

## **Ceanothus Imaging at Lake Hodges**

Project for the  
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Planning Department  
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Conducted by

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## **Introduction**

*Ceanothus verrucosus*, a rare species of ceanothus chaparral, occurs on City of San Diego land around the Lake Hodges reservoir in San Diego County. White flowers are a unique feature of this type of chaparral and these flowers are generally expected to bloom for a brief period during April. The objective of this project was to acquire digital and photographic imagery during the flowering period at two sites near Lake Hodges (Figure 1), georeference and mosaic the imagery, and map the extent of the *C. verrucosus* population using semi-automated image classification. For this project, Blackhawk Helicopters, Inc. provided the helicopter platform and Imagis provided the flight planning, aerial imaging, and image processing.

## **Image Acquisition**

A helicopter flight was scheduled and executed on April 14, 2001. Multispectral digital photographs were acquired at 1 m and 0.5 m spatial resolution with an Airborne Data Acquisition and Registration (ADAR) 5500 system. This system is produced by Positive Systems, Inc. of Whitefish, Montana and images in the 450-540nm, 520-600nm, 610-690nm, and 780-1000nm wavebands. Color print and color slide photographs were acquired using a Nikon F3 35 mm film camera. Color photographs and 1 m ADAR imagery were acquired from 7000 ft above ground, while the 0.5 m ADAR imagery was acquired from 3500 ft above ground.

The color slide film was found to have higher overall quality, compared to the color print film. Therefore, the color slides were converted into digital images for subsequent image processing. The slides were scanned at 4000 points per inch (PPI) using a Howtek professional drum scanner; which produced pixels with a 0.75 ft spatial resolution. Each slide was "oil mounted", scanned for red, green and blue (RGB) colors, and saved in TIF format. The scanned photographs were subsequently imported into ERDAS Imagine for image processing.

## **Image Products**

ADAR 5500 and film-based digital images were georeferenced to a 1997 color infrared (CIR) digital orthophotographic quarter quadrangle (DOQQ) base. This was performed in ERDAS Imagine using approximately 75 ground control points per frame and a rubber sheeting image warping algorithm. Following georeferencing of the individual frames, mosaics were created for each site and data set. Automatic and manually delineated cutlines defined the break between individual frames and a feathering routine was used to radiometrically blend the overlap portions of adjacent frames. The resulting mosaics are shown in Figure 2 through Figure 4.

## **Classification of Ceanothus**

The *C. verrucosus* population near Lake Hodges did not flower as expected during or after April 2001. The absence of the distinct white flowers in the imagery made absolute

identification of *C. verrucosus* through semi-automated image classification nearly impossible. Therefore, the image classification task was modified and called for the production of image drapes from oblique viewing angles. Oblique views of high resolution ADAR image drapes were generated which 1) provided an insightful representation of the sites and 2) provided views from matching perspectives of areas photographed during a year when the *C. verrucosus* was flowering. These products allow for examination of the multispectral characteristics of the non-flowering *C. verrucosus* (Figure 5 to Figure 9).

Image drapes were generated using the Image Drape function in ERDAS Imagine 8.4. A 10 m spatial resolution digital elevation model (DEM) created by the Department of Geography at San Diego State University provided the topographic base for the image drapes. The 1m and 0.5 m resolution ADAR mosaics were draped over the DEM. The 1 m mosaic provided a greater extent of imagery for viewing in the drapes, while the 0.5 m ADAR layer on top provided higher resolution for the primary target locations in the image drapes. At the west site, the CIR DOQQ was included under the ADAR imagery to enable viewing of distant hilltops that were not covered within the ADAR imagery.

Good correspondence in pattern was found between the ground photographs of flowering *C. verrucosus* and the CIR ADAR image drapes when viewed obliquely. This correspondence in pattern will allow for the boundaries and extent of *C. verrucosus* apparent in the ground photographs to be translated into digital maps using the current image mosaics. Future imaging missions at the Lake Hodges sites will begin to mobilize earlier in the season and will catch the brief flowering period of the *C. verrucosus* population.

