C-PLAN

CONSERVATION PLANNING SOFTWARE

User Manual

Last update: 14 February 2005

Department of Environment and Conservation.

Preface.

This manual provides documentation on the functionality available in the conservation planning tool C-Plan, and describes the principles on which it has been built. The manual provides instructions on how to use C-Plan with the ArcView 3.x GIS, covers the steps needed build a C-Plan database, and link it to ArcView 3.x. To learn how to use the various options and functions found in C-Plan you should attempt the tutorials provided in this manual, using the sample data available on the C-Plan web site (see below).

C-Plan was developed as a research tool, and as such, it is subject to on-going development. It is provided 'as is', free of charge, in the hope that it may prove useful to other conservation planning practitioners. Limited support (subject to work commitments) is available through the contact details listed below:

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To reference any part of this manual, please use the following convention:

Pressey, R.L., M. Watts, M. Ridges & T. Barrett. 2005. C-Plan conservation planning software. User Manual. NSW Department of Environment and Conservation.

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1. INSTALLING C-PLAN.

1.1. Obtaining the C-Plan install sets.

To install C-Plan you will need the following two components:

- C-Plan install set
- The Borland Database Engine install set

You can download these installation files from the C-Plan Internet site at:

http://www.ozemail.com.au/~cplan

There are two additional components to C-Plan that are available:

- Marxan: available for download from: http://www.ecology.uq.edu.au/marxan.htm
- SPATTOOL: is available on request by sending an email to: cplan@ozemail.com.au

1.2. System requirements.

C-Plan has been designed to operate using minimal hardware and software requirements. However, the precise requirements for C-Plan to run are dependent upon the size of the C-Plan database. C-Plan will run on a database of any size (there are no built in limits). However, the limits for any given dataset will depend on the capacity and speed of the computer being used.

The following formula gives a rough approximation of C-Plan memory (RAM) use:

Memory used (Kbytes) = (Sites x Features/200) + C

Where C is an adjustment factor that can range from 10,000 to 20,000 depending on the density of non-zero values in the sites x features matrix. Note that this memory use is in addition to that used by the operating system. Also, if C-Plan is being run linked to ArcView, the memory requirements of ArcView needs to be considered, which is usually an additional 30MB, but can vary depending on how much data is being viewed. C-Plan will run with less RAM than indicated in the following recommendations, it will just run more slowly. Ultimate capacity is determined by available virtual memory, which in turn is determined by hard-drive space.

C-Plan runs on any IBM compatible PC with the following specifications:

Hardware	Minimum	Recommended
Processor:	486	Pentium
RAM:	32 MB	80 - 100 MB

Increasing RAM will have the most benefit in reducing turn-around time for large databases. There is a linear increase in memory use with an increase in the number of sites and/or the number of features (see formula above).

C-Plan occupies 12MB of hard-drive space when fully installed (this includes sample databases and manual). For large databases (20 000+ sites & 500+ features) we recommend 80 to 100 MB of free disk space.

C-Plan was developed and tested most rigorously for Windows NT 4.0. However, it has been successively run on computers installed with Windows 9x, 2000 and XP. Note though that the level of testing has not been as extensive for these operating systems, and problems can be encountered, particularly with non-English versions of those operating systems. For the GIS interface, C-Plan links with the ESRI's ArcView 3.x. Note that C-Plan is cannot be linked ArcView2.x, or with ArcGIS. Links for ArcGIS are in development. C-Plan produces reports in the form of comma-delimited files that can be viewed in any spreadsheet program such as Microsoft Excel.

1.3. Procedures for installing C-Plan.

After downloading the files from the C-Plan internet site. These are self-extracting winzip files which should be extracted into a new directory for each. The extracted files will appear in sub-directories on your hard drive. Each sub-directory will be labelled \DISK1, \DISK2 etc.

First install the Borland Database Engine by double-clicking on SETUP.EXE from DISK1 of the Borland Database Engine installation set, if you are using floppy disks insert DISK2 when prompted.

Then install C-Plan by double-clicking SETUP.EXE from DISK1 of the C-Plan installation set, if you are using floppy disks insert DISK2 when prompted. This installation will make all the necessary configuration changes to your operating system. When it is finished, you will be ready to run C-Plan with the sample data.

If it is the first time C-Plan has been installed on your computer, you will be prompted to obtain a registration key from C-Plan Support when you attempt to run C-Plan for the first time. The registration key is derived from the installation key that will be displayed, so please have that number ready when you contact us. C-Plan only needs to be registered once on each computer, but each subsequent computer will require its own installation/registration key.

1.4. Installing additional modules (SPATTOOL & MARXAN)

The installation of these two additional modules is a manual process. The procedures below outline the necessary steps.

1.4.1. SPATTOOL installation.

After down loading and extracting the SPATTOOL module, you should have the following four files:

1. cluster1.exe
2. execit.exe
3. gmtest0.exe
4. spatanal.exe

Copy these files into your C-Plan installation directory (by default this is usually: C:\program files\cplan32)

1.4.2. MARXAN installation.

Once you have registered and obtained a copy of Marxan from the Marxan webpage (http://www.ecology.uq.edu.au/marxan.htm), you should have at least two files (marxan.exe and inedit.exe). To install Marxan for C-Plan to use, create the following path: C:\marxan, and copy these two files into the directory.

1.5. Trouble-shooting the install.

Below is a common set of problems faced when installing C-Plan, along with suggestions on how to fix them.

1.5.1. The C-Plan extension does not appear in ArcView.

The C-Plan ArcView extension (cplan.avx) is moved into the ArcView extensions folder when C-Plan runs for the first time. So it is possible that ArcView can be started before C-Plan has moved the extension. Normally the problem can be alleviated by starting C-Plan from the start menu, however, this does not always work, for a variety of reasons. The problem can be fixed by installing the C-Plan extension file manually:

1. Locate the cplan.avx file. This will be in the arcview subdirectory of the C-Plan install path, normally: C:\Program Files\CPlan32\ArcView.
2. Copy the cplan.avx file and paste it into the ext32 directory of the ArcView install path, normally: C:\ESRI\AV_GIS30\ARCVIEW

1.5.2. Error messages when loading the C-Plan extension in ArcView.

ArcView can produce an error such as that seen in Figure 1.1 when the C-Plan extension is launched in ArcView. The error occurs when the C-Plan extension is launched without the Spatial Analyst extension also loaded. Ensuring that the Spatial Analyst extension is loaded before the C-Plan extension is launched will alleviate this problem.

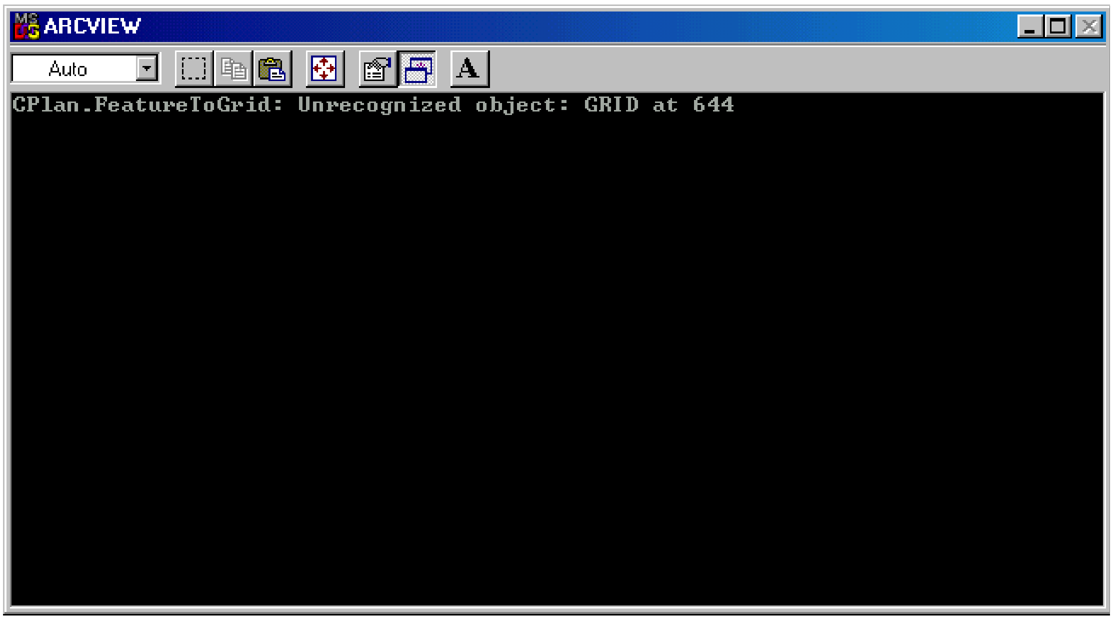


Figure 1.1. Error window when loading C-Plan ArcView extension.

2. INTRODUCTION TO C-PLAN

2.1. C-Plan Concepts

C-Plan is designed around the concept of a decision-support system. Together with a geographic information system (GIS) it:

- maps the options for achieving an explicit conservation goal in a region
- allows users to decide which sites (areas of land or water) should be placed under some form of conservation management
- accepts and displays these decisions, and then lays out the new pattern of options that result

Most of the computer code that makes up the software is designed to calculate and display information (using tables, maps, or diagrams) that can be used to guide conservation planning decisions. Such information includes:

- the characteristics (in terms of the biodiversity feature they contain) of any of the sites involved in the assessment
- collections of sites that have various combinations of characteristics
- the extent to which the conservation target for any particular feature (e.g. species or forest ecosystem) has been reached by conservation decisions made up to that point
- a log of the reasons for making all decisions

One of the key pieces of information that C-Plan calculates and displays is the irreplaceability of each site in the planning region. The irreplaceability of a site can be used as a guide to the importance of that site for achieving a regional conservation goal. Highly irreplaceable sites are crucial for achieving the goal, and failure to select them usually means that the goal for one or more features cannot be achieved. Sites with a low irreplaceability are less crucial because there are other sites that can contribute equally or greater to the achievement of the conservation goal. In other words, sites with a low irreplaceability indicate that there are many options about which one to choose, although some of them must be selected if the regional goal is to be achieved.

All calculations in C-Plan are based on a matrix of sites by features and are driven by feature targets (the area or number of localities of each species, forest ecosystem or other feature) identified as requiring some form of conservation management. The targets are updated each time one or more sites are selected. Updating targets changes the area or number of sites still needed for conservation according to their extent in the recently selected sites. In ArcView, sites are coloured according to whether they have been selected in C-Plan, or according to their current irreplaceability value. At any stage of a conservation planning exercise, you can produce detailed reports on sites and/or features. These reports can be read directly into a spreadsheet program such as Microsoft Excel.

The patterns of irreplaceability in a region change if the conservation targets for features are changed. Higher targets for all features will increase the irreplaceability of sites, effectively reducing the options for achieving all targets. Lowering targets will lower the irreplaceability values of most sites and produce more options for designing the system of conservation areas. Raising the targets for some features and lowering others can produce a similar range of irreplaceability values, but could alter the spatial pattern of those values. How conservation targets are set should reflect broad aims of the project and decisions made at a policy level.

The irreplaceability index is only intended to be a guide for conservation planning. In general, selecting sites with the highest irreplaceability means selecting those that will contribute most to target achievement. It also tends to minimise the number of sites needing to be selected in order to meet all targets since most or all of the highly irreplaceable sites will be needed to achieve the regional conservation goal anyway. Once selected, these sites can act as nodes around which other, less irreplaceable, sites can be grouped in order to address design characteristics of conservation areas. Nevertheless, situations can arise in which it is necessary to make decisions about sites with moderate or low irreplaceability before selecting those with higher irreplaceability values. There are inevitably many factors to consider when designing a system of conservation areas in addition to the biophysical features that they contain and therefore drive irreplaceability. These include aspects of conservation design (e.g. size, shape, connectivity), cultural heritage, and the economic and social implications of protecting particular sites. Such information can be viewed in the GIS in the context of the planning region during the course of the planning exercise.

2.2. Sites

The sites used for analysis and display in C-Plan can be any areas of land or water. They can be areas such as logging compartments; pastoral holdings; or arbitrary grid blocks that subdivide areas of continuous habitat like extensive tracts of forest or rangeland. They can also be discontinuous areas such as forest fragments or wetlands separated by cleared land or contrasting habitats. The only requirement of C-Plan is that they are the areas in the sites by features matrix that are used to record the extent or number of localities of each of the species, vegetation types, or environments used in the analysis of targets and irreplaceability. Sites may also be excluded from the planning process. For instance, if there are land tenures or economic reasons for making certain sites unavailable for selection, they can be excluded in C-Plan. Doing so results in C-Plan recalculating the irreplaceability of the remaining sites, assuming that the excluded sites cannot be selected. In general, this will tend to increase irreplaceability values since there are now fewer sites with which to meet the same conservation goals.

2.3. Features

Features can be physical (eg environmental units defined by combinations of geology and terrain), biological (assemblages, vegetation types, species, populations), cultural (Aboriginal campsites) or aesthetic (wilderness areas). The basic definition of a feature in C-Plan is an attribute of the terrestial or marine environment that is recorded in the sites by features matrix (by the number of occurrences or area covered in relevant sites). This is the generic data that C-Plan uses, in conjunction with targets, to calculate irreplaceability values. Information on the distribution of other attributes that do not have targets but which need to be considered in conservation planning (eg timber values of logging compartments) can also stored in the site database (see section 3.6). This additional information can be used in C-Plan in several ways: by querying the information on each site with a lookup table on the screen; by searching for sites with particular combinations of attributes; or by mapping the distributions of the attributes as an overlay on the screen.

2.4. Feature Targets

A feature target can be calculated in two ways: it can be calculated as an across-the-board percentage of the current total amount of the feature in the study region (e.g. 10% of each) or it can be specified as a user-defined amount. An example of a user-defined target is 15% of the pre-cleared area of each forest ecosystem, effectively giving more conservation emphasis (larger percentages of current areas) to forest ecosystems that have been reduced to a greater extent following European settlement. Targets determine how much influence any feature has on the pattern of irreplaceability and the number of sites needed to meet the target for that feature. Targets can be changed at any time, and in several ways (see section 4.2 for details on how to do this).

As well as using feature targets to drive irreplaceability calculations, it is possible to exclude features from the calculations. This allows you to investigate the contribution of individual features, or sets of features, make to the overall irreplaceability pattern. Being able to restrict which features are used to calculate site irreplaceability can also be useful when the study area contains different environments, such as marine and terrestrial, where it may be necessary to develop separate planning strategies.

2.4.1. Target indices used by C-Plan.

C-Plan utilises a number of different measures of targets, based on the occurrences of features within sites that have been selected, excluded or remain available. The different measures of feature targets are best illustrated by indicating each target on a column graph where the graph height represents the area of a hypothetical feature (see Figure 2.1 and Figure 2.2). The total extant area of this hypothetical feature can be divided up into six different categories depending on how the area occurs within the various statuses a site can adopt within C-Plan. Site status categories are summarised in Table 2.1.

Table 2.1. Site status categories used in C-Plan.

Feature Area Category:	Description:
Not in database	Area of feature's total extent that was not included in the C-Plan database (eg this may be total original extent, prior to land clearing)
I_Excluded	Area of the feature occurring within sites that were set as initially excluded
I_Available	Area of the feature occurring within sites set as initially available
I_Selected	Area of the feature occurring within sites set as initially selected
Excluded	Are of feature within sites that were initially available, but subsequently excluded during the planning process
Selected	Area of features within sites that have been selected during the planning process

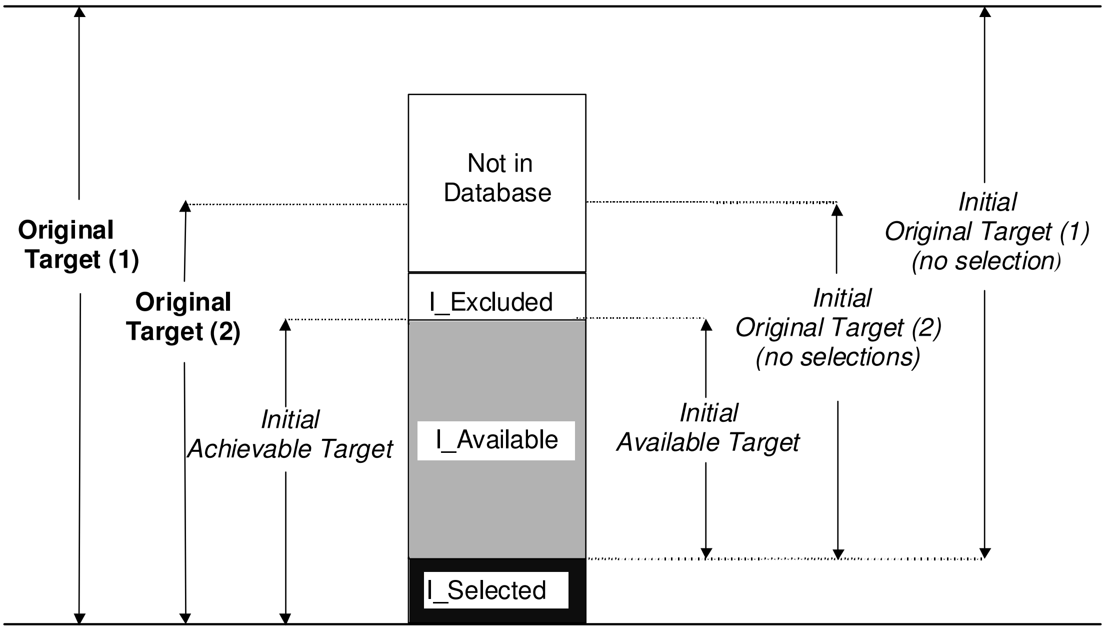


Figure 2.1. Initial target scenario.

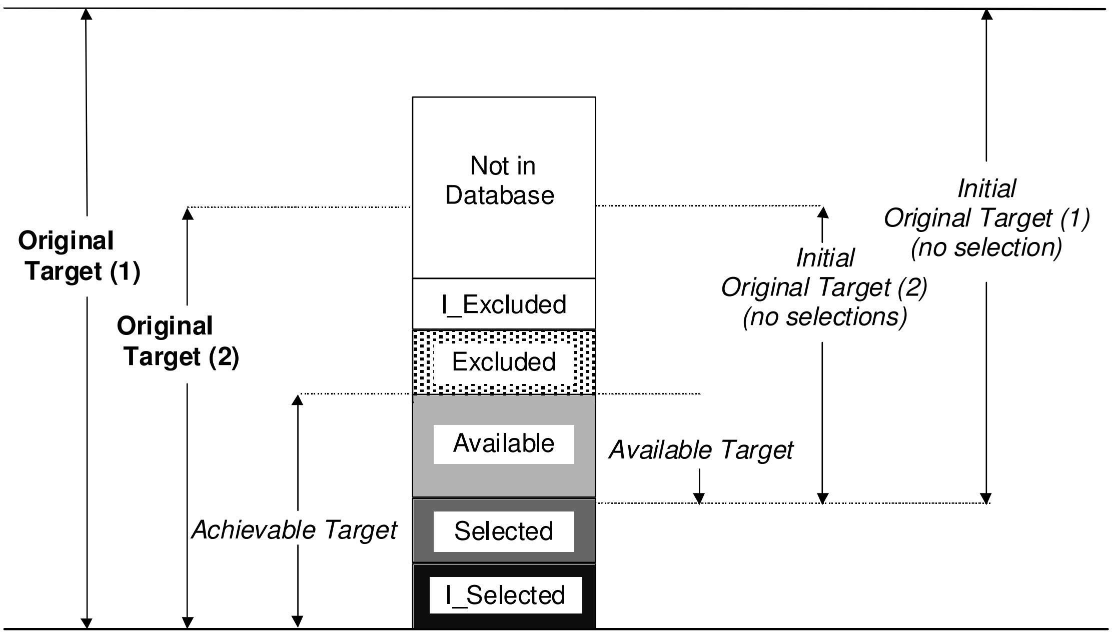


Figure 2.2. Target scenario after site selection.

The feature targets that C-Plan works with can be divided into two categories, those that don't change, and those that change as sites are selected/unselected/excluded during the planning process:

2.4.1.1. Targets that don't change:

Original Target: The 'original' or starting target. The Original Target can be user-defined for each feature (as listed in the features table of the C-Plan database– see section 3.5 for more details) or expressed in terms of a flat percentage of the total feature amount present in the C-Plan database. The flat target is applied by specifying a 'Target %' in the C-Plan control window (see section 4.2). This target value does not take existing protected areas into account. In Figure 2.1 and Figure 2.2 there are two examples of original target; 'Original Target (1)' has been formulated as a percentage of the historical distribution (indicating that a large proportion of the feature has been destroyed) and 'Original Target (2)' has been calculated as a percentage of extant area.

