3.0 HABITAT MONITORING

Habitat monitoring will focus on three areas: (1) permanent habitat loss as a result of development; (2) temporary habitat changes as a result of natural events (e.g., fires and flooding); and (3) loss of habitat value as a result of edge effects or other human-related impacts.

3.1 BASELINE INVENTORY

The MSCP vegetation map was based primarily on 1990 color infra-red aerial photography. Additional data sources included high altitude photographs and existing environmental documentation (both digital data and hardcopy sources). Through a "heads up" digitizing process, on-screen satellite imagery from the same time period as the color infra-red aerial photos was used to input the vegetation communities into the Geographic Information System (GIS). For the most part, limited field-verification of vegetation maps was conducted; however, detailed verification was conducted in selected portions of the study area that had been identified as comprising gaps in the database. Refinements to the vegetation map were made based on comments received on the draft MSCP maps, and were often based on post-1990 field work. As a result, there are localized updates to the 1990 base map that reflect more recent data.

3.2 TRACKING PERMANENT HABITAT LOSSES

Monitoring of landscape-level habitat changes within targeted preserve areas will focus on changes from vegetation to urban and agricultural development, and will be measured against the baseline MSCP vegetation map. Local jurisdictions will track habitat loss within their jurisdictions through their permitting process. This subregional monitoring program will provide an MSCP-wide assessment of habitat acreage lost. This tracking effort will achieve the plan objectives of documenting the protection of habitats, evaluating the impacts of land uses and construction activities in and adjacent to the preserve, and evaluating enforcement difficulties in the preserve.

3.2.1 Methodology

The San Diego Association of Governments (SANDAG) is updating the 1990 vegetation information to reflect 1995 conditions, using a multi-date satellite image change detection model (1990 and 1995 imagery) and 1995 land use coverages for urban and agricultural areas.

Currently, change areas are automatically identified from differences between multi-date panchromatic (black-and-white) satellite imagery. This process identifies areas that have changed, but does not identify the type of change. Change areas are then overlaid with the appropriate land use coverages or color infra-red satellite imagery to determine areas of urban and agricultural change, and appropriate modifications are made to the vegetation map. This process is largely a GIS function, but does require review of changed areas by a biologist to ensure that vegetation is not erroneously classified as developed. Problematic polygons are typically vegetation to agriculture changes. The review process by the biologist includes examination of on-screen imagery and/or hardcopy plots, and limited field-verification efforts, as necessary.

3.2.2 Schedule

SANDAG is currently in the process of updating the 1990 vegetation database to 1995 conditions; the updated vegetation map will be finalized in 1996. SANDAG envisions that they will continue to perform a regional-level land use change detection analysis at approximately five-year intervals, given existing levels of funding. Changes in land cover in habitat areas (i.e., urban development or agriculture) will be documented as part of this process.

3.2.3 Products

Products of this analysis will include an updated vegetation map (scale 1" = 2000') that reflects habitat-to-development changes, and revised preserve acreage figures.

3.2.4 Cost

Costs associated with this task (Tracking Permanent Habitat Loss) are not included in this monitoring plan.

3.3 MONITORING TEMPORARY HABITAT CHANGES

Monitoring temporary habitat changes (e.g., from fire and floods) can be useful in interpreting vegetative trends, thereby ensuring that habitats are not undervalued during "point-in-time" assessments. Monitoring temporary changes also can identify areas in need of active management and provide baseline information for regional vegetation ecology studies. This monitoring effort will achieve the plan objective of documenting change in preserved habitats. Monitoring successional changes in vegetation communities is not proposed as part of this program.

3.3.1 Methodology

3.3.1.1 Fire

Temporary habitat changes resulting from fire can be monitored through post-fire mapping of burned areas, incorporating mapped information into a regional GIS burn layer, and correlating this information with the vegetation map. The primary source for burn data is the California Department of Forestry (CDF). The CDF maps all fires that are 40 acres or greater in size, and has been conducting bum mapping since 1910. Data from 1910 to 1979 are currently on acetate overlays, while data from 1980-1993 have been input into the County of San Diego's GIS and are available in digital format at SANDAG. Data from 1994 to the present are not yet in digital format, but can be obtained in hardcopy form from the CDF. The automated change detection methodology (Section 3.2.1) may also be useful in identifying changes due to fire.

Post-fire field monitoring is not included as a component of the biological monitoring plan. Habitat management plans for each subarea will include fire management plans, and these fire management plans will be the vehicle for any field monitoring that is deemed necessary or desirable. Field monitoring conducted as part of the habitat management plans may include assessments of the post-fire recovery of specific habitats or sensitive species.

3.3.1.2 Floods

Flooding along major drainages may result in the temporary loss of riparian habitat, which provides habitat for several sensitive bird species and cover for additional wildlife species that use drainages as movement corridors. Flooding is a natural component of riverine ecosystems, however, and is important for rejuvenation of the vegetation. As with fires, it is important that temporary conditions associated with flooding, such as bare channels, are not misinterpreted and the habitat undervalued.

Changes associated with flooding (i.e., vegetation to scoured, bare channels) are often dramatic and easily detected from aerial photographs. These types of changes would also be apparent on the panchromatic satellite imagery used in the change detection process. Results of the change detection process will be used to identify changes associated with flooding. Change areas identified along major drainages will be reviewed by a biologist to determine the correct vegetation classification for the changed polygon. This review process will include examination of on-screen imagery and/or hardcopy plots, and limited field-verification.

3.3.2 Schedule

Assessment of temporary habitat changes will be conducted at five-year intervals, in conjunction with the vegetation-to-development change detection process.

3.3.3 Products

Products from monitoring of temporary habitat changes within the preserve system will include (1) a digital burn layer and (2) updates to the baseline vegetation map.

