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Forest monitoring information needs in Canada

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Outline

- ✦ **The mandate of the CFS**
- ✦ Canada's forests
- ✦ Information needs
- ✦ Responding to information needs:
 - National Forest Inventory
 - Forest fragmentation
 - Biodiversity monitoring

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Mandate of the Canadian Forest Service (CFS)

- National science-based policy institution; NRCan
- Provides analysis/advice to GoC on key forest matters
- Leader in forest science innovative approaches to sustainable forest management
- Promotes competitiveness of Canada's forest sector









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Canada's Forests

- 10% of the world's forests
- 20-30% of the world's boreal forest
- 20% of the world's fresh water resources
- 180 tree species
- 93,000 other species



Wulder, M.A., C. Campbell, J.C. White, M. Flannigan, and I.D. Campbell, 2007. National Context in the International Circumboreal Community. *The Forestry Chronicle*, Vol. 83, No. 4, pp. 539-556.



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Canada's Forests

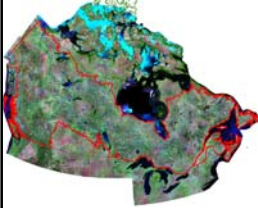
- 998.4 million hectares
- 402.1 million hectares of forest and wooded lands
- 143 million hectares subject to commercial activity








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Canada's Forests

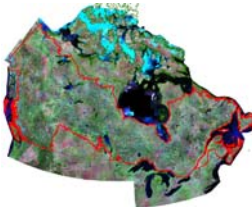


- 0.4% (0.9 million ha) is harvested annually
- In 2005:
 - 56,000 ha deforested
 - 9,400 ha afforested
- ~ 3 million hectares of forest are affected by fire and insects annually



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Canada's Forests



- 361,300 direct jobs
- 900,000 indirect jobs
- 3% of GDP
- Forest product exports \$44.6 billion
- World's largest exporter of forest products (16% of global exports in 2004).

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Canada's Forests


- ✗ **93% of forest land is publicly owned:**
 - 77% under provincial or territorial jurisdiction
 - 16% under federal purview
- ✗ **Provinces and territories:**
 - conservation and management of the forest resources on provincial/territorial Crown lands.
- ✗ **Federal government:**
 - national reporting obligations
 - national economy, trade, and international relations
 - federal lands and parks
 - constitutional, treaty, political and legal responsibilities for Aboriginal peoples



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Information Needs: Program



- **Supporting national and international reporting commitments**
 - Kyoto, UN Conventions on Biological Diversity and Climate Change, CCFM C&I, Montréal Process, State of Forests
- **Protecting Canada's forest products market share**
 - certification
- **Increasing complexity of forest management**
 - multiple values: biodiversity, forest products, water
- **Public involvement in decision making**

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Information Needs: Data

- **Monitoring of forests is required at a range of spatial and temporal scales**
 - individual trees to ecosystems
- **Operational forestry**
 - spatially detailed information encompassing a broad suite of attributes.
- **Monitoring change and disturbance events at the landscape level**
- **Broad ecosystem and national level trends**
 - synoptic and temporally dense change detection


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National Forest Inventory



- 1% sample
- 2km x 2km photo plots spaced on a 20km grid
- 1:20,000 air photos
- ground plots
- reporting – 5 year cycle
- remeasurement – 10 year cycle

Gillis, M.D., A.Y. Omule, and T. Brierley. 2005. Monitoring Canada's forests: The National Forest Inventory. *The Forestry Chronicle*, Vol. 81, No. 2, pp. 214-221.

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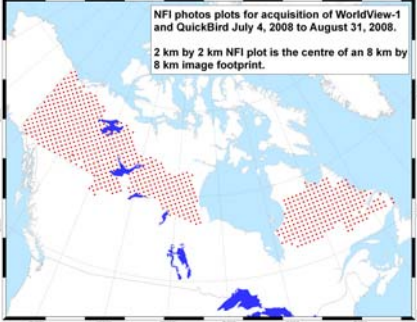
National Forest Inventory: Role for remotely sensed data

- High spatial resolution imagery to complete photo plot requirements.
- Moderate spatial resolution imagery for extension, audit, bias detection, etcetera...

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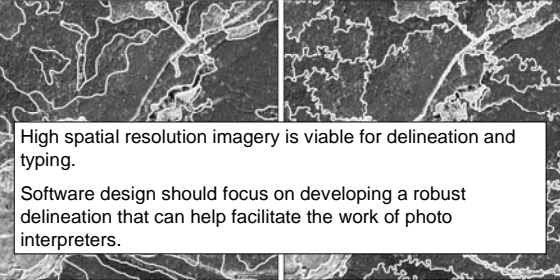


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NFI photos plots for acquisition of WorldView-1 and QuickBird July 4, 2008 to August 31, 2008.
2 km by 2 km NFI plot is the centre of an 8 km by 8 km image footprint.

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High spatial resolution imagery is viable for delineation and typing.
Software design should focus on developing a robust delineation that can help facilitate the work of photo interpreters.

