

GeoBase Land Cover Product

User Needs Assessment

Prepared for

National Land Cover Project Team

Submitted by

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Executive Summary

Land Cover information is required by numerous public sector and private sector organizations. In recognition of this, the GeoBase Steering Committee recently decided that Land Cover would be a priority map layer to add to the GeoBase portal. As the first phase of the project to create a GeoBase Land Cover product, this User Needs Assessment has asked a wide spectrum of users about their needs for Land Cover information, in both the short and long term.

Two major Land Cover products have already been created to meet the needs of specific sectors. The Canadian Forest Service (CFS) created EOSD (Earth Observation for Sustainable Development) to satisfy forest sector requirements, in cooperation with the provincial governments. Agriculture and Agri-Food Canada (AAFC) is currently producing a Land Cover product as part of the National Land and Water Information Service to meet the agriculture sector needs, again in collaboration with the provincial governments.

The Land Cover Community of Practice (LCCoP) was recently established as a national network of federal agencies undertaking sector specific Land Cover monitoring initiatives to:

- Recommend and promote national standards for Land Cover information development;
- Provide a common technical response to national Earth Observation (EO) strategies and policies from the Land Cover perspective;
- Promote and facilitate the sharing of knowledge and data working towards integrated national Land Cover products for Canada;
- Improve the availability, quality, and extent of Land Cover information; and
- Support common infrastructure to develop and share Land Cover information and supporting data.

The National Land Cover Project Team was formed from members of the LCCoP and the GeoBase Program with the objective to integrate Land Cover mapping from provincial and federal organizations and produce a harmonized data base that is consistent with international standards, to meet the broadest range of user needs.

The project team agreed that the objectives of this User Needs Assessment (UNA) were to:

- Present to end users where we are today with current capabilities and product plans.
- Understand their short term Land Cover needs so that we can optimize product development to respond to the extent feasible within budget and schedule constraints.
- Understand their long term Land Cover needs so that we can plan accordingly within reason.

This UNA was funded by GeoConnections.

Once the project team had agreed on the information requirements of the UNA, a questionnaire was drafted and sent out to both targeted and untargeted mailing lists. Three hundred and seventeen responses were received, tabulated and analyzed. Twelve ministries of the Saskatchewan government submitted a single coordinated response, so the number of responses can be considered to be higher than 317. This level of response pleased the project team, since it was far above our expectations.

As follow up to the questionnaire, seven discussion groups were organized in the following cities:

- Federal departments: Ottawa
- Atlantic provinces: Halifax
- Québec: Québec city
- Ontario: Peterborough
- BC & Yukon: Victoria
- Alberta, NWT & Nunavut: Edmonton
- Manitoba and Saskatchewan: Regina.

The objectives of the discussion groups were:

- To inform stakeholders of the status and plans for the GeoBase Land Cover Layer;
- To present the results of the GeoBase Land Cover User Needs Assessment Questionnaire;
- To confirm, correct (if necessary) and flesh out the findings from the questionnaire.

The results of the questionnaire responses and the discussion groups are presented in this report. A representative sample of the responses is provided, carefully avoiding attribution of who said what. The findings are grouped in subject areas. Based on this wealth of information, the major findings and recommendations are presented.

A summary of the major findings follows.

1. The level of interest in the currently planned GeoBase Land Cover product is high, and the product can benefit a large number of users.
2. The GeoBase principles, program and products are appreciated. At the same time, continuing coordination with the provinces is required to integrate datasets and conduct validation and maintenance.
3. The Northern Land Cover product is important and stakeholders are waiting for it. However, Land Cover classification in the North has been found to be challenging.
4. Users are concerned about consistency, accuracy and other aspects of product quality.

5. Product documentation and metadata are important; they should tell users about the data sources, class definitions, accuracies, and how the product can and cannot be used.
6. Users do not want the other GeoBase layers superposed on the Land Cover product. Nor do the sampled users want the water layer in the Land Cover product to match exactly the water boundaries of the National Hydrology Layer.
7. The question of whether future Land Cover products should re-map Land Cover, monitor Land Cover or show change detection remains unclear to the author. Now that the users' views have been collected, the Product Definition team should study this question, and clearly document their approach with rationale.
8. When participants were asked whether they would prefer to receive multiple layers of raw information or to get an integrated product where the layers of raw data had been combined by the producer, the consensus was that users would like both. More expert users would use the raw data to recreate maps in more specific ways. Less expert users would need to have the integration done for them, but they would need to know how the integration had been done i.e. how the product can and cannot be used.

The key recommendations follow.

1. Efforts should continue to issue the product with the currently planned resolution, legend and other attributes.
2. The Northern Land Cover product should be developed as planned.
3. Consideration should be given to adding the following delivery formats for the currently planned Land Cover product and future updates: WMS, WFS, KML and GeoTIFF.
4. A strategy of on-going or repeated consultations at an appropriate frequency should be followed. Expansion of the LCCoP to include provincial governments could be a useful part of this strategy.
5. Establishment of a technical consultation group should be considered, perhaps through the LCCoP.
6. Coordination with the provinces should be continued to integrate datasets and conduct validation and maintenance.
7. Quality assurance should be pursued through assurance of consistency, assessment of accuracy by class, compliance with standards, and other means.
8. Consideration should be given to a higher resolution product in future (approximately 10 m), recognizing that the classification methods and sensor data will change, and forward and backward compatibility must be assured.
9. Consideration should be given to a standard, national, hierarchical, multi-level Land Classification System that spans very coarse scale Land Cover, through to Land Use, and down to the very detailed ecological classification level.
10. Consideration should be given to making wetland classes consistent with the Canadian Wetland Classification system.
11. Consideration should be given to a more detailed agricultural Land Use classification.

12. Future Land Cover initiatives should study the question of whether new Land Cover products should re-map Land Cover or monitor Land Cover change. The approach selected should be clearly documented with rationale.
13. Regarding the timing of updates, consideration should be given to harmonizing the Land Cover product updates to the agricultural census and population census of Statistics Canada. The cost effectiveness of this approach should be compared to the approach of updating frequently changing areas more often than areas that change more slowly.
14. Consideration should be given to delivering future Land Cover products in both vector and raster format.
15. Consideration should be given to producing a low resolution Land Cover product very frequently, perhaps annually, to detect change areas.
16. Consideration should be given to creating a National Monitoring Strategy to provide a framework for monitoring at all levels of government in Canada.
17. As it is not possible to create a product to serve all needs, the project team must clearly identify the intended use of the GeoBase product, so it is clear to users what the product is intended to provide.

The author believes that the project objectives have been satisfied. He is grateful for the opportunity to do this work, and looks forward to a successful launch of the GeoBase Land Cover Product.

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1. Introduction

Multiple Federal and Provincial agencies have mapped Land Cover to meet their specific needs. As a result, Land Cover data currently exists at various vintages, utilizing different legends, at different scales, and representing differing geographic areas. Many of the recently completed Land Cover projects undertaken in Canada were produced to address differing sector-based information needs; the Canadian Forest Service and Agriculture and Agri-Food Canada have been working together since 2003 to produce Land Cover with sector-specific legends and classification methodology, but compatible resolutions, spatial and temporal extents. While the quality and consistency of the maps are high, there remain considerations for merging these differing map products to produce a nationally comprehensive Land Cover map. Consequently there is a lack of a contiguous depiction of Land Cover for the entire land mass of Canada at high resolution. In recent years, it has become clear that a nationally contiguous, higher resolution, wall-to-wall depiction of Land Cover is required to meet a broad range of user needs, as well as providing a consistent national standard to address regional needs.

In April 2007, the ADMs (Assistant Deputy Ministers) representing the Canadian Council on Geomatics¹ (CCOG) agreed that Land Cover should be added to GeoBase² as a new high priority framework layer. The National Land Cover Data project was created to work with stakeholders and address the requirement for contiguous national Land Cover data by defining and developing a harmonized Land Cover dataset for Canada.

The main objective of the National Land Cover Project is to integrate Land Cover mapping from provincial and federal organizations and produce a harmonized data base that is consistent with international standards, to meet the broadest range of user needs.

The National Land Cover Project has adopted a phased approach: Phase 1, User Needs Assessment; Phase 2, Data Product Definition; and Phase 3, Implementation. This report addresses Phase 1, User Needs Assessment.

Significant up-front technical work of Phase 2, Data Product Definition, has already been completed; this phase is being done by the Centre for Topographic Information (CTI) of Natural Resources Canada (NRCan) in collaboration with the Agriculture and Agri-Food Canada and the Canadian Forest Service of NRCan, with partial funding from the Government Related Initiatives Program (GRIP) of the Canadian Space Agency (CSA).

¹ The Canadian Council on Geomatics, created in 1972, is the major federal-provincial-territorial consultative body for geographic information management. CCOG provides a forum for exchanging information on programs, considers common operational issues, discusses proposed legislation relevant to geomatics (particularly land surveying), and develops and promotes national geomatics standards.

² GeoBase is a federal, provincial and territorial government initiative that is overseen by the CCOG. It is undertaken to ensure the provision of, and access to, a common, up-to-date and maintained base of quality geospatial data for all of Canada. Through the GeoBase portal, users with an interest in the field of geomatics have access to quality geospatial information at no cost and with unrestricted use. CCOG has endorsed the vision and principles behind GeoBase, supports the GeoBase action plan, and commissioned a Steering Committee to carry out its objectives. For more information, see www.geobase.ca.

During Phase 3, Implementation, the Integrated Data Products will be developed. Phase 3 will start once phases 1 and 2 are complete, and it is planned to complete during the 2009-2010 fiscal year. In Phase 3, CTI will integrate sectoral Land Cover data and convert them into data that will abide by international standards. These data may then be accessed through the GeoBase portal.

This User Needs Assessment was funded by GeoConnections (see www.geoconnections.org/en/index.html).

2. Land Cover Background

2.1 Definitions

Land Cover refers to the vegetative or non-vegetative characteristics of a portion of the Earth's surface. Land Cover classification can be done over a hierarchy of detail, to meet user needs, or to accommodate the information content of the data source (e.g., land --> vegetated --> treed --> coniferous --> pine).

Land Use is the way in which humans use the earth's surface. Uses are classified as urban, rural, agricultural, forested, etc., with more specific sub-classifications useful for specific purposes. Land Use can be an additional descriptor of a Land Cover class (e.g., coniferous Land Cover can be a plantation).

Land Cover legends are developed to meet a specified set of needs, and consequently classification methods and legends are often unique. Land Cover legends usually attempt to stick to Land Cover, but sometimes Land Use creeps in; for example, 'Agriculture', 'Cropland' and 'Pasture', all Land Use classes, can be found in agricultural Land Cover legends.

2.2 Organizations, Players and Products

In November 2005, the Inter Agency Committee on Geomatics³ (IACG) approved the formation of an interdepartmental Land Cover Community of Practice (LCCoP); the IACG had previously appointed Agriculture and Agri-Food Canada (AAFC) as the Geomatics Community Coordinator for Land Use. The mission of the LCCoP is to create a national network of federal agencies undertaking sector specific Land Cover monitoring initiatives to:

- Recommend and promote national standards for Land Cover information development;
- Provide a common technical response to national EO strategies and policies from the Land Cover perspective;
- Promote and facilitate the sharing of knowledge and data working towards integrated national Land Cover products for Canada;
- Improve the availability, quality, and extent of Land Cover information; and
- Support common infrastructure to develop and share Land Cover information and supporting data.

³ See http://www.iacg-cmoig.org/home/about_e.php

The LCCoP is comprised of Land Cover data users and data producers. Currently the two most active mapping agencies are:

- Earth Observation for the Sustainable Development of Forests (EOSD), by the Canadian Forest Service (CFS) of NRCan;
- National Land and Water Information Service (NLWIS), by Agriculture and Agri-Food Canada.

EOSD, working in partnership with the provinces and territories and with the collaboration of the CSA, has produced a Land Cover map of the forested area of Canada; this map is available to Canadians at no charge. This map supports the National Forest Inventory; the date is circa 2000. An update circa 2005 has been proposed. For more information, see http://www.pfc.forestry.ca/EOSD/index_e.html. Figure 1 shows an overview of the EOSD Land Cover product.

NLWIS is also working to integrate Land Cover with provincial inventories, in this case for agricultural purposes, and to make it available as a single product, again at no charge. For more information, see www.agr.gc.ca/nlwis/index_e.cfm. The NLWIS Land Cover product is complete and available for agricultural regions of Manitoba, Saskatchewan, Alberta and the Peace River district of British Columbia. It is nearing completion for the whole of the agricultural extent of Canada.

An analysis of early requests for NLWIS Land Cover data are shown in Figure 2 and Figure 3. Figure 2 shows who placed the first 70 requests up to February 2008. Not surprisingly, AAFC accounts for about one third and other federal government departments another third. But a wide range of stakeholders made the remaining requests.

Figure 3 shows the application of the requestors. It seems surprising that only 50% of the requests were for agriculture, considering that NLWIS was designed to serve the agricultural community. The remaining half of the requests were motivated by several different needs, as shown.

Figure 1 EOSD Land Cover Overview

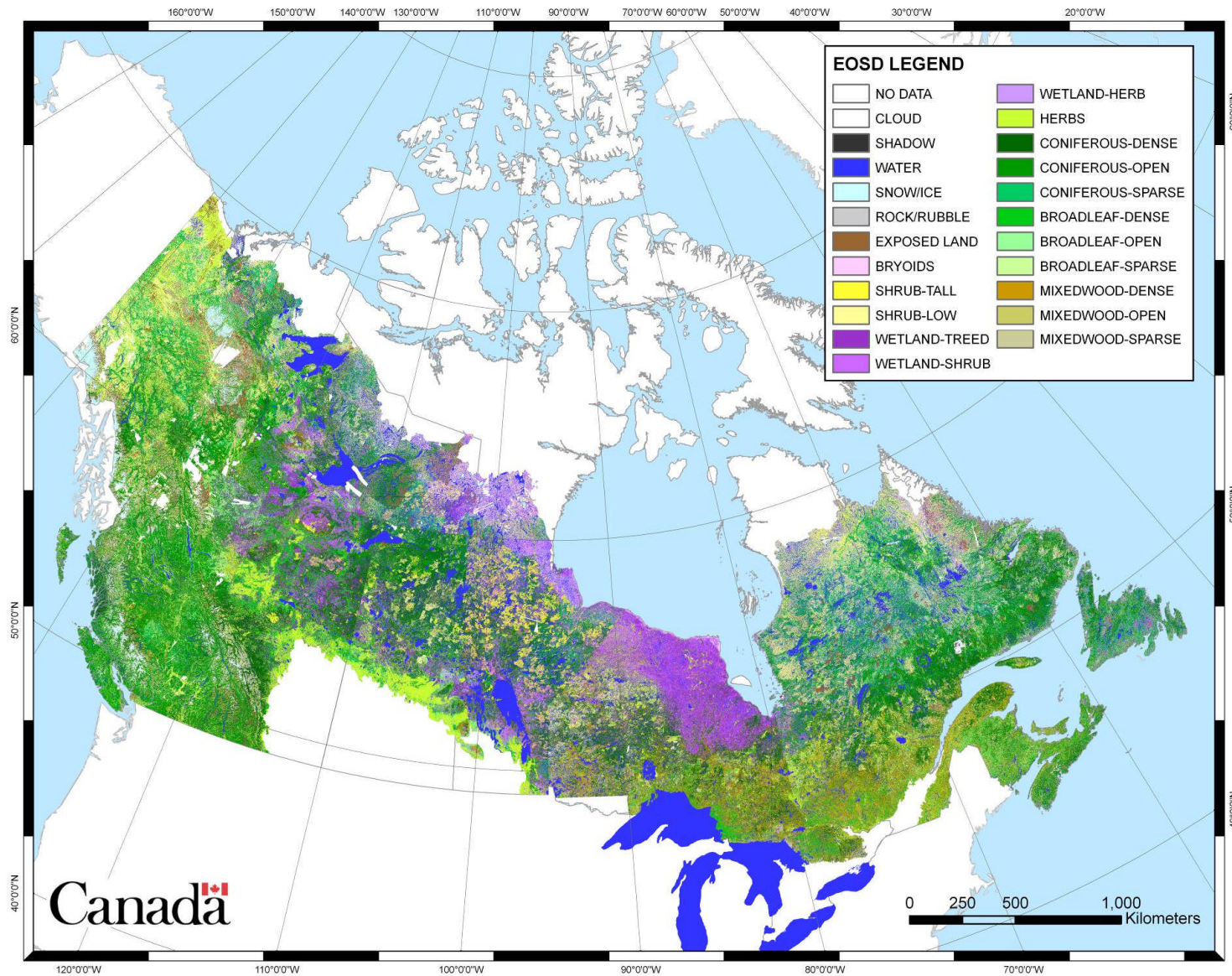


Figure 2 Who Requested NLWIS Land Cover Data?