3.3.4 Cost

Costs associated with these tasks are strictly for a biologist to review change areas, direct GIS personnel in on-screen modifications, and conduct limited field-verification efforts, as necessary. It is assumed that SANDAG will be responsible for obtaining satellite imagery and other photography, providing personnel to identify potential change areas, making changes (with the assistance of a biologist), and updating the GIS vegetation database. The cost for a biologist (per monitoring period and in 1996 dollars) is approximately $6,000 for reviewing changes associated with burns and flooding. This includes 80 hours of office time and 40 hours of field time. If SANDAG does not conduct an assessment of temporary habitat changes, it is estimated that an additional $15,000 - $20,000 would be required for someone else to conduct this work.

3.4 MONITORING HABITAT VALUE

Vegetation monitoring for habitat value is designed to identify adverse changes in the vegetation over time as a result of human activities. Detection of such changes may warrant active management. Habitat value monitoring will focus on potential edge-affected areas, although selected habitats within the core of the preserve also will be monitored to provide a comparison to edge areas. Prioritized habitats for monitoring include coastal sage scrub (including maritime succulent scrub), southern maritime chaparral, and grassland. As monitoring budgets allow, additional habitat types such as oak woodland, riparian habitats, and chaparral should be monitored, as well. It is assumed that vernal pools will be adequately assessed in association with other existing or proposed monitoring programs. When existing or proposed vernal pool monitoring efforts are terminated, the wildlife agencies will evaluate the need to re-prioritize monitoring efforts to continue assessing these resources over time. This monitoring effort will achieve the plan objectives of documenting changes in preserved habitats, evaluating the impacts of land uses and construction activities in and adjacent to the preserve, and evaluating management activities and enforcement difficulties in the preserve.

3.4.1 Methodology

The primary objective of long-term habitat monitoring is to identify temporal trends in vegetative conditions that may require active management. Although quantitative monitoring using a large number of transects is the most precise way to identify trends, it is labor-intensive and cost-prohibitive when applied to an area the size of the MSCP preserve. It is therefore recommended that an alternative plot method be used to assess vegetative trends over time. This alternative method will utilize a combination of cover class estimations and direct counts within plots, allow a larger number of locations to be monitored, and allow monitoring to occur on a more regular basis. This plot method will, in effect, function as an early indicator of declining vegetative conditions.

It is assumed that temporal trends in vegetation can be extrapolated beyond the boundaries of the sampling sites. It is important to note, however, that habitat value monitoring is not intended to be representative of habitat quality and condition throughout the entire preserve, nor is it intended to identify all areas of habitat disturbance. Although some disturbance events will certainly be identified during habitat monitoring, the overall assessment of habitat quality and condition within the entire preserve area will generally be accomplished by a combination of habitat monitoring through satellite imagery (Section 3.2) and on-ground visual inspections by the habitat reserve manager as part of the habitat management program.

The objective of habitat monitoring is to detect changes over time, as measured against baseline conditions rather than any pre-set "success criteria." In most cases, a determination of significant adverse declines in habitat condition will be made only after two or more consecutive monitoring periods indicate declining conditions. Furthermore, data will need to be assessed in relation to climate and rainfall factors to ensure that declines are not due to environmental parameters. The type and cause of habitat decline will determine the type and extent of management activities that are applied.

This section outlines tasks necessary to conduct the habitat value monitoring program. These include establishing specific monitoring plots within general monitoring locations, and establishing permanent point locations for sampling; acquiring appropriately-scaled base maps; refining the baseline vegetation map; establishing photodocumentation points; field monitoring; and data collection and analysis. It should be noted that not all monitoring parameters can be identified within the context of this plan, since some parameters will be dependent on a detailed assessment of field conditions.

3.4.1.1 Habitat Monitoring Locations

Locations for long-term vegetation monitoring are depicted in Figure 3-1 and summarized in Table 3-1. For the most part, habitat monitoring locations will be used for other types of monitoring, as well. Of the 29 habitat monitoring locations that have been identified, 13 are for coastal sage scrub, 7 are for grasslands, 6 are for southern maritime chaparral, and 3 are for maritime succulent scrub. Although the objective is to monitor all identified locations, some redundancy has been incorporated into the selection of monitoring locations to accommodate both access issues and potential limitations on monitoring budgets and/or personnel. Within each habitat category, monitoring locations can be prioritized, if needed. Considerations for prioritizing monitoring locations should include the following: (1) adequate geographic representation of the habitat type; (2) need for replicate locations; (3) presence of other types of monitoring at the same location; and (4) sensitivity/priority of other types of monitoring.

