Déline will be used for calibration of measurements from digital images. More advanced levels of this project would include collecting this type of data from all fish collected as part of the stock assessment studies. This data could be collected as part of any studies involving biological sampling of fish populations (e.g., knowledge gap I). Such data could be combined with genetic studies (as described in VI) to determine if different phenotypes are genetically unique.

Project Time Frame: It is recommended that this study be conducted in the near future (1-5 years) for lake trout and lake cisco and in the medium term (5-10 years) for lake whitefish.

(VIII) *Migration patterns and critical habitats of species within GBL & watershed.*

Introduction: This knowledge gap is closely associated with the other studies which are designed to help understand the distribution and structure of the stocks of major fish species in Great Bear Lake and the watershed. The objective of this research is to determine the extent of movements and the time and location of spawning, rearing and overwintering for harvested fish populations in Great Bear Lake and the watershed streams and lakes. There is currently little or no information on migration patterns and corridors and habitats critical to sustainability of the major species, including lake trout, lake whitefish, lake cisco and grayling. The emphasis in this study will be on species identified from the harvest statistics as being of immediate concern to the people of Déline. The immediate benefit of the research will be to identify migration corridors and critical habitat (particularly spawning grounds) for protection and stock management.

Project Description: The study would involve marking about 1000 fish/species per arm of GBL or watershed lake or stream with floy tags and radio tagging with aerial tracking of approximately 30 fish /species/arm of GBL or watershed lake or stream. One arm of the lake would be investigated per year. An enhanced level of the project would include a larger number of fish, or to conduct the work in more

than one location in the same year. Much of the work could be conducted by trained residents of Déline who could be involved in the tagging and surveys.

Project Time Frame: For Great Bear Lake, it is recommended that the data for this study are collected in the short term (1-5 years) for lake trout and lake whitefish, the medium term (5-10 years) for lake cisco and grayling and in the long term (10+ years) for other species. For harvested species in the Great Bear Lake watershed, it is recommended that data be obtained in the short term (1-5 years).

(IX) *Determine mortality rates of fish released in the sport fishery.*

Introduction: One of the major questions facing the managers of the fishery of lakes such as Great Bear Lake is the rate of mortality and injury that occurs in lake trout and grayling that have been caught and released. This issue has also been raised at several workshops in Déline because of the concerns that fish caught by anglers, particularly trophy fish, are returned to the lake but may not survive. Estimates currently being used for the Great Bear Lake trout fishery were determined from a study of lake trout captured in Great Slave Lake in the 1970s and there have been no studies on grayling.

Project Description: This project will conduct a basic catch and release study in an area near Déline to determine the rate of release mortality of sport fish. Up-to-date experimental methods will be used. The number of fish needed will be determined at the time of the study. The study will need to be conducted one time only and could be run near the community of Déline.

Project Time Frame: It is recommended that data for lake trout be obtained over the short term (1-5 years) and in the medium term (5-10 years) for grayling.

(X) *Document current baseline conditions for fish habitat in GBL & watershed.*

Introduction: The Department of Fisheries and Oceans fish habitat management (FHM) division administers the habitat management program which is to conserve and manage fish habitat and to sustain fisheries resources. Fish habitat is defined as any spawning grounds and nursery, rearing and food supply and migration areas on which fish depend directly or indirectly. In Great Bear Lake, judicious habitat management would ensure that the spawning areas for all stocks of the major fish species are protected, which will help to ensure the protection of the fish species in the lake. To accomplish this protection, however, work needs to be done to identify important spawning areas and the resources required by the fish stocks to continue. Environmental Sciences Division is the group in the Central and Arctic Region that is responsible for fish habitat science. The Project objectives are: to provide information on important and critical fish habitat features in the Great Bear Lake Watershed, to assist in the maintenance and

protection of the productive capacity of fish habitat and to maintain the maximum natural capability of habitats to produce healthy fish, and to support aquatic organisms upon which fish depend.

Project Description: Identifying critical fish habitat in Great Bear Lake involves studies at several levels. This project potentially would create a detailed map of fish and benthic invertebrate habitat for the entire near shore area of GBL. It would identify suitable spawning habitat and identify productive regions in the lake in relationship to fetch patterns and substrate types. The project also could be expanded into neighbouring lakes and large rivers. Shoreline and littoral zone classification would be accomplished initially by using satellite imagery and by modeling fetch patterns in relationship to climatic variables. A community visit (year one) to collect TEK on spawning areas would be required to document those habitat types for input into search strategies. Aerial photography of the entire lake shore and ground-truthing of the photography with a single beam acoustic lakebed classification system and bottom grabs would be done in the second year.

Project Time Frame: This area of research is considered to be a priority for the long term integrity of the lake and should be conducted over the short term (1-5 years).

6.6 Aquatic Ecology Research and Monitoring Plan

Although there is a major emphasis on studying and understanding the fisheries in Great Bear Lake, major question also remain about the rest of the aquatic biological community which provides food and support for the larger fish species. For some lakes, such as the Great Lakes, research on aquatic ecology has been conducted for over 40 years, which results in a wealth of knowledge about the influence of nutrients, variations in the types and number of plants and animals that comprise the plankton in the lakes and how invasive species of organisms have changed the structure of the aquatic community. Researchers can now model the ecology of the lakes and predict how they will respond to increased or decreased nutrient inputs, climate warming, and changes in fish species. They also can model how much food is there to support the fish population, which is helpful in setting fishing limits. Very little of this information is available in Great Bear Lake which makes it very difficult to predict what may happen to the lake with increased development, increasing population and the effects of changes in environmental quality due to climate change or the long-range transport of contaminants. Moreover, Great Bear Lake has special features including very clear waters which are a consequence of low nutrient levels, lake size, and a short summer, all of which limit microscopic plant growth. Increased nutrient inputs (with population development) and warming could result in a change in water clarity and the overall features of Great Bear Lake.

