MIDDLE MACKENZIE RIVER PROJECT

A Proposal to carry out LANDCOVER, WATERBIRD and WATER CHEMISTRY INVENTORIES

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EXECUTIVE SUMMARY

The recent resurgence of oil and natural gas exploration, and the attendant likelihood of a Mackenzie Valley pipeline for future development in the NWT, has increased the potential for conflict of uses of waterbird habitats.. With recent land claim settlements in place, these industrial developments are now being carefully considered by Aboriginal and Inuit groups as they move towards fully exercising control over resources in their respective regions. As the influence of local decision making increases, affected parties are both interested and obligated to proactively manage development within their respective areas. However, sound and effective land management decisions are often hampered by an inability to access relevant information. The Middle Mackenzie River Project is an integrated inventory proposal for a key area in the Taiga Plain of Canada's Northwest Territories. This project will not only serve the needs of local inhabitants and resource managers, but will also be a key component of Ducks Unlimited Canada's newest conservation program focusing on the Western Boreal Forest.

We propose to help provide this essential information, before significant development occurs, by conducting landcover, waterbird and water chemistry inventories. Following completion and verification of the landcover inventory, we will conduct change detection analysis to provide insight into these potential effects.

Landsat Scene Classification

We will complete a landcover inventory on a Landsat Thematic Mapper (TM) satellite scene, covering approximately 5.7 million ha (14 million acres), with a spatial resolution (pixel size) of 30m x 30m. Up to six bands of information are combined to produce spectrally unique signatures, which can then be classified using helicopter field verification. For forested areas, summer images are purchased to capture maximum biomass production. An unsupervised classification provides up to 30 cover classes from which up to 30 field verification sites per cover class are chosen for helicopter ground truthing. Two-thirds of the sites are used to process the image (classification), while the remaining third are used for independent cover-type accuracy assessment. The rigorous and standardized protocols employed typically result in individual cover class accuracy of 80-95%. This process has been found to be very cost effective with total costs of $0.12-$0.14/ha as estimated from similar work in work in Canada where mapping has been completed on over 35 million ha of boreal and tundra habitat using this methodology..

Change Detection

Change detection may be undertaken in conjunction with the Landsat image classification, which provides accurate and current baseline information on landcover features within the 5.7 M ha scene. Changes may be assessed by comparing historical (e.g., mid-'80's) images of the same area with the current landcover attributes using change detection algorithms. This l allows documentation of both natural changes (e.g. fires, climate change) and anthropogenic changes (resource extraction development). This information can then be used by managers to help understand the past, present, and help manage future impacts to the land base.

Waterbird Surveys

Complementing the landcover inventory is the proposed evaluation of the use of selected wetland areas by waterfowl and other wetland-dependent waterbirds. Oral history and Traditional Environmental Knowledge (TEK) suggests that certain wetland habitats/areas associated with many of the large lakes in the Mackenzie Valley are important migratory waterbird staging areas. As well, the numerous post-glacial ponds, fens, bogs, lakes and streams are breeding habitat for a wide variety of species (Ferguson, 1997). This component of the proposal will allow a broad scale analysis of the density and variability of waterbird use of wetland systems at this latitude. Wetland habitats used by COSEWIC-listed or locally sensitive species (e.g. scoters, scaup, swans, cranes, loons, shorebirds) will also be specifically identified through this faunal inventory. An understanding of the variability and range of waterbird use at a variety of habitats is complementary to site and landscape scale interpretation of the potential impacts of future resource extraction activities.

Water Chemistry

Accompanying the waterbird surveys, we are proposing an initial water chemistry survey of a sub-sample of sites selected for the waterbird survey program. Analysis will include characterization of pH, conductivity, salinity, nutrients, primary productivity, alkalinity, carbonate and bicarbonate, and dominant ions in surface waters across the region. This sampling regime will assist in defining the relative productivity of wetlands within the scene, help to develop the linkages between wetland type, productivity and waterbird use, and determine the range of variability in wetlands located on the scene under investigation. Collection and analysis of isotope samples will assist in determining the relative importance of different surface water inputs to these systems. Determination of these hydrologic linkages may be particularly important in interpreting nutrient and other chemical constituent budgets in wetlands underlain by permanent or discontinuous permafrost. This in turn will allow development of hypotheses on the effects of various land-use practices on wetland water quality and productivity.

