

Title: Deploying ArcPad for Noxious Weed Population Monitoring

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Abstract

Noxious weed surveys were performed in the upper North Fork of the Feather River (hereafter referred to as the study area), 35 miles east of Oroville, California in the fall of 2003. ArcPad 6.0.2 was deployed to document all rated noxious weed species as defined by California Department of Food and Agriculture (CDFA), California Exotic Pest Prevention Council (CalEPPC) and the Plumas National Forest (PNF). The study area totaled 1,585 acres (2.5 square miles) bisected by the Feather River. Biologists mapped weeds using handheld iPAQ PocketPC (PDA's) equipped with battery packs and Pharos GPS receivers. Orthorectified natural color aerial photographs were used as base maps and a custom form was populated with information about the weed infestations from a pull down list that included details such as weed name, associate weeds, and population size. The survey provides baseline information to kick-off a weed-monitoring program in the study area.

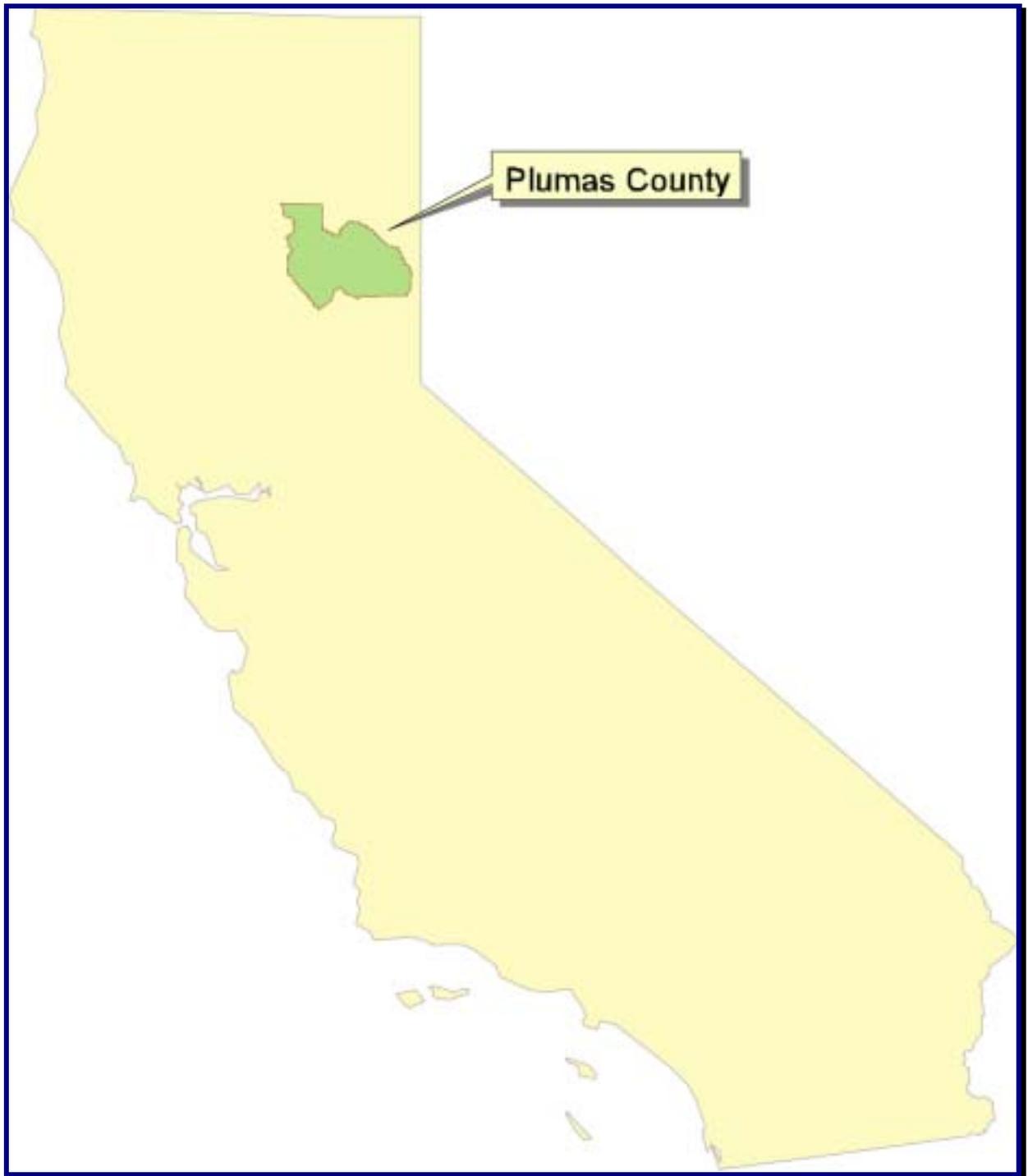
Study Description and Purpose

Noxious weed surveys and mapping work were conducted by teams of botanists from July through September 2003 in a project area covering approximately 1,585 acres of land within the North Fork Feather River (NFFR) watershed (figure 1). The NFFR watershed area contains a variety of natural habitats typical of the northern Sierra Nevada, ranging from mixed conifer forest to riparian habitats. The survey area extends from an elevation of approximately 1,500 feet above sea level to over 2,300 feet above sea level.

Habitat types within the survey area are largely riparian, with mixed pine-oak forest dominating the upland areas. The riparian corridor over story is composed of white alder (*Alnus rhombifolia*) with narrow-leaved willow (*Salix exigua* ssp. *exigua*), dusky willow (*Salix exigua* ssp. *melanopsis*), and arroyo willow (*Salix lasiolepis*) present in varying densities. The understory is dominated by torrent sedge (*Carex nudata*), reed canary grass (*Phalaris arundinacea*), cheat grass (*Bromus tectorum*), Himalayan blackberry (*Rubus discolor*), bouncing-bet (*Saponaria officinalis*), and Mediterranean mustard (*Hirschfeldia incana*). Upland areas are dominated by native trees, including ponderosa pine (*Pinus ponderosa*), California black oak (*Quercus kelloggii*), Douglas fir (*Pseudotsuga menziesii*), and the native shrub, white-leaf manzanita (*Arctostaphylos viscida* ssp. *viscida*).

