Multi-Resolution Data Blending to Enable Wide Area Synthetic-Landsat Coverage, Predictable Product Development, and Change Detection.

Mike Wulder (Canadian Forest Service)

Landsat Science Team Meeting
January 19-21, 2010

Computer History Museum
1401 N Shoreline Boulevard,
Mountain View, CA 94043

Wouldn’t it be nice to have a predicable image data stream, with user defined date, no seams, over a wide-area, suitable for mapping and monitoring activities?

Further, we also want change capture possible on a bi-weekly basis.

Synthetic data support

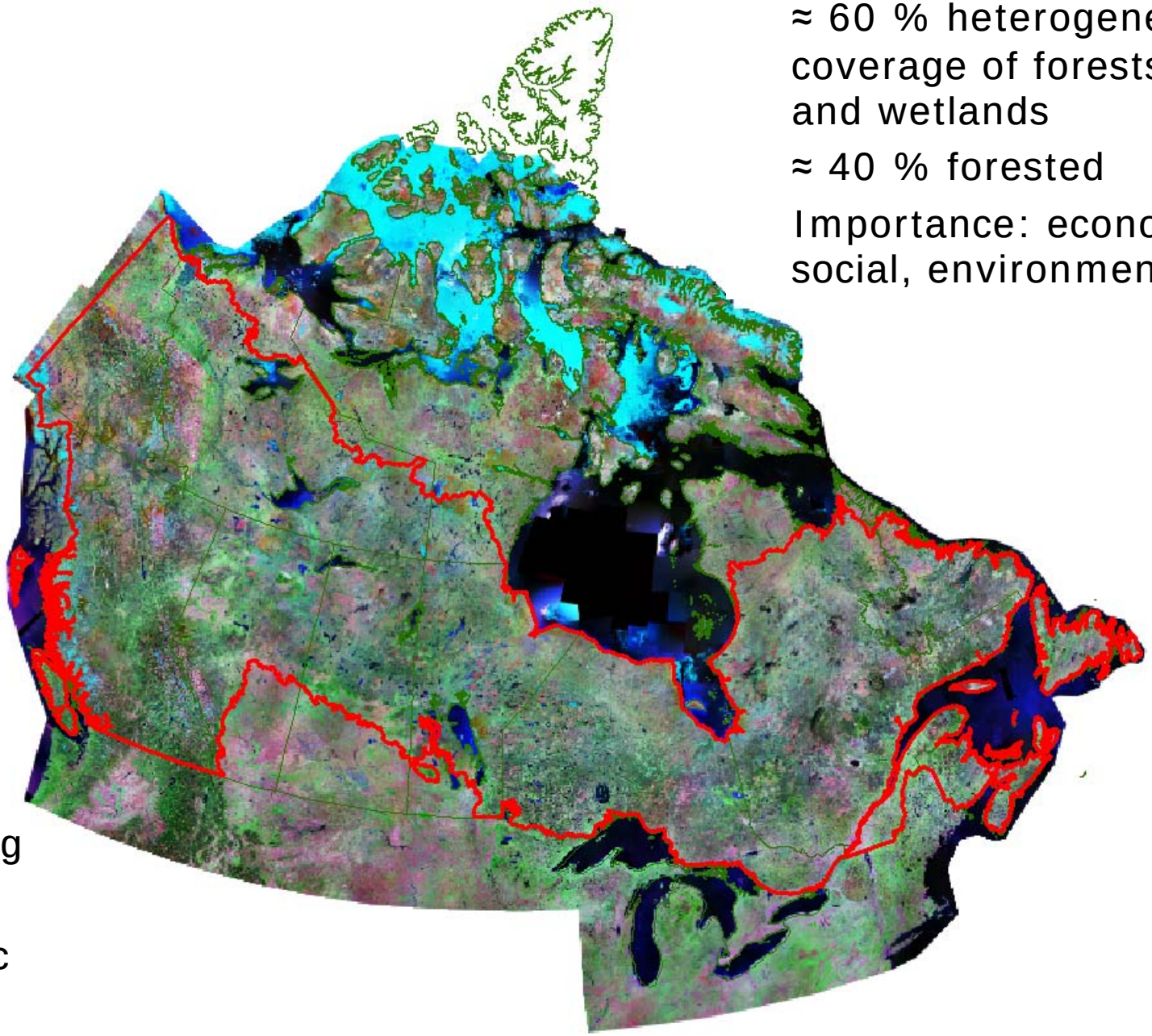
- **Gao, F.; Masek, J.; Schwaller, M., and Hall, F. On the Blending of the Landsat and MODIS Surface Reflectance: Predicting Daily Landsat Surface Reflectance. Transactions on Geoscience and Remote Sensing. 2006; 44(8):2207-2218.**
- Hilker, T.; Wulder, M. A.; Coops, N. C.; Linke, J.; McDermid, G.; Masek, J. G.; Gao, F., and White, J. A New Data Fusion Model for High Spatial- and Temporal-Resolution Mapping of Forest Disturbance Based on Landsat and MODIS. Remote Sensing of Environment. 2009; 113:1613-1627.
- Hilker, T.; Wulder, M. A.; Coops, N. C.; Seitz, N.; White, J. C.; Gao, F.; Masek, J. G., and Stenhouse, G. Generation of Dense Time Series Synthetic Landsat Data Through Data Blending with MODIS Using a Spatial and Temporal Adaptive Reflectance Fusion Model. Remote Sensing of Environment. 2009; 113:1988-1999.
- Roy, D.P., Ju, J., Lewis, P., Schaaf, C., Gao, F., Hansen, M., Lindquist, E., 2008, Multi-temporal MODIS-Landsat data fusion for relative radiometric normalization, gap filling, and prediction of Landsat data, *Remote Sensing of Environment*, 112:3112-3130.
- Roy, D.P, Ju, J., Kline, K., Scaramuzza, P. L., Kovalskyy, V., Hansen, M., Loveland, T.R., Vermote, E., and Zhang, C. (2009). Web-enabled Landsat Data (WELD) preliminary results: Landsat ETM+ composited mosaics of the conterminous United States. *Remote Sensing of Environment*. In press.