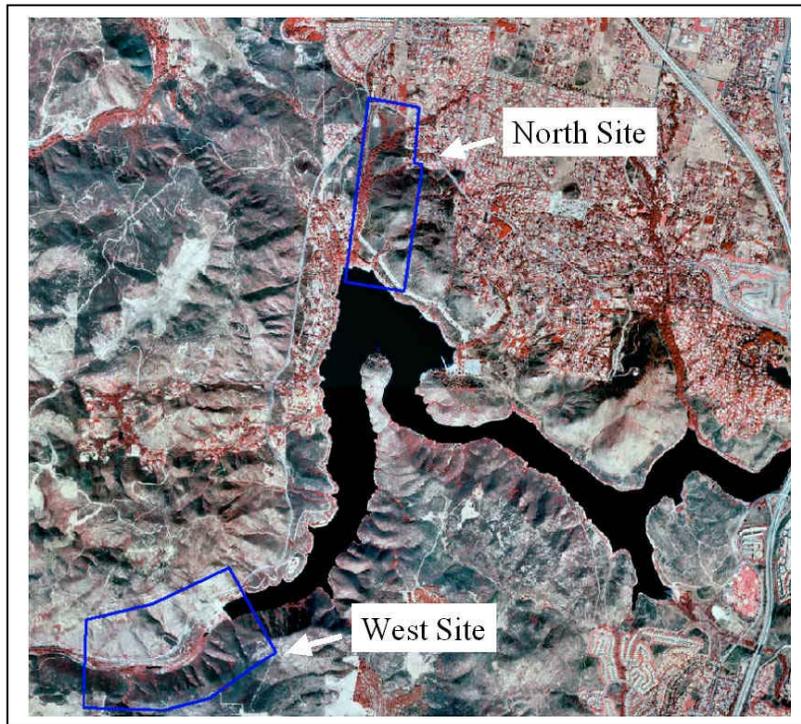


Figure 1. North and west study sites near Lake Hodges, CA.

