

Post-Wildfire Mass Movement and Erosion Events in British Columbia, 2003–2009

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Outline:

- Landslide incidents after the 2003 fires
- Risk analysis procedure for post-wildfire natural hazards
- 2007 fires in the West Kootenays – application of the procedure
- Research project on post-wildfire runoff, erosion, and mass wasting processes
- Landslide events following the 2007 fires



Events following the 2003 wildfires:

Kuskonook debris flow, August 2004 – two houses destroyed, other buildings damaged, Highway 3A closed for several days. Water repellent soil in headwaters area, severely burned by 2003 fire, was identified as the main cause of the event. A high intensity rainstorm was the trigger.





Landslide / erosion / flood events following 2003 fires

- Okanagan Mtn. Park Fire - 2003
- Cedar Hills - 2004
- Strawberry Hills - 2004
- Kuskonook - 2004
- Lamb Creek - 2004
- Vaseux - 2004
- Hellroar Creek - 2005
- McLure Fire - 2005
- McGillivray Fire - 2005
- Mt Ingersoll Fire - 2005



Risk analysis procedure for post-wildfire natural hazards: Outline of the risk management process

- What is risk?
Risk = Hazard X Consequence
(e.g. probability of a hazardous event occurring X probability of the event impacting the element at risk)
- Communication with stakeholders about risks is important at all stages.
- MFR risk analysis procedure only deals with the first 3 steps.
- Steps 4 – 6 include evaluating whether or not risks are tolerable, developing strategies to control or mitigate risks, and acting on these strategies.

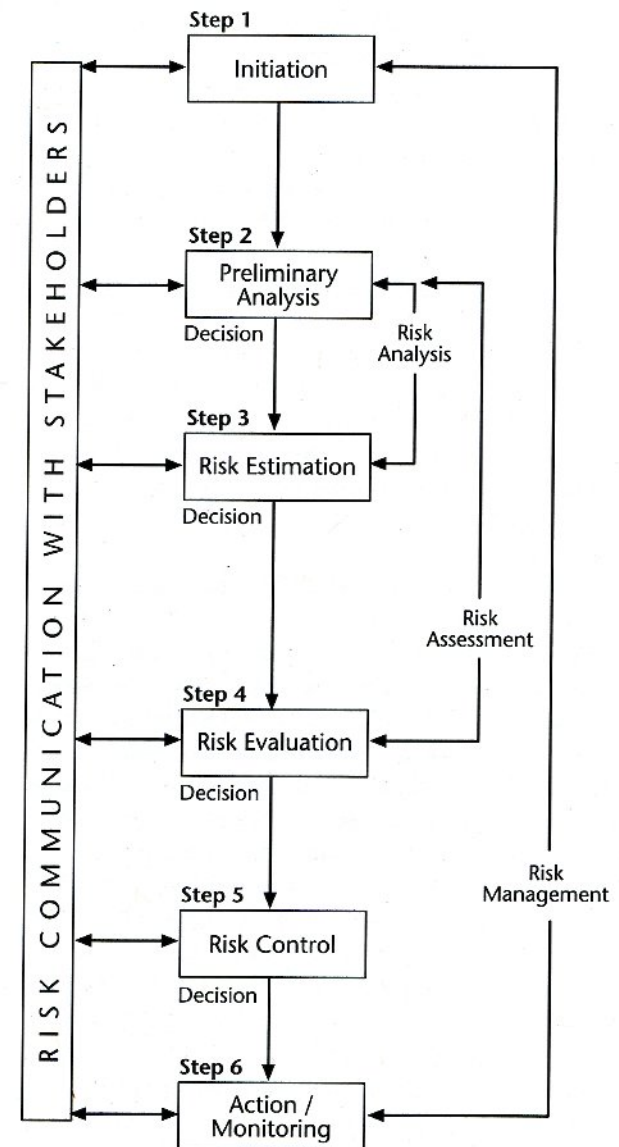


FIGURE 2 Six steps in the decision-making framework for risk management (adapted from CSA 1997).