Budget

This project will be strengthened by the input and support of affected Aboriginal groups (e.g., Gwich'in Renewable Resources Board, Sahtu Renewable Resources Board). This will allow Aboriginal land managers, government regulators and extraction industries to work together, in a coordinated and cooperative project that will provide important and accurate information that will be used to make sound land management decisions and promote ecosystem integrity. Total costs of all components is approximately $1.65 million over a four year period beginning in 2003 and includes: Landcover Inventory over two years, Waterbird Inventory over three years and Water Chemistry Sampling over one year.

BACKGROUND

In recent years, increased activity by forestry, oil and gas, mining, hydro-electric, agriculture, recreational interests and climate change has greatly expanded the potential for impacts on the Western Boreal Forest (WBF) ecosystem. The consequences of these impacts on wetland systems remains largely unknown. Ducks Unlimited Canada (DUC) established its Western Boreal Forest Initiative (WBFI) in the summer of 1997 to help begin to address these obvious wetland system needs. Partnerships have been established with Industry, Government Agencies, Universities, Aboriginal Peoples and others who share DUC's goal of conserving these important boreal wetland systems and sustaining their functions and values. Ducks Unlimited believes this goal is consistent with and complementary to Government and Industry's goal of a developed, yet sustainable forest ecosystem.

The Western Boreal Forest is second only to the Prairie Pothole Region in terms of continental waterfowl production and has been ranked number three in priority of the 26 most important, limiting and threatened waterfowl habitat areas in North America (Ducks Unlimited, 1994). A recent review of over 9 million technical and scientific papers pertaining to wetlands, waterbirds and their habitats in the circumpolar boreal zone revealed that significant regional information gaps exist (Foote, 1998). A large area of the western boreal region is surveyed annually by the U.S. and Canadian Wildlife Services (Ferguson, 1997), including extensive coverage of the Mackenzie River Valley. These surveys have shown that for reasons yet to be determined, populations of prominent boreal nesting species such as lesser scaup and scoters are declining. As a result, these species are currently the emphasis of research projects (Austin, 1998; Pers. Comm. Tom Rothe, Alaska Dept Fish and Game, Anchorage).

The Northwest Territories (NT) portion of the WBF is a great expanse of sub-arctic woodland, crossing four distinct ecozones. Unlike the intensive land-use and cyclical drought conditions found in more southern regions, this area remains relatively unscathed by human activity and provides critical breeding, moulting and staging habitat for significant numbers of the continent's waterbirds.

The recent reopening of the Western Arctic to oil and natural gas exploration has increased the potential for conflict between waterbird habitats and human activities. Many regions of the North, especially the Mackenzie River Valley, are experiencing expanding industrial developments and the talk of a Mackenzie Valley pipeline. Unlike 25 years ago, these developments are now being welcomed by governments and First Nations (Avery 2000). With the settlement of three of six land claims within the NT, Aboriginal and Inuit groups are in a better position and motivated to proactively control and manage development within their own settled areas. Estimates from the National Energy Board of one billion barrels of oil and nine trillion cubic feet of natural gas (Avery 2000) within the Mackenzie Delta and 235 million recoverable barrels of oil at Norman Wells (DIAND 1995) as well as funding formula's for pipeline development being discussed at senior industry, aboriginal and government levels, has raised expectations of large scale development in the near future.

Some groups are concerned about the speed and scale of the industrial development. To that end the Protected Area Strategy (PAS) of the NT has been receiving attention. The PAS began in

1999 with the approval of industry, governments, aboriginal groups and ENGO's. The idea of the strategy was to set up for community based protection/conservation of selected areas within the NWT that had either cultural and/or ecological significance. Since its inception, projects have been slowly entering into the PAS framework. To date the best successes have come from Sahyoue and Edacho on Great Bear Lake as well as the recently announced interim land withdrawal for Edehzhie within the Deh Cho region. Ducks Unlimited Canada and others propose that there is room for both development and conservation within the NWT and to that end are working with communities to help identify and move forward potential areas of interest for conservation.

