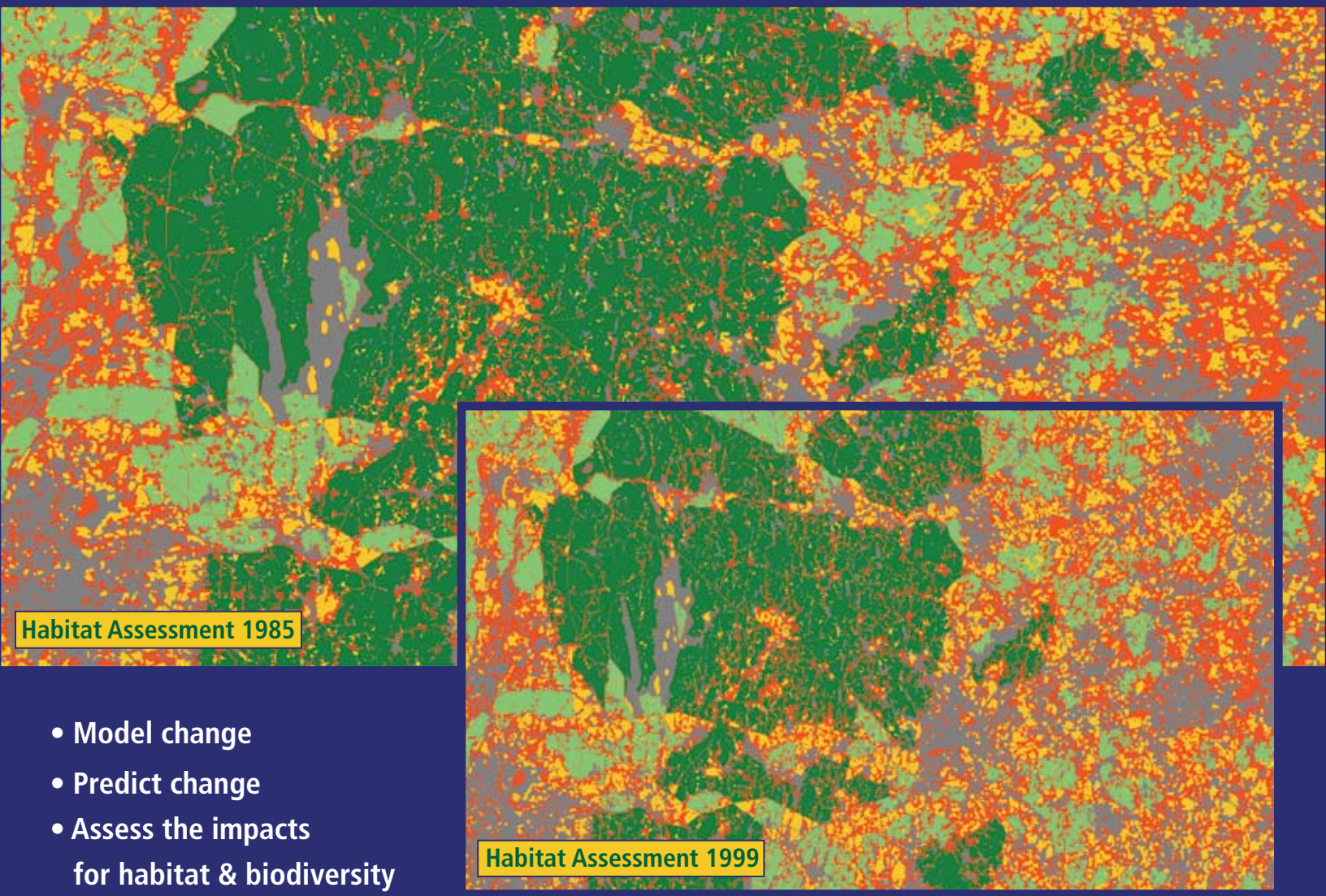
Land Change Modeler™
for ArcGIS®

A software extension for analyzing and predicting land cover change and assessing the implications of that change for biodiversity



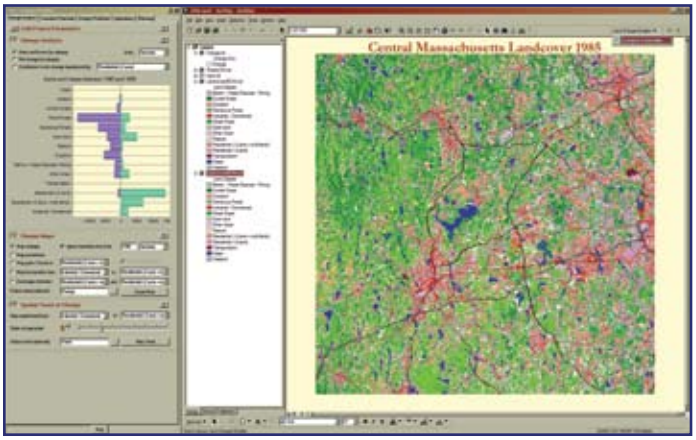
- Model change
- Predict change
- Assess the impacts for habitat & biodiversity
- Plan for the future

