California Native Plant Society
2707 K Street, Suite 1
Sacramento CA, 95816

STATE OF CALIFORNIA
State Energy Resources
Conservation and Development Commission

In the Matter of:)
The Application for Certification)
for the Ivanpah Solar Electric)
Generating System)

DOCKET NO. 07-AFC-5

INTERVENOR CALIFORNIA NATIVE PLANT SOCIETY

Opening Testimony of California Native Plant Society

Docket 07-AFC-5

December 18, 2009

Greg Suba, Tara Hansen, Jim André
California Native Plant Society
2707 K Street, Suite 1
Sacramento, CA 95816
Phone: 916-447-2677 x 206
gsuba@cnps.org
thansen@cnps.org
granites@telis.org

BIOLOGICAL RESOURCES

Introduction

A. Name: Jim Andre, Greg Suba

B. Qualifications: Mr. Andre and Mr. Suba's qualifications are as noted in their attached resumes.

C. Prior Filings
This testimony represents the position of the California Native Plant Society regarding the Application for Certification of the Ivanpah Solar Electric Generating System. In addition to the statements herein, this testimony incorporates by reference the information in the following documents previously submitted in this proceeding:

1. CNPS Mojave Chapter letter of comment re: Ivanpah Solar Electric Generating System Preliminary Staff Assessment, submitted February 6, 2009

2. Applicant's Supplemental Data Set 2I, submitted August 10, 2009

3. CEC Final Staff Assessment for the ISEGS AFC, submitted November 3, 2009

4. CNPS Preliminary Pre-Hearing Conference Statement, submitted November 16, 2009

D. Exhibit List

Doc. no.	Author and title
1000	California Native Plant Society, 1989. Policy on Transplanting.
1001	California Native Plant Society, 1998a. CNPS Statement Opposing Transplantation as a Mitigation to Rare Plants.
1002	California Native Plant Society, 1998b. CNPS Policy on Mitigation Guidelines regarding Impacts to Rare, Threatened, and Endangered Plants.
1003	California Public Resource Code, Section 21083 (2). (p. 22)
1004	Leppig, G. and J.W. White. 2006. Conservation of peripheral plant populations in California. Madrono 53(3): 264-274.
1005	Pavlik, B. 2008. The California Deserts: An Ecological Rediscovery. University California Press: Berkeley, CA, pp. ( )
1006	Saunders, D., R. Hobbs, and C. Margules. 1991. Biological consequences of ecosystem fragmentation: A review. Conservation Biology 5(1):18-32.
1007	Thrall, P.H., J.J. Burdon, and B.R. Murray. 2000. The metapopulation paradigm: a fragmented view of conservation biology. In: Young, A.G. and G.M. Clarke (eds) Genetics, Demography, and Viability of Fragmented Populations. Cambridge University Press: Cambridge, UK, pp. 75-95.
1008	Wohlfahrt, G., L. Fensternmaker, and J. Arnone. 2008. Large annual net ecosystem CO2 uptake of a Mojave Desert ecosystem. Global Change Biology 14: 1475-1487.

Summary
CNPS supports the development of alternative, green energy sources, as long as those programs do not unnecessarily degrade healthy, diverse ecosystems. The proposed ISEGS project will cause significant, avoidable, adverse impacts to native vegetation communities and significant impacts to rare plant populations on the site, and within the surrounding Ivanpah Valley area. These impacts will have permanent (i.e., effects will persist for thousands of years) effects on ecosystem functions that have been evolving within the Ivanpah Valley for millennia. The area within the proposed project footprint will be affected directly, and the areas surrounding the project footprint will be affected indirectly during project construction and operational phases.

This project would be precedent setting as the first of several large proposed utility scale renewable energy projects of similar size (several thousand acres) to be constructed and operated within Ivanpah Valley. Dozens of similar projects are proposed throughout the California Desert Conservation Area. Impacts to biological resources associated with the proposed project, and related mitigation requirements would also be precedent setting for projects of this scale. Several projects, including this one, are being permitted at a "fast-tracked" pace, and outside of a comprehensive regional planning process, such as the SESA PEIS and/or the DRECP process.

The proposed ISEGS project and other proposed projects in the Ivanpah Valley, will cumulatively impact the viability of vegetation communities and rare plant populations. Furthermore, the project will fundamentally alter the functional integrity of the landscape, and reduce the desert landscape's unique ability to sequester atmospheric carbon dioxide (a greenhouse gas) 24-hours per day (Wohlfahrt et al., 2008).

Rare Plants
Significant populations to rare plants will occur on the proposed project site, as described in the project's Final Staff Assessment (FSA) report prepared by California Energy Commission (CEC) staff.

Rare plant surveys lack late summer/early fall-flowering taxa inventory
Approximately 40% of the plant taxa in Ivanpah Valley flower in late summer/early fall. Of these, 20-25 potential special status plants flower in the summer/fall. All of these plants require ideal conditions for growth. Surveys, no matter how thorough, when performed during seasons and in years in which specific growth conditions are absent may fail to record the presence and/or full range extent of rare plants in desert habitats.

The floristic surveys conducted by the applicant during Spring 2008 were performed well, and by well-qualified field personnel. However, floristic surveys for desert rare plants must be performed by qualified botanists over a number of years during both spring and summer/fall flowering seasons in order to maximize the probability of identifying all special status species with the potential to occur on the project site. Without an accurate inventory of plant taxa that occur on site, it is not possible to fully assess project impacts to special status plants and therefore meaningful mitigation cannot be developed.

Furthermore, the Eastern Mojave Desert is a botanical frontier where in the past few years alone, there have been a number of very significant botanical finds and where more are to be expected. Examples just for Ivanpah Valley include, *Amaranthus crassipes* (near Nipton, new to CA), *Oenothera cavernae* (Primm to Clark Mtn, new to CA), *Muilla coronata* (a 70-mile eastern range extension, new to Eastern San Bernardino County), *Leptochloa uninervia* (from near Nipton, new to the Mojave Desert). The *M. coronata* was found just west of the proposed ISEGS project area at the base of Clark Mt. in early spring. By the time surveys of the proposed ISEGS site were conducted in late April and May, *M. coronata* plants were dried and not observable during the spring surveys. This later example illustrates how surveys conducted when growth conditions are adequate (as they were in spring of 2008), may be too narrow in their window of timing to detect important rare plant occurrences.

The FSA report's Special-Status Plant Impact Avoidance and Minimization measure (BIO 18) requires the applicant to conduct pre-construction surveys for both spring and summer/fall blooming taxa but only within the specified project areas. Vegetative structures of some of the spring flowering rare plants occur in localities other than those mapped the previous year. Since the purpose of pre-construction surveys is to quantify each taxon's occurrence on site, pre-construction surveys should be conducted on all project lands that are undeveloped at the time surveys are performed in order to obtain a full accounting of plant occurrences (e.g., *Asclepias nyctaginifolia* spreads underground and sends vegetative clones above ground in different locations year after year; *Enneapogon desvauxii* is an annual grass and so its distribution is ephemeral year to year). Since summer/fall surveys have yet to be performed at the project site, there is no baseline information on the presence and extent of these taxa. Therefore, summer/fall surveys need to be conducted throughout the entire site before any construction begins in order to obtain a full account of special status species on site.

Below is an initial list of potential special status plants that flower in late summer/early fall in Ivanpah Valley. This list was compiled from California Natural Diversity Database (CNDDB) records, herbarium records, and from recommendations from experts in the field:

Amaranthus watsonii
Bouteloua eriopoda
Bouteloua trifida
Chamaesyce revoluta
Cordylanthus parviflorus
Euphorbia exstipulata var. exstipulata
Juncus nodosus
Muhlenbergia appressa
Muhlenbergia arsenei
Muhlenbergia fragilis
Muhlenbergia pauciflora
Munroa squarrosa
Physalis lobata
Piptatherum micranthum
Sanvitalia abertii
Schkuhria multiflora var. multiflora
Scleropogon brevifolius
Tragia ramosa

Project impacts to rare plants
The project will deploy heliostats, power towers, associated building structures, pipelines, and roads across approximately 4,000 acres of ecologically intact desert habitat, where naturally functioning ecological processes predominate over recent man-made intrusions. The completed project footprint will fragment 4,000 acres of diverse and intact desert plant communities. This includes rendering large rare plant populations, into fragments of various sizes. The biological affects of ecosystem fragmentation are well documented (Saunders et al., 1991). In general, the fragmentation of rare plant habitat on the project site will lead to two fundamental changes across the landscape; 1) an increasing isolation of remnant populations, and 2) a decrease in the total amount of available habitat for remnant populations. These two phenomena will be repeated throughout Ivanpah Valley, and where rare plants occur within the footprints of proposed neighboring energy projects, and the hundreds of thousands of acres of the Greater Mojave Desert ecosystem in California, Arizona, and Nevada where hundreds of utility-scale wind and solar project applications are being proposed.

To manage for viable rare plant populations on the project site, it will be necessary to identify project-related threats to those populations. Threats include, but are not limited to, altered light regimes due to shading by heliostats, altered hydrological conditions due to intercepted and redirected rainfall patterns and mirror washing, soil compaction during construction and

operational phases of the project, altered soil nutrient conditions due to modified nutrient uptake by regularly mowed vegetation, and the introduction and spread of invasive weeds. With so many threats it is difficult to understand how they ultimately affect the viability of specific plant populations or metapopulations, how the threats themselves may interact, and how to come up with effective methods to alleviate them.

For example, habitat fragmentation caused by development of the proposed ISEGS project, and other subsequent energy projects in Ivanpah Valley, will impact numerous rare plant populations, but the severity and extent of these impact is not well known. It is safe to assume that larger populations that are broken into smaller populations will suffer from a restricted exchange of pollen or seed, and this has important genetic and demographic consequences. Additionally, habitat fragmentation results in the increase of edge effects and the deterioration of habitat quality. It may alter plant-pathogen and plant-herbivore dynamics. Due to lack of time, funding or available expertise, the full range of demographic vs. genetic stochasticity parameters are rarely integrated into population viability analyses. Until such detailed analyses become available, managers must work with scientists to maintain natural ecological processes and provide the best natural conditions for populations and metapopulations to persist. A central principle of ecosystem management is to delineate the primary threats to each species and their habitats and to minimize or eliminate these threats to the greatest possible extent.

