WEST KITIKMEOT / SLAVE STUDY SOCIETY

Re: VEGETATION CLASSIFICATION FOR THE WEST KITIKMEOT / SLAVE STUDY FINAL REPORT

Disclaimer

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Oct. 15/02

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VEGETATION CLASSIFICATION FOR THE WEST KITIKMEOT / SLAVE STUDY REGION

FINAL REPORT TO THE WEST KITIKMEOT / SLAVE STUDY SOCIETY

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SUMMARY

Remote sensing is an important tool for classifying and mapping land cover types for large, remote areas such as the West Kitikmeot / Slave Study area. Satellite imagery can be analyzed to provide information that can be used for land use planning, wildlife management, environmental monitoring and assessment and other applications.

A four year baseline study was carried out to classify and map land and water cover types of the West Kitikmeot / Slave Study area. The objectives of the study were:
1) to produce a geometrically corrected land and water classification for the West Kitikmeot / Slave Study area;
2) to describe and map the classes using Landsat Thematic Mapper (TM) satellite imagery and field data;
3) to analyze the classification for its accuracy; and
4) to produce hardcopy maps of the area, a digital database of the classification, and an accompanying report.

The study area extends from the arctic coast of Coronation Gulf, to the taiga forest below treeline, to the south. It includes parts of two terrestrial ecozones, the Southern Arctic and the Taiga Shield ecozones.

The project involved the visual and computer analysis of eight overlapping Landsat TM satellite images, covering an area of approximately 200,000 km^2 (Fig. 1). Image analysis was carried out at the NWT Centre for Remote Sensing, in Yellowknife, from 1997 to 2001. Summer fieldwork was carried out annually from 1997 to 2000 to collect ground data to assist in the computer classification of the satellite imagery.

For each satellite image, several enhancements were produced for visual interpretation of the land and water cover types. Computer image analysis was used along with ground data to classify the imagery of the study area into 22 land and water classes. The classification of terrestrial sites was based on broad vegetation types or plant communities and modifying features such as terrain type or soil moisture. A variety of potential users from government and industry provided initial input into the classification to ensure that the land cover classes could be interpreted as wildlife habitat units for the study area. Figure 2 is a mosaic of the satellite images showing the final classification. A list of grouped and individual land and water classes as determined by the project is provided below.

- **Water**
  - Deep Water
  - Shallow Water
- **Wetlands**
  - Sedge Wetland
  - Tussock/Hummock (Sedge Association)
  - Riparian Tall Shrub
  - Low Shrub
  - Birch Seep
  - Peat Bog
- **Heath Tundra**
  - Heath Tundra (<30% Rock)
  - Heath/Bedrock (30-80% Bedrock)
  - Heath/Boulders (30-80% Boulders)
- **Boulder and Bedrock Associations**
  - Boulder Association (>80% Boulders)
  - Bedrock Association (>80% Bedrock)
- **Forest**
  - Spruce Forest
  - Mixed Forest
  - Young Burns (< 10 years old)
  - Old Burns (10 years or older)
- **Unvegetated Terrain**
  - Ice and Snow
  - Gravel
  - Bare Ground
- **Eskers**
  - Esker Complex
- **Lichen**
  - Lichen Veneer
- **Unclassified**
  - Unclassified

Each of the classification units is described in this report. Following completion of the classification, an initial accuracy assessment was carried out to determine how well the computer classified each of the satellite images. A summary of the classification accuracy for each satellite image is provided in Table 1. Overall accuracy ranged from 51 to 82 %. Cover and accuracy tables for the individual Landsat scenes are provided in Appendix I. Although the initial accuracies appear to be low, there appears to be overlap between some classes. The scope of the project did not allow an independent "users" accuracy assessment to be carried out. Users of the classified imagery will need to conduct their own field accuracy assessments to determine how well the individual mapped classes represent the land and water cover types found on the ground.

From the beginning, this project has been linked to a number of West Kitikmeot / Slave Study projects and other studies in the Slave Geological Province. The database of classified imagery has proven to be a valuable source of information for a variety of users including wildlife biologists, BHP Diamonds Inc., Diavik Diamonds Inc., and the Treaty 11 Dogrib Council.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the contribution of many people, organizations and companies who provided support to this project. During the initial design stages of the project, input and support was provided by a variety of potential users of the project's products including Diavik Diamond Mines Inc. and their environmental consultants, Golder Associates, Dogrib Treaty 11 Council, and biologists with the Department of Resources, Wildlife and Economic Development. Diavik Diamond Mines provided the initial data that formed the basis of the vegetation classification. The West Kitikmeot Slave Study Society and the Department of Resources, Wildlife and Economic Development provided financial support for the project. The Department of Indian Affairs and Northern Development provided some of the satellite images of the study area and assisted with logistic support to the field program. Private sector companies that assisted with the project include Air Tindi Ltd., Arctic Excursions Ltd., Great Slave Helicopters Ltd., Nunasi Helicopters Inc., BHP Diamonds Inc., BHP Minerals, Kennecott Canada, and Echo Bay Mines Ltd.

We also acknowledge the cooperative efforts of many of the West Kitikmeot Slave Study researchers whose assistance and cooperation contributed to the success of this study. And finally, thanks go to the staff at the NWT Centre for Remote Sensing who spent many hours producing the digital and hard copy products for this project.

TABLE OF CONTENTS

1.0 OBJECTIVES

Mineral exploration and mining activities increased on the central barrens of the Slave Geological Province following the discovery of diamonds in the Lac de Gras area in 1991. As part of the environmental assessment process, site specific landcover classifications have been routinely developed for new mines. BHP Diamonds Inc. mapped and described "ecosystem" units using aerial photographs as part of their environmental assessment for the Ekati Diamond Mine development (BHP Diamonds Inc. 1995). Diavik Diamond Mines Inc. also described vegetation/habitat units using Landsat Thematic Mapper satellite imagery (Diavik 1997) in the vicinity of their proposed mine. However, a regional land cover classification for the Slave Geological Province did not exist for monitoring and assessing the cumulative impacts of multiple developments.

In 1995, the Canadian Environmental Assessment Act came into force bringing new requirements for the assessment of cumulative effects of major development projects. In 1997, we initiated a four-year study, under the West Kitikmeot / Slave Study, to produce a regional landcover classification to assist resource managers in government, industry and aboriginal organizations in planning and assessing cumulative effects of new non-renewable resource projects in the Slave Geological Province. Based on vegetation cover types, the classification uses modifying biophysical features of the landscape, such as substrate and moisture levels, to determine land cover classes that can be directly interpreted as wildlife habitat units. Habitat information is essential to manage wildlife and wildlife habitat successfully in response to proposed mining, infrastructure and other industrial developments. Geographic information systems require good baseline habitat data and other types of georeferenced data to be effective tools for resource management.
The specific objectives of the study are:
to produce a geometrically corrected land cover classification for the West Kitikmeot / Slave Study area;
to describe and map landcover classes using digital Landsat Thematic Mapper satellite imagery;
to analyze the classification and determine its accuracy; and

to produce hardcopy maps, a digital database of the classification and an accompanying report.

2.0 DESCRIPTION

2.1 Study Area

The West Kitikmeot/Slave Study area is defined by the Slave Geological Province (SGP), an area of approximately 200,000 km^2 in the Taiga Shield and Southern Arctic ecozones (Fig. 1).

The Taiga Shield Ecozone is defined by two large biophysical features, the Taiga Forest and the Canadian Shield. The climate is characterized by relatively short, cool summers and long cold winters. The mean annual temperature is approximately -7.5^0C with a mean summer temperature of 9^0C and a mean winter temperature of -24.5^0C. The mean annual precipitation ranges from 200-300 mm. The landscape is rolling, consisting of uplands and lowlands. Bedrock outcrops are common along with hummocky and ridged morainal deposits (Ecological Stratification Working Group 1995). Permafrost is generally continuous. Numerous lakes, wetlands, open forests and meadows pattern the landscape. The northern limit of this ecozone consists of patchy lichen woodlands and open arctic tundra. The treeline also passes through northern portions of this region.

