Interpretation guide of natural geographic features from ETM+ Landsat imagery and aerial photography: String bog

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Introduction

The purpose of this project is to create a visual interpretative guide to the natural geographical entities in the geospatial database (GDB) using Landsat7 ETM+ imagery and aerial photography. The methodology and information fact sheet were developed by Provencher and Dubois (2004a), and the application of this procedure to a test case has already garnered a consensus among the staff of CTI at Sherbrooke (Provencher and Dubois (2004b). The meanings of the sections of the fact sheets are explained in the appendix.

The eight natural entities in the GDB (Centre for Topographic Information, 2004) fall under eight themes that are grouped into three domains: hydrography, landforms, and vegetation (**Table 1**). In practice, for interpretive purposes they are often subdivided further and represented by 17 fact sheets.

N.B.: Elaboration of the illustrative examples and potential elements of confusion was constrained by the limited time allocated to this guide. It is recommended that they be supplemented as other cases are documented, especially from Landsat ETM+ imagery.

Table 1: Hierarchy of natural geographical entities

Domain	Theme	Sub-theme	GDB entity	Fact sheet
Hydrography	Watercourse	Perennial watercourse	Permanent water	Permanent water
		Alluvium	Intermittent water	Intermittent water
		Waterfall	Water disturbance	Waterfalls and rapids
		Rapids	Water disturbance	Waterfalls and rapids
	Waterbody	Perennial freshwater body	Permanent water	Permanent water
		Alluvium, rocky surface	Intermittent water	Intermittent water
		Saltwater	Permanent water	Permanent water
		Alluvium, rocky surface (tidal flat)	Intermittent water	Intermittent water
		Reef	Water disturbance	Reef
	Wetland	Tundra pond	Saturated soil	Tundra ponds
		Palsa bog	Saturated soil	Palsa bog
		Marsh, swamp, and uniform peat bog (wetland)	Saturated soil	Wetlands (marshes and swamps, peat bogs
		String bog	Saturated soil	Wetlands (string bog)
Landforms	Glacial landform	Glacial debris	Landform	Glacial debris
		Esker	Landform	Esker
		Moraine	Landform	Moraine
		Glacier, glacial ice cap, and ice shelf	Permanent snow and ice	Permanent snow and ice
	Periglacial landform	Polygonal soil	Landform	Tundra polygon
		Pingo	Landform	Pingo
	Littoral landform	Barrier beach and spit	Landform (sand)	Barrier beach and spit
	Eolian landform	Dunes	Landform (sand)	Dunes
Vegetation	Wooded region		Wooded region	Wooded region

1- Name of entity

String bog

2- Hierarchy

Hydrography – saturated soil – string bog

3- Definition

String bog: A region formed of a succession of crests of fibrous vegetation, generally sphagnum moss, and frequently dotted with variably-sized waterbodies (Standard and Catalogue from the GDB, 2004/08/16). An area (wooded or open) that was formerly a lake in which strings of vegetation, primarily sphagnum moss, mat together and form numerous pools of water (Standard and Catalogue from the polychromatic chart, 2001/06/04).

According to Boivin (2005) the string bog (a bog laid out in strips) consists of alternating bands of vegetation (folds of peat) and depressions that are usually filled with water. There are three basic structures: concentric, linear, and anastomosed (Hamelin and Cook, 1967).

4- Summary table of elements of identification

Table 2: Summary of identifying elements for string bogs

Shape	View from top: surface more or less regular
	View from side: succession of narrow ridges and trenches
Dimensions	Diameter: a few decametres to a few kilometres
	Height: decimetres to metres
Topographic position	Any topographic position (interfluve, hillside bench, valley bottom)
Drainage	Poor
Vegetation	Herbaceous (sphagnum moss, heath)
Emplacement process	Filling in of a lake basin with organic deposits
State	Stable in the medium to long term
Spatio-temporal variations	None in the timeframe of human observation, unless drained or mined
Environment	Throughout Canada, especially in northern regions of permafrost
Identification on imagery	Bands 4-3-2 and band 5
Identification with B/W aerial photography	Structure: alternating water and vegetation
Elements of confusion	Marsh and peat bog

5- Characteristics

5.1- Specific to the entity

5.1.1- Shape

View from top: surface more or less regular
View from side: flat surface

5.1.2- Dimensions

Diameter: several decametres to several hundred metres, even reaching kilometres for the entire bog. The strips are approximately one to three metres wide, one kilometre long, and one metre high (Boivin, 2005).