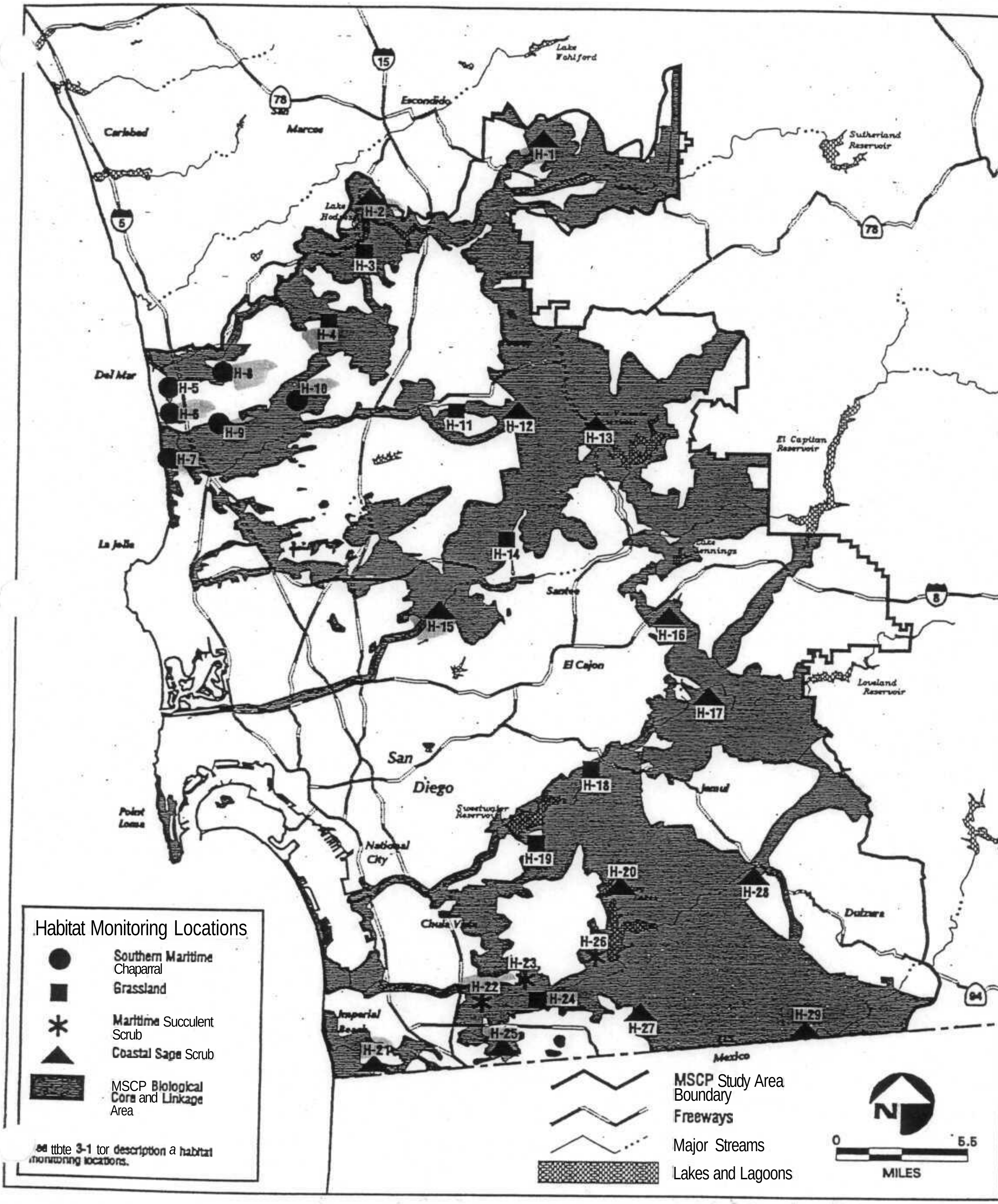

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FIGURE

Habitat Monitoring Locations

3-1

/mscp/plots/figures/habmon8x11.aml

04/19/96

Table 3-1

HABITAT MONITORING LOCATIONS[1]

MONITORING LOCATION[2]	GENERAL LOCATION	HABITAT	OTHER MONITORING[3,4]
H-1	San Diego Wild Animal Park	Coastal Sage Scrub	Wildlife (C-4)
H-2	Lake Hodges	Coastal Sage Scrub	Wildlife (C-3)
H-3	Eastern Santa Fe Valley/4-S Ranch	Grassland	Wildlife (C-2)
H-4	Santa Fe Valley	Grassland	Linkage (L-4)
H-5	Del Mar Heights (Crest Canyon)	Southern Maritime Chaparral	Plants (P-3)
H-6	Torrey Pines State Reserve Extension	Southern Maritime Chaparral	Plants (P-6)
H-7	Torrey Pines State Reserve	Southern Maritime Chaparral	Plants (P-7)
H-8	San Dieguito River Bluffs	Southern Maritime Chaparral	Plants (P-5)
H-9	Carmel Mountain	Southern Maritime Chaparral	Plants (P-8)
H-10	Del Mar Mesa	Southern Maritime Chaparral	Plants (P-10)
H-11	Poway	Grassland	
H-12	South Poway	Coastal Sage Scrub	Wildlife (C-10)
H-13	Northwest San Vicente Reservoir	Coastal Sage Scrub	Wildlife (C-11)
H-14	Sycamore Canyon	Grassland	Plants (P-15)
H-15	Mission Trails Regional Park	Coastal Sage Scrub	Wildlife (C-13)
H-16	Lakeside/Crest	Coastal Sage Scrub	Wildlife (C-17)
H-17	McGinty Mountain and Vicinity	Coastal Sage Scrub	Wildlife (C-18)
H-18	Rancho San Diego-Campo Village South	Grassland	
H-19	San Miguel Mountain	Grassland	Plants (P-19), Wildlife (R-5)
H-20	Southwest Jamul Mountains	Coastal Sage Scrub	Wildlife (C-23)
H-21	Goat Canyon-Spooner's Mesa	Coastal Sage Scrub	Plants (P-23), Wildlife (C-29)
H-22	Otay River Valley/West Otay Mesa	Maritime Succulent Scrub	Plants (P-25)
H-23	Wolf Canyon	Maritime Succulent Scrub	Plants (P-27), Wildlife (C-25)
H-24	Otay River West	Grassland	Plants (P-28)
H-25	Spring Canyon	Coastal Sage Scrub	Plants (P-26), Wildlife (C-30)
H-26	Lower Salt Creek	Maritime Succulent Scrub	Plants (P-31), Wildlife (C-26)
H-27	East Otay Mesa	Coastal Sage Scrub	Plants (P-32), Wildlife (C-28)
H-28	Northeast San Ysidro Mountains	Coastal Sage Scrub	Plants (P-35), Wildlife (C-24)
H-29	Marron Valley	Coastal Sage Scrub	Plants (P-34), Wildlife (C-31)

1 Includes only priority habitat types.
2 Refer to Figure 3-1 for a depiction of habitat monitoring locations.
3 Refers to other types of monitoring that may occur at the same location; see Rgures 4-1,.5-2, and 5-6.
4 Under wildlife, C = Coastal sage scrub plots for gnatcatcher and cactus wren. R = Raptor monitoring locations.