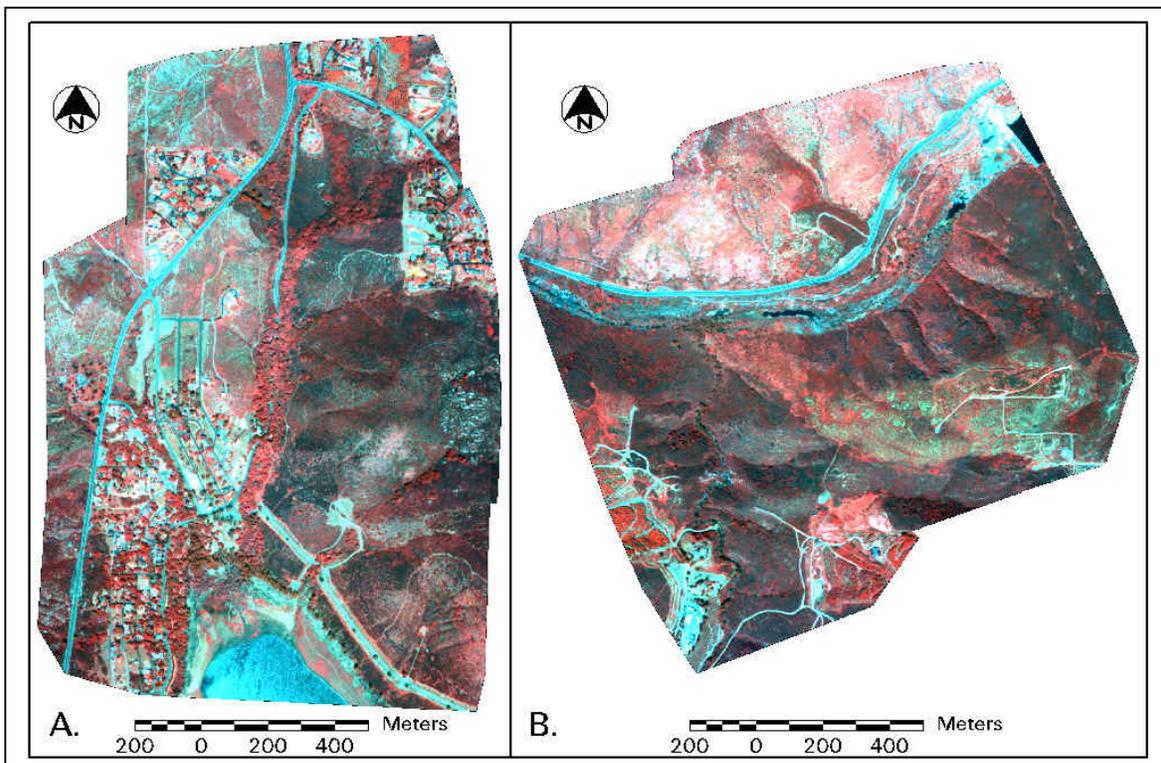


Figure 2. ADAR 1 m mosaics for a) north site and b) west site.

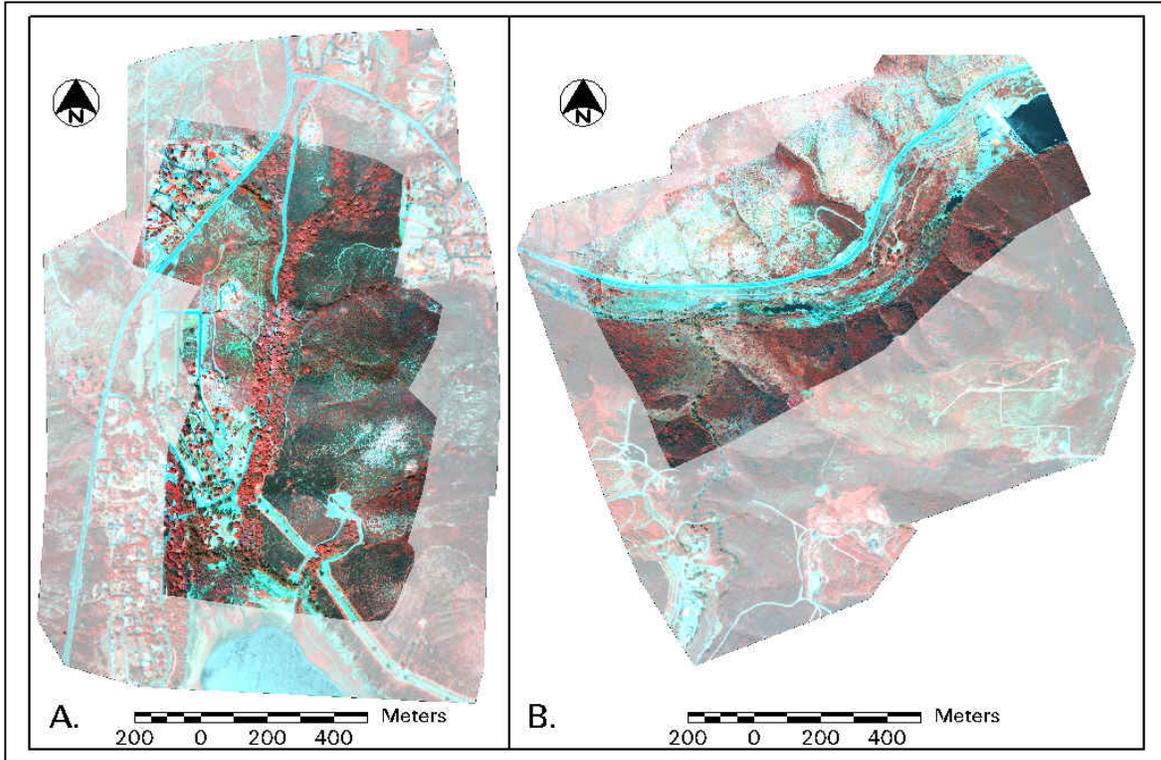


Figure 3. ADAR 0.5 m mosaics for a) north site and b) west site.