5.1.3-   Topographic position

String bogs occupy topographical depressions (former lakebeds) located in interfluves, hillside benches, and valley bottoms that are in the process of filling in with organic matter.

5.1.4-   Drainage

String bogs are characterized by very poor drainage. The trenches between the peat ridges are permanently under water. Some sectors of string bogs even include lakes and ponds.

5.1.5-   Vegetation

The vegetation of the string bog is dominated by herbaceous plants consisting of sphagnum moss and heath.

5.2-   Relative to the entity's dynamics

5.2.1-   Emplacement process

String bogs are the result of a lake basin being filled, generally from the periphery toward the centre, by plant matter that accumulates over the years without decaying into organic materials because the regional climate is sufficiently cold to impede this process.

Boivin (2005) identified three causes of reticulation: formation of ice lenses on a mat of continuous vegetation in conjunction with splintering, shifting of the layer of organic materials caused by the thaw of the ice lenses, and detachment of strips of vegetation caused by frost action in a moist environment.

5.2.2-   State

The string bog is an inherited formation in Canada's temperate, southern regions. In more northern regions of permafrost it is a dynamic formation.

5.2.3-   Spatio-temporal variations

The string bog is a slowly evolving environment. It requires hundreds, or even thousands, of years to come into existence before encompassing the entire lake basin in which it forms.

On the other hand, it can be destroyed within a few years or decades by draining or mining.

5.3-   Relative to the environment

String bogs may be present in all environments that were, or are, periglacial. Thus, they can be found anywhere in Canada.

6- Optimal conditions for identification

With aerial photography, the unique structure of the string bog facilitates its identification. The alternation of strips of peat with strips of water in long bands that run more or less crisscross is unique and cannot be mistaken for any other formation.

With ETM+ imagery, the alternation of strips of peat with strips of water may be confused with a moist environment if the bands of vegetation and peat are narrower than the spatial resolution of the image.