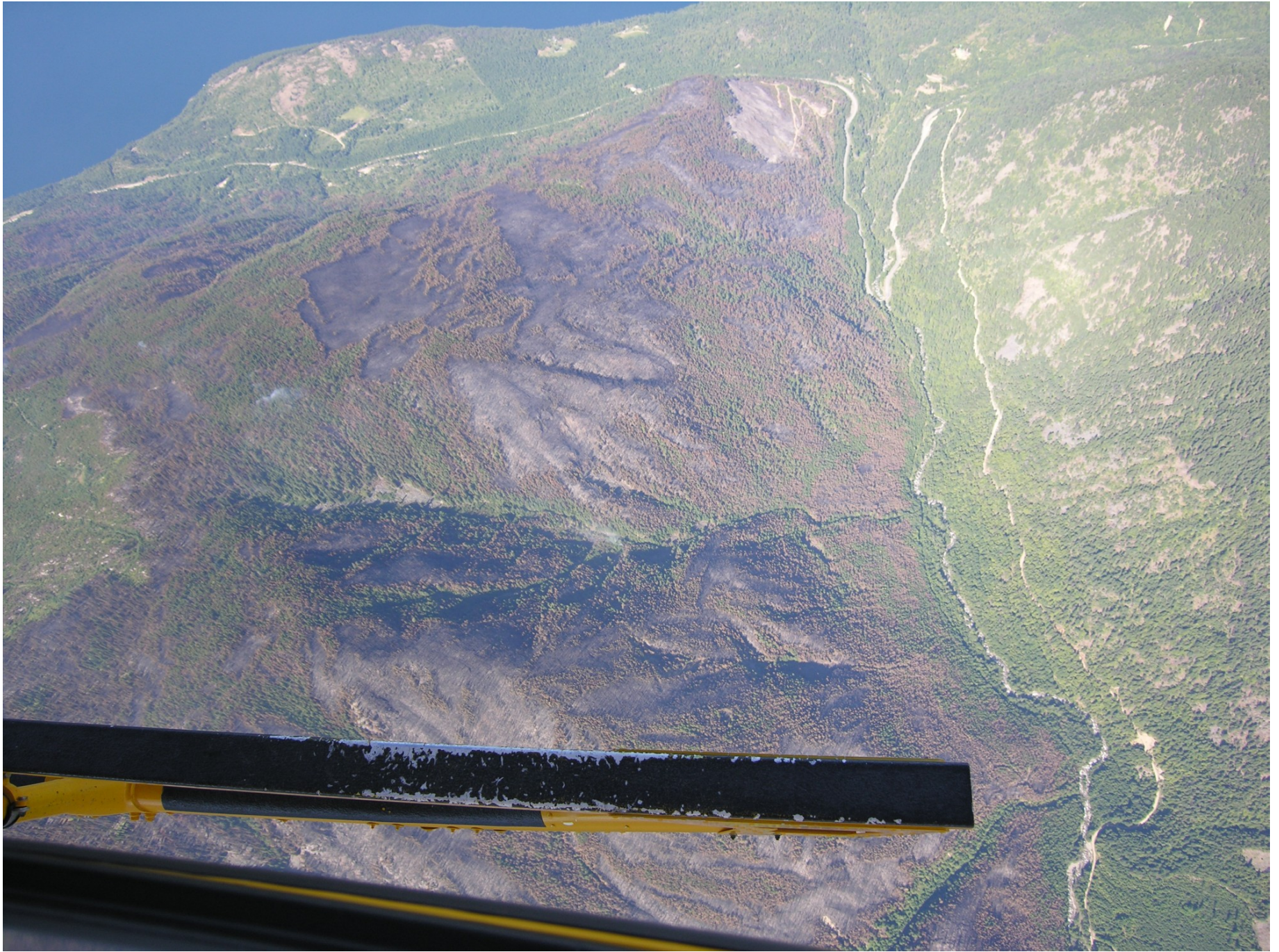
Risk Analysis Procedure:

- Based in part on the US Forest Service BAER (Burned Area Emergency Response) program.
- Screen all fires using the Protection database – typically include all interface fires, and fires >100 ha near highways, in community watersheds, etc.
- Preliminary flyover or ground reconnaissance if there is a concern.
- A risk analysis is conducted where warranted (soil, stream channel, or landslide hazards and consequences).
- The main objective is to identify risks, and warn or inform affected stakeholders.
- Risk reduction or mitigation strategies depend on stakeholder involvement (e.g. land owners/managers).