If we are to pursue the conservation of important waterbird areas, as well as other important natural values, within the NT we need large-scale projects to help identify areas of value. This however identifies one of the greatest information gaps across the vast WBF, an accurate inventory of wetlands and riparian areas and their surrounding uplands. Existing landcover inventory and mapping information is unreliable, patchy, incomplete or at too gross a scale to allow for sound management decisions. Other key objectives of Ducks Unlimited's Western Boreal Forest Region include associated waterbird surveys on different wetland types, establishment of water chemistry values and ecological research on waterbird species of concern. On the Taiga Plain of the Mackenzie River Valley we have the opportunity to acquire a more detailed understanding of some of the key migratory waterbird species habitat before significant development occurs. With the support of communities and others, important waterbird areas may be identified as significant enough to enter into the PAS. This proposal describes a landcover, waterbird and water chemistry inventory project based around Fort Good Hope on the Middle Mackenzie River Valley (Figure 1.). Typified by abundant shallow lakes, ponds and wetlands this area has long been recognized as important breeding habitat for waterbirds (Nettleship and Smith 1975). Results from this comprehensive and integrated project will provide partners and land use managers with accurate, Aboriginal and western science-based information necessary to make wise management decisions. The information gathered for this project will also add to already existing information from similar projects conducted by DUC and her many partners. These projects to date include the Peel Plateau and Lower Mackenzie River Projects to the northwest of this proposed project as well as the Sahtu Project located to the southeast. We feel with the completion of the Middle Mackenzie Valley Project that a large area intercepting critically important waterbird and mammal habitats, proposed pipeline route and other values can help local managers make more informed decision about land use in their respective regions.