7- Examples

Source : Images Canada, photographie GSC2001-146

Figure 1 : Example of a braided string bog where water bodies represent a larger surface than the peat strips.
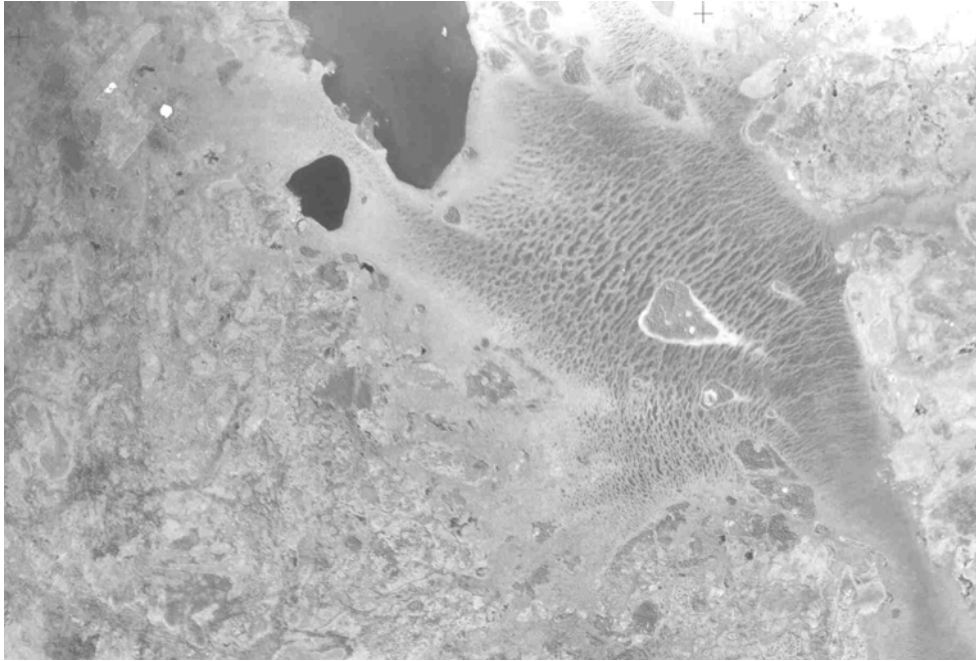
Source : photo A14191 (99), T.S.C.A.P. no 301, Original scale 1 : 41 000, map 63 J/09, 54°35' N – 98°25' O. Drunken Lake (Manitoba)
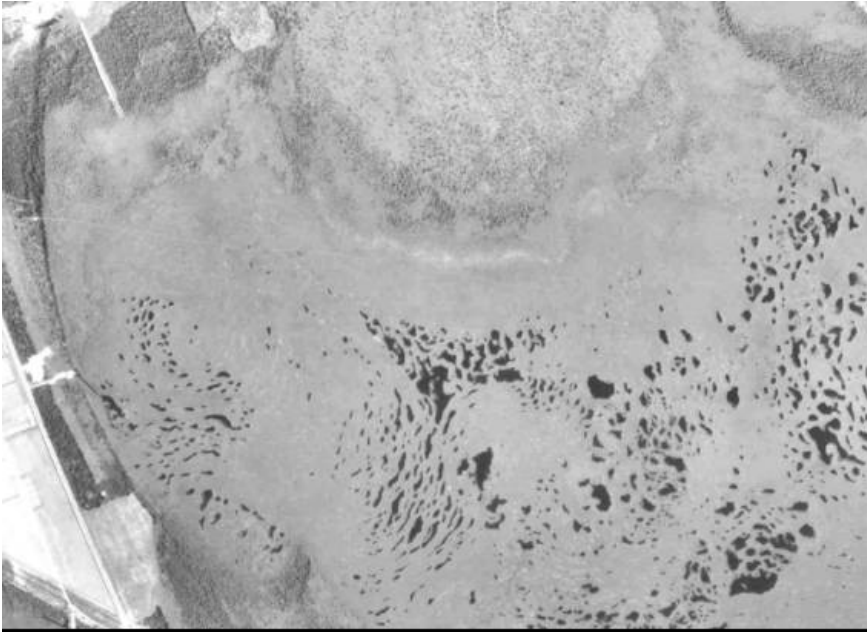
Figure 2 : Example of a braided string bog (aerial view)

