Figure LA-1. A 3-D view of the Moose burn, northwest Montana, taken by Landsat ETM+ on 9 September 2001. On the left, spectral Band 4 and Band 7 are displayed as a composite of green and red, respectively. On the right, differencing the NBR before and after fire has derived an initial assessment of burn severity. The gradient of differenced NBR has been stratified to identify burn severity levels, including: unburned, low (green), moderate-low (yellow), moderate-high (orange), and high (red).

Figure LA-2. The Kootenai Complex from the interior of Glacier National Park captured by Landsat 12 Sept. 1999, a year after the fire. The range of colors within the perimeter shows patterns of burning, gradations of reddish-brown (no burn to low severity) through dark blue (high severity). Information about how the fire interacted with the landscape is also evident. Red areas are perennial snowfields and glaciers nestled among the rocky peaks (light blue to white).

Figure LA-3. This mosaic of two Landsat 7 ETM+ scenes from 12 Sept 1999, shows the Yukon Charlie region of Alaska. Nine large burns are clearly visible (dark purple) from fires earlier in the summer. This type of remote sensing data allows managers to discover details of burns, like these, which because of daunting logistics, may never be visited on the ground. The challenge has been to find the best measure of severity from such data, and to develop protocols that offer standardization, so burns can be compared spatially and temporally.

Figure LA-4. These images show the Anaconda burn area, on the west side of Glacier National Park, on 10 July 1999 (left) soon before the fire, and on 25 June 2000 (right) about nine months after the burn. The light area above is a 1994 burn still evident on the landscape. Clouds appear as bright white in the 2000 image. Knowledge of pre-fire conditions allows one to gauge severity through change detection techniques, and explore relationships between burn patterns and vegetation structure and composition.

Figure LA-5. Fire creates heterogeneity on the landscape. How does one define severity so this mosaic of effects can be mapped across broad regions? Viewed from space, features on the ground become aggregated across multiple levels to make up the spectral signals received by satellite. Upper canopies are important, but so too are lower strata that may show through the canopy, or become more prominent after fire. To assess severity, key features within each stratum are evaluated that have relevance to ecological effects on the site, as well as potential for contributing to the satellite signal.

Figure LA-6. A hypothetical 30x30 meter forest site experiences a fire. Short-term severity reflects change to pre-fire community components (vertical bars). Long-term, it reflects both that change, plus unique site conditions that prevail into the future. In reality, many response variables are aggregated over many strata of the forest to determine the overall severity on the site.

Figure LA-7. Change in band reflectance and the variation from before to after fire is indicative of each band's information content for severity. This example is typical for most burns. R4 shows the greatest decrease while R7 has the greatest increase after fire. Their difference, then, yields the greatest range of change across all bandwidths.

Figure LA-8. Seasonal difference in phenology is evident in false-color Landsat images from the Lamar Valley of Yellowstone National Park, Wyoming. The unburned landscape is not static as communities progress from productive (left) to unproductive states (right).

Figure LA-9. Initial and extended assessments require imagery from different periods before and after fire. The timing significantly affects what the NBR is measuring; see below for details.

Figure LA-10. Pre- and post-fire images of NBR illustrate A) values near zero from old burn; B) highly positive values of living vegetation; and C) strongly negative values of recent burn. Compare with figure LA-4 showing false-color composite images of this area.

Figure LA-11. The difference of NBR images from figure LA-10 yields a gradient of detected change. A) medium-gray areas are near zero, indicating no change; B) lighter gray is moderate change; C) near-white is highly positive, indicating a large magnitude of change. D) is cloud in the post-fire dataset.

Figure LA-12. Enlargement of figure LA-11 showing detail of the digitized perimeter, see text.

Figure LA-13. Frequency distribution of pixel values within two burns from1994 in Glacier National Park, Montana. Starvation had proportionately more area burned at higher severity than Adair.

Figure LA-14. Stratified delta NBR image (left) and the data masked by the burn perimeter (right). Severity levels were derived from thresholds in table LA-2, showing unburned, low, moderate-low, moderate-high, and high as gray, green, yellow, orange, and red, respectively. Areas outside perimeter with elevated values are relatively easy to discern as snow, clouds, or dry patches away from the burn, refer to figure LA-2.

Table LA-1. Three composite levels (A-C) encompass the five strata level (1-5). CBI scoring is completed for each strata and averaged to the desired composite level.

<table>
<tr><td rowspan="5">A. Total Plot</td><td rowspan="3">B. Understory</td><td>1. Substrates</td></tr>
<tr><td>2. Herbs, Low shrubs Shrubs and Small Trees less than 1 meter</td></tr>
<tr><td>3. Tall Shrubs and Sapling Trees 1 to 5 meters</td></tr>
<tr><td rowspan="2">C. Overstory</td><td>4. Intermediate Trees (pole-sized trees, subcanopy)</td></tr>
<tr><td>5. Big Trees (mature, dominant/co-dominant, upper canopyupper canopy, dominant/co-dominant trees)</td></tr>
</table>

Table LA-2. Ordinal severity levels and *example* range of ΔNBR (scaled by 10^3), to the right.

Severity Level	Δ**d**NBR Range
Enhanced Regrowth, High	-500 to -251
Enhanced Regrowth, Lo	-250 to -101
Unburned	**-100 to +99**
Low Severity	+100 to +269
Moderate-low Severity	+270 to +439
Moderate-high Severity	+440 to +659
High Severity	+660 to +1300

(**dNBR** value ranges are flexible; scene-pair dependent; shifts in thresholds ±100 points are possible. **dNBR** less than about -550, or greater than about +1350 may also occur, but are *not* considered burned. Rather, they likely are anomalies caused by miss-registration, clouds, or other factors not related to real land cover differences.)