Risk Analysis – Springer Fire 2007



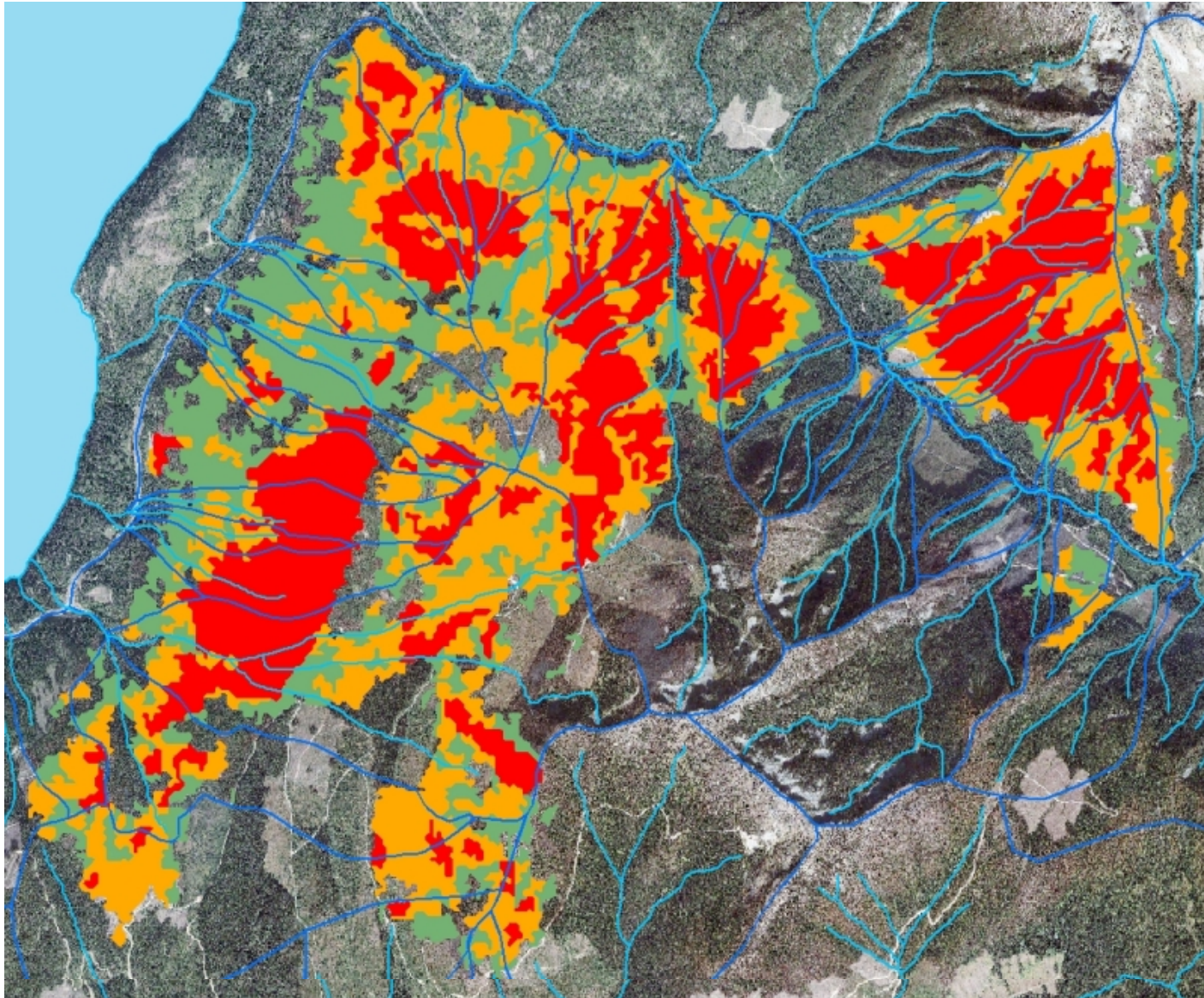
Fire N50372, 8 km north of Slocan



Springer Fire – Vegetation Burn Severity Map

Quickbird satellite image Sept 2007, purchased by Southeast Fire Centre

BARC (Burned Area Reflectance Classification) mapping from Landsat imagery, provided by US Forest Service