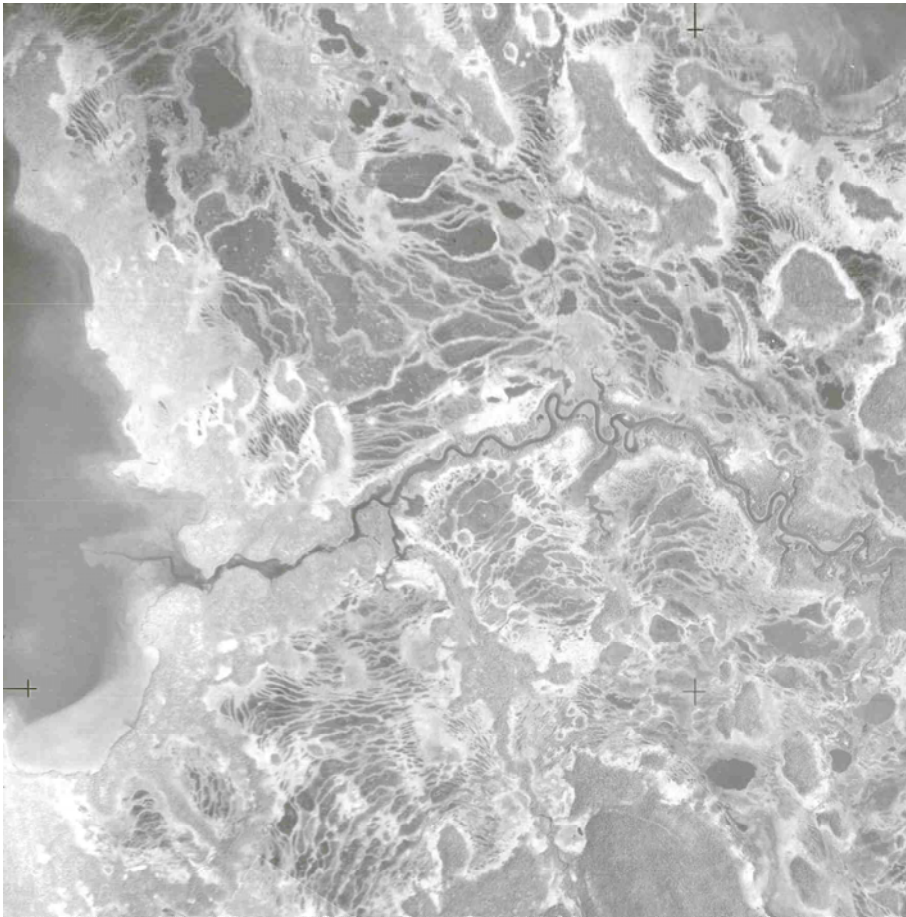Source : Images Canada, photographie GSC 2001-150

Figure 3 : Example of a string bog where the peat strips are as important as the water surfaces (oblique view)

Source : photo A12058 (130), T.S.C.A.P. no 151, Original scale 1 : 36 000, map 23 B/16, 52°46' N – 66°28' O, Petite-Hermine Lake (Newfoundland)

Figure 4 : Example of linear string bogs (aerial view)

Source : H.Q. (Hydro-québec) 77-1006 (9), Original scale 1 : 20 000, carte 22 F/01, 49°05' N – 68°22' O, **Manicouagan Peninsula** (Québec)

Figure 5 : Example of a concentric string bog (aerial view)

8- Interpretation

8.1-   Critical path

The critical path encompasses two phases: distinguishing and delimiting the form, and identifying it.

8.1.1-   Distinction and delimitation

On aerial photography, the decisive criterion for identifying string bogs is the alternation between bands of peat and water within a structure that is unique to each bog.

On ETM+ imagery, a combination of bands 4-3-2 and band 5 should allow string bogs to be distinguished from uniform bogs, provided the bands of water and of peat are sufficiently broad to register.

8.1.2-   Identification

The identification process for string bogs requires that the analyst address the various elements of confusion and recognition (Table 3). The greater the analyst's knowledge and experience, the more accurate the outcome of this labour of discrimination will be.

8.2-   Cross-checking with complementary sources of information

Probably all Canadian provinces and territories have inventories of wetlands and bogs, including string bogs, that are maintained by branches of government or conservation agencies.

9- Elements of confusion

Table 3: Elements of confusion and recognition between string bogs and other entities or forms

Entity or form	Elements of confusion	Elements of recognition	Examples
Marsh	- Plant cover - Flatness of surface	- Regularity of the plant cover	
Uniform bog	- Similar spectral signature if little water	- None - Use of aerial photography	

10- Bibliography

Boivin, A. (2005) Les principales formes périglaciaires : essai de classification et de synthétisation, Département de Géographie et télédétection, Université de Sherbrooke, Sherbrooke, 81 p.

Buteau, P. (2001) Les tourbières du Québec : nature et répartition, Ministère des ressources naturelles du Québec, Québec, 10 p.

Buteau, P., Dignard, N. et Grondin, P. (1994) Système de classification des milieux humides du Québec. Ministère de l'Énergie, de mines et des ressources du Canada et Ministère des Ressources naturelles du Québec, Québec, 25 p.

Hamelin, L.-E. et Cook, F.A. (1967) Le périglaciaire par l'image. Illustrated glossary of periglacial phenomena. Les presses de l'Université Laval, Québec, 237 p.