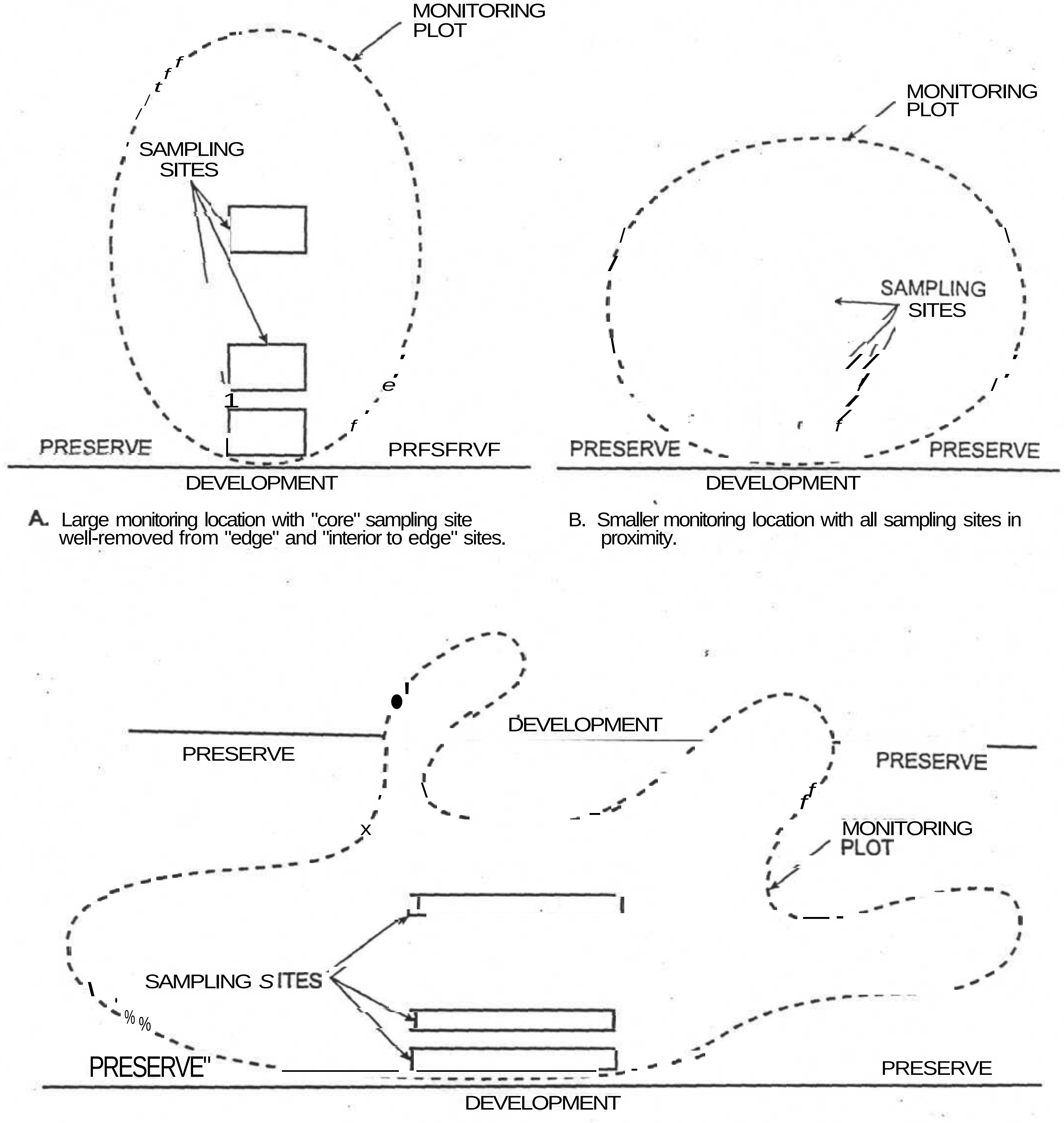
Monitoring locations shown in Figure 3-1 are generalized and represent habitat patches of varying sizes. In actuality, a monitoring "plot" will be established within each of the generalized monitoring locations shown in Figure 3-1 for habitat monitoring. These monitoring plots will range from approximately 50-200 acres in size, depending on the amount of habitat available. In general, monitoring plots in coastal locales will be smaller than monitoring plots in inland areas. This is a direct correlation of the amount of habitat fragmentation (and thus, smaller habitat patches) in the more coastal, urbanized portions of the preserve versus larger, more intact blocks of habitat toward the interior.

Because the primary objective of the monitoring program is to detect temporal changes in vegetative conditions relative to distance from preserve edges, the monitoring plot will be divided (stratified) into three areas or sampling sites, as described in Section 3.4.1.2 and depicted in Figure 3-2. The shape of the monitoring plot (and thus, the sampling sites) may vary, depending on the shape of the habitat patch and its position relative to development or other potential sources of edge effects (Figure 3-2). Exact position and shape of the monitoring plots will be determined during the implementation phase of the monitoring program.

Once monitoring plots have been established, their exact coordinates will be mapped onto orthophotographs and input into a GIS. If orthophotographs are not available, coordinates could be registered in the field using a Global Positioning System (GPS). Detailed field notes should record the methodology for selecting monitoring plots so that subsequent plots in other areas of the preserve will be established in a consistent manner.