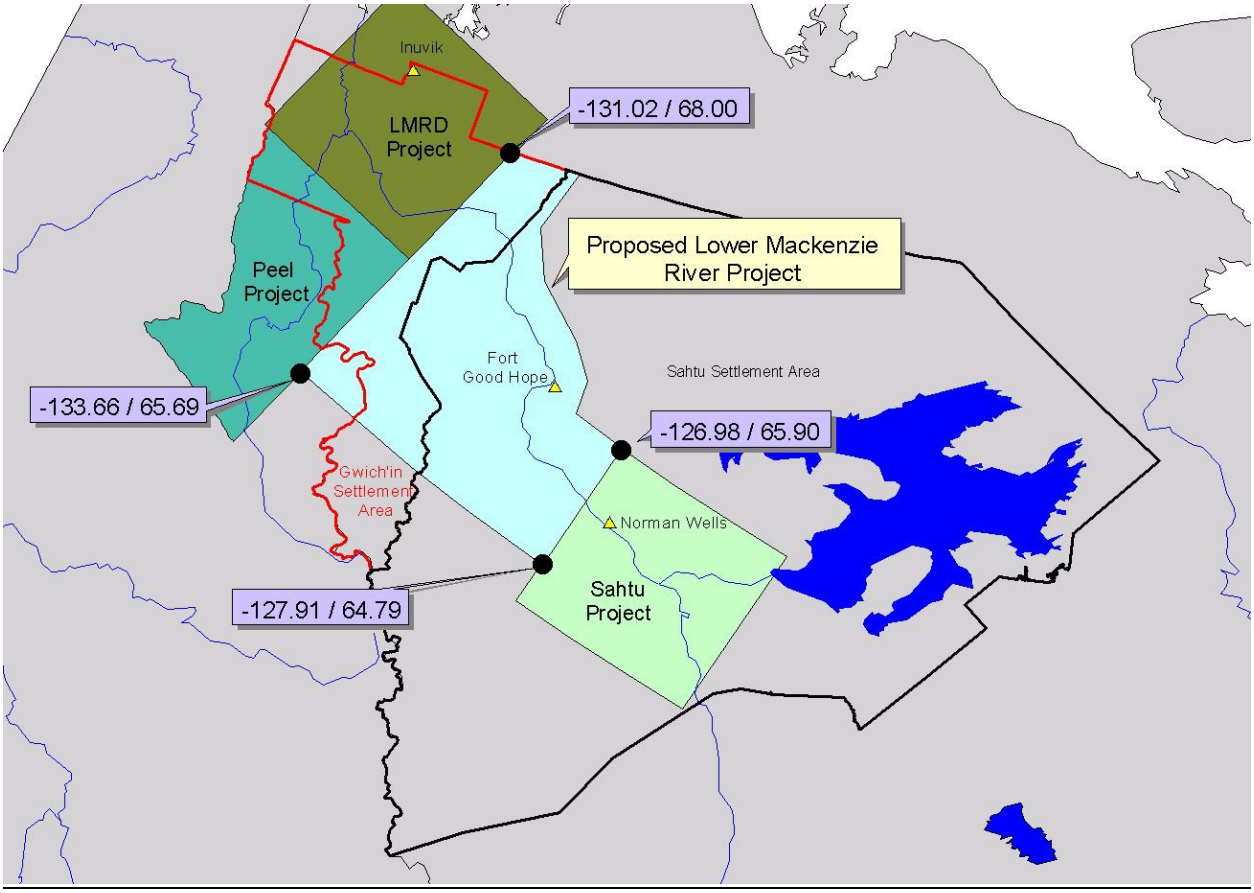

Figure 1: Proposed Area for Middle Mackenzie River Project

I. EARTHCOVER INVENTORY and MAPPING

OVERVIEW

Ducks Unlimited has developed and utilizes a GIS-based TM Satellite earthcover inventory and mapping program that provides an accurate, digital inventory of all earthcover classes. Over the past 14 years, DU and her partners have used this method to inventory and map over 70 million hectares of boreal and tundra habitat in Alaska, providing an invaluable management tool to resource managers. This protocol uses extensive field verification with helicopters to increase accuracy assessment of final products and is now accepted as a statewide earth cover procedure (pers. comm. John Payne, Bureau of Land Management, Anchorage, AK).

A Landsat Thematic Mapper (TM) satellite scene covers 3.2 million ha (8 million acres) and has a spatial resolution of 30m x 30m (pixel size). Up to six bands of information are combined to produce spectrally unique signatures that are classified via extensive field verification. For forested areas, summer scenes are purchased to capture maximum biomass production. An unsupervised classification provides up to 30 cover classes from which up to 30 field verification sites per cover class are chosen for helicopter ground truthing. Two-thirds of the sites are used to process the image (classification), while the remaining 1/3 are used for independent cover-type accuracy assessment. The rigid and standardized protocols result in individual cover class

accuracies of 80-95% (pers. comm.. Dr. Fritz Reid, DU Sacramento). This process has been found to also be very economical and cost effective with total costs of $0.12-$0.14/ha .

The classification is hierarchical in structure, starting at treetop and progressing downward through brush, shrub, grass, bare ground, etc. DU will continue to integrate the landcover classification scheme that was developed for the Sahtu, Peel, and Lower Mackenzie River Projects, which are adjacent to this proposed Middle Mackenzie River Project. . A detailed, technical description or our methods can be found in Appendix I. This project will result in accurate, economical, digital map products available to all partners for various planning and management activities. In a GIS environment, other geo-referenced data sets can be readily imported and analyzed (i.e., wildlife population data; trapline information; seismic line activity; well site and pipeline locations; traditional harvest information; cultural sites; fires; hydrography; etc.) A comprehensive debriefing session at the completion of the project with all partners will explore these opportunities in more detail.

PROJECT AREA

The proposed Middle Mackenzie River Project encompasses a portion of the predominantly spruce forested Taiga Plain (Nettleship and Smith 1975).

The Taiga Plain extends from northeastern British Columbia and northern Alberta into the southwesterly end of the Northwest Territories and is dominated by Canada's largest river, the Mackenzie. The climate consists of long cold winters followed by short cool summers with a mean annual temperature of –10°C (6.5°C summer mean and –26°C winter mean) and mean annual precipitation levels of 200mm. The Taiga Plain ecozone is characterized by open, slow growing, mainly, black spruce (*Picea mariana*) dominated forests. Shrubs include dwarf birch, willow and Labrador tea (*Ledum spp.*) with bearberry (*Arctostaphylos spp.*), mosses and sedges dominating the understory. Upland areas tend to support both white (*Picea glauca*) and black spruce, lodgepole pine (*Pinus contorta*), tamarack (*Larix laricina*), white birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*) (Ecological Stratification Working Group 1995).