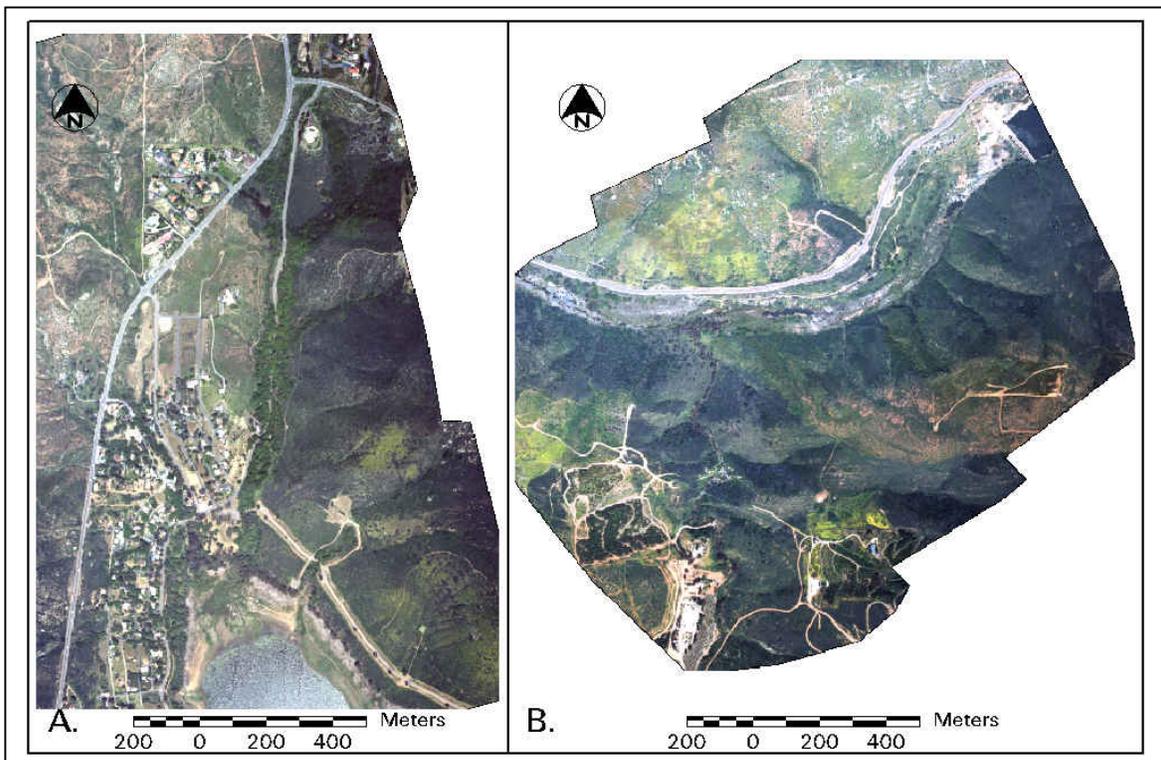


Figure 4. Color film mosaics for a) north site and b) west site.

