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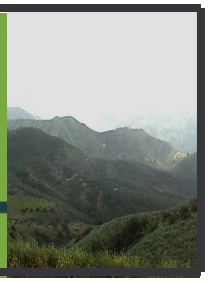

# Developing a Compliance Monitoring Framework for Conservation Easements: Case Study - The North Irvine Ranch

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## Project Significance

One of the fastest growing land-protection tools in the United States is the "conservation easement," a voluntary legal agreement that places restrictions on how land can be used in order to protect historic sites, open space, particular species, or natural communities. In California alone The Nature Conservancy (TNC) held conservation easements protect some 150,000 acres of privately owned land. Currently there is no standard method to ensure compliance with easement agreements and their stated goals. The strength of an easement program lies in the diligence of the conservation organization's monitoring activities and its ability to uphold the terms of the easements agreements. The goal of this project is to set up a compliance monitoring program that will help land managers track changes associated with human disturbances and begin to determine if the conservation values of the land are being maintained through the determination of compliance with the terms of the easements. The North Irvine Ranch was used as a case study to develop the program.

## Background

Recently, TNC secured easements over 11,500-acres in Orange County, California. This land, known as the North Irvine Ranch (NIR), is valued for its high biological diversity, large size, connectivity with other important areas (Cleveland National Forest, Fremont/Windy Ridge, and Coal Canyon Ecological Reserve), diverse physical features, sensitive and threatened or endangered species (fig 1).

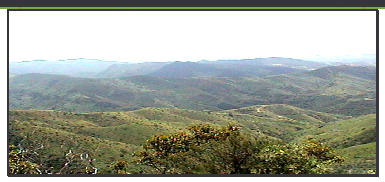


**Figure 1: Fremont Canyon NIR**

## Problem Statement

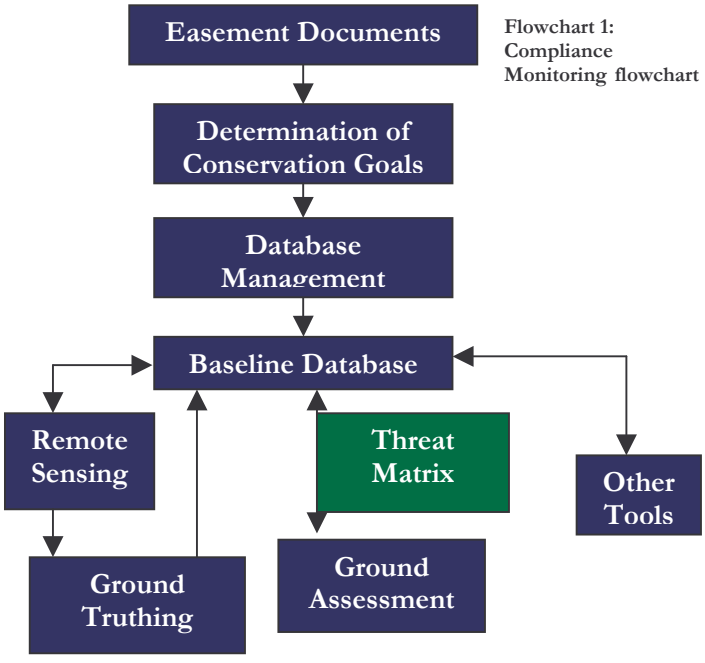
The purpose of this project was to design an effective monitoring strategy to help land managers determine compliance with the terms set forth in the easement agreements.

## Approach

A four step-monitoring framework was developed to determine compliance using the North Irvine Ranch (NIR) as a case study.

1) Analyze the easement contract to determine monitoring targets per the NIR's easement document.
2) Document baseline conditions
3) Implement a hierarchical monitoring framework utilizing:
    a. Remote Sensing
    b. Ground Truthing
    c. Ground Assessment
4) Develop stakeholder communication

This framework will be directly applicable to other TNC conservation easements instituted in California.




**Flowchart 1: Compliance Monitoring flowchart**

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## Determining Monitoring Targets

A conservation easement document is made up of a collection of restrictions and obligations that restrict the activities that may occur on the property and imposes obligations of both the landowner and easement holder. Anthropogenic features and activities that are restricted by the NIR easement agreement, and hence need to be monitored, are listed in table 1.

- **Residential and other buildings**
- **Roads and trails**
- **Fences, gates and walls**
- **Electric power lines, pipelines, wells and tanks**
- **Fuel modification areas**
- **Arterial highways**
- **Grazing and farm areas**
- **Educational and recreational areas**
- **Mining and drilling**
- **Surrounding properties**

**Figure 2: Monitoring Targets for NIR**

### Baseline Data Acquisition and Documentation

In order to measure change it is necessary to document a baseline of current conditions from which future measurements can be compared. Easement holders should structure baseline documentation to match the goals stated in the easement documents. To determine compliance with the NIR easement agreements, a baseline database was developed incorporating land use and developed features, with consideration to some ecological and geological features. Digital data was gathered from a number of different sources, normalized, and mapped in ArcGIS and entered into a MS Access relational baseline.