6.6.1 Objectives

- To determine the primary features of the aquatic ecology in Great Bear Lake through focused studies at a Master station in the vicinity of Déline,

- To training members of the Déline community to conduct much of the detailed sampling at the Master station. Foster research partnerships for shorter term and/or more specialized studies,
- To survey Great Bear Lake to assess how these features vary between the major arms and the inshore versus offshore,
- To conduct important rate measurements including plant and bacterial growth rates, small animal (zooplankton) feeding rates, and predation rates of forage fish and small animals,
- To determine food web and contaminant pathways, and
- To conduct similar studies in smaller lakes and tributaries located inside the drainage basin

6.6.2 Knowledge Gaps and Action Plans

(I) *Aquatic ecology in Great Bear Lake in the vicinity of Déline.*

Introduction: To provide fundamental information on the presence and growth of single-celled plants and zooplankton and other, it is important to begin studying the aquatic ecology of Great Bear Lake. These studies will determine plant and animal cycles and what types of food support the fish populations. The most basic studies sample aquatic plants and animals and determine their abundance and composition. More advanced studies measure their growth rates and feeding rates. Experiments can be conducted to add plant nutrients to determine what limits plant growth and/or how increased inputs would affect the microscopic plants. In some areas further south, new species of phytoplankton, rooted plants, and invertebrates have colonized lakes and rivers, with many of these species having nuisance properties. As development continues in the north, the likelihood that such species may be transported into the north and successfully colonize lakes and rivers increases. It is important that programs be established to determine the current features of the Great Bear Lake plant and invertebrate communities and monitor for change.

Project Description: A Master station which allows the sampling of plants and animals in the water column would be established near Déline. This would be the same station as the water quality station which was discussed in the previous section. The basic plan of the project calls for the collection of samples bi-weekly during the open water season. Microscopic plant cells and bacteria would be collected from the same depths as the water quality samples and preserved for later analysis using high magnification microscopes. Zooplankton would be collected with the water samples or with vertical net tows. Organisms on the bottom of the lake would be collected with a bottom grab at stations of at least two depths. Nearshore forage fish will be collected with beach seines and electrofishing at fixed locations, e.g., rocky areas, sandy areas, marshy areas. The enhanced level of the project would conduct samples quarterly during the year and bi-weekly during the summer. Studies conducted over winter would provide information on how microscopic plants and animals survive the winter.

Throughout the year, experimental studies could be conducted to measure plant growth rates, factors limiting phytoplankton growth (nutrients and metals), zooplankton grazing and vertical migrations, adaptations to low light levels during periods of long ice cover, the seasonal accumulation and loss of lipid (fat) reserves, etc. Studies also could be conducted investigating the movement of material to the lake floor. This program would be linked to meteorological mooring studies and contaminant cycling studies.

Project Timeframe: It is recommended that this project be initiated in the short term (1-5 years).

(II) *Spatial variations in the aquatic ecology of Great Bear Lake.*

Great Bear Lake is a large lake with five major arms and a central area. The shallow areas, especially those in protected waters and near tributary inflows, are probably the most important areas in the lake for plant and animal growth, including fish. However, apart from studies conducted in the 1960s, little is known about how the aquatic ecology of Great Bear Lake varies from one arm to another and from the nearshore to the offshore.

A general survey of the aquatic ecology of Great Bear Lake waters is required to determine inshore-offshore differences in these features, and to determine the effects of tributary inputs on the ecology and productivity of the major arms of the lake. Such a study would be linked with tributary studies, water quality studies, fisheries studies, and studies of the heat budget of the lake. They also would be linked with satellite imagery studies, to provide estimates of plant cell abundances through chlorophyll measurements. Measurements of plant growth rates (primary productivity) could be applied to the entire lake based on frequent sampling at Déline, lake wide surveys, and satellite imagery.

Project Description: the basic project to address this knowledge gap will be to conduct a single lake wide survey of water chemistry, plankton profiles and abundance and sediment-dwelling organisms in the major arms and the offshore region of the lake. This study would take 3-4 weeks to complete depending on the number of measurements made. With planning and sufficient resources, this study could be linked to studies using acoustics to measure lake depths (bathymetry) and fish and plankton populations (a sophisticated fish finder). Primary production rates would be measured at some sites. The enhanced version of this project would include a complete set of analyses in more arms of the lake (e.g. 2-3 arms).

Project Timeframe: It is recommended that this project be initiated in the short term (1-5 years).

(III) *Contaminant Pathways in Great Bear Lake Food Webs.*

Introduction: Contaminants are of a subject of much concern in aquatic ecosystems everywhere. Contaminants such as PCBs, toxaphene, and mercury are of concern to Great Bear Lake because fish are relatively old and hence have accumulated contaminants over a long period. The concentrations are not sufficiently high to merit consumption advisories but should be monitored from time to time.

The other issue is how contaminants enter and move through the food web. Unlike Great Slave Lake, Great Bear Lake has very clear water. Contaminants such as PCB and toxaphene may move faster into Great Bear Lake food web and into the fish than in Great Slave Lake. This is why PCBs and toxaphene may be higher in Great Bear Lake trout than in Great Slave Lake. Mercury has different pathways and watershed inputs may be very important in bringing in mercury into the lake in the forms in which it most readily moves into the food web.