In general, threats come in three types 1) threats imposed by changes in the environment, either by natural or human causes, 2) threats resulting from disturbance of important interactions with other species, and 3) genetic threats. Current environmental threats to the proposed ISEGS site and surrounding lands are considerable. These include climate change (e.g., altered precipitation and fire regimes), habitat fragmentation (e.g., roads, heliostat fields, structures), direct disturbance (e.g., mowing, hydrological alterations, deposition of atmospheric nitrogen) and exploitation (e.g., cactus collecting). Disturbance of biotic interactions might include destruction of key pollinator guilds, altered pathogen and herbivore interactions, and hybridization with introduced natives (e.g., CalTrans revegetation programs). An important principle that must be considered is that we lack a basic knowledge of the biological and ecological requirements required to appropriately manage many rare species. In order to prioritize management of rare plants related to any proposed project, we must understand their distributions, life-history attributes, and identify any threats to their viability. Finally, management for conservation of rare plants should always take place in the context of the key processes of their ecosystem (e.g., practices developed in the Nebraska prairies may not be appropriate in the California Deserts).

Cumulative Impacts

The cumulative impacts of the proposed ISEGS project combined with other proposed energy projects in Ivanpah Valley represent a scale of impact on functional habitat that is unprecedented in its range and pace. Cumulative impacts identified in the California Energy Commission (CEC) Final Staff Assessment (FSA) for the proposed project will have cumulatively considerable adverse effects to the Ivanpah Valley ecosystem. "Cumulatively considerable" means that the incremental effects of an individual project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects. *(CA PRC Sec. 21083 (2))*. The FSA concludes that the cumulative effects of these proposed actions to the biological resources in the Ivanpah Valley will have significant, unmitigable impacts to rare plants, but falls short of requiring meaningful mitigation to address these cumulative impacts.

Vegetation surveys to determine potential desert tortoise relocation and translocation habitat quality are insufficient

Plant Surveys were performed in July/August 2009 to determine whether habitat quality of proposed desert tortoise translocation areas were of equal or greater quality than the habitat quality at the project site. This comparison used measures of perennial shrubs and succulent species abundance, richness, and diversity as surrogate indicators of desert tortoise habitat quality. The survey rationale, design, methods, and analysis contain flaws that call into question

the validity of conclusions presented in the report, Vegetation Surveys for Potential Relocation and Translocation Areas (in Applicant's Supplemental Data Response, Set 2I, August 10, 2009).

An accurate assessment of desert tortoise habitat quality must take into account the quantity and quality of food sources available. Highest quality food for desert tortoise are native annual plants, whose protein and water content provide the optimum opportunity to rehydrate and flush salts concentrated during hibernation from their bladders, and to accumulate the energy necessary to mate successfully (Pavlik 2008). The surveys were conducted in the middle of summer when few annuals are present.

The report does not provide a rationale for the number of sampling sites chosen, or whether the sites were chosen at random. No statistical test was performed to compare similarities/differences between project and proposed translocation sites, so conclusions cannot be confirmed to any level of significance.

Rare Plant Avoidance and Minimization Measures (BIO 18) do not provide mitigation for rare plant losses

The FSA report directs the applicant to implement several measures under "BIO 18" that are generally in agreement with CNPS policies and guidelines on rare plant mitigation requirements (CNPS 1989, CNPS 1998a, CNPS 1998b). Additionally, BIO 18 measures would provide important information on the population dynamics and population viability of the project's five reported special status plant taxa. This data could assist in the future management of these taxa both on the proposed ISEGS project and on other projects where they might occur.

However, the FSA report's rare plant avoidance and minimization measures fail to provide real and meaningful mitigation for the significant impacts to rare plant populations that will occur on site as a direct result of the project. For real mitigation to occur, (e.g., mitigation that addresses the impacts to rare plant populations) at a minimum the applicant must be required to conduct off-site surveys to identify lands with additional occurrences of the special status plants that are to be destroyed by the project, and place the lands where identified plants occur under conservation easement before being allowed to commence construction.

During a FSA Workshop on December 15, 2009 there was some discussion of intentionally managing the "quasi-natural" vegetation under heliostat fields as rare plant refugia. This discussion is still on-going between CEC staff and the applicant at the time of submission of this testimony. CNPS reserves the right as an intervenor party to place comments into the administrative records regarding any future project changes relating to these on-going discussions.

Efforts to manage heliostat fields as areas for rare plant protection would be experimental in nature, meaning there is no current data that assures, or provides sufficient confidence, for success. Therefore, any management plan to this effect would need to be designed in such a way as to produce results that would better inform future decisions - whether the results are positive or negative; and it would need to have benchmarks for success and for remedial action to buffer against losses that could lead to extirpation or extinction of a species. In terms of rare plant conservation under solar mirrors, there is no foundation of success to point to, but many instances of species failing in response to ecosystem fragmentation, especially when management decisions focus on preserving a population's spatial distribution patterns at the expense of hindering a population's biological processes (Thrall et al., 2000). If the proposed project is built, the opportunity for rare plant conservation, ironically, will be in the knowledge we gain by documenting the loss of populations. A meaningful mitigation measure would be for additional surveys to be required on private lands to identify additional off-site populations and place them under conservation easements before project construction is allowed to commence.

Every attempt can be made to protect known rare plants onsite, but the reality is that the proposed ISEGS project will, in fact, destroy the function and integrity of the ecosystem on the

site. This is a precedent-setting project, and CNPS realizes that rare plant mitigation details must be discussed. However, when one views such proposals with even a general understanding of rare plant conservation biology theory and academic research on threats to rarity, the proposed mitigation scenarios can only be seen as implausible and inadequate. Rather than trying to navigate through claims of avoiding impacts *in situ*, we must realize that if this project goes in, there will incur a take that is not avoidable, and that the attention of all parties involved must shift to the development of real and meaningful alternatives.

CURRICULUM VITAE

JAMES M. ANDRE **PO Box 101, Kelso CA 92351**
Research Center Director/Plant Ecologist **Home: (619) 733-9927 Office: (619) 733-4222**
UC Riverside - Sweeney Granite Mountains Desert Research Center **Email: granites@telis.org**

EDUCATION

M.A. Botany, 1989, Humboldt State University, Arcata, CA.
Thesis: *Population Biology and Conservation of Abronia alpina in the Southern Sierra Nevada, Inyo County*.
B.A. Plant Ecology/Geography of Ecosystems, 1982, University of California, Los Angeles

RESEARCH INTERESTS

Rare plant conservation biology and recovery, vascular plant floristics (western U.S.), demographics of long-lived desert shrubs, alpine ecology, vegetation analysis and classification, species distribution ecology, invasive plants, vegetation dynamics of coastal and interior dunes, and impacts and restoration ecology (particularly in systems impacted by livestock grazing).

PROFESSIONAL EXPERIENCE

1993-present	Director, University of California's Sweeney Granite Mountains Desert Research Center
2008-present	Chair, California Native Plant Society Rare Plant Program
1995-present	Curator, GMDRC Herbarium
1997-present	Adjunct professor, Lecturer, University of California Riverside
1985-present	Independent Consultant. Clients include Southern Nevada Water Authority, Native American Land Conservancy, Southern California Edison; Bureau of Land Management; Dept. of Defense; Los Angeles Dept. of Water and Power; US Forest Service, USFWS, BLM, National Park Service; The Nature Conservancy; Counties of San Diego, Inyo, Humboldt and Stanislaus; FAA, California Native Plant Society, East Bay Municipal Water District.
1989-1993	Senior Plant Ecologist, BioSystems Analysis, Inc, Tiburon, CA.
1987-1989	Research Associate - Plant Ecologist, Humboldt State University
1983-1989	Forest Botanist, U.S. Forest Service, Inyo National Forest
1986-1987	Teaching Assistant, Humboldt State University
1982-1983	Research Assistant, San Diego State Univ. (vernal pools studies)
1981-1982	Preserve Manager, Ewing Oak Preserve, The Nature Conservancy, San Diego Co.
1979-1980	Botanist/Ornithologist, National Park Service, Santa Monica Mountains National Recreation Area.

BOTANICAL RESEARCH AND INVENTORY

- awarded more than 25 academic research grants (ex. National Science Foundation, Smithsonian) and 40 government agency research contracts, managing grant budgets ranging from $500 to $8,100,000.

- oversee and facilitate 165 current multi-disciplinary research projects affiliated with the UC Granite Mountains Desert Research Center.

- principal investigator on more than 100 academic research projects in the California and Nevada deserts since 1994.

- lead author on numerous published regional floras and annotated vascular plant checklists, including floras for the Owens Valley, Mojave National Preserve, Big Pine Canyon, Dead Mountains, Old Woman Mountains, Ash Meadows Natl. Wildlife Refuge, and Schell Creek Range.

- conducted over 400 floristic inventories in the desert southwest since 1979 (full list available upon request, some examples included below).

- principal investigator conducting comprehensive studies in population ecology, demographics and threats analysis to evaluate conservation status for more than 100 California rare plants (full list available upon request). Examples include *Abronia alpina*, *Erysimum menziesii*, *Pogogyne abramsii*, *Eriogonum thornei, Penstemon albomarginatus, Plagiobothrys parishii*and *Eriophyllum mohavense*.

- directed (ongoing) the Flora of the Mojave National Preserve Project, a floristic study of the 1,700,000 acre Mojave National Preserve and surrounding 500,000 acres. Included 7000 hours of field surveys, published annotated checklist of plants, compiled database of records submitted to NPSpecies national database; illustrated technical flora (book) is pending.

- conducted numerous large-scale floristic inventories including the 2 million-acre Golden Trout Wilderness, 800,000 acre Joshua Tree National Park (NPS), 900,000 acre Owens Valley survey, and 500,000 acre 20 Palms Marine Corps Base (DOD).

- principal investigator on 3 year project develop rare plant status reviews for 8 federally-listed species at Ash Meadows National Wildlife Refuge, Nye Co. Nevada.

- project manager of the DOD Legacy Program coastal dunes ecological study which included population studies and habitat analyses of four rare plant species on the coastal dunes and bluffs at USMC Camp Pendleton, CA.

- conducted rare plant surveys for 845-mile PG&E-PGT Pipeline from Alberta to Fresno, the 275-mile Tuscarora Pipeline Project from Reno to Malin, Oregon and the 384-mile Mojave Pipeline Project from Needles to Bakersfield. For the later project, developed and implemented rare plant and vegetation restoration, long-term monitoring, and evaluated 10-year post-construction success of restoration measures.

- 15 yrs experience as Curator of the University of California- Granite Mountains Herbarium.

- conducted inventory and mapping of more than 100 seeps and springs (40,000 acres) as part of the Lower Owens River Project, Inyo County, CA. Developed demographic monitoring and impact studies on Inyo County star-tulip (*Calochortus excavatus)* and Owens Valley checkerbloom (*Sidalcea covillei*).