The Southern Arctic Ecozone extends from MacKay Lake in the south to Coronation Gulf in the north. This ecozone is typically low arctic tundra with a mean annual temperature of -10.5^0C, a summer mean of 6^0C and a winter mean of -26.5^0C (Ecological Stratification Working Group 1995). This region is semi-arid with annual precipitation similar to that of the Taiga Shield; permafrost is continuous. This ecozone features a gently rolling landscape of uplands, lowlands and plateaus. Upland areas are predominantly unvegetated rock outcrops of Canadian Shield. Eskers are an important landscape feature that provides much of the relief in this ecozone. To the north, the Bathurst Hills consist of a series of rugged ridges that reach nearly 200 m above the

surrounding terrain. Lowlands are typically sedge dominated wetland complexes of fens and bogs and associated tundra lakes. Vegetative cover is typical low arctic tundra dominated by heath and shrub species such as Labrador tea, dwarf birch and willow. The southern limit of this ecozone approaches the treeline where scattered stands of stunted black and white spruce are found.

Eight Landsat Thematic Mapper scenes were analyzed to produce a landcover classification for the West Kitikmeot/Slave Study area (Fig.1). The scenes cover tundra regions, treeline and transition forest to the south. Two Landsat scenes extending north from Great Slave Lake were not included in the study since this region is boreal forest of the Taiga Shield Ecozone. Vegetation in this region is characterized by medium to tall, closed stands of trembling aspen, balsam poplar, white spruce and black spruce (Ecological Stratification Working Group 1995). Forest Management Division, Department of Resources, Wildlife and Economic Development is undertaking a separate study to classify and map forest cover types for all regions of the boreal forest in the Northwest Territories.

2.2 Image Analysis

Digital Landsat Thematic Mapper (TM) data acquired from 1989 to 1997 was obtained for this project. To create the vegetation based land cover classification, digital image analysis techniques were performed using PCI^{TM} image analysis software. The Landsat TM data were geometrically corrected to the Universal Transverse Mercator (UTM) grid using 1:250,000 scale digital topographic maps and resampled from 30 m pixel resolution to 25 m pixel resolution. Adaptive enhancements were performed on each image to increase the contrast between vegetation types which aided in visual analysis and the selection of homogeneous training units of different vegetation types. In this process, image data is evaluated and histograms of the reflectance values are used to generate look-up tables. The reflectance values of any image quite often only cover a part of the full range of grey level values from 1 to 255. The adaptive enhancement produces an enhanced image based on the median value of the reflectances in the image. This

produces an image with higher contrast where the full range of grey values for each band is used.

Water classes, as well as snow and ice, were extracted from an unsupervised classification of the images. Maximum likelihood supervised classifications using TM bands 2,3,4,5 and 7 were carried out. Band 1 was not used due to atmospheric effects, which cause problems with the classification. The classifier quantitatively evaluated the variance and correlation of the reflectance category when classifying unknown pixels, assuming a normal distribution of the data. Existing ground data and newly acquired field data were used in producing the final classification of the individual Landsat scenes. In all scenes, a small number of pixels remain unclassified. Additional training data were used to reduce this problem as much as possible. A post classification filter was run to smooth the overall effect of the classification. In some cases where an acceptable accuracy for a computer generated class could not be obtained (e.g. forest burns and eskers), a manual making technique was used to delineate the class.

Accuracy assessments were conducted for each classified Landsat scene following the methods of Story and Congaltan (1986). The accuracy assessments used field data to examine the accuracy between the training areas and the final classification. An independent verification of the accuracy of the classification to field conditions was not carried out.

2.3 Field Work

From 1997 to 2000, an annual summer field program was undertaken to collect ground data for each of the Landsat scenes being analyzed. Low level aerial surveys, using a Bell 206-B helicopter, were flown in either late July or early August when maximum plant growth had been attained. Table 2 provides a summary of the satellite images classified and the field program carried out to collect ground data. Between 300 and 500 ground sites were examined for each Landsat satellite image.

The field crew consisted of two observers and the pilot. Working with hardcopy, enhanced satellite maps, the observers recorded detailed information from the air and ground to inventory and describe land cover types based on vegetation cover and modifying features. Information recorded included landform type, topography, slope and aspect, micro-relief, moisture level, substrate type, and percent vegetative cover by stratum. Oblique 35mm photographs were taken from the air and ground for reference purposes and to provide additional information to assist in the computer classification. The sequential nature of the project allowed the collection of additional field data in one summer to be used to refine previous year's classification work and to provide data for the accuracy assessment.

3.0 RESULTS

3.1 Land and Water Cover Classes

A total of 22 land and water cover types were classified and mapped using digital image analysis techniques as described above. A twenty-third class was added for unclassified pixels. Seventeen terrestrial cover types were identified as unique vegetation/habitat units characterized by plant communities and site physiography. Three classes represent unvegetated terrain – snow and ice, gravel and bare ground. Two water classes - deep and shallow water bodies - were also included. Given the geographic extent of the project, not all land and water cover types are found in every satellite image. A classification based on moisture regime was not produced given the variability of climate, topography and other contributing factors in the large study area. The following is a description of the classification units.

3.1.1 Deep Water

Deep, clear lakes and major river systems characterize this class of water body. In general, these water bodies have water depths greater than 2 m. From a remote sensing

perspective, this class is easily distinguished since light readily penetrates deep bodies of water with little or no reflectance back to the receiving satellite. This occurs since long wavelength energy (e.g. TM Band 4) is absorbed by water. As wavelengths decrease (e.g. TM Band 1), energy penetration through water increases such that shallower lakes reflect more energy than deeper lakes.

3.1.2 Shallow Water

This class of water body is characterized by shallow water approximately 2 m deep or less. Water bodies that contain submergent or emergent vegetation may also be included in this classification unit. Typically, shallow water bodies are easily identified on satellite imagery by their high reflectance. This is caused by light reflecting off the bottom of the water body and any aquatic vegetation. Turbid water also has the same effect.

3.1.3 Sedge Wetland

Wetland complexes are typically wet sedge meadows and other sedge associations of non-tussock plant species. Sedge species such as *Carex aquatilis* and *C. bigelowii*, and cotton grass (*Eriophorum angustifolium*) are the dominant vegetation types. Plant species occupy wet, low lying sites where standing water is present throughout much of the growing season. The substrate is usually organic or silty soils.

3.1.4 Tussock/Hummock (Sedge Association)

Plants belonging to the sedge family (Cyperaceae) are also dominant in this vegetation unit. Tussock cotton grasses such as *Eriophorum vaginatum and E. russeolum* are common. These sites are drier and less frequently flooded than sedge wetlands.

Tussocks produce hummocks or mounds of 0.4 to 1 m in diameter. Hummocks are typically composed of old tussocks invaded by bog rosemary (*Andromeda polifolia*), cloudberry (*Rubus Chamaemorus*), Labrador tea (*Ledum decumbens*), blueberry (*Vaccinium* spp.), and cranberry (*Vaccinium Vitis-idaea*). Sphagnum moss typically occupies the troughs between hummocks. Dwarf birch (*Betula* spp.) and willow (*Salix* spp.) tend to become established on the older hummocks (Diavik Diamond Mines Inc. 1998). Sedge wetlands and Tussock/Hummock vegetation provide important foraging areas for barren-ground caribou.

3.1.5 Heath Tundra (<30% Rock)

This class of heath tundra is a closed mat plant community that grows on moderate to well drained soils, covering most of the upland areas. Plants generally belong to the heath family, the Ericaceae. The vegetation layer forms a mat of low shrubs dominated by dwarf birch and Labrador tea. Other common plant species include lingonberry, blueberry, crowberry, alpine milkvetch (*Astragalus alpinus*) and alpine azalea (*Loiseleuria procumbens*). Herb and moss layers are not well developed. Typical lichens include several species of Cetraria, Cladina, Cladonia and others. As a closed mat community, vegetation covers at least 70 percent of the surface of the ground.

3.1.6 Heath/Bedrock (30-80% Bedrock)

Where heath tundra thins and bedrock outcrops are exposed, vegetation is discontinuous and is best described as open mat heath tundra. This class of heath tundra is easily distinguished on satellite imagery due to the presence of bedrock, reduced vegetative cover and therefore a distinctive highly reflective spectral signature. Plant species are typical heath species described above.

3.1.7 Heath/Boulders (30-80% Boulders)

Heath with boulder fields is also an open mat plant community class. It can be distinguished from the heath/bedrock class because of the spectral differences between bedrock and boulders. Textural differences between boulders and bedrock are significant from an image analysis perspective. Differences in lichen composition and cover on boulders and bedrock outcrops also contribute to the identification of these separate classes.

3.1.8 Boulder Association (>80% Boulders)

Large areas of boulder fields exist in the central part of the study area and are found to a lesser extent in other areas. Boulder associations include boulder outcrops, boulder streams and drainages, as well as glacial eratics. This land cover type supports very little plant growth. Boulders, however, support a variety of rock lichens. Crustose lichens which are common include *Umbilicaria* spp. (rock tripe), *Xanthoria elegans* (orange rock lichen), *Rizocarpon geographicum* (green map lichen), *Parmeliopsis ambigua* (green starburst lichen), and others.