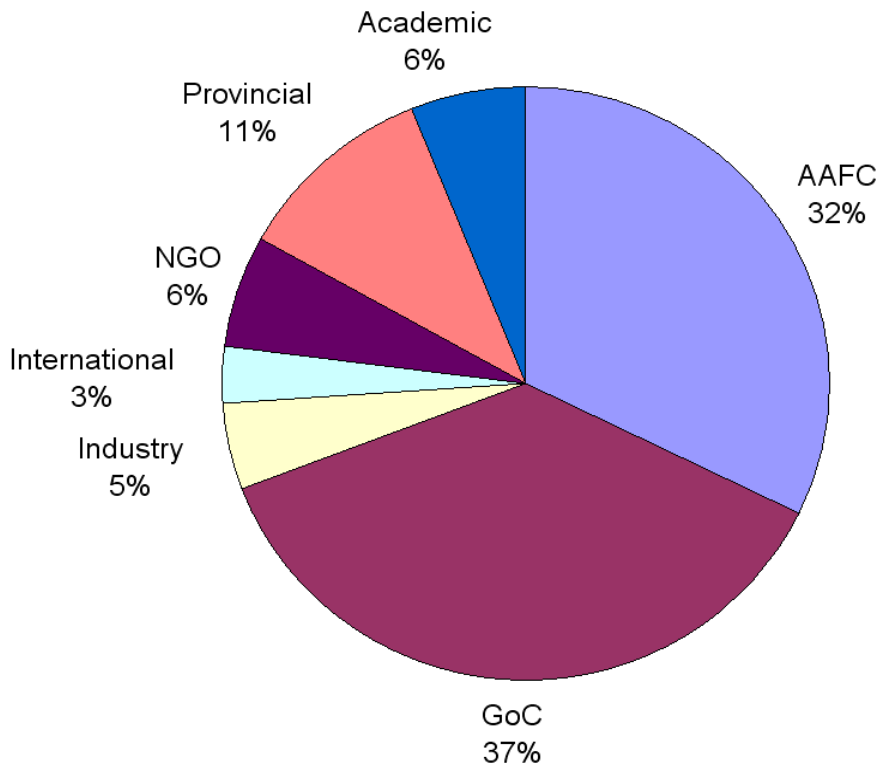
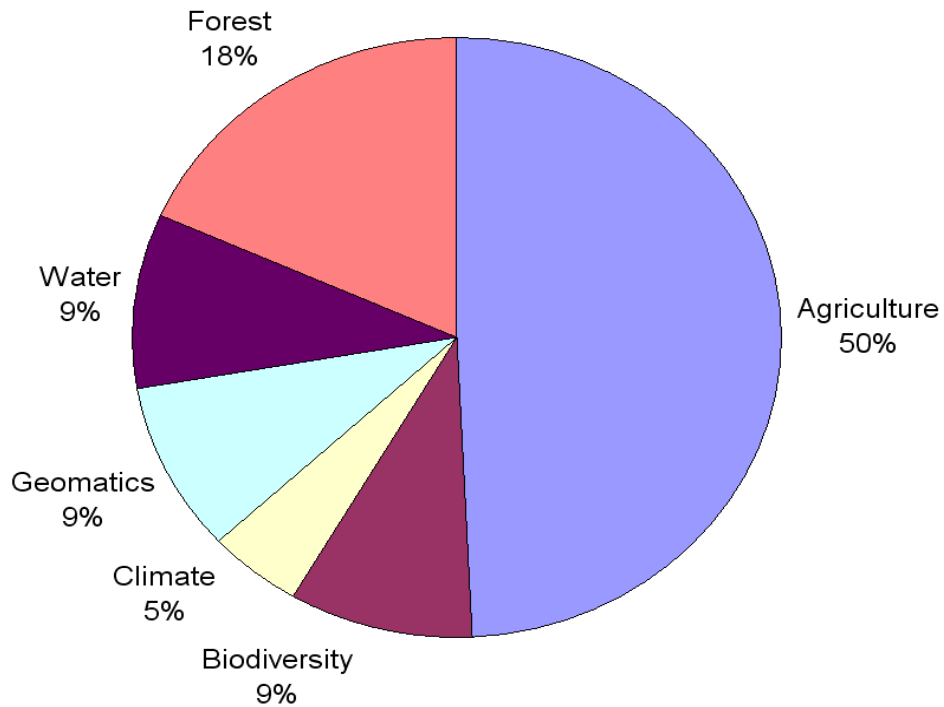


Figure 3 The Application Sectors of the Early Requestors of NLWIS Land Cover Data



Other agencies are also working on developing operational Land Cover activities, including but not limited to the following:

- Environment Canada is leading a team with the goal of creating a Canadian Wetland Inventory [Fournier et al, 2007]; the methodology has been developed and they are awaiting funding approval.
- The Canada Centre for Remote Sensing (CCRS) of NRCan is advancing techniques for Land Cover mapping in urban environments and also north of the treeline.

Together these agencies have produced, are producing, or will produce Land Cover mapping for the majority of the country. The active mapping agencies have worked internally and with the provinces to meet Land Cover data needs specific to their sector. There are some disparities in classifications, however both EOSD and NLWIS are based on Landsat imagery, so this provides a common scale, and efforts have been made to coordinate mapping activities as much as possible. Through the National Land Cover Data Project, the LCCoP now has a tremendous opportunity to further this coordination and work with the stakeholder community beyond their sectors to determine Land Cover requirements and develop integrated products to meet broad community needs. In doing so, this project will address the CCOG need for a framework Land Cover data layer.

The team members and their roles in the National Land Cover Project are:

- Agriculture Canada
 - Project leadership
 - Agricultural mapping
- NRCan-CFS
 - Forest mapping
 - Project coordination and logistical support (LCCoP Secretariat)
- NRCan- Centre for Topographic Information
 - Geospatial data product definition and product development
- Ontario Ministry of Natural Resources
 - Provincial Coordination Advisor
- Canadian Space Agency
 - GRIP Funding for map product development
- NRCan – GeoConnections
 - Funding of the User Needs Assessment.

2.3 Standards

Users often suffer incompatibility and inconsistency between different data sources. Standards attempt to control this problem by specifying, in a way that has been agreed by the larger community, the answers to one or more of the following questions:

- how specific types of data should be used?
- how created?
- how classified?
- how formatted?

- how interfaced? and
- how quality should be ensured?

The project will comply with the following ISO (International Organization for Standardization) standards to the extent feasible:

ISO 19144-1 Geographic information – Classification Systems Part 1: Classification System Structure, and;

ISO 19144-2 Geographic information – Classification Systems Part 2: Land Cover Classification System (LCCS).

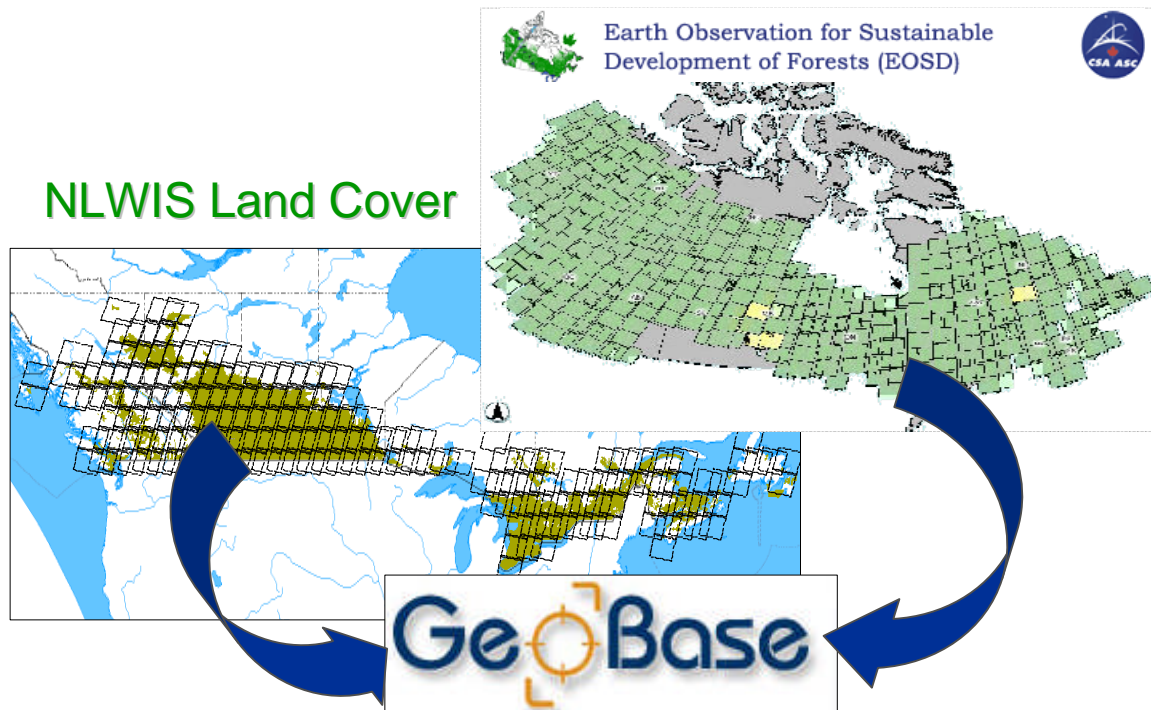
Standards will be met by compliance, as much as possible, with the current ISO standard represented by the UN-FAO (Food and Agriculture Organization of the United Nations) Land Cover Classification System [FAO, 2005]. The LCCS was developed as a comprehensive, standardized *a priori* classification system, designed to meet specific user requirements. The LCCS is categorically exhaustive and can be used for any Land Cover classification initiative anywhere in the world, following a set of diagnostic criteria that allow for correlations with regionally or nationally developed and existing classifications and legends. It should be noted that the CFS and AAFC Land Cover legends have already been correlated to the LCCS. While it is not possible to develop standard legends because they are specific to use, it is possible to adopt standard classification systems, and currently compliance with the LCCS constitutes an international standard [GOFC-GOLD, 2007].

Other standards that the National Land Cover Project will follow are addressed in the next section.

2.4 Currently Planned Land Cover Product

In order to exploit recent sectoral initiatives and make the results accessible to the broadest set of stakeholders, and do so in the quickest, most affordable way, the currently planned GeoBase National Land Cover Product will be based on an integration of existing federal and provincial mapping products. This is represented graphically in Figure 4.

Figure 4 Integration of EOSD and NLWIS



The currently planned Land Cover product is the result of raster thematic data originating from classified Landsat 7 or 5 ortho-images, for the agricultural and forest areas of Canada. Satellite imagery was acquired circa 2000. The forest cover was produced by the EOSD project and the agricultural coverage is being compiled by the NLWIS project. Again, both of these projects are working closely with provincial partners.

The legends of the two products are being harmonized to allow for the compilation of a single coverage of Canada. The intent is to preserve as much thematic class detail as possible. A pixel resolution of 30 metres, which corresponds to a scale of 1:50K, is proposed for the product. The initial source data for the Land Cover theme will be converted to vector format in order to be geometrically adjusted with the GeoBase Data Alignment Layer. Figure 5 shows the proposed EOSD-NLWIS harmonized legend. Legend classes from both products are planned to be integrated and preserved as best possible; in other words, detailed agricultural classes will appear in regions/areas where they are mapped, and detailed forest classes will appear in regions/areas in which they are mapped.

The EOSD dataset covers the forested areas of Canada and the NLWIS dataset covers the agricultural extent of Canada. As shown in Figure 6, neither one covers the north. A project to complete the Land Cover product for northern Canada (north of the forested and agricultural zones) is under discussion.