9,970,610 km^2

≈ 60 % heterogeneous coverage of forests, lakes and wetlands

≈ 40 % forested

Importance: economic, social, environmental



National

- Reporting

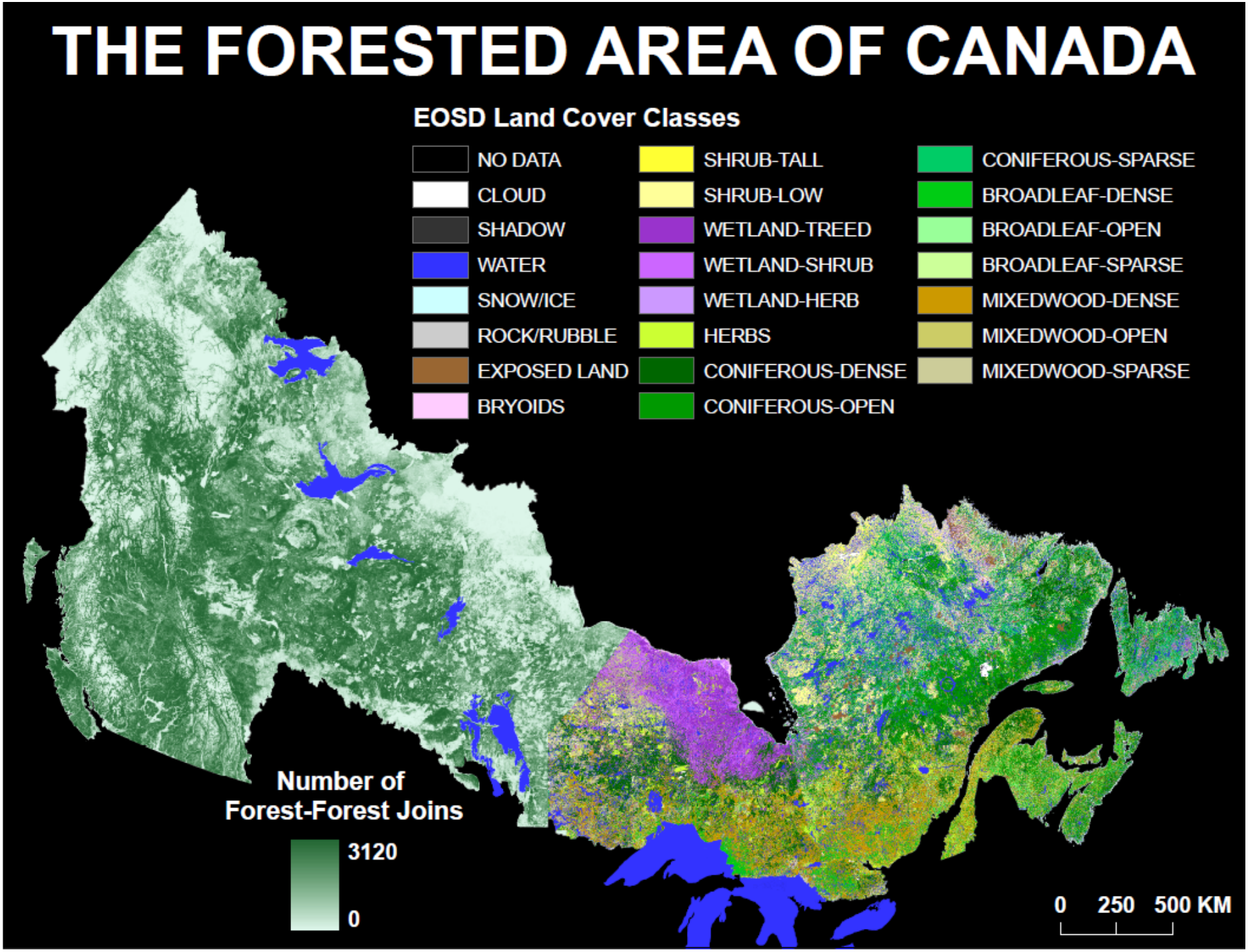
Regional

- Strategic

Local

- Operations

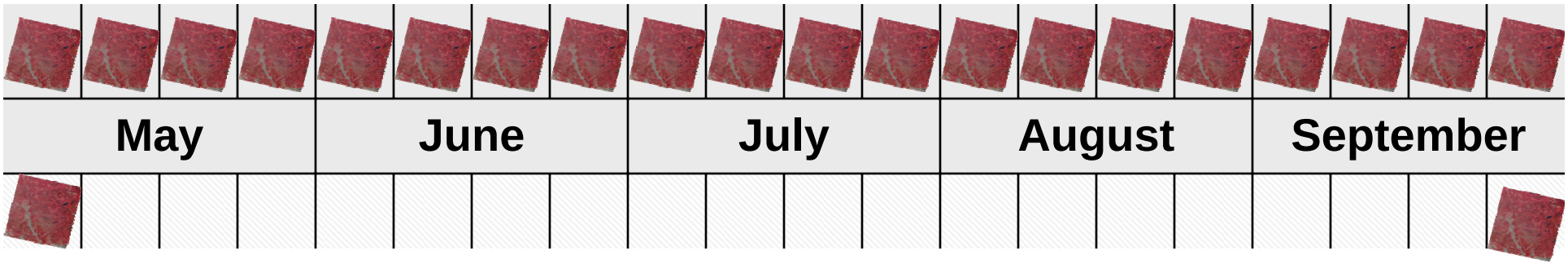
THE FORESTED AREA OF CANADA



Landsat image opportunities

Address clouds, shadows, short growing season, phenology differences

