McClelland Wetland Study

Multispectral Image Classification and Change Detection in the Canadian Oilsands

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SUNCOR ENERGY

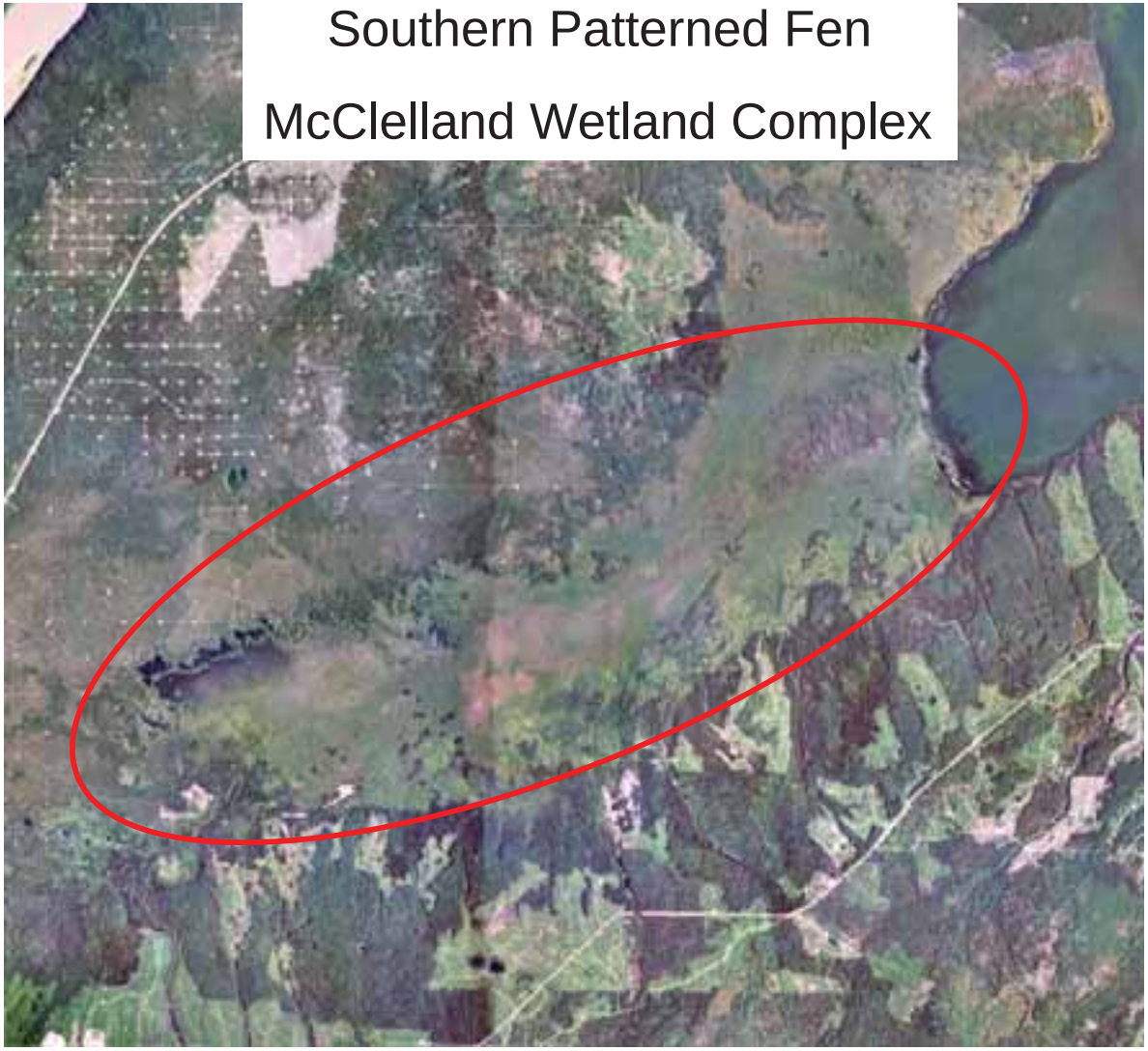
Suncor Energy

Study Area

- Located 90 km north of Fort McMurray, just east of the Athabasca River in the province of Alberta, Canada
- The McClelland Lake watershed includes a unique system of wetlands, including two patterned fens to make up the McClelland Lake Wetland Complex
- The southerly patterned fen overlaps one of the Suncor oil sands mining lease boundaries - Forthills

Study Area

- A patterned fen is a peat land fed by ground water and characterized by a pattern of ridges (called strings) and hollows (called flarks).
- There is also swamp like vegetation along the outer edges of the fen.



Purpose

- Conduct a baseline study of the fen extent for potential use in post mining reclamation
  - Team included ecologists, environmental engineers and GIS analysts

Purpose

1. Use satellite remote sensing techniques to delineate the McClelland Lake wetland boundary.

2. Use a series of images from 1974 to 2007 to track any historical changes in the wetland boundary and indicate a maximal composite extent.

