Using Oblique Historical Photos to Determine Past Mountain Pine Beetle Susceptibility

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burning ecoLogic

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Understanding the Epidemic

• Why is current epidemic so massive?
• Convergence of many factors
• Interruption/alteration of the factors that normally control landscape outbreaks
Cross-scale Drivers of Natural Disturbances Prone to Anthropogenic Amplification: The Dynamics of Bark Beetle Eruptions

KENNETH F. RAFFA, BRIAN H. AUKEMA, BARBARA J. BENTZ, ALLAN L. CARROLL, JEFFREY A. HICKE, MONICA G. TURNER, AND WILLIAM H. ROMME
Figure 2. Thresholds, multiple causalities, and sources of feedback in the population dynamics of bark beetles: Conceptual diagram of the sequence of thresholds (solid boxes) that must be crossed to produce a landscape-scale eruption. Thresholds progress across hierarchical scales from individuals (host entry), through local (aggregation, establishment, reproduction) and transient (stand- and landscape-scale eruption) phases, to regime shifts in the landscape. Arrows indicate internal and external sources of feedback and potential regime shifts. Internal causes include beetle behavior, physiology, host defense chemistry, local beetle density, canopy density, induced defenses, attack density and rate, microbial symbionts, phloem thickness, predators, competitors, microbial symbionts, and beetle physiology. External sources of feedback include drought, biotic stresses on host, temperature, ecophysiological processes, stand dynamics, succession, disturbance, geophysical barriers, anthropogenic activities, and artificially favorable habitats.
Understanding the Epidemic

• Interruption of disturbance dynamics
• Less fire* = more trees. Mostly pine. Mostly beetle food.
• But we have not quantified changes in landscape structure directly (has been inferred, and back-casted, but not directly measured)
Learning from the Past

• What if we could directly measure historical landscape structure?

• Could evaluate many historical changes:
  • Vegetation composition
  • MPB susceptibility
  • Grizzly habitat
  • Caribou habitat
  • Fire risk
  • Fire regimes
Phototopographic surveying: 1880’s-1950’s
Repeat Photography (Mountain Legacy Project): 1998-Ongoing
1. The largest repeat photography project in the world.
2. 140,000+ images from western Canadian mountain regions
3. Taken by several surveyors from the late 19th to the early 20th centuries.
4. Most of these images were taken using 4” by 6” glass plate negatives, which reveal astonishing clarity.
5. 4,000+ of these images have been repeated by taking images from the exact locations as the originals
6. Allows researchers to examine historical landscape change.
Ya-ha Tinda, 1918
M.P. Bridgland
Ya-ha Tinda, 2009
Higgs
Saskatchewan Crossing, 1927
M.P. Bridgland
Meadowland Creek, 2009
Higgs
Meadowland Creek, 1923
Lambert
Meadowland Creek, 2009
Higgs
Moose Mountain, Kananaskis 1895
Wheeler
# Requirements

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<th>Photos</th>
<th>Data/Technology</th>
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<td>Multiple photo stations</td>
<td>Detailed DEM</td>
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<td>Clear images</td>
<td>Readily available software</td>
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<tr>
<td>Original and Repeat images</td>
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<td>Accurate location data</td>
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Snow surface albedo estimation using terrestrial photography

J. G. CORRIPIO*
Department of Geography, University of Edinburgh, Drummond Street, Edinburgh EH8 9XP, UK
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**Process**
- Load Data
- Preview GCPs
- Run
- Zoom
- Accept
- Start Again

**Accessory Function**
- Convert to GeoTiff
- Convert to ASCII

**Help**
- Load Settings
- Save Settings

**Quit**
Analysis of change in treeline location. Moose Mountain Centre, Image 12-3

After georeferencing, the vectors drawn in the images can be examined in a GIS (shown in bottom image, overlain on DEM). The treeline vectors within the green square are shown in black line (1895-1897), and orange (2009).
Georeferencing accuracy

White dots = reference point located from oblique image
Red dots = “real world location” of reference points (from orthophoto).

Error = 37.7m (+/- 4.9m MSE)
Georeferencing Oblique Historical Photos to Document Century-scale Changes in Foothills and Rocky Mountain Ecosystems

PhD study:
Chris Stockdale
(supervisor Ellen MacDonald)

Funded by:
NSERC
Stay tuned!

Much more to come by ~2014?