Introduction: Contaminant pathways studies can be conducted in many ways. The simplest is the determination of contaminant levels in different levels of the food web – mud, small animals, small fish, and larger fish. More precise studies can be conducted by measuring how contaminants enter the lake from the air and watershed, how contaminants sink o the lake floor (and hopefully become buried) and how contaminants are loss from a lake. These studies would be linked with other studies (e.g., sediment trap studies, meteorological studies, etc. Detailed studies of this nature allow the system to be modeled and future trends to be predicted. Such an approach is commonly used on the Great Lakes and is easily adapted to Great Bear Lake by bringing in similar specialists.

Project Description: The basic project would include the analysis of plankton and fish samples collected at the Master station at Déline in one year. A similar set of samples would be analyzed in one of the other arms of the lake would be analyzed the following year. More detailed studies would analyze mercury and other contaminants in the aquatic food web and sediments at the Master station and at an offshore station in the Keith Arm. Similar samples at more sites around the lake would help to define the transfer of mercury and other contaminants in the lake as a whole.

More detailed studies would analyze mercury and other contaminants in the aquatic food web and sediments at the Master station and at an offshore station in the Keith Arm. Similar samples at more sites around the lake would help to define the transfer of mercury and other contaminants in the lake as a whole.

Project Timeframe: It is recommended that this project be initiated in the medium term (6-10 years).

(IV) *Aquatic ecology in the streams & rivers in the Great Bear Lake Watershed.*

Introduction: In addition the Great Bear Lake and the tributaries flowing into it, there are numerous smaller lakes and streams in the watershed. Many lakes have traditional importance in fishing (e.g., Lac Ste. Therese, Kelly Lake). There also is good tourist potential for these lakes. Some lakes are located near urban centers and thus could be impacted by atmospheric emissions. Thus, it is important to obtain baseline information on the aquatic ecology of these lakes and their tributaries to help support the traditional fishery. The range of aquatic ecology studies and items sampled is the same as for Great Bear Lake.

Project Description: The project design for this projects recommends a minimum a collection of a limited number of samples once in a summer in major lakes and tributaries in the watershed. The samples would include surface samples for phyto- and zooplankton. More advanced studies would include the summer set of samples, but also include limited number of winter studies as well.

Project Timeframe: It is recommended that this project be initiated in the medium term (6-10 years).

(V) *Ecosystem modeling of Great Bear Lake.*

Introduction: Ecosystem modeling is a powerful tool which can be linked with other components of research and monitoring on Great Bear Lake. The model development should include watershed hydrology modelling perhaps local identified sub- basins, and modelling of the fundamental characteristics of the lake which impact on the water quantity, quality, nutrient distribution, aquatic ecology and the important fisheries questions.

Project Description: This study would be linked with include lake monitoring (surveys and in situ observations, island observations etc) for the basic meteorology (air temperature, water surface temperature, wind speed, wind direction, solar and long wave radiation) of Great Bear Lake. There also would be strategically located temperature moorings with some year-round moorings, transmissometer (light penetration into water), and current observations. Researchers can use these data to model heating and cooling cycles in Great Bear Lake, water movements, the mixing of waters from one area of the lake to another, and describe fish habitat based on temperature requirements. These models also can be used in to develop water quality and fisheries habitat models as well as investigate climate change.

Project Timeframe: It is recommended that this project be initiated in the short term (1-5 yrs).

(VI) *Remedial actions for elevated mercury levels in fish in small lakes.*

Introduction: Elevated mercury levels are a common feature in fish inhabiting small lakes and where the fish population is relatively old. Higher mercury levels

appear to be due in part to the nature of mercury movement in small lakes. In brief, mercury is more easily converted into a form that moves into the food web in small lakes than large lakes. In addition, mercury levels increase with fish age: the older the fish population the higher the mercury levels. While these general principals are known, there has not been a good study of mercury pathways in a lake in the Northwest Territories nor of possible remedial actions.

Project Description: This study would be focused study of mercury pathways from deposition into snow and rainfall into the watershed, to its transformations in wetlands into organic forms and subsequent movement through the food web into top predators. A second element of the study is the detailed assessment of the growth features of the fish population and the overall productivity of the lake. This would set the framework for potential remedial actions, if possible, for the elevated mercury levels. One possibility is to reduce mean fish age through increased harvesting of the older fish. Another possibility may be to alternate the nature of the food web through various manipulations. A study of this nature also can address questions as to how increased warming may affect mercury levels in fish. Because this study would be intensive and complex, there are a multitude of opportunities for community involvement and training.

The ideal location would be Lac Ste. Therese with a field/research camp set up for the 2-3 years this study would require.

Project Timeframe: It is recommended that this project be initiated in the short term (1-5 yrs).

6.7 Neh Karila K'ets'Edi Research and Monitoring Plan

Neh Karila K'ets'Edi is Slavey for "these places: we're protecting them". Neh Karila K'ets'Edi have a combination of important cultural, historic, traditional and/or ecological values that need a higher level of protection than is provided by the Special Management Zone policies, conditions and prohibitions of the Management Plan.

Neh Karila K'ets'Edi are very important to the residents and communities of the Sahtu settlement area, and indeed to all to Canadians. They are important contributors to wildlife and ecological systems, to socio-economic sustainability and to the existing and future social, cultural and economic well-being of the Sahtugot'ine.