3. Use satellite image classification to summarize any change in the McClelland Lake wetland land cover composition.

Purpose

- Classification was conducted twice.
  - Firstly, to delineate the extent
  - Secondly, to distinguish between land cover types within the boundary identified in the first classification

Data

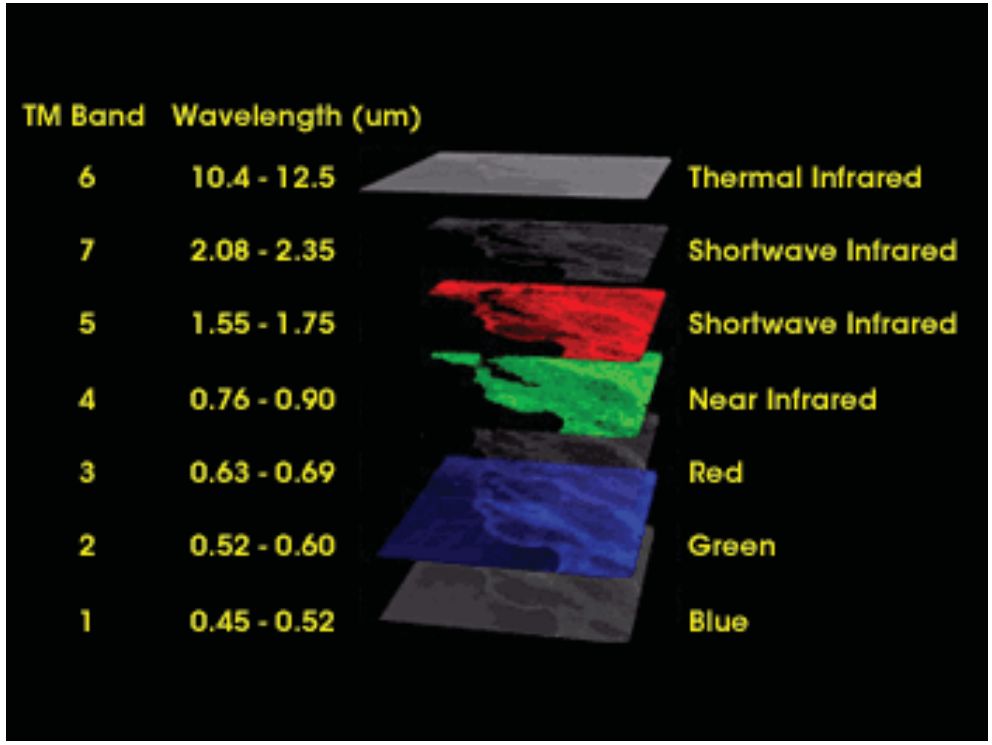
- Landsat 1 MSS
- Landsat 5 TM
  - Relative normalization was performed between the years using the 2007 image as the master
- Canadian Digital Elevation Dataset (25m DEM)
- 25cm aerial photography
  - In the absence of ground control data, air photo interpretation was used as a check

August 2, 1974
August 3, 1988
August 31, 1998
August 7, 2001
September 11, 2002
July 28, 2003
August 25, 2005
July 4, 2006
July 23, 2007

Why Landsat

- Landsat measures electromagnetic radiation that is reflected from the surface using sensors sensitive to the visible and infrared portion of the spectrum.

- The unique interaction of light energy and different land cover, allows separation of land cover types.



Why Landsat

- The lack of surface water in this fen make it a good candidate for satellite image classification

- The unique vegetation that grows in this type of wetland lends itself to the use of Landsat 5 TM. The vegetation properties can be exploited by the multispectral bands to separate fen and swamp from other land cover types

Classifying the Extent

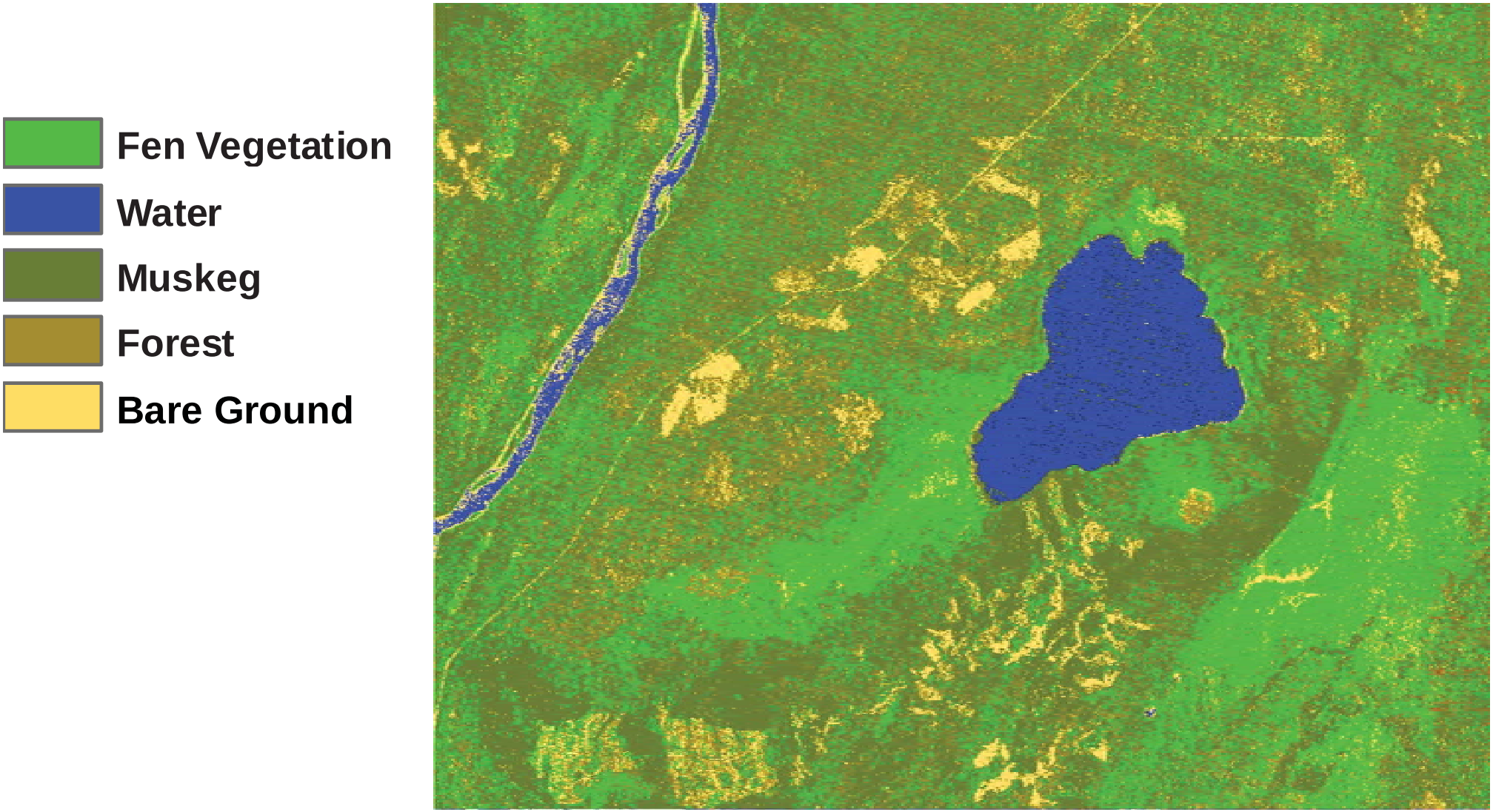
- Isodata classification using the iso cluster and the maximum likelihood classification tools from the spatial analyst tool bar were used to classify the satellite images