- principal investigator of a 90,000 acre floristic inventory and vegetation analysis of the Old Woman Mountains Preserve, eastern San Bernardino County for the Native American Land Conservancy.

- conducted detailed impacts surveys and population analyses for several federal-listed species in Cushenberry Cyn, San Bernardino Co., including Parish's daisy (*Erigeron parishii*), Cushenberry buckwheat (*Eriogonum ovalifolium vineum*), and Cushenberry milkvetch (*Astragalus albens*).

- conducted complete floristic inventories and rare plant surveys along approximately 110 miles of pipeline corridors in the Virgin River area of eastern Clark County, Nevada (Southern Nevada Water Authority).

- principal investigator for botanical surveys for more than 400-miles of proposed water pipeline corridors in White Pine, Lincoln and Clark Counties of Nevada (Southern Nevada Water Authority).

- consulted for numerous interdisciplinary projects on the design and implementation of optimal field sampling protocol, including riparian vegetation/habitat monitoring on the upper Sacramento River as part of a study of the impacts of the Cantara Bridge chemical spill. Provided expert testimony in federal court on research findings.

- conducted more than 30 quantitative vegetation classifications employing ARCGIS, TWINSPAN, DECORANA, and PCA other multivariate software programs. Examples include:
  - riparian vegetation analysis of tributary streams (Bishop and Mill Creeks) of the Owens River employing multi-stage sampling protocols and vegetation monitoring (using a laser theodolite) to determine the effect of changes in stream flow on riparian systems (SCE);
  - characterization and mapping of vegetation at Tonto Creek, AZ for long-term monitoring of change (BOR);
  - characterization and mapping of riparian and meadow vegetation on the Kern Plateau for purpose of monitoring grazing and erosion impacts (USFS);
  - multi-stage classification and monitoring of riparian forest and woodlands along Sacramento and Stanislaus Rivers to monitor affects of alteration of flow regimes upstream (EBMUD);
  - Twinspan and PCA classification of vegetation along Eel and Mad Rivers of Humboldt Co. (USFS);
  - classification and mapping of vegetation series and associations of vernal pools and swales in central Sacramento Valley, CA.;
  - long-term monitoring and classification of vegetation on desert riparian thicket and tamarisk-invaded streams and seeps in the Mojave Desert.

- designed a vegetation classification scheme and reviewed field protocols and data collections for the Mojave Desert Mapping Project (CDFG and DOD, 1998-1999).

- documented vascular plant composition for vernal pools in seven counties in the Sacramento Valley using relevé sampling; assessed temporal changes in species composition and hydrology in the Kearny Mesa vernals pools of San Diego County; developed conservation management for more 8 rare plant taxa, addressing recovery, enhancement, and long-term viability of the species.

NATURAL AREAS MANAGEMENT

- 20 years of experience as a leader in coordinating academia research and regional natural areas management among scientists and agency managers in the Eastern Mojave Desert.

- served as Principal on Inventory and Monitoring Committee to develop protocols for the National Park Service I & M Program - Desert Southwest Region. Provided data and participated in the writing of the National Park Service's Mojave Inventory and Monitoring Network Biological Inventory Study Plan (2001).

- coordinated the writing of a Cooperative Management Agreement between the University of California and the National Park Service for joint management of lands within the Mojave National Preserve.

- served on numerous academic and land management committees including the Desert Advisory Committee (congressional appointment) Science Data Management Interagency Working Group for the Desert Managers Group, Center For Conservation Biology at UC Riverside, Research Advisory Committee - Mojave National Preserve, and the Advisory Council to the California Wild Heritage Campaign, and California Native Plant Society Rare Plant Committee (Chair).

- developed a comprehensive Coastal Dunes Vegetation Management Plan for the 13-mile coastal beach and dune system at Camp Pendleton, California. Study included the development of vegetation monitoring plan, GIS ARC/INFO quantitative habitat mapping, Least Tern and Snowy Plover habitat enhancement, and implementation of rare a plant and dunes recovery and enhancement program (exotic species removal and establishment of native vegetation).

- designed and implemented long-term monitoring for 12 rare plant species in Inyo and eastern San Bernardino Counties to assess the effects of grazing impacts on population dynamics.

- conducted long-term monitoring of special-status plants and vegetation recovery following disturbance in numerous study sites throughout the East Mojave in collaboration with the California and Nevada Native Plant Societies.

- coordinated numerous exotic species control/removal programs including a 7 year study of tamarisk removal along 16 streams in the east Mojave Desert using repeated physical removal and systemic injection of Garlon.

- drafted a Resource Management Plan with the National Park Service for joint management of the federal lands within the Sweeney Granite Mtns Desert Research Center, including removal of exotic burros and plants, erosion control and habitat restoration and enhancement (ongoing).

- developed long-term vegetation and habitat management plans for the Native American Land Conservancy's Old Woman Mountains Preserve.

- developed an illustrated technical manual detailing techniques for high elevation meadow restoration on the Inyo National Forest.

- drafted vegetation management sections of the Inyo National Forest Plan at USDA Forest Service; prepared seven sensitive plant Species Management Guides;

- supervised 10-15-person backcountry crews to evaluate the success of restoration and revegetation of montane meadows in the southern Sierra Nevada degraded by livestock grazing.

- developed a long-term vegetation management plan for Inyo National Forest and coordinated sensitive plant inventory and monitoring.

- conducted a 3-year programmatic botanical assessment for East Bay Municipal Water District's Water Supply Management Program and EIR/EIS, including impact assessment of for 52 proposed reservoir sites and 14 aqueduct corridors in the Central Valley and western Sierra Nevada foothills.

- prepared a comprehensive Hardwoods Management Plan for County of Contra Costa, California.

TEACHING, PRESENTATIONS, CONFERENCE ORGANIZATION

- session chair for more than 20 major workshops and conferences, including the 2009 CNPS Conservation Conference, 2009 Desert Research Symposium, 2004 and 1999 Mojave Desert Science Symposiums.

- co-architect and lead organizer of the Desert Research Symposium and Mojave Desert Science Symposium series.

- developed curricula and taught over 30 university-level field courses or workshops in botany and plant ecology and desert ecology at the Granite Mountains Desert Research Center; taught 9 accredited college courses (including: Humboldt State Univ., UCLA, UC Berkeley, San Diego St. University) in plant ecology and vegetation sampling theory.

- instructor for more than 15 plant taxonomy field courses for the Jepson Herbarium Workshops, Joshua Tree Foundation, and Rancho Santa Ana Botanical Garden; taught numerous field courses in natural history for the Sierra Institute, California Native Plant Society, and Victor Valley College.

- presented over 150 lectures/presentations at university departmental seminars, agency workshops, and scientific conferences, including the opening speaker at the 2009 Southern California Botanists Symposium.

- published a fully-illustrated Ethnobotanical Guide to the Plants of the Old Woman Mountains, an educational guide book along with other educational materials for the Native American Land Conservancy's Old Woman Mountains Preserve.

- developed public education programs which included docent-led field trips and slide presentations for the Ewing Oak, Lanphere-Christensen Dunes Preserves, and Old Woman Mountains Preserves.

SCIENTIFIC REVIEW AND ACADEMIC COMMITTEES

- reviewed numerous academic books including the forthcoming *The Jepson Manual, Higher Plants of California 2nd Ed* and sections of the *Flora of North America*.

- peer-reviewed more than 30 refereed journal submissions and technical papers for Journal of Arid Environments, J. of Ecology, Ecol. Monographs, J. of Conservation Biology, Crosossoma, Madrono, Novon, Fremontia, and USGS, USDA Forest Service and USDI Park Service publications.

- served three years on UC Natural Reserve System's Mildred E. Mathias grant selection committee to evaluate proposals and award University of California graduate research grants to student researchers.

- initiated the establishment of graduate student research grants, including the California Desert Research Fund (Riverside Community Foundation) and Joshua Tree National Park Graduate Student Research Grant; served on selection committee for both grants over the past decade.

- reviewed or prepared technical sections for EIRs/EISs, Biological and Environmental Assessments, FERC Exhibit E's, agency mitigation plans, and numerous endangered species and resource management plans.

- NRS representative (2 year appointment), UC Office of the President Universitywide Advisory Committee

- drafted or reviewed more than 20 federal and state and federal listing petitions (for CDFG, USFWS and CNPS) for listing of rare California and Nevada plant species.

PUBLICATIONS AND TECHNICAL REPORTS

Andre, J. 2009. A profile of rarity and rare plant conservation in the California Deserts. Submitted to Proceedings of the CNPS Conservation Conference, Sacramento, CA.

Andre, J. 2008. "California's Desert Flora: Will we know what we lost?" Desert Report, December Issue

Andre, J. 2007. Gateways to California's regional landscapes: The expanding role of the Sweeney Granite Mountains Desert Research Center in the eastern Mojave Desert. Proceedings from the 40th Anniversary of the UC Natural Reserve System.

Andre, J. and F.J. Smith. A revised checklist of vascular plants in Ash Meadows National Wildlife Refuge. Technical Report, Dept. of Interior USFWS.

Andre, J. 2007. Effects of Hackberry Fire on 10 special-status species in the Mojave National Preserve. Dept. of Interior, National Park Service. Technical Report ESR 8.3.6.

Andre, J. 2007. Enriched woody and succulent shrub associations in the Eastern Mojave Desert. Report to the USGS-NPS Vegetation Mapping Program.

Andre, J. 2006. A vascular flora of the Granite Mountains, San Bernardino County, CA. Crossosoma, vol 32.

Andre, J. 2006. Inventory of Vascular Plants at Mojave National Preserve & Manzanar Historic Site. 2006. Dept. of Interior, Technical Report P2128020178

Clifton, G.L. and J. Andre. 2006. Checklist of vascular plants at Great Basin National Park. Technical Report: Dept of Inteior, National Park Service.

Andre, J. 2005. An Ethnobotanical Guide to the Plants of the Old Woman Mountains Preserve. Chemeheuvi Press.

Andre. J. and E. McDonald. 2004. Ecosystem Monitoring: Linking Ecosystem Attributes to Ecological Processes; Summary and Discussion. In proceedings to the 2nd Mojave Desert Science Symposium, Univ.of Redlands, CA.

Andre, J. 2003. Desert Succulent Shrub: A guide to Wildlife Habitats of California, 2nd Ed. California Dept. of Fish and Game.

Andre, J. and J. Goerrissen. 2005. Proceedings from the 25th Anniversary Symposium of the UC Granite Mountains Desert Research Center. UCR Press.

Andre, J. 2002. An annotated checklist of vascular plants of the Owens Valley, California. Technical Report: County of Inyo.