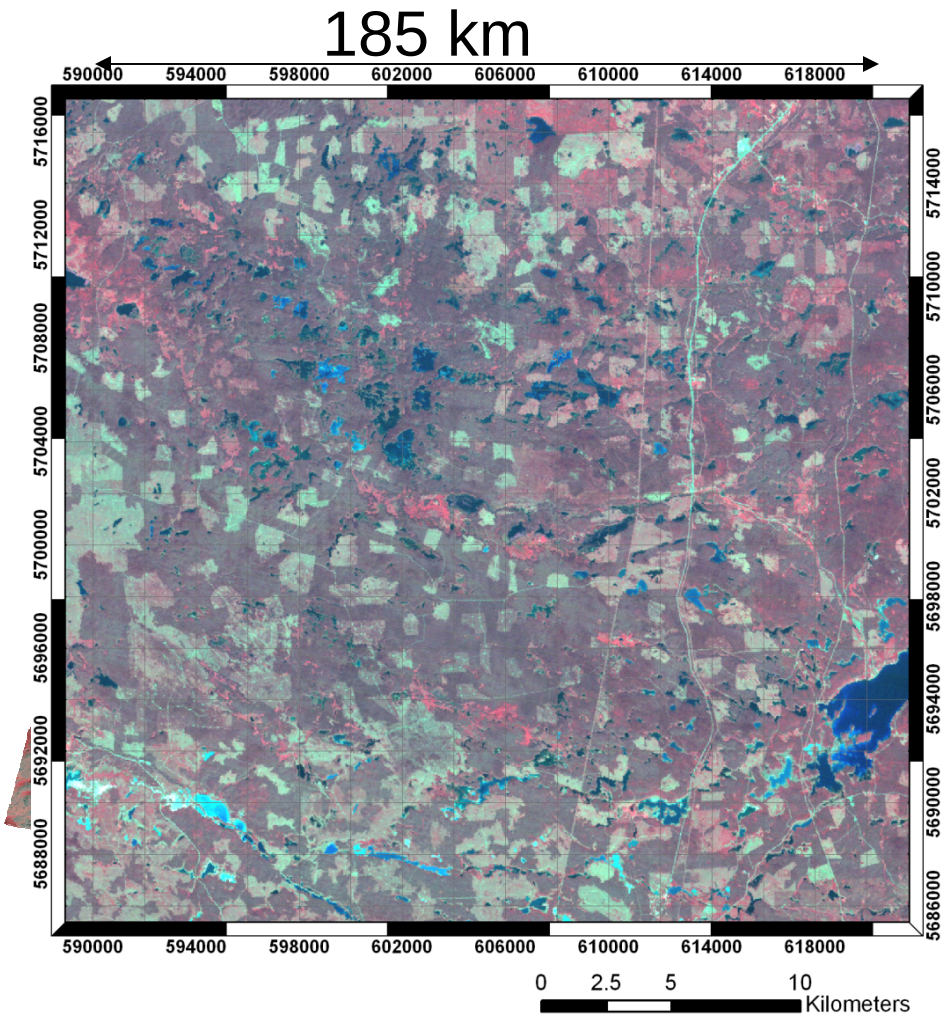
- Fusion of Landsat and MODIS
- Maintain spatial detail from Landsat, create temporal density from MODIS
  - STARFM (Gao et al, TGARS)
  - STAARCH (Hilker et al, RSE)
- Image compositing (Landsat and MODIS)
  - Hansen (Congo), Roy (USA)



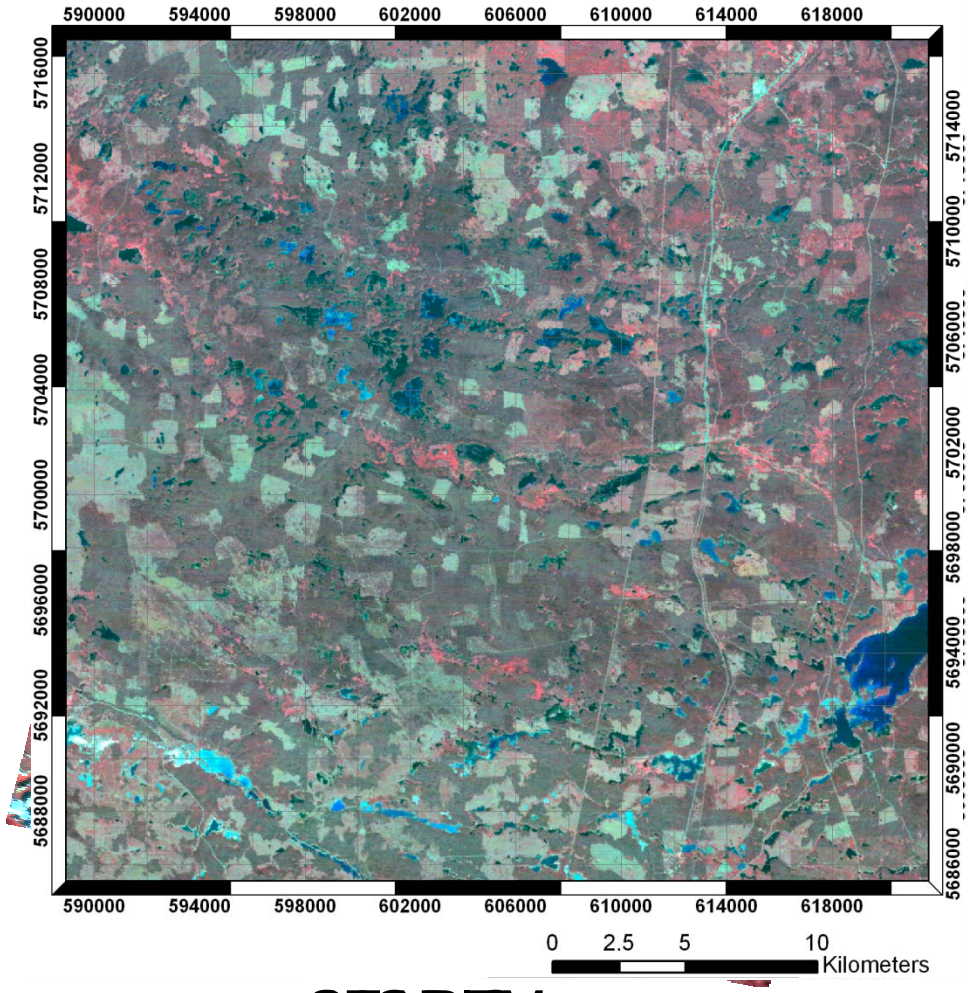
Mode 2: forward and constrained by temporal change