Neh Karila K'ets'Edi include two forms of conservation protection:

a. **Protection Zones**: Protection Zones are to be protected with Protection Zone policies, conditions and prohibitions in the Sahtu Land Use Plan. Oil and gas, and mining development are prohibited in all the Protection Zones. Some of the Protection Zones have additional prohibitions.

b. **Protected Areas**: Protected Areas would have *additional* legislative protection to the Protection Zone policies, conditions and prohibitions the Land Use Plan. Once established, Protected Areas would be managed according to co-operative management agreements negotiated between one or more aboriginal authorities and the legislatively-mandated government management agency. "Protected Areas" includes national parks and national historic sites protected by regulations under the *Canada National Parks Act*, as well as the range of "conservation areas" as defined in section 2.1.1 of the SLCA.

Research and monitoring in and around all Ne Karila K'ets'Edi is needed to ensure these places remain ecologically and culturally intact, and that they continue to contribute to the health of the watershed and Sahtugot'ine.

6.7.1 Objectives

- To determine if areas other than those shown as protection zones need either surface or subsurface protection, such as additional areas of cultural importance or areas that contribute to ecoregion representation in the NWT
- To determine if any protection zones should be pursued as protected areas
- To better understand the complex relationship between development and ecological integrity and change: develop reference sites within Neh Karila K'ets'Edi as benchmarks to monitor, assess and mitigate the impacts (including cumulative impacts) of activities elsewhere in the GBLW
- To set appropriate use and land management protocols that are consistent with the ecological and cultural integrity of these places
- To ensure activities outside of Neh Karila K'ets'Edi are consistent with the ecological and cultural integrity of these places
- To contribute to our overall understanding of these areas, and our ability to communicate their importance

6.7.2 Knowledge Gaps and Action Plans

(I) *Identify areas for permanent protection that are already identified as Protection Zones in the Management Plan.*

Introduction: The Management Plan identifies a number of areas as Protection Zones. Only one (Sahyoue/Edacho) is in the process of potentially becoming a long-term protected area through the Protected Areas Strategy (PAS). However, long-term protection for some areas, such as Edajjla, has been suggested in "*Radekée Gok'é Godi: Places We Take Care Of*" and in working sessions of the Management Plan. A process to determine which, if any, areas other than Sahyoue/Edacho should become protected *areas* rather than protection *zones* is needed.

Project Description: A 2-3 day workshop to determine whether more permanent protection (other than that given under the Sahtu Land Use Plan) is wanted for

any Neh Karila K'ets'Edi. Along with this would be discussion of who should govern these areas along with Déline, and/or who would be a sponsoring agency if an area goes into the PAS process. Once areas are in the PAS process, additional workshops and studies will be needed in accordance with the steps laid out in the PAS.

Project Timeframe: This project should be started in the short term (1-5 years).

(II) *Identify further potential surface and/or subsurface Protected Areas.*

Introduction: There is an estimate that only 20% of the archeological sites in the NWT are documented. This is an example, as noted under the Cultural Research and Monitoring section (6.8), there is still a considerable amount of work to be done on documenting cultural sites within the GBL watershed. Once on-the-land identification with Elders of areas of cultural importance is done, there will likely be other cultural areas identified that need protection.

Likewise once the considerable ecological information gaps (section 6.1-6.3) have begun to be addressed, areas of ecological significance that require some additional protection may be determined.

In addition, PAS Goal 2 is ecological representation. There are 7 ecoregions in the Sahtu portion of the GBL watershed (Grandin Plains, Norman Range, Great Bear Lake Plan, Colville Hills, Dease Arm Plain, Coppermine River Upland and Keller Lake Plain). One (Grandin Plains = Edajjla) is virtually solely within the GBL watershed. Four of the ecoregions are identified in the NWT-PAS Mackenzie Valley Five Year Action Plan: the Norman Range (55), Great Bear Lake Plain (52), Colville Hills (54), and the Dease Arm Plain (35). This Action Plan calls for all ecoregions to have suitable representation of protected areas within the next 5 years. A report (*Conservation Suitability Analysis of the NWT: An Exploratory Approach*, Cizek Environmental Services, Sept. 2004) was done to design an ecologically-representative protected area network throughout the NWT. The report, though preliminary, shows a number of areas within the watershed in addition to the conservation zones that should be protected to meet the goal of adequate ecological representation.

Project Description: A more detailed ecological gap analysis should be done of the whole watershed and of the draft Sahtu Land Use Plan (expected in the fall of 2005). This should help pinpoint areas of particular interest for field studies. Such work should be done in a collaborative, interdisciplinary manner, as noted elsewhere in this report and Management Plan. Also, results from other studies (cultural and ecological) should be input into this analysis.

Once this revised gap analysis is completed, a community workshop to discuss potential additional sites is needed. At that stage, additional ecological, non-renewable and cultural resource assessments may be needed.

A full-time community coordinator to investigate and advance protected areas initiatives and act as a liaison between the community, the GBLWG, the SLUP board and the NWT-PAS is needed as part of projects I and II.

Project Timeframe: This project should be started in the short term (1-5 years).

(III) *Determine if aquatic representation is required within the GBL watershed.*

Introduction: Conservation has focused to date on terrestrial areas. While some work has been done on important cultural areas (such as special harvesting areas for whitefish), no work has concentrated on protecting important aquatic sites, nor has there been any work done on representation of types of smaller rivers and lakes. This type of representation is not as well documented as the terrestrial ecosystem representation. Some factors would likely overlap with terrestrial units such as geology and soil, but most factors would be specific to aquatic systems, such as stream gradient, size, water chemistry (e.g., temperature, pH), connectivity to wetlands and glaciers, benthic complexity, and aquatic focal species representation.

Project Description: Determine a suitable aquatic representation system, then do a gap analysis to determine if any additional SMZ conditions, Protection Zones or Protected Areas are needed.

Project Timeframe: This project should be started in the medium-term (6-10 years).