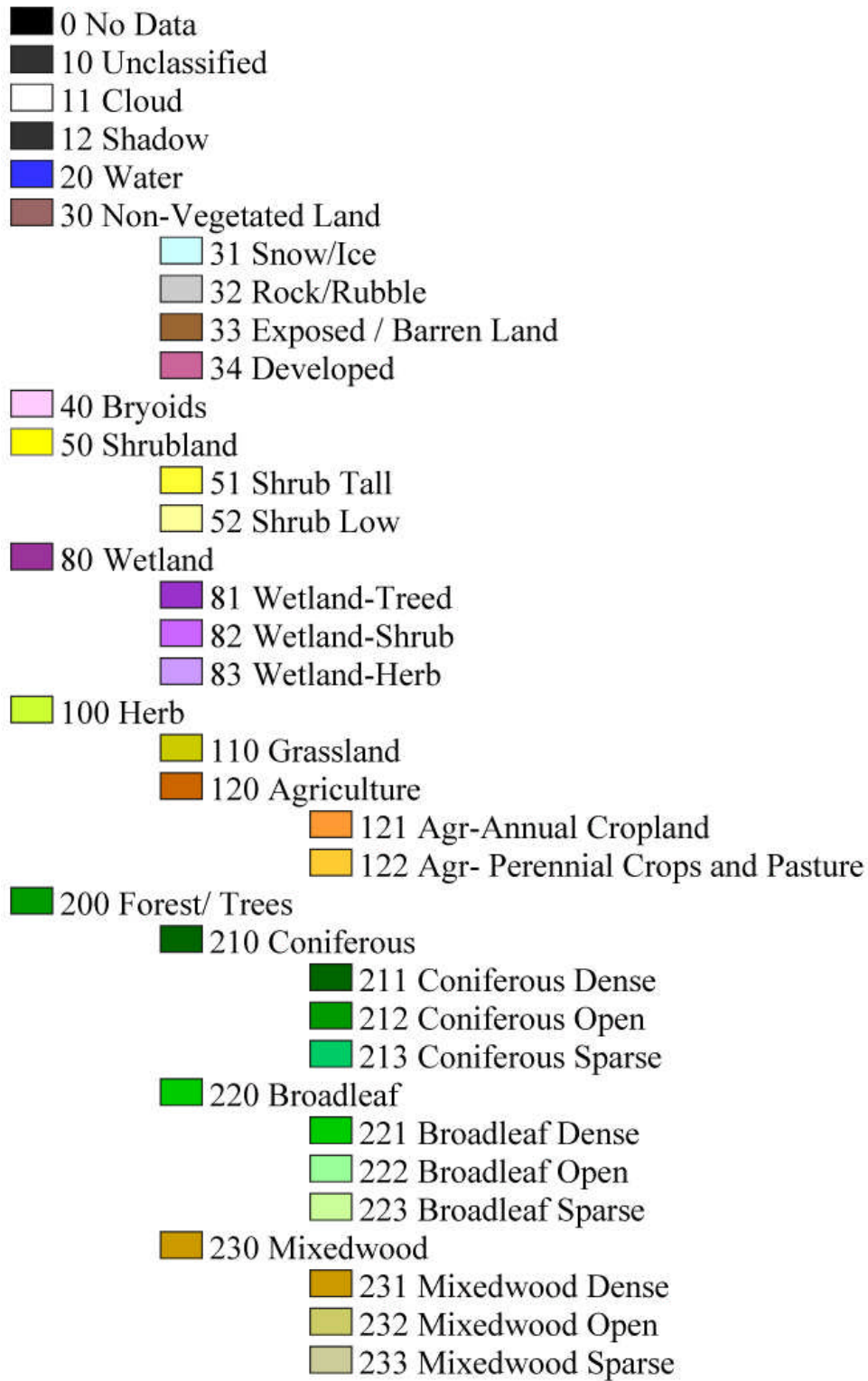


Figure 5 Proposed Harmonized EOSD-NLWIS Legend

Figure 6 Gaps and Overlaps in Land Cover Datasets

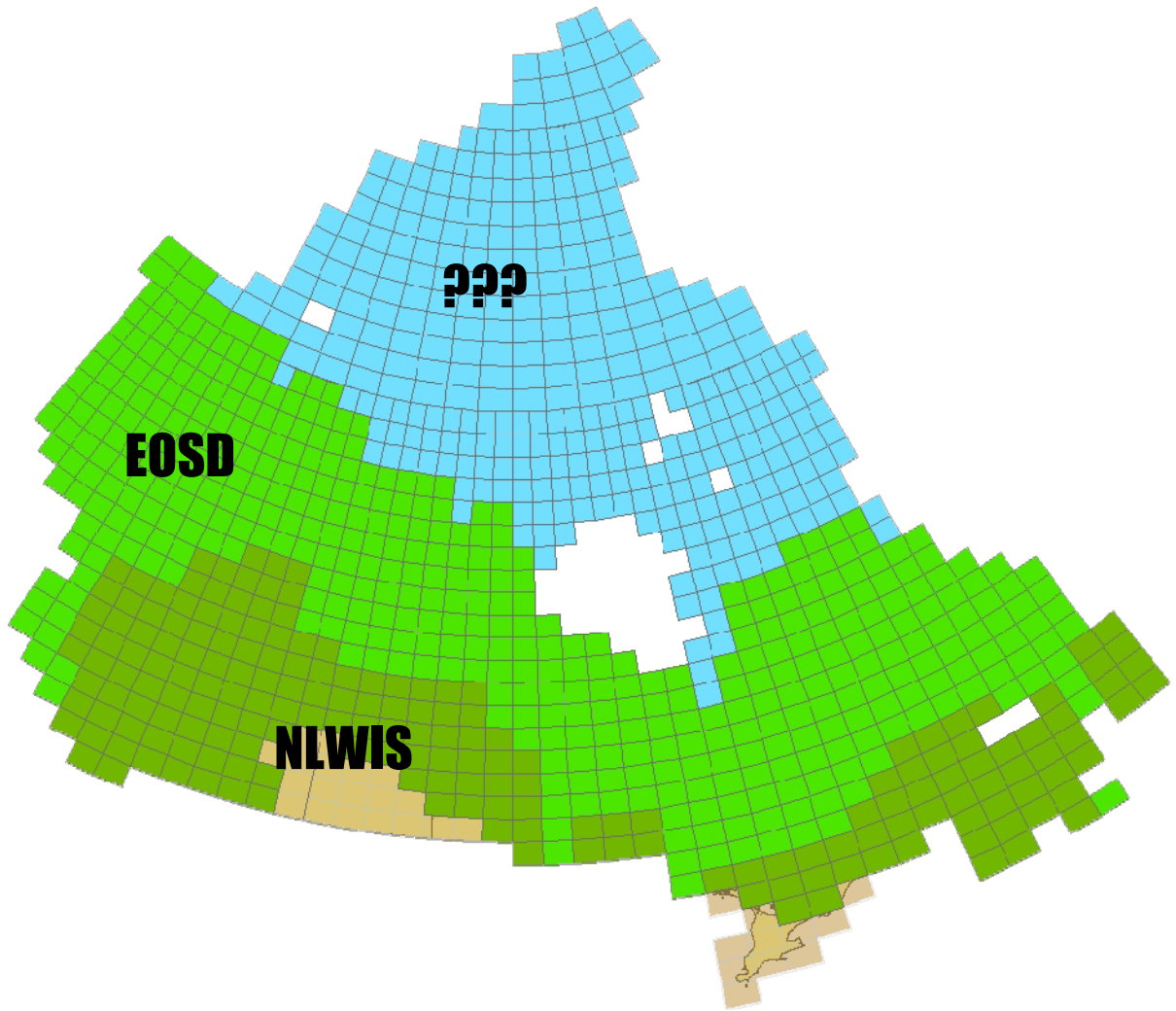
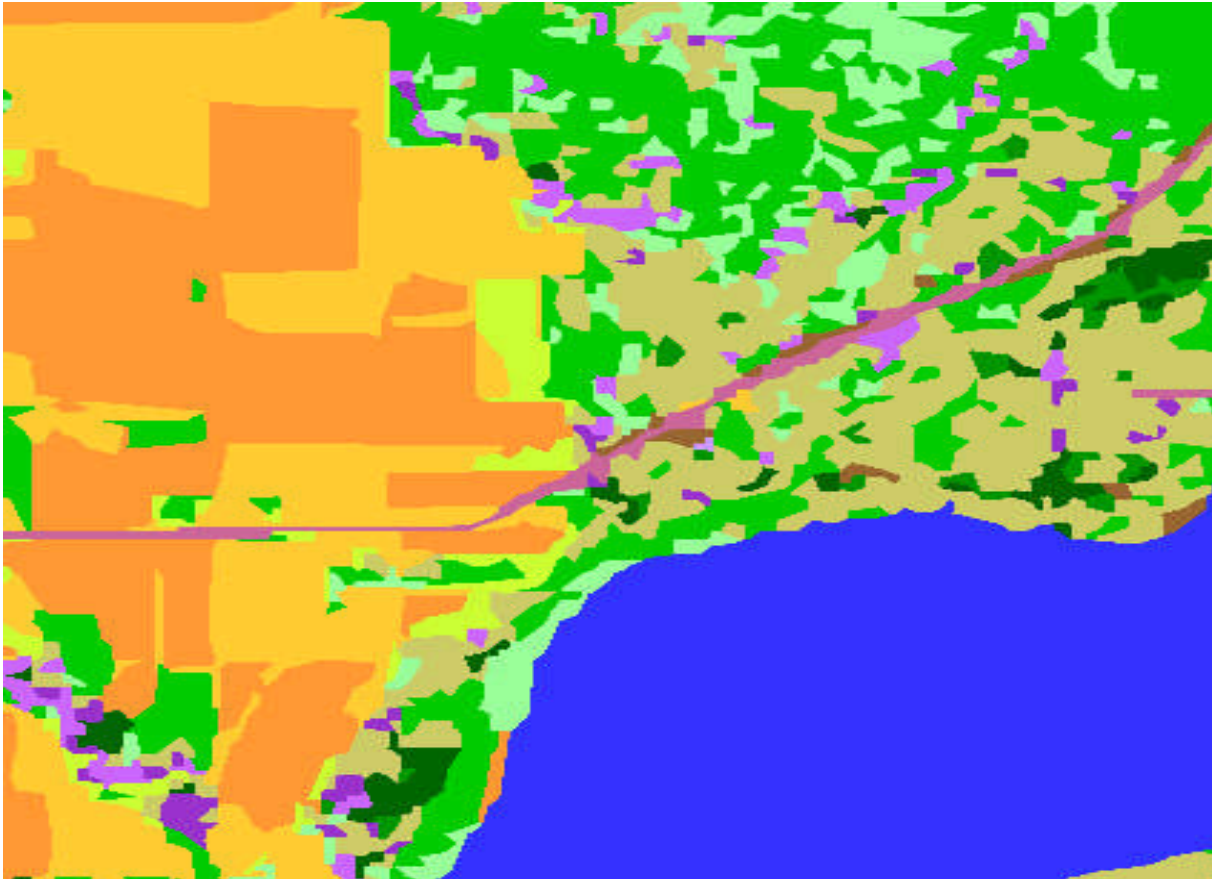


Figure 7 shows a sample Land Cover image in Saskatchewan using the proposed legend. The map centre is 103.84° W, 53.52° N, and the size is 10 km by 5.5 km (not to scale).

Figure 7 Sample Land Cover Image in Saskatchewan



The data will be distributed in 1:250K National Topographic System tiles. The planned data formats will be Shapefile and GML.

As with all GeoBase products, the following key principles will be observed:

- Compatibility with GeoBase Data Alignment Layer (GDAL)
- Adherence to international standards (product specification, classification system, collection metadata, product metadata)
- Data is closest to the source
- Data must be maintained
- National coverage
- No cost and no restriction for users.

The following standards will apply to this product:

- **Data Alignment:** Land Cover mapping has already been aligned using the GeoBase Data Alignment Layer (GDAL).
- **Metadata:** The GeoBase National Land Cover data will be ISO-19115 compliant.
- **Accuracy Assessment:** The Canadian Land Cover Community will continue to work with the international community to develop standards for accuracy assessment.
- **Future Classification Work:** In the future the sectoral Land Cover work will be able to use the LCCS *a priori*.

3. Methodology

The first action that we took when the project started was to draft and agree on a project plan. This plan contained:

- A Work Breakdown Structure which should the scope and the logical structure of the work;
- A strategy for collecting and testing the opinions of stakeholders (to be addressed later);
- Logistics of the questionnaires: transmission, reception and analysis, and also logistics of the discussion groups: invitations, hospitality, venues, recording;
- Schedule;
- Cost estimate;
- Quality management;
- Risk management.

At the beginning of the project, the GeoConnections office pointed us toward two key documents:

- Environics Research Group, 2006. *Survey of Geographic Information Decision Makers*. Prepared for GeoConnections.
- GeoConnections, 2007. *Understanding Users' Needs and User-Centred Design*. www.geoconnections.org

The former document provided findings of a study of users in the four theme areas of GeoConnections:

- Environment and Sustainable Development;
- Aboriginal matters;
- Public safety and security; and
- Public Health.

It was clear from the document that most Land Cover users were in the first theme area, but the project was designed to capture input from users representing all four theme areas.

The second document, “Understanding Users’ Needs and User-Centred Design”, helped us to design our User Needs Assessment (UNA). The document showed the benefits of a UNA: “UNAs increase the chances for success and sustainability of a project. In addition, UNAs help to:

- define the users of, and the demand for, a new product
- ensure that the new product will meet the needs of its intended users
- define, explore and solve users’ problems
- ensure priorities and opportunities are based on user requirements
- ensure accountability in the allocation of public resources.”

The project team agreed that the objectives of this UNA were to:

- Present to end users where we are today with current capabilities and product plans.
- Understand their short term Land Cover needs so that we can optimize product development to respond to the extent feasible within budget and schedule constraints.
- Understand their long term Land Cover needs so that we can plan accordingly within reason.

The project team also agreed on a set of Information Requirements, in other words, what information we really need to get from the UNA exercise. Once the Information Requirements were agreed, they formed the basis for the questionnaire, which is provided in Appendix C⁴. The questionnaire was divided into three main sections:

- Information about the respondent, their use of Land Cover information, current sources of Land Cover data and any shortcomings of those current sources;
- Short term questions about the currently planned Land Cover product, whether it would be useful and comments on its attributes; and
- Long term (meaning 5 – 10 years from now) questions about future Land Cover products.

The short term questions were constrained by the fact that the currently planned product will use existing data. The long term questions were more open, because for the long term we have a “clean sheet of paper”.

The questionnaire was translated by Denis Genest into French.

The strategy behind the UNA was as follows. It was decided not to use a web survey, since programming can be time-consuming, and direct email questions have been found to work well in previous studies. The questionnaire would be emailed to the target audience and asked to reply within 14 days. After 7 days, a reminder email would be sent. The question responses would be analyzed and tabulated.

The questionnaire was sent out to two groups: targeted and untargeted. The targeted groups consisted of:

- Provincial contacts provided by CCOG members
- Agricultural community members
- Forestry community members
- Wetland community members
- Certain key NGOs (such as Ducks Unlimited, Nature Conservancy, Wildlife Habitat Canada)
- The aboriginal community.

⁴ The questionnaire in Appendix C is slightly modified from the version that was sent out. Appendix C contains the Harmonized EOSD-NLWIS Legend in hierarchical format (see Figure 5), whereas the original questionnaire showed the legend without clarifying the hierarchy. This clarification was pointed out to us early in the discussion groups.

The goal was to send the questionnaire to 30 representatives per province.

The untargeted groups consisted of:

- People on the GeoBase mailing list (about 5,000 names)
- Map librarians (CARTA)
- People who respond to a request for Expression of Interest, which was placed on the GeoBase web site.

To reach the aboriginal community, the author made contact with the Executive Director of the National Aboriginal Land Managers Association (NALMA), and she arranged to send the NALMA mailing list to the project team. She also sent a broadcast message to the NALMA members informing them that they would soon receive the questionnaire, and suggesting that it was in their interests to reply to the questionnaire.

To our surprise, it appeared that most respondents were from the untargeted groups. (See the description of the respondents in Section 4.) So the action of sending out the questionnaire to the untargeted groups was definitely worthwhile.