Field surveys focused on areas with conditions suitable for noxious weed colonization. Typical examples of these areas included roadsides, river and stream corridors, campgrounds, buildings, parking areas, and any disturbed areas near human habitations or recreation activities.

Figure 1. Location of study area



Survey techniques varied throughout the study area depending on terrain. Along roads, surveys were performed by walking and inspecting both sides of the road, where appropriate. For campgrounds, large cleared areas, old home sites or logged areas, meandering transects were walked to ensure the greatest amount of visual coverage possible. For large forested upland areas, transects were done with more intense scrutiny on areas with likely habitat for weeds such as burned or logged areas, or abandoned roads. In the river corridor and streambeds, surveys were performed by kayak or where possible, walking linear transects.

General Observations on Weed Infestations

Noxious weeds are abundant and widespread within the study area. Twenty-three species of noxious weeds were found in 1,170 locations. Weed infestations are especially abundant on cobble bars and sandbars in the river corridor, and in disturbed areas such as roadsides and areas near and around human recreation sites such as campgrounds and hiking trails. These areas had a high diversity and concentration of weeds, likely due to a high level of disturbance.

Examples of well-established weed colonies include large stands of Himalayan blackberry and bouncing-bet found on the lower and upper banks of the river corridor; whereas, common agricultural weeds such as yellow starthistle, Johnsongrass, field bindweed, Bermuda grass and puncturevine, typically occur along roadsides and other areas of disturbance.

Target Noxious Weed List

A target list of potential noxious weeds within the survey area was compiled from the Plumas National Forest weed list, and statewide lists available from the California Invasive Plant Council (Cal-IPC, formerly the California Exotic Pest Plant Council, Cal-EPPC) and the California Department of Food and Agriculture (CDFA). A review of information on target list weeds was conducted to familiarize survey team members with their morphological and habitat characteristics.