Andre, J. 1999. Key botanical characteristics associated with biological response to disturbance. Technical Report: California Dept. of Fish and Game.

Andre, J. and B. Pitzer. 1999. Biology and Status of Barstow Woolly-sunflower (*Eriophyllum mohavense*). Technical Report: Dept. of Interior, Bureau of Land Management.

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PROFESSIONAL AFFILIATIONS

American Institute of Biological Sciences (AIBS)
Botanical Society of America (BSA)
Society for Ecological Restoration (SER)
Natural Areas Association (NAA)
Society for Conservation Biology (SCB)
Ecological Society of America (ESA)
California Native Plant Society (Mojave and Bristlecone Chapters)
Nevada Native Plant Society (Las Vegas Chapter)
Southern California Botanists Association
Desert Legume Program, University of Arizona
California Exotic Pest Plant Council
Union of Concerned Scientists

GREG SUBA

2707 K Street, Suite 1
Sacramento, CA 95816

916 447 2677 x-206 office
gsuba@cnps.org

PROFILE

I am a conservation advocate with over 20 years of professional experience as a research scientist and field biologist in marine littoral, forest, and riparian environments. I am dedicated to raising the ecological literacy of communities through education and stewardship.

EXPERIENCE

CONSERVATION PROGRAM DIRECTOR, CALIFORNIA NATIVE PLANT SOCIETY - 2009

Develop and implement conservation program strategy and projects for the California Native Plant Society state office.

COORDINATOR, LAGUNA CREEK WATERSHED COUNCIL; SACRAMENTO COUNTY, CA — 2002-PRESENT

Represent the watershed council and promote the vision of adopting a watershed approach to natural resource management at meetings with residents, landowners, planners, engineers, councilmembers, boardmembers, various stakeholder agency staff, and at public outreach / education events. Summarize and translate findings of technical and cultural surveys into watershed management action recommendations; coordinate and conduct meetings, implement strategic goals, write letters of comment, prepare and deliver presentations, and perform multiple forms of public outreach on behalf of watershed council; develop and maintain watershed education program; develop and maintain citizen stewardship program; participate in upper watershed master planning process (with emphasis on water resource and hydromodification management planning); assist with biological and hydro-geomorphic field surveys; manage the transition of watershed council to 501c3 non-profit, public benefit corporation; develop and maintain watershed council's website (www.lagunacreek.org); provide GIS database management for watershed council; assist with report and grant writing.

PROGRAM MANAGER, SACRAMENTO SPLASH; SACRAMENTO COUNTY, CA — 2000-PRESENT

Responsible for development, outreach, and implementation of Splash High School Program curriculum. Work directly with Splash Program director and sponsoring agency staff to review and revise lessons and activities focused on stormwater, wastewater, and watershed ecology. Recruit, train, and assist participating high school teachers throughout Sacramento County.

PROJECT MANAGER, AMERICAN RIVER CONSERVANCY; COLOMA, CA — 2000-2004

Designed monitoring plan to establish baseline conditions in Sierra Foothill tributary streams to the South Fork American River; secured grant funding; performed macroinvertebrate bioassessment collection and analysis; presented results to stakeholder groups and Boards; trained and coordinated citizen stream monitoring program; wrote reports and grant proposals.

FORESTRY SURVEYOR, EAST-WEST FORESTRY; CALIFORNIA (MANY LOCATIONS) — 1994-2000

Surveyed integrated forest / wilderness area plots throughout the Inyo, Cleveland, San Bernardino, Angeles, Los Padres, Sierra, El Dorado, Tahoe Basin, and Stanislaus National Forests, CA, for the USFS Forest Inventory Analysis (FIA) project. Catalogued data on trees, shrubs, forbs, grasses, fuel loads, and CALVEG types; led and trained field crews.

RESEARCH ASSOCIATE, HOPKINS MARINE STATION OF STANFORD UNIVERSITY; PACIFIC GROVE, CA — 1990-1994

Investigated reproductive strategies of seagrass (*Zostera marina)* populations from the west coast of North America; implications for restoration and management of estuarine seagrass beds.

GRADUATE / RESEARCH ASSISTANT, UNC-CH INSTITUTE OF MARINE SCIENCES; MOREHEAD CITY, NC — 1987-1990

Investigated microscale changes of light and water chemistry within microbial mat communities in intertidal sediments using chemical microelectrodes and fiber-optic light probes. Investigated the role of nitrogen-fixing bacteria in the nitrogen cycle of estuarine and coastal waters of North Carolina.

EDUCATION

M.S., Marine Sciences, University of North Carolina-Chapel Hill, Chapel Hill, NC, 1991

B.S., Biology, (also fulfilled requirements for B.A. in Music), Duke University, Durham NC, 1986

PUBLICATIONS

2009. Laguna Creek Watershed Management Plan. Laguna Creek Watershed Council's final report to California Department of Water Resources CALFED Bay-Delta Program, June 2009.

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BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
1516 NINTH STREET, SACRAMENTO, CA 95814
1-800-822-6228 – WWW.ENERGY.CA.GOV

APPLICATION FOR CERTIFICATION
FOR THE *IVANPAH SOLAR ELECTRIC GENERATING SYSTEM*

DOCKET NO. 07-AFC-5
PROOF OF SERVICE
(Revised 11/23/09)

APPLICANT
Solar Partners, LLC
John Woolard,
Chief Executive Officer
1999 Harrison Street, Suite #500
Oakland, CA 94612

Todd A. Stewart, Project Manager
Ivanpah SEGS
sdeyoung@brightsourceenergy.com
E-mail Preferred

Steve De Young, Project Manager
Ivanpah SEGS.
1999 Harrison Street, Ste. 2150
Oakland, CA 94612
tstewart@brightsourceenergy.com

APPLICANT'S CONSULTANTS
John L. Carrier, J. D.
2485 Natomas Park Dr. #600
Sacramento, CA 95833-2937
jcarrier@ch2m.com

COUNSEL FOR APPLICANT

Jeffery D. Harris
Ellison, Schneider
& Harris L.L.P.
2600 Capitol Avenue, Ste. 400
Sacramento, CA 95816-5905
jdh@eslawfirm.com

INTERESTED AGENCIES
California ISO
e-recipient@caiso.com

Tom Hurshman,
Project Manager
Bureau of Land Management
2465 South Townsend Ave.
Montrose, CO 81401
UUtom_hurshman@blm.gov

Raymond C. Lee, Field Manager
Bureau of Land Management
1303 South U.S. Highway 95
Needles, CA 92363
Raymond_Lee@ca.blm.gov

Becky Jones
California Department of
Fish & Game
36431 41st Street East
Palmdale, CA 93552
dfgpalm@adelphia.netUU

INTERVENORS

California Unions for Reliable Energy ("CURE")
Tanya A. Gulesserian
Marc D. Joseph
Adams Broadwell Joseph & Cardozo
601 Gateway Boulevard, Ste 1000
South San Francisco, CA 94080
tgulesserian@adamsbroadwell.com

Western Watersheds Project
Michael J. Connor, Ph.D.
P.O. Box 2364
Reseda, CA 91337-2364
mjconnor@westernwatersheds.org

Gloria Smith, Joanne Spalding
Sidney Silliman, Devorah Ancel
Sierra Club
85 Second Street, 2nd Fl.
San Francisco, CA 94105
E-mail Service Preferred
gloria.smith@sierraclub.org
joanne.spalding@sierraclub.org
gssilliman@csupomona.edu
devorah.ancel@sierraclub.org

*indicates change

INTERVENORS CONT.
Joshua Basofin, CA Rep.
Defenders of Wildlife
1303 J Street, Ste. 270
Sacramento, CA 95814
E-mail Service Preferred
HHjbasofin@defenders.orgHH

Basin and Range Watch
Laura Cunningham
Kevin Emmerich
P.O. Box 70
Beatty, NV 89003
atomictoadranch@netzero.net

Center for Biological Diversity
Lisa T. Belenky, Sr. Attorney
Ileene Anderson, Public Lands Desert Director
351 California Street, Ste. 600
San Francisco, CA 94104
E-mail Service Preferred
lbelenky@biologicaldiversity.org
ianderson@biologicaldiversity.org

California Native Plant Society
Greg Suba, Tara Hansen & Jim Andre
2707 K Street, Suite 1
Sacramento, California, 95816-5113
E-mail Service Preferred
gsuba@cnps.org
thansen@cnps.org
granites@telis.org

***County of San Bernardino**
385 N. Arrowhead Avenue, 4th Fl.
San Bernardino, California, 92415
bbrizzee@cc.sbcounty.gov

Bart W. Brizzee, Deputy Co. Counsel
ENERGY COMMISSION
JEFFREY D. BYRON
Commissioner and Presiding Member
jbyron@energy.state.ca.us

JAMES D. BOYD
Vice Chairman and
Associate Member
HHjboyd@energy.state.ca.usHH

Paul Kramer
Hearing Officer
.pkramer@energy.state.ca.us

John Kessler
Project Manager
.jkessler@energy.state.ca.us

Dick Ratliff
Staff Counsel
.dratliff@energy.state.ca.us

Public Adviser
publicadviser@energy.state.ca.us

*Indicates change

DECLARATION OF SERVICE

I, Greg Suba, declare that on 12/18, 2009, I served and filed copies of the attached, CNPS Opening Testimony dated, December 18, 2009. The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at: **[www.energy.ca.gov/sitingcases/ivanpah]**.

The documents have been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

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1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
docket@energy.state.ca.us

I declare under penalty of perjury that the foregoing is true and correct.

Gregory K. Suba

*indicates change

5

The metapopulation paradigm: a fragmented view of conservation biology

PETER H. THRALL, JEREMY J. BURDON & BRAD R. MURRAY

ABSTRACT

In the past, single-population approaches have dominated ecology and evolutionary biology. However, populations are not isolated either in time or space, but are connected by among-population processes such as migration and gene flow. While this concept is not new, until recently, there have been relatively few studies that have explicitly investigated the effects of spatial structure on demographic and genetic processes in the context of conservation. The metapopulation framework explicitly recognises and provides a conceptual tool for dealing with the interactions of within- (e.g. birth, death, competition) and among-population processes (e.g. dispersal, gene flow, colonisation and extinction). The ever-growing diversity of empirical and theoretical studies that demonstrate the importance of spatial structure in determining ecological and evolutionary trajectories also indicates that long-term conservation programmes need to focus on regional rather than local within-population persistence. In this regard, it is important to realise that ultimately all populations are ephemeral, and therefore colonisation processes must also be preserved. Clearly, not all species whose populations have undergone fragmentation fit the definition of a metapopulation. Nevertheless, a metapopulation approach to conservation biology is likely to provide a useful tool for developing management strategies as it addresses genetic, species and community effects of fragmentation in a single framework, thereby making explicit questions regarding extinction, population connectedness, species behavioural patterns and the survival of coevolved systems. In essence, a metapopulation perspective ensures a process-oriented, scale-appropriate approach to conservation that focuses attention on among-population processes critical for persistence of many natural systems.