Once the questionnaire replies came in, they were tabulated by Lisa Bowker of the LCCoP secretariat and analyzed by the author. A representative group of respondents were invited to the discussion group meetings by Erin Naydenov of the LCCoP secretariat. It was recognized that some participants in the discussion groups would not be able to travel to the meeting, so arrangements were made for participants to connect by teleconference at no charge. The desired number of participants at the discussion groups was between 8 and 16 (including those on the telephone). Between 22 and 32 people were invited to each discussion group meeting.

The presentation for the discussion groups was drafted; it included statistical analysis of the quantitative answers with a sample of the opinions voiced by respondents. The presentation was translated by Denis Genest.

The objectives of the discussion groups were:

- To inform stakeholders of the status and plans for the GeoBase Land Cover Layer;
- To present the results of the GeoBase Land Cover User Needs Assessment Questionnaire;
- To confirm, correct (if necessary) and flesh out the findings from the questionnaire.

The following seven discussion groups were held:

- Federal departments: Ottawa
- Atlantic provinces: Halifax
- Québec: Québec city
- Ontario: Peterborough
- BC & Yukon: Victoria
- Alberta, NWT & Nunavut: Edmonton

- Manitoba and Saskatchewan: Regina.

The discussion groups were conducted as follows. The author, as facilitator, welcomed the participants. After the introductions, an AAFC representative (Ian Jarvis or Jean-Claude Deguise) gave the opening background presentation. A GeoBase representative (Denis Genest) presented the information about the currently planned GeoBase Land Cover product. The author then presented the findings from the questionnaire regarding the currently planned Land Cover product (short term questions). The participants then wrote down the few most important messages that they wanted to send to the project team. The participants went around the table and announced their important messages. Sometimes there was discussion at this point. Next, the facilitator presented the findings from the long term (open-ended) questions. Again, participants were asked to write down the few most important messages, and again, we went around the table and heard from everyone. After some final discussions, the meeting was adjourned. Lisa Bowker recorded the English language discussion groups (with help from Erin Naydenov in Ottawa and Peterborough) and Yvon Boucher recorded in Québec.

The author then analyzed all of the input from the questionnaires and discussion groups and summarized the findings in this report.

4. The Respondents and Participants

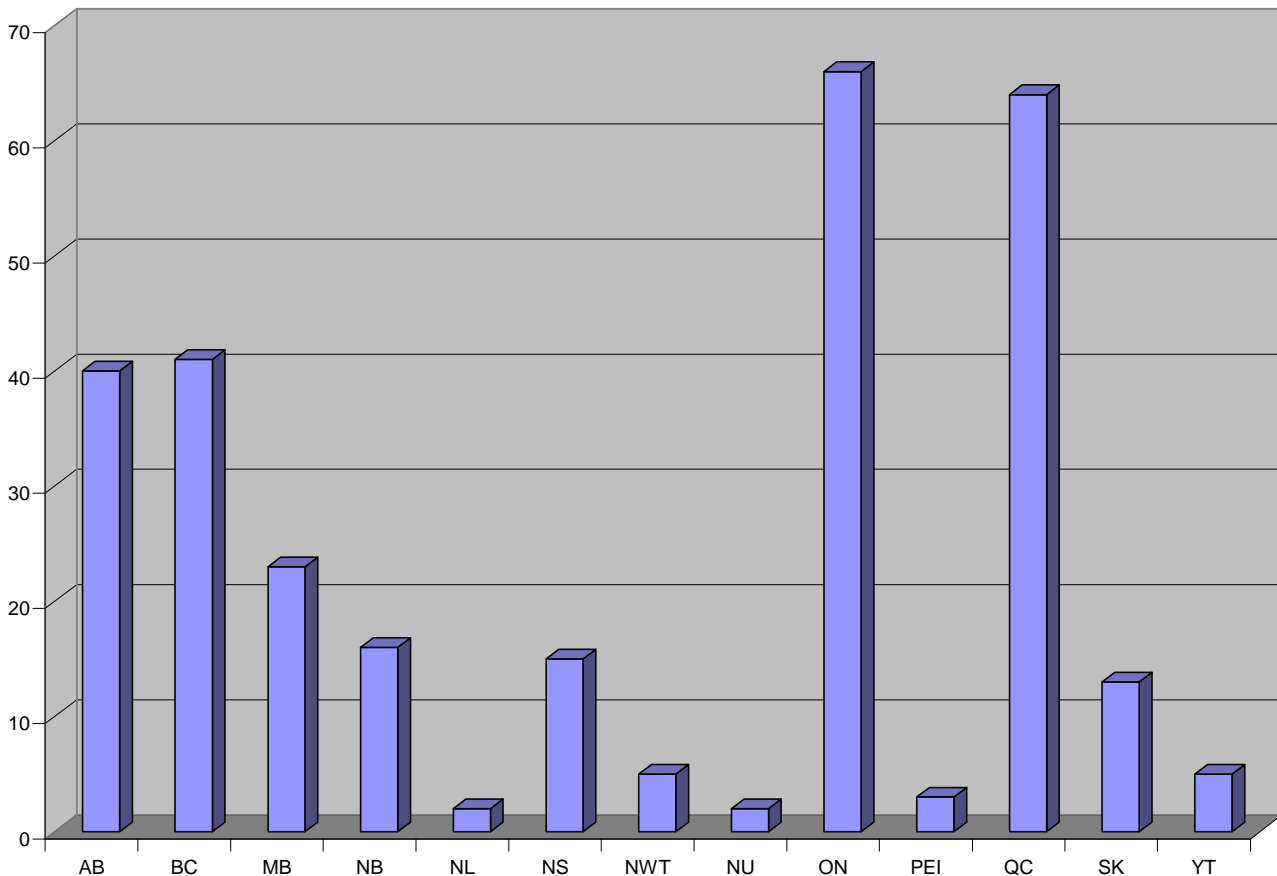
This section discusses the respondents (those who responded to the questionnaire) and the participants at the discussion groups.

Using both the targeted and untargeted approaches (described in Section 3), the project team contacted several categories of stakeholders: federal government, provincial governments, aboriginal communities, NGOs (non-governmental organizations), academia and private service providers.

Three hundred and seventeen questionnaire responses were received, tabulated and analyzed. Twelve ministries of the Saskatchewan government submitted a single coordinated response, so the number of responses can be considered to be higher than 317. This level of response pleased the project team, since it was far above our expectations.

All of the provinces and territories were represented, and the numbers of responses for each are shown in Figure 8. Again, the number of responses from Saskatchewan is misleading, since one response represented 12 ministries of the provincial government.

Figure 8 Numbers of Responses by Province and Territory



There were a few foreign responses (USA: 6, France:2, and one each from Japan and the Czech Republic).

In a few responses, the respondent's location could not be determined from the information provided.

All of the targeted classes of stakeholders (federal government, provincial governments, aboriginal communities, NGOs, academia and private service providers) were represented in the respondents. And all of the GeoConnections themes (Environment and Sustainable Development, Aboriginal matters, Public safety and security and Public Health) were represented in the respondents.

The respondents' applications of Land Cover data varied including conservation & habitat, forestry, education, mining, telecommunications, search and rescue, travel, archeology (!) and others. A few respondents perform medical geography; one of these explained his application as "Landscape Epidemiology: primarily for vector borne diseases, Land Cover can be used to identify the suitability of specific locations to support pathogen, vector and host lifecycle requirements"⁵. A representative of a Medical Transportation Coordination Centre provides "context information for aiding in wayfinding by paramedic field crews."

The geographic areas of interest covered the whole of Canada, and several respondents also do international work.

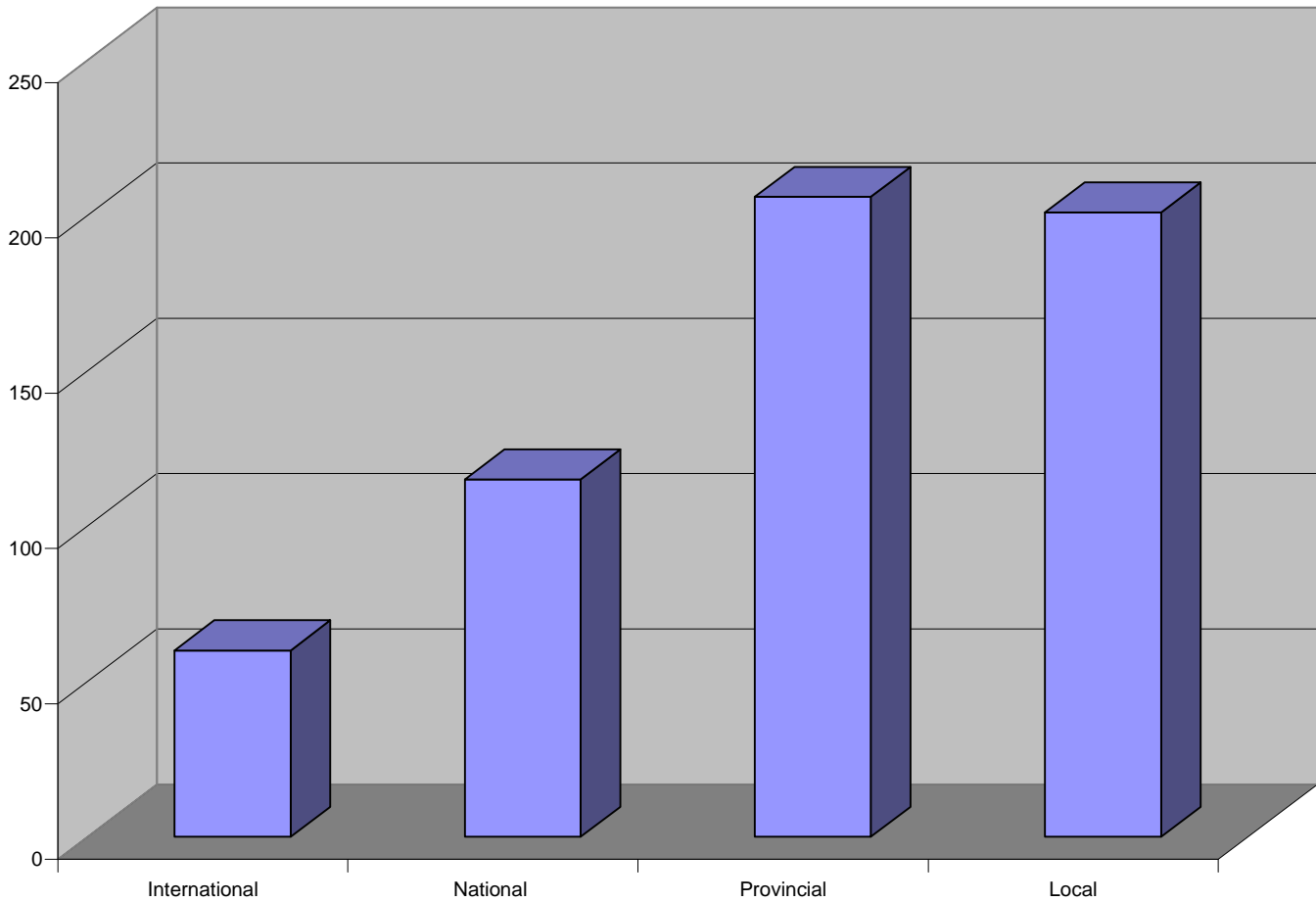
The scales used by the respondents are shown in Figure 9. The 'Provincial' and 'Local' scales were most popular, but some respondents work at 'National' and even 'International' scales.

The respondents currently use various sources of Land Cover data, including aerial photos, USGS, GeoBase, private sources, government web sites, provincial inventories, Google Earth, satellite imagery, EOSD, NLWIS and others. In response to the question about the shortcomings of their present Land Cover data, the replies included:

- Sparse spatial data available north of 51st parallel,
- cost,
- low resolution,
- data inaccuracies,
- not georeferenced,
- lack of harmonization between provinces,
- data too old,
- and others.

⁵ The questionnaire responses have been sampled, with an attempt to accurately reflect the range of responses (without giving 317 responses) and also to maintain the anonymity of each respondent.

Figure 9 The Scales Used by the Respondents



The participants at the seven discussion group represented the whole range of stakeholders (federal government, provincial governments, aboriginal communities, NGOs, academia and private service providers). Attendance at the discussion groups ranged from 6 to 16. In every case, there were free and open exchanges of opinions. Every discussion group addressed some common issues of concern to all (e.g. metadata, the need for high resolution and frequency of update). But each discussion group also brought a fresh outlook and a slightly different perspective. The next two sections examine the findings in detail.

5. Feedback on the Currently Planned Land Cover Product

5.1 Questionnaire responses

Usefulness of the Product

In answer to the question “Would this product be useful to you?”, 80% answered “Yes”, 16% answered “No” and 4% did not answer the question.

Of those who answered that this product would not be useful to them, the overwhelming majority gave the reason that 30 m resolution is too coarse for their application. Some answered “No” because they do not use Land Cover data! A few require data that is more recent than 2000 for their application. A few others found the legend not sufficiently detailed, or not appropriate for their applications.

Resolution or Scale

When asked about the resolution or scale of the currently planned Land Cover product, most people were satisfied, although many would like higher resolution (10 m resolution was mentioned often) if it were available. A few require less resolution (90 m was mentioned).

A thought-provoking reply to the question of scale was the following: “Those products will only be useful for national and perhaps provincial analysis. The resolution and scales are not adequate for regional, local or municipal use. Alignment to provincial vector data will not be consistent and will cause issues. The far north products may be useful above the tree line but southern Ontario, and even within the forested areas in northern Ontario will not benefit very much from the products being generated, with the exception of using the classification as some kind of backdrop/product at a provincial scale.” Despite this view, the project team is aware of regional and municipal uses of the data.

Legend

A sample of replies to the question of legend:

- “Good”
- “As good as it can be given the pixel size”
- “Additional agricultural use classes would be helpful”
- “Incorporate Canadian Forest Fuel types”
- “Require urbanization & populated area classifications”
- “Not fine enough for most uses at the provincial and municipal levels. Need more categories but doubt if that is possible using 30m resolution imagery.”

- “It would be better if the legend was customizable. Would like to be able to group classes or give them different colors, which cannot currently be done with the EOSD classification.”

The consensus appears to be that stakeholders are generally satisfied with the legend.

Compliance with Standards

No-one was opposed to compliance with standards; some were neutral, or unaware of the issue, but most were supportive, and many were strongly supportive. An interesting comment was the following: “Standards are very important; my feeling is that they are few and far between in this sphere however.” Another person said: “We like the NLCD system in USA.” The following comment was insightful: “Do not be a slave to every tag or field possibility but do use established standards as much as is realistically possible.”

Format and Delivery Mechanism

Most comments on the format and delivery mechanism were favourable. Some people suggested a raster format, although Land Cover is already available in raster format through EOSD or NLWIS. One comment was: “I really like the GeoBase concept with freely available Canadian data.” Other suggestions were:

- WFS or WMS,
- GeoTIFF,
- Arcinfo GRID,
- MapInfo compatible,
- “Would prefer the option for a single national file, or at least provincial. I recognize these files will be large but it is preferable to dealing with hundreds of tiles which can be very time consuming.”
- “It would be interesting to be able to send a polygon of our region of interest and have the coverage returned to us by FTP because dealing with image after image, it takes a lot of time to generate a mosaic and prepare the data. Also, raster data is important for us.”