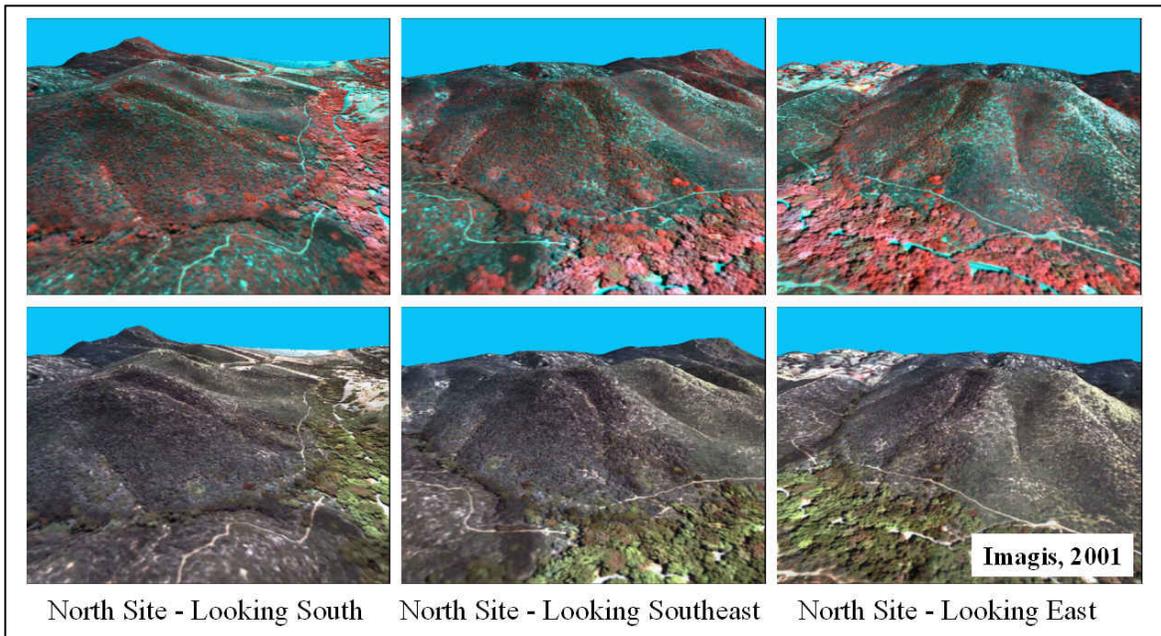


Figure 5. Image drapes of aerial photographs at north site

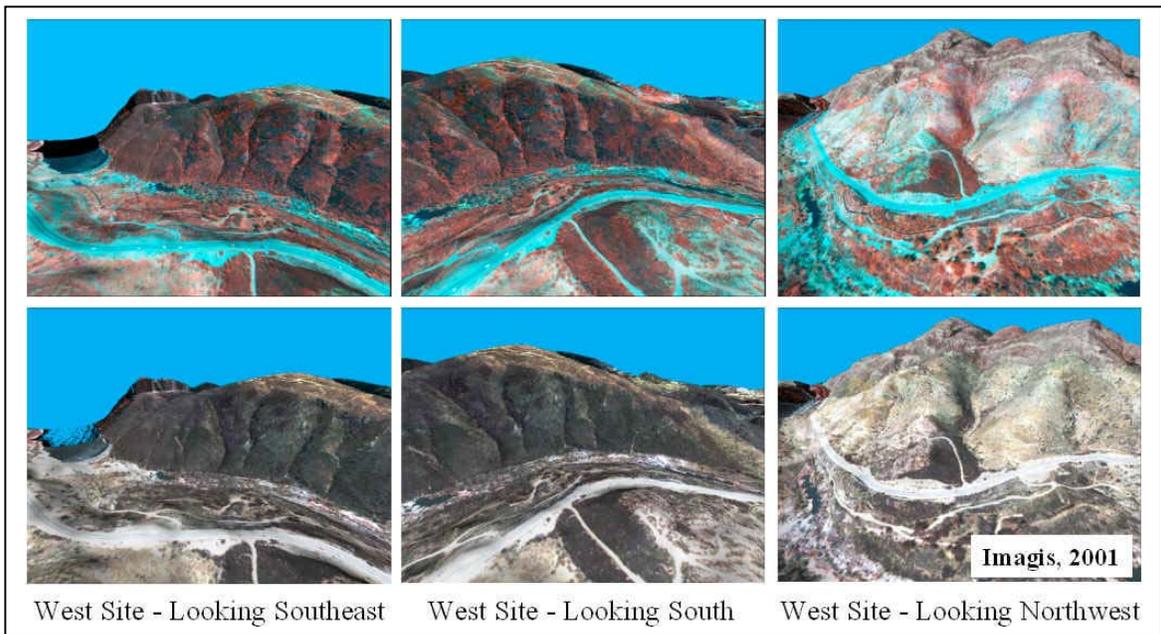


Figure 6. Image drapes of