Implementation of remote sensing techniques for invasive species management

PI: Dr. Nancy Glenn, Idaho State University – Boise, Department of Geosciences
208.345.1994, glennanc@isu.edu

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The primary technical objective for this project was to identify and map leafy spurge in select areas of Clark County using remote sensing imagery. Major project activities included field data collection and image acquisition during summer 2006 and image processing and map production from fall 2006 through summer 2007. Preliminary results were presented to project collaborators during an outreach meeting held in late February 2007. In October 2007, ISU graduate student Jessica Mitchell presented a talk (http://bcal.geology.isu.edu/docs/ESS_MF_Presentation.pdf) and a poster (http://bcal.geology.isu.edu/docs/ESS_Poster_jm.pdf) on the USDA sponsored work at the Inland Northwest Research Alliance Environmental Sensing Symposium. In November 2007, Jessica and PI Nancy Glenn met with the Clark County Soil Conservation District in Dubois, Idaho to discuss the project and provide leafy spurge occurrence maps. Finalized map products (Figures 1 and 2) and electronic data were delivered to interested parties in spring 2009 (Appendix A). In addition, this project resulted in the publication of two peer-reviewed papers in which NRCS support was cited (see Literature Cited) and completion of an ISU MS in GIScience thesis by Jessica.

Accomplishments as they relate to original project objectives and deliverables are as follows:

- ***Maps (hard-copy and electronic) of distribution of leafy spurge (Euphorbia esula) in select areas within Clark County (west of Dubois) based on hyperspectral remote sensing imagery and field analysis.*** The majority of project activities were related to the development of leafy spurge distribution maps, including study area selection/ site investigation; hyperspectral image acquisition; field data collection (111 circular plots 7.32 m in radius); and image analysis. The map products depict locations in Medicine Lodge and Spencer, Idaho where image analysis predicted the presence or absence of leafy spurge (see below).
- ***Accuracy of the maps quantitatively describing the relationship between remote sensing prediction and field validated leafy spurge locations.*** The accuracies of these remote sensing predictions were quantitatively described by comparing remote sensing predictions to data collected on the ground. The Medicine Lodge map correctly classified 85% of the pixels in the study area and the Spencer map correctly classified 67% of the pixels in the study area (see Mitchell and Glenn 2009a).
- ***Identification of leafy spurge detection thresholds for multispectral data for operational implementation.*** Leafy spurge presence/ absence thresholds were determined using ground reference data and the classification technique mixture-tuned matched filtering (MTMF). MTMF classifications indicated that current multispectral sensors such as the Landsat 5 Thematic Mapper are inadequate for regional distribution monitoring of leafy spurge; however a sensor with comparable resolutions but improved instrumentation (e.g., improved

signal to noise) may offer an alternative to hyperspectral data for mapping leafy spurge at regional scales. See Rangeland Management and Ecology publication (Mitchell and Glenn 2009a) for detailed discussion.

- ***Map identifying 'hot spots' (areas) with high likelihood of future invasion of leafy spurge.*** Invasion susceptibility was initially investigated by exploring geostatistical techniques and statistically comparing field data (percent cover, species richness, number of natives/non-natives, shrub cover, etc) to identify leafy spurge predictor variables. There was a weak but significant relationship between shrub cover and leafy spurge occurrence. Hotspot mapping was ultimately replaced by subpixel unmixing research using matched filter maps generated from the MTMF classifications. Each MTMF classification generates a matched filter (MF) image wherein each pixel is assigned a probability value, of which the maximum is 1.0. Probability values can be loosely interpreted as the degree of match between a pixel and an ideal target, or an estimate of target abundance (Mitchell and Glenn 2009b).
- **At least one outreach meeting per year describing project and demonstrating technology to CWMAs.** A project meeting was held in February, 2007 with USDA, USFS and Clark and Bonneville Counties. Project results were presented at a Clark County Soil Conservation District meeting held in November 2007. We also met informally several times to discuss the project with USFS Dubois Ranger District (Shane Jacobsen); Continental Divide Weed Management Association (Keith Bramwell); and Bonneville County Weed (Jeffrey Pettingill).
- **All field and remote sensing data made freely available on website.** Web-access to field and remote sensing data is currently unavailable; however, the information remains freely available (via email, ftp or DVD) to anyone who requests it.

This project, funded by the Conservation Innovative Grant program and financial matches from Bonneville County Weed, Continental Divide Weed Management Association, and Idaho State University, successfully transferred demonstrated remote sensing technology to public and private lands in Clark County, Idaho for leafy spurge detection. The remote sensing flightlines were strategically developed to directly benefit EQIP eligible landowners as well as the BLM and the USFS. Weed managers have been provided up-to-date high resolution maps of leafy spurge distribution that highlight previously unknown invasions in remote areas. These distribution maps were well received by the weed management community because they validate suspected invasions in remote areas. The leafy spurge distribution maps have also be useful in identifying invasions of immediate concern and will serve well as a baseline for evaluating current and future treatment strategies.