Horizontal sedimentary rock (limestone, shale and sandstone) underlies the level to gently rolling plain. The landscape is underlain by permafrost combined with low slope angles resulting in large tracts of waterlogged land. Cryosolic, Gleysolic and Organic soils are typically found throughout the ecozone (Ecological Stratification Working Group 1995).

Faunal species include caribou (woodland and barren land), grizzly and black bears, wolves, moose, wood bison (*Bison bison*), marten (*Martes americana*) and arctic ground squirrels. Birds commonly found include red-throated loons, gray jays (*Perisoreus canadensis*), common raven (*Corvus corax*), northern shrike (*Lanius excubitor*), bald eagles (*Haliaeetus leucocephalis*), peregrine flacons (*Falco peregrinus*), osprey (*Pandion haliaetus*), sharp-tailed grouse (*Tympanuchus phasianellus*) and fox sparrow (*Passerella iliaca*). This ecozone also represents one of the most heavily utilized migratory corridors for waterfowl in North America (Ecological Stratification Working Group 1995, Ducks Unlimited).

Human activities are scattered throughout the lower Mackenzie River area and include subsistence harvesting (hunting, trapping and fishing) by Aboriginal communities. Mineral and hydrocarbon exploration occur within this region (Ecological Stratification Working Group 1995).

A standardized classification scheme for categorizing all earthcover classes in the taiga forest will be developed to meet the needs for a wide range of applications. Fieldwork will be conducted in June-July 2003 using helicopters to collect vegetation data for classification and also for assessing the accuracy of the final map classification. The final products will include digital GIS and raster data earthcover layers, field data and hard copy maps of the land cover classification. The final report will also document the methods used and an ArcView GIS project of the digital products.

The following sections correspond to the attached budget and describe the proposed land cover mapping process.

Project Workplan
The project workplan will provide a detailed description of the work to be performed on this project as well as a schedule of completion dates for the major tasks. This plan will also serve as a reference for Ducks Unlimited to complete the tasks in the agreed time frame. As part of the workplan, DU will organize and lead a meeting between interested parties to review all aspects of the proposed project..

Data Acquisition
Recent terrain-corrected, 5.7 million hectare, Landsat TM Scenes acquired during the summer will be purchased to produce the earth cover map. Any available aerial photography for selected areas within the project area will be chosen and acquired to aid in the classification and accuracy assessment. Digital Elevation Models (DEM's) and other ancillary information will also be acquired as necessary (pending availability) to further aid the classification.

Image Pre-processing
Upon receipt of the Landsat TM imagery, it will be checked for quality and proper registration and then archived for permanent storage. Next, Ducks Unlimited will devise a set of classification definitions, decision rules and schemes that are compatible with current standards for the area for use with satellite imagery, field data and other ancillary data. Field sites will be located using an unsupervised classification approach on the satellite data; aerial photographs will be used to supplement field site selection. Once these sites are selected, they will be plotted over the imagery and their geographic centers calculated which will then be stored in the field GPS unit. A custom data entry form and digital database will be developed by Ducks Unlimited and placed on a laptop computer for inputting field site information while in the field. The digital database program includes a user-friendly interface to maximize efficiency and includes access to digital photographs of each site and the capability to generate statistics.

Field Verification

Field verification will be performed by two five-person crews. Each crew will consist of a pilot, biologist, recorder, navigator and an alternate. The navigator will run the GPS equipment and interpret the field maps. The biologist will possess extensive knowledge of the vegetation in the area. The recorder will verify the vegetation the biologist sees and record those types, percentages and other pertinent information about each field site. The alternate will also handle field logistics and data entry. Initial sampling will be performed by the crews on the ground to verify and standardize the classification and sampling methods. After an initial on-the-ground training session, the rest of the sites will be collected via helicopter to determine the percentage of each species and overall land cover class. Ground verification will be used as needed for sites where the vegetation is difficult to identify and/or species are uncertain.