(IV) *Design long-term integrated Neh Karila K'ets'Edi monitoring program.*

Introduction: Several agencies are likely to be involved in Neh Karila K'ets'Edi management and monitoring. Possibly agencies include Parks Canada, Canadian Wildlife Service, Territorial Parks, and the Sahtu Land Use Planning Board. Management plans done for any Neh Karila K'ets'Edi should include monitoring for the values for which the Neh Karila K'ets'Edi was established. As these individual monitoring plans are developed, it would be best to have monitoring of areas co-ordinated, to give the best overall "picture" of the watershed's health.

Project Description: This project involves two aspects:

a) Develop a tracking system of Neh Karila K'ets'Edi use, e.g. visitors, hunters/trappers, schools.

b) Develop access guidelines to important ecological and cultural areas. This is related as well to the rules and protocols for access and use of cultural sites such as burial sites.

Project Timeframe: This project should be started in the medium term (6-10 years).

(V) *International recognition and designation for the Great Bear Lake Watershed.*

Introduction: While an international designation is not needed in order to manage the lake properly, and an international designation may not be suitable in the short term, Great Bear Lake is indeed *worthy* of international stature.

An international designation doesn't have any force of law. But having an international designation for Great Bear Lake could contribute in a few ways:

1. review of management ideas by independent experts
2. access to sharing ideas globally
3. additional "watching eyes" to make sure we live up to our commitments
4. additional local community capacity-building
5. possibilities for funding targeted at various projects within this R&M Plan
6. celebrate the unique cultural and ecological values globally

Several types of designations or involvement in international initiatives may be possible, including World Heritage Site (United Nations convention), Biosphere Reserve (United Nations "Man and Biosphere" program), Sustainable Arctic Tourism Project (Arctic Council and Northern Forum), or International Association for Great Lakes Research (research group that holds international conferences).

Project Description: Community workshop to discuss various international designations and initiatives, and how they might contribute to the goals of the GBLW Management Plan. From this, follow-up with appropriate nomination or initiative process.

Project Timeframe: This project should be started in the medium term (6-10 years).

(VI) ***Caribou Crossings and Migration Routes***

Introduction: Identification and protection of caribou water crossings and migration routes is a key component for implementation of Mobile Caribou Protection Measures.

Project Description: In addition to ongoing (since 1996) radio-tracking of collared caribou by satellite to identify and map seasonal and annual ranges for barren-ground caribou, it is necessary that local traditional knowledge be used to identify important caribou water crossings and migration routes within the watershed. From both the traditional knowledge and scientific information, the

identification of key sites that need protection, and appropriate means of protection, must be made.

Project Timeframe: This project should be started in the short term.

6.8 Cultural Research and Monitoring Plan

The Great Bear Lake Watershed is a special place for the people of Déline. Their ancestors have been part of and have cared for this place for countless generations. The elders assert that we in turn have a responsibility to treat this watershed with respect and to keep it healthy. The oral tradition and stories that are tied to the land help to define who the Sahtugot'ine are as a people. Legends are from the land and these stories create maps for the people. Names that are given to the land often tell the story.

Two factors come of this. First, cultural integrity is closely tied to ecological integrity (healthy land is needed for a strong culture). Second, the culture is not a material culture, so 'artifacts' *per se* are not the defining feature. The elders have described parts of the land as their 'libraries, schools and colleges'. It is through the use of the land that the culture continues. Thus it can be problematic to consider the cultural integrity of the GBL area separately from its ecological integrity, because often the cultural significance of a particular site or area is owing to its ecological significance (i.e. an area has cultural/historical significance *because* it was/is an important harvesting area for a particular resource). The following interpretations of cultural integrity/research/resources are offered with the understanding that cultural integrity and traditional knowledge permeate *all* aspects of the Research and Monitoring Plan; presumably this goal will be realized through the strong role that community members will continue to play in the implementation of both the Management Plan and the R&M plan. An important consideration here is that most sciences (such as biology and geology) do not include cultural research in their toolbox of methodologies and, therefore, do not provide training in these techniques. It is essential, then, that anthropologists, who are trained in cultural research methods and theory, are part of the team that sets up any multi-disciplinary projects. Furthermore, having other scientists 'tag-along' in cultural research can provide a diverse learning environment where knowledge from elders and various scientists can be shared and collected in partnership.

For work in this section, and TK work covered under other sections, the use and distribution of TK needs to be determined. This is done on a case-by-case between the researcher and the community, as research licenses do include demonstrating community approval. However, there are various guiding policies, such as those developed by the DélineUranium Team, the Mackenzie Valley Environmental Impact Review Board, and the Gwich'in Social and Cultural Institute, that may be useful for putting a policy framework to these decisions.

6.8.1 Objectives

- To ensure that the cultural integrity of the Sahtugot'ine relationship with the GBL watershed is strengthened and maintained
- To collect baseline data within the Great Bear Lake watershed on significant sites, trails, gravesites and archaeological sites
- To develop the community's capability in the fields of cultural research, monitoring and management
- To document TEK and land use practices for future generations and to continue to integrate this knowledge with the Management Plan
- To design, implement and maintain a long-term program to monitor cultural resources
- To document, promote and communicate the cultural heritage of the GBL watershed
- To encourage the transmission of cultural knowledge by educating youth on the land in a traditional way

6.8.2 Knowledge Gaps and Action Plans

(I) *Core Research Capacity.*

Introduction: One of the recommendations in "*Radekée Gok'é Godi: Places We Take Care Of*" was for a Sahtu Cultural Institute. This has not been done; however the need to research, protect and promote cultural resources still exists. Déline has been making efforts to establish a Déline Knowledge Centre, which would, as part of its mandate, include research and education related to cultural resources. Related to that, or on in another capacity, there needs to be core research capacity developed in Déline to undertake all of these projects.