Landsat

Maintaining spatial resolution



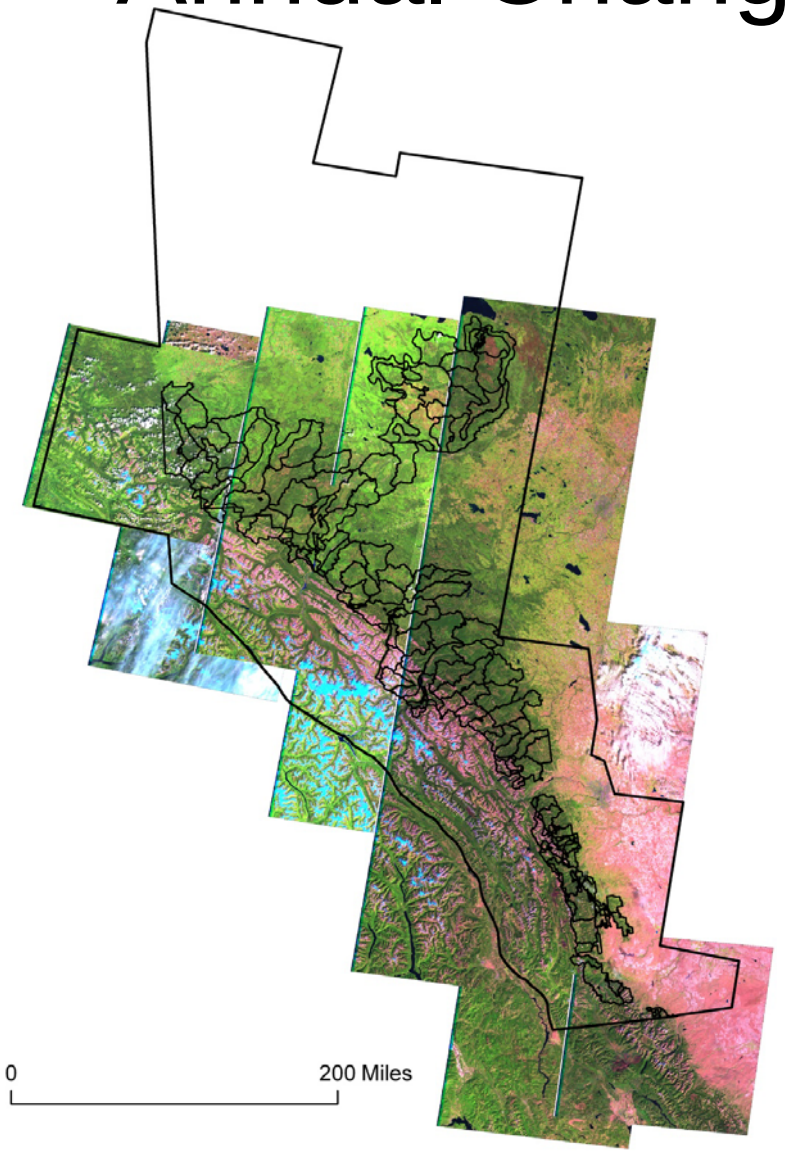
Landsat

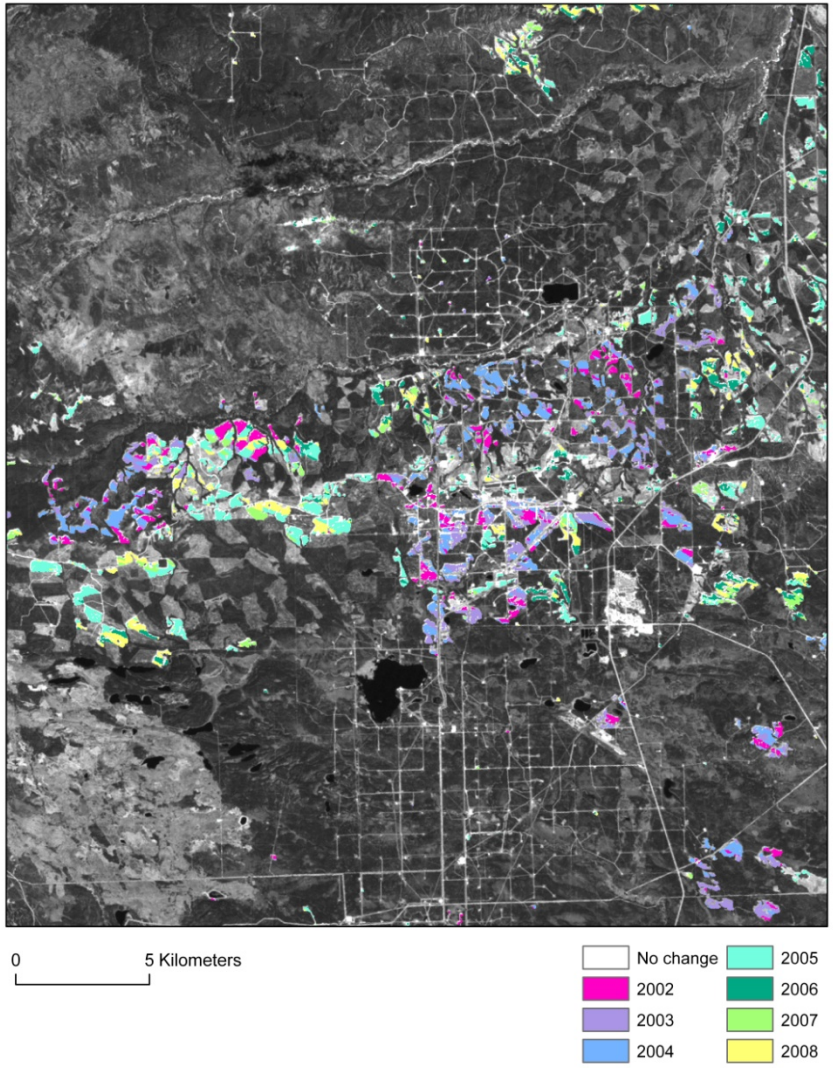


STARFM

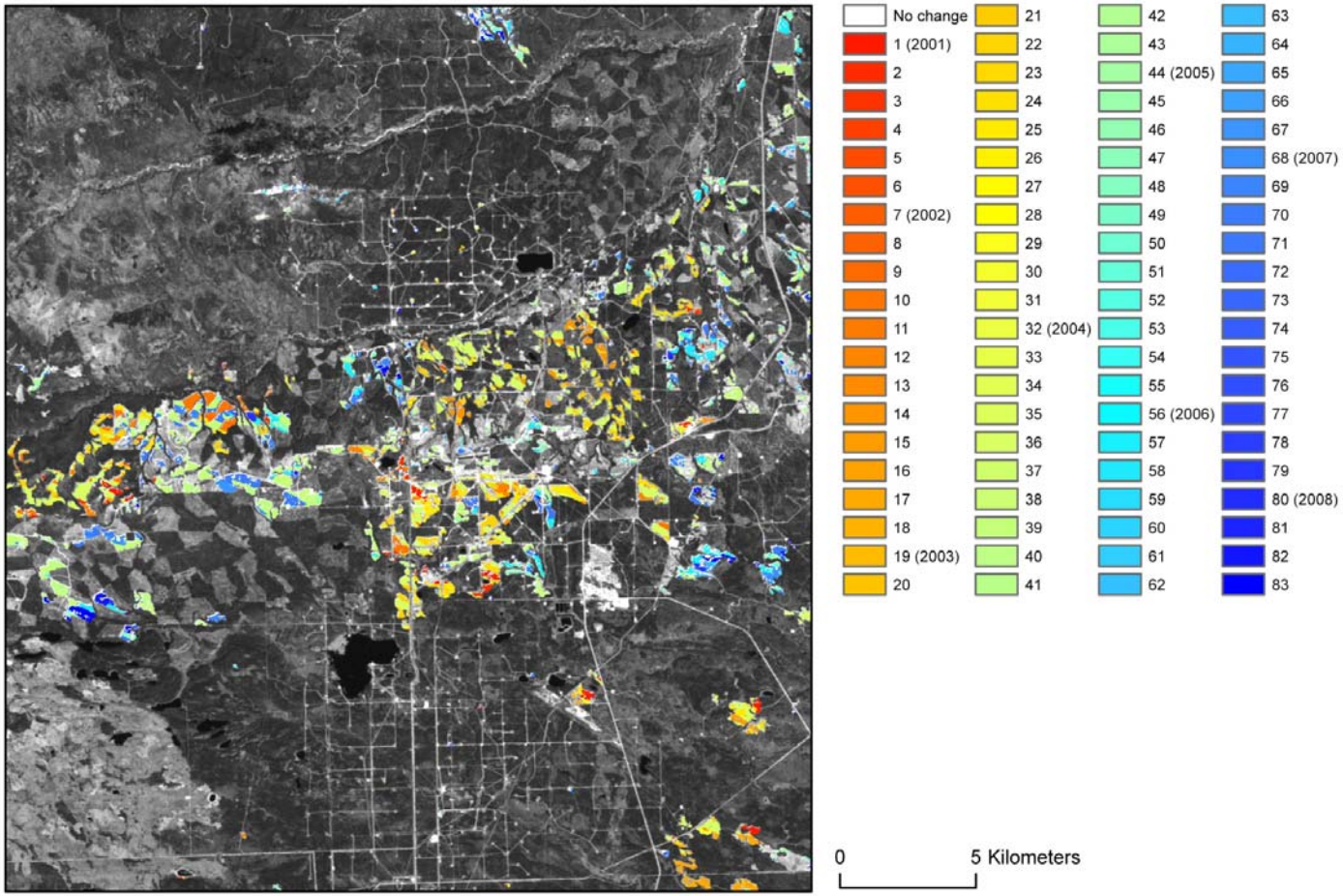
Hilker, T., Wulder, M.A., Coops, N.C., Seitz, N., White, J.C., Gao, F., Masek, J., & Stenhouse, G.B. (2009). Generation of dense time series synthetic Landsat data through data blending with MODIS using the spatial and temporal adaptive reflectance fusion model (STARFM). Remote Sensing of Environment. Vol. 113, No. 9. pp. 1988-1999.