3.4.1.2 Sampling Sites

Stratification of the monitoring plots into sampling sites will allow an assessment of habitat value relative to potential sources of disturbance assumed to originate primarily at preserve edges. Stratification will occur as follows: (1) "edge" sites (<60 m from the preserve boundary), (2) "interior edge" sites (60-180 m from preserve boundary), and (3) "core" sites (>180 m from preserve boundary) (Figure 3-3). Prior to full buildout of the surrounding area, the preserve boundary may not correspond to the edge of development. Therefore, edge sites may not initially be situated in true edge zones. Sampling sites may be contiguous or disjunct, depending on the shape and size of the monitoring plot. Monitoring within each site will provide a measure of the temporal trends in vegetative



A. Large monitoring location with "core" sampling site well-removed from "edge" and "interior to edge" sites.

B. Smaller monitoring location with all sampling sites in proximity.

C. Narrow monitoring location requiring rectangular sampling sites.

Not to Scale

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Potential Sampling Site Shapes and Locations within Monitoring Plots

FIGURE 3-2

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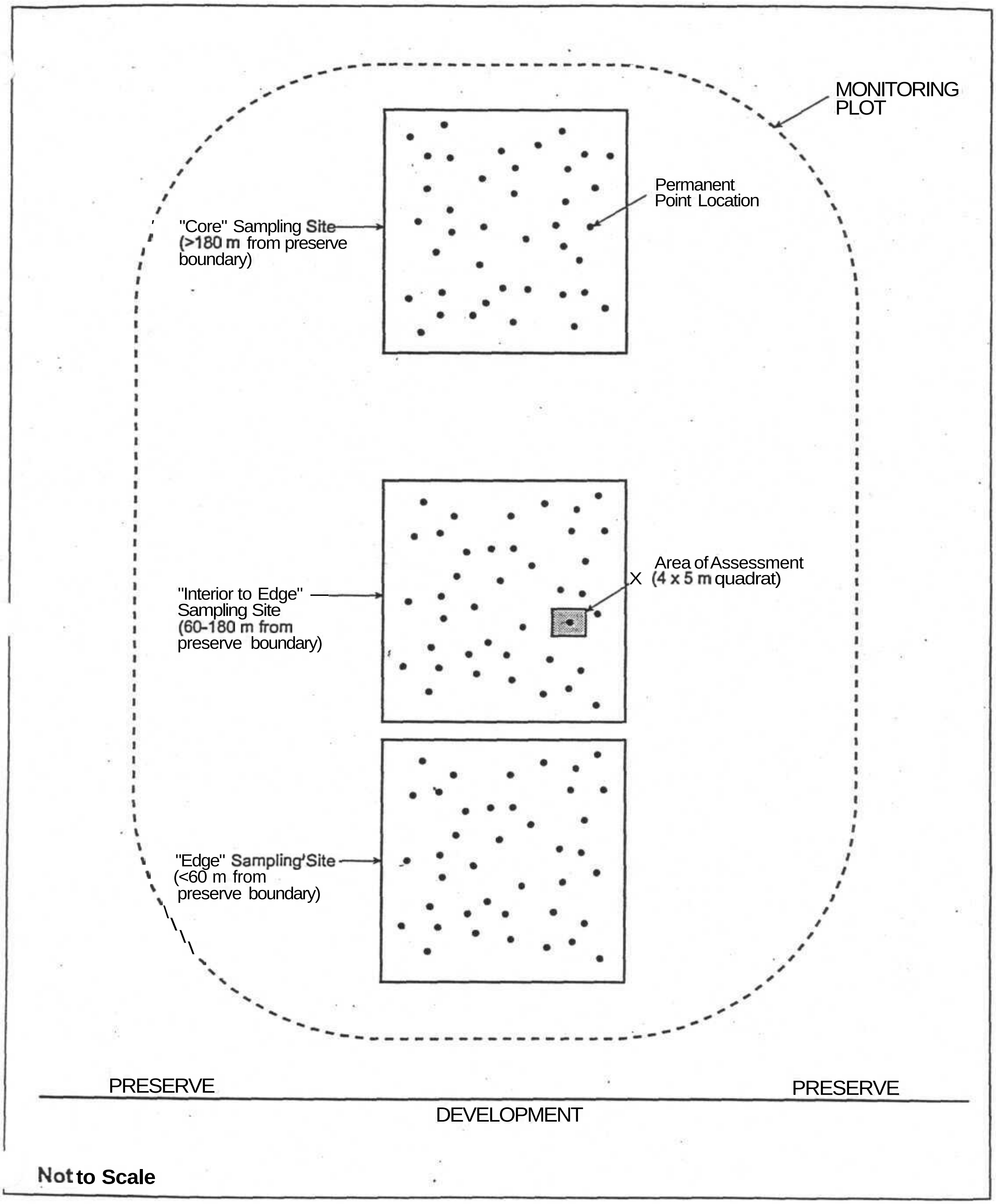

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Example of a Sampling Design within a 200 acre Habitat value Monitoring Plot

FIGURE

3-3

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conditions within the larger preserve area surrounding the monitoring plot. Within the sampling sites, vegetation will be assessed for long-term trends.

3.4.1.3 Permanent Point Locations

To monitor long-term trends, permanent point locations will be established for sampling; these point locations can then be reliably resampled to document changes in vegetative conditions over time. Permanent points will be located in each of the three sampling sites within each monitoring plot (Figure 3-3). Point locations will be distributed throughout each site, using a stratified approach. Placement of the points within each site will be randomized during the initial set-up period, and fixed thereafter. Habitat will be assessed in a 4 x 5 m quadrat around each point, as described in Section 3.4.1.7. For costing purposes, it is assumed that a maximum of 40 points will be required in any one monitoring plot.

Sampling point locations will be permanently marked on the ground using steel rods or other devices to facilitate relocation in subsequent monitoring years. This placement of permanent point locations is designed to detect change in the overall vegetative condition of the monitoring plot over time. It is based on the following assumptions: (1) data collected in the area around each point location can reasonably be extrapolated to the rest of the monitoring plot and (2) there is an adequate density of point locations to reasonably characterize vegetative conditions within the sampling sites. This design has the advantage of being cost-effective and allowing the detection of trends over time. This design will not necessarily detect all problems within the habitat monitoring plot, however, because only a small percentage of the area is being sampled. Because the sampling points are permanent, there will be areas of the monitoring plot that will not be assessed using this method.

An alternative approach using a yearly random placement of point locations (e.g., the location of sampling points would shift each year) would provide a greater potential for sampling more of the monitoring plot, provide a better assessment of the average conditions within the entire monitoring plot, and potentially detect problems that may occur between permanent point locations. However, in order to achieve sufficient statistical power to detect temporal trends in vegetative conditions using this method, the number of point locations would be large and, therefore, cost-prohibitive.