- The 6 multi-spectral bands from the Landsat imagery and a digital elevation model of the area were used as input to the classification.

- The boundary of the wetland was identified by two main classes; fen and treed swamp.

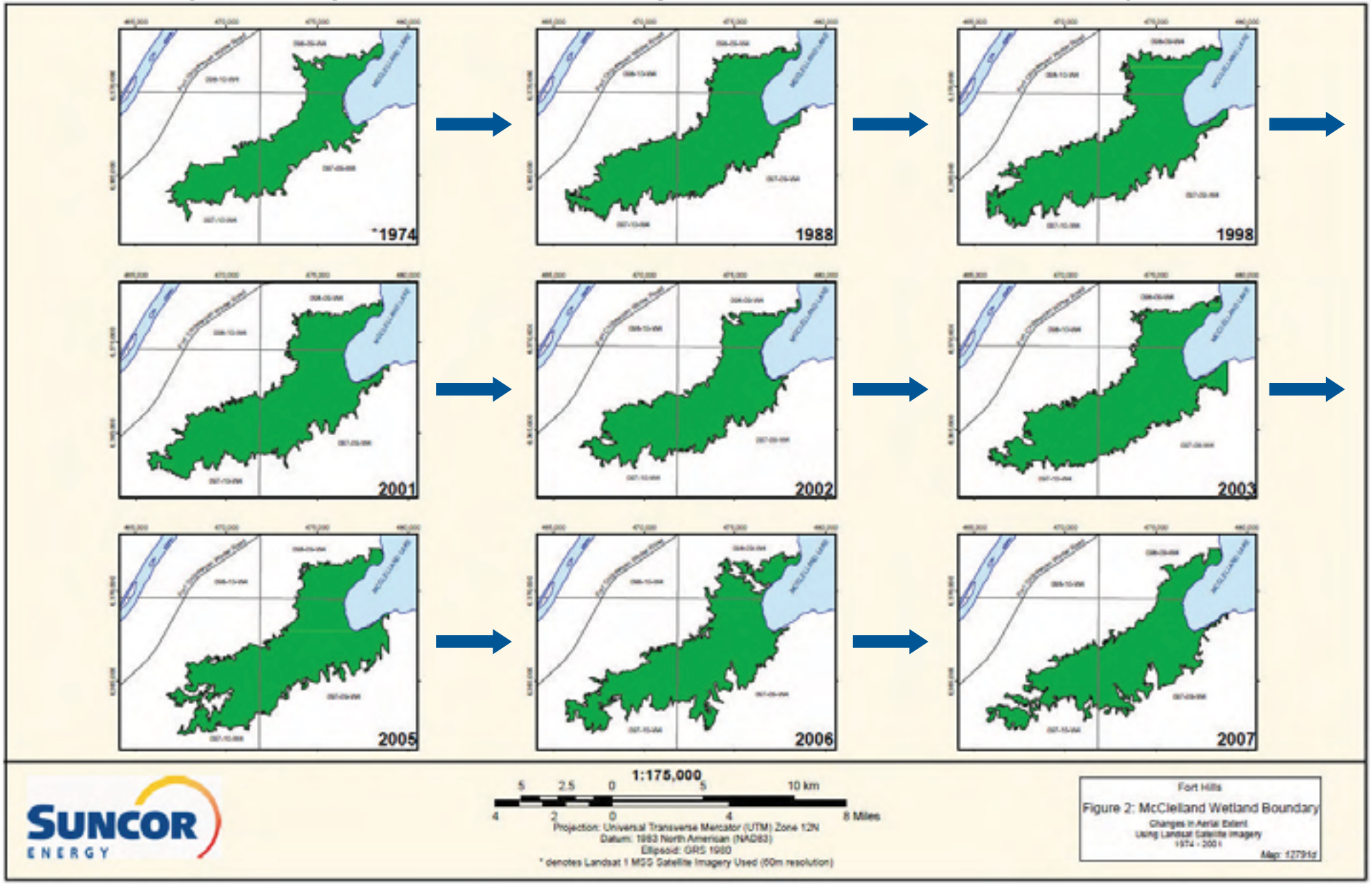
Classifying the Extent

- Classification results from the 2005 Landsat 5 TM imagery



Classifying the Extent

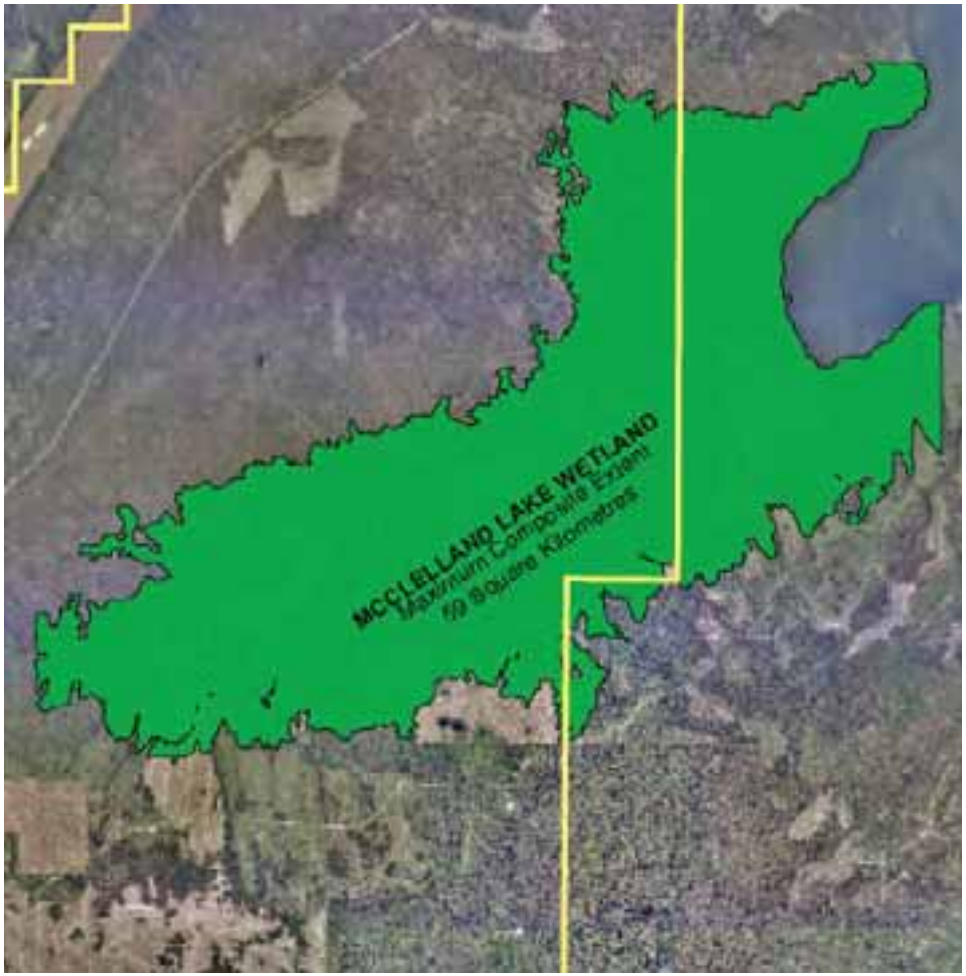
- The fen regions were merged together to create a wetland outline (vector) used for comparison between the years.