Current working area (16 p/r) and Annual Change from STAARCH

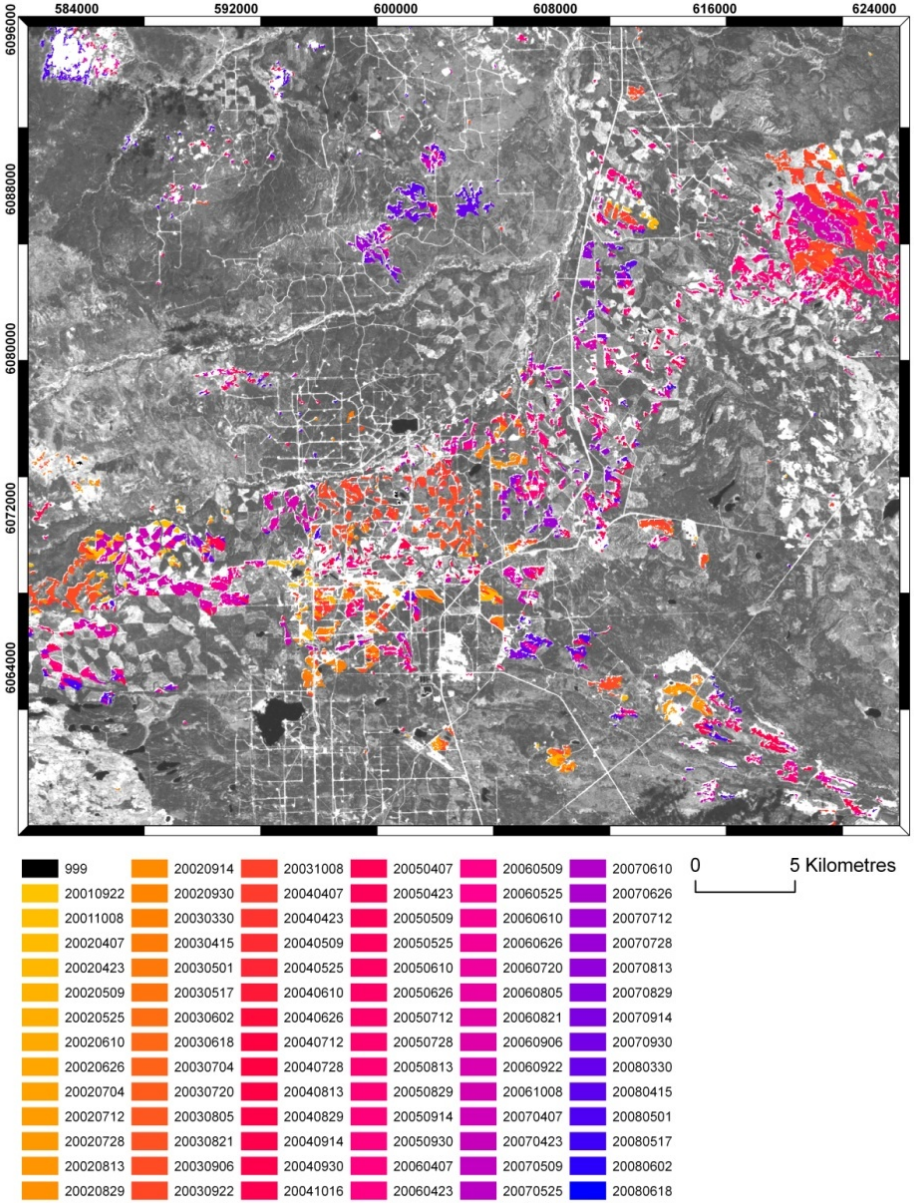




16-Daily change from STAARCH



Hilker, T., Wulder, M.A., Coops, N.C., Linke, J., McDermid, G., Masek, J., Gao, F., and White, J.C. (2009). A new data fusion model for high spatial- and temporal- resolution mapping of forest disturbance based on Landsat and MODIS. Remote Sensing of Environment. Vol. 113, No. 8, pp. 1613-1627.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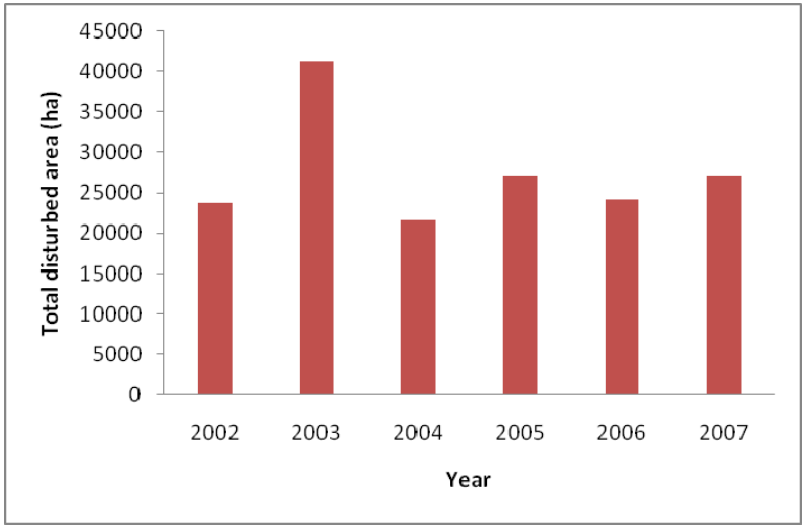
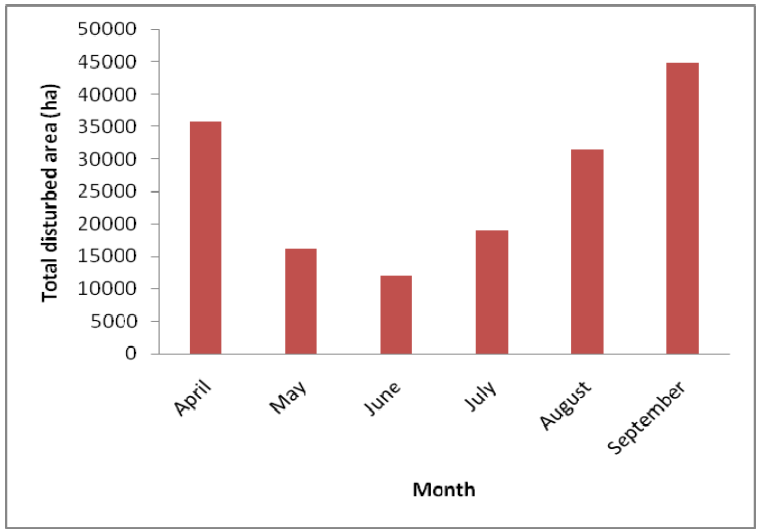
5 Kilometres