Initial Achievable Target: This target is the Original Target trimmed to the amount that is initially achievable in the C-Plan database, considering only those feature amounts in Initial Selected and Initial Available sites.

Initial Original Target (unselected): These 'unselected' targets represent the 'new selection' targets. They are the amounts that are actually needed in addition to existing selections, to meet the respective original targets.

Initial Available Target: This is also a 'new selections' target, except that this target specifically refers to the unselected component of the Initial Achievable Target. It is the amount you need from Initial Available sites to meet the Initial Achievable Target.

2.4.1.2. Targets that change during the planning process:

Original Target (unselected): Amount of Original Target remaining unselected across all sites. This is the Original Target minus the amount in all selected sites. Selected areas include; existing selections (I_Selected) and sites that were selected during the planning process.

Achievable Target: Original Target trimmed to what is achievable in the C-Plan database. The amount of the Original Target that can be found in existing selections and in 'Available' selection units. The Achievable Target takes into account all site Exclusions made in C-Plan.

Available Target: This is the portion of the Achievable Target that is available for selection in C-Plan from 'Available' sites taking all other selections into account (both initial selections and areas selected during the planning process).

2.5. The Concept of Irreplaceability

Irreplaceability is a measure assigned to an area (water or land) which reflects the importance of that area, in the context of the study region, for the achievement of the regional conservation goal. Due to the number of possible combinations of sites that could be selected to form a conservation plan in a given region, irreplaceability is predicted, rather than calculated directly. Early approaches to predicting irreplaceability (Pressey et al. 1994, 1995) have now been replaced by statistical estimation techniques (Ferrier et al. 2000). The method of prediction used in C-Plan offers a fast, and computationally efficient means of predicting irreplaceability. The use of a fast predictor enables C-Plan to display changes in irreplaceability dynamically during the planning process as decisions about site selection are made. A summary of the operation of the irreplaceability calculation used in C-Plan is provided below. For full details of the calculations, the reader is referred to Ferrier et al. (2000). Other methods for calculating irreplaceability have also been developed independently of the method used in C-Plan, such as global site selection algorithms, like that provided in the MARXAN tool (see MARXAN manual, and section 2.10).

To explain the calculation of irreplaceability, consider the problem of selecting a system of protected areas within a given region. Quantitative protection targets have been set for each of the features (e.g. vegetation types, species' habitats) requiring representation. The region has been divided into a number of areas that will serve as selection units or sites. Data have been collated on the amount (e.g. area, number of records) of each feature occurring in each site. The basic objective of the planning process is to select a subset of sites that will, in combination, satisfy the protection targets assigned to each feature.

Irreplaceability is defined as the likelihood that a given site will need to be selected to achieve a specified set of targets or, conversely, the extent to which options for achieving those targets are reduced if the site is not selected (Pressey et al., 1994). Initially, it might be tempting to think that the irreplaceability of a site might be measured by simple arithmetic analysis of the areas of features occurring in the site in relation to the protection targets for these features. For example, an index could be derived by dividing the area of each feature occurring in a site by the target for that feature and then summing these proportions across all features in the site. Although such an index may reveal something about the potential contribution of a site to achieving targets it reveals little about the irreplaceability of that site. This is because the approach does not consider the extent to which a site's contribution can be replaced by selecting other sites in the region, and therefore the extent to which options for achieving targets are reduced if this site is not selected.

Consider, for example, two sites in a region of several hundred sites. Both sites contain a single feature – Site 1 contains 50Ha of vegetation type A while Site 2 contains 50Ha of vegetation type B. Vegetation types A and B both have a target of 100Ha. The two vegetation types differ, however, in total regional extent – vegetation type A has a total area of 150Ha while type B has a total area of 2000Ha. The simple arithmetic approach just described would assign equal priority to these two sites because they each contribute equally to achievement of targets (50Ha, or 50%, of a target of 100Ha). However, the irreplaceability of Site 1 is much higher than that of Site 2 because there are fewer replacements for Site 1 in the region.

In special cases – for example, where sites are of equal size and contain no more than one feature – the simple arithmetic approach can be extended to account for differences in the regional extent (or rarity) of features. An example might be a region divided into equally sized grid cells, each of which is assigned to a single mapped vegetation type. The irreplaceability of a given site can then be calculated by dividing the areal protection target for that site's vegetation type by the total area of the vegetation type across all sites, yielding an index ranging between 0 and 1. For example, if a site contains a vegetation type with a protection target of 400Ha and a total area of 500Ha across the region the irreplaceability of this site is 400/500 = 0.8, a relatively high value. If another site contains a vegetation type with a protection target of 200Ha and a total area of 1000Ha then that site's irreplaceability is 200/1000 = 0.2, a relatively low value.

For most real-world conservation planning exercises sites are of unequal size and contain multiple features. Sites are often defined as sub-catchments, tenure parcels, or fragments of remaining vegetation. Such sites are rarely homogeneous with respect to any given land classification (e.g. mapped vegetation types, land systems). A single site can therefore contain areas of two or more land classes. This situation may be further complicated by inclusion of features with overlapping spatial distributions (e.g. species localities or modelled distributions overlaying areas of vegetation types). If sites are of unequal size and/or each site contains more than one feature, then irreplaceability can no longer be measured using simple arithmetic. In part, this is because the irreplaceability of a site will depend not only on the area of each feature occurring in the site in relation to the feature's target and total regional extent, but also on the way in which that feature is distributed across the region.

Consider a further example involving two sites, each containing a single vegetation type – Site 1 contains 50Ha of vegetation type A and Site 2 contains 50Ha of vegetation type B. Vegetation types A and B have both been assigned a protection target of 100Ha and both have a total regional area of 150Ha. The two types differ, however, in the way in which this total area is distributed across sites in the region. Vegetation type A occurs in just two sites – 50Ha in Site 1 and 100Ha in another site. Vegetation type B occurs in 101 sites – 50Ha in Site 2 and the remaining 100Ha scattered as very small patches across 100 other sites. A simple arithmetic approach to measurement of irreplaceability would assign equal conservation priority to Sites 1 and 2. Yet the real implications of not selecting Site 1, in terms of the reduction in options for achieving targets, clearly differ from those for Site 2. Furthermore, the exact nature of this difference will depend on the likely number of sites that can be selected within the region and the way in which the distributions of vegetation types A and B relate to the distributions of other features in the region. Measurement of irreplaceability in the general case (variable site area and variable number of features per site) is inherently a combinatorial problem that cannot be addressed effectively using simple arithmetic indices.

Pressey et al. (1994) proposed that the irreplaceability of a site be measured as the proportion of all representative combinations of sites in which that site occurs. Consider, for example, a situation in which a system of protected areas must be formed from selecting a combination of n sites from a total of t sites. The number, C, of possible combinations of size n that can be constructed from these sites is:

$$C = t!/n!(t-n)!$$

which is the binomial coefficient. Of this set of all possible combinations, only a subset of combinations will be ‘representative’, that is they achieve all targets (set A in Figure 2.3). The remaining ‘non-representative’ combinations fail to meet targets for one or more features. For any given site x, the set of representative combinations can be further subdivided into two subsets, one containing combinations that include site x (set B in Figure 2.3) and the other containing combinations that do not include site x. According to the approach proposed by Pressey et al. (1994) the irreplaceability of site x is calculated by dividing the number of representative combinations that include site x (set B in Figure 2.3) by the total number of representative combinations (set A in Figure 2.3).

Experimentation conducted since the original irreplaceability measure was proposed by Pressey et al. (1994) has demonstrated a significant improvement in representing the irreplaceability of a site. The set of representative combinations that include site x (set B in Figure 2.3) can be further subdivided into those combinations that would no longer be representative if site x were removed from the combination (set C in Figure 2.3) and those combinations that would still be representative after removal of site x (i.e. combinations in which site x is redundant). A revised measure of irreplaceability can be calculated by dividing the number of representative combinations that include site x, but would no longer be representative if site x were removed (set C in Figure 2.3) by the total number of representative combinations (set A in Figure 2.3).

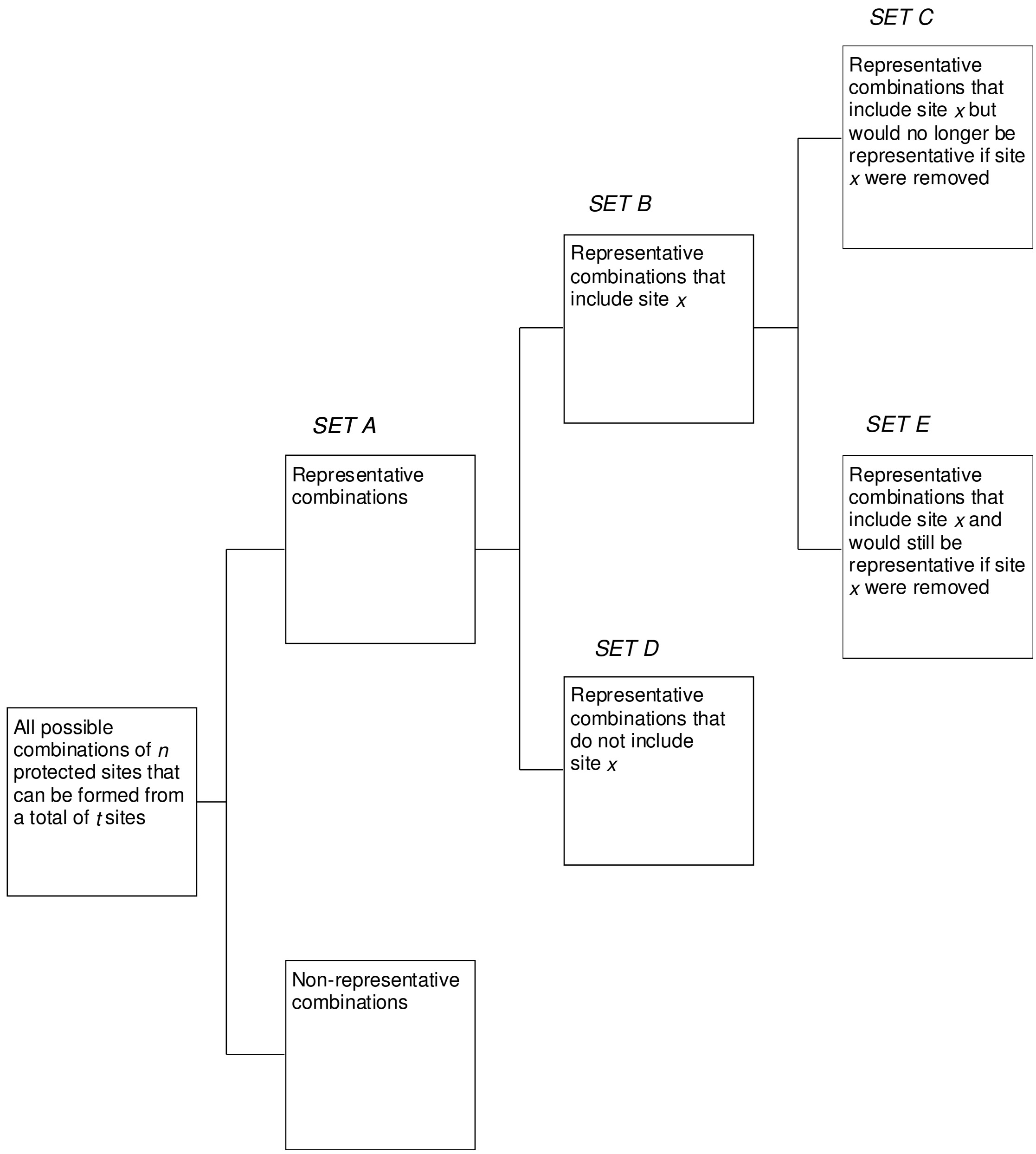


Figure 2.3. Combinatorial sets used in the calculation of irreplaceability.

While the original formulation measures the proportion of representative combinations that include site x, the revised formulation measures the proportion of representative combinations for which site x plays a critical role in achieving one or more protection targets. With the original measure, inclusion of site x in a representative combination affects the calculation of irreplaceability even if that site is not making a critical contribution to achieving targets. This is the problem of 'redundancy' identified by Pressey et al. (1994). The effect of redundancy on the original irreplaceability measure increases with increasing combination size. The problem is removed with the revised measure, and this measure is therefore used in preference to the original measure in C-Plan by default.

The calculation of true irreplaceability for a regional data set is intractable due to the astronomical numbers of combinations that would have to be generated and assessed. Even the fastest super computer cannot perform this task in a realistic time frame. For this reason the number of sites in set C and set E in Figure 2.3 are predicted using statistical methods. For a detailed description of these methods see Ferrier et al. (2000). Despite the statistical assumptions necessary in the use of the predictor, tests have verified that it produces very good fits between estimated and real irreplaceability for small and medium sized datasets.

Irreplaceability values are influenced by the selection combination size (the estimated number of sites required to meet all targets used by the predictor). There is no way of knowing how big the final reserve system will be, so combination size is primarily used to obtain a good spread of site irreplaceability values. Although the absolute irreplaceability value of sites may change under different combination sizes, the ranked order of sites will remain the same. To calculate an initial combination size, the irreplaceability predictor generates an 'average' site assuming each feature is spread evenly across all available sites. It then systematically calculates the irreplaceability of this site under many different combination sizes until it finds a combination size that produces an irreplaceability value of 0.5 for this average site. This combination size is then used for the irreplaceability calculations for all sites. Subsequently, each time a site is selected, the current combination size gets reduced by one.

Sometimes this method of reducing the combination size (by the number of sites that are selected) leads to a combination size that is either too large or too small (for example combination size reduces to zero while there are remaining sites containing features whose targets haven't been met). When this occurs, irreplaceability values approach zero (combination size too large) or one (combination size too small). In these situations C-Plan recalculates combination size again using the same method to obtain a more sensible combination size for the remaining available sites.

2.6. Additional irreplaceability indices.

In addition to calculating site irreplaceability, C-Plan also calculates several other indices that extend the concept. The irreplaceability predictor estimates the likelihood that a given site will need to be selected in order to achieve targets for all features under consideration. Measured in this way, values for multiple feature irreplaceability range between zero and one. However, a limitation of this measure is that it reveals nothing about how many features will fail to meet their target if the site is not selected. This may not be a problem in situations where irreplaceability values for a region are well spread between zero and one, and only a small proportion of sites have very high irreplaceability. However, consider a situation in which many features have been assigned large protection targets relative to the area of these features available for protection. In this situation, a large proportion of sites can be expected to exhibit very high irreplaceability values, many with an irreplaceability of one. In this instance, irreplaceability does not distinguish between sites that are highly irreplaceable for just one or many features. The following indices address this issue in a variety of ways.

2.6.1. Summed irreplaceability.

To address the problem of many highly irreplaceable sites, C-Plan also calculates a related index describing the priority for selection using the irreplaceability calculated individually for each of the features it contains. A 'summed irreplaceability' index for site x can be derived simply by summing the irreplaceability, Irr_{ix}, estimated separately for each feature using the same procedure described above. Since Irr_{ix} values range between zero and one for each feature, the resultant summed irreplaceability value for each site, $SumIrr_x$, can be greater than one, reflecting the number of features contributing to the irreplaceability of a site. Summed irreplaceability can therefore be more applicable than irreplaceability on its own because it can be used to distinguish between a large number of sites having an irreplaceability of one. Similarly, high values are indicative of sites that are highly irreplaceable for many features rather than just one.

2.6.2. Weights for summed irreplaceability.

The calculation of summed irreplaceability gives equal weight to all features occurring in a site when summing the Irr_{ix} values for those features. In some situations it may be desirable to vary the weight given to different features, in which case the index becomes a 'weighted summed irreplaceability' index. The basic aim of this weighting is to give added emphasis to those features most in need of further protection, particularly in situations where it is unlikely that targets for all features will be achieved due to competing socioeconomic demands. The need for weighting features will vary between different applications, as will the exact basis for assigning weights.

C-Plan allows features to be optionally weighted in the calculation of summed irreplaceability using three types of weighting (applied individually or in combination):

- weighting for proportion of planning unit covered;
- weighting for proportion of target already achieved; and
- weighting for vulnerability (selection priority);

All the weighted summed irreplaceability indices are calculated and stored in the site database each time irreplaceability is calculated. This means that you are able to use any of these indices in procedures using values from the sites table.

2.6.2.1. Area weighting.

With the area weighting selected, the weight applied to each feature within a given planning unit is simply the contributing area of the feature expressed as a proportion of the total area of the planning unit. This weighting therefore gives extra emphasis to features that cover a larger proportion of a planning unit, and thereby giving extra emphasis to planning units with a high proportional coverage of features of high irreplaceability. The weighting also adjusts for differences in total area between planning units, by transforming the summed irreplaceability index to be an estimate of the average summed irreplaceability expected for any point selected at random within a planning unit.

Note however, that the area summed irreplaceability weighting treats all values in the C-Plan sites by features matrix as areas. If the features are recorded as points or some other unit other than area, then the index will produce spurious results. In such cases, the measure will usually produce very small numbers. This is not a problem if all the features are recorded in this way, but if you have a mixture of area features and point features then the point feature irreplaceabilities, when weighted according to area, will be very small (approaching zero) in comparison to the area. This effectively means that the point features will no longer contribute to the summed irreplaceability index.

2.6.2.2. Target weighting.

This weighting is designed to give extra emphasis, in summed irreplaceability calculations, to features well below target (in terms of proportion of target met). The weight applied to any given feature ranges between 0 and 1 and is calculated as $1 - (P (1 - M))$, where P is the proportion of the original target already met and M is a user-specified minimum value for the weight (this minimum applies across all features). The minimum proportion (M) is specified in the CPLAN.INI file (see section 3.10).

2.6.2.3. Vulnerability weighting.

Features can also be assigned a vulnerability rating, reflecting the relative priority for each feature to be conserved, and which in turn can be used to weight summed irreplaceability.

The vulnerability rating scheme consists of five classes, 1 (highest reservation priority) to 5 (lowest reservation priority). Within C-Plan each of these classes can be assigned a user-specified weight between 0 and 1 reflecting the desired emphasis to be given to the class in calculation of summed irreplaceability. For example vulnerability classes 1 to 5 might be assigned weights 1.0, 0.8, 0.6, 0.4 and 0.2 respectively. The actual weighting assigned to each of the vulnerability classes is specified in the CPLAN.INI file under the [Sumirr Vulnerability Weightings] heading (for more detail see section 3.10). If you want to change these weighting values you can edit the CPLAN.INI file in a text editor (such as NOTEPAD), and when you next start C-Plan the new weightings will take effect. In order for the vulnerability weighting to be applied a feature vulnerability value needs to exist in the feature database, in a field called 'VULN' (for more detail see section 3.5).

2.6.2.4. Integration of weightings in calculating summed irreplaceability

The three types of feature weighting can be applied in any desired combination within C-Plan. You can turn each of the three weightings on or off at any time (see section 5.8.6 for details on how to do this in C-plan). All of the weights range between 0 and 1. If more than one type of weighting is active then the net weight applied to a feature is simply the product (multiplication) of the two or three individual weights involved. Summed irreplaceability for a planning unit is then estimated by first multiplying each individual feature irreplaceability by its respective net feature weight and then summing these products:

$$\text{Summed irreplaceability} = \sum_{i=1}^{features} Irr_i \times (Wa_i \times Wt_i \times Wv_i)$$

where Irr_i = individual feature irreplaceability for feature i

Wa_i = weighting for proportion of planning unit covered by feature i

Wt_i = weighting for proportion of target met for feature i

Wv_i = weighting for vulnerability of feature i

The following example demonstrates the calculation of weighted summed irreplaceability, with all weightings applied, for a totally irreplaceable site (site X) that is 120ha in size and contains two features with the following attributes:

Table 2.2. Hypothetical values for summed irreplaceability calculation.

Feature	Irr_i	Wa_i	Wt_i	Wv_i^*
Feature 1	1.00	10Ha	5%	2 (0.8)
Feature 2	0.30	110Ha	90%	5 (0.2)

* Using the input weighting index used by C-Plan (1 = 1.0; 2 = 0.8; 3 = 0.6; 4 = 0.4; 5 = 0.2)

Calculation of weighted summed irreplaceability for site X:

$$\text{Summed irreplaceability} = \sum_{i=1}^{features} Irr_i \times (Wa_i \times Wt_i \times Wv_i)$$

$$= 1.0 \times \left[\frac{10}{120} \times 1 - (0.05 \times (1 - 0.2)) \times 0.8\right] + 0.3 \times \left[\frac{110}{120} \times (1 - (0.9 \times (1 - 0.2)) \times 0.2\right]$$

$= 1.0 \times [0.08 \times 0.96 \times 0.8] + 0.3 \times [0.92 \times 0.28 \times 0.2]$

$= 1.0 \times 0.06 + 0.3 \times 0.05$

$= 0.075$

The unweighted summed irreplaceability for site X = 1 + 0.03 = 1.3.