3.1.9 Bedrock Association (>80% Bedrock)

Exposed bedrock supports very little vegetative cover. These areas are generally wind swept and moisture free. Early colonisers such as crustose lichens are common, but vegetative coverage is highly variable and favours protected areas, crevices and depressions where growth can be initiated.

Cover types having discontinuous vegetation, such as described above, may be confused with other cover types because substrate such as bedrock or boulders dominates the reflectances of the vegetation that is present.

3.1.10 Riparian Tall Shrub

This riparian association follows active stream courses, usually with a cobble or boulder substrate. Riparian tall shrub appears as linear plant associations of birch, willow and alder. Tall shrubs such as diamond-leaved willow (*Salix planifolia*) and green alder (*Alnus crispa*) can reach heights up to 4 m. Black spruce may also be associated with this community, particularly in some southern parts of the study area. Understory plant species include dwarf raspberry, dwarf marsh violet, cloudberry, grasses, sedges, club mosses and common horsetail. This vegetation unit is one of the most productive in the study area.

3.1.11 Birch Seep

This vegetation unit occurs in areas of active water seepage through boulder fields and boulder streams. Birch (*Betula* spp.) is the dominant vegetation, which commonly reaches a height of 1 m. Diamond-leaved willow is also present in smaller amounts. Blue joint (*Calamagrostis canadensis*) and water sedge (*Carex aquatilis*) are common plant species occurring in the understory along with crowberry (*Empitrum nigrum*), Labrador tea (*Ledum decumbens*), and mosses.

3.1.12 Low Shrub

Extensive areas of low shrub are found in the northern half of the study. Rather than being associated with water courses (e.g. Birch Seep), these areas are moist and well-

drained and vegetative cover is generally continuous. Birch and willow species dominate these areas – *Betula glauca* is found on acidic sites and *Salix glanulosa* is found on non-acidic sites. Low shrubs are typically 0.5 to 1.0 m in height.

3.1.13 Esker Complex

Eskers provide significant topographic relief to a gently rolling tundra landscape. These linear structures of sand and gravel, formed by glacial rivers, can run for hundreds of kilometres and reach 30 m in height. Eskers support a number of plant communities and are important habitat for wildlife. They are used as travel corridors by caribou, grizzly bears, wolves and other wildlife. The ice-free substrate of sand and gravel provides excellent den sites where digging is relatively easy. Eskers, being a complex of plant communities, can be difficult to classify using computer classifiers.

Esker tops are wind-swept and, therefore, accumulate very little snow during the winter. Vegetation is sparse, composed of plants such as three-toothed saxifrage (*Saxifraga tricuspidata*), moss campion (S*ilene acaulis*), sandwort, blueberry, crowberry, lingonberry, bearberry, and alpine azalea. Vegetation grows in low mats to avoid wind abrasion. Sand and gravel is generally loose and moisture is low.

Esker slopes support several different plant communities depending on their aspect and exposure to wind and snow. Leeward slopes support bands of dwarf birch that may reach heights of 1.5 m. Willow is also present with an understory of ericaceous shrubs including blueberry, Labrador tea, lingonberry and crowberry. Grasses (*Poa* spp.), fireweed (*Epilobium* spp.) and other species are also common. Snowbed communities, which tend to occur on south-facing slopes, support plants such as bog laurel (*Kalmia polyfolia*), arctic heather (*Cassiope tetragona*) and least willow (*Salix herbacea*) where soil moisture is available for much of the growing season. Esker slopes exposed to the prevailing winds develop low heath communities with some dwarf birch.

3.1.14 Lichen Veneer

Many of the flat islands, low peninsulas and esker tops in the study area are covered with a continuous mat of lichen that appears as a "veneer". These sites are windswept and dry, allowing very little other plant growth. Lichen veneer consists mainly of Iceland moss (*Cetraria islandica*), several other species of Cetraria, green and black hair lichens, grey mealy lichen, worm lichens and others (Diavik Diamond Mines Inc. 1998). Saxifrages and heath plants become more common in sites where growing conditions are more favourable.

3.1.15 Spruce Forest

The treeline lies in an area of transition between the tundra and boreal forest to the south. Boreal forest species become more common with the presence of dwarf white spruce (*Picea glauca*) and black spruce (*Picea* mariana). The northern limit of black spruce generally falls short of white spruce in this part of the Northwest Territories (Porsild and Cody 1980). Both species grow in lowland, sheltered areas such as river valleys, where soil moisture is abundant. The forest in this region is typically clumped with outlyers in this predominantly tundra landscape. In some areas, spruce-lichen woodland exists in more favourable habitats.

3.1.16 Mixed Forest

In the most southern part of the study area below treeline, lies a mixed, boreal forest of the Taiga Shield Ecoregion. Vegetation consists of open, stunted stands of black spruce, tamarack (*Larix laricina*) and ground cover of dwarf birch, ericaceous shrubs, cotton grass, lichen and moss. Poorly drained sites support tussock plant communities of sedge, cottongrass and sphagnum moss (Ricketts et al. 1999).

3.1.17 Burns – Young and Old

Forest fires are common in the boreal forest regions of the Northwest Territories and extend to the treeline and beyond. Burns were mapped on one Landsat scene in the southwestern portion of the study area. These burns were classified as young burns (i.e. less than 10 years old) and old burns (i.e. 10 years or older). Regeneration in older burns could be detected on the satellite imagery; very little vegetation had established itself in the young burns. These two classes of burns were mapped using a masking technique whereby the image analyst removes these areas manually rather than having a computer generate the classes. Using this technique does not allow for an accuracy assessment to be carried out for these classes.

3.1.18 Peat Bog

Throughout the southern part of the study area (i.e. Taiga Shield), the terrain is a mosaic of uplands and lowlands. Numerous fens and bogs are scattered among the mixedwood forest in low-lying terrain. Peatlands also occupy these wetland areas of discontinuous permafrost. Peat bogs were easily classified as a separate land cover type when compared to other types of wetlands.

3.1.19 Ice and Snow

This class represents areas of land and water that remain covered with ice or snow late into the growing season. Late snowbeds and river drainages that form large areas of aufeis during the winter are easily distinguished on Landsat TM imagery. This class is relatively small compared to the others.

3.1.20 Gravel

Included in the most northerly satellite image of the study area is the Kent Peninsula. This area consists of both Southern Arctic and Northern Arctic ecozones. A unique land cover class in this area consists of gravel beach ridges found towards the arctic coast and lowland silt deposits found inland.

3.1.21 Bare Ground

The western half of the Kent Peninsula is in the Northern Arctic Ecozone, an area called the Amundsen Gulf Lowlands (Ecological Stratification Working Group 1995). This ecoregion is characterized by dwarf shrub tundra. Wetlands are common in low-lying areas; topographic relief is minimal. Extensive mud flats are also common and are classified as bare ground.

3.1.22 Unclassified

Pixels that could not be successfully assigned to one of the above classes are considered to be unclassified. This is usually a very small class generally less than 10 percent of the classification. For this project, the maximum percentage of unclassified pixels was 6.3%.

Photographs of the land cover classes are provided in Appendix II.

4.0 DISCUSSION OF CLASSIFICATION RESULTS AND ACCURACY ASSESSMENT

The results of the classification for each Landsat TM image are provided in Appendix I. The first table provides a quantitative assessment of each class within the scene, and the second provides an initial assessment of the accuracy of the classification. Using a confusion matrix, the "Producer's accuracy" and the "Users accuracy" were calculated following the method developed by Story and Congalton (1986). The Producer's accuracy refers to the probability that reference classes have been correctly classified. This type of accuracy measures for errors of omission (i.e. samples that have not been correctly classified and therefore omitted from that class). The User's accuracy refers to the probability that a sample from the classified image represents the land cover at that location on the ground. This type of accuracy assessment measures for errors of commission (i.e. misclassification of pixels into another class). The overall accuracy for the classification was calculated by dividing the sum of the major diagonal (i.e. the number of correct classifications) by the total number of samples taken. A summary of accuracy assessment for each Landsat image is provided in Table 1. Accuracies range from 49 to 76% for Producer's, 52 to 85% for User's and 51 to 82% overall. Although further refinements to the classification could result in increased accuracy, it is believed that overlapping classes are ecologically similar (e.g. Heath Tundra and Heath Bedrock). An independent accuracy assessment should be carried out using a new dataset of ground data to verify the accuracy of the classification to field conditions.