Classifying the Extent

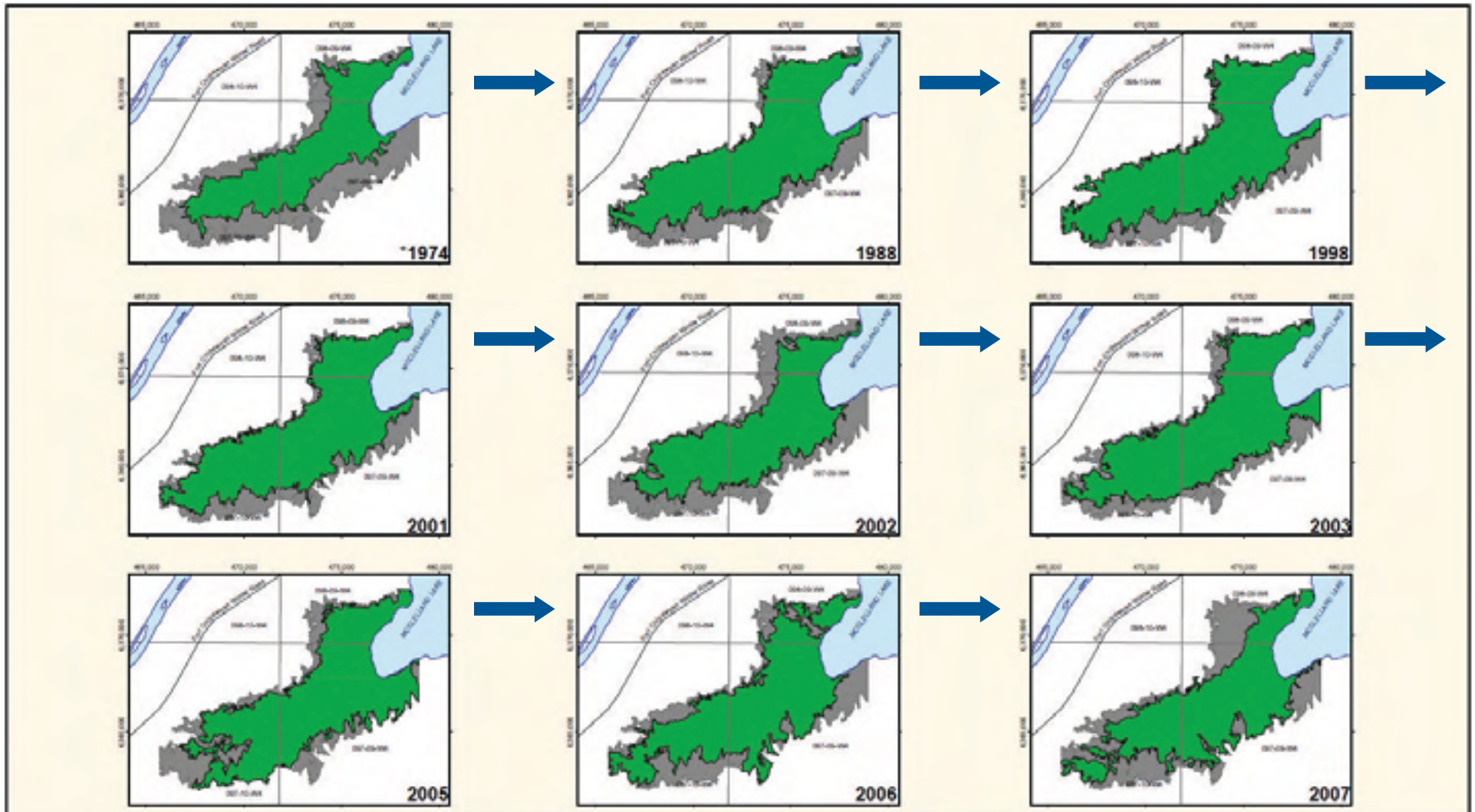
- Combining the results from the annual boundaries, an overall wetland extent was created delineating the maximal composite extent for the time period (1974 to 2007).