As you can see from the above example, when all the weightings are applied it only takes one small weighting to downgrade the feature irreplaceability value. For feature 1 it is the small area weighting. If the area weighting was not used (so only the target and vulnerability weightings were applied) the weighting for feature one would have been 0.96 x 0.8 = 0.77, a much larger value than 0.06.

Figure 2.4 illustrates the combined effect of weightings for vulnerability and proportion of target achieved if, for example, vulnerability classes 1 to 5 were assigned weights 1.0, 0.8, 0.6, 0.4 and 0.2 respectively, and M was assigned a value of 0.2.

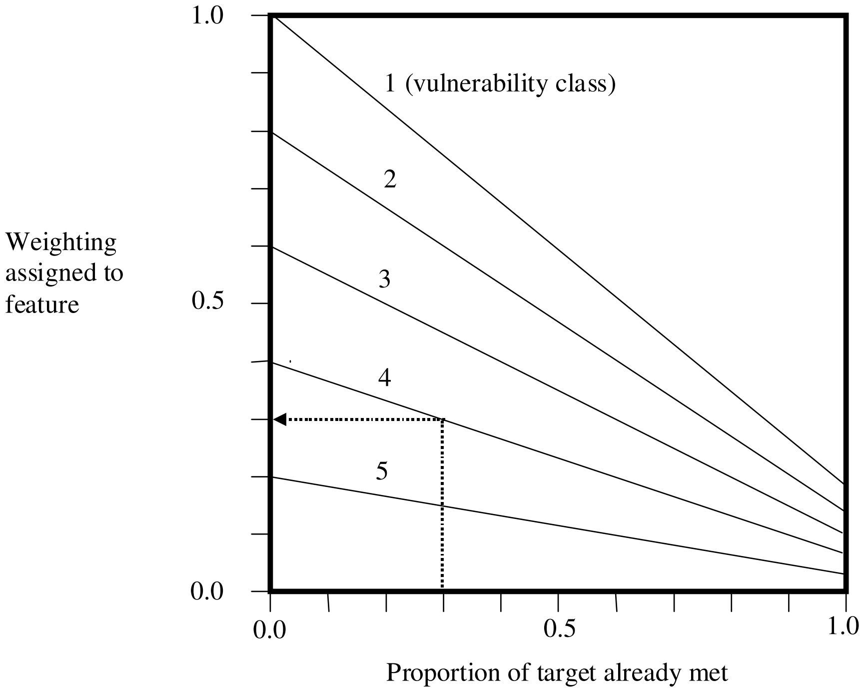


Figure 2.4. Graph demonstrating the effect of combining two weightings.

Each diagonal line in this graph relates to an individual vulnerability class. The weighting to be assigned to a feature is equal to the weighting for the relevant vulnerability class when none of the feature's target has been met and then drops linearly to a minimum proportion (M) of this initial weighting as the target is progressively achieved. For example, consider an entity in vulnerability class 4 for which 30% of target has been met. The weighting for this entity would be:

0.4 x (1 - (0.3 x (1 - 0.2)) = 0.304 (see dotted line on graph).

2.6.3. Weighted average irreplaceability.

Weighted average irreplaceability is a weighted average of the feature irreplaceabilities in a site. The measure is only applicable for those features that are mutually exclusive spatially (i.e. do not overlap, like forest ecosystems for example). Values for weighted average irreplaceability range from 0 to 1. High values indicate that the site is relatively full of features for which it has high feature irreplaceabilities (i.e. a large percentage of the site's area is occupied by these features). Low values indicate either that the site is relatively full of features for which it has low irreplaceabilities or that it contains only relatively small areas of features for which it is highly irreplaceable. For example, two sites with site irreplaceabilities of 1 could vary in weighted average irreplaceability from 0.1 to 0.95.

C-Plan recognises which features are spatial mutually exclusive by the order in which they appear in the sites by features matrix (see section 3.4). When the sites by features matrix is initially created, these mutually exclusive features are included at the beginning of the feature lists and the number of these features is specified in the build database wizard.

The following example demonstrates the calculation of area weighted average irreplaceability for a totally irreplaceable site (site X) that is 120ha in size and contains two mutually exclusive features with the following attributes:

Feature 1:	feature irreplaceability = 1	Area in site = 10ha
Feature 2:	feature irreplaceability = 0.5	Area in site = 110ha

Area Weighted Irreplaceability (site X) = ((1*10) + (0.5*10)) / 120 = 0.54

2.6.4. Percent contribution.

Percentage contribution is the percentage of the total area of each site that would contribute to remaining targets if the site was selected. It is calculated only for features that are spatially mutually exclusive.

Table 2.3. Hypothetical values for percent contribution calculation.

Feature	Irr_i	Area	Remaining target	Ta_i
Feature 1	1.00	10Ha	90Ha	10
Feature 2	0.30	110Ha	20Ha	20

To continue with the example from above, for a 120Ha site, with the two features described in Table 2.3, the calculation of percent contribution would be as follows:

Where: Ta_I = Area of feature within site that can contribute to target

Sa_x = Area of site x

$$\text{Percent contribution} = \frac{\sum_{i=1}^{features} Ta_i}{Sa_x} \text{ X } 100$$

$$= \frac{10+20}{120} \text{ X } 100$$

$$= 25$$

2.7. C-Plan Structure

In addition to the calculation of irreplaceability, C-Plan includes additional functionality for performing calculations associated with particular tasks. Figure 2.5 illustrates the relationship between C-Plan, the irreplaceability predictor, and the MINSET, SPATTOOL and MARXAN modules. The SPATTOOL and MARXAN modules are separate applications that were developed independently of C-Plan.

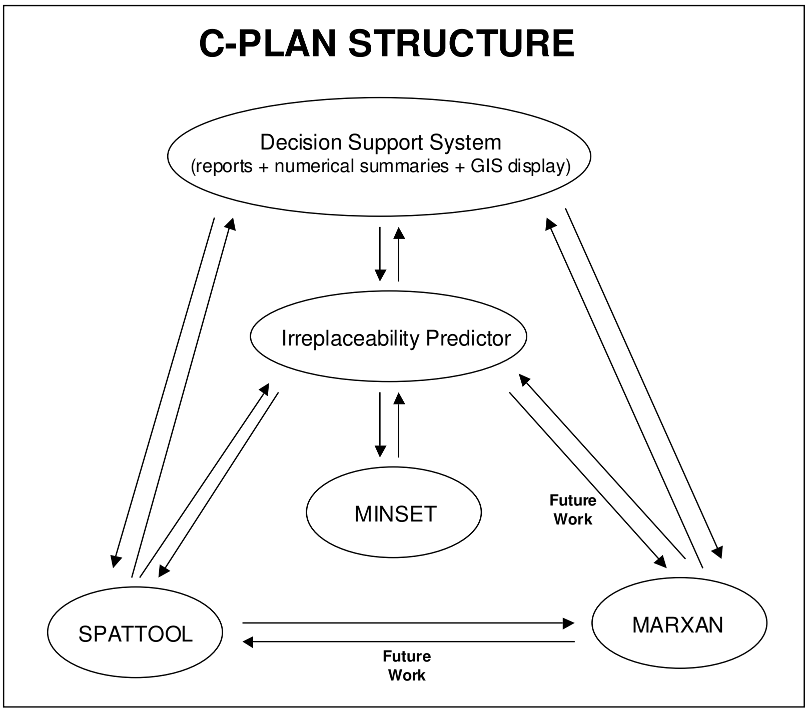


Figure 2.5. Structure of C-Plan and related applications.

2.8. MINSET

The MINSET function is a modifiable algorithm used as a tool to identify an approximate 'minimum set' of sites that would fulfil a specific aim (the stopping condition) if selected. For example, a desired outcome (or aim) in a conservation scenario might read something like:

"Achieve conservation targets for as many features as possible while minimising the impact on wood resources"

Other 'costs' besides wood resources that could be minimised using a MINSET might include: total land area selected or the acquisition cost of this area.

To achieve this aim the MINSET uses a set of rules to select one or more sites in an iterative search routine. The way these sites are selected is best explained by way of an example. To address the MINSET aim given above we could design the following hypothetical algorithm:

Rule 1.

Select the site with the highest site irreplaceability value.

(If there is a tie (>1 site) then go to Rule 2)

Rule 2.

Select the site with the lowest resource value (wood volume, area or acquisition cost).

(If there is a tie then go to Rule 3)

Rule 3.

Select a site with the highest summed irreplaceability value.

(If there is a tie then go to Rule 4)

Rule 4.

Select the first site in the list.

On the first iteration the site with the highest site irreplaceability will be selected, but there is often more than one site with an equal highest site irreplaceability (usually 'IRREPL=1'). The second rule acts as a tie-breaker for the sites selected in the first rule. If there is still a tie at the level of the second rule, ie. two or more sites with site irreplaceability of 'IRREPL=1' and have an equal lowest wood resource value, then the next rule acts as a tie-breaker for these sites. This process continues until there is only one site left. You can also specify how many sites to select on each iteration.

The higher the rule is in the algorithm the more influence it will have on the final set of sites selected. Rules lower down in the algorithm may not be used if there are no ties in the preceding rules.

After each selection C-Plan recalculates all irreplaceability indices and a new site is selected in the same way as the last. When the stopping condition is reached, C-Plan stops selecting sites and displays an information window informing you of the number of times each rule was used as the last rule to select a site.

MINSET stopping conditions can include:

- A specified number of iterations.
- Until all or a subset of feature targets are satisfied.
- When a specified resource limit is reached (e.g. 20% of resources in reserved sites).

The literature on conservation planning has proposed many minset algorithms (see Pressey et al. 1997 for review). The advantage of the C-Plan minset menu is that it allows you to design algorithms from a menu of rules and to compare the results of alternative rules on any given data set.

2.9. SPATTOOL

The following description of the SPATTOOL is adapted from:

NSW NPWS. 1999. Development of C-Plan functionality to guide achievement of spatial configuration objectives. A project undertaken for the Joint Commonwealth NSW regional Forest Agreement Steering Committee as part of the NSW Comprehensive Regional Assessments project number NA 60/EH.

The object of SPATTOOL is to automate the derivation of measures (indices) that guide the achievement of spatial configuration objectives for a set of sites selected in C-Plan. The tool implements two types of measure:

- *Measures of patch size and connectivity* to facilitate improved consideration of criteria such as ‘reserves should be large enough to sustain the viability, quality, and integrity of populations’; ‘protection of the largest and least fragmented areas of old-growth’; large reserved areas are preferable to small ones’; and ‘reserves should be linked through a variety of mechanisms’.
- *Measures of geographical and environmental spread* to facilitate improved consideration of criteria such as ‘reserved areas should be replicated across the geographic range of the forest ecosystem’; ‘the reserve system should … sample the full range of biological variation typical of its geographic range’; and ‘representation of old-growth forest across the geographic range of the forest ecosystem’.

These measures can be considered at two different points within C-Plan:

- When assessing the 'potential contribution' that individual unselected planning units would make if they were added to the set of already selected sites. With the SPATOOL, potential contribution is measured in terms of the contribution a site makes to achieving spatial configuration objectives relating to patch-size/connectivity and geographical/environmental spread.
- When evaluating the current configuration of selected sites. The configuration is measured in terms of the achievement of spatial configuration objectives relating to patch-size/connectivity and geographic /environmental spread.

2.9.1. Potential contribution of individual planning units.

C-Plan generates a number of indices (irreplaceability etc) that measure the potential contribution of unselected sites to the achievement of area feature targets. These indices only use information on the occurrence of features within the site of interest, without any consideration of the distribution of features in the surrounding area or the proximity of existing reserves. The SPATOOL allows spatial context to be automatically factored into the derivation of any of the existing indices.

C-Plan can produce an irreplaceability index reflecting spatial context by first estimating the irreplaceability for individual planning units in the normal manner and then transforming the value for each site according the values of other sites in the surrounding area. The extent of the 'surrounding area' considered in these calculations is determined by a user-specified radius. The transformed index assigned to each planning unit is calculated as a distance and area weighted average of the values (eg summed irreplaceabilities) of sites falling within a specified radius of the site of interest. The contribution of each site within this radius decreases with increasing distance from the site of interest and also decreases with decreasing site area. If only a part of a site lies within the radius, the contribution of that site to the weighted average is appropriately adjusted. Pre-selected planning units (e.g. existing reserves) are allocated a user specified constant value reflecting the weight these sites should carry in the calculations. This allows the user to control the extent to which the spatial index will reflect proximity to existing selected sites in addition to proximity to unselected areas of high conservation value.

By transforming an irreplaceability index to reflect spatial context, the index is no longer just a measure of the potential contribution of each planning unit to achievement of areal feature targets. Instead, it is a measure of the extent to which the unit is close to other units of high potential value and/or already selected sites. Spatially transformed indices can be derived for any specified subset of features, or all features combined. When C-Plan is asked to derive an index (eg summed irreplaceability) adjusted for spatial context, both the original index and the transformed index are generated and made available for mapping in selection rules.

Spatial data used in deriving the index are extracted from a special-purpose spatial data structure containing the area of each unit and the distances (edge to edge) between all possible pairs of units in the region. The shape of units is not considered in the approach– all units are assumed to be circular. The index, *Spat_contrib_index*, is calculated for a given planning unit *x* as follows (see also Figure 2.6):

$$\textit{Spat\_contrib\_index} = \sum_{i=1}^{n} V_i \left(1 - \left(\frac{D}{d_{\max}} \right)^C \right) \frac{A}{\pi (d_{\max})^2}$$

Where

d_{max} = the specified radius (m) around the unit of interest, *x*

n = the number of planning units within the specified radius

V_I = the value of the planning unit *I* (in terms of the specified irreplaceability index)

C = a user specified constant (between 0 and 1) that determines how quickly the weight applied to surrounding units diminishes with increasing distance from the unit of interest

D = $(\beta + \delta)/2$

A = $3a_i(\delta - \beta)/(\phi - \beta)$

a_i = the area (m^2) of planning unit *I*

$$\beta = r_x + d_{ix}$$

$$\delta = r_x + d_{ix} + 2r_i$$

$$\phi = \begin{cases} \delta & \text{if } \delta \le d_{\max} \\ d_{\max} & \text{if } \delta > d_{\max} \end{cases}$$

r_i = the radius of planning unit *i* (assuming circular shape)

d_{ix} = the distance (edge to edge) between planning unit *i* and the unit of interest, *x*

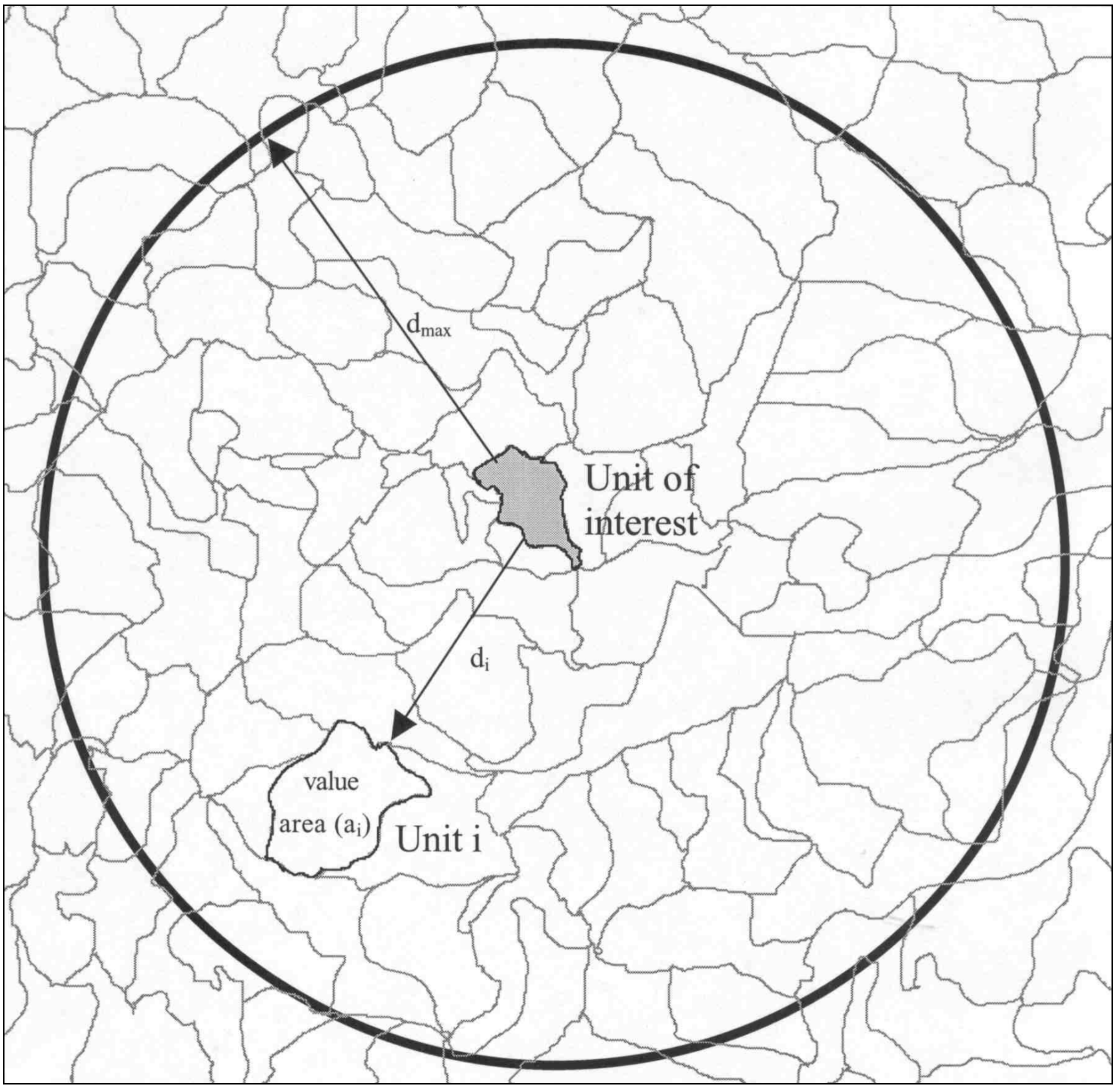


Figure 2.6. Parameters used in transforming irreplaceability indices to reflect spatial context.

2.9.2. Configuration of selected sites.

The SPATOOL can also be used to calculate a patch-size/connectivity configuration index for all selected sites at any point during the planning process. The index measures the extent to which a set of selected sites consists of large, well connected blocks, as apposed to small isolated fragments. The analytical approach is largely new, but incorporates ideas from incidence modelling of metapopulations (Hanski 1994, 1997) and gravity modelling of spatial interaction processes (Sen and Smith 1995). An overall index can be calculated for all features in the C-Plan database, as well as separate indices for feature subsets.

Two sets of data are used to calculate the index for a given feature:

- The area of the feature of interest contained within the selected set of sites; and the total area of each site (and therefore the proportion of the site occupied by the feature).
- The straight line distance (or separation) between each pair of selected sites. For example, if there are three selected sites: A, B and C, then the data consist of distances A to B, A to C, and B to C. Each distance is initially measured as the minimum straight line distance between the edges of the two units involved. If two planning units are immediate neighbours (ie they abut) the distance between them is zero.

Calculating the index for a given feature involves the following steps:

1. The distance between each pair of sites is adjusted upwards to account for the distribution of the feature of interest within the two sites involved. It is assumed that the units are circular in shape and that the known area of the feature in each unit is distributed randomly across the total extent of that unit. The adjusted distance is an estimate of the mean distance across unreserved and/or suitable land traversed in travelling along a straight line between any two randomly selected occurrences of the feature (one in each unit). This adjusted distance therefore reflects both the separation of the two units and gaps in the distribution of the feature of interest within each unit. An adjusted distance is also calculated between each unit and itself, which is an estimate of the mean distance across gaps in distribution encountered along a straight line connecting any two randomly selected occurrences of the feature (both in the unit of interest).

2. The adjusted distances from step 1 are used to derive a ‘minimum spanning tree’ connecting all selected planning units containing the feature of interest. A minimum spanning tree is a special type of linked graph consisting of nodes (planning units in this case) and connections (or branches) such that: i) all nodes have at least one connection; ii) there are no loops in the tree; and iii) the summed length of branches in minimal (see Gower and Ross 1969 for details).

   An example of a minimum spanning tree connecting eight planning units is given in Figure 2.7. The circles depict planning units, with A_i denoting the area of the feature of interest within planning unit *i*. The values on the branches of the tree are the adjusted distances between each pair of connected units (ie the units at either end of a given branch).