Risk Analysis – Springer Fire



- Ground truth burn severity maps
- Test for water repellency
- Assess hazards

Risk Analysis - Springer Fire 2007



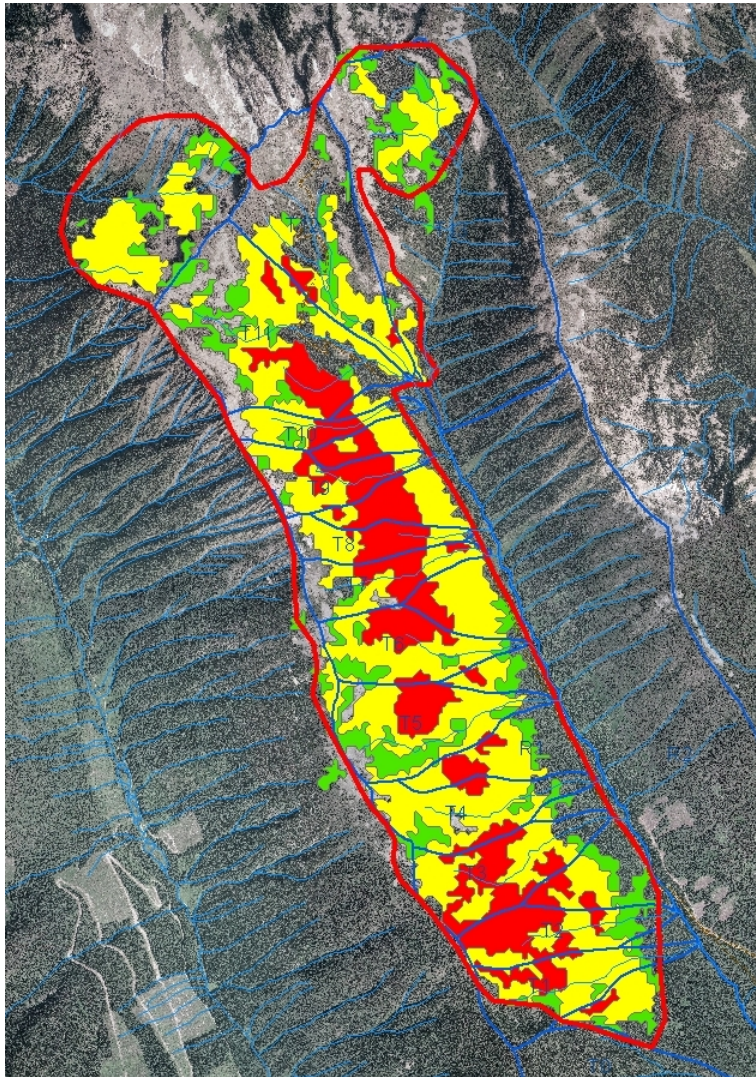
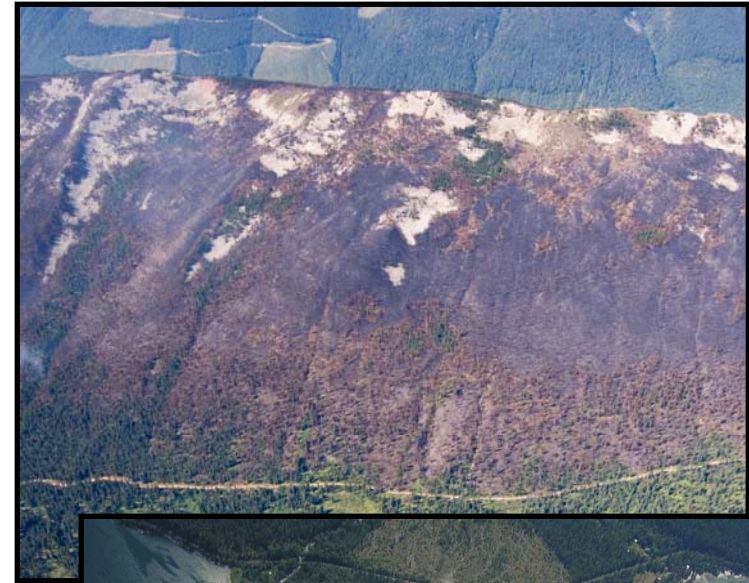
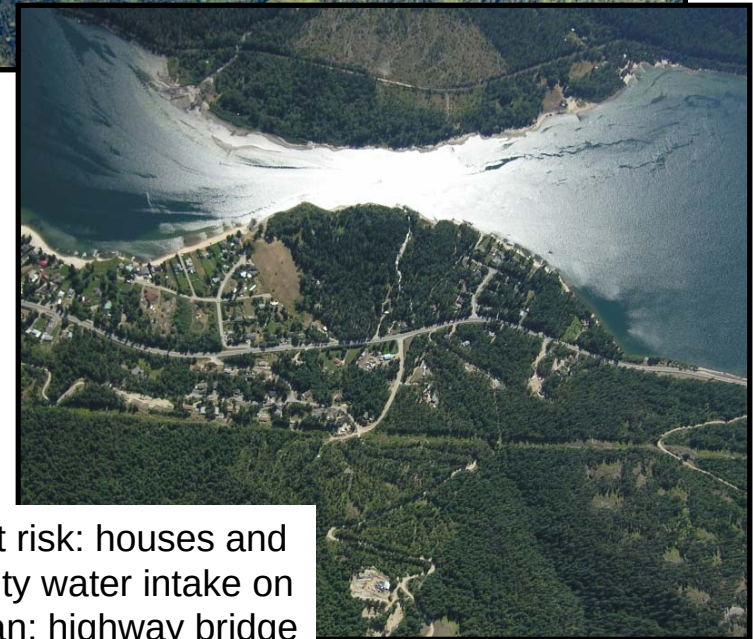
Risk Analysis – Sitkum Fire 2007



Fire N70347, 15 km north of Nelson

Sitkum Fire 2007

39% of the Sitkum Creek watershed was burned.



Values at risk: houses and community water intake on alluvial fan; highway bridge

Mitigation works:

- At the Springer and Sitkum Fires, this included deactivation of old roads, and erosion control in selected high-risk areas. Broadcast treatment of high-severity burned areas with aerial straw mulching was used on parts of these burns.



Research project:

A study of post-wildfire runoff, erosion, and mass wasting processes received three years of FIA-FSP funding beginning in 2007.