- The total footprint the fen has occupied during that time period is 59 km2



Classifying the Extent

- Each years extent was then compared to the combined extent

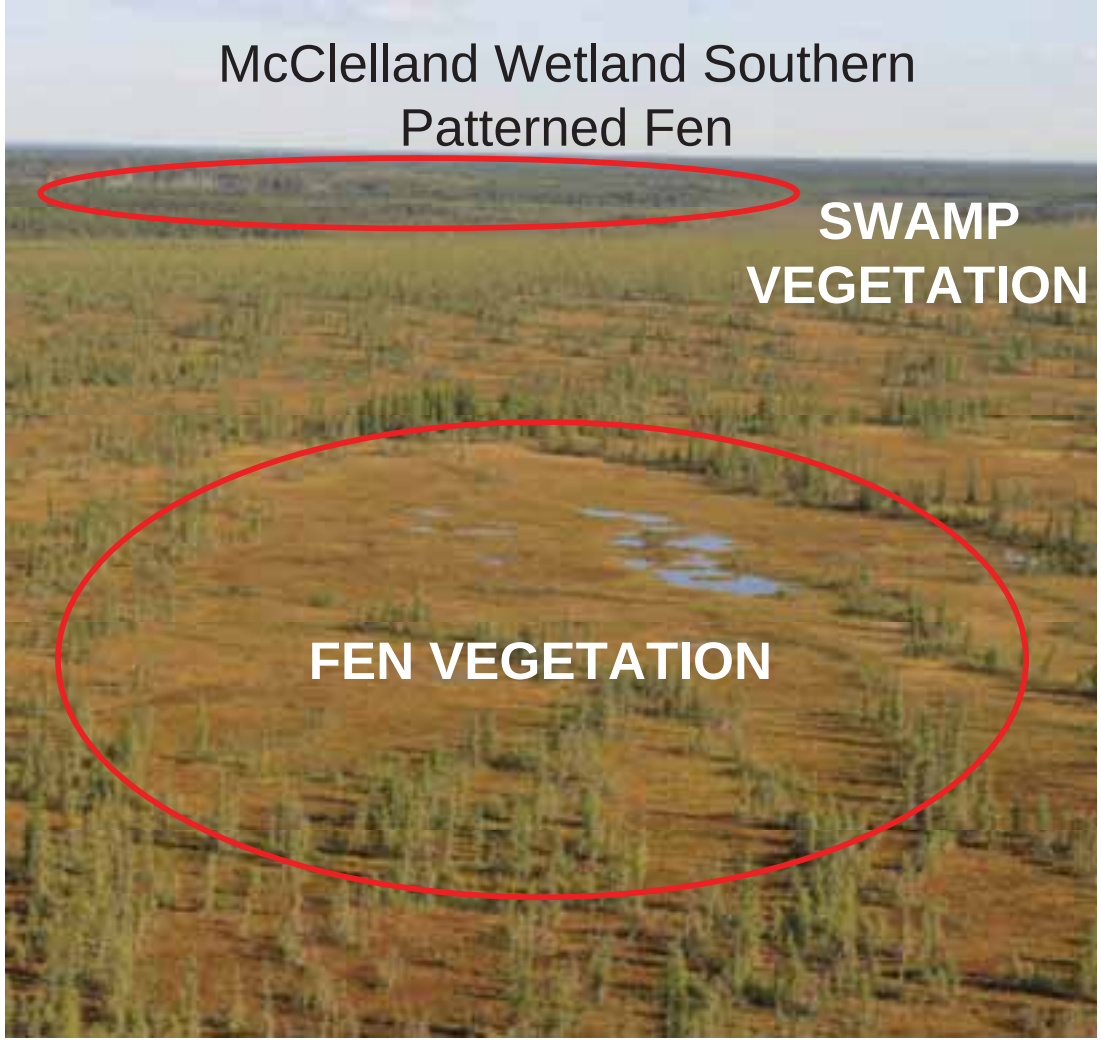


Maximum Area	Minimum Area
47 km^2	37km^2

Fort Hills
Figure 2: McClelland Wetland Boundary
Changes in Aerial Extent
Using Landsat Satellite Imagery
1974 - 2001
Map: 1279Id

Land Cover Classification

- Within the wetland boundary there were three distinct land cover groups separated.
  - fen vegetation