Aerial Photographic Basemaps and Survey Boundary

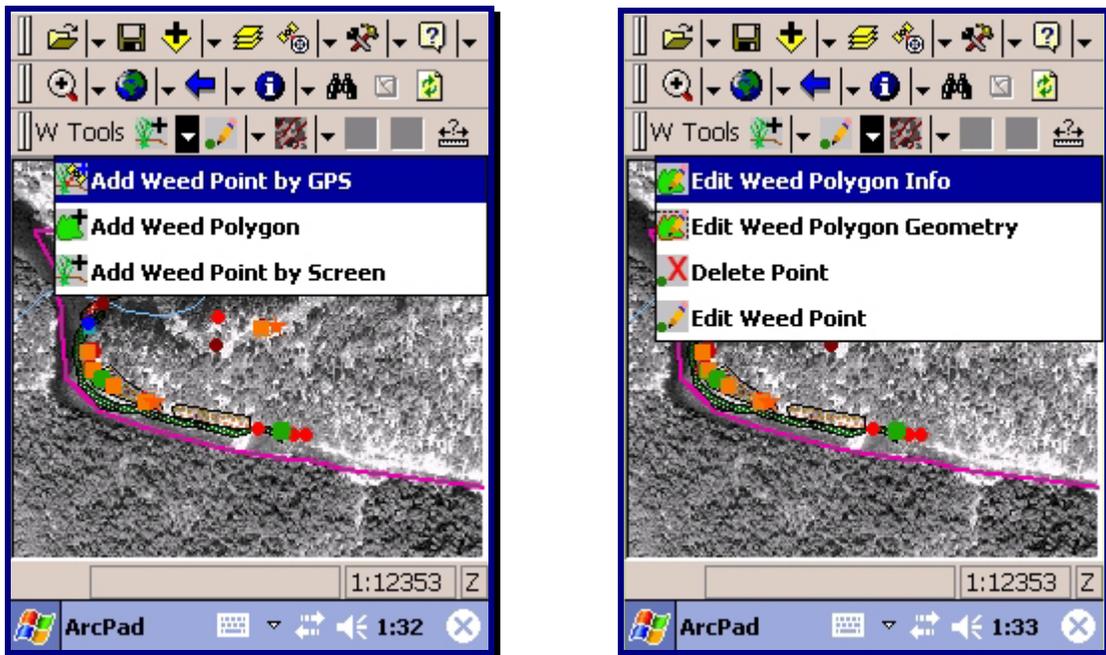
Recently flown high-resolution geo-rectified aerial photographs of the survey area and the project boundary shapefile were acquired. The images were seamlessly joined and indexed in ArcView 8.3, making them available to the survey teams in both large format paper map sheets and in electronic file format.

ArcPad Custom Field Data Collection Description

Field data collection required that a predetermined set of information be collected whenever a population of target noxious weeds was found, and that the survey effort include all suitable habitats within the survey area. An electronic custom form was developed for ArcPad 6.0.2 that included fields for recording a variety of information at each weed site. To the greatest extent possible, “pick lists” were used in the format of the custom form to expedite work in the field. These included: species name, associated vegetation type, local disturbance factors (weed vectors), percent ground cover, and estimated number of plants. A complete listing of data fields used is presented in Appendix A.

Data collection was further expedited by creating a customized ArcPad interface (figure 2). This interface included “add weed” dropdown tools whereby the user could add a weed point or polygon feature by GPS or, in the event of poor GPS reception, add weed point or polygon by screen. This entails digitizing the location on the screen with the stylus pen. Additional custom tools included “edit weed” dropdown tools. These tools only allow for the editing of the database but not the geometry of the point or polygon features.

Figure 2. Custom weed point and polygon data capture toolbar.



Ground-truthing and Field Checks

In July 2003, preliminary fieldwork was conducted to verify photographic interpretations and test operation of the electronic equipment. During this process, improvements were made to the custom data forms that better reflected the best information to be gathered about the weed populations.