THE METAPOPULATION PARADIGM: AN INTRODUCTION

Traditionally, ecological studies of natural systems have been dominated by a focus on single populations, or several populations sampled at a single point in time. Reflecting this, much of the theory associated with population dynamics, genetics and interspecific interactions (e.g. competition, predation) has been framed in the context of single-population deterministic models, in part because of the usefulness of tractable mathematical formulations for stability analysis. However, notwithstanding their narrow focus, these single-population approaches have been invaluable in disentangling interactions between various within-population demographic and genetic processes, and their impact on ecological and evolutionary dynamics.

Despite the practical emphasis on single populations, ecologists and evolutionary biologists have long been intrigued with understanding the processes that lead to patterns of abundance and distribution at a range of spatial scales (e.g. Andrewartha & Birch, 1954), beginning with the early work of Wallace, and including the development of the influential theory of island biogeography (MacArthur & Wilson, 1967; see Quammen, 1996 for a recent discussion and review). The recognition that spatial structure might influence species persistence in interspecific interactions has also resulted in a range of studies, including Huffaker's classic experiments on mites (Huffaker, 1958), and theoretical work on spatial models of predator–prey interactions (Hassell & May, 1988; Taylor, 1988, 1990; Hassell *et al.*, 1991; Wilson & Hassell, 1997) and competition (Comins & Hassell, 1987). In contrast, population geneticists and evolutionary biologists have shown particular interest in spatial structure with respect to the way in which among-population processes of gene flow and migration might influence genetic change and evolution (e.g. shifting balance theory: Wright, 1940, 1943; island model: Wright, 1951). More recently, the importance of colonisation and extinction processes for regional persistence and population genetic structure have also come under investigation (Slatkin, 1977; Wade & McCauley, 1988; Whitlock & McCauley, 1990; Gilpin, 1991; Thrall *et al.*, 1998). This has led to the development of a whole range of biologically realistic spatiotemporal modelling approaches (Kareiva, 1990; Czárán & Bartha, 1992; Durrett & Levin, 1994; Gilpin, 1996; Tilman & Kareiva, 1997; Bascompte & Solé, 1998).

Indeed, it is now widely recognised not only that most species are patchily distributed in nature, but that in many cases, populations occupying these patches are ephemeral (e.g. Andrewartha & Birch, 1954; Antonovics

et al., 1997; McCauley, 1997*a*). Following the work of Richard Levins (1969, 1970), these ideas have been broadly embraced by a single conceptual framework (metapopulations), incorporating the idea that local populations (or communities) are connected by among-population processes, and these processes can potentially affect, and be affected by, within-population demographic and genetic processes. Hanski (1991) defined a metapopulation as a system of local populations (the scale at which individuals move and interact with each other on a regular basis) connected by dispersing individuals (in plant metapopulations, this would also include gene flow through pollen or seeds). A crucial component of the definition of a metapopulation *sensu stricto* is its emphasis on colonisation/extinction processes whereby all local populations have a significant probability of extinction (Moilanen & Hanski, 1998). However, population size is an important determinant of extinction probabilities, and therefore differential probabilities of extinction (e.g. island–mainland situations) are likely to be more generally the case. Correlated environmental effects may also be important in some systems, leading to similar extinction probabilities at some spatial scales greater than that of local patches (Harrison & Quinn, 1989). As a consequence of these caveats, the metapopulation concept should perhaps be broadened to include any system where colonisation/extinction dynamics play a significant role in the dynamics and persistence of a species or community (Hanski, 1998). The metapopulation approach has been widely publicised in two recent edited volumes (Gilpin & Hanski, 1991; Hanski & Gilpin, 1997).

There is some debate about what types of genetic structures might be found in metapopulations, especially where population turnover is an important feature of the dynamics (Harrison & Hastings, 1996). In general, theory suggests that among-population genetic structure will depend on the nature of among-population dispersal (Whitlock & McCauley, 1990; McCauley, 1991), with genetic differentiation of populations being magnified in proportion to the probability that colonists are drawn from a single source. Empirical studies explicitly relating these colonisation/extinction processes to genetic variation are scarce. However, McCauley and coworkers (McCauley, 1994; McCauley *et al.*, 1995) found that the genetic structure of local populations of the plant *Silene alba* was enhanced by colonisation and extinction processes, with relatively little mixing of individuals from multiple source populations and greater divergence in younger populations. Other work on the metapopulation dynamics of *S. alba* has also demonstrated significant rates of population turnover in this system (Antonovics *et al.*, 1994; Thrall & Antonovics, 1995). Similarly, studies on a

metapopulation of *S. dioica* indicated that colonisation played an important role in determining the genetic structure of populations, although colonising propagules were derived from many, rather than few source populations (Giles & Goudet, 1997*a*, *b*). In contrast, counter to classical metapopulation model predictions, Dybdal (1994) found that even though colonists in tidepool populations of copepods were likely to be drawn from only one or a few sources, younger populations were less differentiated than older ones. He postulated that this might be due to the fact that colonists were actually less likely to be drawn from older populations. It is still largely an open question as to how genetic outcomes should depend on the type of metapopulation structure and life-history features of the organisms involved (Thrall & Burdon, 1997).

The extent to which any natural systems depend on a balance between colonisation and extinction processes for persistence has also been questioned (Harrison, 1991, 1994). However, when broadly defined as the interaction between within-population processes and among-population movement, metapopulation dynamics are inevitably a feature of all natural systems (Antonovics *et al.*, 1994; Husband & Barrett, 1996). Indeed, there is now a wide range of empirical studies that have demonstrated the importance of among-population demographic processes, ranging from insects and other invertebrates (Addicott, 1978; Bengtsson, 1989; Hanski *et al.*, 1994) through to amphibians (Gill, 1978; Sjögren, 1991*a*; Driscoll, 1998), mammals (Paillat & Butet, 1996; Moilanen *et al.*, 1998) and plants (Menges, 1990; Ouborg, 1993*a*; McCauley, 1994; Overton, 1994; McCauley *et al.*, 1995; Husband & Barrett, 1996), as well as host–pathogen interactions (Antonovics *et al.*, 1994; Burdon *et al.*, 1995; Thrall & Antonovics, 1995; Grenfell & Harwood, 1997; Burdon & Thrall, 1999). Eriksson (1996), however, suggested with respect to plants that long-lived species with clonal propagation or extensive seed banks may be much less dependent on the balance between colonisation and extinction required for regional persistence in a metapopulation. Certainly, metapopulation dynamics are likely to be much more apparent in annual plants or other short-lived species, but it is inevitable that population turnover will be a feature of most systems at some spatial or temporal scale. In fact, studies on a wide range of organisms, including predator–prey, host–parasitoid and plant–herbivore systems, provide solid evidence that local population extinction is not infrequent in nature (Sabelis & Diekmann, 1988; Fahrig & Merriam, 1992; Merriam & Wegner, 1992).

ECOLOGICAL AND GENETIC NEIGHBOURHOODS: THE IMPORTANCE OF REGIONAL SPATIAL STRUCTURE

Landscapes at many spatial scales are becoming increasingly fragmented as a result of human intervention – an activity that further emphasises the importance of understanding spatial processes. In this context, it should also be noted that 'metapopulation-like' situations can be created by habitat degradation as well as outright fragmentation. Such processes will be a permanent feature of many (if not all) ecosystems for the foreseeable future, and are rapidly becoming of significant concern among conservation biologists (Fig. 5.1), in large part because of the greater risk of extinction faced by small isolated populations. Given the enormous impact that fragmentation can have on genetic structure, ecological and evolutionary dynamics, and therefore population persistence, it is of paramount importance that strategies for conservation management also acknowledge this fundamental process. Moreover, stochastic and historical effects operating at local scales will often produce misleading (and in some cases erroneous) conclusions; one very real effect of fragmentation is to increase the likelihood that local populations will be in a non-equilibrium state (Olivieri *et al.*, 1990). Thus, understanding the causes and consequences of genetic and demographic processes at the within-population level requires that neighbouring demes also be taken into account because of gene flow and migration. Such considerations may have practical as well as theoretical implications, e.g. with respect to establishment of artificial populations for conservation purposes. A cogent demonstration of this was recently provided by a study showing that gene flow from diploid populations of an endangered daisy (*Rutidosis leptorrhynchoides*) into nearby re-established tetraploid populations was causing high levels of chromosomal abnormalities and reduced seed set (Young & Murray, in press).

For these reasons, a compelling argument can be made that viable long-term conservation programmes must place greater emphasis on regional persistence than has been done in the past. In this regard, it is crucial to realise that ultimately all populations are ephemeral, and hence for any species to have a long-term future, colonisation processes must also be preserved. In other words, this means setting aside areas of suitable habitat where species are not currently found, as well as maintaining existing populations. This is the core of the relevance of the metapopulation concept for conservation, where there is a continuum from large essentially 'global' systems through to an opposite extreme of many single, unconnected populations or habitat fragments (Fig. 5.2).