Manual, forest inventory **IKONS Pan** Automated, segmentation

Wulder, M.A., J.C. White, G.J. Hay, and G. Castilla. 2008. Towards automated segmentation of forest inventory polygons on high spatial resolution satellite imagery. *The Forestry Chronicle*, Vol. 84, No. 2, pp. 221- 230.

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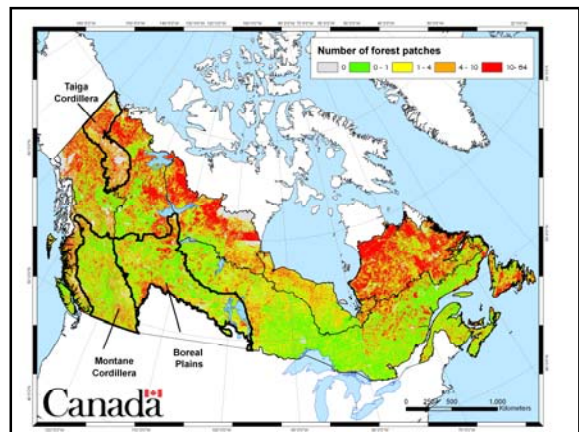
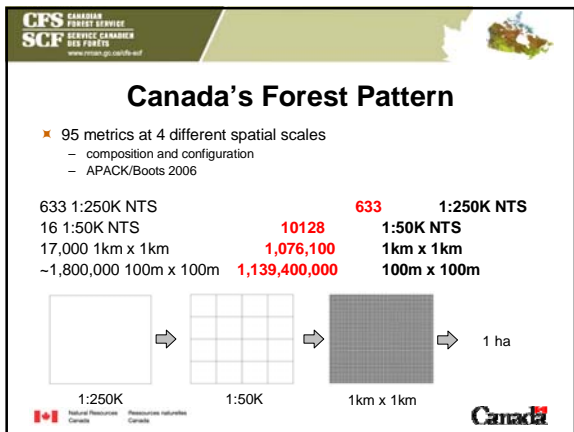
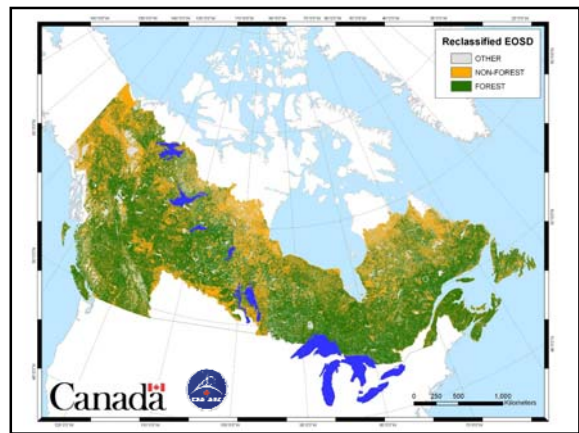
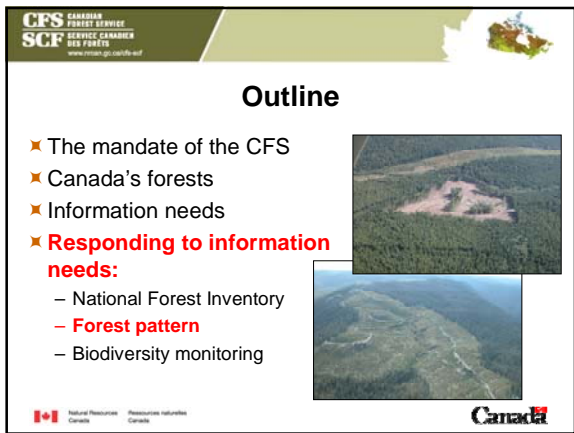
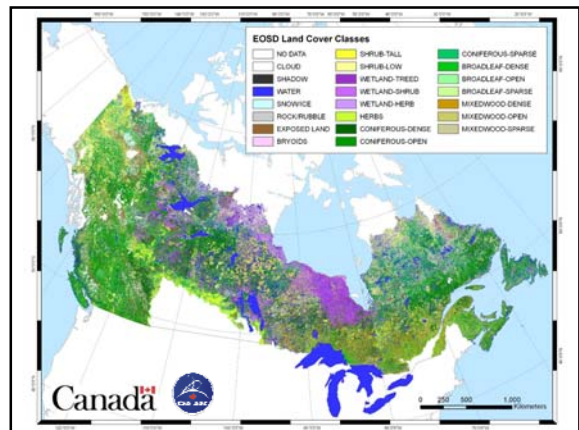
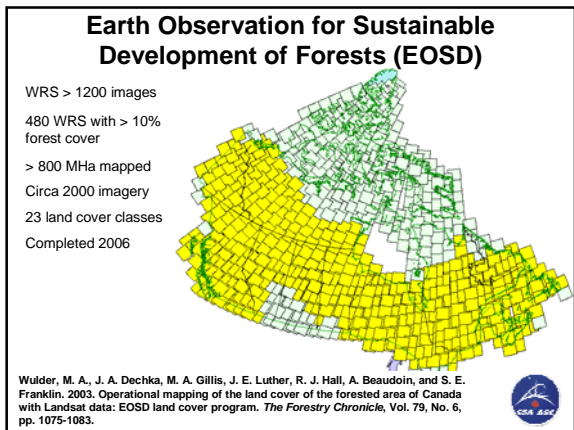
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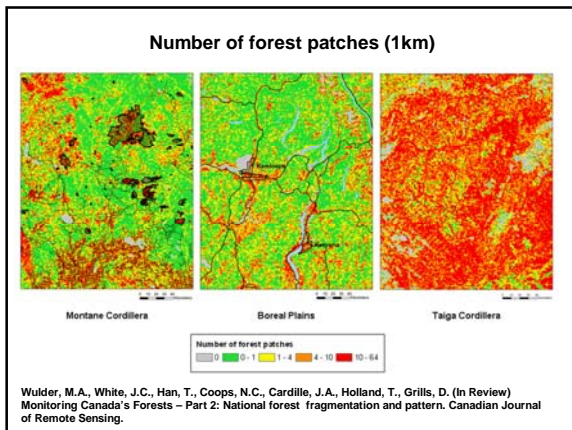
Role of moderate spatial resolution imagery in the NFI