Project Description: A Cultural Research Director, 3 Fieldworkers and a Data/Communications Manager; would be needed for a period of five years

Project Timeframe: This project should be started in the short term (1-5 years).

(II) *Cultural Resources Baseline Data Collection and Analysis.*

Introduction: Sahtugot'ine use of the GBL watershed has traditionally focused on a number of traditional use sites where seasonally abundant resources are available and can be harvested in accordance with traditional practices. These locations, distributed throughout the entire watershed, were accessed through a network of well defined trails creating a complex use of land and resources, used over seasons and centuries. These locations and trails are still important today, providing access to food and other resources critical to Sahtugot'ine health and well-being. Understanding traditional land use can also help inform other aspects

of cultural resources research and documentation, particularly in locating and interpreting archaeological and burial sites.[5]

As part of the Claim, a study called "*Radekée Gok'é Godi: Places We Take Care Of*" (Sahtu Heritage Places and Sites Joint Working Group, 2000) reported on a sample of the existing heritage places and sites important to the Sahtu Dene and Métis. Many of the places (such as Etirato/Whitefish River, and Turili/Johnny Hoe Fishery) formed the basis for protection zones. However, as reflected in the report's recommendations, there is still much work to be done in collecting and documenting the oral histories of culturally significant sites (including traditional trails, burial sites and archaeological sites). Furthermore, it is far from certain that the extant research, which has been conducted as part of larger regional projects, represents a true and complete inventory of cultural resources on Great Bear Lake.

Thus although some progress has been made in the attempt to inventory culturally significant sites in the GBL watershed, this task is far from complete.

Project Description: The first phase is to conduct a review and gap analysis of extant information on cultural resources within the watershed (literature review). Phase II is to collect and record additional baseline data (locations, place names, oral histories, visual documentation) on significant sites, trails, gravesites and archaeological sites. Once the material is gathered, a data analysis is needed to assess cultural resource and land management implications.

Although we have been primarily concerned thus far with cultural resources as features of the land, it should be noted that cultural/heritage resources could also refer to artifacts or historical records. Section 26.2.7 of the Sahtu Dene and Métis Comprehensive Land Claim Agreement states that any such objects which have been removed from the settlement area should be returned, provided that appropriate facilities and expertise exist to ensure their proper care and maintenance. A further aspect of baseline data collection could thus involve researching the existence and whereabouts of historical artifacts and records, and working towards the development of an appropriate facility to house them upon being returned to the Sahtu.

Radekée Gok'é Godi: Places We Take Care Of notes several projects where oral history and archaeological research is needed. While many of these are associated with the protection zones of the Management Place (see also PAS section of R&M report), the story of Yamoria Eht'ene (Yamoria and the Giant

[5] It should be noted that the concept of geographical significance can be quite diverse, given the broadly divergent areas of the watershed where different families historically travelled. In the land use planning process, some community members were opposed to selecting specific fixed areas over others, arguing that the entire Déline District is equally important to people. This is logical, given that the people are required to follow the shifting geography of the wildlife resources on which their subsistence depended. The community has in various forums since asserted that much more work is required to fully map the cultural landscape of the GBL watershed.

Beavers) stands out. Pieces of this story were told throughout the many workshops associated with the development of the Management Plan. As stated in *Radekée Gok'é Godi: Places We Take Care Of,* this "story of Yamoria links several important sites". Its central importance to the people, its geographic extent across the lake, and the fact that it links so many terrestrial sites points to this as an important story to document properly.

Project Timeframe: This project should be started in the short term (1-5 years).

(III) *Place Names Compilation and Research.*

Introduction: Traditional place names have been used for centuries to refer to important landmarks, cultural sites, and resource harvesting locales. Traditional place names are also used as mnemonic devices to help remember aspects of oral culture associated with place, and are therefore a window into both current and past land use. While this is an important part of all research, there is specific work associated with place names that is required. Researchers such as Cornelius Osgood (1928, 1953, 1975) and John Tetso (1980s and 1990s) and others have recorded many traditional names and published them in a variety of forms. Two things are missing from such works:
a) The stories associated with each place are often missing
b) The spatial extent of the name is often missing (i.e., names are not 'dots' on a map, but have a specific geographic area they cover)
Furthermore, the results of place name research efforts have never been complied into a single resource.

Project Description: Compiling existing research, including stories and mapped spatial extent, should be compiled into one source and one map. From this, identifying gaps and devising additional research to address the missing components (particularly collecting and documenting the oral narratives associated with place) should be done.

Project Timeframe: This project should be started in the short term (1-5 years).

(IV) *Burial Site Identification and Recording.*

Introduction: Focus groups held with approximately 60 community members representing women and men of three age groups have confirmed that it is of the utmost importance that *burial sites* around the lake are identified and protected. This must be a priority not only due to the general desire and right of all peoples to remember and respect their dead, but also because gravesites are physical manifestations of Sahtugot'ine ancestry and history that are inscribed on the landscape around the lake – they speak poignantly of the intimate historical relationship between a people and their environment.

Burial sites are protected through the Mackenzie Valley Land Use Regulations, pursuant to the *Mackenzie Valley Resource Management Act*, which make it illegal to conduct a development activity within 30 metres of a burial. However, though there have been several projects designed to record burials in various locations in the watershed, often as part of other research efforts, there has never been a systematic recording of all burials within the GBL watershed. The best way to protect them is to record their location and share this data widely with all agencies involved land management.