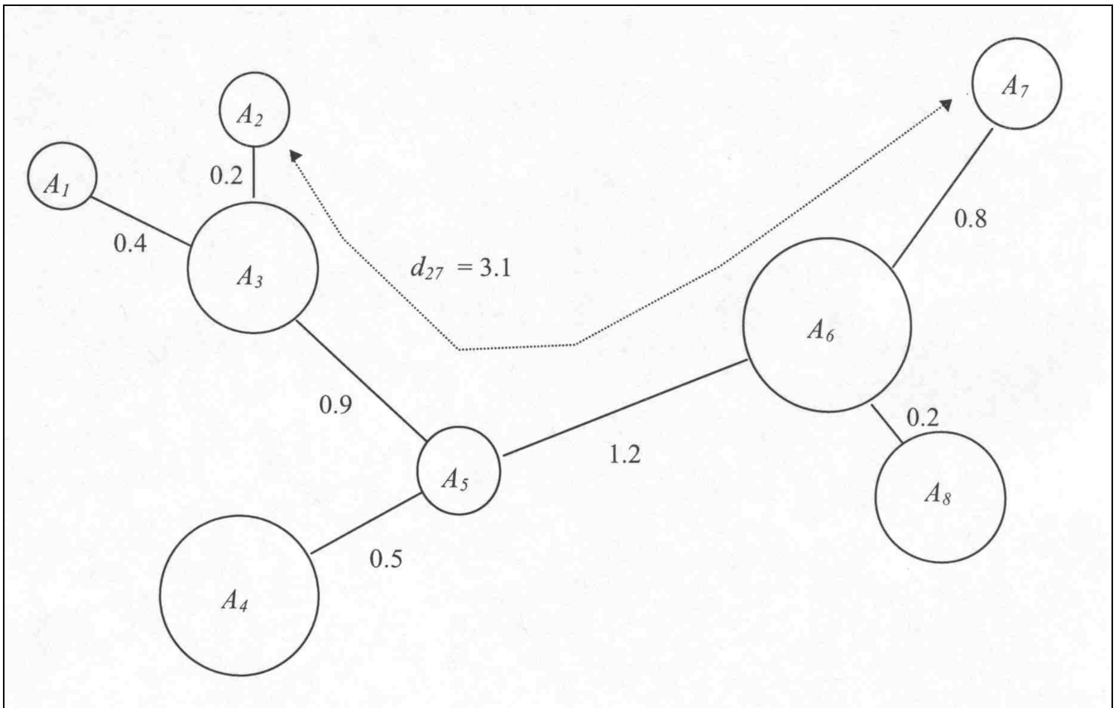


Figure 2.7. Example of a minimum spanning tree connecting eight planning units.

3. The minimum spanning tree derived in Step 2 is used to estimate the 'effective distance' between all possible pairs of planning units in the set of selected sites. The effective distance d_{ij} between sites *i* and *j* is calculated as the sum of the lengths of all branches connecting these two sites. For example, in Figure 2.7 the effective distance between units 2 and 7 is 3.1.

4. An index of the configuration of selected sites, in terms of patch size/connectivity is then calculated as:

$$Spat\_config\_index = \frac{\sqrt{\sum_{i=1}^{n}\sum_{j=1}^{n} A_i A_j e^{-\left(\frac{d_{ij}}{c}\right)}}}{\sum_{i=1}^{n} A_i}$$

Where: n = the number of selected planning units

d_{ij} = the effective distance between planning units i and j

A_i = the area of the feature of interest in planning unit i

c = a constant parameter specified by the user

The parameter c determines how quickly the spatial interaction units declines with increasing separation. When dealing with individual species this parameter should be an estimate of the mean dispersal distance of the species of interest (see Hanski 1994). C-Plan allows the user to specify a c value to be used in the overall configuration index, as well as separate c values for individual features.

The configuration index described above ranges between zero and one. A value of one indicates a set of sites configured as one contiguous area, with no internal gaps. The value of the index decreases with increasing fragmentation of the selected areas. The index is therefore a measure of the shape of the selected set of sites, not area. C-Plan also uses this index to derive a measure of configuration that combines both the shape and the total area of a set of selected sites (or the selected area of a particular feature). This is achieved by simply multiplying the initial index by the total selected area of a feature, ie cancelling out the denominator in the above equation.

The indices described above can be used to compare different site selection scenarios/options in terms of spatial configuration. This can be done in real-time during the planning process, allowing the impact of site selection decisions on spatial configuration to be progressively tracked throughout the process. Unless some target is set for the index (in relation to a feature), such comparisons, while extremely useful, will be relative only. In other words it can be used to say something about whether selected set A is better configured for a particular feature than selected set B. However, this does not indicate anything about how good scenario A or B is in relation to a desired or optimum configuration, ie. a target or objective.

Setting realistic targets for each patch size/connectivity index is not easy. It is theoretically possible to derive a target value from the parameters indicating optimum patch size, minimum and maximum spacing between patches and average proportional occupancy of the feature within patches. However, such a target may not be achievable if sufficient patches satisfying these parameters do not exist in the region of interest. An alternative approach involves using C-Plan to manually configure a hypothetical set of sites for each feature (eg fauna species), containing the exact area of habitat targeted for the feature and exhibiting a spatial configuration which experts feel is 'optimum' for the feature in terms of patch size/connectivity. The configuration index calculated for this optimum set of sites can then serve as a target or objective for the feature concerned.

2.9.3. Spatial contribution of individual planning units.

When calculating summed irreplaceability, C-Plan can already weight features according to the proportion of target met for each feature. This weighting can be further adjusted to account for geographical/environmental spread. The analytical approach employed is largely new, but was inspired by recent work by Faith and Walker (1996) on the measurement of environmental diversity. The adjustment is applied only to those features for which a configuration goal has been specified, in terms of the level of spread required. Such a goal is specified in C-Plan by assigning a 'spread radius' to the feature concerned. For this feature, the proportion of target met for a given planning unit is then estimated for that part of the region falling within the specified radius of the unit rather than for the region as a whole. The proportion of target met for a given feature therefore varies between planning units, reflecting the extent to which site selection has been evenly spread across the range of the feature. This effectively adjusts the feature weights to give emphasis to planning units in those parts of the region with poorest reservation of the feature.

For a given feature, the adjusted proportion of target met p_x in planning unit x is calculated as follows (see also Figure 2.8):

$$p_x = \frac{\sum_{i=1}^{n_r} A_i \left(1 - \left(\frac{d_i}{d_{\max}}\right)^C\right)}{\sum_{j=1}^{n_a} A_j \left(1 - \left(\frac{d_j}{d\max}\right)^C\right)} \times \frac{A_{total}}{A_{target}}$$

where: d_{max} = the specified radius around the unit of interest

n_r = the number of selected planning units within the specified radius

n_a = the total number of planning units within the specified radius

A_i = the area of the feature in planning unit i

d_i = the distance between planning unit i and the unit of interest

C = a user specified constant (between 0 and 1) that determines how quickly the weight applied to surrounding planning units diminishes with increasing distance from the unit of interest

A_{target} = the target for the feature, for the entire region

A_{total} the total area of the feature, across the entire region

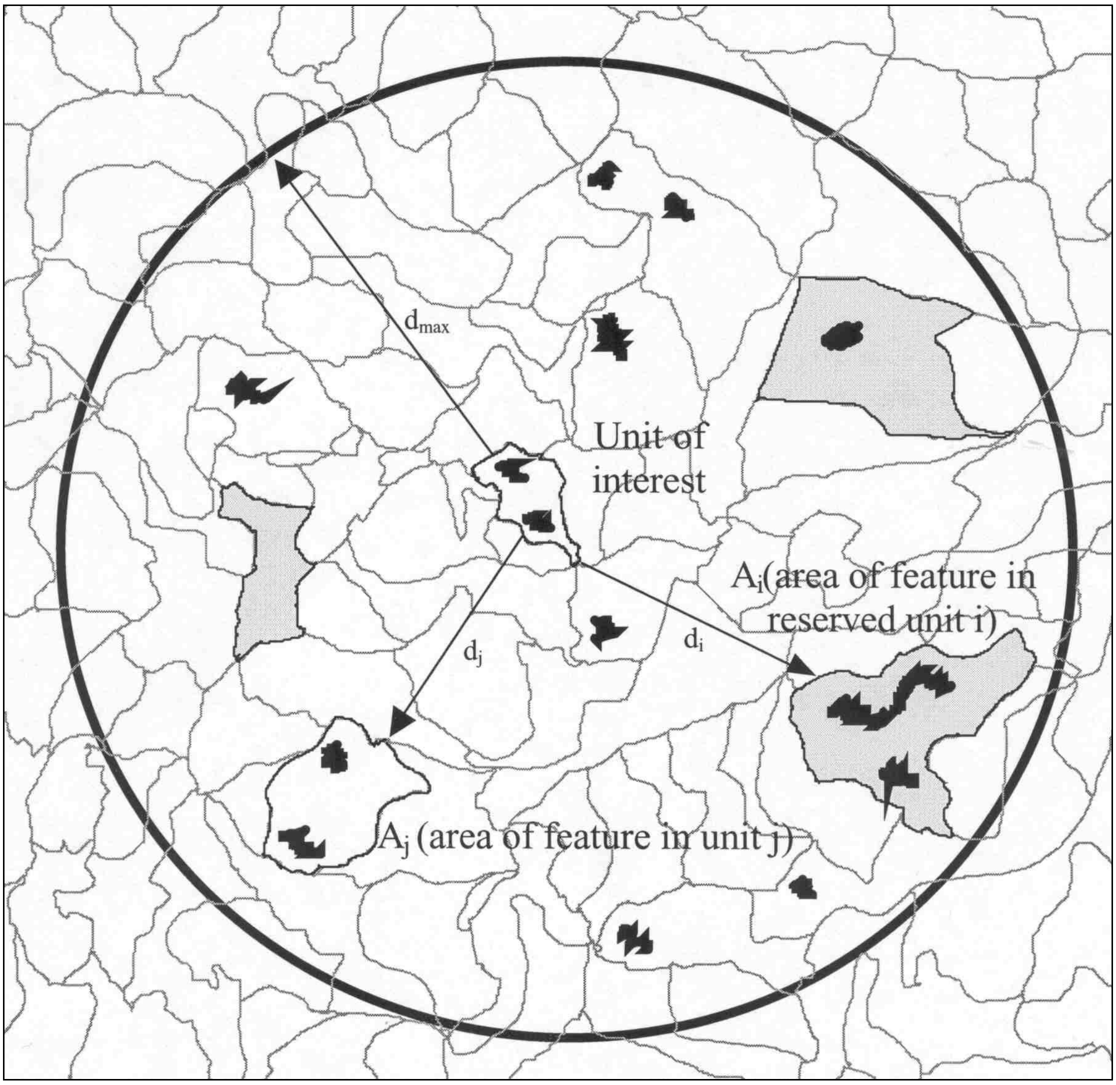


Figure 2.8. Parameters used to calculation the proportion of target achieved for a given feature, adjusted to reflect geographical spread. Light shading indicates areas currently selected. Dark shading indicates the feature of interest.

In the current implementation of the above approach, all distances are simple geographical distances. The weighting therefore considers geographical spread but not environmental spread (although the former is likely to function reasonably well as a surrogate for the later). The approach could be readily extended to incorporate consideration of environmental spread by replacing the underlying inter-unit distance matrix based on geographical distance with one based on some amalgam of geographical and environmental distance- eg predicted biological dissimilarities derived from modelling of biological survey data in relation to geographical and environmental separation of sites.

2.9.4. Current configuration of selected sites.

For any given feature assigned a spread radius, C-Plan can also calculate (and report on) an overall measure of the spread of reservation across the feature's range. This index is derived using the 'adjusted proportion of target met' values calculated for individual planning units. The index is essentially a measure of the evenness of these values, and ranges from 0(very uneven, biased spread of selected sites) to 1 (very even, unbiased spread of selected sites):

$$Spread\_index = \frac{\sum_{i=1}^{n} \left(\frac{p_i}{p_{mean}} \right) A_i}{\sum_{i=1}^{n} A_i}$$ (if p_i / p_{mean} > 1 then set equal to 1)

where $$p_{mean} = \frac{\sum_{i=1}^{n} p_i A_i}{\sum_{i=1}^{n} A_i}$$

n = total number of planning units in the region (including selected sites)

p_i = proportion of target met within specified radius of planning unit i

A_i = area of feature in planning unit i

As for the patch size/connectivity index, this spread index must always be interpreted in conjunction with information on the total area of the feature selected.

2.9.5. Implementation in C-Plan.

The major components of the SPATTOOL's integration with C-Plan are illustrated in Figure 2.9. The main challenge in developing the software was to achieve computational efficiency that enabled 'real time' calculation of the configuration measures. In other words, the indices have been designed to be calculated in seconds rather than minutes or hours. This efficiency is achieved by performing much of the required computations in a data pre-processing phase. In the pre-processing phase, an ArcView script is used to derive a 'spatial data matrix' from the planning unit shape file. The spatial data matrix contains information on the distances (edge to edge) between all possible pairs of planning units, and the areas of those units. This information is stored in a very compact binary form and is indexed and linked in a way that optimises the speed with which the software can query the distance between any two planning units, or query which other planning units are closest to a given unit, or fall within a specified radius of a given unit. For a large region, the computation time required to derive the spatial data matrix can be several hours or even days. However the operation need only be performed once for a given region.

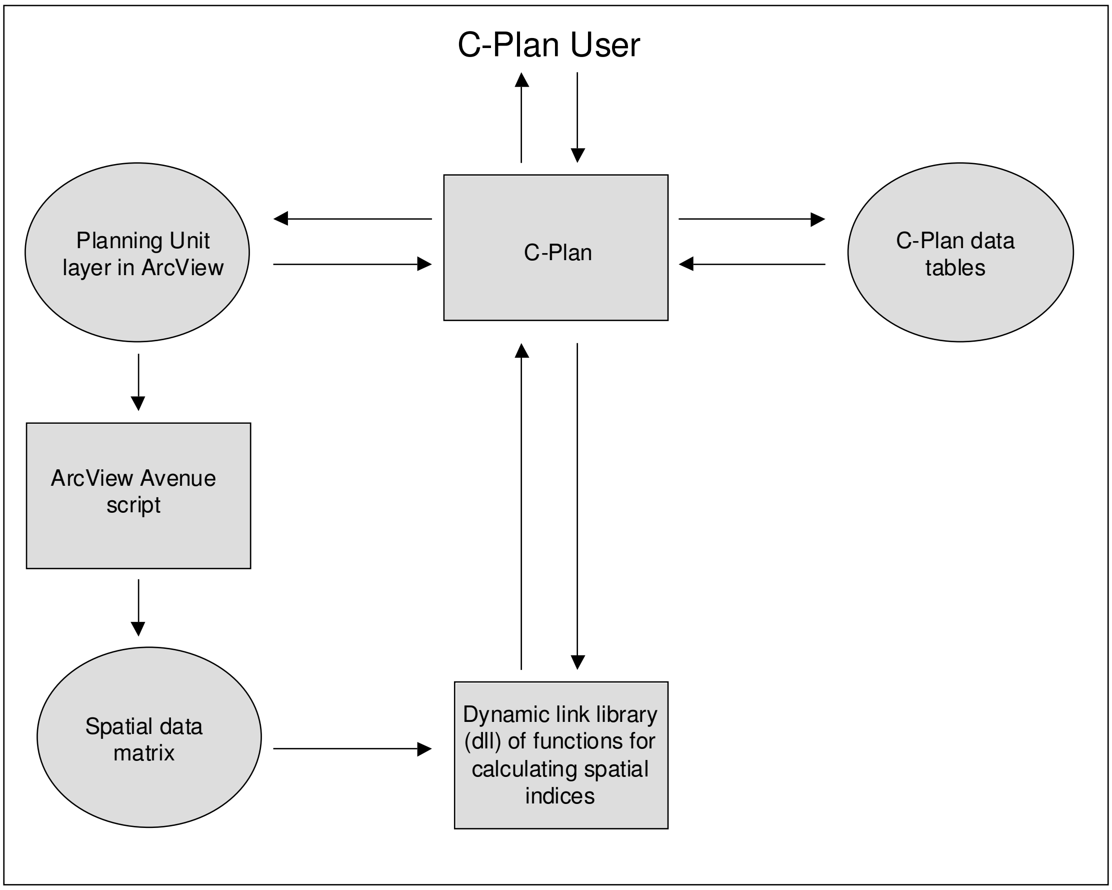


Figure 2.9. Integration of the SPATTOOL with C-Plan.

Functions for calculating the various spatial configuration indices are contained within a Dynamic Link Library (dll) coded using the C++ programming language. These functions are called directly by C-Plan, which passes the data (eg feature areas, selection status of planning units) required for calculating a specific index or set of indices. The dll functions extract all required spatial information directly from the spatial data matrix. Computational efficiency is further optimised through the use of a number of innovative data structures and algorithms within the dll functions. For example the building, storage and traversal of the minimum spanning trees used to calculate configuration indices of patch size/connectivity is performed using a sophisticated algorithm based on fibonacci heaps.

2.10. MARXAN

Marxan is a conservation design tool that approaches the selection of areas globally (i.e. for the entire planning domain) using a combination of annealing and heuristic algorithms. Its utility lies in the ability to consider a range of factors, in conjunction, when selecting a set of sites. These factors can include design features, such as minimising the boundary length (i.e. maximising compactness) of new conservation areas, representing features in clumps, and also in a minimum number of clumps separated by a specified distance (to minimise risk from catastrophic events). Details on the algorithms employed by Marxan are provided in its accompanying manual, which is available from the Marxan website:

http://www.ecology.uq.edu.au/marxan.htm

Marxan requires similar information to that used by C-Plan: a features table, a sites table, and a sites by features matrix. C-Plan includes functions to convert the files used by C-Plan into the format required by Marxan. In addition, C-Plan also includes functions for importing and displaying Marxan results. These are all accessed from within the C-Plan interface, so that the majority of Marxan's functionality is available from within C-Plan (see Figure 2.10 & Section 5.3).

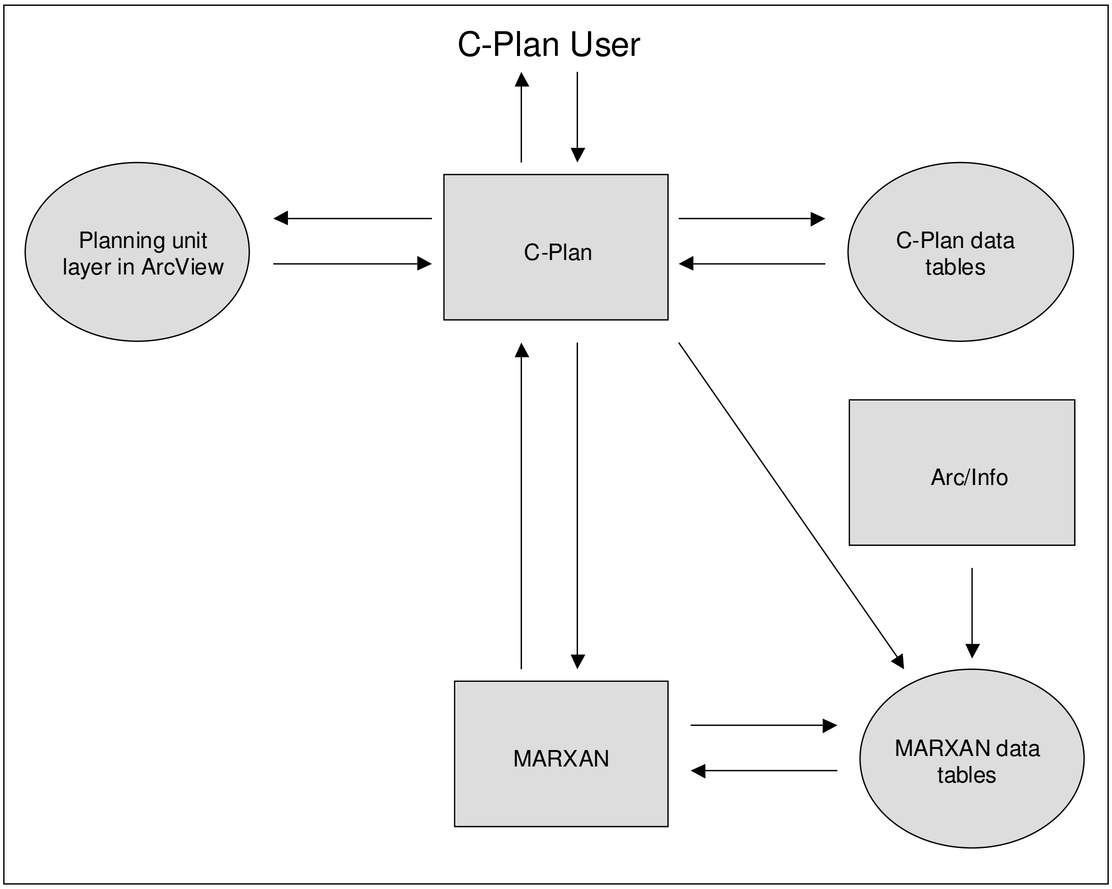


Figure 2.10. Marxan's integration with C-Plan.