3.4.1.4 Digital Orthophotography

Monitoring for vegetation trends will require more detailed base maps within monitoring plots than have been available to date. Digital Orthophotography of the monitoring locations will be used as a photographic base map for detailed vegetation mapping of the monitoring plot (Section 3.4.1.5) and will be useful as a permanent record. Development of a digital terrain model (DTM), which is an array of point data with elevation values, is required to create the digital orthophotos. This DTM can then be used to generate slope, aspect, and elevation contour information that can be used in the monitoring program. The digital orthophotographic data will need to be obtained only once at the start of the monitoring program. Ideally, digital orthophotos will be taken in both the visual spectrum and near-infrared with a minimum 1 m pixel resolution. If black-and-white orthophotos are used, then color aerial photographs also may be needed to assist in photointerpretation of vegetation types. The digital orthophotos should be corrected for distortion related to terrain and camera tilt, and should have a minimum accuracy of 1.5 m.

Currently, 1992 black-and-white digital Orthophotography exists for the City of San Diego, and would be available for use in the monitoring program. These data have a resolution of 0.15-0.6 m (0.5-2 feet [ft]), with 0.6-m (2-ft) contours. The City of Chula Vista is in the process of compiling similar data, and is currently having the orthophotos flown. In addition, a consortium of local partners is proposing to fund a similar effort for the County of San Diego. These 1994/1995 back-and-white digital orthophotos, which will have a resolution of 1 m, are expected to be available in early 1997. In addition to the digital orthophotographs, it may be valuable to obtain color aerial photographs for specific monitoring locations', as warranted by natural or man-induced disturbance events (e.g., fire, flooding, clearing, off-road vehicle activity).

Another imagery acquisition project may also benefit the monitoring process. Color infrared orthos at 1 m resolution probably will be flown in summer 1996 as part of a transborder (U.S./Mexico) project for a 100-mile buffer on each side of the border. A local partnership with the U.S. Geological Survey may be formed to create digital orthos. These orthos probably would be available in late 1997 or 1998.

3.4.1.5 Vegetation Map Refinements for Monitoring Plots

Vegetation within the MSCP study area is currently mapped at a regional level of detail. Identifying vegetative trends, however, will require a more detailed vegetation map for the monitoring plots. Currently, for example, areas of chamise or southern mixed chaparral may be included within southern maritime chaparral, and maritime succulent scrub may not always be differentiated from other forms of coastal sage scrub. Therefore, refined vegetation mapping will be conducted for each monitoring plot. The refined mapping will be a one-time event, and mapping units will be to the association or sub-association level, as appropriate. This mapping effort will also correct for categorical and positional errors inherent in the regional database. Mapping will be conducted directly onto a hardcopy version of the digital orthophotograph, and input into the GIS. For some monitoring plots, detailed, project-level information may be available and should be used as the basis for this detailed mapping. Field-verification should still be conducted, however, to ensure that the mapping reflects the most recent vegetative conditions.

3.4.1.6 Photodocumentation for Monitoring Plots

Permanent photodocumentation points will be established within each monitoring plot and will be utilized to provide a photographic record over time of the general vegetative characteristics of the plot. At least one photodocumentation point will be established within each sampling site (three sites per monitoring plot); this photodocumentation point will correlate to a permanent sampling point location. The camera will be mounted at a height above the vegetation to minimize distortion. Color film will be used, and photographs will be taken at the same time of year to minimize discrepancies due to phenology. In addition, cameras will maintain the same orientation and focal length from year to year. Each photograph will include a card that provides relevant information (e.g., transect identification number, date). Photographs will be taken during each monitoring period.

3.4.1.7 Habitat Value Monitoring in the Field

Habitat value monitoring will focus primarily on measurable aspects of the vegetation that can serve as indicators of both short- and long-term vegetative "health." This monitoring is not intended to identify vegetative disturbances throughout the preserve; rather, it will provide an indication of vegetative trends. This quantitative monitoring will be supplemented by visual observations of disturbance events or other physical conditions in or near the monitoring plot that may be affecting the vegetation (e.g., invasive exotic species, clearing of vegetation). This "qualitative" information is easily collected and intended primarily to supplement overall habitat management monitoring by the preserve manager. This information may also be valuable in interpreting results of the quantitative data collection effort

Quantitative Monitoring

Quantitative monitoring will obtain data on both native (or naturalized) plants and invasive plants in the monitoring plots. For the purpose of this program, invasive species are defined as aggressive or noxious weed species (i.e., nonnative species that are growing or spreading rapidly, outcompeting native species, and difficult to control). A list of the more common invasive species in the MSCP study area is included as Appendix B to this document. In addition, the Jepson Manual (Hickman 1993) lists species considered legally noxious by the State of California, and the California Exotic Pest Plant Council has produced a list of exotic pest plants of greatest ecological concern in California (CalEPPC 1994). These sources will be consulted to determine whether or not a species is considered invasive, as defined above.

Quantitative data will be collected within permanent, established quadrats at each point location within each sampling site (Section 3.4.1.3). The goal for the first monitoring period at any monitoring plot will be to establish baseline conditions. Thereafter, between-year comparisons can be made to identify significant changes in vegetative conditions. With enough years of data, a time-series analysis can be performed to identify significant trends in vegetative conditions. Positive trends will be considered stable conditions (assuming the vegetation is undisturbed at the time baseline data are collected) or shifts toward climax or subclimax communities, whereas negative trends will be an increase in nonnative species. An assessment of negative trends will need to consider site factors such as recent burns before recommending management actions.