  - swamp vegetation
  - other land cover including bare ground



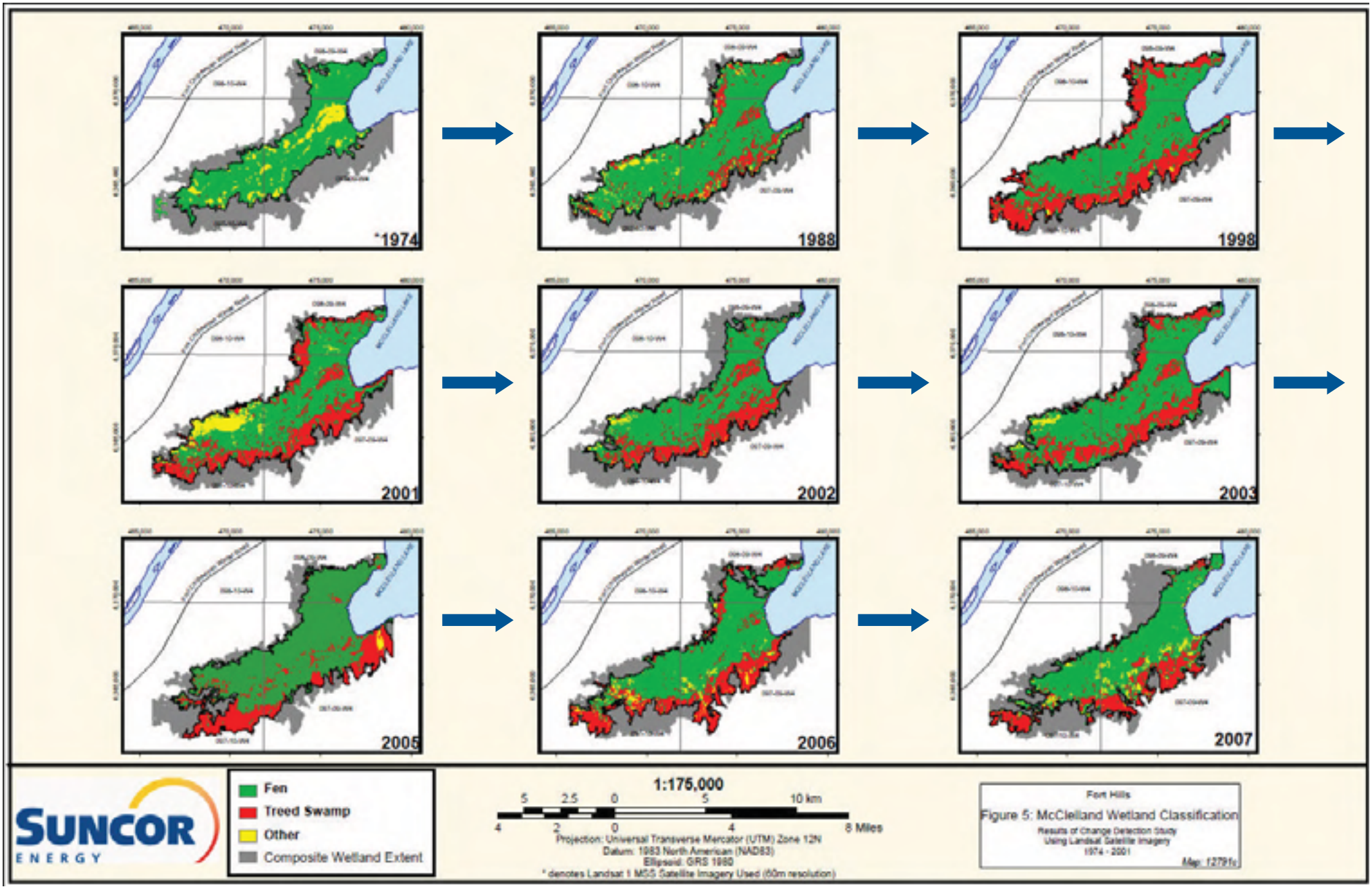
Land Cover Classification

- Isodata classification using a combination of the Iso Cluster and the Maximum Likelihood Classification tools from the spatial analyst tool bar were used to classify the satellite images for the second time

- This classification was conducted on masked Landsat scenes using only the feature envelope of the maximal composite extent identified in the first classification