### Data Management

The NIR database focuses on linear features and point attributes for changes in ownership, size, use, maintenance, access, relative permits, or status. These all work together so that if an attribute exhibits change, as detected in remote sensing or ground assessment, the database can quantify the amount of change. In this way the database serves as a template by which all future suppositions of change may be weighed. Remote sensing and ground assessment may also reveal small transitions in the landscape. The database can then relate those changes to other features and against the baseline to measure the true extent of change. By interlinking attributes across the easement (*i.e.* roads to developments) managers are better able to detect changes early on.

### Remote Sensing

Remote sensing is a powerful tool for determining land cover change over large land areas (such as the 11,500-acre NIR easement). Using low-level aerial photography (ADAR) or very high-resolution satellite imagery, change can be identified by interpreting differences in spectral reflectance of the ground cover relative to a baseline image.

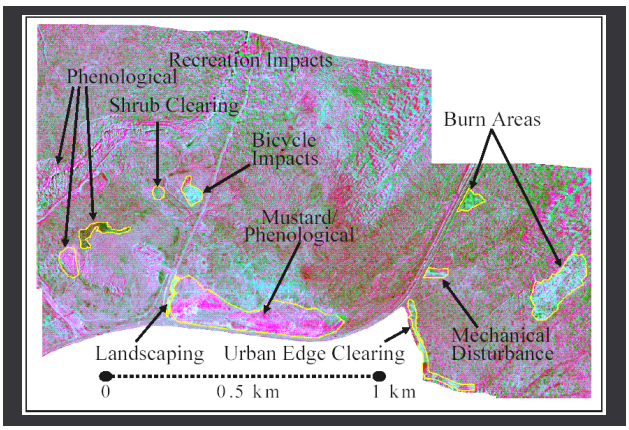


**Figure 3: Difference imaging output (Image courtesy of Doug Stowe)**

For example by setting multispectral/multitemporal remotely sensed images to separate color schemes (such as blue/green and red), then overlaying these images in a software package such as ERDAS Imagine or IDL/ENVI, changes in land cover can be identified (fig 3).

### Ground Truthing

Remotely sensed data, given a fine enough resolution at the appropriate spatial scale can provide accurate characteristics of disturbance features on site. In terms of compliance monitoring, the images obtained act more as a tool for the initial detection of change in land use cover and it is the act of ground truthing that verifies the presence/absence and extent of disturbance. In some cases aspects of the landscape, developments, or disturbances cannot be accurately detected nor their geographical extent precisely measured remotely. In such cases ground truthing is mandatory to determine these specific characteristics.

In the case of monitoring the NIR easement properties to determine compliance with the terms of the easement agreements, where amounts of allowable land use change and/or habitat removal is relatively small (on average < 2% of total easement acreage), follow-up ground truthing is necessary to concretely determine the nature of change indicated by remote sensing.

**Ground Assessment**

As a complement to remote sensing and ground truthing, ground assessment can be used to further verify whether the landowner is in compliance with the terms of the easement agreements. Monitoring via ground assessment is a tool by which areas are visited and inspected for alterations associated with human related disturbances. Annual ground assessment via foot and/or vehicle shall serve as the primary monitoring tool in between remote sensing sessions. Due to the difficulty in monitoring vast expanses of terrain by ground, it is important to prioritize ground-monitoring sites.

The "Threat Matrix" is a ground assessment tool that prioritizes areas that may pose a threat to the conservation values of the NIR. The protocol identifies a gridded matrix that a land manager could use to estimate the likelihood of each kind of land-use change for a particular site within the grid, given the current conditions of the site. The type of land-use change in a site might be the potential threat of road widening, a new road, a new trail, development expansion, new development, or trail widening. The existing condition or conditions in a site might be roads, trails, development, or a combination thereof. Those likelihoods would be combined to get an overall threat value score for the site. Next, the total threat value of the site was computed by multiplying the overall threat value to the weight of the land-use concerns. The weight of each land-use change was based on three factors: 1) affect of land-use change to conservation values of the NIR, 2) relative importance of assessing a particular type of land-use change by ground versus remote sensing, and 3) extent of a particular type of land-use change in comparison to the maximum allowable land-use change within the easement properties. The final step to the Threat Matrix was to prioritize the areas in the NIR for assessment based upon the total threat values, where the sites with the largest total threat value are considered as areas of highest priority for ground assessment**.** Figure 5 is an example of a threat matrix output showing the sites with the highest priority for ground assessment.