Other Inputs

The following comments were a few of the many important and insightful ones:

- “Make sure that the documentation is available to provide users with a contextual understanding of the product and caveats that must be observed in interpretation or future analysis.”
- “While the 2000 data collection date is better than much of the imagery we are currently working with, it is still somewhat dated. Is there any estimate of how much has changed from data collection date to delivery dates?”
- “‘A project to complete the Land Cover product...’ (Taken from survey outline) This would be very useful, especially the transition from Boreal to Tundra.”
- “Horizontal and vertical integration.”

- “This product would be useful for large-scale temporal studies of Land Cover Change in Alberta. In particular, migration of Ecological Zones from climate change, and change due to large-scale industrial/commercial development.”
- “What are the plans for maintenance?”
- “Rapidly changing landscape in southern Alberta makes 2000 imagery a bit dated.”
- “Need to know projections etc. to be able to do spatial analysis.”
- “Established methodology to report accuracies with an accompanying user’s guide.”
- “Additional classes core urban (close space >30m buildings), dense urban (close space 15-30m buildings), urban commercial/residential (3-15m buildings), suburban (with/without trees 3 to 9m), commercial buildings (3-9 m high), industrial (large area 3m-9m buildings), airports; large asphalt/concrete areas; utility stations (power generation, sewer & water treatment); population density classes.”
- “It would be beneficial if this product could be updated on a regular basis such as in conjunction with the Census of Agriculture (every 5 years) to support the reporting of agricultural sustainability indicators as well as to support the analysis of Land Use change for other reporting purposes.”
- “Thanks for asking for concerns and input; it is very much appreciated.”

5.2 Issues Raised during the Discussion Groups

The following are a sample of the key issues raised during the discussion groups, regarding the currently planned Land Cover Product.

Positive Feedback

“I find it great to finally have Land Cover data available free for everyone. Too bad it took so long. A similar product was available in the US many years ago.”

“In general, it looks like a great product.”

“Significant progress has been made; it is wonderful to see all the cooperation and partnerships. The group should be commended. The User Needs approach is also excellent and typically a neglected element in the past.”

“Land Cover in the context of GeoBase may not fit our particular provincial product needs, but it is important to support a national product.”

“The GeoBase initiative is a fabulous initiative and the effort is commendable.”

“This is an important contribution to the international Land Cover community and plans to complete global Land Cover products.”

General Guidance

“Maintain the focus and intent of product. Keep it to Land Cover and don’t get into Land Use. Keep in mind the scale of the product; it needs consistent scale and product characteristics across the country.”

“What support can the provinces bring in the future?”

“The north is important, but classification in the north is difficult.”

“Specify the target clientele to avoid disappointments.”

“We use mostly vector formats in GeoBase because of the National Topographic Database which is vector based, so that the new products are compatible with the entire heritage that is already there. In addition, future Land Cover products will use different sensors for raw data (i.e. not Landsat). Vector representations are better for sensor independent mapping than raster representations.”

“More focus needs to be applied to make this product useful in an operational sense for the provinces. A national inventory for national needs is good, but may not assist the provinces in getting their jobs done.” “More provincial involvement at every phase. Formal representation on a steering committee.” Related to these views, the discussion groups had a consensus that they would like the LCCoP to expand to include the provinces.

“Consider a Technical Consultation Group to discuss technical problems and solutions.”

“Re-packaging and cross-walking data to a common standard makes good sense. The benefit to me as a user is that it takes the technical burden off the user for working across agricultural and forest zones or jurisdictions.”

Scale

“People talk about scale and resolution. Scale and resolution is no longer a good measure. We use a Minimum Mapping Unit. 30m scale is misleading because the thought is that it would be clearer than can be presented.”

Several people in Atlantic Canada expressed the view that 30 m resolution is marginally useful in that part of the country, because farms and local ecosystems tend to be smaller.

Accuracy

“I am concerned about the accuracy of the data.”

“Accuracy Assessments are required spatially and thematically. The user needs to be able to determine Fitness for Use. The Accuracy Assessment provides the user with a guideline as to what the product can and can’t be used for.”

“Accuracy Assessments are used as a mechanism to report on quality control; the producer must keep on top of how accurate the data is and employ a means of quality control for the analyst providing the data.”

“Quality control and validation of the product. More effort needs to be applied to ensure that the final products are in fact correct and can be integrated with existing high resolution products.”

Consistency

“Concerns about consistency between datasets and even within datasets e.g. EOSD has significant changes occurring around provincial boundaries.”

“Make sure every map for every region is consistent (scale, precision, colours or legend, etc.)”

Hierarchical Legend

“I like the idea of being able to group together certain categories in the legend e.g. all forest into one category. Most maps I make are national-level and are for visual reference (versus analysis), and too much information is harder to deal with.”

“The national vegetation classification system should be taken into account.”

“Standardization is important in the legend. It must be designed such that the user can move to more detail using local data.”

“It will be a useful product for the Watershed Authority. I would hope that harmonization won’t result in loss of categories through lumping, especially agricultural classes.”

Standards

“Proving or establishing compliance with LCCS is very important for the future.”

“Follow as closely as possible the Land Cover standards, either LCCS of FAO or the US NLCD.”

Documentation and Metadata

“The documentation needs to be clear and available so people can understand the source and methods used. There should be two versions: both a condensed version and a complete, detailed version for reference in making future products.”

“Be mindful that the general public will be consumers of this product. Ensure that not only are the metadata ISO compliant (as planned) but also that they are readily findable/accessible on GeoBase and easily comprehended. FAQ (frequently asked questions) is always a good thing.”

“Metadata should describe the class system: who mapped it, what it was, where it is today. Each data class should be clearly defined: what it is, and what it isn’t.”

“Complete metadata are needed and they should include information about the data itself, validation methods (number of points, statistical tests) and the horizontal and vertical integration.”

“There is no need for long metadata. The important points of metadata can be put in an Executive Summary to give easy access to the metadata. Just put the points that belong in the metadata including what was the information digitized from? Overall errors of omission etc can be captured through contingency tables.”

“The boundaries etc should be clickable and the attributes of each polygon should pop up (when the data was collected etc).”

“Definitions of each cover type. E.g. does Pasture/Forage include both native and tame forage?”

“Please convey the appropriate limitations of wetland/deep water bodies identified within the datasets, to help to deter incorrect use of change detection across Canada, and simultaneous Land Use issues e.g. crop and wetland in the prairies. This could be contained in the metadata or in the legend; limitations and strengths must be defined.”

Age of the Data

“The age of the data (circa 2000) is an issue. It’s already 8 years old, so millions of hectares of burns, logging and pine beetle are not represented.”

“The biggest limitation will be the circa 2000. Change information is required to add value to the product.”

Superposition of other Layers

“Do not superpose other databases e.g. roads or hydrology to complete the Land Use mapping.”

In a few discussion groups, the team asked whether the ‘water’ layer should match exactly the water boundaries of the GeoBase Hydrology layer. The consensus appeared to be that it should not, because users are accustomed to taking numerous data sources and finding the best information from among the data sources. The project team felt that there should be no expectation that Land Cover “Water” and GeoBase Hydrology be the same. One is a classification (probability) map of what the satellite sees, while the other is base mapping.

Summary

Not surprisingly, the views were not unanimous. The challenge of the project team is to sift through these comments and make decisions that will suit the largest group of stakeholders and benefit Canada as much as possible.

A summary of both the short term and the long term findings is provided in Section 7.

6. Feedback on Long Term Land Cover Products

A coast-coast-coast orthoimage product is currently being acquired with SPOT data of 10 m resolution. This data may be of use for future Land Cover products. However, it will not be useful for agricultural Land Cover, which requires at least two (cloud-free) acquisitions per year at different times of the growing season. AAFC is currently working on developing annual crop monitoring which may be useful to support future Land Cover initiatives.

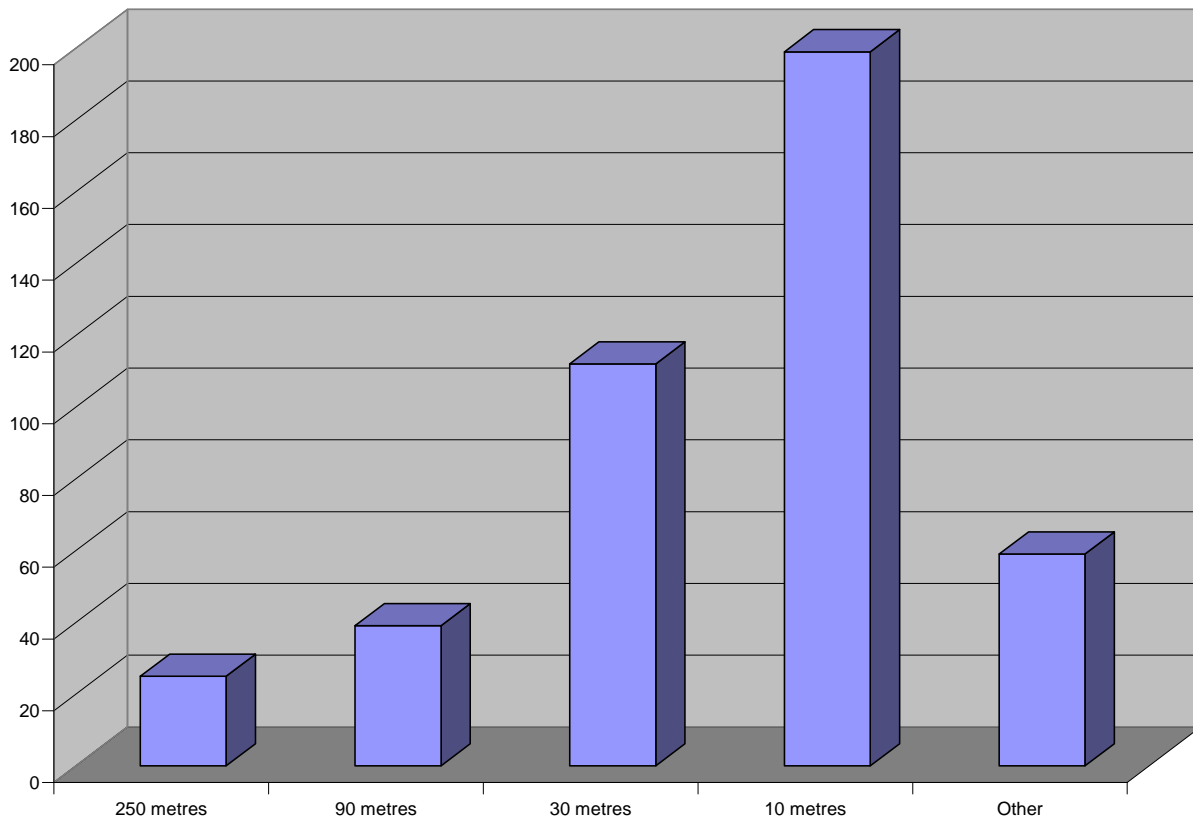
The long term questions are more open, since the project team has a “clean sheet of paper”; i.e. no design decisions have been taken. The project team sought views about such questions as timing, resolution, change monitoring versus wall to wall mapping, legend, etc.

6.1 Questionnaire responses

Future Resolution Needs

The statistics of the answers to the question: “What are your future Land Cover needs in terms of resolution?” are shown in Figure 10. The total number of responses was 434, so

Figure 10 Future Resolution Needs

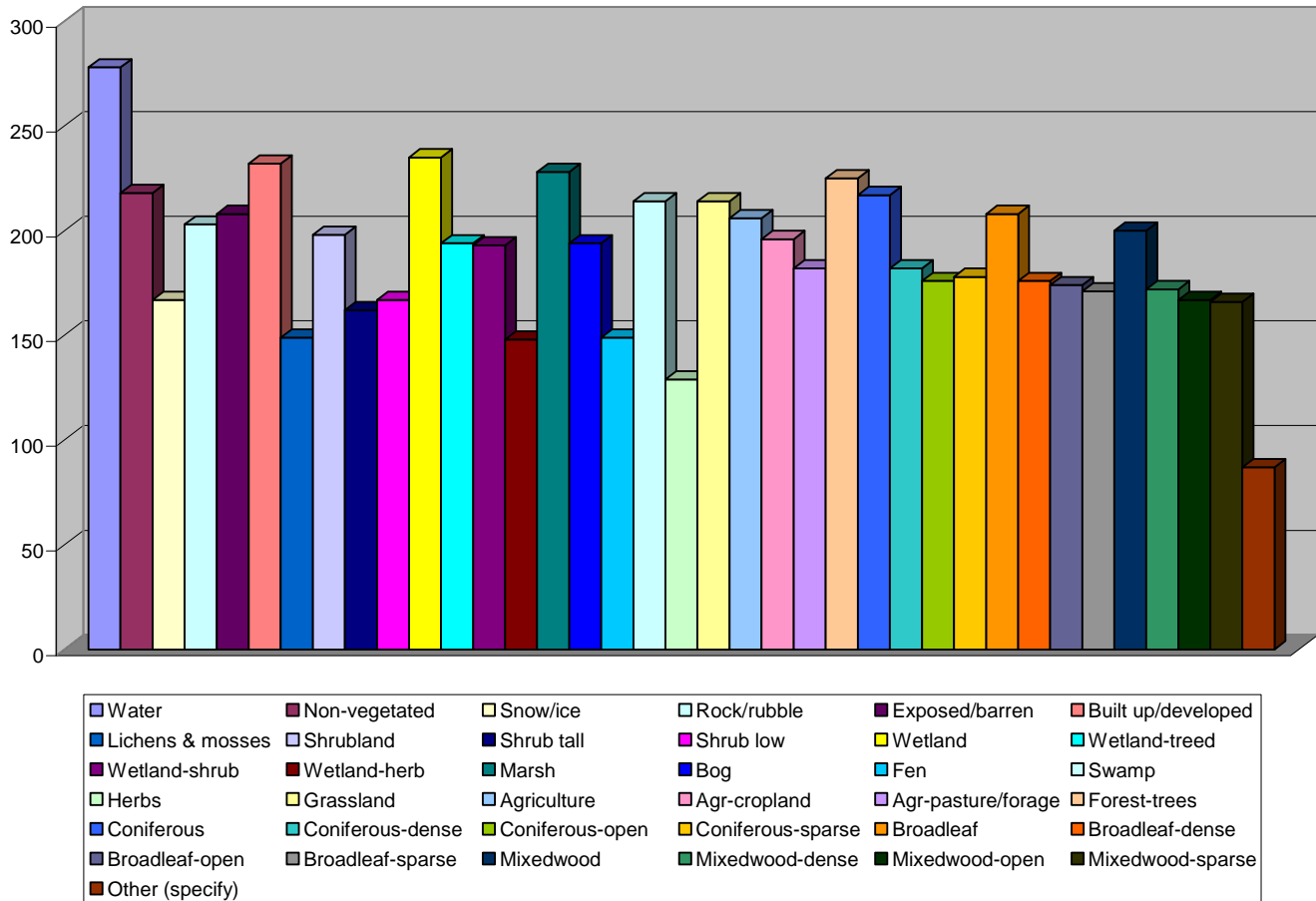


clearly, many respondents answered more than once. The most popular reply was 10 metres, although some people plan to work at resolution values up to 250 metres. The ‘other’ values ranged from 1 to 8 metres, and the average was 2.6 metres.