5.0 LINKS WITH OTHER STUDIES

This baseline study was designed to provide information for a variety of projects, including several of the West Kitikmeot / Slave Study. Table 3 lists organizations and programs that are currently using the land cover data produced from this study. It is fully

expected that the classification and map products will continue to be used in various disciplines and projects in the years to come. Resource managers in government, industry and aboriginal organizations will use the database in geographic information systems, computer modelling exercises (e.g. cumulative effects assessment), development planning and environmental monitoring. Two examples of studies that relied on products from this project are the grizzly bear study of spatial organization and habitat selection (McLoughlin et al. 1999) and the Dogrib Treaty 11 Council traditional knowledge study of habitat of the Dogrib traditional territory (Dogrib Treaty 11 Council in prep.)

6.0 TRAINING ACTIVITIES AND RESULTS

This project provided training and work experience opportunities for several people over the four-year period. Greg Smith worked as the image analyst for the project and gained valuable training and experience in the field and in the remote sensing centre. Karin Clark and Krista Bobey also assisted with summer fieldwork.

7.0 EXPENDITURES AND SOURCE OF FUNDS

Financial resources for this project were provided by the West Kitikmeot / Slave Study Society and the Department of Resources, Wildlife and Economic Development, Government of the Northwest Territories. Annual financial statements were submitted independently to the Society office.

8.0 SCHEDULE AND ANY CHANGES

Field and laboratory work for this project were completed as scheduled with some minor changes due to staffing problems with the image analyst and priorities set by users of the project's products. The order in which the satellite images were analyzed changed to

accommodate other researcher's project schedules and to maximize efficiencies in conducting fieldwork.

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TABLES

Table 1. Summary of accuracy assessment for each Landsat TM scene – percent correct

Scene Number	Producer's Accuracy[1]	User's Accuracy[2]	Overall Accuracy[3]
45-15	66	68	67
44-14	59	58	55
46-14	60	59	60
43-13	63	65	65
45-12	49	52	51
46-13	57	60	60
44-15	76	85	82
46-15	68	74	68

[1]Producer's accuracy indicates the probability that a class has been correctly classified on the ground.

[2]User's accuracy indicates the probability that a sample area from the classified image represents what is actually found on the ground.

[3]Overall accuracy = $\frac{\text{sum of number of correctly classified area}}{\text{total number of areas}}$

Table 2. Summary of Landsat TM satellite images analyzed and field program

Year of Image Analysis	Image number	Image Acquisition Date	Field Survey Dates	Survey Hours Flown/Year
1997/98	45-15	26 July 1989	5-8 August 1997	15.0
1998/99	44-14 46-14	3 July 1994 1 Sept 1994	4-14 August 1998	40.3
1999/00	43-13 45-12 46-13	15 July 1996 1 Aug 1997 20 July 1996	24 July – 12 Aug 1999	64.8
2000/01	44-15 46-15	2 Aug 1994 1 Sep 1994	20-25 July 2000	29.5

Table 3. Project linkages to other studies

User Organization/Program	Application
Diavik Diamond Mines Inc.	Environmental planning and assessment including habitat loss
BHP Diamonds Inc.	Monitoring habitat loss from mine development
Dogrib Treaty 11 Council	Comparative study with traditional knowledge study of habitat
GNWT Protected Areas Program	Vegetation classification to provide baseline information for protected areas selection
GNWT and other regulatory agencies	Cumulative effects assessment of multiple mine developments in the SGP
Wildlife and Fisheries, GNWT	Contributed wildlife habitat information to various wildlife studies in the WKSS area

FIGURES

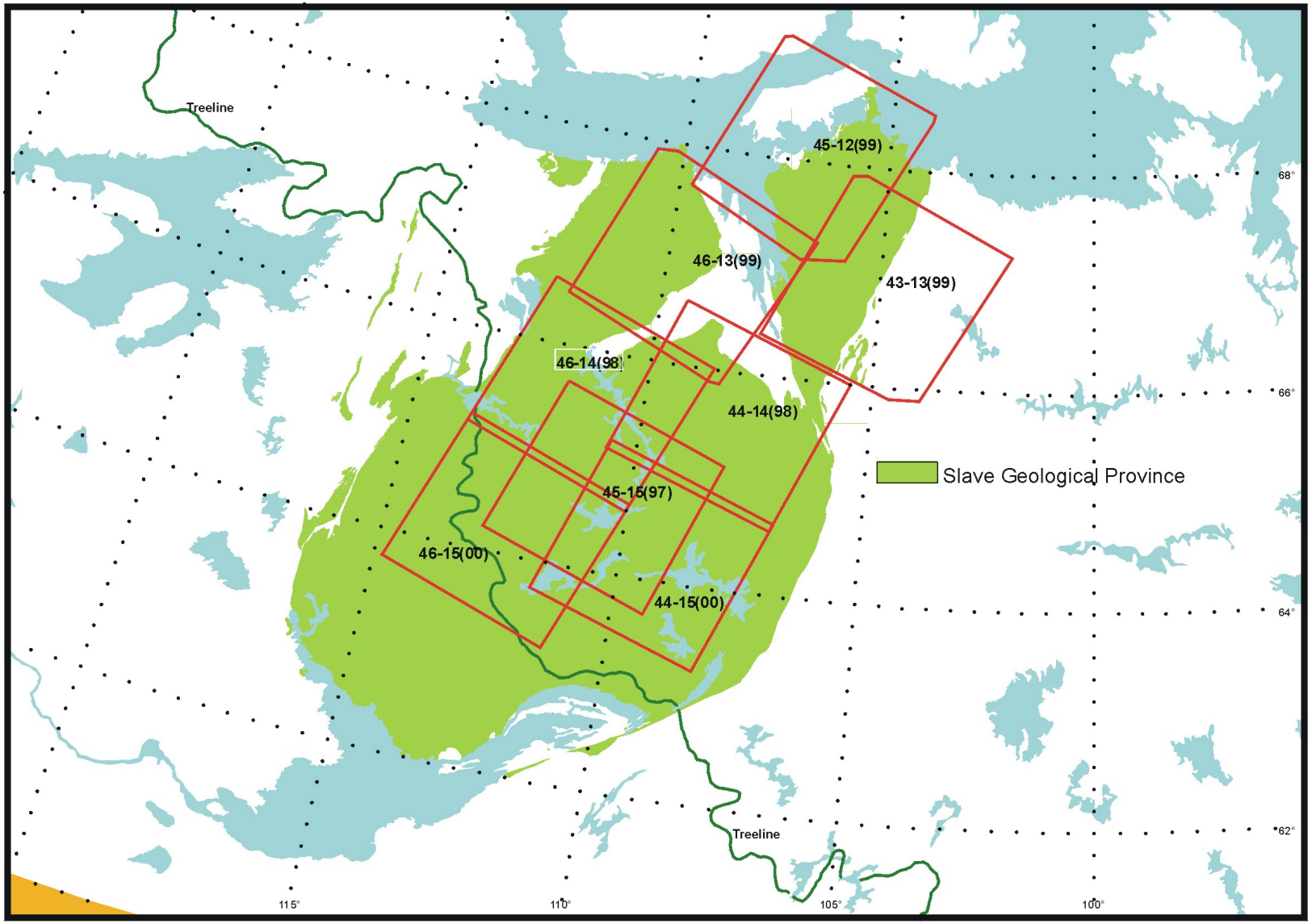


Figure 1. Map of Landsat scenes analyzed in the West Kitikmeot / Slave Study area. Landsat TM scene number followed by the year of analysis is indicated.