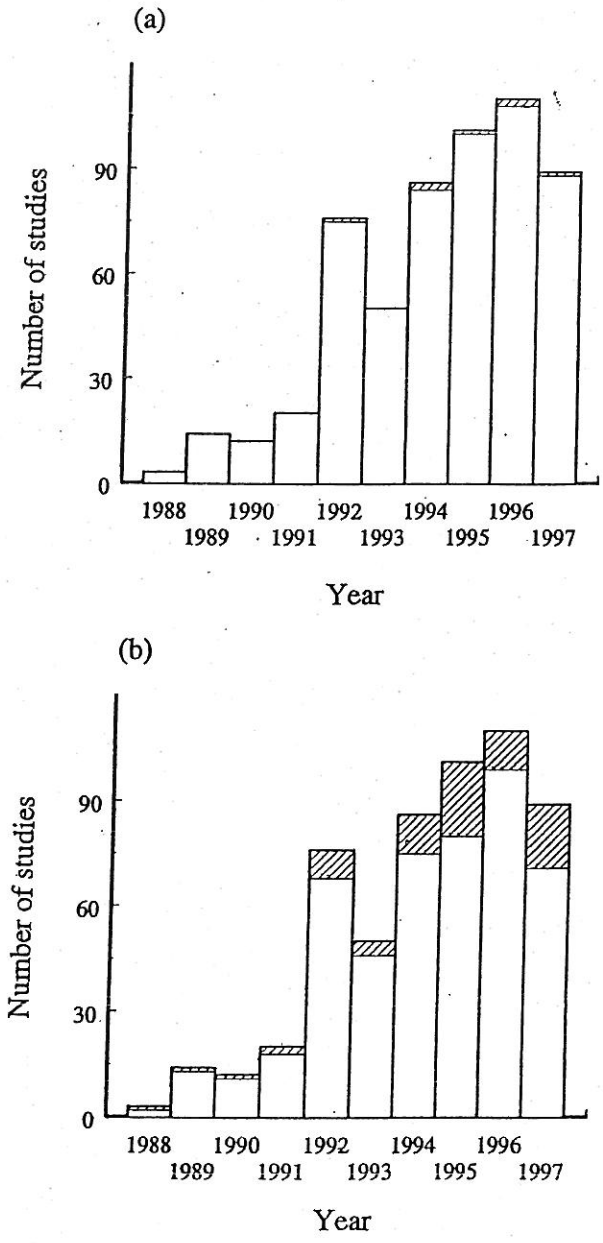

Fig. 5.1. Year-by-year account of the total number of conservation biology studies (empty bars) and the total number of studies incorporating both conservation biology and (a) metapopulation theory (hatched bars) and (b) fragmentation (hatched bars). Data obtained from searches of *Current Contents* (CAB – Abstracts) for 1988 to 1997, using terms 'conservation biology', 'conservation biology and metapopulation' and 'conservation biology and fragmentation'. Note that the 1997 search is up to and including October.

Identifying fragmented systems that have long-term viability

Perhaps the most important conservation issue that the metapopulation approach can usefully address is to identify conditions in which frag-

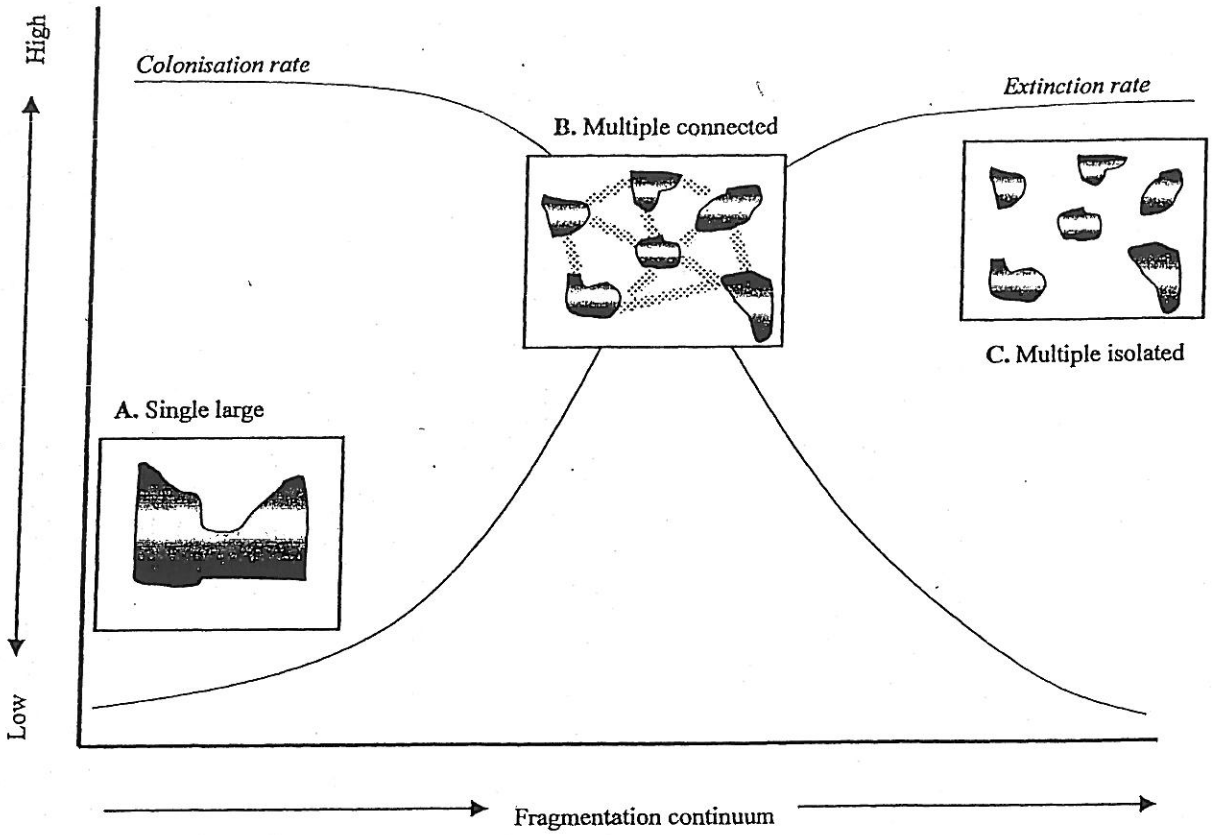

Fig. 5.2. Schematic diagram of the relationship between the continuum of species and community fragmentation and the relative importance of among-population processes for the dynamics. Where individual species or communities fit on the metapopulation axis is determined by a complex of factors including (but not limited to) life-history features that influence dispersal, colonisation and extinction phenomena. Note that even large natural areas (inset A) are rarely homogeneous, and thus among-patch movement will still play an important role in the dynamics. Inset B depicts the level of fragmentation at which the balance between colonisation and extinction processes can potentially result in long-term regional persistence. Conservation efforts centred on preserving such processes may thus provide the best chance of maintaining biodiversity, especially given that fragmentation is becoming a dominant feature of most landscapes.

mented systems can persist as 'habitat area is lost and the remaining habitat becomes ever more fragmented' (Hanski, 1998). In order to integrate recent work on spatial structure and metapopulation dynamics into conservation practices, we need to become better informed as to how demographic and ecological processes are affected by fragmentation in natural systems (there are several excellent case studies in the present volume that address some of these issues). For example, how can we utilise knowledge about the impact of fragmentation to manage biodiversity effectively? Specific concerns that relate to spatial structure and fragmentation include the

loss of genetic diversity through genetic drift and inbreeding effects which may lead to increased extinction rates, and even system collapse (Gilpin & Soulé, 1986; Lynch *et al.*, 1995*a*, *b*; Thrall *et al.*, 1998). As a case in point, increased risk of extinction due to inbreeding effects has recently been demonstrated in a fritillary butterfly metapopulation (Saccheri *et al.*, 1998). In general, the importance of genetic and demographic stochasticity will depend on the type of metapopulation structure (i.e. stochastic effects will be relatively more important in systems composed primarily of small populations; Holsinger, Chapter 4, this volume).

Other issues relate to how various kinds of fragmentation processes might influence the relative persistence of species with different life histories. This will be a particularly important consideration in situations where the focus of conservation efforts is on species or communities that can function in a metapopulation situation. Some authors have also suggested that consideration should be given to how rates of spread of diseases depend on the degree of connectedness of patches across the landscape (Simberloff, 1988; Hess, 1994, 1996*a*, *b*). Whether pathogen or parasite movement should be taken into account when designing networks of habitat patches has not, to our knowledge, been critically addressed, although several theoretical studies have focused on how among-population connectedness influences pathogen dynamics and persistence (Thrall & Antonovics, 1995; Grenfell & Harwood, 1997; Thrall & Burdon, 1999).

The metapopulation paradigm provides a useful conceptual framework within which to address such questions, as it explicitly acknowledges that local populations are not isolated either in time or space. Furthermore, while fragmentation has certainly contributed to increased extinction rates in small populations, metapopulation theory tells us that even in fragmented systems, many species may have the ability to persist if individual patches are connected by dispersal (Moilanen & Hanski, 1998). While real-world metapopulations are unlikely to match several of the assumptions of the original Levins model (e.g. homogeneity of habitat quality and patch size, equal probability of dispersal to any site), increasing numbers of researchers are employing a range of descriptive, experimental, theoretical and computer-simulation approaches to ask how ecological and evolutionary processes are influenced by the incorporation of spatial structure in natural systems. These studies range from empirical work on small mammals inhabiting archipelagos to biologically realistic computer simulations of host–pathogen interactions that are integrated with empirical studies. In fact, much of the recent theoretical work on metapopulations has centred on exploring the consequences of departures from the classical Levins

models. In the context of conservation, the most important of these are considerations of the interactions that occur between within- (e.g. birth, death, competition) and among-population (e.g. dispersal, gene flow, colonisation and extinction) processes, and how altering these may impact on species persistence.

Carrying out metapopulation studies in a conservation context

While all metapopulations (by definition) consist of spatially structured sets of habitat patches, not all fragmented ecosystems show the minimum requirement of stochastic extinction–recolonisation dynamics that fit the definition of a metapopulation (Hanski, 1994*a*). Therefore, it also follows that not all species in recently fragmented systems will have evolved to persist in a metapopulation situation. Nevertheless, a metapopulation approach to conservation biology is likely to provide one of the most useful tools for developing management strategies that optimise among-population processes critical for persistence of many natural systems. For example, Hanski (1994*b*) outlines methods for estimating the risk of metapopulation extinction and stochastic steady state. This approach can be used to investigate the likelihood of different outcomes when a fraction of patches is removed from the system (a possibility that is all too pertinent to conservation biology). Hanski's approach is based on simple metapopulation models which allow for estimation of colonisation and extinction probabilities from empirical patch occupancy data (often the very data that is most readily available from field studies). Hanski (1994*b*) illustrates this with an example from a metapopulation of fritillary butterflies (*Melitaea cinxia*) that assesses the 'relative importance of each patch for persistence of the metapopulation'. Similarly, Day & Possingham (1995) used a stochastic metapopulation approach to examine the spatial structure of populations of malleefowl, *Leipoa ocellata*, in southern Australia. With their model, they were able to quantify how further habitat loss (and consequent alterations in patch arrangement) would influence metapopulation extinction probabilities.

How do we approach the seemingly daunting task of carrying out metapopulation-type studies? Both practical issues associated with sampling multiple sites across time and also aspects of the species biology that determine relevant spatial scales for within- vs. among-population interactions must be taken into account (Antonovics *et al.*, 1994). As noted by Husband & Barrett (1996), one needs to consider the distribution of a species within its geographic range, the discreteness of habitats occupied and dispersal capability – these all play a role in determining connectivity and therefore

what constitutes a local population. Demographic and genetic information may provide other criteria for defining local populations and metapopulations (Husband & Barrett, 1996); in this regard the concept of ecological and genetic neighbourhoods (Antonovics & Levin, 1980) is likely to provide a useful starting point. It is also possible to study metapopulation dynamics experimentally, using 'model' species that are easily manipulable in laboratory situations, such as bacteria and protozoa (Burkey, 1997), or where artificial populations can be readily established and maintained in the field (Thrall & Antonovics, 1995). However, in many cases, especially where endangered species are involved, experimental manipulation may be excluded and inferring metapopulation processes such as colonisation/extinction rates from pattern data becomes essential (Hanski, 1994*a*).