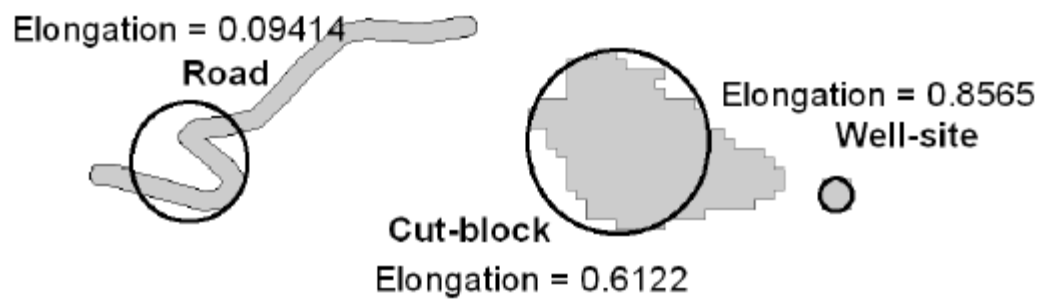

Total disturbed area (ha)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
2002
2003
2004
2005
2006
2007
Year

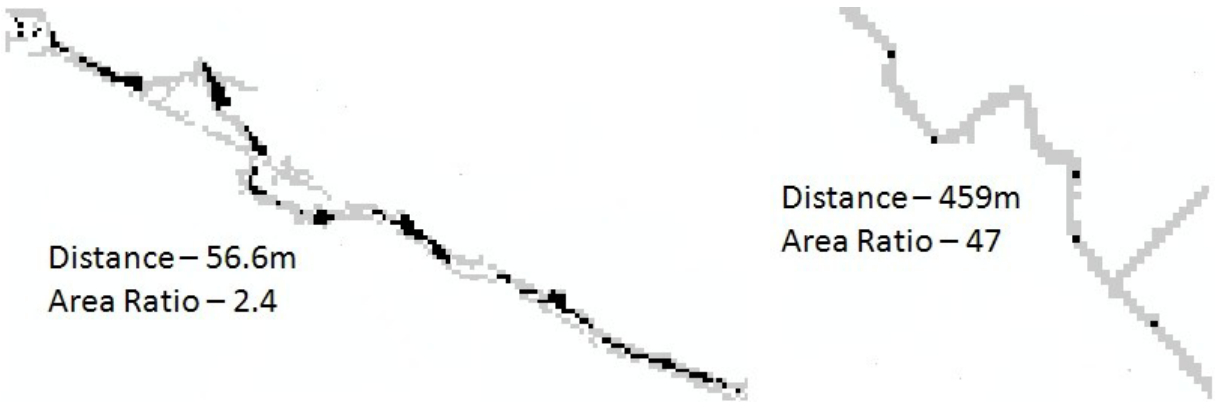

Total disturbed area (ha)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
April
May
June
July
August
September
Month

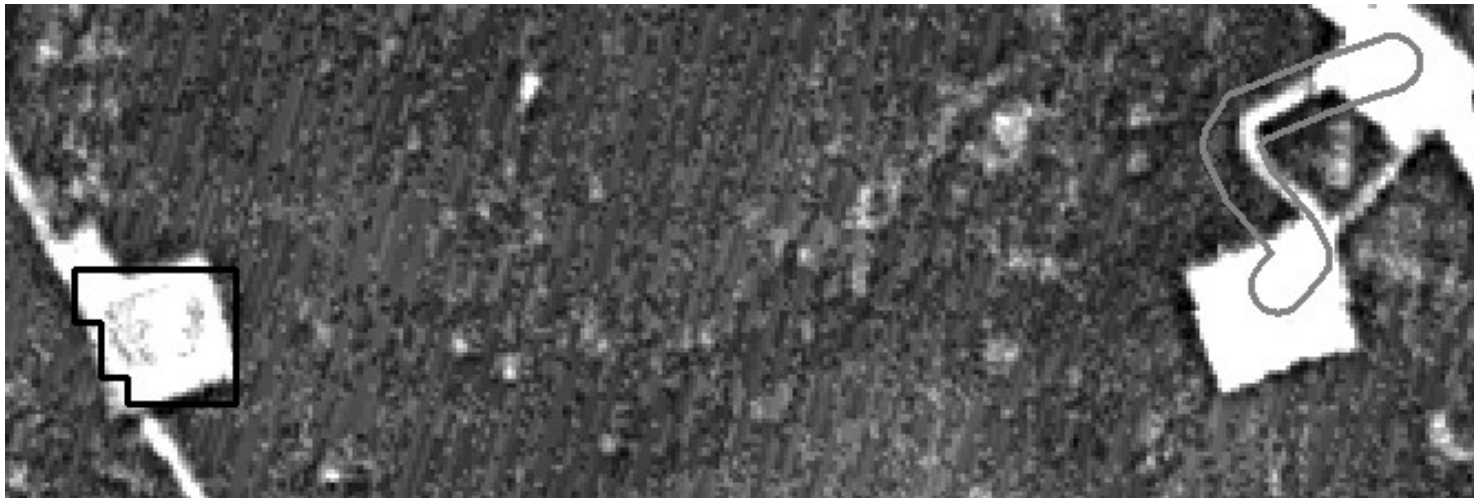
Change Attribution

- approaches have been developed to:
  - find change (as with standard procedures or STAARCH)
  - label changes
    - 1. using spatial information;
    - 2. using image fusion
- result is detection and labelling (e.g., well site, cut block, road) of changes in an increasingly automated fashion