Classes in the Legend of a Future Land Cover Product

The statistics of the answers to the question about classes in the legend of a future Land Cover product are shown in Figure 11. (The meanings of the bars, starting from the left side, go along the top row of the legend of the figure, then along the second row, etc.).

Figure 11 Classes in the Legend of a Future Land Cover Product



Clearly, ‘Water’ is the most popular class, but no class is really unpopular. The right-most bar represents ‘other’. The suggestions for other classes included:

- “Bryoides”
- “Forest Fires by year”
- “Road”
- “More agriculture lands (refer to USA agriculture land classification) such as cattle farm, dairy farm, hay, forage operation. Urban, residences, industry sites, mining sites, construction sites, etc”
- “Dense urban vs. Light urban”

- “Water classification (running, stagnant, deep, shallow)”
- “A shallow water class would be nice to complete the Canadian Wetland Classification system.”
- “All, but need to distinguish between natural grassland areas and those grazed as part of rangeland. For wetlands, I prefer ‘bog’, ‘fen’ etc rather than ‘wetland shrub’ although this will require ecologists to interpret rather than just image classification. Would prefer some indication of forest age which would mean cross checking with provincial forest cover.”

The project team believes that ‘bryoides’ are synonymous with ‘lichens and mosses’. The comment about urban classes is interesting, as are the comments about water. The last comment is insightful too.

Suggested Standards

The suggested standards included the following:

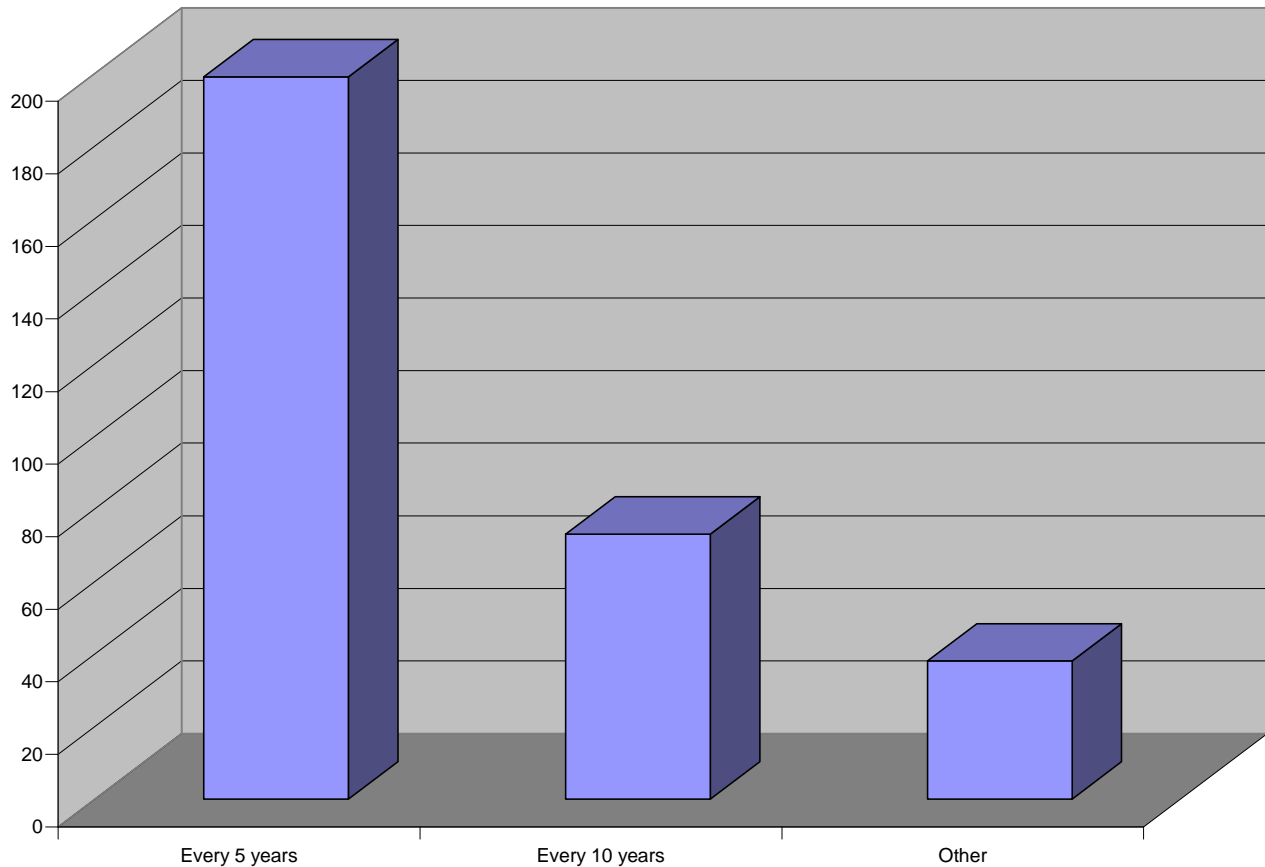
- “The classification system should fit into a recognized classification system, such as the US or Canadian National Vegetation Classification and the Canadian Wetland Classification System.”
- “Georeferenced mapping, similar to GeoBase”
- “GeoConnections CGDI”
- “ISO TC 211; US FGDC; OGC.”
- “ISO”
- “As many as possible. While I am not familiar with Land Cover standards, keeping standards compliance is of great importance, especially when data from multiple sources will be combined in one use. At best, try not to create classes which straddle multiple classes in the usual standards.”
- “Current Standards ok”
- “How about a common standard that includes metadata.”

Suggested Update Frequency

The statistics of the responses to the question “To show changes in Land Cover, how often should the Land Cover coverage of Canada be updated?” are shown in Figure 12. The most popular answer was 5 years. Some suggestions by those who answered ‘other’ include:

- “Would it be possible to select a year or an interval. Some of the municipal sites offer orthophotos from different years and it can be very useful to select coverages at different times to note changes in habitat.”
- “Every 2 years” (repeated by a few respondents)
- “Depends on what is being monitored! Pick 5 years to keep products current and relevant. Most forested areas could be every 10 years.”
- “As often as possible for operational use”
- “Yearly or every 2 years for urban areas”
- “5 years suburban, 10 years rural.”

Figure 12 Suggested Update Frequency

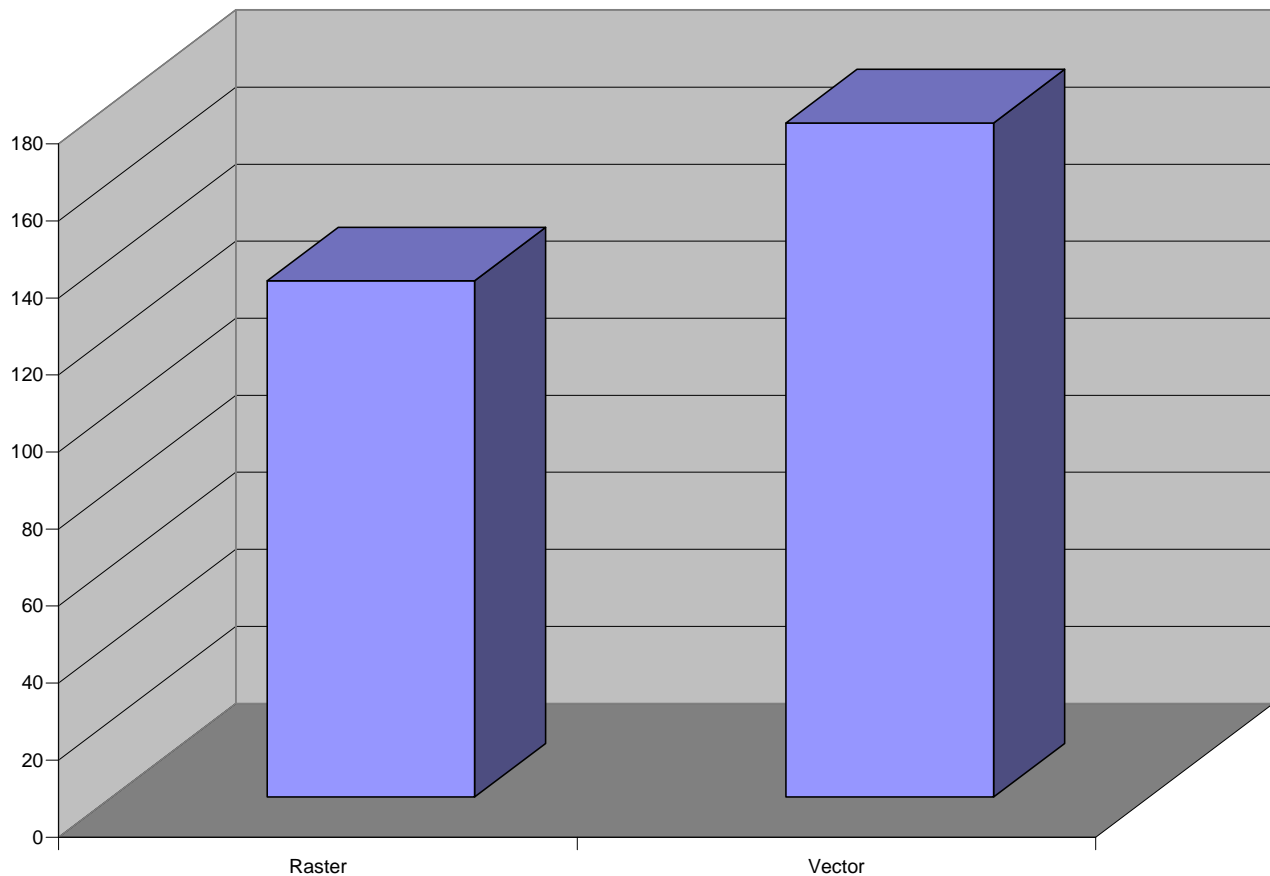


The third suggestion (‘depends on what is being monitored’) seems astute. Recent experience of gathering appropriate satellite data indicates that it takes 3 - 5 years to collect cloud-free imagery of the whole of Canada. So taking a ‘snapshot’ every year appears to be a non-starter.

Preference to Raster or Vector Form

The statistics of the responses to the question “Would you prefer that future products be in vector or raster form?” are shown in Figure 13. There were more people who preferred Vector, but not by a wide margin. The Raster supporters form a substantial proportion of the Land Cover community too.

Figure 13 Preference for Vector or Raster Form

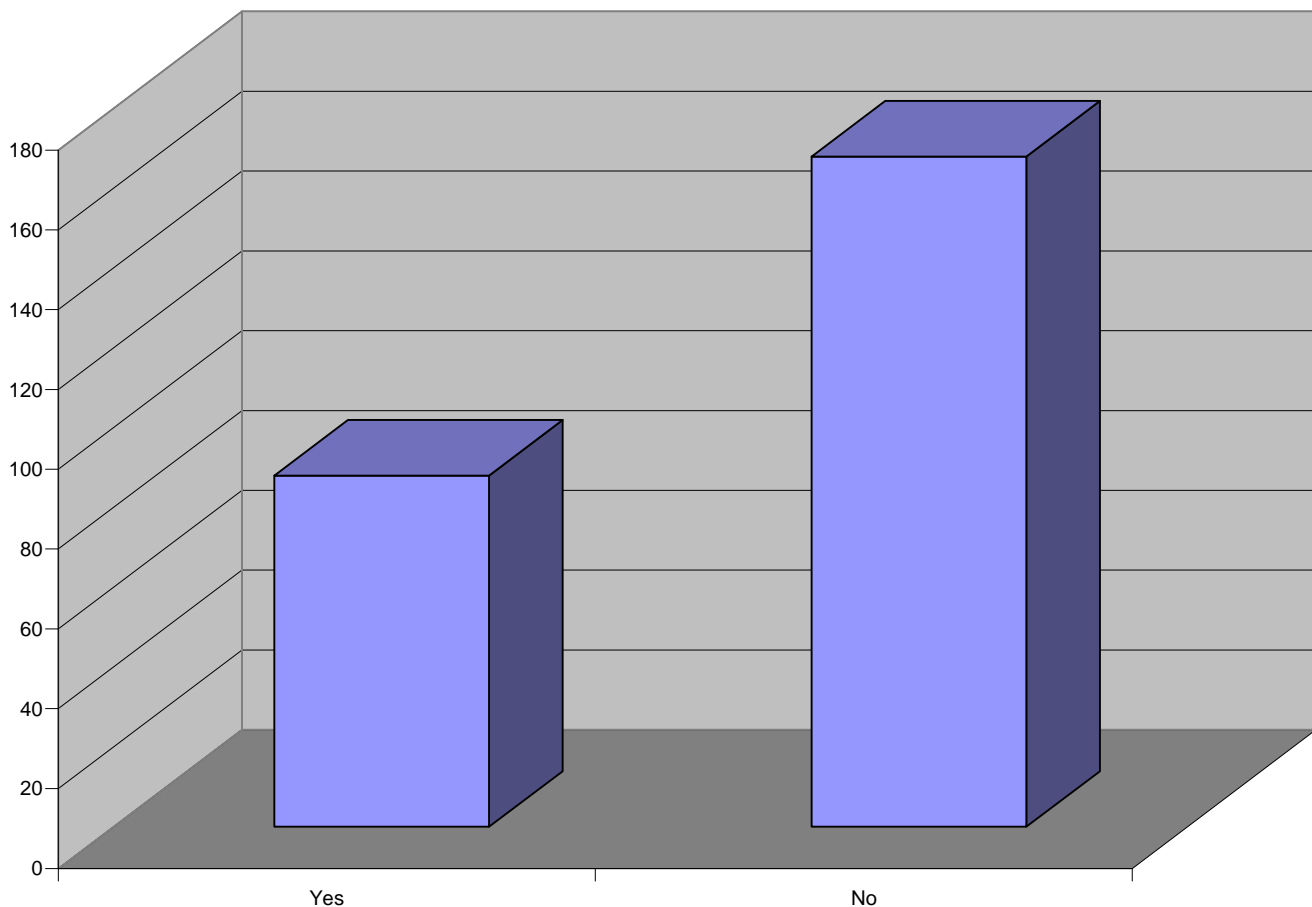


Delivery Format

The statistics of the responses to the question “Do you need delivery of future Land Cover products in a format other than Shapefile or GML?” are shown in Figure 14. Most respondents were satisfied with Shapefile and GML. Some of the suggestions for other formats were:

- “KML”
- “How about a georeferenced image/raster (i.e. geotif or pix)?”
- “I believe LandXML would be a worthwhile consideration. Besides elevation data, it also contains alignment and parcel data.”
- “GEOTIFF” (suggested by a few respondents)
- “Something that can be imported/read to Matlab”
- “jpg, bmp”
- “grid file”
- “Shapefile and Mr Sid”
- “BSQ, BIL, BIP, PIX – any raster format.”