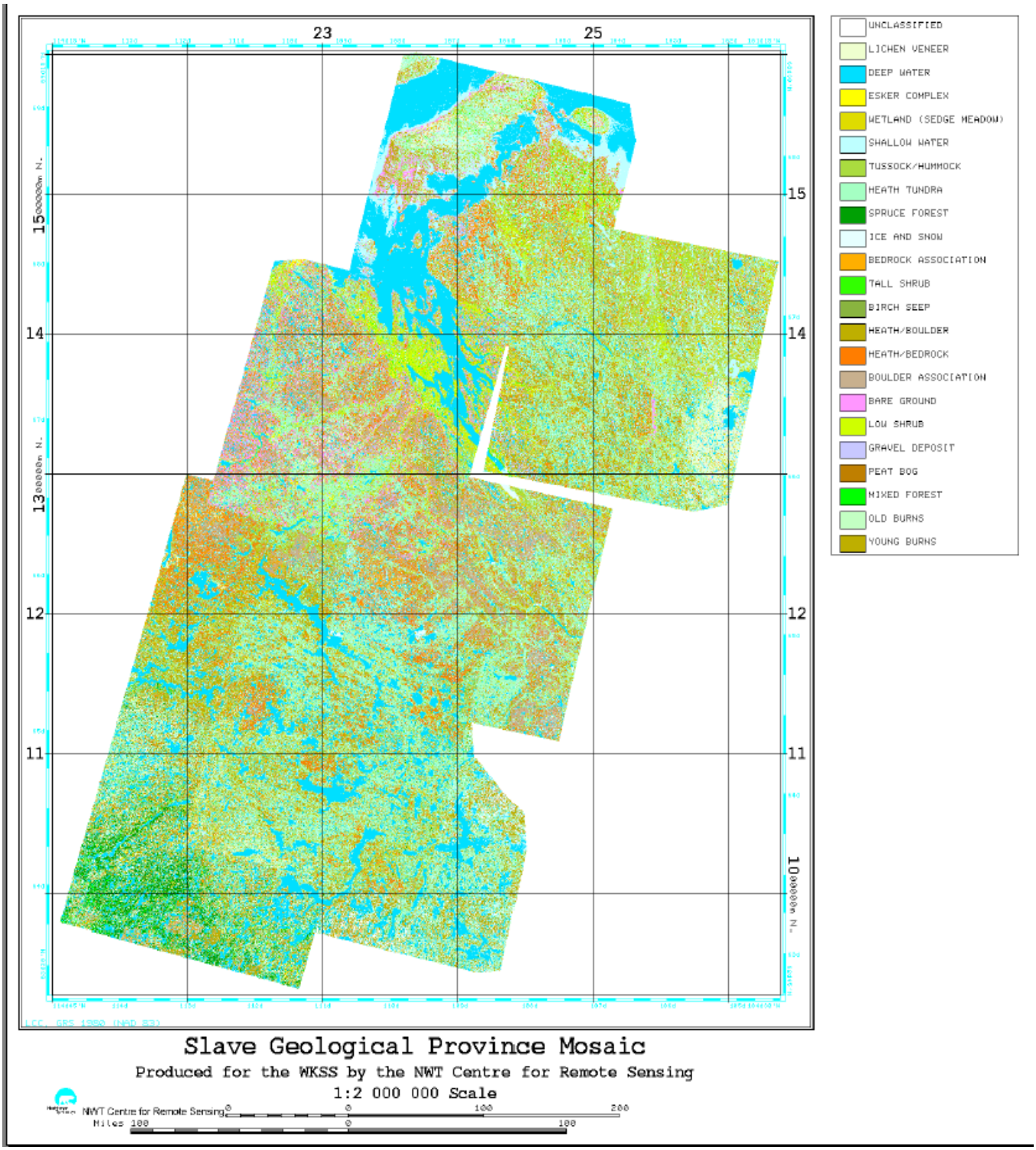


Figure 2. Classified image of the West Kitikmeot / Slave Study region.

APPENDIX I – COVER AND ACCURACY TABLES

Table 4A. Classification results for Scene 45-15

Class	Km^2	%Image
Lichen Veneer	1070	3.43
Deep Water	6368	20.40
Esker Complex	335	1.07
Sedge Wetland	1110	3.56
Shallow Water	3035	9.72
Tussock/Hummock	3033	9.72
Heath Tundra	9341	29.92
Spruce Forest	104	0.33
Bedrock Association	921	2.95
Tall Shrub	100	0.32
Birch Seep	343	1.10
Heath/Boulder	3266	10.46
Heath/Bedrock	1869	5.99
Boulder Association	320	1.02
Total	31215	100.00

Note: The number of pixels in each class was not calculated.

Table 4B. Accuracy assessment for Scene 45-15

Code Name	LIVE	DEWA	ESCO	WELA	SHWA	TUHU	HETU	SPFO	BEAS	TASH	BISE	HEBO	HEBE	BOAS	TOTAL	Producer's Accuracy
LIVE	73.4	0	4.3	1.3	0	1.6	13.2	0	0.5	0.1	0	3.3	0	0.7	98.4	73.4
DEWA	0	93.9	0	0	5.8	0	0	0	0.2	0	0	0	0	0	99.9	93.9
ESCO	9.8	0	54.8	0.4	0.8	4.3	8.4	0.6	0.5	0.1	0.3	5.8	2	6.9	94.7	54.8
WELA	2.6	0	1	46.9	0.9	7.5	16.1	1.6	17.5	1.6	0.3	1.8	0	1.1	98.9	46.9
SHWA	0	0	0	0	99.2	0	0	0	0.2	0	0	0	0	0.2	99.6	99.2
TUHU	7.4	0	0.3	22.8	0.1	30.8	11.8	4	4.4	1.2	2.2	7.5	5.7	0.6	98.8	30.8
HETU	3.5	0	0.4	1.8	0	1.1	86.7	0.3	0	1.8	1.3	2.4	0	0.1	99.4	86.7
SPFO	0	0	0	1.6	1.1	0.8	7.7	64.5	1.4	1.9	16.4	0	0	1.4	96.8	64.5
BEAS	0.6	0	1.2	19.4	3.2	2	0	0.9	67.4	0	0	0	0.5	2.5	97.7	67.4
TASH	0.6	0	1.8	0.2	0.9	0.6	4	5	0.1	65.1	16.3	0.1	0	0.5	95.2	65.1
BISE	0	0	0.6	0.9	0.3	2.4	9.9	9.3	0	7.2	67	1.2	0.6	0.6	100	67
HEBO	10.5	0	1.5	1.5	0	4.1	7.8	0	0.1	0.1	0	56.2	15.9	1.2	98.9	56.2
HEBE	0.1	0	2.3	1	0	4.4	1.6	0	1	0.1	0	7.7	66.8	15.2	100.2	66.8
BOAS	0	0	3.3	0	2.9	0.1	1.7	0	0.2	0	0	3.8	36.7	50.7	99.4	50.7
TOTAL	108.5	93.9	71.5	97.8	115.2	59.7	168.9	86.2	93.5	79.2	104	89.8	128	81.7	1378	
User's Accuracy	67.6	100	76.6	47.9	86.1	51.5	51.3	74.8	72	82.1	64.5	62.5	52.1	62		

Table 5A. Classification results for Scene 44-14

Class	Pixels	Km^2	%Image
Lichen Veneer	175603	110	0.35
Deep Water	4867257	3042	9.64
Sedge Wetland	4405691	2753	8.73
Shallow Water	3778492	2361	7.48
Tussock/Hummock	1212299	758	2.40
Heath Tundra	12929957	8081	25.61
Bedrock Association	1499592	937	2.97
Tall Shrub	151655	95	0.30
Birch Seep	44194	27	0.09
Heath Boulder	4975971	3109	9.85
Heath Bedrock	4485132	2803	8.88
Boulder Association	10016518	6260	19.84
Ice and Snow	1834964	1147	3.63
Unclassified	115303	72	0.23
Total	50492628	31555	100.00

Note: The Esker Complex class is not present in this image.

Table 5B. Accuracy assessment for Scene 44-14

Code Name	LIVE	DEWA	WELA	SHWA	TUHU	HETU	BEAS	TASH	BISE	HEBO	HEBE	BOAS	ICSN	TOTAL	Producer's Accuracy
LIVE	82.6	0	5	4.9	0	4.6	0.5	0	0	0.2	0.2	2.1	0	100.1	82.52
DEWA	0	88.3	0	0.2	0	0	0	0	0	0	0	0	11.5	100	88.3
WELA	0	0	48	1.7	10.3	28.4	0	2.7	0.5	5.4	0.5	2.4	0	99.9	48.05
SHWA	0	0	0	99.4	0	0	0	0	0	0	0	0	0.6	100	99.4
TUHU	0	0	26.8	0.9	27.5	32.9	0	1.9	0.4	6.7	1.4	1.4	0	99.9	27.53
HETU	0	0	7.8	0.3	5.2	79.7	0	3	0.9	2.3	0.4	0.4	0	100	79.7
BEAS	0.1	0	1.6	7.2	0.1	0.8	36.7	0	0	2.3	9.6	41.7	0	100.1	36.66
TASH	0	0	16.6	8.1	19.5	35	0	11.5	1.1	2.1	0	6.1	0	100	11.5
BISE	0	0	13.3	0	20	33.3	0	33.3	0	0	0	0	0	99.9	0
HEBO	0.4	0	11.5	1	1.5	13.2	2.5	0.5	0	27	21.9	20.4	0	99.9	27.03
HEBE	0.5	0	1.7	1.8	0.4	4.6	6.1	0	0	12.3	44.4	28.2	0	100	44.4
BOAS	0	0	0.2	3.7	0.1	0	5.8	0	0	2.4	3.1	84.7	0	100	84.7
ICSN	0	3.9	0	13.5	0	0	0	0	0	0	0	0	82.5	99.9	82.58
TOTAL	83.6	92.2	132.5	142.7	84.6	232.5	51.6	52.9	2.9	60.7	81.5	187.4	94.6	1299.7	
User's Accuracy	98.8	95.77	36.23	69.66	32.51	34.28	71.12	21.74	0	44.48	54.48	45.2	87.21		