The Land Change Modeler is a software extension for ArcGIS oriented to the pressing problem of accelerated land conversion and the very specific needs of biodiversity conservation. Tools for the assessment and prediction of land cover change and its implications are sequentially organized around major task areas--change analysis, change prediction, impact assessment for habitat and biodiversity, and planning interventions.

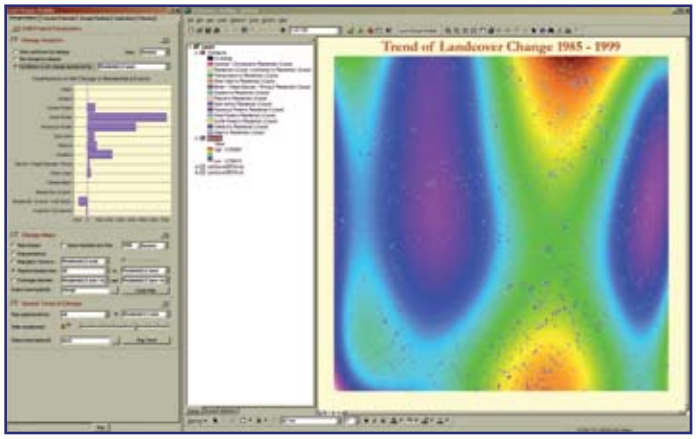
Clark Labs worked with Conservation International over a period of several years to develop this flexible software environment that can be used for a variety of land change scenarios and contexts. Users concerned with land change, conservation and biodiversity will find that this application provides a robust set of tools for the analysis of change and the creation of viable plans and scenarios for the future.

Analyzing Change

A set of tools is included for the rapid assessment of change. The user specifies two land cover maps of different dates and immediately can review and evaluate area gains and losses, net change, persistence and specific transitions both in map and graphical form. A change abstraction tool is also included, based on trend surface analysis, to uncover the underlying trends of complex change.



The Change Analysis panel provides a set of tools for understanding the nature and extent of land cover change, including graphs of gains and losses, net changes and contributions experienced by any category. A simple one-click interface provides the ability to generate rapid maps of change, persistence, specific transitions and exchanges between categories.

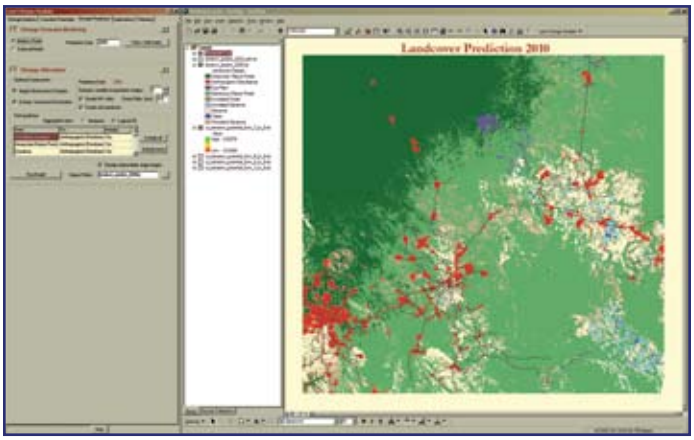


A utility is provided for mapping the spatial trend of change--a very useful abstraction tool in areas of complex change. Polynomial trend surfaces up to the 9th order can be mapped.

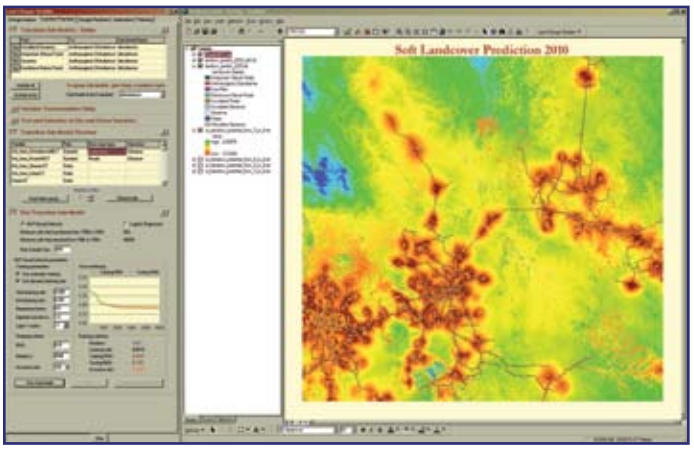
Modeling the Potential for Change

Using past land transition information and incorporating environmental variable maps that might drive or explain such change, Land Change Modeler can create a GIS data layer expression of transition potential—the likelihood that a land use will transition in the future. Each transition is modeled with either Logistic Regression or a Multi-Layer Perceptron neural network, resulting in a potential map for each transition—an expression of time-specific potential for change.