Figure 14 Delivery of Future Land Cover Products in a Format other than Shapefile or GML?



Other Inputs

A sample of the many important and insightful additional comments follows:

- “I think there are different needs for rural Land Cover and Land Cover in urban areas which should be focused on a different set of categories, at better resolution and be updated on a more frequent basis. This would have benefits for urban planning exercises.”
- “I would suggest that a focus should be placed on existing high resolution data, NB, PEI, and NS all have complete forest inventory mapping at high resolution – the forest data for these layers could be used. These datasets have a cleared lands layer from which agricultural classification could be developed. It would be more advantageous to have higher resolution coverage in areas of high activity than lower resolution data over all areas.”
- “An impervious attribute would be nice.”
- “I think this would be a great dataset, I wish you well!”
- “Biomass would be useful and structural elements of forest cover: density, height, closure, etc.)”

- “Tiles scheduled for Land Cover updates may be better served by dividing the nation into frequently updated areas with high populations and critical areas of interest, and less frequently updated areas such as the north where less and slower change is normally expected. However, these (less frequently updated) areas could be modified as issues arise such as melting of ice sheets or logging areas are of interest.”
- “The challenge I have comes with pulling layers from different sources and then bringing this together in one or a series of maps.”
- “The coarse Land Cover proposed may not correlate to NB’s finer resolution coverage.”
- “Great Initiative!!! Gosh, I sure could have used a data source like this over my 14 years of 3D landscape simulations!! Cannot count the number of times I have made up 10-30 meter resolution data of an area just to get something on the land!!”
- “I am very interested in your initiatives in Northern lands. Keep me informed.”
- “Needs to be updated otherwise policy will be based on old and outdated information resulting in poor decisions.”

6.2 Issues Raised during the Discussion Groups

The following are a sample of the key issues raised during the discussion groups, regarding the long term planning for Land Cover Products.

Land Cover Mapping versus Land Cover Monitoring versus Change Detection

“Consider making this a Land Cover Monitoring product similar to NLCD.”

“Make a clear distinction between Change Detection and Monitoring; they are different animals. Monitoring is sample based finite measuring that we can extrapolate across broader situations, whereas in Change Detection, we are not just dealing with a pixel over time, but we also have to validate that something has changed from class a to class b. Is it really feasible even at 10 m resolution? There are many pitfalls and opportunities for errors and misinterpretation of results.”

“It should be comparable to older versions to allow for change detection analysis.”

“Can Land Cover data be used to monitor terrain change in the permafrost terrain?”

“Must be backward and forward compatible.”

“We need a clear vision of how this product would support monitoring efforts in Canada. What specific features are we monitoring?”

“Updated Land Cover product versus Land Cover change map: which is more useful? A Land Cover change map is less expensive and time-consuming, but more limited in its use.”

“Is it a monitoring product? If so, an update is not a re-mapping.”

“Design the product from the start as a multi-temporal monitoring product.”

“It is important to keep historical datasets; we should not replace an old product by the update, rather we should offer a new product and keep the old product too. For monitoring, it is important to have access to older methods and data.”

“Keep this as a basic, fundamental data layer that can be combined, analyzed or modeled with other data layers to generate derivative products.”

Hierarchical Legend

“With the hierarchical classification, it should go from very coarse down to a very fine scale (species). This would break down to site level and would allow for more accurate rolling up to larger classifications; we could take it down to vegetative species at the most specific and Land/Water at the most general. Like the Anderson model in the US. The agricultural classes should be expanded. The rest of the classes should be based on the Ecological Land Classification (ELC).”

“Don’t lose the history. If classification types evolve (e.g. one existing class is split into 2-3 new ones), retain cross reference tables and ensure this is documented.”

“Better granularity on agriculture cover types – differentiate crop types.”

“Detailed grassland legend – and really distinguish all natural vegetation types from altered landscape.”

“Wetland classes should be included as proposed by the Canadian Wetland Inventory (CWI). However, the CWI should probably be a separate layer as part of the National Hydrographic Network.”

“The future classification system would need to include a class for pine to be useful to Saskatchewan FMFP (Fire Management & Forest Protection) Branch. The ability to acquire imagery and conduct a classified supervision is not as onerous as it once was. If pine was not included in the future Land Cover classification SK FMFP would continue developing its own imagery based forest cover data. There are significantly different fire behavior characteristics between stand characteristics of these two genus (fuel types).”

“Specialized classes should be reserved for specialized products. The more classes, the more groundtruthing required. Sponsor specialized inventories where required due to special interest, changes, local government needs, etc.”

“Improvements to legend and Land Cover types need to be nested to allow historical or trend analysis.”

“For fire behaviour prediction, more data in the classification (e.g. tree species, understory, soil moisture) would be more useful than increased resolution.”

“The classification method changes according to the image resolution. When you change the resolution, a lot changes.”

“Caution: moving to higher resolution will require changes in classification methodology. Spatially, 10 m and 30 m are very different. Spectrally, 4 band SPOT is different than 6 band Landsat.”

“Define a piece of land and only apply one title because things like Permafrost can be placed over many categories. Ephemeral water is temporary.”

Resolution

“Better resolution i.e. 10m.”

“Increase resolution while ensuring compatibility with the circa 2000 product.”

“There will always be a need for regional or local data set.”

“From our perspective, enhanced resolution is likely more important than a more frequent revision cycle and more recent dates of imagery.”

“30 m resolution is a limitation and a finer resolution (of 10 m?) would be better. Recommend a finer resolution be developed if possible and in conjunction develop additional products or tools to upscale this data for users whose need is for smaller scale information.”

“Resist the temptation to produce a higher resolution product, unless it is as affordable as the current product.”

“Introduce the concept of variable resolution:

- Spatially: higher resolution for active areas;
- Temporally: greater frequency for active areas.”

“This is a national product. It should have consistent attributes (resolution etc) across Canada.”

“For the region north of 51^o: consultation with a broad range of users and data developers to capture the current, historic and changing landscape properties i.e. permafrost and organic landscapes.

Update Frequency

“The duration interval is dependent on the change of the feature that is being observed i.e. urban change requires greater frequency than old growth forest.”

“Look at a low-resolution, high-frequency product (MODIS/MERIS) to determine change and the need for update.”

“Update information on a basis that is practical for the scale. I like the idea of updating more intensively used or areas prone to rapid Land Cover change (eg. urban/rural boundary, agricultural area, agriculture/forest fringe etc) more frequently. A 5 year update for these areas would suit many purposes and may be realistic. A 10 year update for other areas which are slower to change may be appropriate.”

“Updates every 5 years would be able to coincide with the agricultural census and the population census of Statistics Canada, and allow time for standards and partnerships.”

“Resolution and frequency depend on use. Does anyone need 10 m resolution of the Ellesmere Ice Cap? Coarse resolution and high frequency (e.g. annual MODIS or MERIS or VGT) would be great.”

“The update frequency should depend on highly dynamic areas. Some areas of the North are becoming highly dynamic areas and may need frequent updates.”

“Frequency – Every five years and link to agricultural census years e.g., 2001, 2006.”

“Our community needs to put pressure on the government to maintain and update the product on a regular basis.”

“Updating in accordance with the national census could be part of a National Monitoring Strategy.”

“Update at 250 metres monthly, at 30 metres every 5 years, at 10 metres every 10 years. Coarse resolution can guide you as to where to do updates.”

Program Management

“A fed-prov technical steering group is required.”

“Integrate this initiative with the National Forest Inventory.”

“Assess ‘Lessons Learned’ from past national and provincial Land Cover initiatives.”

“The ability for regional, provincial and possibly local Land Cover initiatives to contribute should be considered in updating the long term product.”

“If you build it, they will come. However it needs to be a living, evolving product to meet needs of the future and to take advantage of developing technologies.”

“There will be issues with the disparity between a coarse National data set and updated high resolution regional data set; how can we resolve these? Google Earth is rapidly developing as a carrier for data; some investigation should be done to see where we should be heading in relation to that.”

“Should have articulation of a product/implementation vision. Will NRCan-CTI be leading the collection and processing of source data, production and dissemination? Or will standards be developed from data collection upwards to enable synergy in disparate production?”

“We need clarity in trade-offs that lead to the development of the future Land Cover product. With EOSD, CFS showed clearly what the trade-offs were and how we arrived at certain decisions. People respond favourably to this clarity and transparency. More transparency leads to more confidence in the integrity of the decisions along the way for accuracy and valid results.”

“Avoid trying to answer too many objectives: different update frequencies, different scales, etc make the project too heavy and difficult to realize.”

“Utilize existing provincial data sources e.g. provincial forest inventory (NS), Forest and Agland (PEI).”

“In order to stick to the GeoBase principle of ‘maintenance closest to source’, there has to alignment to provincial maintenance programs.”

“There should be a long term Information Management Strategy, covering consultation, development, production, maintenance and update.”

“Keep NALMA informed of the status of the project so that we can keep our regional land associations updated.”

“Training of users is needed in the use of the product.”

“Potential for integration with other GeoBase layers like roads and buildings. All of this falls under the heading of Thematic Consistency.”

“Bright future: GeoBase will be the cornerstone of authoritative information for Canada.”

Quality Management

“The more ground truthing/verification, the better.”

“It is very important that the product be accurate, and the accuracy known in quantitative terms by class.”

“Beware: spatial filtering of data results in loss of information e.g. riparian areas being filtered out. Perhaps two different products (filtered and unfiltered) should be available.”

“Will be there be sample ground truthed verifications– esp. in provinces where there is finer resolution data available such as NS.”

“Adherence to national and international evolving methods and standards.”

Level of Integration

In a few discussion groups, the participants were asked whether they would prefer to receive multiple layers of raw information or to get an integrated product where the layers of raw data had been combined by the producer. The consensus was that users would like both. More expert users would use the raw data to recreate maps in more specific ways. Less expert users would need to have the integration done for them, but they would need to know how the integration had been done i.e. how the product can and cannot be used.

Raster versus Vector

“Make a raster version available in addition to the vector version, or provide sufficient technical details to allow users to use raster sources in place of the vector product. (There may be issues related to GDAL.)”

“I agree with the result showing more interest in a vector product, as future data will very likely not be only Landsat based, particularly during the gap at the end of the decade.”

“With regard to the view that vectorization allows for sensor independence, NLCD requires raster for the 2006 version and future updates, to be able to produce the change mask. Sounds like they’ve come up with solutions we should consider.”

“Strengthen the accuracy assessment aspects and results so users can correctly qualify the conclusions they arrive at when using the data.”

“Raster format is more practical for spatial analysis.”

Delivery Format

“WMS is interesting for users.”

“Regarding format, KML is a good idea, and so is GeoTIFF.”

Summary

Again, the views were not unanimous. For example, there was support for the concept of variable resolution, both in space and time. Others felt that the product attributes must be consistent across Canada. Regarding spatial resolution, there may not be a contradiction. The product is issued at a consistent resolution across Canada to support modeling, analysis and macroscopic studies, but a higher resolution version can also be issued for regions where it is justified.

A summary of both the short term and the long term findings is provided in the next section.

7. Conclusions and Recommendations

The value of the questionnaire responses and discussion groups is certainly evident from the sample of views. This User Needs Assessment will provide valuable input to the GeoBase data producers and the LCCoP.

But the user consultations should not end now. The perspectives of users change with time, technology, economic conditions, experience with products from both governments and commercial sources, and development of new standards and methods. Also the views collected depend on the sample of stakeholders who participated. Care was taken in this project to collect views from a wide and representative sample, but each time a new group of stakeholders comes together, the ensuing findings will be somewhat different. Therefore, a strategy of on-going or repeated consultations at an appropriate frequency should be followed. Expansion of the LCCoP to include provincial governments could be a useful part of this strategy, and the time appears to be ripe for doing so.

In addition, the suggestion of creating a technical consultation group was also made. GeoConnections has had success with its CGDI (Canadian Geospatial Data Infrastructure) Development Network (see www.geoconnections.org/en/communities/developers/index.html). The GeoBase program might consider a similar approach. Such a technical consultation group should be considered as well as, not instead of, user consultations.

A summary of the major findings follows.

1. The level of interest in the currently planned GeoBase Land Cover product is high, and the product can benefit a large number of users.
2. The GeoBase principles, program and products are appreciated. At the same time, continuing coordination with the provinces is required to integrate datasets and conduct validation and maintenance.
3. The Northern Land Cover product is important and stakeholders are waiting for it. However, Land Cover classification in the North has been found to be challenging.
4. Users are concerned about consistency, accuracy and other aspects of product quality.
5. Product documentation and metadata are important; they should tell users about the data sources, class definitions, accuracies, and how the product can and cannot be used.
6. Users do not want the other GeoBase layers superposed on the Land Cover product. Nor do they want the water layer in the Land Cover product to match exactly the water boundaries of the National Hydrology Layer.
7. The question of whether future Land Cover products should re-map Land Cover, monitor Land Cover or show change detection remains unclear to the author.

- Now that the users' views have been collected, the Product Definition team should study this question, and clearly document their approach with rationale.
8. When participants were asked whether they would prefer to receive multiple layers of raw information or to get an integrated product where the layers of raw data had been combined by the producer, the consensus was that users would like both. More expert users would use the raw data to recreate maps in more specific ways. Less expert users would need to have the integration done for them, but they would need to know how the integration had been done i.e. how the product can and cannot be used.

The key recommendations follow.

1. Efforts should continue to issue the product with the currently planned resolution, legend and other attributes.
2. The Northern Land Cover product should be developed as planned.
3. Consideration should be given to adding the following delivery formats for the currently planned Land Cover product and future updates: WMS, WFS, KML and GeoTIFF.
4. A strategy of on-going or repeated consultations at an appropriate frequency should be followed. Expansion of the LCCoP to include provincial governments could be a useful part of this strategy.
5. Establishment of a technical consultation group should be considered, perhaps through the LCCoP.
6. Coordination with the provinces should be continued to integrate datasets and conduct validation and maintenance.
7. Quality assurance should be pursued through assurance of consistency, assessment of accuracy by class, compliance with standards, and other means.
8. Consideration should be given to a higher resolution product in future (approximately 10 m), recognizing that the classification methods and sensor data will change, and forward and backward compatibility must be assured.
9. Consideration should be given to a standard, national, hierarchical, multi-level Land Classification System that spans very coarse scale Land Cover, through to Land Use, and down to the very detailed ecological classification level.
10. Consideration should be given to making wetland classes consistent with the Canadian Wetland Classification system.
11. Consideration should be given to a more detailed agricultural Land Use classification.
12. Future Land Cover initiatives should study the question of whether new Land Cover products should re-map Land Cover or monitor Land Cover change. The approach selected should be clearly documented with rationale.
13. Regarding the timing of updates, consideration should be given to harmonizing the Land Cover product updates to the agricultural census and population census of Statistics Canada. The cost effectiveness of this approach should be compared to the approach of updating frequently changing areas more often than areas that change more slowly.