Table 6A. Classification results for Scene 46-14

Class	Pixels	Km^2	%Image
Lichen Veneer	435970	272	1.39
Deep Water	6265159	3916	19.93
Esker Complex	184164	115	0.59
Sedge Wetland	2083281	1302	6.63
Shallow Water	3077014	1923	9.79
Tussock Hummock	2484312	1553	7.90
Heath Tundra	5116789	3198	16.28
Spruce Forest	77882	49	0.25
Bedrock Association	489651	306	1.56
Tall Shrub	87301	55	0.28
Birch Seep	488855	305	1.55
Heath Boulder	7783735	4865	24.76
Heath Bedrock	1734546	1084	5.52
Boulder Association	1063011	664	3.38
Unclassified	61260	38	0.19
Total	31432930	19645	100.00

Table 6B. Accuracy assessment for Scene 46 – 14

Code Name	LIVE	DEWA	ESCO	WELA	SHWA	TUHU	HETU	SPFO	BEAS	TASH	BISE	HEBO	HEBE	BOAS	TOTAL	Producer's Accuracy
LIVE	70.3	0	2.93	3.73	0	0.8	3.82	0	0.27	0	0.18	2.84	11.8	0.09	96.8	72.7
DEWA	0	90.13	0	0	9.86	0	0	0	0	0	0	0	0	0	99.9	90.1
ESCO	2.41	0	61.08	1.39	0.09	0.74	0.83	0	5.38	0.19	0.19	1.2	12.6	6.58	92.7	65.9
WELA	1.86	0	2.22	38.8	1.23	19.48	3.37	5.9	0.08	2.22	7.8	11.9	1.35	0.91	97.1	39.9
SHWA	0	0	0.01	0	99.9	0	0	0	0	0	0	0	0	0	99.9	99.9
TUHU	0.14	0	0.42	14.99	0.6	44.61	6.25	3.29	0.05	3.19	16	6.29	0.65	0.56	97	45.9
HETU	3.61	0	1.15	2.45	0	19.43	48.72	0.06	0.04	0.91	6.06	6.85	3.75	0.01	93.0	52.4
SPFO	0	0	0	4.53	8.5	0.57	0	79.9	0	3.12	1.13	1.13	0	0	98.9	80.8
BEAS	0.29	0	3.74	0.58	0.03	0.17	0.35	0	51.3	0	0.09	7.2	6.56	13.7	83.9	61.1
TASH	0	0	1.26	10.64	1.05	23.74	4.48	12.2	0	20.7	18.8	4.97	0	0.35	98.2	21.1
BISE	0	0	1.72	6.9	0	32.76	2.3	2.87	0	8.05	33.9	7.47	0	0	95.9	35.3
HEBO	3.27	0	0.34	9.41	0.06	6.17	4.47	1.14	1.08	1.63	5.27	39.2	6.76	2.62	81.4	48.1
HEBE	4.72	0	5.51	0.52	0	0.52	3.67	0	6.56	0	0	13.9	50.1	1.31	86.9	57.7
BOAS	0.12	0	4.44	2.97	0.27	0.24	0.03	0	14.2	0	0.42	12	1.68	61.4	97.8	62.8
TOTAL	86.8	90.1	84.8	96.9	121.6	149.2	78.3	105	79	40	89.9	115	95.3	87.5	1319	
User's Accuracy	81.1	100	72.01	40.04	82.16	29.89	62.23	75.9	64.9	51.7	37.7	34.1	52.6	70.2		

Table 7A. Classification results for Scene 43-13

Class	Pixels	Km^2	%Image
Lichen Veneer	2852317	1661	5.22
Deep Water	886027	2266	7.12
Esker Complex	1089968	636	2.00
Sedge Wetland	6762619	3939	12.38
Shallow Water	7174039	4181	13.14
Tussock Hummock	4575198	2667	8.38
Heath Tundra	2165376	7089	22.28
Bedrock Association	946337	550	1.73
Tall Shrub	145832	86	0.27
Heath Boulders	7500682	4369	13.73
Heath Bedrock	2722123	1585	4.98
Boulder Association	540399	315	0.99
Bare Ground	1061664	617	1.94
Birch Seep	1137873	662	2.08
Gravel	1314101	767	2.41
Unclassified	737885	430	1.35
Total	54612440	31820	100.00

Table 7B. Accuracy assessment for Scene 43 - 13

Code Name	LIVE	DEWA	ESCO	WELA	SHWA	TUHU	HETU	BEAS	TASH	HEBO	HEBE	BOAS	BAGD	BISE	GRDP	Total	Producer's Accuracy
LIVE	76.6	0	0.5	3.2	0.5	0.2	5.9	0.3	0	5.3	3.1	1.6	1.1	0	0.5	98.8	76.6
DEWA	0	89.2	0	0	10.8	0	0	0	0	0	0	0	0	0	0	100	89.2
ESCO	3.8	0	50.9	5.8	2.2	0.7	4.4	1.8	0	3.1	3	14.8	4.6	0.1	2.4	97.6	50.9
WELA	2.5	0	0.5	63.5	3	7.1	11.3	0	0.3	0.8	0.2	0.1	1.3	3.2	0.2	94	63.5
SHWA	2.8	2.8	0.7	0.7	94.2	0	0	0	0	0	0	0	0.6	0	0	101.8	94.2
TUHU	0	0.2	0.2	10.5	0.1	52.8	8.3	0	2.6	0.8	0.1	0	0.4	20.7	0.1	96.8	52.8
HETU	4.4	0	0.8	15.6	0.1	4.8	63.6	0.1	0	5.2	0.5	0.1	1.5	2.4	0.2	99.3	63.6
BEAS	1.2	0	2.2	0.6	0.6	0.1	0.6	48.3	0	4.8	22.9	5.1	1.9	0	7.8	96.1	48.3
TASH	0	0	0	0.2	0.2	2.7	0	0	77	0	0	0	0	11.9	0	92	77
HEBO	8.6	0	1.1	2.7	0.2	0.2	15.1	4.1	0	40.2	15.7	3.5	0.6	0.1	7.7	99.8	40.2
HEBE	3.6	0	1.9	2.4	0.8	0.3	4.5	17	0	22.8	32.4	4.7	1.2	0	7.8	99.4	32.4
BOAS	5.3	0	6.9	0.6	0.3	0	2	12.7	0	15	11.1	36.1	0.5	0	7.7	98.2	36.1
BAGD	2.4	0	9.8	0.8	0.2	0.6	1.5	0.6	0	1.6	0.4	2.2	71.8	0.1	0.2	92.2	71.8
BISE	0	0	0.1	3.3	0.2	11	3.5	0	14.1	0.1	0	0	0	65.6	0	97.9	65.6
GRDP	0	0	1.8	1.6	0.8	0	0.3	1.6	0	4.7	1.3	2.3	1.3	0	82.3	98	82.3
Total	111.2	92.2	77.4	111.5	114.2	80.5	121	86.5	94	104.4	90.7	70.5	86.8	104.1	116.9	1461.9	
User's Accuracy	68.9	96	65.8	56.7	82.6	65.6	52.6	55.8	81.9	38.7	35.7	51.2	82.7	63.1	70.3		

Table 8A. Classification results for Scene 45-12

Class	Pixels	Km^2	%Image
Lichen Veneer	2099404	1228	3.86
Deep Water	13800037	8080	25.39
Esker Complex[1]	-	-	-
Sedge Wetland	2601109	1525	4.79
Shallow Water	9876600	5782	18.17
Tussock Hummock	3055481	1789	5.62
Heath Tundra	6697658	3920	12.32
Bedrock Association	953665	558	1.75
Tall Shrub	1951152	1142	3.59
Heath Boulders	1441603	843	2.65
Heath Bedrock	4775704	2797	8.79
Boulder Association	689137	405	1.27
Bare Ground	1925712	1126	3.54
Low Shrub	1713597	1002	3.15
Gravel	1577467	923	2.90
Unclassified	1198038	700	2.20
Total	54356364	31820	100.00