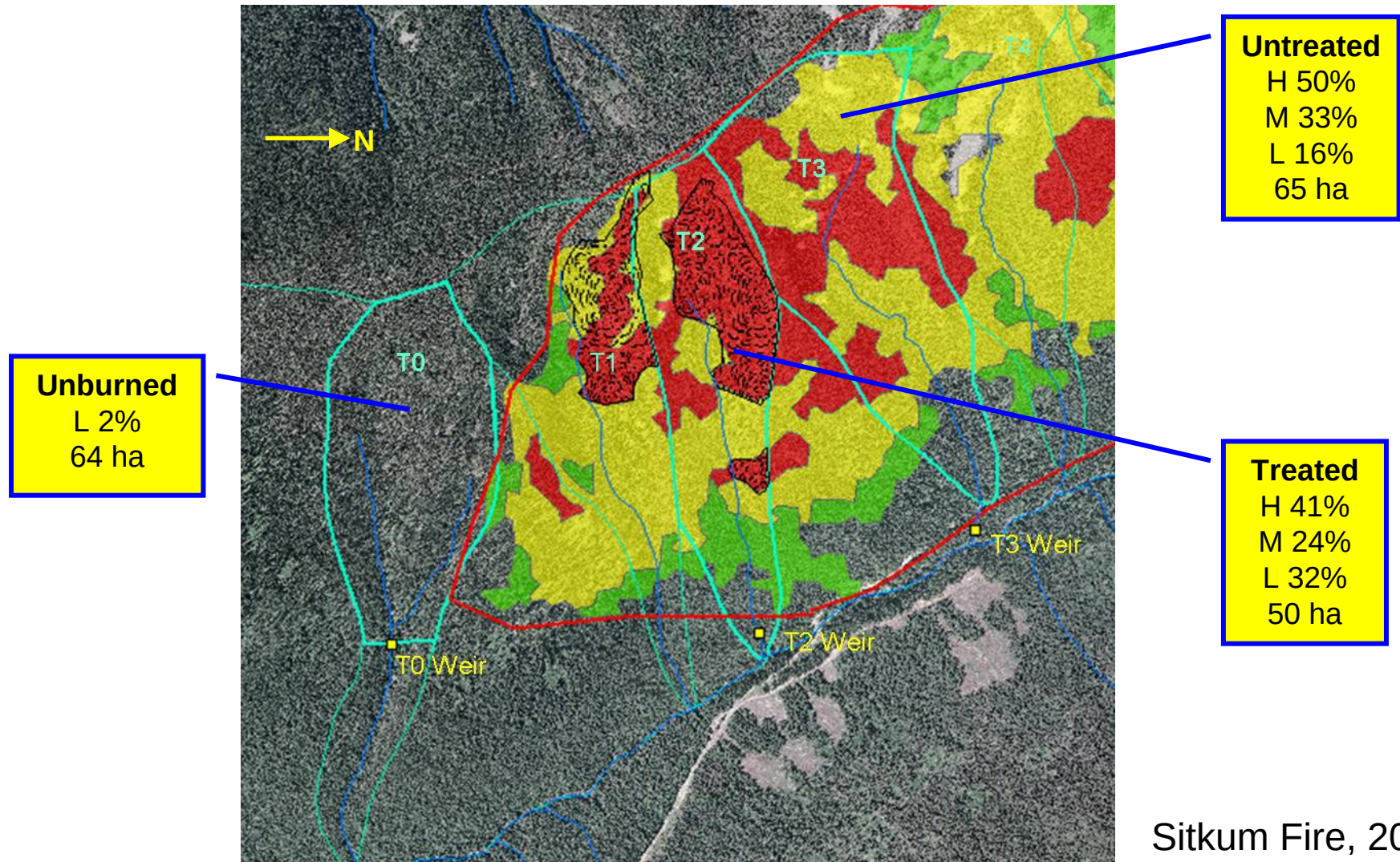
Study team: Peter Jordan, Ashley Covert, Mike Curran, Amy O'Neill
(Southern Interior Forest Region, Nelson)

The study addresses the following questions:

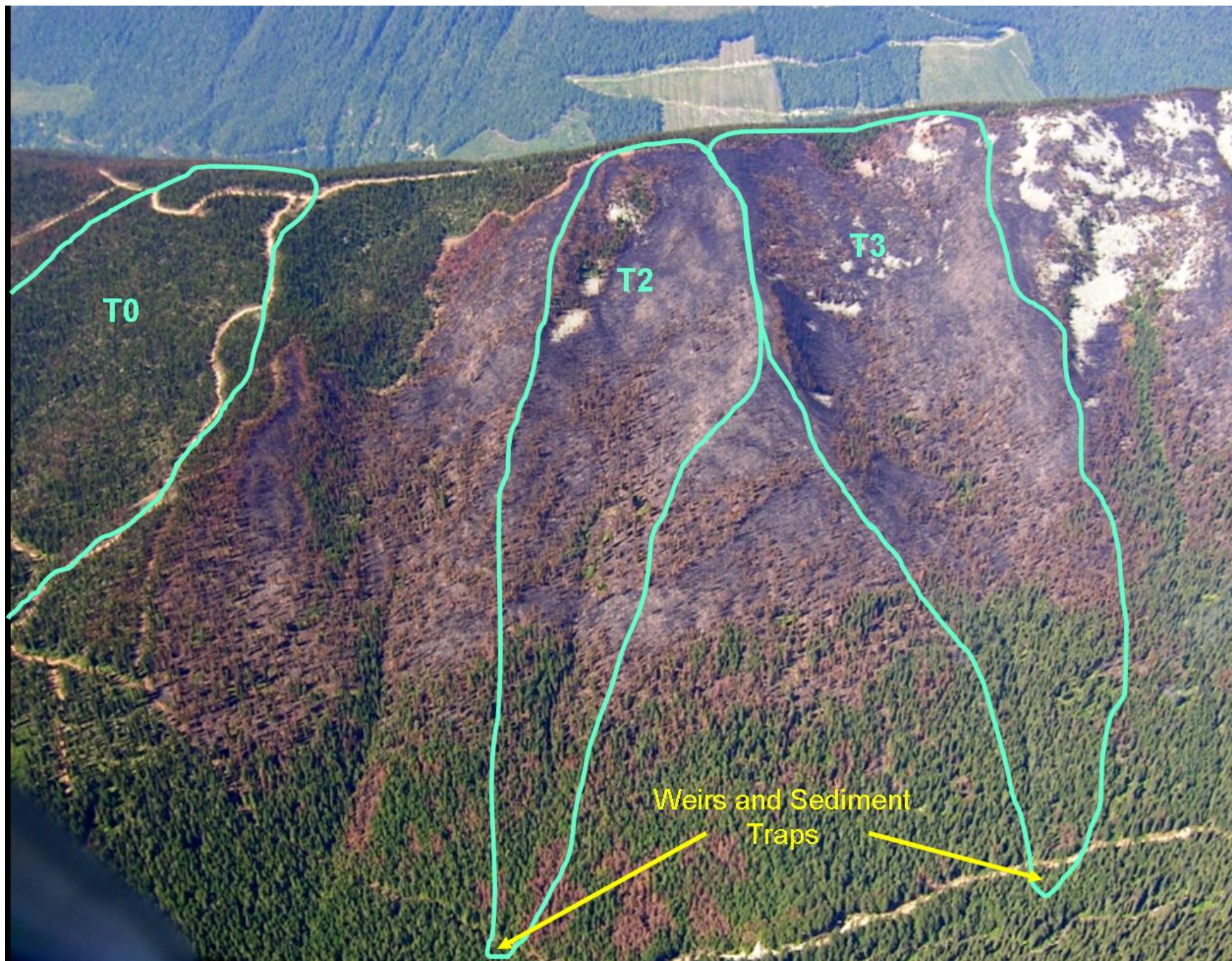
- What burn severity and extent is necessary to generate substantial overland flow?
- What are the roles of water repellent soils, loss of forest floor, and other factors such as plugging of soil pores?
- What are the best ways to measure and map post-fire soil hydrologic changes?
- What is the influence of pre-fire weather and soil moisture on soil burn severity?
- What rainfall intensities are necessary to produce overland flow and trigger mass movement events?
- How long does hydrologic recovery take after fire?