***Conceptual Overview of Threat Matrix model:***

The threat value at a given site i was numerically expressed as:

$$T_j(i) = \Sigma\, \alpha_{jk} C_k(i)$$

where,

| | | |
|---|---|---|
| T | = | threat of land-use change j, in site i |
| $\alpha$ | = | 1 if j could be affected by k and 0 if j could not be affected by k |
| k | = | type of condition |
| C | = | 1 if k is present in site i and 0 if k is not present site i |

Once a threat value was assigned for a given site i, the total threat value for site i was numerically expressed as:

$$TV(i) = \Sigma\, w_j T_j(i)$$

where,

| | | |
|---|---|---|
| $TV_{(i)}$ | = | total threat value of site i |
| $\mathbf{w_j}$ | = | the threat weight associated with land-use change type j, 1= least threatening and 10= most threatening |
| $T_{j(i)}$ | = | threat of land-use change j, in site i |

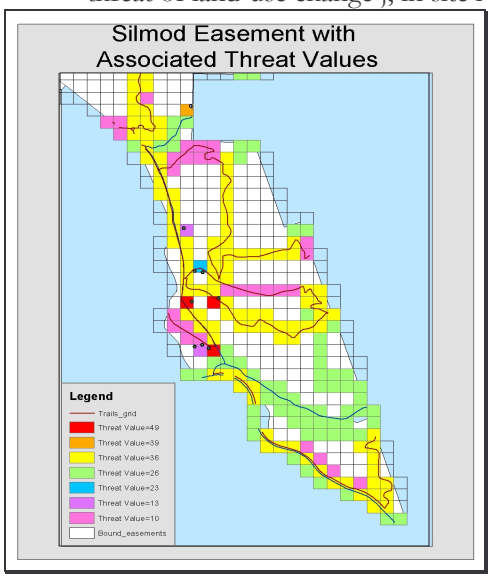


**Figure 4:** Example of a "Threat Matrix" output. The threat weights are arbitrary and would be typically assigned by the Land Manager. The red areas represent the highest priority areas for ground assessment and the white areas represent the lowest priority for ground assessment.

**Developing Stakeholder Communication**

Proactive measures are a valuable component of a compliance monitoring program. These are not "monitoring" tools per se, rather tools for maintaining lines of communication to prevent problems from arising. A number of different proactive measures exist, such as; establishing a good rapport with the property owner, local government, and community. A good relationship makes it more likely that the owner will comply with the easement conditions. An informed local government could prevent activities that conflict with the easement terms by notifying the easement holder before an action is commenced. Community education and involvement should be considered, as these can be particularly useful in solving problems or threats to the property.

## Key Recommendations for Compliance Monitoring at North Irvine Ranch

**Baseline Database**

- Develop MS Access relational database for the NIR
- Focus on compliance related attributes with statistical properties

**Database Management**

- Enter new data from monitoring tasks, permitting, and stakeholder updates
- Develop standard queries to monitor data for change
- Assign security settings and back up data Remote Sensing
- Utilize Airborne Data Acquisition and Registration (ADAR) every third year
- Use multispectral imaging using GPS triggers for greatest positional accuracy

**Remote Sensing**

- Use ADAR as the remote sensing platform, with Digital Globe's Quickbird being a strong alternative for monitoring the NIR..
- Shoot images (baseline and future) in true color as well as multispectral characteristics
- Use GPS triggers for greatest positional accuracy.
- Acquire remote sensing images every three years.
- Use difference imaging software to detect change and create maps of those changes.

**Ground Truthing**

- Ground truth all changes detected through remote sensing.
- Document ground truthing using photos and GPS units, if change is detected permanent photo stations should be considered.
- Document all false positive findings for future reference.

**Ground Assessment**

- Use "Threat Matrix" model to prioritize areas to be assessed annually.
- Document ground assessment using photos and GPS units, if change is detected permanent photo stations should be considered

**Other Tools for Compliance Monitoring**

- Conduct quarterly meetings between TNC and land owner until the monitoring plan has been agreed upon and semi-annual meetings thereafter
- Provide the easement documents to the applicable stakeholders to educate them about the NIR's conservation values, background, allowed uses and restrictions
- Request to be notified by the Grantor or applicable stakeholders of planned activities at the NIR to determine if any impacts to NIR's conservation values would result

## Conclusion

Compliance monitoring is a necessity given the complexity of use rights associated with conservation easements. The NIR monitoring framework addresses this necessity through a qualitative and quantitative monitoring plan that allows land managers to identify and measure change, catalogue those changes, and maintain open dialogue with stakeholders to ensure that the terms of the easement agreements are being met. The monitoring framework developed for the NIR property is also suitable for determining compliance with conservation easements of various types and sizes. In addition, aspects of this monitoring framework could be applied to biological monitoring.