Vegetative Parameters. Quantitative vegetation data collection will focus on estimates and/or direct counts of species cover, density, and frequency. Cover is the percentage of the ground surface that is covered by vegetation material, and is a useful measure for long-term monitoring because it is sensitive to biotic and edaphic influences. Cover is an important measurement as it relates to plant biomass within a sampling site if the vegetation layers or stratum are considered (Daubenmire 1968; Mueller-Dombois and Ellenberg

1974). Plant biomass has a major influence on the light and temperature within a vegetative stand, it influences water relations and relates to nutrient cycling within a stand, and it is directly related to the wildlife use in an area (Mueller-Dombois and Ellenberg 1974).

Density refers to the number of individuals in a given unit of area. This measure is used to describe vegetation characteristics of a community. Estimates of density are useful for monitoring plant responses to environmental perturbations. One difficulty in density counts is the recognition of individuals. Tree and single-stemmed growth forms present few problems, but many other plant forms can be problematical. Accurate density measurements rely on a knowledge of the plant life forms being sampled. A second consideration for density counts is the marginal effect of the quadrat and the decision of whether to include an individual as being in or out of the sampling area. Generally, if the individual is rooted within or largely rooted within the sampling quadrat, it is included in the density count.

Frequency is a measure of a species' presence and distribution in a community, and is a useful tool to detect changes in the vegetative composition of a plant community over time. No counting is involved; frequency simply relates to the number of times a species occurs in a set number of stratified sampling plots, expressed as a percentage of the total number of plots evaluated. Although frequency data will indicate a change in species population, it will not identify the vegetative characteristic that has changed (Bonham 1989). Therefore, additional measurements (e.g., cover, density) are needed to provide a more complete analysis of the nature of the change, since frequency measurements can overemphasize the importance of species whose individuals are widely distributed in the sampled vegetation (Bonham 1989; Clarke 1986).

Monitoring Methodologies. Biologists will obtain quantitative data using quadrat sampling methods. Data can be collect either by species or by canopy level (i.e., tree, shrub or subshrub, herb). Recommended methodologies are summarized below.

For all habitats, it is recommended that a 4 x 5 m quadrat be used for sampling at each point location within each strata or sampling site. Assuming 40 point locations per sampling site, a total sampling area of 800 m^2 will be obtained per sampling site, or 2400 m^2 per monitoring plot.

Cover data for all species will be obtained by estimating cover within the 4 x 5 m quadrat at each sampling point. Estimates of plant species cover will be collected using a modified Daubenmire cover scale (Mueller-Dombois and Ellenberg 1974). This modified method utilizes cover ranges, as shown below. For statistical calculations, cover ranges for all observations will be converted to the cover range midpoint values shown below.

Cover Range (%)	Cover Range Midpoint (%)
95-100	97.5
75-95	85
50-75	62.5
25-50	37.5
5-25	15
1-5	3

Data should be collected for the tree, shrub or subshrub, and herbaceous layers, as applicable, as well as the ground layer (including bare ground, rock, or plant litter).

Density counts of all shrub species also will be estimated within the quadrats. However, density of herbaceous species in grassland habitat will not be measured. Density and size of individual annual plants can vary tremendously between years depending on environmental conditions and factors of inter- and intraspecific competition. Percent cover is a better estimate of dominance and plant biomass in grasslands and will be used for this habitat.

Frequency data will be obtained by recording all species (i.e., presence) rooted in each quadrat. The proportion of quadrats that contain a species is the frequency for that species. Thus, if a species occurs in 20 of the 40 quadrats, it has a frequency of 50 percent.

Qualitative Monitoring

In addition to quantitative monitoring at permanent point locations, obvious signs of disturbance will be recorded in each sampling site, regardless of whether or not they are associated with a point location. Factors that will be of interest include habitat disturbance (both natural and human-induced) and surface or subsurface disturbance. The natural habitat disturbance event of particular concern is fire. Human-induced habitat disturbance refers to direct vegetative disturbance, as might be caused by recreational activities (trampling), unauthorized off-road vehicles (crushing, fragmentation), or disking or clearing of vegetation. The degree of disturbance may result in temporary or permanent vegetation impacts and will require different levels of management activities. Observations of surface or subsurface disturbance will focus on those physical characteristics of the site or surrounding area that affect the vegetation onsite. Examples of surface or subsurface disturbance include erosion and changes in watershed or hydrological patterns caused by landform alterations or water diversion. Areas of obvious disturbance will be recorded in field notes and mapped onto base maps during the monitoring effort. However, no quantitative measurements of habitat, surface, or subsurface disturbances will be made.

3.4.1.8 Data Collection

It is critical to the success of the monitoring program that a central data collection system and a central repository for data be established and accessible to all personnel involved in the monitoring program. Standardizing data collection is essential to meeting monitoring objectives and streamlining the data collection, analysis, and reporting efforts. Protocol and/or refinements can be made as the program evolves and as monitoring priorities shift; however, any changes should be well-documented and accessible to all persons involved in monitoring.

Monitoring documentation should include the following: data collection field forms, data reduction forms, and final summary forms (Clarke 1986) (Appendix A). Establishing these forms in advance of the field effort will ensure that all aspects of the monitoring effort are examined, and will focus the effort on the stated objective(s). In addition, maps should be provided (as needed) that depict individual site disturbances and other indicators/evidence of change.

Data collection field forms will be used to record quantitative data at each point location and assess general conditions within the sampling site. Data reduction forms will be used in the office subsequent to the quantitative data collection effort to summarize sampling site data and perform initial data analyses (i.e., means, variances, standard deviations, etc.). A final summary form will be used to provide an evaluation of each monitoring plot. Final summary forms are designed to condense quantitative data into summary statistics that reveal the overall patterns being monitored. These forms will provide information used in the monitoring reports.

Any mapping that accompanies the qualitative habitat monitoring evaluation will be conducted on the refined vegetation maps prepared for each monitoring location (Section 3.4.1.5). The focus of this mapping will be to show the extent of the disturbance and/or area of vegetative decline.