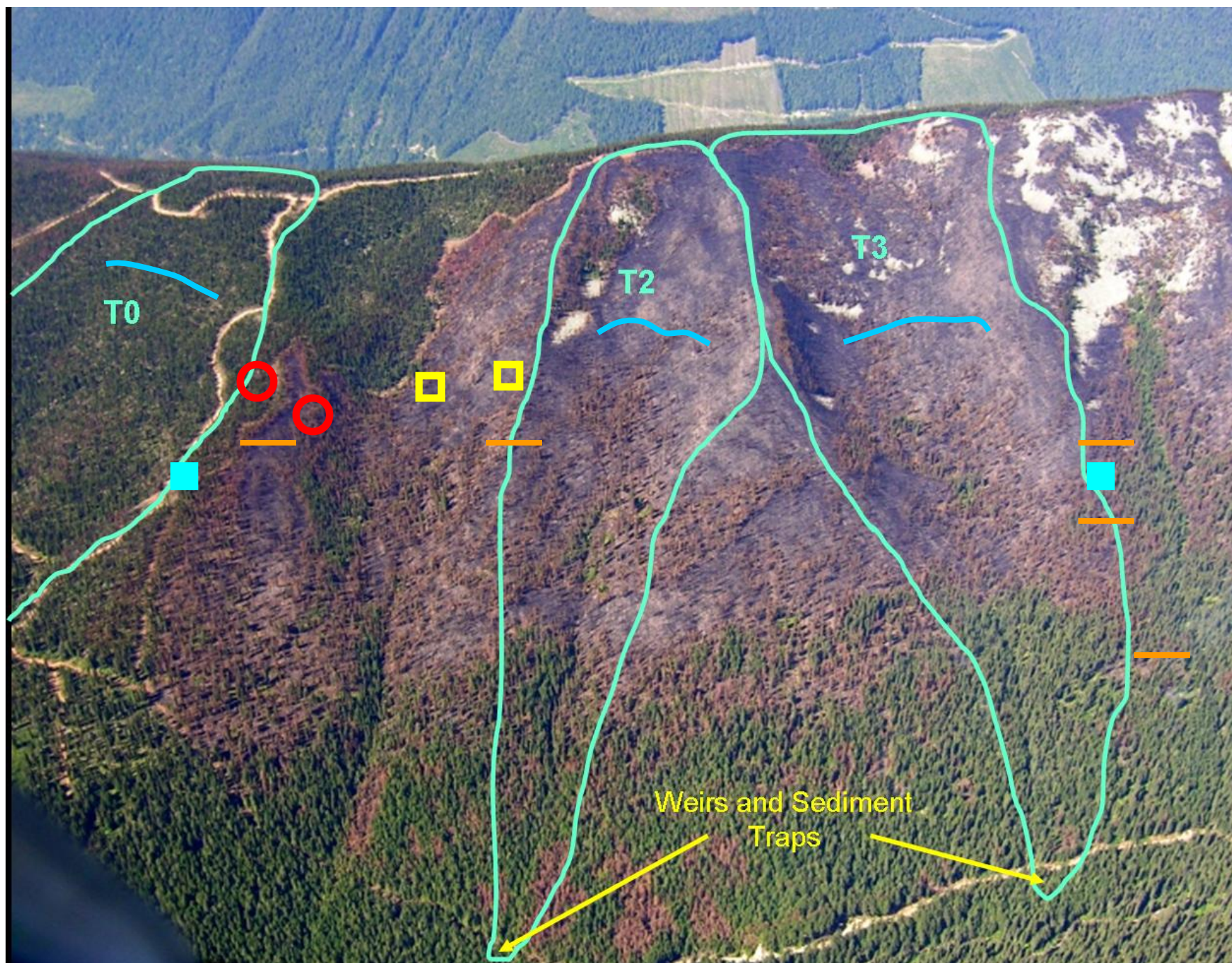
What roles do forest canopy loss, and extent of burn severity, have in peak streamflow, channel instability, and sediment yield?