Appendix: the meanings of the sections

1. Name of entity

The name of the entity as it appears in the GDB and in Topolan7.

2. Position in hierarchy

The position of the entity in the hierarchical structure of entities in the GDB.

3. Definition

A brief description based on the entity's principal characteristics and allowing it to be distinguished from any other natural or manmade entity in the GDB.

Only the core features are part of the definition. A detailed description of the characteristics necessary for identification is given in Section 4.

4. Summary table of elements of identification

Presentation of a table summarizing the entity's characteristics (Section 5), of the optimal conditions for identification on ETM+ imagery and black and white (B/W) aerial photography (Section 6), and of the elements of confusion (Section 9).

5. Characteristics

Categorization and description of the characteristics useful for visual identification of the entity.

5.1. Specific to the entity

Characteristics unique to the entity that allow all aspects useful for its identification to be grasped.

5.1.1. Shape

Distinction between linear, point, and areal shapes, three-dimensional pattern of the entity.

5.1.2. Dimensions

Expanse (length, width, diameter) and height of the entity: minima, maxima, and means.

5.1.3. Topographic position

Location of the entity relative to major landforms: drainage basin, mountain, plateau, plain, valley, slope, etc.

5.1.4. Drainage

Surface moisture, outside of saturated zones, in connection with the texture of the materials in the entity.

5.1.5. Vegetation

Presence of vegetation typical of the entity or patterns of plant associations making it possible to distinguish the entity.

5.2. Relative to the entity's dynamics

Characteristics pertaining to the origin and the state of the entity.

5.2.1. Emplacement process

The agent or set of agents responsible for the entity's emplacement and evolution.

5.2.2. State

Dynamic state of the entity: inherited or current. In the case of inherited features, we speak of paleolandforms; in the case of current landforms, we speak of their ongoing formation.

5.2.3. Spatio-temporal variations

Variations in the entity or its appearance that are functions of cyclical conditions (seasonal, multi-year, etc.) or event driven.

5.3. Relative to the environment

Characteristic of the conditions in the entity's milieu and its relationship with other entities or forms present in this milieu.

6. Optimal conditions for identification

Drawing on documentary sources and the experience of the participants, establishment of the optimal conditions for visual identification of the entity. Using satellite imagery, determine the capability of Landset7 ETM+ to capture the characteristics of the entity and identify the band or combination of bands best for visually distinguishing and identifying the entity. Using B/W aerial photography, identify the hues and textures that are most representative of the entity. In cases in which the relief may be significant, recommend the use of stereoscopy.

7. Examples

Illustrating the entity with examples reflecting several of its aspects:

7.3. Land-based photography

Photographs of the landscape that present one or several examples of the entity's aspects, as they might be seen from the ground.

7.3. Aerial photography

Oblique or vertical aerial photographs that present on or several examples of the entity's aspects, as they might be seen from the air.

7.3. Satellite imagery

Satellite images (from Landsat7 ETM+) that present one or several examples of the entity's aspects, as they might be seen from space.

8. Interpretation

Identification of the entity proceeds from interpreting the information in the imagery or aerial photography and complementary sources of information. The quality of the outcome of this interpretive activity will depend upon the knowledge and the experience of the analyst.

8.1. Critical path

Establishing a unique critical path of interpretation for each entity from the imagery or aerial photography on the basis of its characteristics.

8.1.1. Distinction and delimitation

The possibility of distinguishing and delimiting the shape on the image or aerial photograph has been established and the criteria for success have been described.

8.1.2. Identification

Contrasting the various elements of confusion and recognition with other entities or forms for purposes of identification.

8.2. Use of complementary sources of information

Complementing or cross-checking the interpretation with additional sources of information that are easily accessible, such as those on known Internet sites.

9. Elements of confusion

Identifying the entities and forms with which the entity in question can be confused in a table, along with the differentiating features.

10. Bibliography

A list of useful documents quoted in the previous sections.