Literate Cited

Mitchell, J., and Glenn, N.F., 2009a., Leafy Spurge (*Euphorbia esula* L.) Classification Performance Using Hyperspectral and Multispectral Sensors. *Rangeland Ecology & Management*, 62: 16-27. http://bcal.geology.isu.edu/docs/Mitchell_Glenn_REM_2009.pdf

Mitchell, J. J. and Glenn, N. F. 2009b. Subpixel abundance estimates in mixture-tuned matched filtering classifications of leafy spurge (*Euphorbia esula* L.). *International Journal of Remote Sensing*, in press.

Appendix A
List of Interested Parties Who Received Mapping Products / Technology Transfer

1. Shane Q. Jacobson, Sup. Natural Resource Specialist, Dubois Ranger District , USFS
   - Digital data and posters (delivered in person)

2. Bo Billman, Clark County Weed Superintendent
   - Digital data and posters (delivered in person, left w/ office assistant)

3. Steve Smart, Natural Resources Conservation Service Project Coordinator, Rexburg, Idaho.
   - Digital data and several posters for distribution (delivered in person)

4. Jeffrey Pettingill, Bonneville County Weed Superintendent, Idaho Falls, Idaho.
   - Digital data and posters (delivered in person)

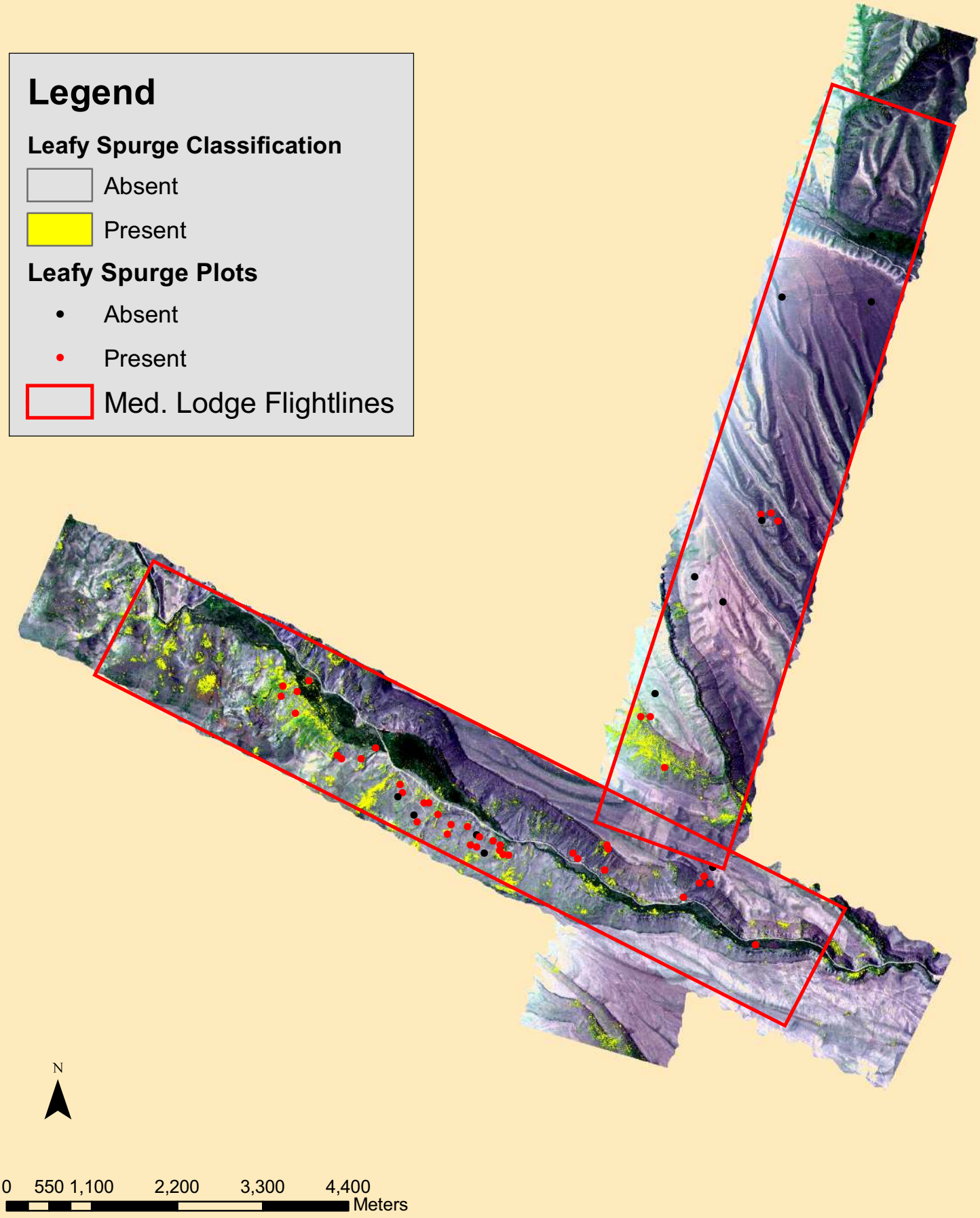
5. Scott Minnie, Range Conservationist, Bureau of Land Management, Idaho Falls, Idaho.
   - Digital data (delivered in person, left w/ colleague)