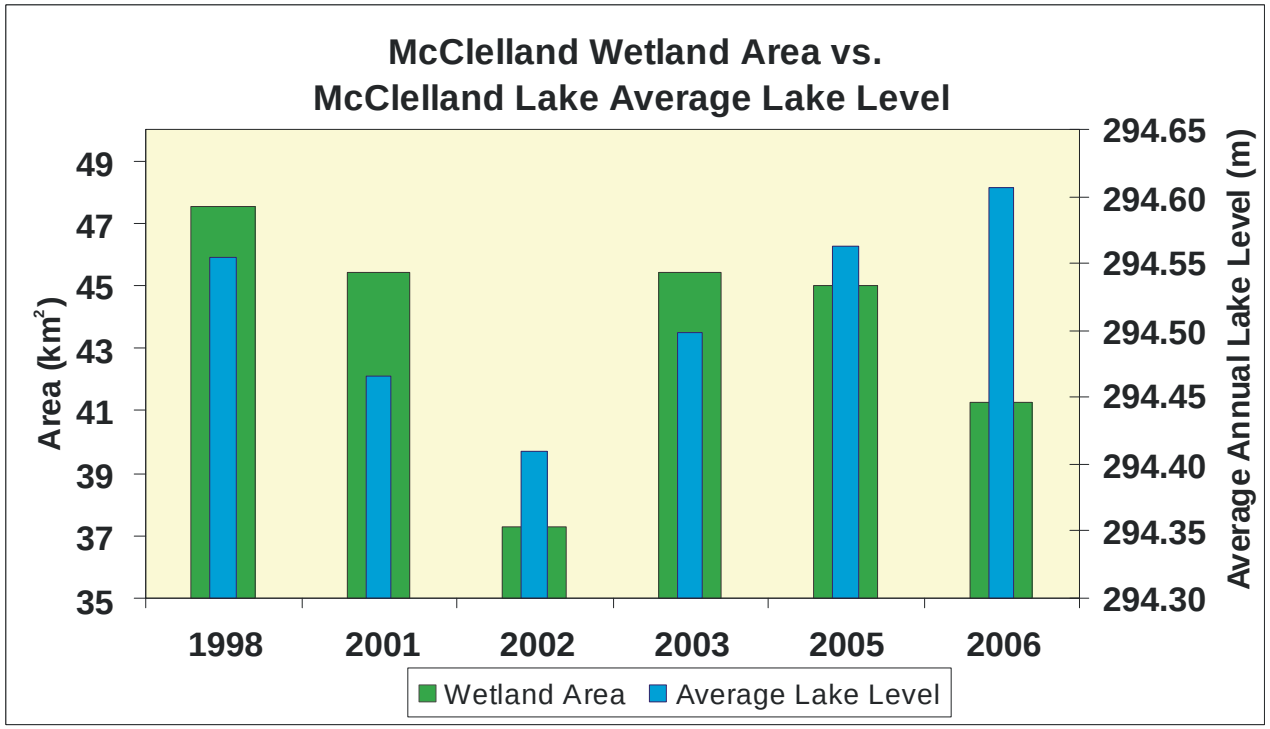
- The percentage of fen and treed swamp within these boundaries were computed for each year and compared.

Land Cover Classification



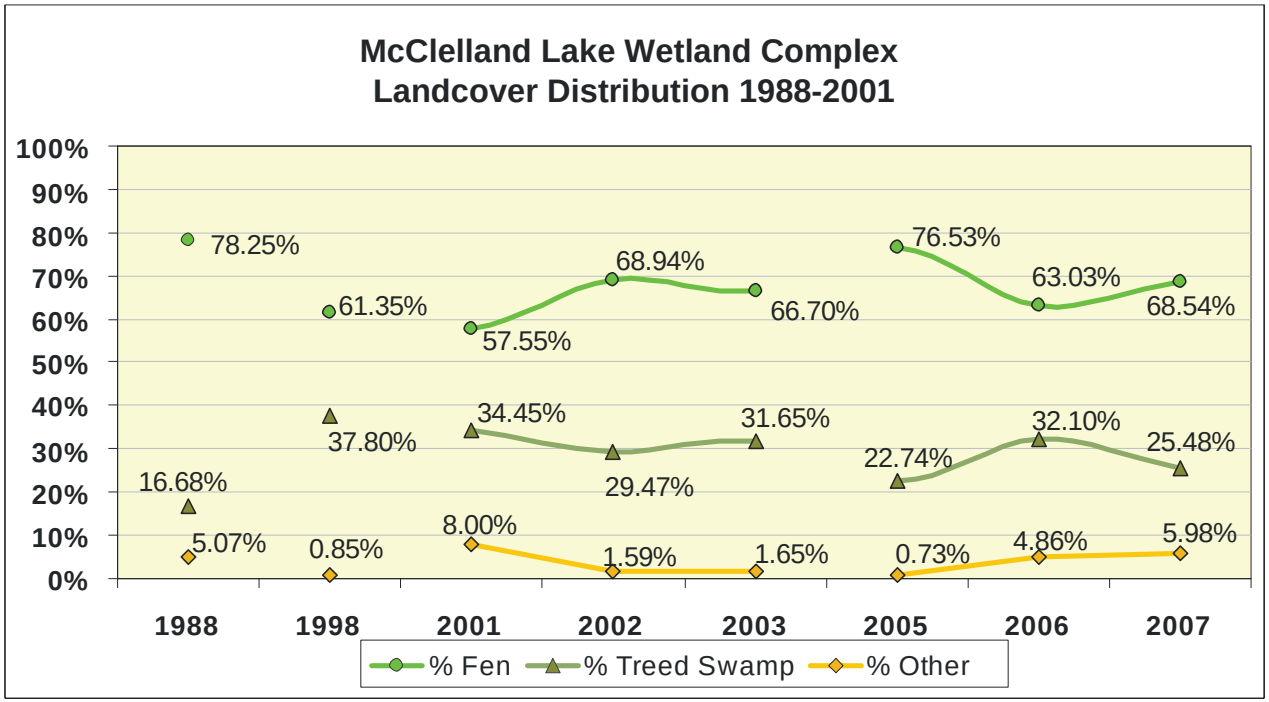
Comparison to Lake Levels

- As expected with a ground water fed wetland, there was no relationship between lake levels and extent of the fen