aerial photographs at west site

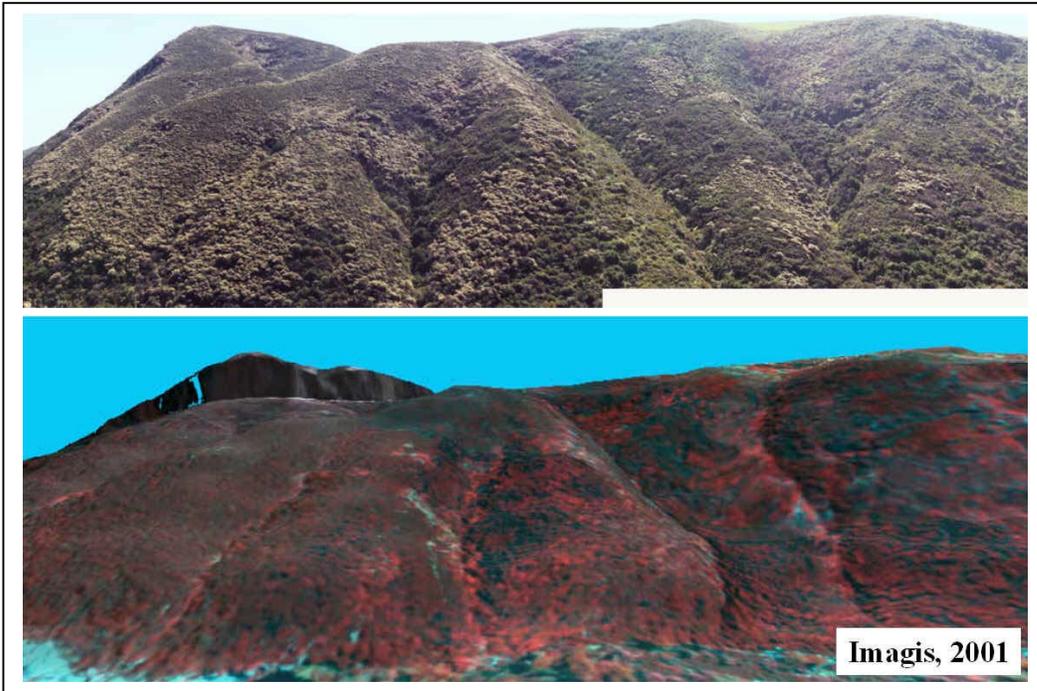


Figure 7. Ground photo of flowering *C. verrucosus* and ADAR image drape of south slope at west site.