- “Paired” Watershed Study



Sitkum Fire, 2007















Landslide events following the 2007 fires

Fall 2007: Springer fire – large debris flow in steep gully

Spring 2008: Springer fire

- large debris flow originating in severely burned, “gentle-over-steep”, previously logged area
- small debris slide from an old landing

Sitkum fire – debris slide from mining road, into creek

Summer 2008: Springer fire

- two large and several small debris flows in steep gullies



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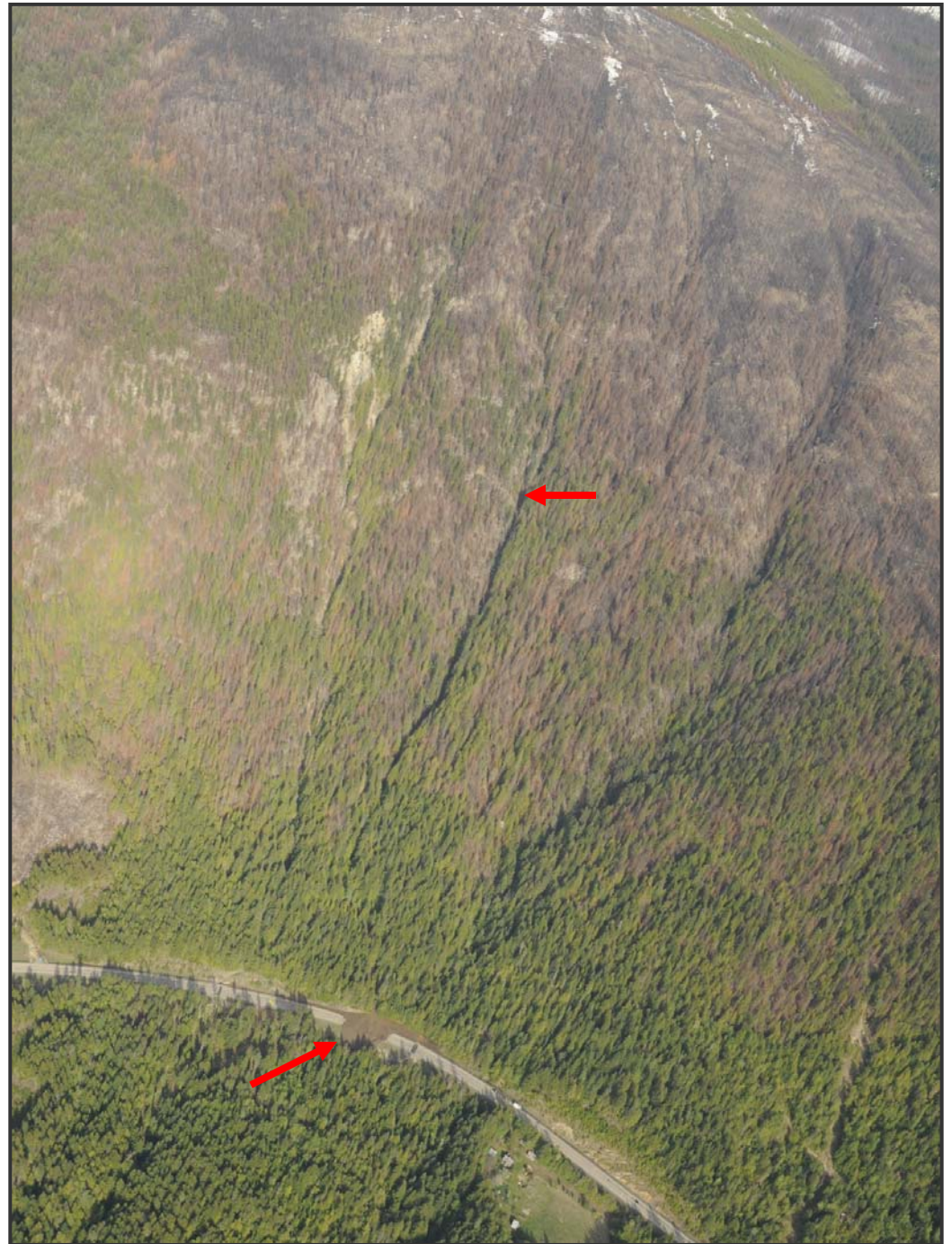
Springer fire: September 2007