Comparing Vegetation

- Increases and decreases in swamp vs fen vegetation were inversely related



Limitations

- Ground control data scheduled to be collected was cancelled as the project was put on hold. This prevented us from conducting an accuracy assessment

- Scarcity of cloud free Landsat scenes with similar dates (ie: summer scene vs. winter) prevented us from analysing all years in the study period

- A ground water monitoring program was being established at the time of analysis. No data was available for comparisons similar to the lake level data but using ground water levels.

Future Work

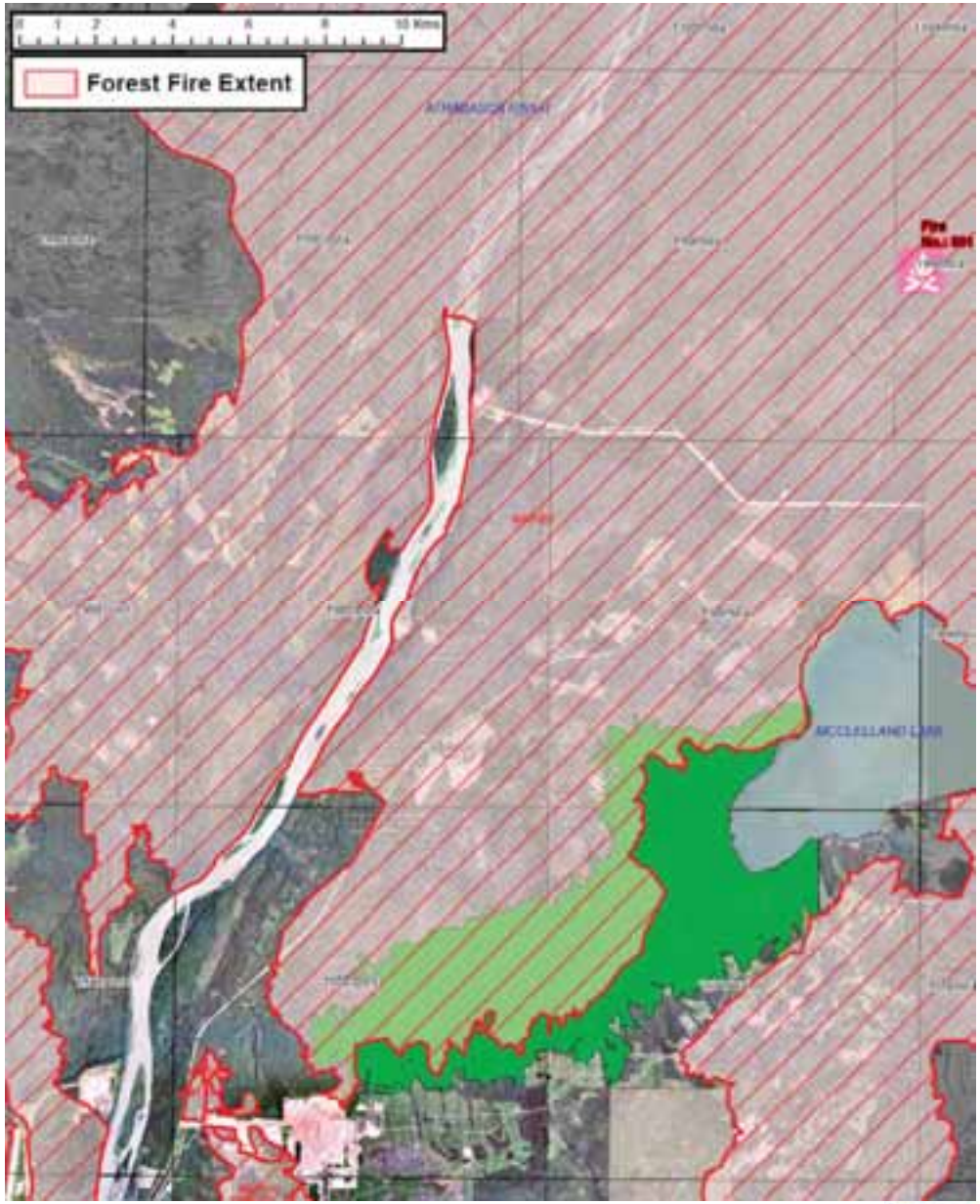
- The spacing between the flarks and strings was of particular interest to the ecologists. Examining the change in spacing is a future project to further the understanding of the fen

- Due to recent forest fire activity future work may include fire damage assessments and/or a fire scar land cover class

Current News

- The wildfires in northern Alberta have recently crept south to the patterned fen.

- The fire has reached over 400,000 ha in size



Thank You

Questions are Welcome