The environmental variables can be static, expressing aspects of basic suitability for the transition under consideration, or dynamic, time-dependent drivers such as proximity to existing development or infrastructure. Dynamic variables are recalculated at each iteration during the course of a prediction. Variables can be tested to confirm whether or not they hold explanatory power for the transition.



One result of the prediction process is this hard prediction map that is a single realization. During the set-up of the change prediction analysis, you can specify variables to be dynamic. You can also specify the presence of planning interventions and major infrastructure improvements.



The soft prediction maps vulnerability to change for a selected set of transitions and provides a comprehensive assessment of change potential.

Predicting Change

The dynamic change prediction relies on these historical transitions and models forward to a specified future date. The quantity of change can either be modeled through a Markov Chain analysis or by providing a transition probability matrix from an external (e.g., econometric) model.

Land Change Modeler allows for the specification of the number of reassessment stages during which dynamic variables are updated. At each stage, the system also checks for the presence of planning interventions, important parameters that may alter the course of development in the change prediction process. Interventions include constraints and incentives, such as proposed reserved areas, and infrastructural changes, such as roads or developments. Interventions are specified in the Planning tab.

For the actual prediction output, you have the option of creating a hard prediction based on a multi-objective land competition model, with a single realization. A soft prediction output is also provided which is a continuous map of vulnerability to change for the selected set of transitions. The soft prediction model is generally preferred for habitat and biodiversity assessment since it provides a comprehensive assessment of change potential.

Impact Assessment for Habitat and Biodiversity

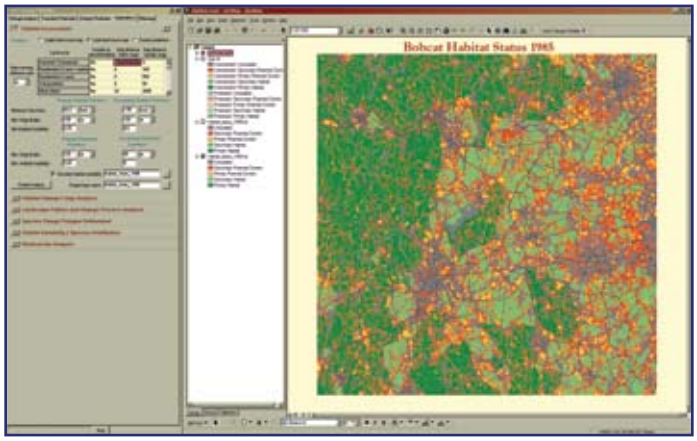
A wide range of tools is provided for assessing the implications of change for ecological sustainability. These include tools for species-specific habitat assessment, habitat change analysis, gap analysis, landscape pattern analysis, species distribution modeling, and biodiversity analysis. Specifically:

✓Species-specific habitat assessment. Based on existing or predicted land cover maps and a map of species-specific habitat suitability, the habitat assessment tool develops a map with primary and secondary habitats and primary and secondary potential corridors. Important parameters that control this process include the home range size, buffers based on sensitivity to humans and the ability to cross gaps within home ranges and during dispersal.

✓ Habitat change. Detection of changes in habitat status and gap analysis by comparison to a map of protection status.

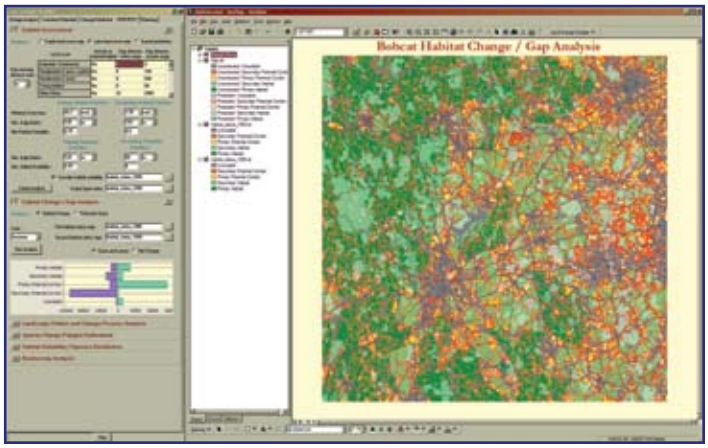
✓ Land cover pattern and change process analysis. Tools are available to assess patterns in the landscape (e.g., edge density or relative richness) or to characterize the nature of change underway between two land cover maps.