Image Classification
After completing the field data collection, the field data will be quality checked for errors and entered into a digital database. The field site attributes will then be related to an Arc/Info coverage of the field sites. A subset of the field data will be set aside from the classification for accuracy assessment. A combined supervised/unsupervised technique will be used to classify the imagery into land cover categories.

Accuracy Assessment
If needed, additional accuracy sites will be photo-interpreted to supplement the sites collected in the field. The accuracy assessment sites will then be summarized with the classification to produce and error matrix. Standard accuracy assessment statistics will then be generated from the matrix for each cover type.

Change Detection
Historic Landsat TM pre-1990 images may be used to perform change detection analysis. A proven change detection technique, such as image differencing, will be used to extract areas of change from the imagery. The result will be a map of change areas indicated by a gain or loss of spectral reflectance. The areas of change will be identified using ancillary data such as aerial photography and existing base maps. Using both the historic Landsat TM images and the recent Landsat TM images, fire scars will be identified and mapped. This historic fire scar information will be invaluable in modeling succession and fire patterns for future planning. Other significant changes that may be detected include forest harvest, oil and gas activity, natural succession, and changes due to global warming (e.g.: melting permafrost).

Final Products
The final products will consist of a digital earth cover dataset of the 5.7 million hectare TM Landsat Scenes, hard copy maps, a detailed documentation of the analysis methods and products, metadata, an ArcView project of the products developed and a CD of the final products. Fieldwork will be carried out during summer 2003, with final products delivered by mid 2005 via a comprehensive debriefing workshop with all partners.

Cost Estimate – Landcover Mapping
(Note: Financial information is not included in this pdf file)

II. ASSOCIATED WATERBIRD INVENTORY

A proposal to conduct detailed landcover inventory and mapping of a 5.7 million ha (14 million-acre) TM satellite scene of the lower Mackenzie River Watershed is presented above. Complementing the inventory is the proposed evaluation of the use of selected wetland areas by waterfowl and other wetland-dependent waterbirds. This information will be combined with Traditional Environmental Knowledge (TEK) to provide a comprehensive understanding of waterbird and wetland resources in the region. Wetland habitats associated with many of the large lakes in the Middle Mackenzie River Watershed area are important migratory waterbird staging areas. The Hume-Ramparts complex has been identified by Ducks Unlimited as a world class habitat for many waterbirds, including Pacific loons, scaup and others (Kay, pers. comm.). The community of Fort Good Hope have long known the value of this area for waterbirds and other wildlife as it has traditionally been used to train younger hunters and trappers. As well, the numerous post-glacial ponds, fens, bogs, lakes and streams are breeding habitat for a wide variety of species (Ferguson, 1997). This component of the proposal will allow a broad scale analysis of the density and variability of waterbird use of wetland systems at this latitude. Wetland habitats used by COSEWIC listed or locally sensitive species (e.g. swans, cranes, loons, shorebirds) will also be specifically identified through this faunal inventory. This synoptic survey will provide an assessment of wetlands capability within the TM Scene area and an indication of the importance of the various wetland types/riparian areas to breeding and post-breeding waterbirds. An understanding of the variability and range of waterbird use at a variety of sites is complementary to site and landscape scale interpretation of the potential impacts of future resource extraction activities.

Specific intervals of interest include the breeding, brood rearing, molting, and spring and pre-migration staging periods. Identification of the value of various wetland/riparian area types and specific sites will be accomplished using four (4) rotary-wing aerial surveys during spring/summer (breeding and brood surveys) and two (2) fixed-wing aerial surveys in early spring/late summer and early fall (migration/molting/staging surveys).

NOTE: Methods, protocols and SOP's will be similar to surveys carried out on the Peace Athabasca Delta and Ft Nelson wetlands during 1998 and 1999, and endorsed by Parks Canada, CWS and Alberta Fish and Wildlife and the BC Ministry of Forests.

This component of the cooperative agreement will be initiated in 2004 using the supervised classification of the TM Scene for site selection. Waterbird surveys will employ a subset of wetland classes (approximately 150 different basins) across a size gradient. Historical inventory information and aerial photography will assist in site selection.