Whilst the majority of the data required by Marxan can be derived from the C-Plan database, for full Marxan functionality, additional data needs to be manually generated. This includes additional feature penalty factors (costs for not achieving one or more targets), minimum feature clump sizes and clump separation distances. These can all be entered into the C-Plan feature table using the Marxan naming conventions (see Marxan manual & section 3.8.2), and if present, C-Plan will convert them along with the other C-Plan data to the format used by Marxan. Additionally, many Marxan functions require a boundary length file, which stores the length of the common edge between each pair of adjacent polygons in the planning unit file. Marxan uses the boundary length information to monitor the boundary length of selected conservation areas. Deriving the boundary length file however requires deriving the topology of a shapefile, which cannot be done straight-forwardly in ArcView. A script for generating the boundary length file is available from C-Plan support, but requires access to Arc/Info in order to run it.

3. BUILDING A C-PLAN DATABASE.

3.1. Steps in building a C-Plan database.

The are six steps required to build a C-Plan database:

1. Prepare a planning unit layer (GIS)
2. Compile biodiversity feature layers (GIS)
3. Prepare sites x features matrix (GIS)
4. Prepare feature table (GIS and/or spreadsheet)
5. Prepare sites table (GIS and/or spreadsheet)
6. Build the C-Plan database (Table Editor Wizard).

These steps are summarised in Figure 3.1.

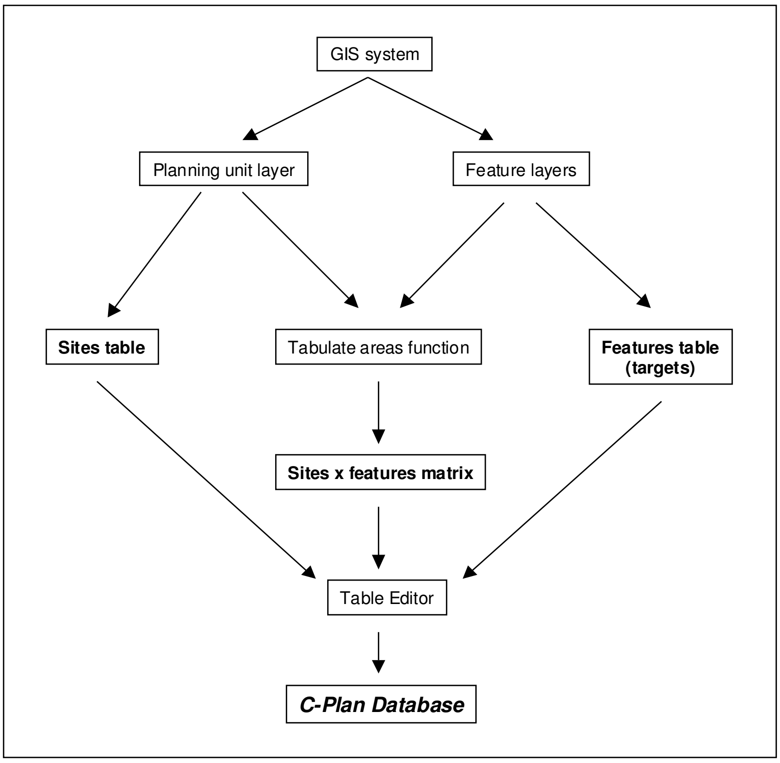


Figure 3.1. Steps for building a C-Plan database.

3.2. Preparing a planning unit layer.

This step involves deriving a polygon GIS layer describing the areal units that you will use for decision making. These can be based upon, for example, forestry compartments; cadastre; or an arbitrary grid or hexagon array. Essentially, the planning unit layer should enable the user to make the minimal areal selection practical for the exercise. If, for example, this is different vegetation communities within individual cadastre, then these will need to represented as individual polygons within the planning unit layer.

There is a trade-off between the number of polygons in the planning unit layer and the speed with which C-Plan can calculate irreplaceability and update the GIS display. C-Plan has no built-in restrictions with the number of sites or features for which it can use to compute irreplaceability. However, there is a limit of 4 billion records in a dbase table, which limits the number of polygons possible in an ArcView shapefile (other restrictions may be experienced in different GIS systems). In practice, these limits have never been approached, and other limits, such as the amount of available RAM and virtual memory in the computer have the greatest influence on the time it takes C-Plan to calculate irreplaceability.

As the planning unit layer also forms the basis of the sites table, it is usually worth preparing the fields required in the sites table when constructing the planning unit layer. At a minimum, this should include a unique, numerical, ID value for each polygon (site), and the area of each site (this area should normally be in the same units as that used in the sites by features matrix and targets in the features table—see below). In addition, it can also contain an optional name field, resource fields for use in MINSET selections, or any other field that may prove useful for performing site searches from within C-Plan (see section 3.6).

Once you've built your planning unit layer, it must be saved as an ArcView shapefile, and saved in the same directory in which the C-Plan database will be saved.

3.3. Preparing feature layers.

A wide variety of feature types can be included into a C-Plan database. These can include:

- Spatially discrete landcover classes (e.g. vegetation types, bioregions, soils, landsystems)
- Point records (e.g. species records, survey plots)
- Point buffers (e.g. buffers around bat roost sites, or areas of rare plant sightings)
- Linear buffers (e.g. margins along an endaphic interface)
- Probability layers (e.g. predictive models of a species distribution)
- Condition classes (e.g. mapped areas of vegetation condition)

Each of these types of features will be represented differently in the GIS, varying for example between grid (raster) layers to points. The way each of these is used to produce the sites x features layers is also necessarily different, as are the calculation of targets—see below.

3.4. Generating the sites by features matrix in ArcView 3.x.

The sites by features matrix is a tabular listing of the amount of each feature occurring within each site, for all sites in the planning unit layer, and for all features to be used in the C-Plan database. In the majority of cases this involves a GIS procedure, the exact procedure of which depends upon the kind of features involved. The GIS procedure for different data types are summarised below:

- Spatially mutually exclusive data, point buffers, linear buffers, condition classes (tabulate areas function within ArcView)

- Point records (custom script[1] based on the SelectByPoint function in ArcView)
- Probability layers (custom script based on the ZonalStats function in ArcView)

> *When preparing tables (either in ArcView, Excel, or any other program), it is important to remember the conventions used in dbase tables, since this is the format built and used by C-Plan:*
>
> - *Column headings are limited to 10 characters in length*
> - *Field names cannot be duplicated*
> - *Only uppercase A-Z, numbers and _ (underscore) characters are allowed in field names*
> - *Field names must start with a letter*
> - *There is a limit of 255 fields (if there are more than 255 features in your database, you'll need to generate multiple sites x features tables—each with its own site key field)*

As outlined in Section 2.6.3, C-Plan makes additional irreplaceability calculations based on features that are spatially mutually exclusive. To do this, C-Plan needs to know which features are in this form. It recognises these features by the order that they occur in the sites x features table. If you have spatially mutually exclusive features included in your C-Plan database, and you wish them to be used for calculating the weighted average index, then they must be placed at the beginning of the sites x features matrix. When building a C-Plan database with the wizard in the Table Editor, it asks you how many spatially mutually exclusive features are ordered at the beginning of the sites x features table. It is therefore worth considering the order of features carefully when constructing the sites by features tables.

> *You can also edit the number of spatially mutually features C-Plan reads at the beginning of the sites x features at anytime in the CPLAN.INI file under the [Database name] section (labelled 'PCCONTRCutOff='). Change the value and restart C-Plan for the change to take affect.*

SITEKEY	FEAT01	FEAT02	FEAT03	FEAT04	FEAT05	FEAT06
1	546	96	0.763	1.304	4	2
2	356	0	9.537	5.130	3	0
3	878	498	5.673	0.813	14	6
4	0	964	5.578	2.201	0	3
5	4734	494	0.000	0.000	5	7
6	494	4986	2.578	3.973	2	5
7	964	49	4.743	4.369	4	0
8	964	0	3.765	2.979	6	7
9	96	449	0.000	0.000	4	3
10	49	49	5.553	2.644	2	5

Table 3.1. Example sites x features table.

[1] Email C-Plan support for a copy of these scripts

3.5. Generating a features table.

The features table is a table listing each feature (as it is listed in the sites x features table); it's full name; and it's target. The column listing the feature codes (corresponding to the column headings in the sites x features table) is case sensitive, and should have the feature code in upper case (column headings are stored as upper case in dbase files). Failure to observe the case of the feature codes can result in the C-Plan database wizard being unable to link the features in your features table to the columns in your site x features table.

At a minimum (in order to build the C-Plan database), the following fields are required (additional fields can be added after the database has been constructed):

- Feature code (listing all the column headings (upper case) as they appear in the sites by features table)
- Feature name (listing the names of each feature as a text string up to 255 characters in length)
- Feature target (listing of the target for each feature)

Avoid the use of tabs and commas in the feature and site name fields as these can produce confused columns if the table is saved as a comma or tab delimited spreadsheet file.

FEATURE	NAME	TARGET
FEAT01	Land system 1	2724
FEAT02	Land system 2	2276
FEAT03	Habitat model 1	11.457
FEAT04	Habitat model 2	7.024
FEAT05	Species records 1	13
FEAT06	Species records 2	11

Table 3.2. Example features table.

3.6. Generating a sites table.

The sites table is a listing of the information about each site (polygon) that C-Plan requires in order to construct the C-Plan database. The information is most easily derived when constructing the planning unit layer (see section 3.2). At a minimum (in order to build the C-Plan database), the following fields are required (additional fields can be added post database construction):

- Site ID (a numerical ID number for each site corresponding to those Ids used in the sites x features matrix)
- Site Name (an additional name field used to identify each site. A text string up to 255 characters in length. This field can be the same as the Site ID, but can be useful if there are other identifiers for each site, e.g. compartment ID)
- Site Area (listing of the area of each site. The area should be in the same units as the areal values in the sites x features matrix)

- Site Tenure (this can be as simple as available/selected, or can be a detailed listing of tenure types. C-Plan uses these tenure types to assign an initial status class to each site).

SITEKEY	AREA	STATUS
1	642	Available
2	356	Selected
3	1376	Available
4	964	Available
5	5228	Excluded
6	5480	Available
7	1013	Available
8	964	Selected
9	545	Available
10	98	Available

Table 3.3. Example sites table.

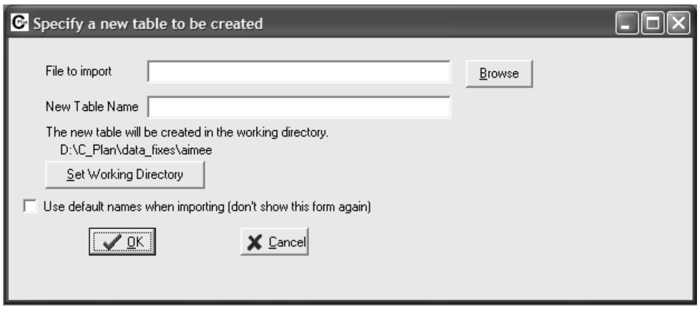
3.7. Building the database with the table editor.

Once you have constructed the sites, features and site x features tables, the database is ready to be constructed using the wizard in the Table Editor. The following steps describe the process of building a C-Plan database using the table editor.

1. Launch the table editor by clicking: Start -> Programs -> C-Plan -> C-Plan table editor

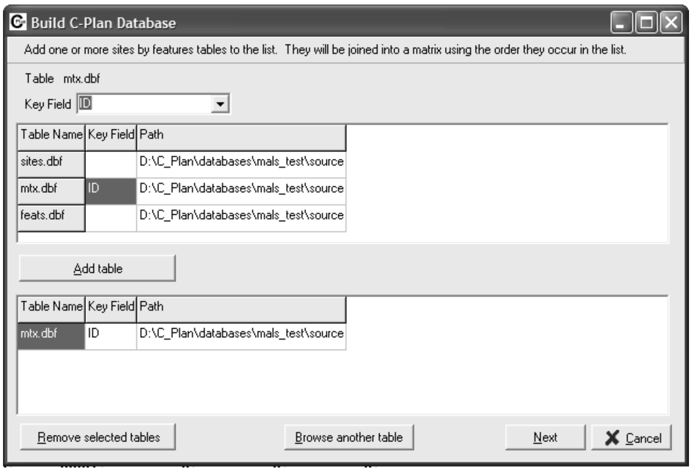
You'll see the following window:

2. If your tables are in dbase format, click the open table button () and navigate to where your tables are located and open them. If your tables are in comma delimited (*.csv), space delimited (*.txt) or C-Plan matrix format (*.mtx) you can import them by clicking Import under the File menu, and the following dialog is displayed:



Click the Browse button to locate your files and specify their format. If necessary set the table name and working directory (where the new table will be save in dbase format), and click OK when finished.

3. With your tables open, launch the database wizard by clicking on 'Build C-Plan database' under the Wizards menu. The following screen will be displayed:

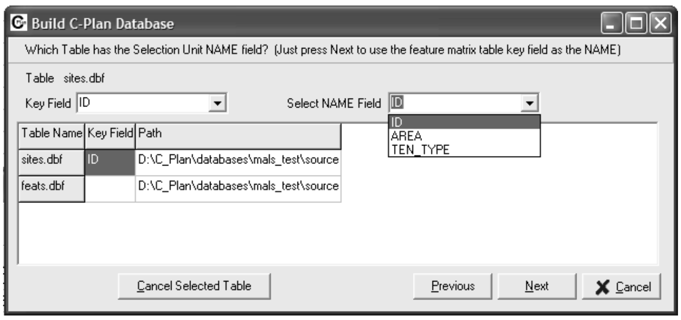


Click under the 'Key Field' column to select the fields of the matrix table (or first matrix table). The fields in the table will be listed in the 'Key Field' drop down list. Select the field containing the site keys and click the 'Add table' button to add it to the list of tables C-Plan will use for building the database matrix. Repeat the process for additional tables if more than one table is to be added to the matrix.

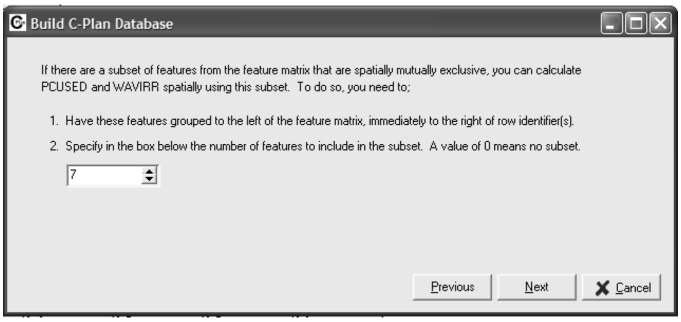
The order that tables are added to this list determines the order that they will appear in the database matrix. So if you have a table containing only mutually exclusive features that you wish to be used in weighted average irreplaceability calculations, then be sure to add it to the list first.

Click 'Next' to continue.

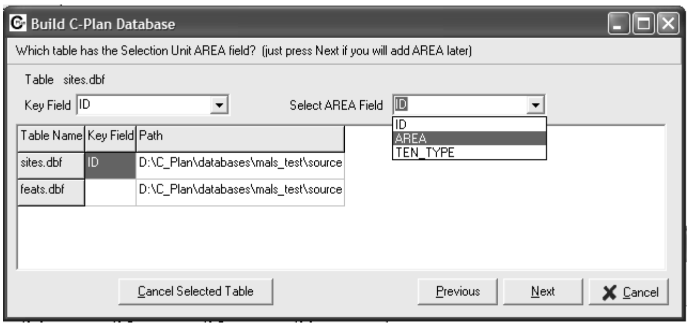
4. The following screen (see below) asks you to specify the sites table. Identify the site key field as in Step 3, and additionally specify the field in the sites table containing the site name. If no name field is required, select the site key field instead. Click 'Next' to continue.



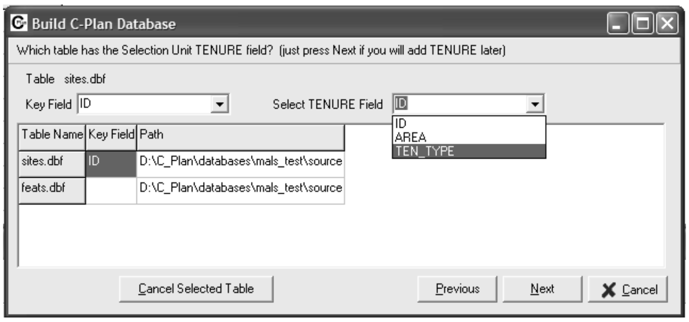
5. The next screen requires you to specify the number of spatially mutually exclusive features in the (combined) matrix file. Enter the number of spatially mutually exclusive fields in the box on the screen. Click 'Next' to continue.



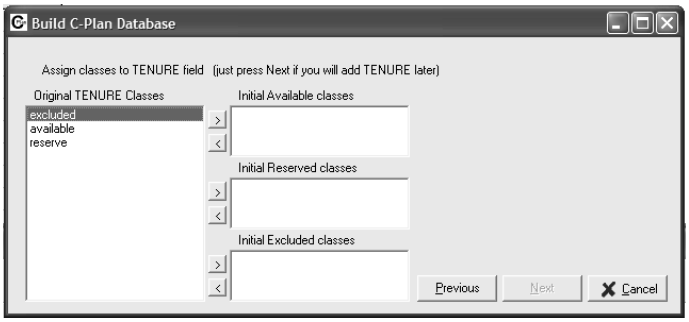
6. The next screen is similar to step 4, but this time asks for the table containing the area of each site. As before, specify the table by clicking in the Key Field column, selected the Site Key Field in the 'Key Field' drop down list, and select the field containing the area in each site in the 'Select AREA Field' drop down list. Click 'Next' to continue.



7. The next screen asks for the table containing the tenure of each site. This does not have to be tenure, but is used to specify the initial site classes in the database. As in the previous step, specify the table by clicking in the Key Field column, selected the Site Key Field in the 'Key Field' drop down list, and select the field containing the area in each site in the 'Select TENURE Field' drop down list. Click 'Next' to continue.

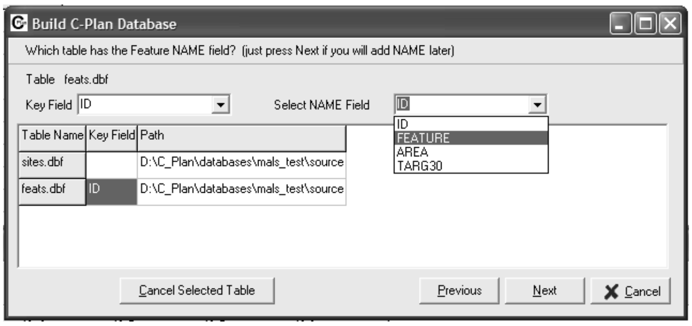


8. The following screen lists the unique values from the field you specified as the tenure field in the previous step. The are listed in the 'Original TENURE Classes' box. In this example, the tenure classes were simply: 'excluded'; 'available'; and 'reserve'. Select each class and add it to the appropriate initial site class using the arrows adjacent to each box. Click 'Next' to continue.



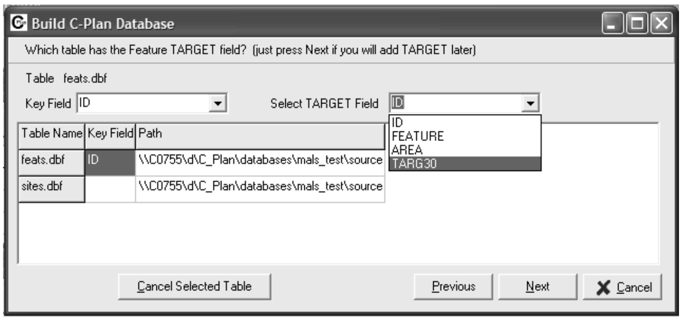
When a database is initially created you must specify all sites to one of three initial site classes: available, reserved (selected) or excluded. Initially selected sites contribute to targets, and are mainly used to specify sites already in a reserve network. Initially available sites are those that may be selected during the planning process. Initially excluded sites are completed ignored during all C-Plan calculations involving targets.

9. The next screen asks for information about the features table. As per the sites information screens, select the feature table containing the feature names, and specify the Key Field (feature keys) and name field (feature names) in the drop down lists. Click 'Next' to continue.

