affected lands under existing conditions were identified using the MSHCP vegetation map, Bioregions map and major highways map. These polygon-based data layers were converted to 100-foot pixel grids. Lands were either classified as Habitat or urban/agricultural. Based on distance between urban/agricultural lands and Habitat, "Edge Effects" were defined as follows: 0-250 feet – strongly affected; 251-600 feet – somewhat affected; >600 feet – relatively unaffected. The application of this tool to analysis of the MSHCP Conservation Area is described in greater detail in *Section A* of the MSHCP Reference Document – *Volume II of the MSHCP Plan.*

3.1.4 Applicable Conservation Biology Principles

General principles of conservation biology are captured by the reserve design tenets described in the NCCP General Process Guidelines and NCCP Act (CDFG 1998). These reserve design tenets provided a framework for the conservation planning process. They can be summarized as follows:

- conserve focus species and their Habitats throughout the Plan Area
- conserve large Habitat blocks
- conserve Habitat diversity
- keep reserves contiguous and connected
- protect reserves from encroachment and invasion by non-native species

The theoretical and empirical underpinnings of the NCCP reserve design tenets can be found in the conservation biology literature, of which key concepts are summarized here.

Although many factors can be incorporated into reserve design and selection, diversity, rarity, naturalness, size and representativeness are the most widely used (Margules *et al.* 1988). Other considerations include island biogeography design principles of MacArthur and Wilson (1963 and 1967): (1) area effect - the larger the preserve, the greater the species richness (*i.e.*, species/area relationship) and the greater the chances of long-term viability of populations (more individuals); (2) isolation or distance effect - the less the distance between reserve units, the greater the opportunity for gene flow, colonization, and rescue effect (*e.g.*, also see Brown and Kodric-Brown 1977); (3) species equilibrium - the number of species that an area can support is determined by a balance between colonization and extinction; and (4) Edge Effect - the larger the ratio of reserve area to reserve perimeter, the lesser the Edge Effect.

An Edge Effect is defined as a change in the "conditions or species composition within an otherwise uniform Habitat as one approaches a boundary with a different Habitat (Ricklefs 1993)." Edge Effects at the boundary between natural lands and human-occupied lands ("urban edge effects") arise due to human-related intrusions such as lighting, noise, invasive species, exotic predators (dogs, cats, and opossums), hunting, trapping, off-road activities, dumping, and other forms of recreation and disturbance. Although some species are in some ways unaffected by edges [*e.g.*, reproductive output of the rufous-crowned sparrow (Morrison and Bolger 2002), distribution of arthropod species (Bolger *et al.* 2000)] or even show preferences for edges (*e.g.*, indigo buntings and northern cardinals in Woodward *et al.* 2001), human-induced edge effects are generally unfavorable to native species.

Another important feature of reserve design is the spatial arrangement of wildlife movement corridors and Habitat Linkages between core Habitat areas. At this point it is useful to contrast movement corridors with Habitat Linkages. Movement corridors are often linear and facilitate efficient movement by providing adequate cover and lack of physical obstacles for movement (Beier and Loe 1992). Movement corridors do not provide Live-In Habitat for species. Linkages, in contrast, are areas providing permanent resident "Live-In" Habitat as well as movement Habitat for a particular species. The Linkage contains resources that meet the life history requirements for the species the Linkage is intended to serve. Known as landscape Linkages, these areas are capable of sustaining a full range of community/ecosystem processes, thus enabling seed dispersal and animal movement over a period of generations (USFWS 1999). Each Habitat connection may be defined as a corridor or a Linkage for each species. Therefore, although areas in the MSHCP designated as Linkages may in fact function only as movement corridors for some species, for simplicity, connections between blocks of Habitat are always referred to generally as Linkages in this document.

Connectedness through landscape Linkages and movement corridors is important because Habitat fragmentation and isolation lead to extinction of local populations and are the most serious threats to biological diversity. Bolger *et al.* (1997) found fewer rodent species in fragments isolated for longer periods of time and by greater distances. Lower arthropod diversity was also observed by Bolger *et al.* (2000) in older and smaller Habitat fragments. The probability of extinction becomes greater as immigration and emigration are impeded by conversion of natural Habitat between occupied or potential Habitat patches to inhospitable land covers. Habitat Linkages, therefore, serve to ameliorate Habitat fragmentation and isolation by permitting the following: (1) the travel, migration and meeting of mates for wide-ranging animals; (2) plant propagation; (3) interchange of genetic material; (4) movement of populations in response to environmental changes and disasters; and (5) colonization of available Habitat by individuals (Beier and Loe 1992).

Empirical evidence exists to support the utility of Linkages and corridors. In a study by Beier (1995), radio-tagged mountain lions never crossed into urban areas; individuals used defined movement corridors for dispersal and for traveling between areas comprising their home ranges. Beier and Noss's (1998) review of thirty-two empirical studies pertaining to the utility of wildlife corridors supported the idea that corridors are "valuable conservation tools." Price *et al.* (1994) also encourage the consideration of connectedness, particularly for endangered species such as the Stephens' kangaroo rat. Habitat connections are particularly important to the persistence of metapopulations which comprise this species' populations.

Using the available data, the five tenets listed at the beginning of this section were incorporated in the conservation planning process. The species list developed early in the planning process, as described in *Section 2.1.4* of this document, along with the species occurrence database and input provided by local biologists and the information assembled for the species accounts (presented in *Section B* of the MSHCP Reference Document – *Volume II of the MSHCP Plan*), provided guidance for the overall species needs that would need to be met within the conserved areas. The MSHCP vegetation map, coastal sage scrub quality model, and edge analysis were combined and used in a variety of ways to identify the presence and locations of existing large Habitat blocks for potential inclusion within conserved areas. These data and analyses also were used to evaluate existing and potential locations for Habitat Linkages. Data were generally analyzed by plotting hard copy maps of data layers and using acetate overlays to assess combined layers. This overlay technique was also conducted digitally using ArcView.

3.1.5 Review of Reserve Selection Models and Methods

In the spring of 1999 DUDEK reviewed several documents and papers from the "gray" and published scientific literature regarding theoretical and applied reserve selection techniques, ranging from relatively subjective ranking approaches (*e.g.,* Duever and Noss 1990; *San Diego Multiple Species Conservation Program [MSCP] and North San Diego County Multiple Habitat Conservation Program [MHCP])* to highly automated reserve selection approaches (*e.g.,* Church *et al.* 1996). Based on this selective review of the literature, it was determined that these reserve selection procedures held little promise for *a priori* reserve design in the MSHCP planning effort for several reasons: (1) the lack of necessary data to run most of the models; (2) the lack of time and resources to collect such data; (3) the lack of time and resources to validate the results of the models; and (4) the scale differences for the MSHCP Plan Area (highly parcelized) compared to typical scales of 1/4 sections (160 acres) and sections (640 acres) used in the scientific models. Nonetheless, it is instructive to review some of the reserve selection approaches described in the