Note: [1]Data not available

Table 8B. Accuracy assessment for Scene 45-12

Code Name	LIVE	DEWA	ESCO	WELA	SHWA	TUHU	HETU	BEAS	TASH	HEBO	HEBE	BOAS	BAGD	LOSH	GRDP	Total	Producer's Accuracy
LIVE	49.1	0	4.7	0.5	0.8	4.6	5.5	1.1	0.5	3.6	6.1	0.3	12.3	0.2	1.3	90.6	49
DEWA	0	98.7	0	0	1.1	0	0	0	0	0	0	0	0	0	0	99.8	98.7
ESCO	0.9	0	46.3	1.1	1.3	1.6	7.8	1.3	0.8	1.2	0.7	0.6	24.1	0.1	5.4	93.2	46.3
WELA	0	0	0.6	37.6	2.2	19.6	12.6	0.1	7.8	0.2	0.9	0.1	2.4	14.8	0.4	99.3	37.6
SHWA	0	0	0	0	99.9	0	0	0	0	0	0	0	0	0	0	99.9	99.9
TUHU	0.8	0	0.4	14.3	0.1	25.6	19.2	0	6.2	0.3	0.3	0.1	3.6	28.8	0.1	99.8	25.6
HETU	0.5	0	2.5	4.7	0	12	55.4	0	2.7	0.4	0.4	0	13	7.7	0.2	99.5	55.4
BEAS	1.3	0	3.6	0.3	0.6	0.2	0.6	19.5	0.1	4.4	5.8	24.8	20.9	0	11.5	93.6	19.5
TASH	0	0	1.6	10.8	0.8	11.9	3.2	0.3	29.9	0	0.4	0	0.2	35.7	0.5	95.3	29.9
HEBO	6.2	0	1.6	0.3	0.4	0.9	2.7	2.9	0	10.4	11.5	20.7	35.8	0	5.9	99.3	10.4
HEBE	7.8	0	1.1	0.7	0.3	0.3	1.7	2.9	0	8.5	17.5	18.9	32.3	0	7.2	99.2	17.5
BOAS	1.1	0	0.3	0.1	0.3	0.1	0.3	2.5	0	4.3	6.7	68.4	12.5	0	2.6	99.2	68.4
BAGD	2.2	0	7.3	0.2	0.3	1.4	4.5	1.9	0.7	1.3	0.7	2.3	51.5	1.3	0.9	76.5	51.5
LOSH	0	0	0.2	5.6	0.1	15.5	4.9	0	11.1	0	0.2	0	0.3	61.3	0.3	99.5	61.3
GRDP	0.3	0	5.6	1	2	0.5	0.7	4.4	0.7	1.8	6.9	1.7	8.4	0.1	63.4	97.5	63.4
Total	70.2	98.7	75.8	77.2	110	94.2	119	36.9	60.5	36.4	58.1	138	217.3	150	99.7	1442	
User's Accuracy	69.7	100	61.1	48.7	90.6	27.2	46.6	52.8	49.4	28.6	30.1	49.6	23.7	40.9	63.6		

Table 9A. Classification results for Scene 46-13

Class	Pixels	Km^2	%Image
Lichen Veneer	889155	518	1.63
Deep Water	8560338	4980	15.60
Esker Complex	1222613	709	2.23
Sedge Wetland	3116489	1813	5.70
Shallow Water	2311726	1345	4.23
Tussock Hummock	3854793	2242	7.05
Heath Tundra	8263883	4808	15.11
Bedrock Association	988778	576	1.81
Tall Shrub	993443	579	1.82
Heath Boulders	2148454	1250	3.93
Heath Bedrock	3669816	2135	6.71
Boulder Association	4233571	2463	7.74
Bare Ground	9499574	5526	17.37
Low Shrub	1769566	1028	3.23
Gravel	2458628	1428	4.49
Unclassified	724105	420	1.32
Total	54704929	31820	100.00

Table 9B. Accuracy assessment for Scene 46-13

Code Name	LIVE	DEWA	WELA	SHWA	TUHU	HETU	BEAS	TASH	HEBO	HEBE	BOAS	BAGD	LOSH	GRDP	Total	Producer's Accuracy
LIVE	68.3	0	0.3	0	0.4	2.9	1.5	0	14	4.8	3.9	1.8	0	1.6	99.5	68.3
DEWA	0	88.7	0	11.3	0	0	0	0	0	0	0	0	0	0	100	88.7
WELA	1.1	0	57.6	2	11.5	7.6	0	6.1	0.8	1.3	0.7	2.4	5.3	0.5	96.9	57.6
SHWA	0	0.4	2.9	94.4	0	0	0	0	0	0	0	0	0	0	97.7	94.4
TUHU	0.7	0	4.7	0	42.5	14.5	0	4.1	1.5	0.7	0.1	0.9	26.8	0	96.5	42.5
HETU	4.8	0	3.5	0.1	16.4	50.2	0	6.3	1.3	2.3	0.2	2.5	9.7	0.1	97.4	50.2
BEAS	1.8	0	0.3	0	0.1	0.6	36.8	0.5	2.9	25.5	5.5	2.7	0	18.2	94.9	36.8
TASH	1.2	0	14.6	0	7.3	13.4	0	31.7	0	4.9	0	2.4	18.3	0	93.8	31.7
HEBO	12.4	0	0.2	0.1	0	2.9	0.3	2	44	23	7.4	5.5	0	2.2	100	44
HEBE	3.9	0	0.8	0.1	0.5	5.8	11.7	1.4	0.8	49.5	6.8	2.1	0	15	98.4	49.5
BOAS	4.7	0	0.5	0	0	2.1	7	0.8	0.5	25.7	42.4	1.3	0	10.5	95.5	42.4
BAGD	11.3	0	3.3	0.2	0.4	1.8	0	0.2	4.4	2	3.1	67.1	0	0.4	94.2	67.1
LOSH	0.2	0	5.3	0	17.8	5.3	0	5.5	0.3	0.4	0	1	61.4	0.1	97.3	61.4
GRDP	2.5	0	2	0.1	0.2	0.3	4.7	0.2	2.4	5.2	6.9	1.1	0	71	96.6	71
Total	112.9	89.1	96	108	97.1	107	62	58.8	72.9	145	77	90.8	122	120	1358.7	
User's Accuracy	60.4	99.6	60	87.1	43.8	46.7	59.4	53.9	60.3	34.1	55.1	73.9	50.5	59.3		

Note: Accuracy assessment for Esker Complex could not be calculated because of the manual classification technique used.

Table 10A. Classification results for Scene 44-15

Class	Pixels	Km^2	%Image
Heath Tundra	12571706	7857	25.06
Sedge Wetland	654878	409	1.31
Tall Shrub	105307	66	0.21
Spruce Forest	403434	252	0.80
Tussock/Hummock	1075553	672	2.14
Lichen Veneer	1192518	745	2.38
Bedrock Association	95234	59	0.19
Peat Bog	47454	29	0.09
Birch Seep	115841	72	0.23
Boulder Association	364943	228	0.73
Heath Bedrock	958757	599	1.91
Heath Boulder	8892438	5557	17.73
Deep Water	11149699	6968	22.23
Shallow Water	5127624	3205	10.22
Unclassified	3165015	1978	6.31
Total	59838882	31275	100.00

Table 10B. Accuracy assessment for Scene 44-15

Code / Name	HETU	WELA	TASH	SPFO	TUHU	LIVE	BEAS	PEBO	BISE	BOAS	HEBE	HEBO	DEWA	SHWA	Total	Producer's Accuracy
HETU	85.4	0.8	1.2	1	1.1	0.8	0	0	0.3	0	0.1	6.7	0	0.1	97.5	87.59
WELA	4.6	83.8	0	0	1.5	0	0	1.3	0	0	0.3	0.4	0	0.1	92	91.09
TASH	17	0	52.7	20.4	0	0	0	0	1.1	0	0	0	0	0	91.2	57.79
SPFO	5.1	0	0	86	0	0	0	0	2.9	0	0	0	0	0	94	91.49
TUHU	3.6	0	0	0	94.3	0	0	0.8	0	0	0.2	0	0	0	98.9	95.35
LIVE	1.8	0	0	1.9	0	85.6	0	0	0	0	0.1	0.1	0	0.5	90	78.67
BEAS	0.3	0.3	0	0	0	0.1	70.8	0	0	5.1	1.4	11.2	0	0	89.2	79.37
PEBO	0	2.9	0	0	0	0	0	80	0	0	4.3	5.7	0	0	92.9	86.11
BISE	5.4	0	0	5.4	0	0	0	0	87.5	0	0	1.8	0	0	100.1	87.41
BOAS	0.1	0	0	0	0	0	1.8	0	0	70.1	3.7	14.9	0	0	90.6	77.37
HEBE	0.5	4.1	0	0	0.2	0.6	2.6	1.4	0	11.1	55.1	17.3	0	0	92.9	59.31
HEBO	6.1	1	0	0	0	0.5	0.6	0.2	0	8.5	1.6	79.6	0	0	98.1	81.14
DEWA	0	0	0	0	0	0	0	0	0	0	0	0	100	0	100	100
SHWA	0.1	0.1	0	0	0	0.5	0	0	0	0	0	0	0	99.3	100	99.3
Total	130	93	53.9	114.7	97.1	88.1	75.8	83.7	91.8	94.8	66.8	137.7	100	100	1327	
User's Accuracy	65.69	90.11	97.8	74.98	97.12	97.16	93.4	95.58	95.32	73.95	82.49	57.81	100	99.3		