Mobile GIS Hardware / Software Description

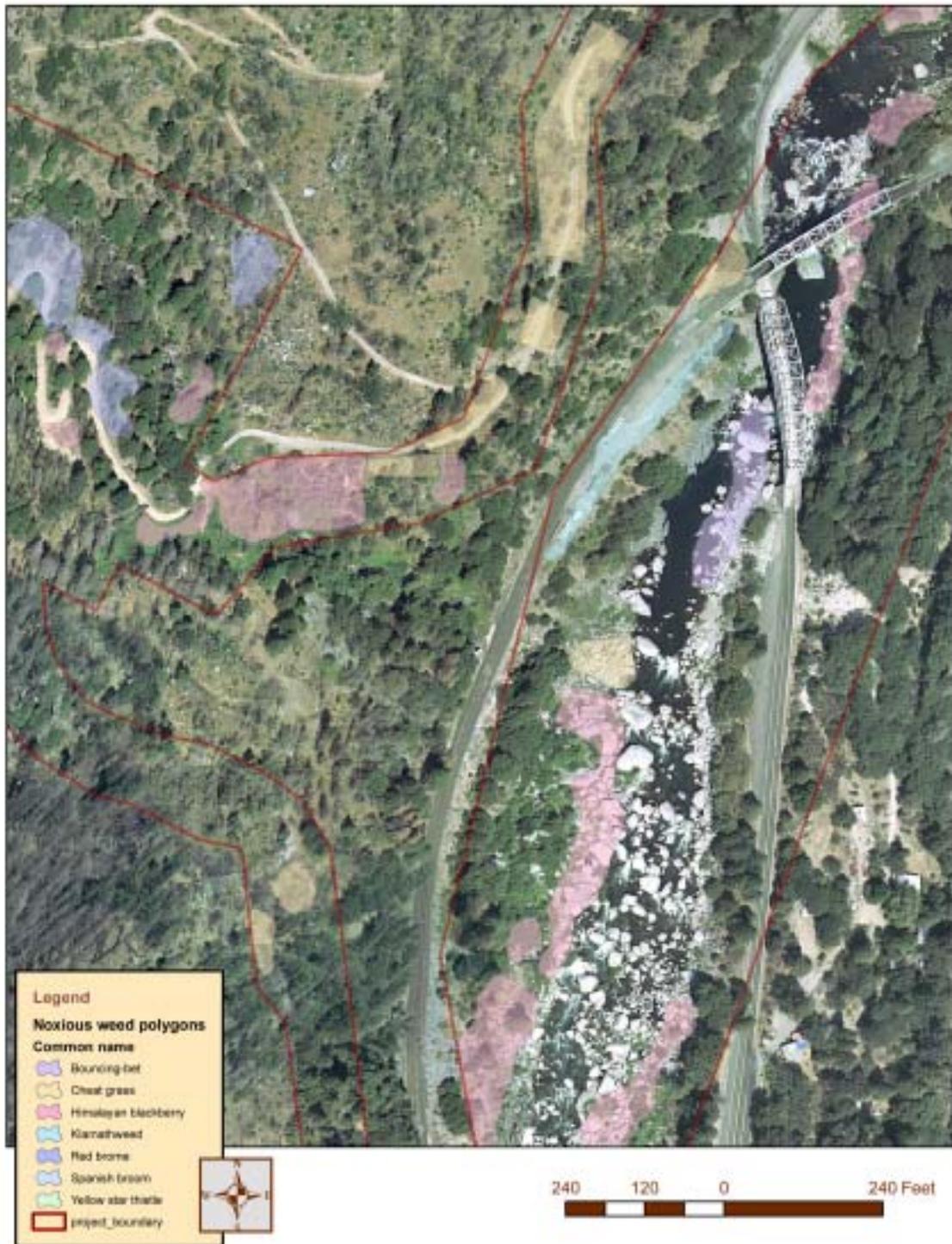
The field data was collected electronically using a touch screen handheld iPAQ Pocket PC 3970 (PDA) running customized ArcPad 6.0.2 software. A Dual-Slot Expansion Pack was added and an additional 128 mb CompactFlash card with the project files filled one slot and the Pharos GPS receiver filled the other slot. The Pharos GPS is a 12 channel receiver with a horizontal accuracy rating of 15m 2D-root mean square (RMS). The GIS background layers included USGS topographic quad coverage of the project area, natural color aerial orthophotos, and the project survey area boundary. With the GPS deployed, and the high resolution color aerial photos, surveyors were able to visually monitor their location relative to survey boundaries and other survey area features. All field data collected in ArcPad were imported seamlessly into ArcView 8.3.