✓ Species range polygon refinement. This exploratory tool allows for the refinement of species distribution maps through the analysis of environmental variables.

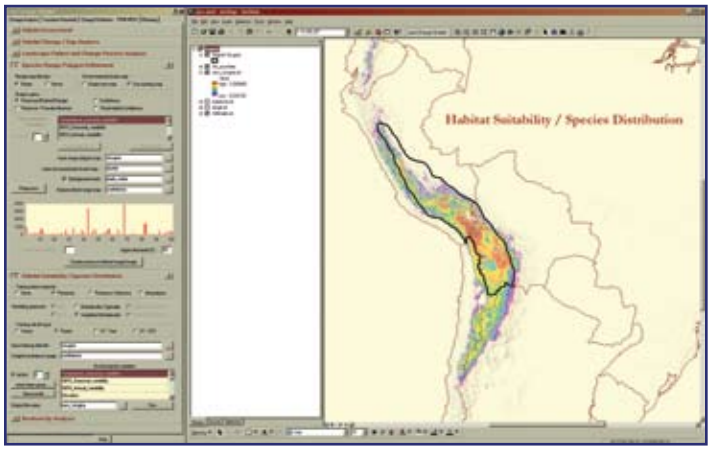


The Habitat Assessment panel maps areas into categories of primary and secondary habitat, primary and secondary potential corridor and unsuitable lands based on land cover and habitat suitability along with parameters such as home range size, buffer widths, and gap crossing distances within range and during dispersal.

Meeting the challenges of environmental decision making with GIS.



Tools are available for the detection of change including gap analysis, most often characterized by gaps in protected habitat for a specific species.



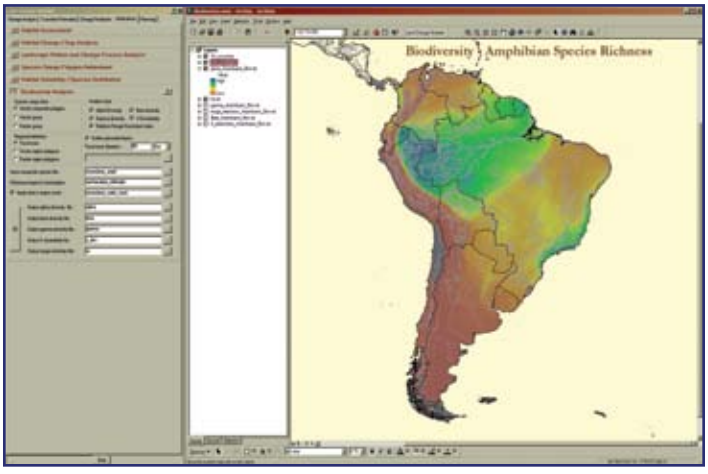
The Implications tab of Land Change Modeler provides a set of utilities for species distribution modeling. In this illustration, a range polygon has been refined by establishing confidence in various portions of the original polygons based on a modeling from environmental variables. This confidence mapping then weights the mean and variance-covariance matrix that underlies the calculation of Mahalanobis Typicalities for modeling from presence data.

✓ Species distribution modeling. Tools are available for developing species-specific habitat suitability and distribution maps. Procedures are available for modeling presence, presence/absence, and abundance data.

✓ Biodiversity assessment. Using collections of species range polygons (such as those provided by NatureServe), this tool permits the development of maps of alpha diversity (local species richness), gamma diversity (regional richness), beta diversity (Whittaker's and Sorensen's) and relative range restriction.

Planning Interventions

The Land Change Modeler allows the user to specify planning interventions that may alter the course of development including constraints and incentives, such as proposed reserved areas, infrastructure modifications, and biological corridors.



The Biodiversity Analysis panel provides the capability of mapping five different measures of biodiversity: alpha, gamma and beta diversity (Whittaker's), Sorensen's Dissimilarity Index and an index of relative range restriction.

System Requirements

The Land Change Modeler is a 32-bit system designed for professional-level use on platforms employing the Microsoft® Windows operating system and the ESRI® ArcGIS® software.

- Pentium-based PC (Pentium IV or higher recommended) or equivalent running Microsoft® Windows Vista, Windows XP, Windows 2000®, or Windows NT®
- ArcGIS 9.2 SP2 or later
- Minimum display of 1024 x 768 with 64,000 colors (higher resolutions and widescreen formats are recommended)
- 512 MB RAM, 1 GB recommended
- 256 MB hard disk space

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