Table 11A. Classification results for Scene 46-15

Class	Pixels	Km^2	%Image
Heath Bedrock	1105652	691	2.19
Tall Shrub	1141189	713	2.26
Heath Boulder	4288002	2680	8.49
Heath Tundra	10139480	6337	20.07
Sedge Wetland	1674464	1046	3.31
Boulder Association	1411517	882	2.79
Lichen Veneer	2311725	1445	4.57
Bedrock Association	629471	393	1.25
Tussock/Hummock	46443	29	0.09
Esker Complex	575198	359	1.14
Spruce Forest	4981873	3114	9.86
Peat Bog	2043611	1277	4.04
Mixed Forest	792216	495	1.57
Birch Seep	2260254	1413	4.47
Old Burn	1189613	744	2.35
Young Burn	559239	349	1.11
Deep Water	10635651	6647	21.05
Shallow Water	3252120	2033	6.44
Unclassified	1494972	934	2.96
Total	50532690	31581	100.0

Table 11B. Accuracy assessment for Scene 46-15

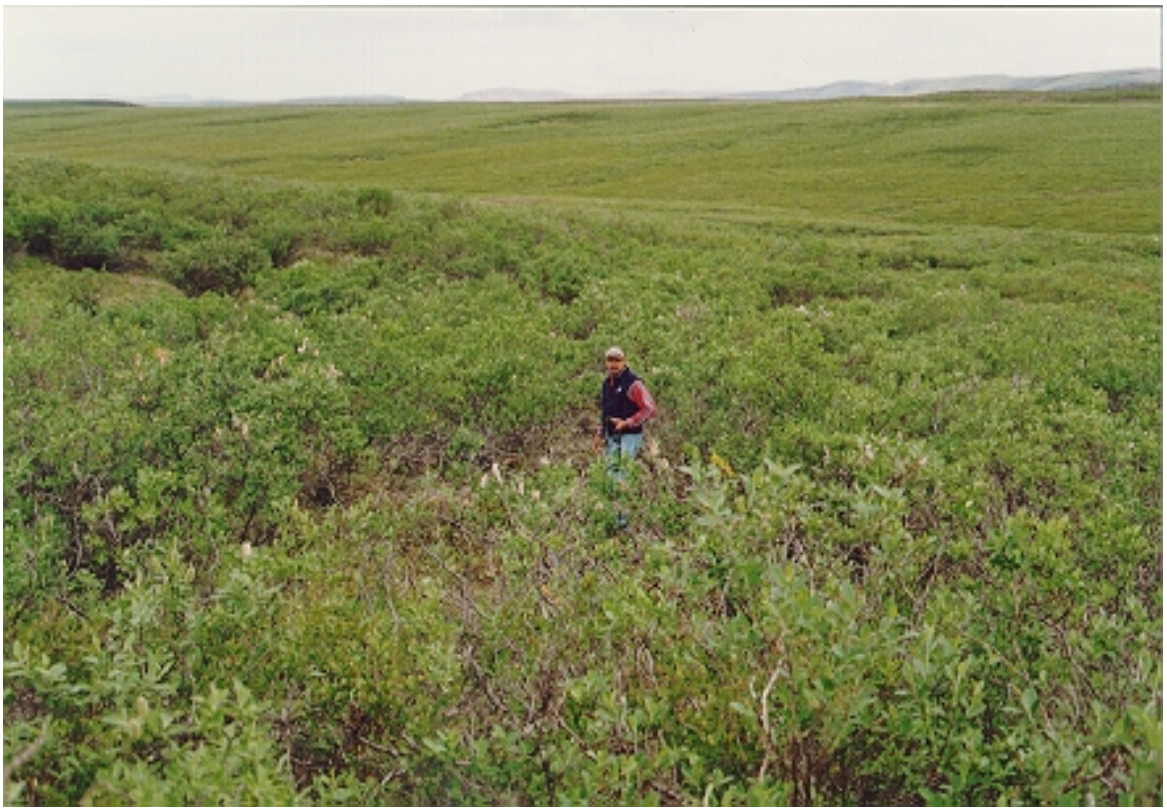
Name	HEBE	TASH	HEBO	HETU	WELA	BOAS	LIVE	BEAS	TUHU	SPFO	PEBO	MXFO	BISE	Total	Producer's Accuracy
HEBE	32.1	2.9	0.7	33.7	7.8	17.8	1.0	0.0	0.0	0.7	1.0	0.9	0.6	99.2	32.4
TASH	0.0	72.5	0.2	10.1	0.9	1.0	0.0	0.0	0.0	0.7	0.0	3.0	7.8	96.2	75.4
HEBO	0.0	2.2	87.3	4.1	0.7	0.7	0.0	0.0	0.0	3.7	0.0	0.0	0.7	99.4	87.8
HETU	0.0	3.1	0.1	85.0	5.0	0.2	0.4	0.0	0.0	0.1	0.2	0.6	3.7	98.4	86.4
WELA	0.3	2.3	1.2	12.5	77.5	0.4	0.2	0.0	0.0	1.1	0.4	0.2	2.5	98.6	78.6
BOAS	5.0	0.7	1.9	10.3	1.2	67.0	0.3	0.0	0.4	8.0	0.0	0.9	0.5	96.2	69.6
LIVE	0.0	0.0	0.0	12.3	0.0	0.0	69.3	0.0	0.0	1.8	6.7	0.0	2.1	92.2	75.2
BEAS	7.9	0.2	0.0	9.2	0.0	2.4	0.0	78.6	0.0	0.4	0.0	0.4	0.0	99.1	79.3
TUHU	0.0	13.5	1.4	41.3	1.4	2.2	9.0	0.0	12.6	1.8	9.7	0.7	3.6	97.2	13.0
SPFO	0.1	3.6	3.5	4.2	0.8	0.9	0.8	0.0	0.0	79.1	0.0	1.9	3.6	98.5	80.3
PEBO	0.0	0.0	0.0	1.2	11.5	1.0	3.4	0.0	0.2	1.2	77.1	0.3	1.9	97.8	78.8
MXFO	1.7	6.7	0.3	2.1	1.0	4.8	0.0	0.0	0.0	11.1	0.0	66.0	4.6	98.3	67.1
BISE	0.0	5.7	4.0	11.9	0.6	1.1	8.5	0.0	0.0	5.7	0.0	0.0	59.7	97.2	61.4
Total:	47.1	113.4	100.6	237.9	108.4	99.5	92.9	78.6	13.2	115.4	95.1	74.9	91.3	1258	
User's Accuracy	68.2	63.9	86.8	35.7	71.5	67.3	74.6	100.0	95.5	68.5	81.1	88.1	65.4		

Note: The following classes were delineated using a masking technique and therefore are not included in the accuracy assessment – Esker Complex, Old and Young Burns, Deep and Shallow Water.

APPENDIX II - PHOTOGRAPHS

Photograph 1. Sedge Wetland

Photograph 2. Tussock/Hummock



Photograph 3. Riparian Tall Shrub

Photograph 4. Birch Seep and Low Shrub

Photograph 5. Peat Bog

Photograph 6. Heath Tundra

Photograph 7. Heath/Bedrock


Photograph 8. Heath/Boulders

Photograph 9. Boulder Association

Photograph 10. Bedrock Association

Photograph 11. Spruce Forest

Photograph 12. Mixed Forest

Photograph 13. Snow and Ice

Photograph 14. Gravel

Photograph 15. Bare Ground

Photograph 16. Esker Complex

Photograph 17. Lichen Veneer