The positioning of most noxious weed infestations was accomplished on the ground using the Pharos GPS receiver. For infestations consisting of one or a few individuals, a point feature was recorded, either by allowing the GPS to record a position, or creating the feature by hand using ArcPad's "add point by screen" option. For larger infestations, a polygon feature was recorded by digitizing it directly in ArcPad using the "add polygon by screen" on the aerial photograph. Where infestations could not be directly accessed due to site constraints, and in places where GPS satellite coverage was not available, locations were estimated as accurately as possible, using features on the aerial photo base map and were then created using the "add point/polygon by screen" technique.

GIS Data Management and Processing

Data management during the project study consisted of downloading the project files daily to a folder with the current date and datalogger ID. In this way, we minimized the potential loss of data due to unforeseen equipment failure to a single days work. Data processing entailed reviewing and editing polygon vector data as well as any editing required to the noxious weed database followed by production of the resulting weed distribution map (figure 3). All editing of vector data and the database was done in ArcView 8.3 to maintain database integrity.

Figure 3. Noxious weed distribution sample map



Conclusion

Advantages

- Seamless GIS data transfer and integration
- Easy to deploy custom features such as drop down menus and add/edit toolbar functions used to populate database
- Visually attractive
- Standardizes data collection and reduces data entry boo boo's
- Small, light, and portable

Caveats

- Small screen size
- Even smaller when you add custom toolbars
- It's easy to lose the stylus pen or use it for something it's not intended for

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Appendix A.

Project Database Fields and Dropdown Menu Choices
Species Name
<i>Acroptilon repens</i>
<i>Aegilops cylindrica</i>
<i>Aegilops triuncialis</i>
<i>Ailanthus altissima</i>
<i>Allium vineale</i>
<i>Arundo donax</i>
<i>Bassia hyssopifolia</i>
<i>Brassica nigra</i>
<i>Bromus madritensis ssp. rubens</i>
<i>Leucanthemum vulgare</i>
<i>Bromus tectorum</i>
<i>Cardaria chalapensis</i>
<i>Cardaria draba</i>
<i>Cardaria pubescens</i>
<i>Carduus acanthoides</i>
<i>Carduus nutans</i>
<i>Carduus pycnocephalus</i>
<i>Centaurea calcitrapa</i>
<i>Centaurea diffusa</i>
<i>Centaurea maculosa</i>
<i>Centaurea melitensis</i>
<i>Centaurea solstitialis</i>
<i>Centaurea squarrosa</i>
<i>Chondrilla juncea</i>
<i>Chorisporea tenella</i>
<i>Cirsium arvense</i>
<i>Cirsium ochrocentrum</i>
<i>Cirsium undulatum</i>
<i>Cirsium vulgare</i>
<i>Conium maculatum</i>
<i>Convolvulus arvensis</i>
<i>Cortaderia selloana</i>
<i>Crupina vulgaris</i>
<i>Cynara cardunculus</i>
<i>Cynodon dactylon</i>
<i>Cyperus rotundus</i>
<i>Cytisus scoparius</i>
<i>Elytrigia repens</i>
<i>Euphorbia esula</i>
<i>Euphorbia oblongata</i>
<i>Festuca arundinacea</i>
<i>Ficus carica</i>
<i>Foeniculum vulgare</i>
<i>Genista monspessulana</i>
<i>Gypsophila paniculata var. paniculata</i>
<i>Hedera helix</i>
<i>Hirschfieldia incana</i>
<i>Holcus lanatus</i>