Species of interest, including all waterfowl, colonial waterbirds (e.g., gulls, terns) and other wetland-dependent avian species (e.g., loons, shorebirds) will be recorded as encountered. Other

species of interest will be recorded on surveys of the sites including estimates of beaver use and activity as well as any other species accounts determined to be of interest to the project partners.

Information from a literature review currently underway by DU Canada will be integrated in the analysis of data collected during the habitat monitoring component. The waterbird-wetland database will be incorporated as point data and will be available for inclusion as a digital data layer with the landcover mapping and inventory product previously specified. A detailed technical report summarizing this monitoring effort will be produced in spring 2005, following completion of the first year of the 3-year waterbird survey program.

Cost Estimate - Waterbird Inventory, Year 1 of 3 year project
(Note: Financial information is not included in this pdf file)

III. WATER CHEMISTRY SAMPLING

Accompanying the waterbird surveys, DU in association with Dr. Kevin Devito from the Dept. of Biological Sciences at the University of Alberta is proposing an initial water chemistry survey of a sub-sample of sites selected for the waterbird survey program. Analysis will include characterization of pH, conductivity, salinity, nutrients and dominant ion composition in surface waters across the region. This sampling regime will assist in defining the relative productivity of wetlands within the scene, help to develop the linkages between wetland type, productivity and waterbird use, and determine the range of variability in wetlands located on the scene under investigation. Collection and analysis of samples for isotope analysis will assist in determining the relative importance of ground water versus surface water inputs to these systems. This in turn will allow development of hypotheses on the effects of various land-use practices on wetland water quality and productivity. Collectively, interpretation of these data will provide an indication in determining of how surficial or landscape features (hydrology, relief, till deposits) are linked with regional geology, and how this may affect wetland productivity. If these interactions are occurring, the work should provide evidence at which scale these interactions occur (local versus intermediate or regional versus Ecozone or Western Boreal Forest-wide).

Samples will be taken using a helicopter equipped with fixed floats, and will occur coincidental (during the same week as) with the second brood survey to minimize additional costs associated with travel, meals and lodging. Two individuals from the University of Alberta will be on site to assist with sample collection and to facilitate sample preparation and analysis while on site. Partial sample processing will be undertaken as samples are collected (pH, conductivity, salinity, sample filtration) with the bulk of the analysis occurring at Dr. Devito's facilities at the University of Alberta. Sample volume required will vary from one to two litres at one location per wetland, depending on specific analyses to be undertaken. Sites will be selected from the universe defined by those waterbird sites sampled during the pair and brood periods, in consultation with project coordinators (Bruce MacDonald) and DU GIS Specialists (Al Richard). Sample analysis will include, but will not be limited to, for the following parameters: pH, conductivity, salinity, total and soluble reactive phosphorus, nitrate, total dissolved nitrogen, total nitrogen, chlorophyll *a,* alkalinity, silica, carbonate and bicarbonate, dissolve organic carbon, dominant ions (e.g., Na, K, Ca, Mg), and oxygen and hydrogen isotopes.

Preliminary work has been conducted at the Sahtu Project and the second will be completed on the Lower Mackenzie River Project this year (2003). Evaluation of results from these more northern regions of the Taiga Plain will allow comparison with nearby areas exhibiting differing geological histories and landscape framework (inter- and intra-ecoregion wetland comparisons). These data will also provide a benchmark for evaluating the value and potential of wetlands for waterbirds in the context of the Taiga Plain specifically, and the Western Boreal Ecosystem in general.

Final products generated and made available in digital format to cooperating agencies will include proofed data files identifying site location (latitude/longitude and UTM) and results of the water chemistry analysis. These products will be cross-referenced to individual basins (using unique basin identifiers) for ease in linking bird use statistics with water chemistry data. Additional work beyond 2001 (e.g., evaluation of inter-annual variability, more precise estimation of within-wetland class variation) may be developed pending data analysis and discussion of the results obtained with the Project Coordinators, DU and the Principle Investigators.

Cost Estimate Baseline Water Chemistry
(Note: Financial information is not included in this pdf file)

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