Project Description: Unlike other sites with material artifacts (which require investigation by an archaeologist for scientific investigation) burial sites are readily recorded in conjunction with other research projects. Thus as part of the all research projects, the recording of grave sites should be done as standard procedure. Furthermore, community members, through the Band or RRC, should be encouraged to record grave sites. For this, GPS units should be loaned to band members traveling within the watershed that are willing to undertake this task and give the information back to the RRC.

The records should include:
-latitude and longitude
-traditional place name (if known)
-other known name (if known)
- name of deceased
- genealogical information (if known)
-description of location
-description of grave

This information should be included in annual updates to the Management Plan and/or the Sahtu Land Use Plan.

Project Timeframe: This project should be started in the short term (1-5 years).

(V) *TEK: Land Use and Managemen*t.

Introduction: Over the generations, Dene people have evolved a rich body of ecological knowledge and subsistence practices. These have included an understanding of country food and furbearer resources, weather, and medicinal plants. As well, Dene culture has involved a rigorous set of protocols for ensuring proper respect for the land (land management). The elders of Déline have identified a need for documentation of traditional ecological knowledge and land use practices, including protocols, so that this knowledge resource can be harnessed by future generations and integrated into ecological research and monitoring activities. The Dene Cultural Institute's *Traditional Ecological Knowledge: A Pilot Project conducted in Fort Good Hope and Colville Lake, NT, 1989-1993* is a good starting point for developing a research program in this area. Also, studies conducted by the Dogrib Treaty 11 Council could provide useful

ideas for the design and implementation of a similar project in the GBL watershed.

Project Description: Document TEK and land use practices through on-the-land work that involves Elders, youth and researchers. The project should maximize the opportunities for Elders and youth to share and transmit knowledge, utilizing traditional pedagogical techniques where appropriate.
This results need to be linked through databases for use by the Déline Renewable Resources Council, the Sahtu Land Use Planning Board, protected areas agencies and other land management agencies.

Project Timeframe: This project should be started in the medium term (3-5 years).

(VI) *Design long-term cultural integrity monitoring program.*

Introduction: With the research collected through previous projects, it will be possible to design a long-term monitoring program. This is the crucial step that the base research work is leading to.

Project Description: The monitoring program will need to integrate the significant sites, trails, gravesites and archaeological sites research; land and cultural resource management information, data base integration, and legislation/enforcement into a long-term monitoring plan. The program will need to include at least one on-the-land pilot project that ties site research, TEK, management and other issues together. The pilot project will need to include youth, Elders and researchers.

Such a plan would likely articulate rules and protocols for access and use of these sites (i.e. restrictions on development, access to tourists, etc.) as well as programs for long-term protection and maintenance. In addition, requirements for development project-specific work will need to be tied into the overall cultural integrity monitoring program as well as the Management Plan.

Community consultation should be the primary mechanism for developing such a plan, in order to ensure that it accurately reflects community priorities and preferences for which sites should be protected, and the most appropriate methods for ensuring long-term integrity. In other words, it falls primarily to the Sahtugot'ine themselves to develop appropriate methods of caring for their cultural and historical places and resources.

This plan could be closely integrated with long-term environmental monitoring activities, both to increase logistical efficiency and to reflect the real synthesis of ecological and cultural interests within the framework of Sahtugot'ine culture.

Project Timeframe: This project should be started in the medium term (3-5 years).

(VII) *Communications/Education.*

Introduction: While communicating all research and monitoring information is an important part of all projects in this R& M Plan, there is a special need for more extensive communications and education work focused on culture resources. Simply finding sites and protecting them is not enough to ensure cultural integrity: the culture must be living for its integrity to be sustained. Hence communication and education to fully involve children, youth, adults and elders is needed. Dissemination of knowledge among partners and to the public at large is also important, as with other aspects of the R&M plan.

Project Description: Youth and Elders need to be involved in the on-the-land activities, where cultural knowledge about the GBL watershed can be shared and experienced. An ongoing newsletter series, website updates (either through a GBL website, or through the Déline community website), video, literature, signage/plaques on the land, are part of the communications/education. Local/regional educators should be assisted with the development of teaching material that can be integrated into school curricula. Also, a centre in Déline should be established where visitors can become aware of the culture and history of the area and community members can develop traditional and new forms of cultural expression.

Project Timeframe: This project should be started in the short term (1-5 years) since it is intended as a corollary to other projects described above.

6.9 Economics Research and Monitoring

A main principle of the watershed management plan is that "Activities in the GBLW protect and promote the existing and future social, cultural and *economic* well-being of residents of the watershed", and the economic well-being of Déline participants is particularly recognized.

Economics is part of the social and cultural structure of the community. It measures the distribution of goods, and the satisfaction of human needs. So while money is often tied to economics, it isn't necessarily so (and traditionally would not have been the case). Economic activity in the watershed was traditionally, and mostly continues to be, in terms of use of renewable resources. For instance, the GNWT (ENT) estimates the average yearly harvest of barren ground caribou in the Sahtu to be approximately 2500 animals. Using a $20/kg meat replacement value, ENT estimates the herd's meat replacement value alone, were hunters to buy comparable meat in their local stores, to be worth $2.8 million to the Sahtu settlement area annually. (This estimate does not include the cultural value of the herd and its harvest, nor the herd's potential value to the big game hunting industry in the Sahtu.) The watershed's fish are important for food (traditional economy), and further the trophy-size lake trout and grayling are important to the local cash economy. Building on the uses of renewable resources, a number of

community workshops identified tourism/outfitting as the key sector to pursue to bring jobs and money to Déline. Big-game hunting of musk-ox is an example of this.