Both implicit and explicit modelling approaches have been developed to investigate spatial issues (Hanski, 1994*b*); the former include analytically tractable but often somewhat unrealistic theoretical models based on Levins's original concept, as well as more complex structured metapopulation models (e.g. Verboom & Metz, 1991), while the latter are often centred around biologically realistic, but analytically less friendly computer simulations. Both theoretical and computer-simulation studies have a special role to play as they also allow the investigation of many questions related to spatial scale that are not tractable empirically. Thus, these approaches have focused particularly on local vs. regional dynamics and their longer-term coevolutionary effects. Spatially explicit simulations have also proved useful as predictive tools for investigating the consequences of varying patch number and arrangement within reserves, and thus may be of assistance in identifying, not only how many, but which patches should be kept in a system. It is encouraging that in many cases, useful information may be derived from models based entirely on patch area and isolation (Moilanen & Hanski, 1998), both factors for which information is readily available.

LESSONS FOR CONSERVATION FROM METAPOPULATION STUDIES

Genetic effects

There are several general problems that have been raised with respect to increasing fragmentation and the consequent loss of connectivity among local populations. Notable among these are issues relating to genetic structure, for example, concerns over the loss of genetic diversity and inbreeding effects (Lacy, 1987; Gilpin, 1991; Thrall *et al.*, 1998). While a subject of intense interest among conservation biologists, empirical studies explicitly

relating metapopulation dynamics (i.e. population turnover) to genetic fitness are almost non-existent, and non-conclusive. However, Richards (1997, and Chapter 16, this volume) has clearly demonstrated that smaller, more isolated populations of the plant *Silene alba* have higher levels of inbreeding, manifested as reductions in seed germination rates. Importantly, experimental work showed that fitness in these populations could be significantly enhanced by increased gene flow from other populations (Richards, 1997) – one of the criteria suggested by Harrison (1994) as a justification for using metapopulation models. Similarly, Young *et al.* (1999, and Chapter 19, this volume) found in the daisy *Rutidosis leptorrhynchoides* that the degree of correlated paternity was negatively related to population size and positively correlated with isolation, indicating the possibility of biparental inbreeding effects. Stochastic population simulations based on several years of demographic data for *R. leptorrhynchoides* also hint at a negative relationship between persistence time and the level of correlated paternity (Young *et al.*, Chapter 20). In contrast, work on a metapopulation of pool frogs (*Rana lessonae*) in northern Sweden indicated that while higher levels of population turnover resulted in reduced heterozygosity, this did not translate into lower fitness (Sjögren, 1991*a*, *b*). On several grounds, it has been argued that extinction of small populations is likely to occur for demographic or environmental reasons long before inbreeding effects will become important (Lande, 1988; Holsinger, Chapter 4, this volume). Clearly, this is an issue that is still far from resolved. However, in species with strong self-incompatibility systems, genetic effects may be manifest at a far earlier stage, effectively reducing population size very substantially (Young *et al.*, Chapter 20).

Species and community effects

Other important concerns relate to the maintenance of diverse species assemblages and communities. Under what conditions can fragmented systems maintain their integrity with respect to species composition? Much has been written about one single aspect of this issue, and that is with respect to fragment size in relation to effects on community structure [i.e. single large or several small (SLOSS); see Quammen, 1996 for a general review of this debate]. For example, long-term large-scale experiments in the Amazon basin (Lovejoy & Bierregaard, 1990) were explicitly focused on addressing this question. A great many researchers have argued both for and against particular sizes and numbers of reserves on economic, political and biological grounds, and it may well be that metapopulation theory can aid in determining optimal spatial structuring of patches. However, while

fragment size is clearly important, it does not take into account issues of connectedness and the need to preserve colonisation processes at the among-population level for both ecological and genetic reasons.

Metapopulation viability

A wide range of recent studies that explicitly use the metapopulation framework has already indicated a number of important features of fragmented systems that are crucial to conservation biology. Firstly, various empirical studies have provided evidence that both population size and isolation can affect demographic and genetic parameters (Barrett & Kohn, 1991). For example, small populations of *Eucalyptus albens* (white box) have been shown to have less genetic diversity than large ones, this effect being more pronounced in more isolated sites (Prober & Brown, 1994). Similar results have been obtained in studies of the roadside weed *Silene alba* (Richards, 1997, and Chapter 16, this volume). Secondly, whether due to demographic, genetic or environmental causes, local patches often go extinct, which is a major reason for the simple rule that we should be preserving as much habitat as possible. In this regard, one of the most important lessons to be learned from metapopulation models is that 'currently unoccupied habitat fragments may be critical for long-term persistence' (Hanski, 1998). At the same time, both empirical and theoretical studies of metapopulations indicate that even though local extinction is common in a system, regional persistence may still be possible.

Paradoxically and deceptively, simulation studies have demonstrated the possibility that in many cases, metapopulations below the colonisation/extinction balance (and hence on the path to annihilation) can still have a high percentage of occupied sites at any particular point in time (Hanski, 1998). This may occur during the lag phase before past habitat destruction becomes manifest as declining numbers of populations in remaining areas, and begs the critical question of how we will know when we have passed a threshold. This highlights the importance of identifying 'indicator variables' in relation to species and community characteristics that can provide clues to the current and potential future state of fragmented systems (Brown *et al.*, 1997; Thrall *et al.*, 1998). It also shows quite clearly the potentially misleading nature of 'snapshot' studies taken at a single point in time or restricted to one or a few populations.

As noted by Hanski (1998), based on simple models, several important general conclusions can be drawn about how metapopulations respond to processes of fragmentation. Firstly, because among-population connectivity is lost in a non-linear fashion, gradual loss of habitat can result in a

sudden shift from a positive equilibrium to regional extinction. Secondly, metapopulation decline in response to fragmentation occurs with a time-lag, sometimes referred to as the 'extinction debt' (Tilman *et al.*, 1994), which basically means that current extinctions are happening because of past habitat destruction. Thirdly, the equilibrium number of suitable but unoccupied patches existing in a metapopulation before fragmentation will be equal to the colonisation/extinction threshold. All of these factors highlight the difficulty of determining precisely when a system has passed the threshold for collapse, and moreover emphasise the fact that, in all likelihood, this point will be reached well before a decline in population numbers is obvious (Gutiérrez & Harrison, 1996; Thrall *et al.*, 1998).

On the positive side, the corollary to these observations is that metapopulation theory also suggests several obvious ways in which the likelihood of regional persistence can be enhanced: these include increasing the number of habitat patches, increasing the degree of clumping of these patches, increasing variance in patch size (e.g. moving towards a core–satellite structure) and increasing connectivity (Harrison & Fahrig, 1995; discussed in Wiens, 1996).

PRACTICAL APPLICATIONS OF METAPOPULATION THEORY

In the previous sections, we have argued for the general importance of understanding spatial structure, and taking it into account when implementing conservation strategies. How can we use knowledge about the effects of fragmentation to manage biodiversity? In practical terms this may translate into understanding how metapopulation extinction is a function of the number, size, quality and connectivity of habitat patches in the system (Drechsler & Wissel, 1998). Are there situations where such approaches have been implemented?

One clear example of how metapopulation thinking has been useful in a practical sense is with respect to the northern spotted owl in the northwestern United States (Gutiérrez & Harrison, 1996; Noon & McKelvey, 1996). As has been widely publicised, old-growth forests in this region have been heavily logged, leaving only discrete fragments in which spotted owls can persist. The application of metapopulation modelling to the conservation of spotted owls has led to a management approach that emphasises patch size and spacing consistent with persistence in a metapopulation (Wiens, 1996). Other examples include the Florida scrub jay (Stith *et al.*, 1996), kangaroo rats (Price & Gilpin, 1996), greater gliders in Australia (Possingham *et al.*, 1994) and pool frogs in Sweden (Sjögren-Gulve & Ray,

1996). In contrast, there appear to be relatively few examples where metapopulation thinking has been explicitly applied to conservation of plant species (but see Menges, 1990, 1991*b* with respect to Furbish's lousewort *Pedicularis furbishae*) although a wide range of studies has focused on genetic and demographic consequences of fragmentation in plant populations (e.g. Richards, 1996; Young & Brown, 1998).

Will we ultimately be reduced to artificially dispersing individuals among reserves? It has been suggested that knowledge of metapopulation dynamics may allow us to perform the functions of dispersal and recolonisation of locally extinct habitat patches, and that the metapopulation approach may also be able to guide conservation efforts in terms of optimal numbers and placement of translocated plants and animals, as well as genetic sources (McCullough, 1996). This may be of particular importance if we accept the argument that as suitable habitat areas become ever more isolated, and intervening areas increasingly hostile due to further development, most species will require help to move among patches (Simberloff, 1988).

Another area where metapopulation theory may inform conservation biology is in restoration ecology, where the realisable goal is often to regenerate a semi-natural system (in the sense of containing a subset of the original community). In a practical sense, it may well pay to identify and focus on species that have at least some potential to persist in a metapopulation-like situation. Biologically realistic metapopulation simulations should prove useful in identifying general characteristics that such species are likely to possess.

SPATIAL AND BEHAVIOURAL INTERACTIONS TO CONSIDER

Extinction thresholds

A major and increasingly urgent problem for conservation biologists is understanding to what extent systems can be fragmented, and the number of individual populations lost, before collapse occurs (whether for genetic, demographic or environmental reasons). This issue clearly relates to the concept of minimum viable metapopulations, defined as the 'minimum number of interacting local populations necessary for the long-term persistence of the metapopulation' (Hanski *et al.*, 1996*a*). Understanding factors that influence extinction risks in endangered metapopulations is an important component of management (Drechsler & Wissel, 1998). In this regard, it is important to develop a conceptual framework that allows some predictive power with respect to how spatial structure (e.g. core–satellite vs.

many small populations) interacts with biological factors to determine persistence thresholds. Theoretical work on metapopulations certainly shows that thresholds for persistence exist, and at the most basic level this translates into a balance between extinction and colonisation processes (Levins, 1969, 1970). However, exactly how any threshold depends on various life-history features (e.g. dispersal capability, life span, the existence of seed banks in plant metapopulations) is not well understood. Indeed for most species we have very little knowledge of either their dynamics or their dispersal ability (Wiens, 1996). However, there are some theoretical studies that relate dynamics in metapopulations to dispersal (e.g. Herben & Söderström, 1992; Olivieri *et al.*, 1995). In the context of island biogeography, studies of colonisation ability in relation to life history suggest that the best colonisers are those that are generalists or are self-fertile; with respect to mammals, size appears to be positively correlated with colonisation ability, but the opposite has been shown to be true for insects (see Ebenhard, 1991 for a review). There is no reason to believe these general patterns will not be applicable in fragmented environments. However, ultimately at some spatial scales most organisms have limited dispersal, and therefore beyond that distance, increasing isolation brings a decreasing probability of colonisation. This provides an upper limit to the extent of fragmentation (with its almost inevitable dual effects of increased isolation and habitat loss) that is possible while yet maintaining the metapopulation.