- **Confirm/verify the inventory**
- **Land cover products**
 - Provide basic photo plot data in the North
 - Provide the potential to extend the NFI beyond 1%
 - Opportunities for inventory audit, bias detection
- **Change products**
 - Assess change (quantify location, extent, type)
 - As a coarse filter to identify need to revisit plots

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BioSpace: Biodiversity Monitoring

- ✦ Traditional approaches to measuring biodiversity are useful, but spatially constrained
- ✦ RS offers the opportunity for large area characterizations of biodiversity that are:
 - systematic
 - repeatable
 - spatially exhaustive
- ✦ Rationale:
 - national
 - low-cost
 - current state + change through time

BioSpace: Biodiversity Monitoring

- ✦ Key indicators of diversity that can be derived from Earth observation data include measures of:
 1. topography
 2. vegetation production or function
 3. spatial arrangement and structure of habitat
 4. metrics of disturbance
- ✦ National early warning system, indicating areas where of potential biodiversity change may be occurring.

BioSpace

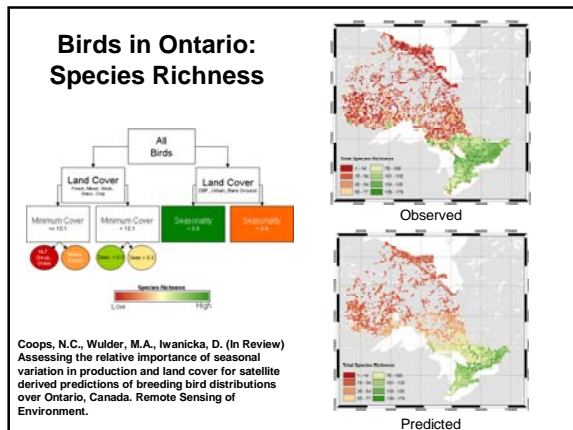
	Topography	Production	Land Cover and fragmentation	Disturbance
Spatial resolution	90 m < 60° N, 1km > 60° N	1000 m	25 m	1000m
Image extent	Canada Wide	All vegetated areas	All forested areas	Canada Wide
Type of data	RADAR	IPAR	Enhanced Thematic Mapper	Greenness and Temperature
Platform	Shuttle	Terra / Aqua / MERIS	Landsat	Terra / Aqua
Temporal	Single	Monthly / Annual	Once	8-day
Cost	Free	Free	Free	Free
Processing	Elevation Residuals	Dynamic Habitat Index (DHI)	Image classification	Disturbance Index

Duro, D.C., Coops, N.C., Wulder, M.A., Han, T. 2007. Development of a large area biodiversity monitoring system driven by remote sensing. *Progress in Physical Geography*, Vol. 31, No. 3, pp.1-26.

Dynamic Habitat Index

1. Cumulative annual greenness
2. Minimum level of perennial cover
3. Degree of vegetation seasonality

Coops, N.C., Wulder, M.A., Duro, D.C., Han, T., Berry, S. 2008. The development of a Canadian dynamic habitat index using multi-temporal satellite estimates of canopy light absorbance. *Ecological Indicators*, Vol. 8, pp. 754-766.



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Summary

- Broad range of information needs and data requirements
 - multi-scale, multi-temporal
 - monitoring through time
- Refinement of existing methods
 - NFI and semi-automated delineation
- Integrating data sources and information
- New applications and value-added
- Data generalization
 - data analysis, information generation, synthesis, and reporting

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All EOSD LC 2000 data available for download, by tile, province, or UTM zone: <http://www4.safarah.org>

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