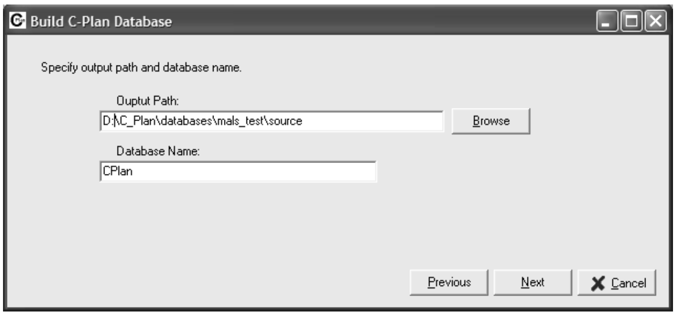


The Key Field for the features table must contain the list of features as they appear in your matrix tables, or otherwise the Table Editor will fail to locate one or more features when it builds the matrix. To avoid this problem, ensure that the Feature Keys in the feature table are identical to those in your matrix files. The feature keys are case sensitive. Note that if your matrix file is in dbase format, the column headings are stored in upper case.

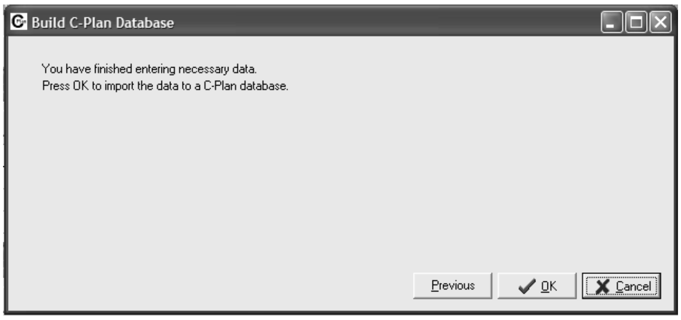
10. The next screen requests you to specify which field in the features table contains the feature targets. Select the table from the Key Field column, the Feature Key Field in the Key Field drop down list, and the Target Field in the Select TARGET Field drop down list. Click 'Next' to continue.



11. The penultimate window asks to specify a path where the new C-Plan database will be stored. Click the Browse button to select a path other than that set by default (current working directory). Optionally, enter a name for the new database (the default is CPlan).



12. The final screen informs you that all the necessary information has been entered and the Table Editor is ready to build the new database. The build will commence when you click the OK button.



3.8. Set-up for additional modules.

3.8.1. SPATTOOL module.

Run the script in arcview

3.8.2. MARXAN module.

Run the build Marxan database item under the Marxan menu.

3.9. Adding additional fields (vulnerability + resource)

Including the vuln field for applying vulnerability weight to sumirr.

The first step in this process is to create a comma delimited (CSV) file that contains two fields: the feature name (or feature ID) field and the vulnerability field. You can use the feature database (DBF) file as a template for creating this file by opening it in a spreadsheet program (such as Excel) and then using 'Save As' to save it as a CSV file. You will then need to add the 'VULN' field heading and classify each of the features into one of the five vulnerability classes. When you have completed assigning vulnerability classes you can import the vulnerability field into the feature database by following the instructions in the 'C-Plan Table Editor Manual'.

Resource fields- set in the C-Plan ini file

3.10. The cplan.ini file.

3.11. Trouble-shooting C-Plan database problems.

The file may be in use error- due to duplicate field headings. Check the field headings, else, also check whether you have complied with dbase naming conventions prior to saving the file in dbase format (see section 3.7).

4. RUNNING and USING C-PLAN.

4.1. Starting C-Plan.

C-Plan can be started in a couple of different ways, depending on whether you intend using it in conjunction with ArcView. C-Plan can be launched to run on its own from Start > Programs > C-Plan > C-Plan. This launches the database manager:

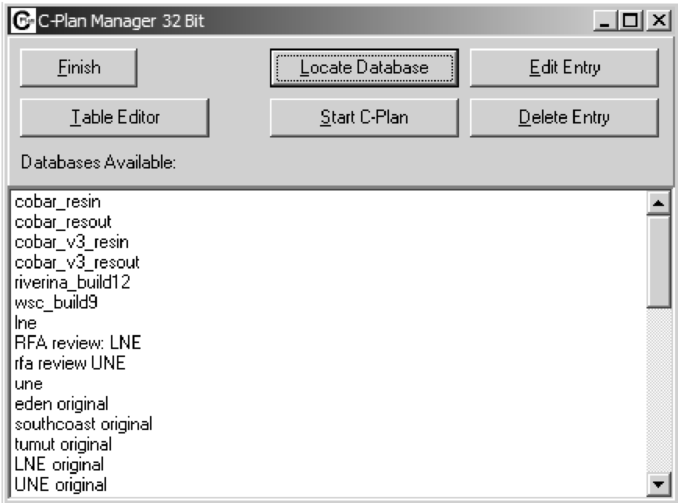


Figure 4.1. C-Plan database manager.

From this window you can select a previously used C-Plan database, or locate and use another.

FINISH: closes the window

LOCATE DATABASE: launches a file browser to locate another C-Plan database

EDIT ENTRY: edit the listed name of the database

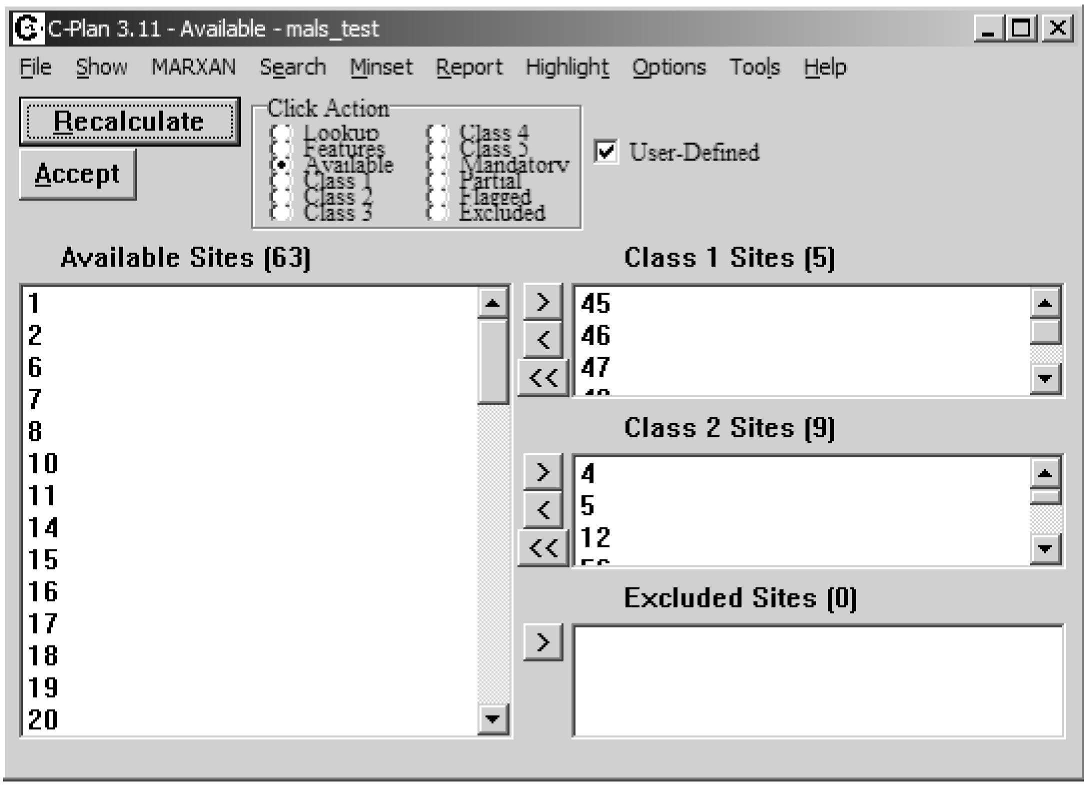
TABLE EDITOR: launches the C-Plan table editor

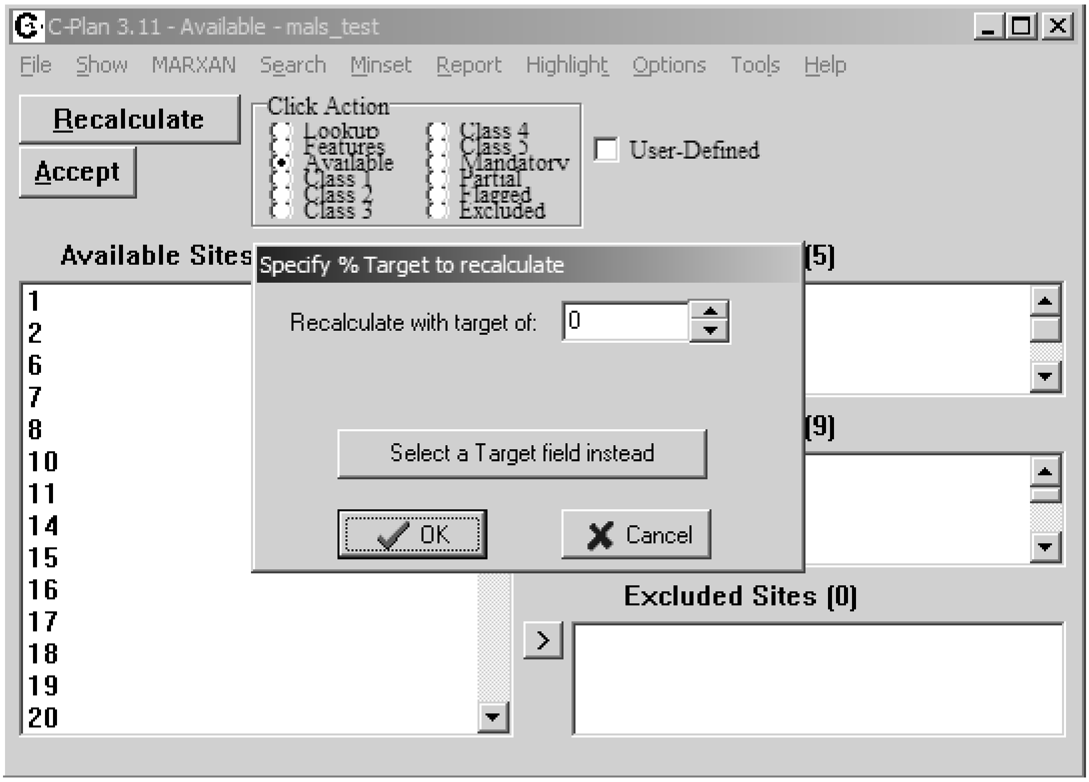
START C-PLAN: launches C-Plan using the highlighted database

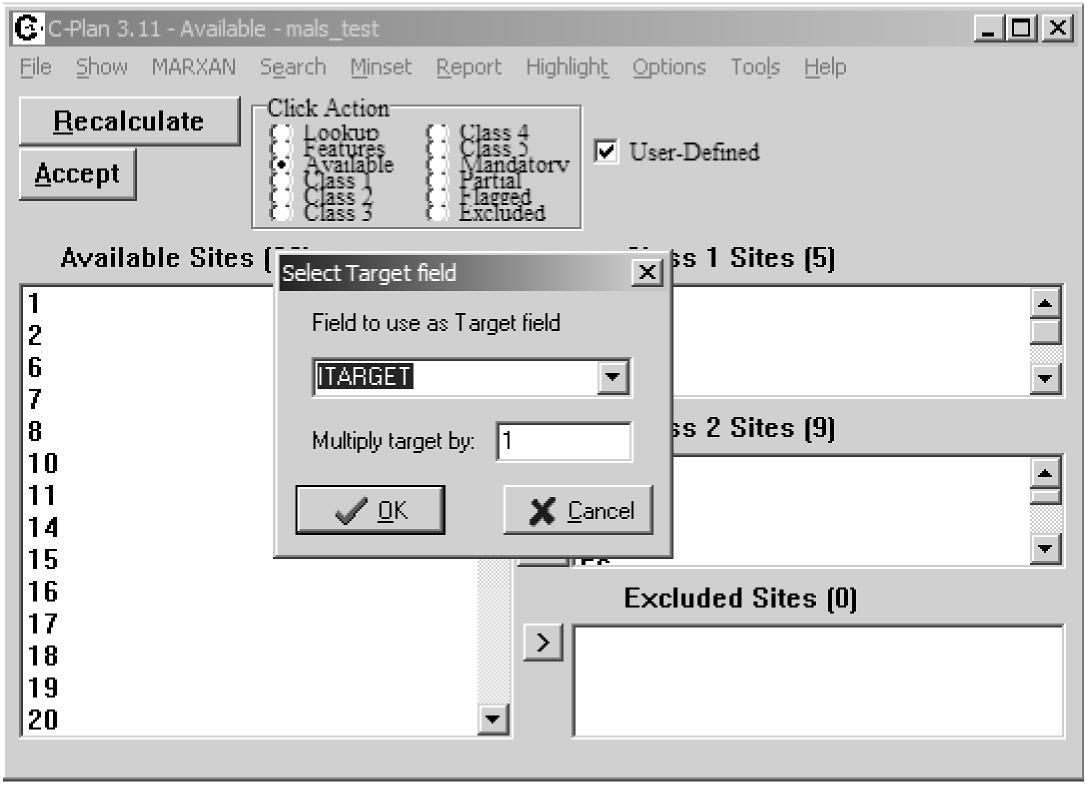
DELETE ENTRY: Removes the selected database from the list (this doesn't not delete the database).

Alternatively, C-Plan can also be launched from within ArcView. Firstly, ensure the spatial analyst extension is loaded, and then load the C-Plan extension (located under File > Extensions…). Open a new ArcView view window, and load the planning unit layer shapefile, highlight it in the View's Table of Contents, and click on the

4.2. C-Plan control window.







4.3. Interogating sites.

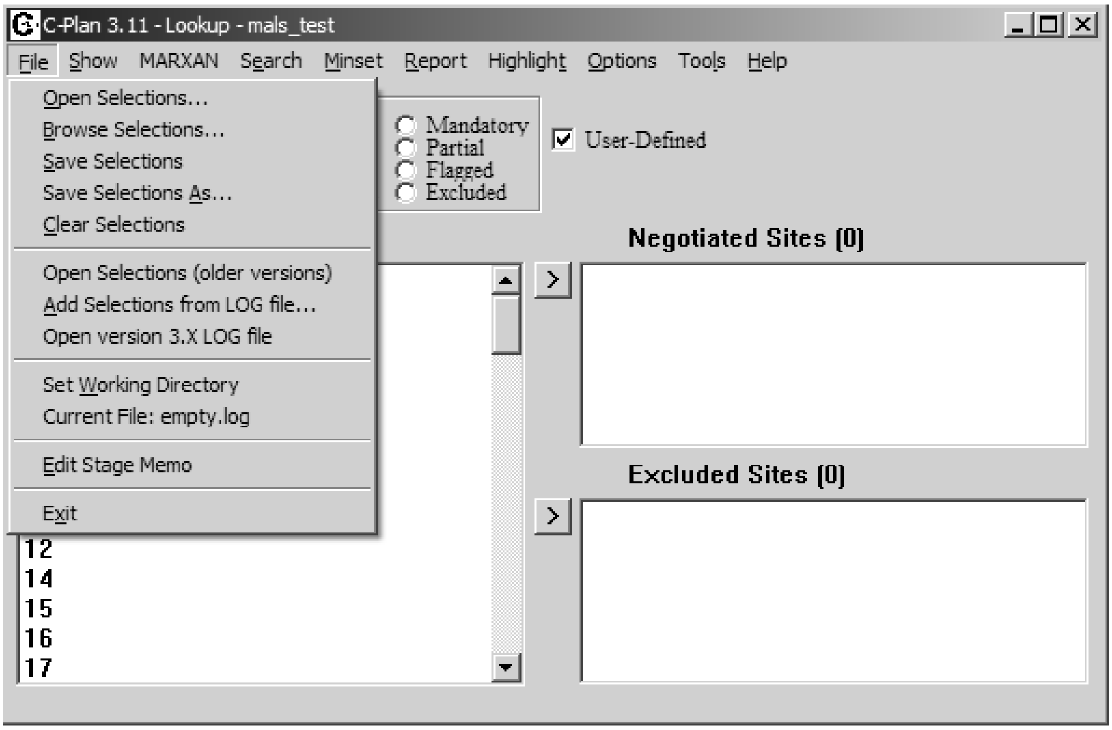
4.4. Making selections.

4.5. Slection classes.

4.6. C-Plan tutorial.

5. FUNCTIONAL LIST OF C-PLAN FUNCTIONS & MENU ITEMS.

5.1. File.



5.1.1. Open selections.

Opens a previously saved LOG file.

When a new LOG file is loaded, C-Plan will automatically recalculate site indices and update site status to reflect the configuration recorded in the LOG file.

> *LOG files keep a record of all selections and de-selections performed on a database. By default, a special LOG file called AUTOSAVE.LOG (stored on the database path) is continuously updated, recording the status of sites every time a selection or deselection is made. This file is used as a default backup file. The autosave LOG file can be used to return you to the stage just before the program was unexpectedly terminated.*

5.1.2. Browse selections.

When a LOG file is first saved, you are given the option of including a description. This information can be viewed before the LOG file is loaded by using the **File | Browse Selections** menu item.

This option is essentially the same as **File | Open Selections** except that it gives you the option of browsing through the LOG file description memos. This description also includes the date that the LOG file was last saved. Once you decide which selection file to use it is accepted and used by C-Plan.

It is possible to edit the contents of the stage memo in C-Plan once the LOG file has been loaded by selecting the menu item **File | Edit Stage Memo**.

5.1.3. Save selections.

Use this menu item to save the current status and configuration of sites.

If the current session has not been initiated with a previously saved LOG file, you are prompted to enter a new name for the LOG file, or use the default name of SAMPLE.LOG. If a LOG file is loaded during a session, or a new LOG file is created, then this file will be updated, and the save date (which can be viewed by selecting **File | Browse Selections**) will also be updated.

If another LOG file with the same name already exists you are prompted to confirm the replacement of the original LOG file.

5.1.4. Save selections as.

Saves the current status and configuration of sites to a new LOG file.

You are prompted to enter a name for the new LOG file, the LOG extension is automatically added. You are also given the option of including a text memo to describe the LOG file being created. These descriptions can then be viewed before the LOG file is opened using **File | Browse Selections**.

5.1.5. Clear selections.

This option clears all selections by moving all sites back into the available class. You will be asked if you want to save the current log file before clearing selections.

5.1.6. Open selections (older versions).

Earlier versions of C-Plan used a modified LOG file that is incompatible with some more recently developed functions. Open selection LOG files with this option will enable you to open a LOG file from any version of C-Plan, although the memo field and date/time stamp may not be preserved.

5.1.7. Add selections from LOG file.

This option allows you to import selections from a previously saved LOG file and add them to the current set of selected sites. This option will only change the status of sites if they are in the Available class in the current C-Plan session. For example, if, in the LOG file site X is in the site class 1, but in your current session site X is in the Flagged site class, then using the **File | Add Selections from LOG file** option will not change the status of site X in your current session. If, in your current session, site X is Available then it would be moved into Site Class 1 and an entry would be added to the selection log recording which sites were moved as well as the name and path of the LOG file used.

5.1.8. Set working directory.

The working directory is used by C-Plan as the default output path for saving reports and any other output files. Being able to select the working directory can be useful when you want all the reports generated by C-Plan in a specific directory. For example you could have a different output directory for each C-Plan database or planning session.

5.1.9. Current file.

Displays the name of the current LOG file being used and has no other function.

5.1.10. Edit stage memo.

Use this item to add or edit a description in the stage memo. You must first click inside the text box, and then type in the description. If the [OK] button is clicked, before adding any text, no description will be included in the stage memo.