Landsat
IRS-1C

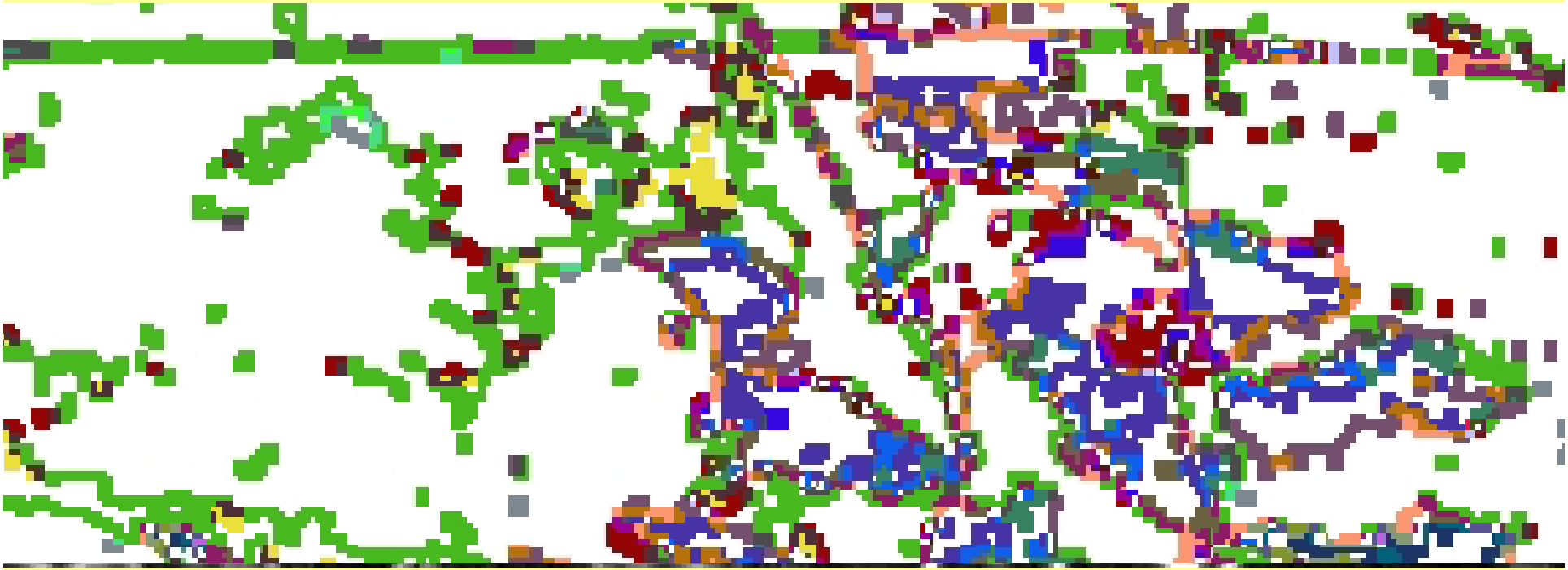






Quantitative Edge Development

- Edges inform on habitat characteristics
- Consistent and quantitative development desired
- Can use edge detection and integration with land cover products to:
  - Produce edges and edge strength (Wombling)
  - Generate class transitions (classes on either side of edge)
  - Combine edges, strength, and transitions



- Classified image data;
- Tasseled Cap Wetness (based on image spectral values);
- Wombled edges (brightness relates strength);
- Class transitions at edge locations and combine with model input, describe outputs / trends

Conclusions

- Seamless, high temporal resolution, non-scene based, mosaic, products are possible
- Sensor data with high temporal- and spatial-resolutions can be integrated
- Frequent change products can be generated
- Additional information products can in-turn be generated

- Be sensitive to dates.
- Consider definitions
- Time series – need to consider persistence of change (for attribution)

Thank you

Contact Information:

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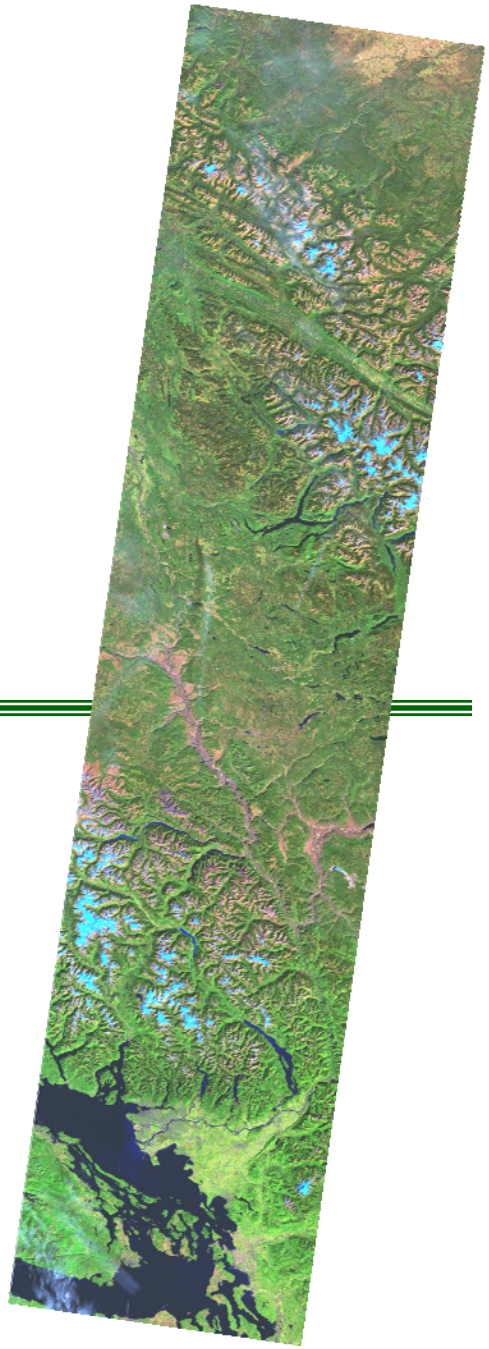

Canada

Natural Resources Canada | Ressources naturelles Canada

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