14. Consideration should be given to delivering future Land Cover products in both vector and raster format.
15. Consideration should be given to producing a low resolution Land Cover product very frequently, perhaps annually, to detect change areas.
16. Consideration should be given to creating a National Monitoring Strategy to provide a framework for monitoring at all levels of government in Canada.
17. As it is not possible to create a product to serve all needs, the project team must clearly identify the intended use of the GeoBase product, so it is clear to users what the product is intended to provide.

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Appendix A – Key Web Sites

CGDI Development Network web site:

www.geoconnections.org/en/communities/developers/index.html

EOSD web site: www.pfc.forestry.ca/EOSD/index_e.html

FAO LCCS document:

www.fao.org/icatalog/search/dett.asp?aries_id=106397&ch_lang=en

GeoBase web site: www.geobase.ca

GeoConnections web site: www.geoconnections.org/en/index.html

IACG web site: www.iacg-cmoig.org/home/about_e.php

NLCD web site: www.epa.gov/mrlc/nlcd.html

NLWIS web site: www.agr.gc.ca/nlwis/index_e.cfm

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Appendix C – Questionnaire

GeoBase Land Cover Layer Questionnaire

- GeoBase is a federal, provincial and territorial government initiative that provides users with access to quality geospatial information at no cost and with unrestricted use.
- The GeoBase Steering Committee has identified Land Cover data as a new high priority theme to be developed and managed in GeoBase.
- GeoBase and the [Land Cover Community of Practice](#) have embarked on the National Land Cover Data project, whose main objective is to integrate Land Cover mapping from provincial and federal organizations and to produce a harmonized data base that is consistent with international standards, in order to meet the broadest range of user needs.
- The National Land Cover Project plans to integrate existing Land Cover information compiled by Natural Resources Canada's Canadian Forest Service and Agriculture and Agri-Food Canada into a single product for Canadians.
- We would like to have your comments on the usefulness of the currently planned product. And we want to understand your long term Land Cover information needs so that we can plan for future products.
- We sincerely wish to respond to needs of Canadian users to the extent possible within the project constraints.
- The questionnaire will take approximately 20 minutes to complete.
- Your participation is greatly appreciated. It will help us to improve the product.

Respondent's Profile

Name _____
Title _____
Organization _____
Phone _____
E-mail _____

Section A. Your Use of Land Cover Data

1. What is your main application and need for Land Cover data?

2. What is your geographic area of interest?

3. What scale do you work at?

International ____ National ____ Provincial ____ Local ____

4. What are your current sources of Land Cover data? Do the current sources have any shortcomings (quality, price, etc)? If so, please describe them.

Section B. The Currently Planned Product

The currently planned Land Cover product is the result of raster thematic data originating from classified Landsat 7 or 5 ortho-images, for agricultural and forest areas of Canada. Satellite imagery was acquired circa 2000. The forest cover was produced by the Earth Observation for Sustainable Development (EOSD) project, an initiative of the Canadian Forest Service (CFS) with the collaboration of the Canadian Space Agency and in partnership with the provincial and territorial governments. The agricultural coverage is being compiled by the National Land and Water Information Service (NLWIS) of Agriculture and Agri-Food Canada with the incorporation of provincial initiatives.

The legends of the two products are being harmonized to allow for the compilation of a single coverage of Canada. The intent is to preserve as much thematic class detail as possible. A pixel resolution of 30 metres, which corresponds to a scale of 1:50K, is proposed for the product. The initial source data for the Land Cover theme will be converted to vector format in order to be geometrically adjusted with the GeoBase Data Alignment Layer. Figure 1 shows a proposed EOSD-NLWIS harmonized legend. Figure 2 shows a sample Land Cover image using this legend.

A project to complete the Land Cover product for northern Canada (north of the forested and agricultural zones) is under discussion.

The data will be distributed in 1:250K National Topographic System tiles. The data formats will be Shapefile and GML.

5. Would this product be useful to you? Yes _____ No _____

6. What comments do you have about this product in terms of:

- a. Resolution or scale? _____
- b. Classification legend? _____
- c. Compliance with standards? _____
- d. Format and delivery mechanism? _____
- e. Other? _____

Section C. Your Needs for Future (5 – 10 years from now) Land Cover Products

7. What are your future Land Cover needs in terms of resolution?

250 metres ___ 90 metres ___ 30 metres ___ 10 metres ___ other ___

8. Please write 'X' to indicate the classes that you would like to see in the legend of a future Land Cover product.

Water _____	Non-Vegetated Land _____	Snow/Ice _____
Rock/Rubble _____	Exposed/Barren Land _____	Built up/Developed _____
Lichens & Mosses _____	Shrubland _____	Shrub Tall _____

Shrub Low _____	Wetland _____	Wetland-Treed _____
Wetland-Shrub _____	Wetland-Herb _____	Marsh _____
Bog _____	Fen _____	Swamp _____
Herbs _____	Grassland _____	Agriculture _____
Agr-Cropland _____	Agr-Pasture/Forage _____	Forest/Trees _____
Coniferous _____	Coniferous-Dense _____	Coniferous-Open _____
Coniferous-Sparse _____	Broadleaf _____	Broadleaf-Dense _____
Broadleaf-Open _____	Broadleaf-Sparse _____	Mixedwood _____
Mixedwood-Dense _____	Mixedwood-Open _____	Mixedwood-Sparse _____
Other (Please specify)		

9. What standards, if any, do you think a future product should comply with?

10. To show changes in Land Cover, how often should the Land Cover coverage of Canada be updated?

Every 5 years _____ Every 10 years _____ Other _____

11. Would you prefer that future products be in vector or raster form?

Raster _____ Vector _____

12. Do you need delivery of future Land Cover products in a format other than Shapefile or GML? Yes _____ No _____ If yes, please specify the format(s)

13. Do you have any additional views about the future Land Cover data layer that you would like to share?

14. Is there anyone else from your organization or in other organizations to whom you think we should speak? Yes _____ No _____ If so, who?

Thank you for your time and contribution to this study. It will help us to improve the product.

This project is financially supported by GeoConnections, a national program initiative led by Natural Resources Canada. GeoConnections and its program participants are working to enhance the Canadian Geospatial Data Infrastructure, an online resource that enables decision-makers to assess, combine, and apply geographic information to gain new insights into social, environmental and economic issues.

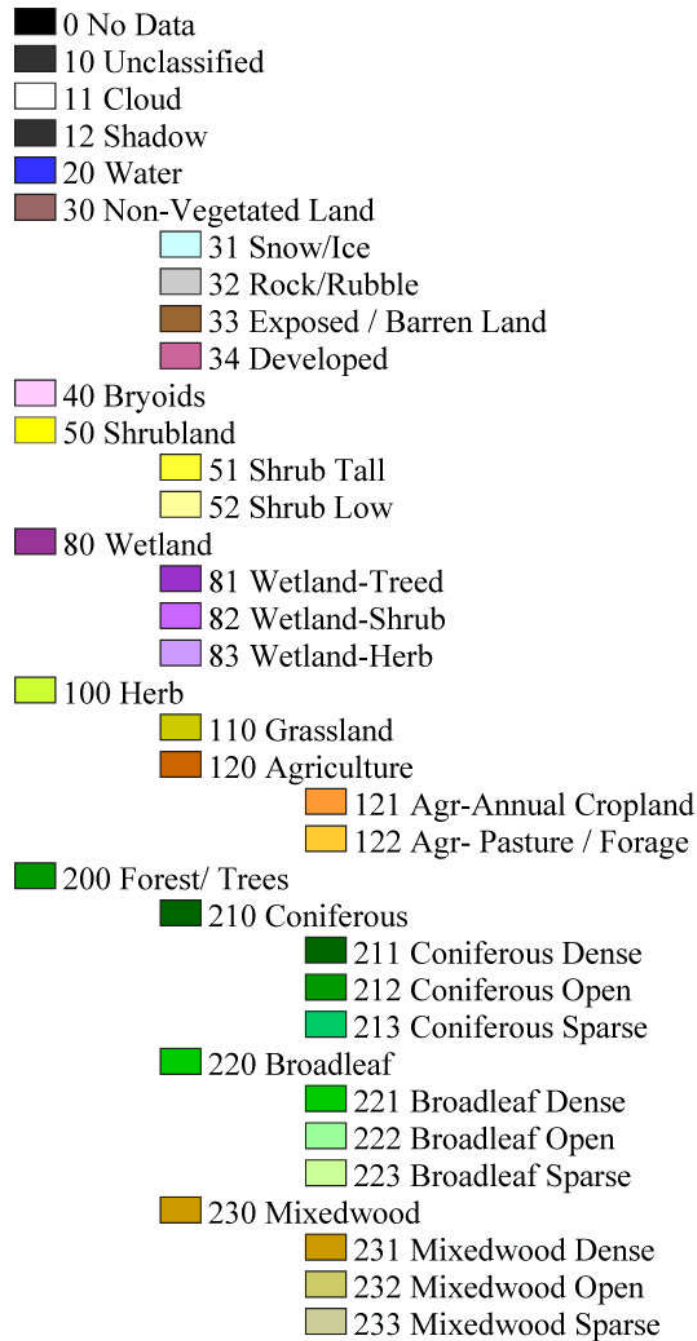


Figure 1 EOSD-NLWIS Harmonized Legend

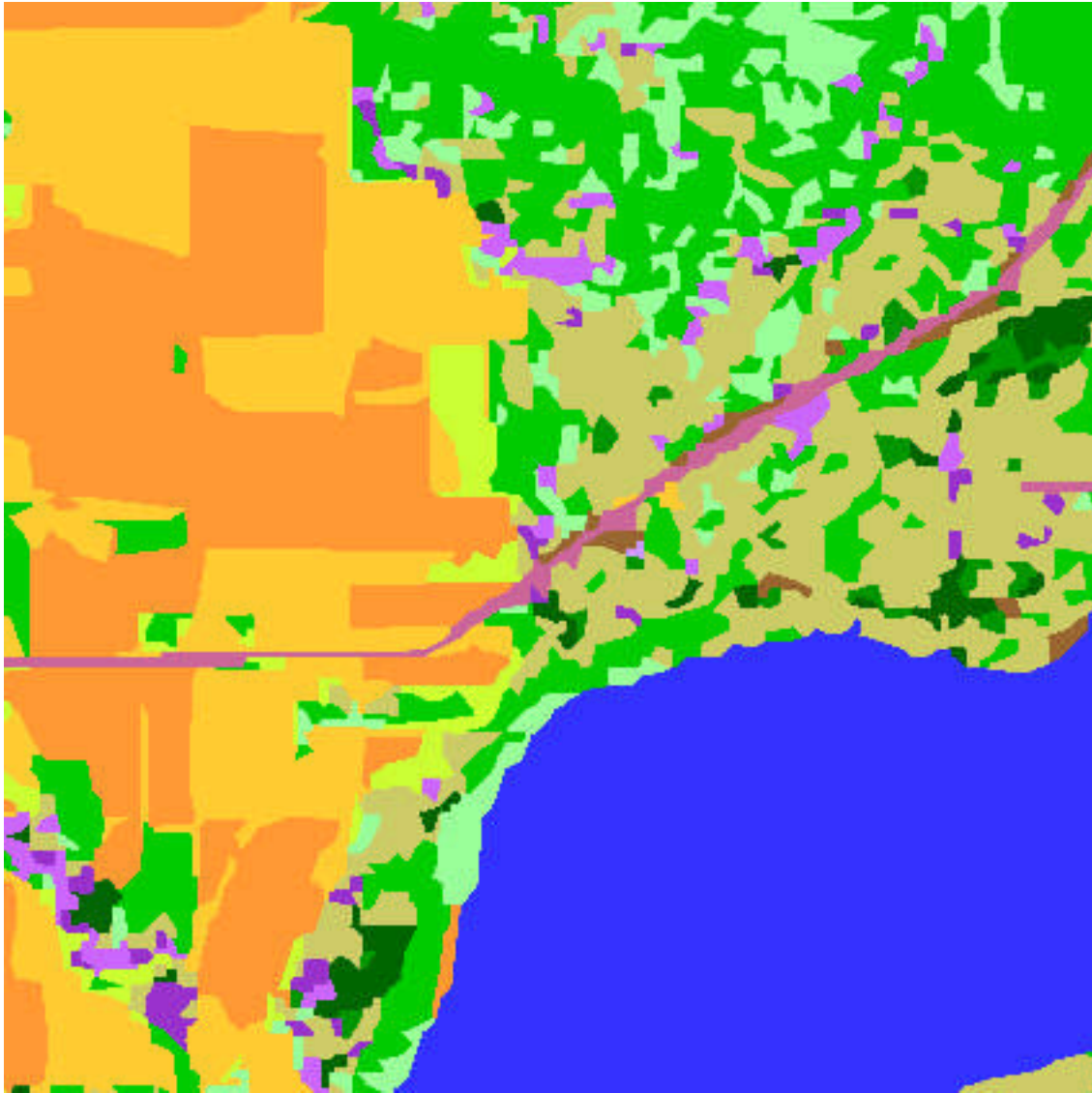


Figure 2 Sample Image of Land Cover in Saskatchewan (Map centre 103.84 W, 53.52 N, size 10 km by 5.5 km)

Appendix D - Acronyms

AAFC	Agriculture and Agri-Food Canada
ADMs	Assistant Deputy Ministers
CCOG	Canadian Council on Geomatics
CCRS	Canada Centre for Remote Sensing
CFS	Canadian Forest Service
CGDI	Canadian Geospatial Data Infrastructure
CSA	Canadian Space Agency
CTI	Centre for Topographic Information
CWI	Canadian Wetland Inventory
ELC	Ecological Land Classification
EO	Earth Observation
EOSD	Earth Observation for the Sustainable Development of Forests
FAO	Food and Agriculture Organization of the United Nations
FAQ	frequently asked questions
FMFP	Fire Management & Forest Protection
GDAL	GeoBase Data Alignment Layer
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
GRIP	Government Related Initiatives Program
IACG	Inter Agency Committee on Geomatics
ISO	International Organization for Standardization
LCCoP	Land Cover Community of Practice
LCCS	Land Cover Classification System
NALMA	National Aboriginal Land Managers Association
NGO	non-governmental organization
NLCD	National Land Cover Data
NLWIS	National Land and Water Information Service
NRCan	Natural Resources Canada
NWT	Northwest Territories
PFRA	Prairie Farm Rehabilitation Administration
UNA	User Needs Assessment
US	United States
USGS	US Geological Service
WMS	Web Map Service