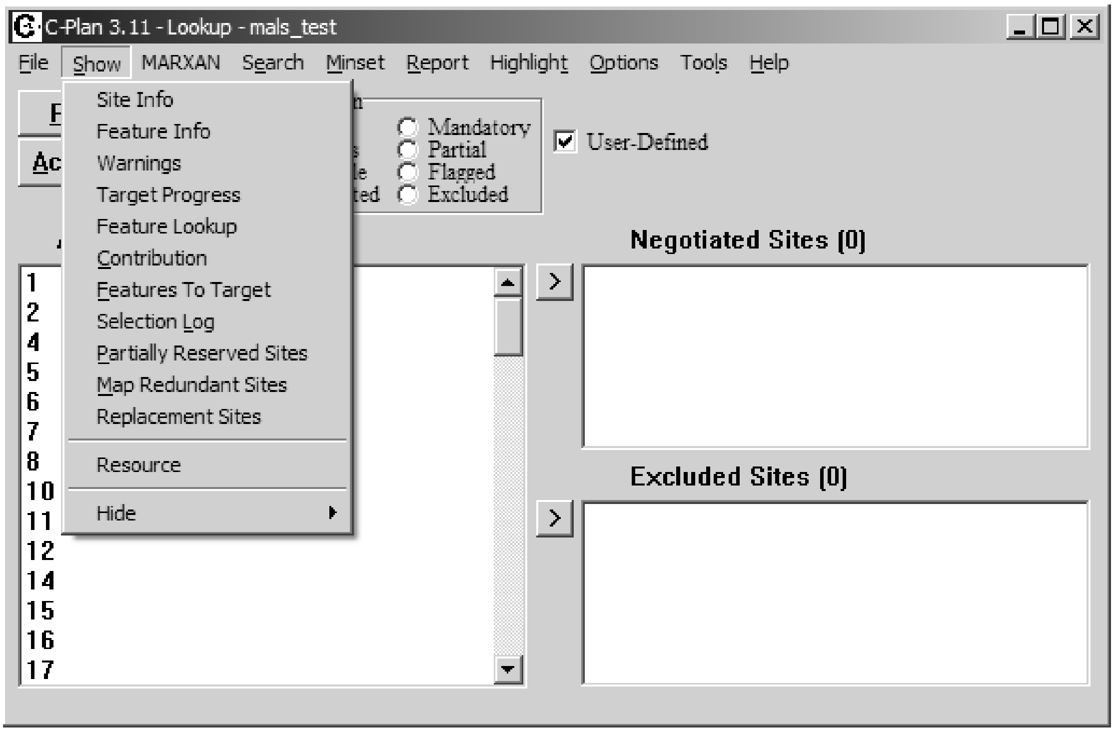
The stage memo is a section in each LOG file where you can include a description about the stage that the LOG represents. Use the stage memo as a tool for keeping track of planning sessions and as a prompt for what the set of selections in a LOG file represent.

5.1.11. Exit.

Exit terminates C-Plan. If the current site choices have not been saved, you are prompted to save them. In addition, if the current C-Plan option settings have not been saved you are prompted to save these options into the C-Plan configuration file (cplan.ini). Saving the option settings will mean that the next time C-Plan runs it will open with the same settings.

C-Plan options saved in the cplan.ini file are unique to each C-Plan database.

5.2. Show.



5.2.1. Site info.

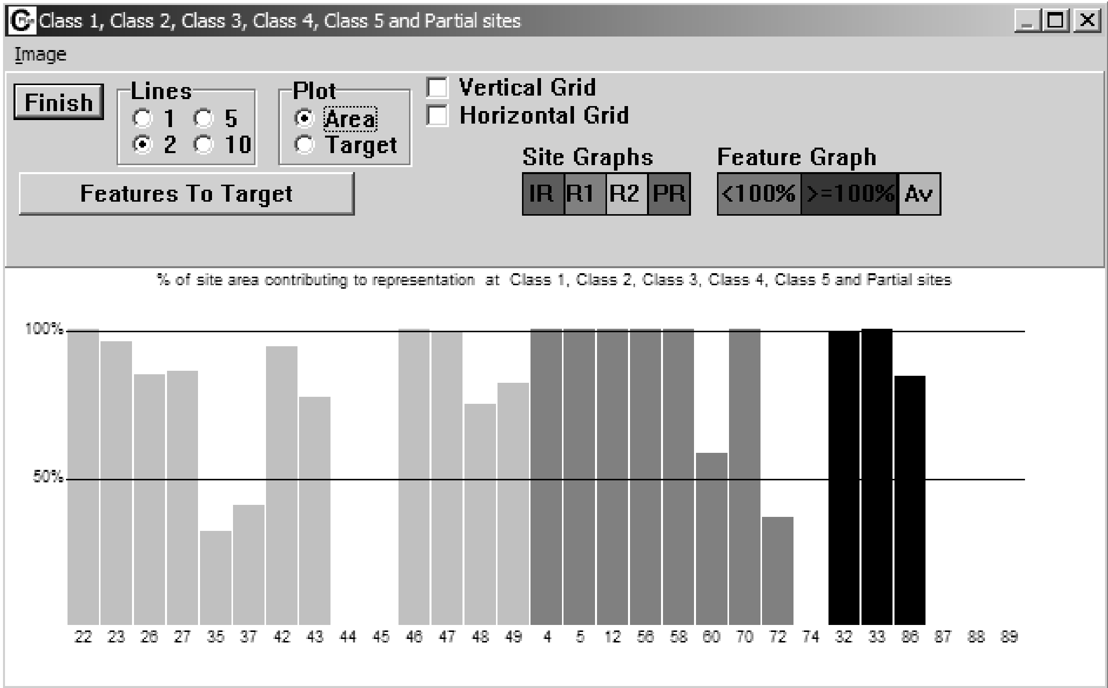
5.2.2. Feature info.

5.2.3. Warnings.

5.2.4. Target progress.

5.2.5. Feature lookup.

5.2.6. Contribution.



> *Use the contribution window to quickly see how individual sites are contributing to targets without having to generate a report. If [Recalculate] has not been run since the last selection it will be run automatically before displaying this window.*

The Contribution window displays two measures of site contribution; ‘Targets’ contribution and ‘Area’ contribution. Each column of the graph represents a selected site. The height of each column is a measure of the contribution each selected site is making to the achievement of targets. This is either in terms of the proportion of its area that is contributing to targets, or the proportion of all features to which the features it contains are contributing to meeting targets.

For example, if a site only contains one feature and half of the site area is needed to satisfy the feature target, then the area contribution is 50%. The principle is the same when a site contains many features. The selection of a site may satisfy many targets, and at the same time have a small area contribution if all those features only needed small areas to satisfy their targets. Alternatively a site may satisfy no targets and have a target contribution value of 100 if all the features occurring within the site are contributing to unsatisfied feature targets.

> *Clicking on a column of the graph in the contribution window changes the display to a feature breakdown graph. In this graph, each feature occurring in the site is represented by a vertical column. The height and colour of each column indicate how the site is contributing to the achievement of the target for each feature.*

PLOT: The ‘Area’ graph displays the percent area of each site that contributed to targets at the time the site was selected. The ‘Target’ graph displays the percent of all features satisfied at the time each site was selected, as well as the percent of feature targets satisfied by existing selections.

LINES: toggles between 1, 2, 5 and 10 graduated horizontal grid lines on the selected graph.

VERTICAL GRID: places dashed vertical grid lines between site columns.

HORIZONTAL GRID: places dashed graduated horizontal grid lines over the graphs.

SITE GRAPH LEGEND: these colours indicate the status of each of the selected sites. IS = initially selected; R1-R5 = different selection categories; PS = partially selected

FEATURE GRAPH LEGEND: these colours indicate the target achievement status of each feature. <100% = target unsatisfied; >=100% target achieved; Av = not occurring in any selected sites (only possible in partially selected sites).

FINISH: closes the window and returns to the C-Plan control window.

FEATURES TO TARGET: launches the features to target window (see section 5.2.7).

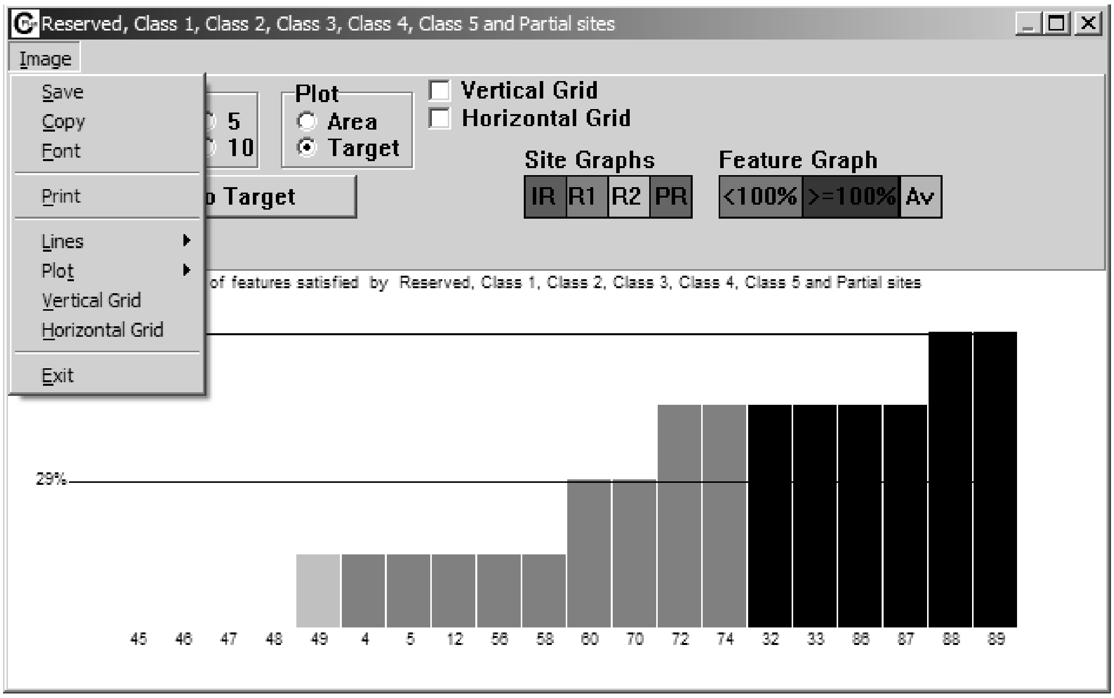


Image menu:

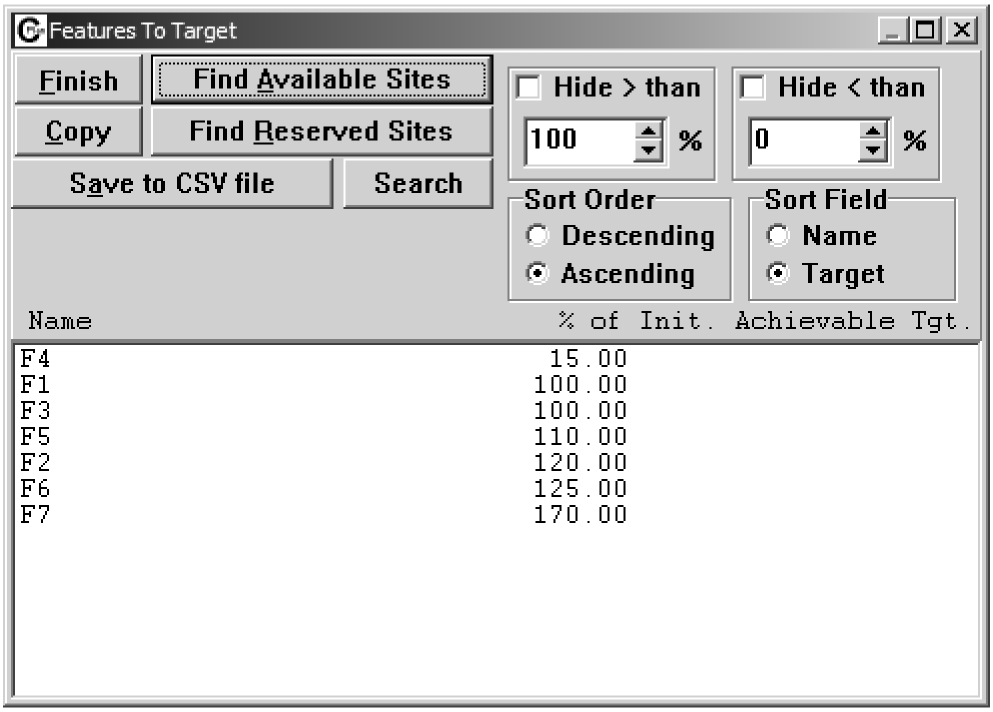
Save = save the graph as a bitmap image.

Copy = copy a bitmap of the graph to the clipboard for pasting into other applications.

Font = change the display font on the graph.

Print = prints the graph on the default printer

5.2.7. Features to target.



Use the Features to Target window to obtain a quick breakdown of target achievement across all features in the database.

For each feature in the database, the Features To Target window displays the percent of the Initial Achievable target satisfied by all selected sites. If the feature is over-represented it will have a percentage value greater than 100. If the feature remains under represented the percentage value will be less than 100.

FINISH: Closes the window and returns you to the last active window.

COPY: Copies highlighted text to the clipboard.

FIND AVAILABLE SITES: When one or more under represented features (with '% of Init. Achievable Tgt.' < 100) are highlighted in the list box, clicking this button will launch the Available Sites window (see section 5.2.7.1). The Available Sites window will then list all the sites in the Available class that contain one or more of the highlighted features.

FIND SELECTED SITES: When one or more features are highlighted in the list box, clicking this button will launch the Selected Sites window (see section 5.2.7.2). The Selected Sites window lists all the sites in selected classes that contain one or more of the highlighted features.

SAVE TO CSV FILE: To view contents of the Features to Target information as a spreadsheet click on this button to generate a comma delimited report.

SEARCH: Launches the Find window (see below) and allows you to search the features list for any text string you enter in the 'Find What:' text box. This can be very useful if there are a large number of features.

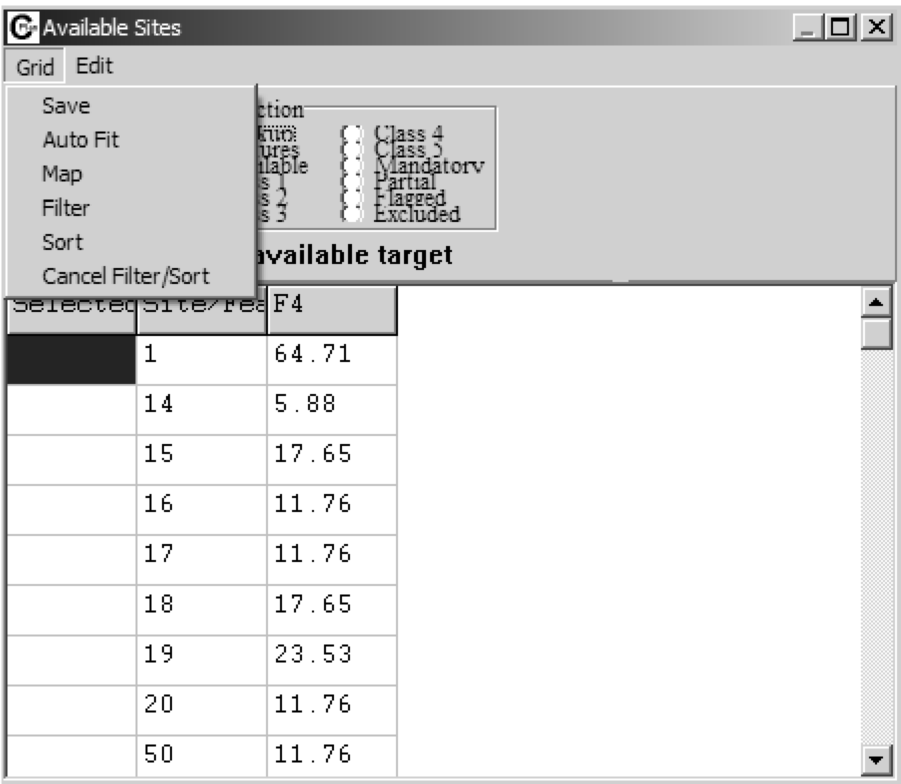
HIDE > OR < THAN: These options allow you to restrict the features displayed in the list box to those with a '% of Init. Achievable Tgt.' value greater than and/or less than a specified value. The cut-off values are entered in the text box.

SORT ORDER: Sorts the features by the '% of Init. Achievable Tgt.' value, either in descending or ascending order.

5.2.7.1. Find Available Sites.

This window is only launched when you click the Find Available Sites button in the Features to Target window.

The list box in this window displays all the Available sites that contain one or more of the features highlighted in the Features to Target window. The figures represent the remaining feature target (Available target in the feature report) that would be satisfied if the site was to be selected.



5.2.7.1.1. Save.

5.2.7.1.2. Autofit.

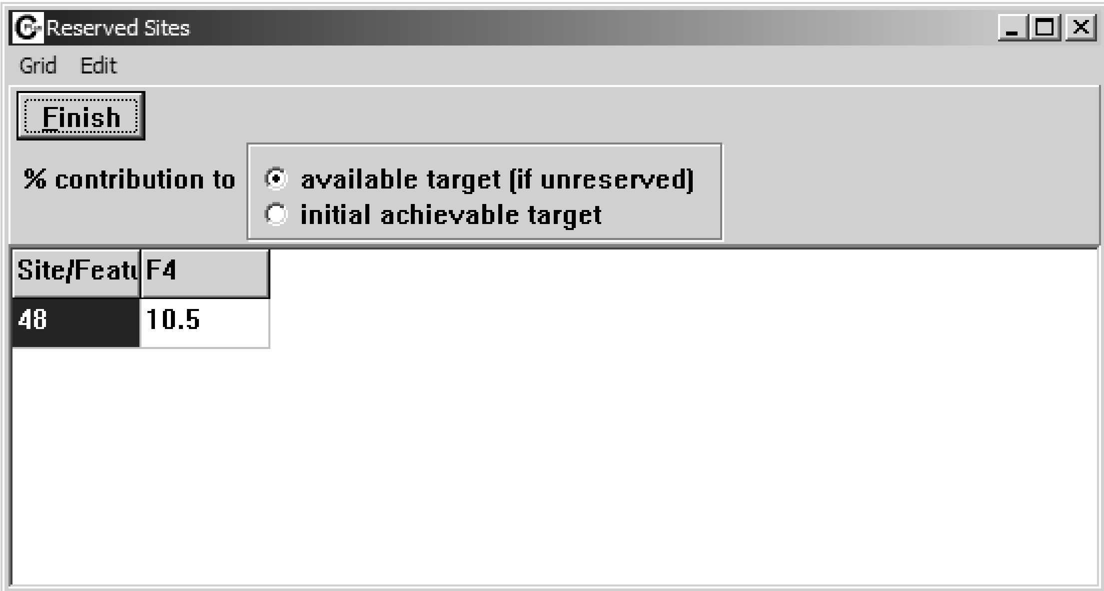
5.2.7.1.3. Map.

5.2.7.1.4. Filter.

5.2.7.1.5. Sort.

5.2.7.1.6. Cancel Filter/Sort.

5.2.7.2. Find selected sites.



This window is only launched when you click the Find Selected Sites button in the Features to Target window.

5.2.8. Selection log.

5.2.9. Partially selected sites.

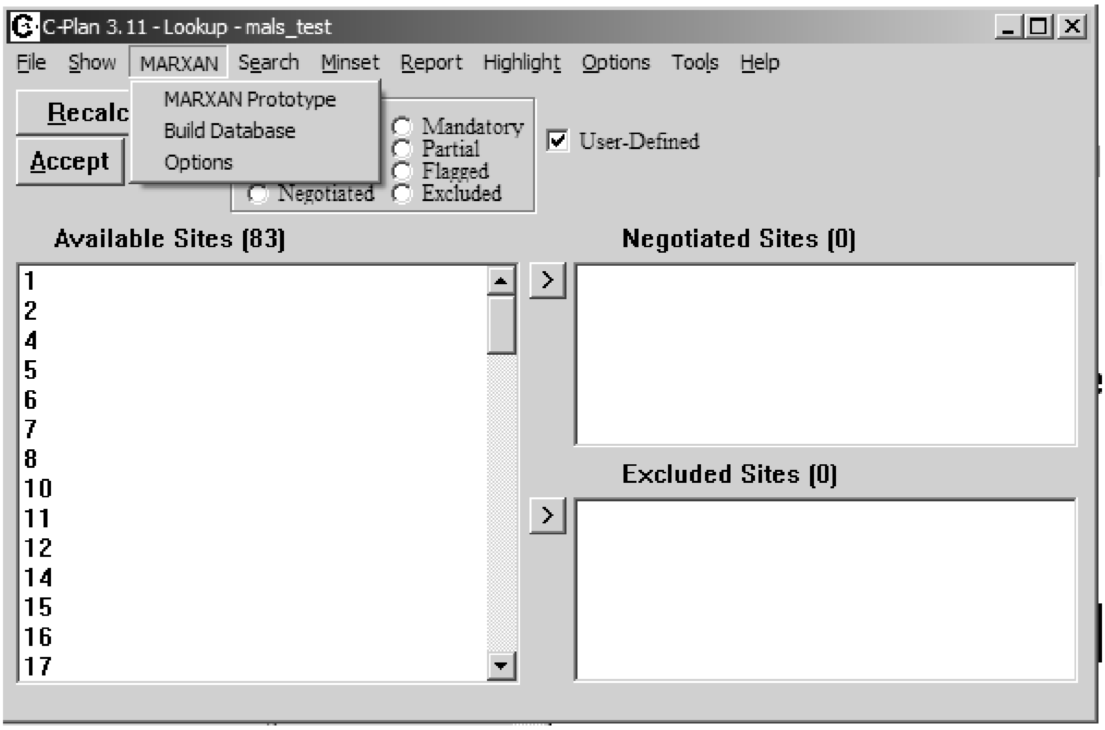
5.2.10. Map redundant sites.