- debris flow in steep, rocky gullies
- triggered by the first minor rainshower after the fire was out
- probable initiation mechanisms – sediment bulking in multiple headwater gullies; possible overland flow from water repellent soil on ridge



Springer fire: May 2008

- Large debris flow (5000 m³) during spring snowmelt
- unusually rapid melt, 30°+ weather



Probable causes:

- increased snow accumulation and snowmelt rate in burned area
- drainage diversions from roads, trails, and landings in old logging

Other events in May 2008:

- small debris slide in old trails and landing



Sitkum fire: debris slide on road; probable high groundwater levels due to snowmelt from burned area above



Springer fire: Summer 2008

- two large debris flows (1000 m³ +, several small debris flows



Events following 2003 fires: 16 significant documented events

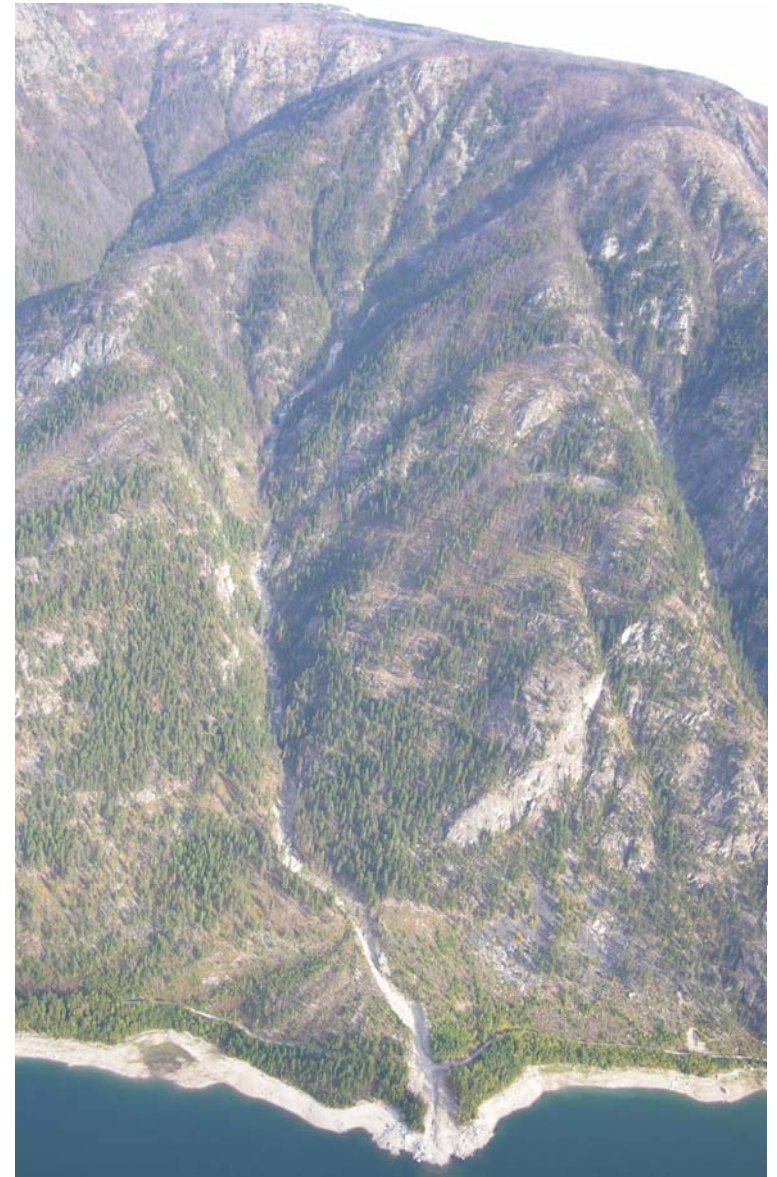
- 8 debris flows
- 6 debris floods
- 2 debris slides/avalanches



Initiating mechanisms:

Peak flow in channel

2003 Ingersoll fire – debris flows in October 2005



Progressive sediment bulking from soil erosion

2003 Cedar Hills fire, June 2004 debris flood/flow events



Photos: Bill Grainger

Infiltration-triggered debris slides or debris avalanches

– typically occur downslope from areas of enhanced runoff

2003 Ingersoll fire – debris avalanche below point of drainage diversion by logging road



Summary of initiating mechanisms: (post- 2003 and 2007 events)

- Peak flow in channel (runoff-triggered) 13
- Sediment bulking – from soil erosion 1
- Sediment bulking – in steep gully headwalls 3
- Debris slide/avalanche (infiltration-triggered) 5

Conclusions:

- There are three main mechanisms for initiation of post-wildfire debris flows (and debris floods) in this region: peak flow in channels; sediment bulking from soil or channel erosion; and infiltration-caused debris slides.
- Post-wildfire events have occurred in 3 meteorological circumstances: high-intensity summer rainstorms; low-intensity fall frontal rainstorms; and spring snowmelt.
- Several significant events have been caused by drainage diversions on inadequately-deactivated logging roads. This demonstrates that engineering treatments (e.g. road deactivation, drainage structure upgrades) are at least as important as broadcast treatments.