3.4.1.9 Data Analysis

The quantitative vegetation data for each site will be analyzed by the wildlife agencies using parametric methods. The intent of the analysis will be to (1) compare vegetative characteristics within a given monitoring plot over time and (2) compare different sites within a monitoring plot over time. The sampling design also will allow a comparison of edge effects among different monitoring locations within the MSCP preserve, if desired. However, this latter analysis is not included in the cost estimates for this program.

Data analysis can occur at either the species or canopy level, and should include an assessment of native (or naturalized) species versus invasive exotic species. Percent cover, estimated by cover classes in quadrats, will be averaged among quadrats for each sampling site. Densities of shrub or tree species will be averaged among quadrats for each sampling site. Plant species frequencies will be obtained for each sampling site from the species presence data within the quadrats. Means and standard deviations for species cover, density, and frequency data will be calculated for an entire sampling site from all quadrats in a given habitat. These data also may be grouped and summarized to show means and standard deviations for tree, shrub or subshrub, and herbaceous species and for native (or naturalized) species and invasive exotic species, respectively. Where quadrats have sampled different micro-environments (e.g., slope aspect, slope position, elevation), these data may be combined and summarized to show possible trends relative to these features. The primary intent, however, is not to compare different sites or micro-environments within a sampling site, but to provide a reference from which to compare vegetative characteristics within a given site over time.

If quantitative data collection at a monitoring location occurs over a period of monitoring years, then "baseline" data from the initial quantitative sampling period can be compared to data collected in subsequent years. In this case, percent cover and mean densities and frequencies for trees, shrubs or subshrubs, and herbaceous plants (as appropriate) will be graphed as a function of sampling period to illustrate any changes that have occurred. A statistical hypothesis test, such as a paired t-test, Analysis of Variance (ANOVA), or repeated measures ANOVA, should be employed to facilitate drawing conclusions about trends in the vegetation. A paired t-test could be used to test whether the deviation between years, for a particular variable, is significantly different from zero.

In addition to statistical testing, a simple index number will be calculated to show the percentage increase or decrease in the parameters measured. The index number is defined as the ratio of one value to the other, multiplied by 100. When the comparison number equals the base number, the resulting index number will have a value of 100. Apparent trends that are statistically insignificant (i.e., index numbers are not statistically different from a value of 100) will be tested for adequacy of sample size with statistical power analysis methods. Study sites for which a decline in vegetation quality is detected from the qualitative monitoring may require management actions and/or may potentially warrant quantitative sampling to better-define the problem.

Once multiple years of data are collected, a time series analysis will be used to identify significant trends. The major task of a time series analysis is'to describe the nature of the variation of a variable at different points in time so that its future values can be predicted (Kachigan 1986).

3.4.2 Schedule

Habitat value monitoring will occur at approximately five-year intervals. Certain aspects of this monitoring, such as establishing monitoring plots, acquiring digital orthophotography, refining vegetation maps, and establishing sampling sites and permanent point locations, will occur during the first year of the program or the first year that a monitoring location is included in the program. Other aspects of the monitoring program, such as acquiring other photography, photodocumentation, and data collection and analysis, will occur at each monitoring plot during each monitoring period (i.e., at five-year intervals).

3.4.3 Products

The main product of the habitat value monitoring will include a report (with accompanying maps) that indicates the status of the habitat at each monitoring location. The report format will facilitate its use by preserve managers, and will provide a concise summary of proposed actions, their purpose and priority, schedule for implementation, maintenance frequency, labor and materials, and cost estimate for implementing any proposed actions. If habitat monitoring occurs in a year in which a comprehensive report will be prepared, then results of the monitoring and any recommendations will be included in this comprehensive report. If monitoring occurs in an alternate year, a brief status report will be prepared, as outlined in Section 6.0, with complete results and recommendations included in the next comprehensive report.

3.4.4 Cost

Habitat value monitoring costs may vary between monitoring plots depending on the size of the plot and number of points. In addition, some monitoring costs will occur only during the first monitoring period. First year costs are estimated at $117,740 (in 1996 dollars) for the entire MSCP preserve system. Of this total, approximately $62,321 are strictly one-time costs associated with the set-up of the habitat monitoring program. Note, however, that the preserve system will not be dedicated all at once, but will be developed over a period of time. Thus, actual costs will be dependent on the number of these locations that have been dedicated to the MSCP preserve system in any one monitoring period.

A breakdown of monitoring costs is presented in Table 3-2. These costs assume that (1) 29 plots will be monitored; (2) monitoring plots will be approximately 200 acres in size; and (3) a maximum of 40 monitoring points per monitoring plot will be evaluated. It is further assumed that both digital orthophotography and color aerial photographs will be available; neither of these items is included in the costs presented in Table 3-2. Should it become necessary to purchase either orthophotographs or color aerials, the maximum additional cost per initial survey period is estimated to be $7,800 ($2,000 for orthophotographs; $5,800 for color aerials of 29 monitoring locations). An additional, optional cost of about $20,000-$30,000 is estimated for the purchase of a GPS device with an accuracy level of approximately 1 m.

Table 3-2

COST ESTIMATE FOR HABITAT VALUE MONITORING[1]

	First Monitoring Period	Subsequent Monitoring Periods [2]	Subsequent Monitoring Periods [3]
Baseline Data Collection (Per Monitoring Plot)	$514	---	---
Sampling Design Set-up (Per Monitoring Plot)	$1,635	---	—
Field Effort (Per Monitoring Plot)	$1,500	$1,500	$1,500
Data Analysis/Report Preparation (Per Monitoring Plot)	$300	$734	$921
Coordination/Senior Review (Per Monitoring Plot)	$111	$193	$264
Total Costs (Per Monitoring Plot)	$4,060	$2,427	$2,685
Total Costs (Per Survey Year)[1]	$117,740	$70,383	$77,865

1 Assumes 29 monitoring locations; however, actual costs will depend on the number of locations that have been dedicated to the MSCP preserve system in any one monitoring period.

2 Refers to monitoring periods that have a status report requirement (see Section 6.0).

3 Refers to monitoring periods that have a comprehensive report requirement (see Section 6.0).