There are other outside interests in economic development. The mining industry and the oil and gas industry have goals other than the economic well-being of watershed residents. Similarly, the possible hydro-electric dam on the Great Bear River is a potential source of money for the community that does not have as its goal the economic well-being of Déline or the Sahtu. These companies tend to be large, multi-national corporations which operate in a different way than local businesses. The Territorial and Federal Governments also have economic development interests. While these are to some extent community-based, they have other constituents (other than Déline) that they are trying to satisfy.

At this point, the GNWT has tended to say 'economic development' of whatever type is good. However, this is leading to great problems and confusion, particularly seen in the gas project now. Additionally, there is a problem of when operations cease, the effects don't. Historically, this has meant that when operations cease, there was waste to clean-up (see Chapter 9 of Management Plan). The community would like the ongoing effects after an operation ceases to be positive, such as having a pool of trained, experienced workers; local companies that have increased and diversified their services; and residents with specialized training and skills.

This section more specifically is to develop standards and parameters to ensure that current and future economic development initiatives are consistent with the principles for the management of the GBLW.

6.9.1 Objectives

- To collect baseline data on the existing economic circumstances within the Great Bear Lake watershed, including information on the basic needs of Déline
- To document traditional knowledge regarding 'economic' health
- To combine both scientific and traditional knowledge on economics and communicate this to the community of Déline
- To develop a series of indicators to define 'sustainable development' in a holistic and integrated way, including accounting for the qualitative aspects of life in the community, the financial aspects, infrastructure, and the health of the watershed in general
- To develop a series of indicators to define measure economic and financial success in Déline's terms, and the capacity within Déline to measure that success
- To research economic development opportunities that could maximize local jobs, produces goods locally for local and regional consumption, retain and enhance spiritual connection to the land, and reflect the political structures in Déline and the Sahtu
- To research ways to build on existing opportunities and successes, such as the tourism industry and helping local businesses expand or diversify their operations
- To develop a capacity-building plan, that identifies the gaps in the workforce (in terms of Déline's needs and outside companies) and appropriate strategies to meet those gaps, in such a way that the whole community can benefit

- To develop standards to evaluate how economic development projects by corporations or groups other than Déline Land Corporation/ Sahtugot'ine interact with the ability of the Déline Land Corporation to pursue tourism, trapping and any other development projects they wish to pursue
- To develop a strategic plan to capitalize on the economic opportunities generated by the establishment of Neh Karila K'ets'Edi.
- To design, implement and maintain a long-term program to monitor economic strength of Déline

6.9.2 Knowledge Gaps and Action Plan

Specific projects need to be identified, along with primary research bodies, to undertake this work and meet these objectives. Work should begin immediately.

7.0 Concluding Remarks

The research and monitoring projects for Great Bear Lake and its watershed are ambitious with a multitude of complex studies proposed over a very broad geographic area. The funds to conduct these studies have yet to be identified. However the Working Group is encouraged that much has already been accomplished and is very optimistic about the future. This is based on three considerations.

First, while there is a limited amount of research and monitoring being conducted on Great Bear Lake and its watershed, a wealth of information already exists as revealed in the recent review of the studies conducted on Great Bear Lake over the past few decades. A great deal of this information is in the form of reports including the literature survey *What the "White Man" Knows About the Natural History of Great Bear Lake*, the Traditional Ecological Knowledge (2003), and the Aquatic (2003) and Terrestrial (2004) State of Knowledge Reports. All of these recognize the traditional role of Déline in understanding and maintaining the land and water resources of the watershed. All three reports have highlighted knowledge gaps, ecological stressors and the need for research and monitoring in a future management plan.

Much progress on the goals and objectives outlined in this plan can be accomplished in the next 1-5 years if this information can be synthesized to the next higher scientific level and published in the scientific literature. Such publications fuel scientific and monitoring interest in a region of environmental issue and stimulate new funding, collaborations, and other partnerships. It is clear that Déline is most welcoming of such partnerships.

Second, there has also been an increase in the number and nature of studies conducted on Great Bear Lake and its surrounding region over the past 2-3 years. These studies include fish stock assessments studies in Great Bear Lake, caribou studies, oral history work, studies of mercury lake food webs, organochlorines in lake trout, and studies of the heating and cooling of the lake and the implications to other aspects of Great Bear Lake limnology. Funding has been provided by a number of programs including the Sahtu

Renewable Resources Board, the Northern Ecosystem Initiative, the Northern Contaminants Program, Parks Canada and GEWEX, to name a few. There has been strong federal involvement including Environment Canada, Department of Fisheries and Oceans and Department of Indian Affairs and Northern Development. Collaborations between federal departments have been successful as have collaborations with Déline. Great Bear Lake is also receiving more international interest with a researcher from the United States Great Lakes Fisheries Commission investigating lake trout populations.

Third, the GBLWG is strongly encouraged by the leadership, vision, and enthusiasm provided by Déline, Déline's commitment to the protection of Great Bear Lake and its watershed, and its desire to work with others who share similar ideals. Priority areas have been established with respect to waters, lands, plants and animals and concerns regarding resource protection, climatic variability, culture and economics, including increased development in the watershed. As the vision for the research and monitoring plan becomes more focused and peoples of different backgrounds work together, means will be found to implement the plan. Central to this is the goodwill and interest of Déline and sound and cost effective research and monitoring study designs. There is a long-term commitment to this vision which, while starting small, has much potential for growth. One is encouraged by the number of research and monitoring stations that have been established in North America and elsewhere including Lake Tahoe (USA), Lake Baikal (Siberia), and the very long-term programs on the Laurentian Great Lakes. The Great Bear Lake watershed has this potential.