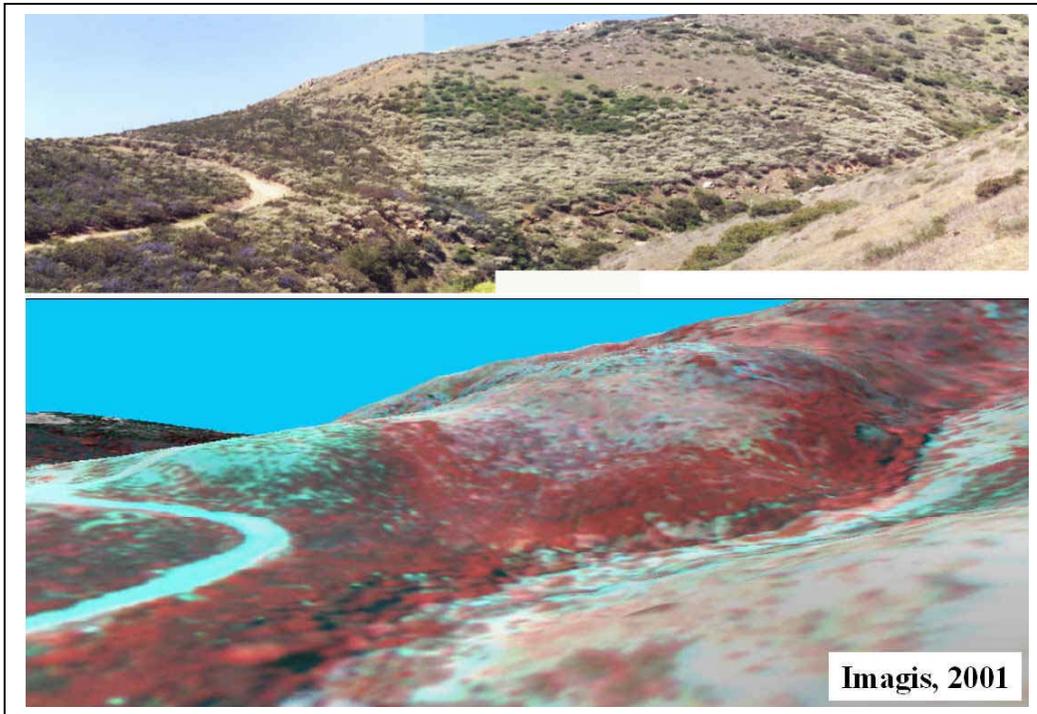


Figure 8. Ground photo of flowering *C. verrucosus* and ADAR image drape of north slope at west site.

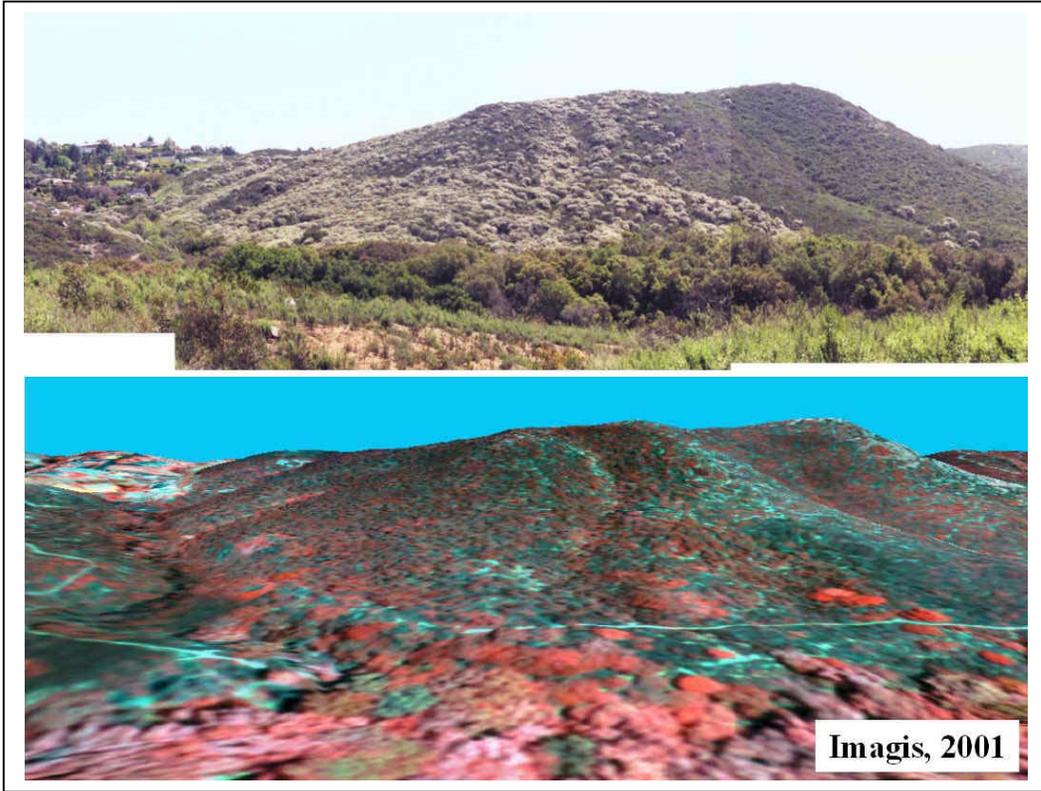


Figure 9. Ground photo of flowering *C. verrucosus* and ADAR image drape of slope at north site.