<i>Hydrilla verticillata</i>
<i>Hypericum perforatum</i>
<i>Hypochaeris radicata</i>
<i>Isatis tinctoria</i>
<i>Iva axillaris</i>
<i>Lepidium latifolium</i>
<i>Leucanthemum vulgare</i>
<i>Linaria genistifolia</i> ssp. <i>dalmatica</i>
<i>Lolium multiflorum</i>
<i>Lythrum salicaria</i>
<i>Mentha pulegium</i>
<i>Myriophyllum aquaticum</i>
<i>Myriophyllum spicatum</i>
<i>Onopordum acanthium</i> ssp. <i>acanthium</i>
<i>Phalaris aquatica</i>
<i>Potamogeton crispus</i>
<i>Prunus cerasifera</i>
<i>Robinia pseudoacacia</i>
<i>Rubus discolor</i>
<i>Salsola paulsenii</i>
<i>Salvia aethiopsis</i>
<i>Saponaria officinalis</i>
<i>Silybum marianum</i>
<i>Solanum carolinense</i>
<i>Solanum dimidiatum</i>
<i>Solanum eleagnifolium</i>
<i>Solanum lanceolatum</i>
<i>Sorghum halapense</i>
<i>Spartium junceum</i>
<i>Taeniatherum caput-medusae</i>
<i>Tamarix gallica</i> , <i>T. spp.</i>
<i>Tribulus terrestris</i>
<i>Verbascum thapsus</i>
<i>Verbena bonariensis</i> , <i>V. littoralis</i>
<i>Vinca major</i>
Cal-EPPC Rating
<i>A-1. Widespread</i>
<i>A-2. Regional</i>
<i>B. Lesser Invasiveness</i>
<i>Red Alert. Potential explosive</i>
<i>Considered but not listed</i>
<i>Annual grasses</i>
<i>Need more information</i>
CDFA Rating
<i>A</i>
<i>B</i>
<i>C</i>
<i>TBD</i>
Disturbance

<i>Livestock Grazing</i>
<i>Spoil Storage</i>
<i>Other</i>
<i>ORV Use</i>
<i>Timber Harvesting</i>
<i>Vegetation Management</i>
<i>Hydrology</i>
<i>Facility Site</i>
<i>Linear ROW</i>
<i>Project Road</i>
<i>Non-Project Road</i>
<i>Dispersed Use</i>
<i>Camp Ground</i>
Environmental Constrants
<i>hydrologic feature, class 1 stream</i>
<i>hydrologic feature, intermittent stream</i>
<i>hydrologic feature, ephemeral stream</i>
<i>hydrologic feature, canal</i>
<i>hydrologic feature, lake or reservoir</i>
<i>hydrologic feature, spring</i>
<i>hydrologic feature, drainage channel</i>
<i>protected flora</i>
<i>culturally significant flora</i>
<i>protected fauna</i>
<i>culturally sensitive site</i>
<i>erosion hazard potential (slope > 30%)</i>
Estimated Number of Plants
<i>0-25</i>
<i>25-50</i>
<i>50-100</i>
<i>100-200</i>
<i>200-300</i>
<i>>300</i>
Flowering Time
<i>April-June</i>
<i>June-Aug.</i>
<i>June-July</i>
<i>June-Sept.</i>
<i>May-Aug.</i>
<i>May-July</i>
<i>May-June</i>
Lifecycle
<i>Perennial</i>
<i>Biennial</i>
<i>Annual/Biennial</i>
<i>Annual</i>
Control Measures
<i>manual/mechanical</i>

<i>chemical</i>
<i>biological</i>
<i>fire</i>
<i>no control</i>
<i>other</i>
Plumas National Forest Rating
<i>A</i>
<i>B</i>
<i>C</i>
Vectors
<i>Livestock grazing</i>
<i>None</i>
<i>Other</i>
<i>Road maintenance</i>
<i>Timber harvesting</i>
<i>Vegetation management</i>
<i>Vehicle Travel</i>
<i>Human</i>

References

Benefield, C., J. DiTomaso, G. Kyser, S. Orloff, K. Churches, D. Marcum and G. Nader. Bossard, C., J. Randall, and M. Hoshovsky, eds. *Invasive Plants of California's Wildlands*. Univ. of Calif. Press, Berkely, Calif.

California Department of Food and Agriculture (CDFA). 2003. EncycloWeedia: notes on identification, biology and management of plants defined as noxious weeds by California law.

California Exotic Pest Plant Council. 1999. The Cal-EPPC list: exotic pest plants of greatest ecological concern in California. Unpublished list. Available at: www.Cal-IPC.org

Clifton, G. 2001. Plumas County and Plumas National Forest flora, draft. Unpublished report.

Hickman, J. 1993. *The Jepson Manual*. Univ. of California Press, Berkeley, Calif.

Whitson, T. (ed.). 1999. *Weeds of the West*, 5th edition. Western Society of Weed Science, Jackson, Wyoming

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