6. Kim Goodwin, Project Coordinator, Dept. Land Resources & Environmental Sciences, Montana State University, Bozeman, MT.
   - Digital data (sent USPS w/ coverletter)

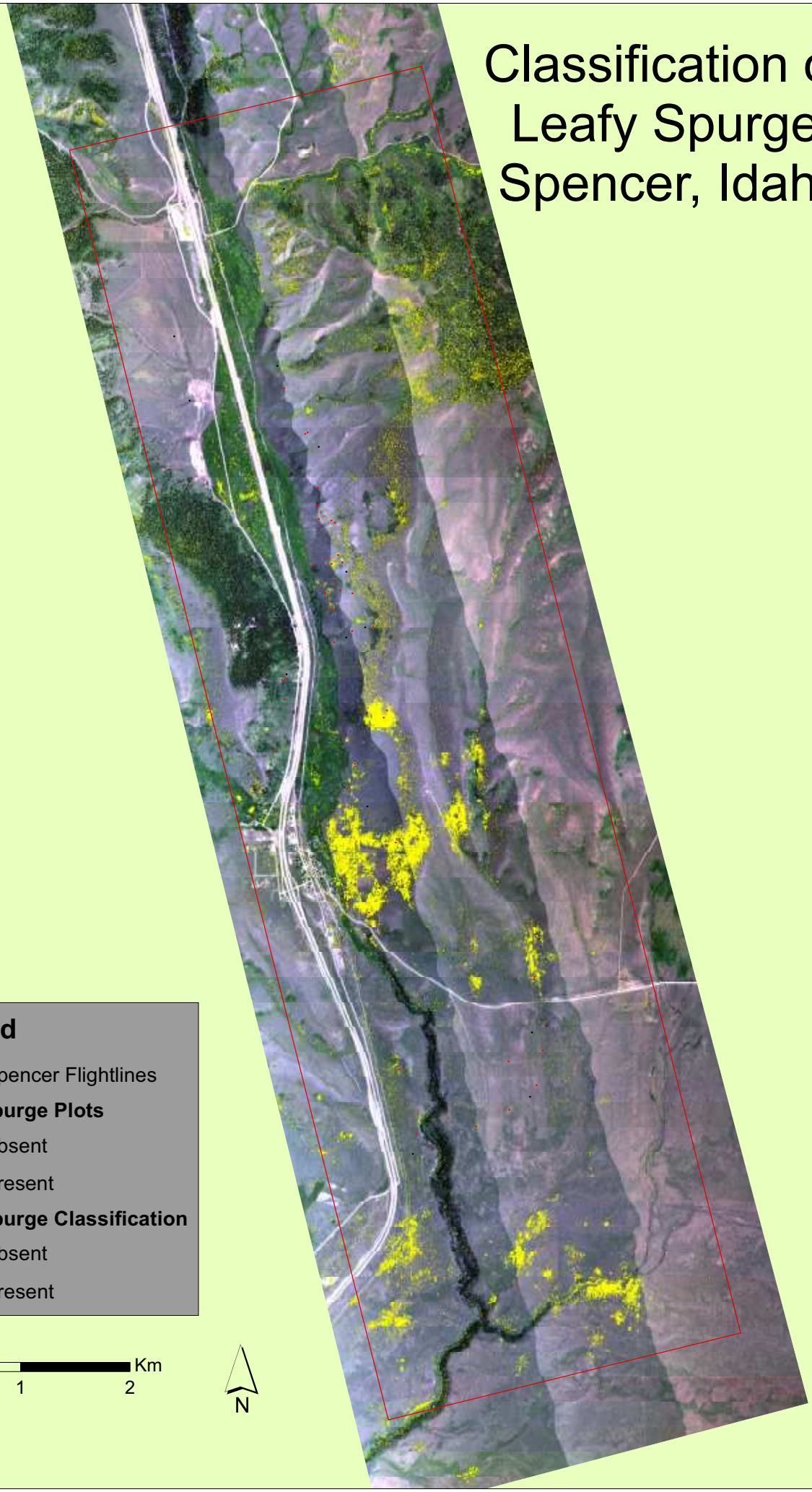
7. Keith Bramwell, Continental Divide Weed Management Association, Dubois, ID
   - Digital data and posters (sent USPS w/ coverletter)

8. Paul Muirbrook, Bingham County Weed Superintendent, Bingham County, ID
   Digital data and posters (delivered in person)

Hyperspectral Classification of Leafy Spurge in Medicine Lodge, Idaho



Classification of Leafy Spurge, Spencer, Idaho



Legend

Spencer Flightlines

Leafy Spurge Plots

Absent

Present

Leafy Spurge Classification

Absent

Present

0 0.5 1 2 Km

N