5.2.11. Replacement sites.

5.2.12. Resource.

5.2.13. Hide.

5.3. Marxan.

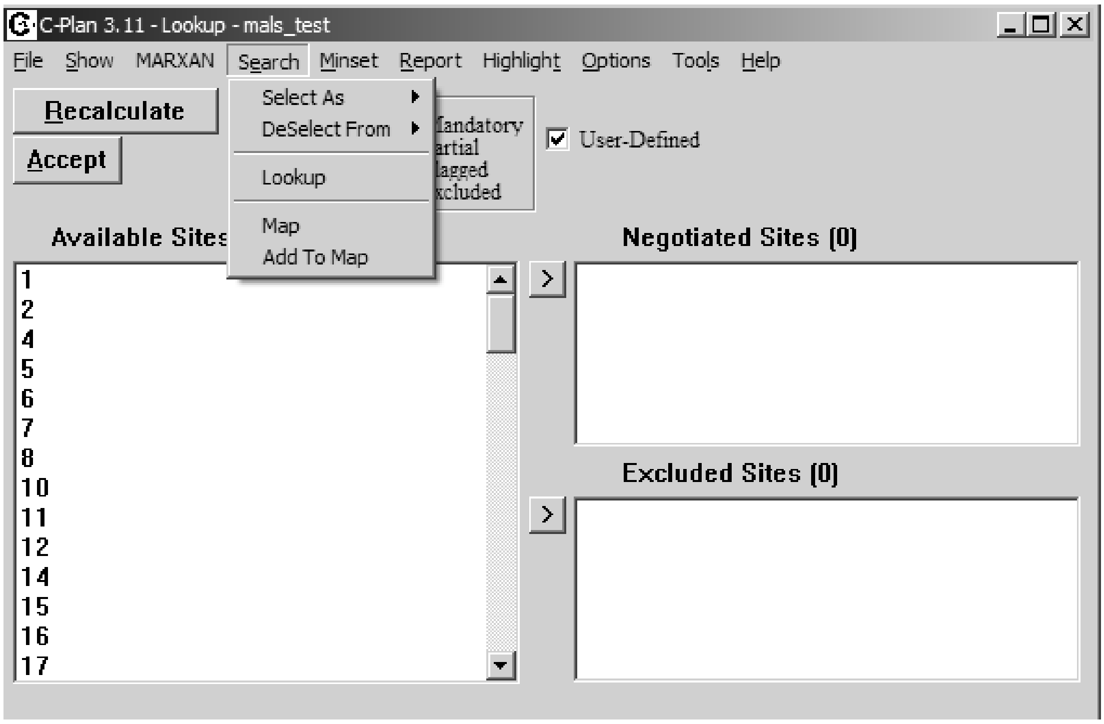


5.3.1. MARXAN prototype.

5.3.2. Build database.

5.3.3. Options.

5.4. Search.



5.4.1. Select as.

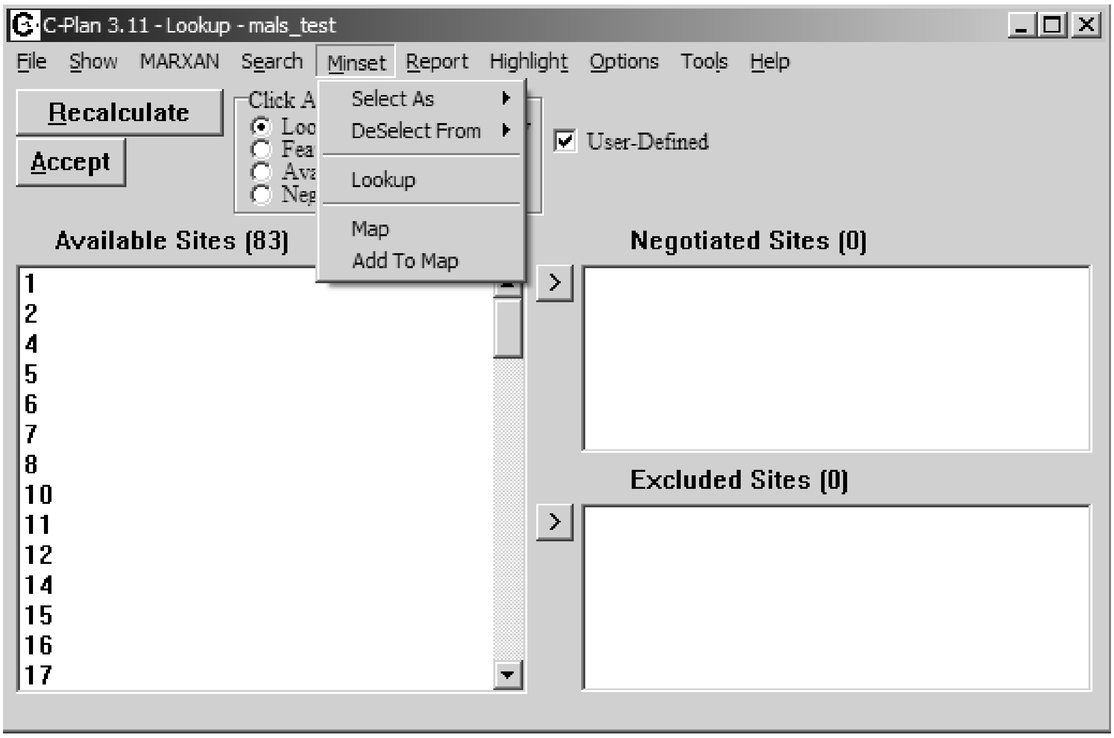
5.4.2. Deselect from.

5.4.3. Lookup.

5.4.4. Map.

5.4.5. Add to map.

5.5. Minset.



5.5.1. Select as.

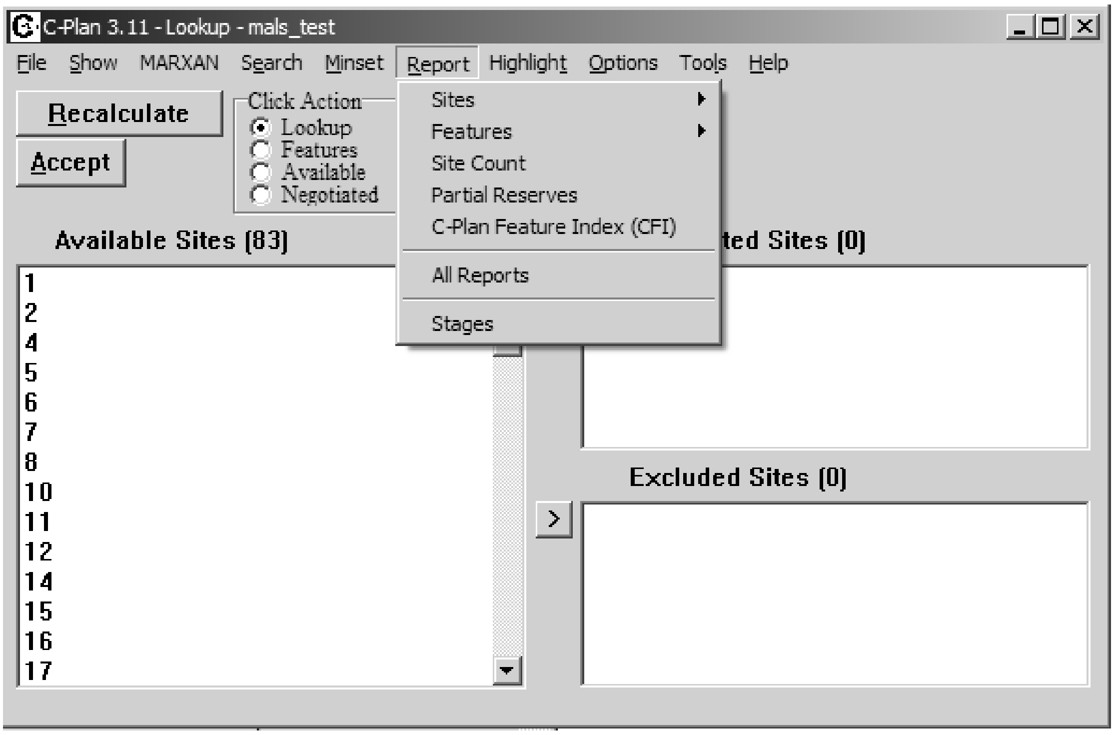
5.5.2. Deselect from.

5.5.3. Lookup.

5.5.4. Map.

5.5.5. Add to map.

5.6. Report.



5.6.1. Sites.

5.6.2. Features.

5.6.3. Site count.

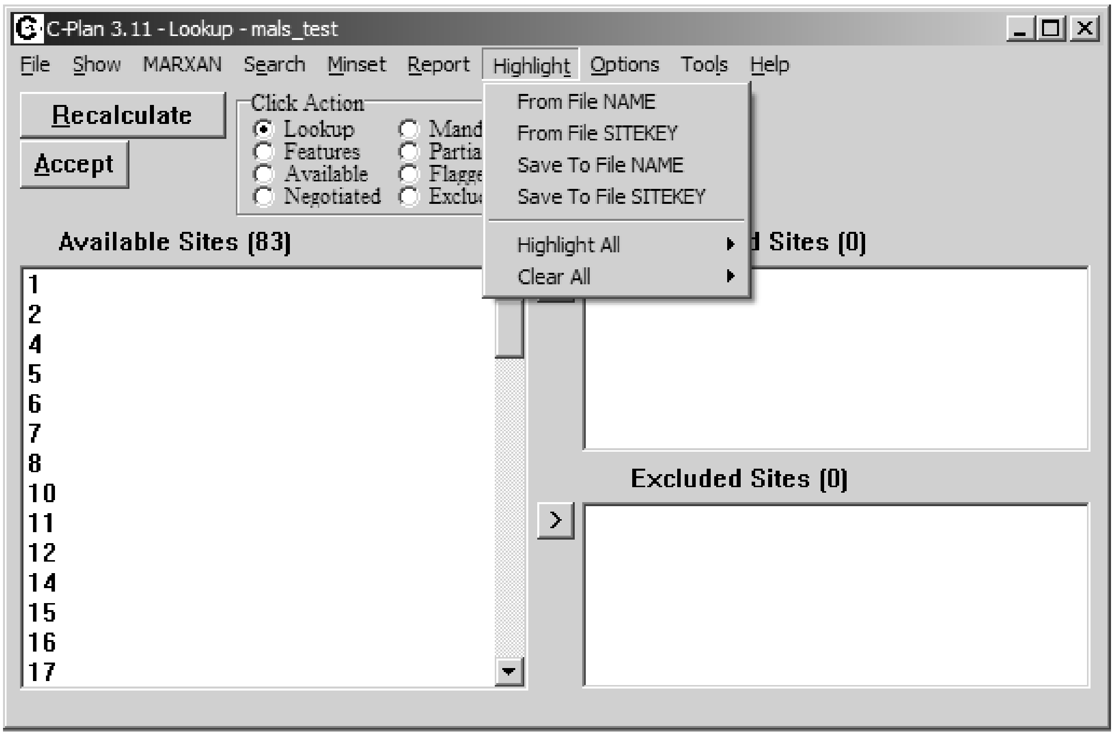
5.6.4. Partial reserves.

5.6.5. C-Plan feature index (CFI).

5.6.6. All reports.

5.6.7. Stages.

5.7. Highlight.



5.7.1. From file name.

5.7.2. From file sitekey.

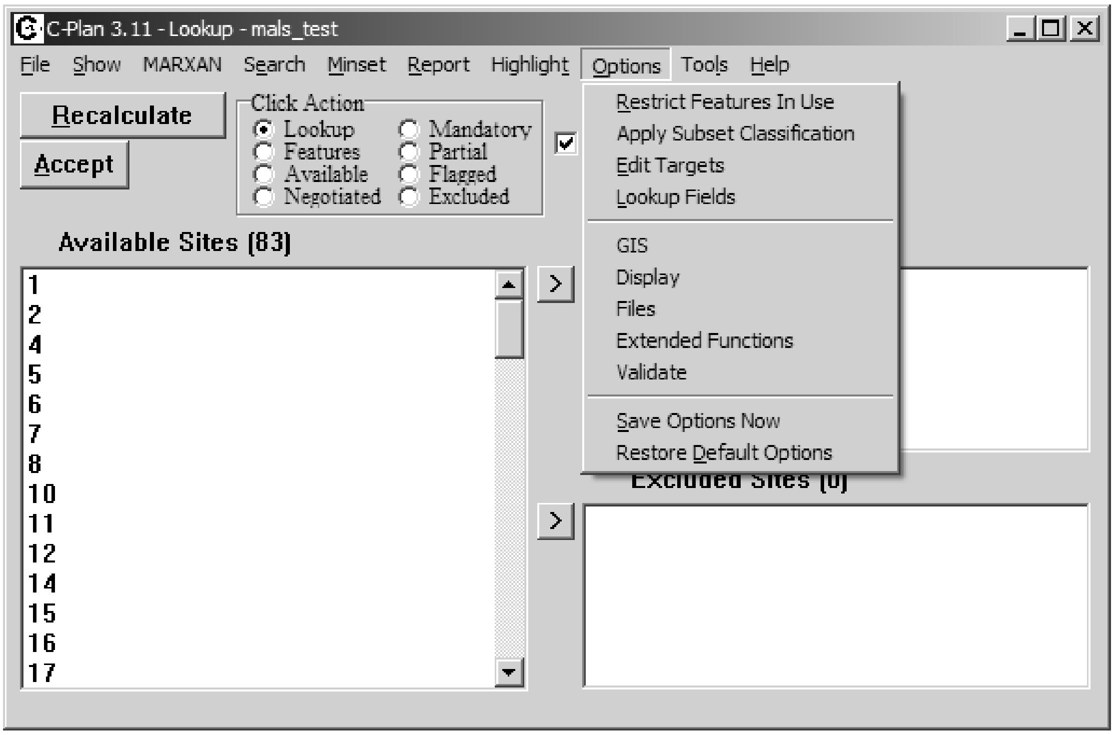
5.7.3. Save to file name.

5.7.4. Save to file sitekey.

5.7.5. Highlight all.

5.7.6. Clear all.

5.8. Options.



5.8.1. Restrict features in use.

5.8.2. Apply subset classification.

5.8.3. Edit targets.

5.8.4. Lookup fields.

5.8.5. GIS

5.8.6. Display.

5.8.7. Files.

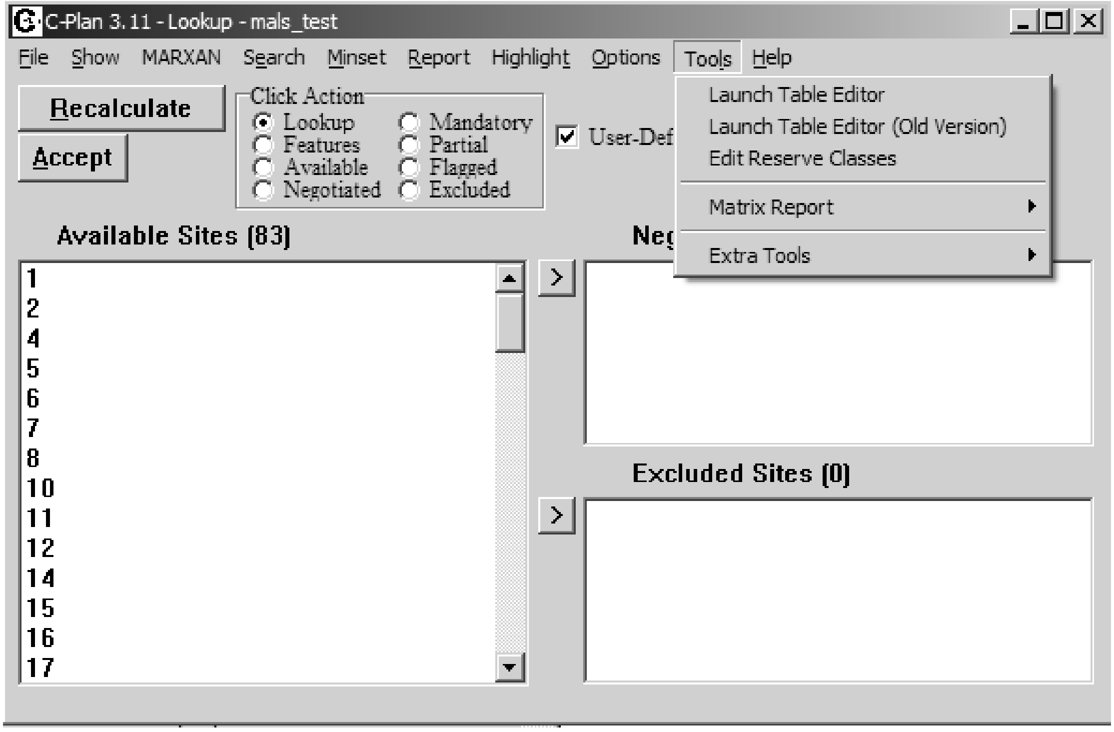
5.8.8. Extended functions.

5.8.9. Validate.

5.8.10. Save options now.

5.8.11. Restore default options.

5.9. Tools.



5.9.1. Launch table editor.

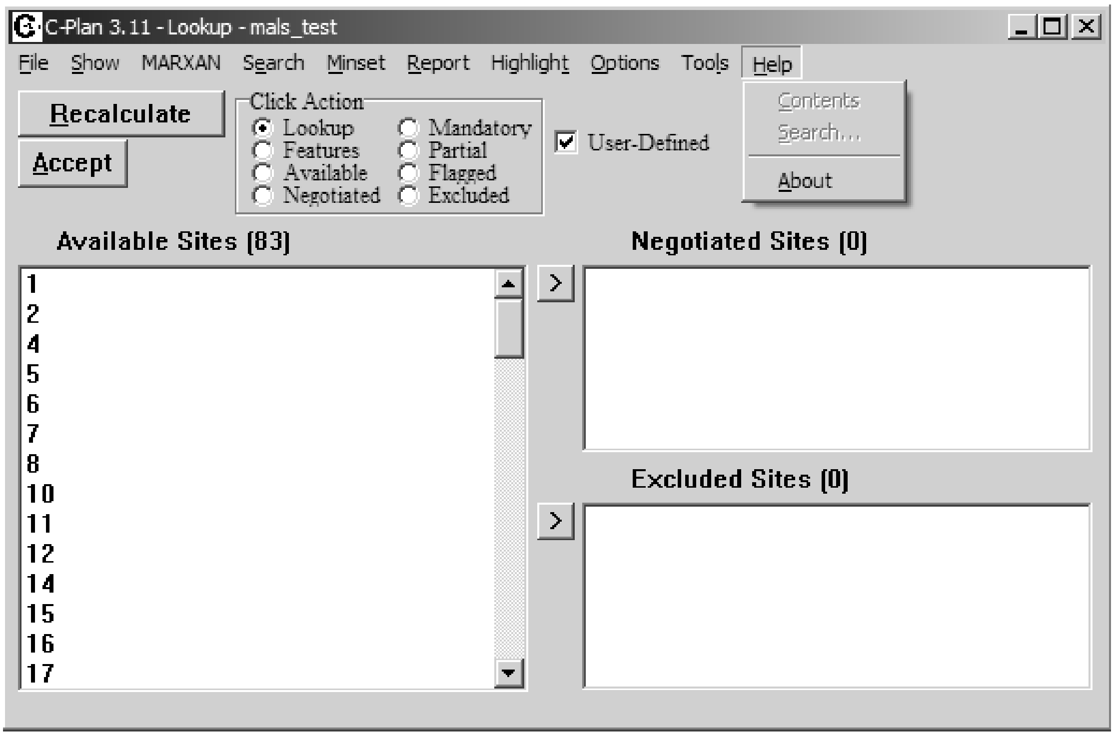
5.9.2. Launch table editor (Old version).

5.9.3. Edit reserve classes.

5.9.4. Matrix Report.

5.9.5. Extra tools.

5.10. Help.


C-Plan 3.11 - Lookup - mals_test
File Show MARXAN Search Minset Report Highlight Options Tools Help
Recalculate
Accept
Click Action
Lookup
Features
Available
Negotiated
Mandatory
Partial
Flagged
Excluded
User-Defined
Contents
Search...
About
Available Sites (83)
1
2
4
5
6
7
8
10
11
12
14
15
16
17
Negotiated Sites (0)
Excluded Sites (0)

6. FUNCTIONAL LIST OF TABLE EDITOR MENUS.

6.1. File.

6.2. Wizards.

6.3. Table.

6.4. Window.

6.5. Help.

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