Ascertaining what factors determine the conditions under which extinction rates exceed colonisation rates is essential to developing a true appreciation of the vulnerability of individual species (Harrison & Quinn, 1989; Frankel *et al.*, 1995). When integrated across multiple species this has direct links to the concept of conservation at the community level (i.e. metacommunities: Hanski & Gilpin, 1991*a*; Wilson, 1992). Within a single community type, species may have very different disturbance requirements or dispersal distances (e.g. consider the range of fruit-dispersal mechanisms in tropical forest tree species) leading to different extinction thresholds. While it may be possible to determine extinction thresholds for a range of single-species metapopulations, this may grossly underestimate the threshold required to maintain the intact community. Identifying extinction criteria for those organisms that are highly mobile may provide a conservative estimate of the total amount of habitat necessary to preserve particular community types (Frankel *et al.*, 1995), although it will still be necessary to understand how loss of connectivity within conserved regions impacts less vagile species (or those with more specialised requirements). A major challenge for the future is then to develop the concept of mini-

mum community thresholds – otherwise, fragmentation may lead to qualitatively different communities, with drastically altered coevolutionary interactions and characteristics (e.g. with respect to ecosystem function).

A further complexity is that distance-independent extinction (correlated environmental variation) could lead to correlated extinction probabilities for conspecific populations (Harrison & Quinn, 1989). Such a possibility effectively reduces the number of demes in a metapopulation, as well as global persistence time, yet most metapopulation models still assume that local populations experience completely independent extinction (Harrison & Quinn, 1989). The very real potential for correlated environmental variation at spatial scales greater than single-habitat patches clearly indicates the need for management strategies that conserve as many habitat/environment types as possible, so as to maximise the probability of regional persistence.

Movement of pests, pathogens, parasites and predators

While, in general, metapopulation modelling has indicated that increased connectivity will lead to increased persistence at the regional scale (e.g. Harrison & Fahrig, 1995), some authors have suggested that there may also be negative consequences, at least in highly connected networks. For example, increased ability to move among populations may also facilitate the spread of infectious diseases and parasites (Dobson & May, 1986; Simberloff, 1988; Hobbs, 1992; Hess, 1994, 1996*a*, *b*). In fact, Simberloff (1988) has gone so far as to suggest that fragmentation may actually have the positive effect of reducing disease. Indeed, positive correlations have been found between disease incidence and the disease status of neighbouring populations in two natural plant–pathogen systems (Burdon *et al.*, 1995; Ericson *et al.*, 1999). Whether or not this is a real issue is an open question as there may well be trade-offs between the positive effects of increased ability of the host to move among patches and the negative effects of disease. Indeed, using simple Levins-type models, Hess (1994, 1996*a*, *b*) showed that there may be intermediate levels of connectedness that are optimal. However, these results do not take into account the fact that increased movement will also result in greater movement of resistance genes, and may also aid in disease avoidance, nor do they incorporate other aspects of coevolutionary interactions between host and pathogens. For example, recent empirical studies of a protozoan parasite (*Ophryocystis elektroscirrha*) of monarch butterflies with different patterns of migration suggest that life history and population structure may interact to determine disease prevalence, and the evolution of virulence (S. Altizer, unpublished data); para-

sites in non-migratory host populations were generally more virulent and disease prevalence was higher than in migratory populations. Overall, we would argue that disease is generally unlikely to provide a novel threat for species that have been artificially fragmented, as increasing connectivity is not likely to lead to the introduction of diseases that were not present in pre-fragmented times.

With respect to predation, increased connectivity may assist the movement of predators from one prey population to another. A classic illustration of this is given by the loss of native species on oceanic islands when predators such as rats and cats have been introduced (Simberloff, 1988). In a metapopulation context, a particularly good example is provided by the decline in frogs (*Rana muscosa*) as a consequence of the spread of introduced predatory fish in streams and drainage ditches that connect populations (Bradford *et al.*, 1993). Furthermore, where corridors are narrow it has been argued that they may often act as 'demographic sinks' doing more harm than good (Soulé & Gilpin, 1991). Thus, the effective degree of connectivity with respect to species persistence may be quite different from the perceived level if factors such as predation and behavioural complexities (see below) are not taken into account.

Behavioural issues

It has been suggested that increasing connectivity could lead to loss of individuals because of movement into suboptimal habitats (Hobbs, 1992). As a cautionary note, patterns of species behaviour may also alter model predictions and thresholds for extinction. For example, in a study of Columbian ground squirrels (*Spermophilus columbianus*), Weddell (1991) showed that squirrels did not disperse to new patches but settled near other individuals. Thus, social attraction can lead to reduced probabilities of patch colonisation, making the system more sensitive to fragmentation than would be otherwise expected. It seems likely that this will be a general issue for social species. Of critical importance for many species will be distinguishing between habitat patches used for different purposes (e.g. breeding vs. feeding). Moreover, movement among patches may often be non-random with respect to identity – e.g. young males leaving home territories to find mates. The extent to which such types of behaviour alter predictions for metapopulation dynamics is unknown. Overall, metapopulation management models for animals need to consider behavioural complexities (e.g. requirements for periodic migration: Hobbs, 1992) that would reduce the effective number of habitat patches, or change regional persistence thresholds. Other ecological features that apply to plants as well as animals, such

as competitive interactions among species, may also be important factors to consider (Tilman *et al.*, 1994; Wiens, 1996).

Conservation of coevolutionary processes

Coevolutionary interactions between different organisms ranging from symbiotic (e.g. mycorrhiza fungal – plant and rhizobia bacterial – plant associations) to totally parasitic (e.g. fungal and viral diseases of plants and animals) are being increasingly recognised as both sources of biodiversity in their own right and as fundamental ecosystem processes that affect both population and community structure and function. However, conservation of these associations may be particularly complicated as the survival of one or both players is often inextricably tied to the continued existence of their partner(s). Examples of this phenomenon are myriad, including very many micro-organisms and invertebrates associated with plants.

Following the spatial pattern of their major component, coevolutionary associations typically occur as a series of individual, co-occurring populations distributed patchily across the landscape. As Thompson (1994, 1997) has pointed out, across this range of populations that represents a species' presence in an area (metapopulation) there are likely to be 'hotspots' of coevolutionary activity as well as others in which change is occurring far less rapidly. These hotspots may reflect a range of phenomena – both biological (e.g. enhanced recombination in the genome of either player through hybridisation with other ecotypes or species) and physical (e.g. sites that particularly favour the development of parasites) – that act as sources of variation in the metapopulation as a whole, and which consequently provide the driving force for continuing evolutionary change. A priori identification of such sites of high coevolutionary activity is very difficult if not impossible. Yet they must be maintained if such interactions are to continue to develop and change.

Increasingly, empirical evidence from coevolutionary studies is highlighting the diversity of responses achieved as coevolutionary partners respond to each other in different demes of single metapopulations. Thus in the interaction between *Linum marginale* (native Australian flax) and *Melampsora lini* (flax rust), the size of *Linum* and *Melampsora* populations, their ephemerality and their genetic structure often vary markedly between closely adjacent demes of a single metapopulation (Burdon & Jarosz, 1991; Burdon & Thrall, 1999). This interpopulational diversity provides a long-term 'insurance' for the continued existence of the association as individual local populations flicker in and out of existence. Equally importantly,

though, the unpredictable changes in both the direction and intensity of selective interactions that occur as a result of these changes mean that we cannot predict the long-term trajectory of such associations nor can we expect to maintain them simply by preserving one or two populations. Indeed, recent increasingly sophisticated computer-simulation modelling clearly indicates the lack of clear predictive correlations between the behaviour of interactions at the level of the individual deme and that at the metapopulation level (Thrall & Burdon, 1999).

Failure to conserve such interactions within metapopulation arenas will inevitably lead to their eventual collapse. In many instances, this may result in the extinction of the antagonist. When this is a viral or fungal pathogen such a loss may raise little public concern (Dobson & May, 1986). However, what if the antagonist driven to extinction is a moth or spectacular butterfly? Or even a specialised variety of bird? Moreover, because of the unpredictable nature of interactions, we cannot say a priori what might be the long-term consequences of the extinction of individual players in coevolutionary plays. Micro-organisms are frequently ignored by ecologists and conservation biologists, but their potential as powerful selective forces shaping the demography and genetics of their hosts is well documented in their use as biological control agents.

CONCLUSIONS AND FUTURE DIRECTIONS

As noted at the beginning of this chapter, much of population ecology has focused on studies of single populations, and has further assumed that dynamics in local populations are deterministic, with local stability a viable outcome. It is of considerable concern that this view may have influenced the development of conservation management practices centred around preserving existing populations and/or patterns across the landscape. However the metapopulation perspective has highlighted the fact that local populations are, in fact, ephemeral, thereby emphasising the need to ensure that long-term conservation planning focuses on spatial scales larger than the single population. Moreover, we would argue that, generally speaking, there needs to be a frameshift towards conserving process rather than patterns (patterns are also ephemeral). In the context of studies on the ecology of mosses, Herben & Söderström (1992) specifically note that the 'primary aim in the protection of species living on temporary, patchy habitats is to identify and preserve the conditions that enable the dynamic process to operate'. We concur wholeheartedly and argue that this applies to all

species, although the relevant spatial and temporal scales will vary in different situations. In fact, this argument could be extended to preserving coevolutionary processes rather than species themselves – ultimately, nothing is permanent except change! The importance of emphasising regional persistence applies equally to many different levels of organisation, ranging from metapopulations of a single species (or coevolutionary interaction) through to entire communities and ecosystems.

The bottom line is that fragmentation results in two fundamental changes across the landscape: firstly, it leads to increasing isolation of habitat patches, and secondly, it results in a decrease in the total amount of available habitat (Simberloff, 1988). The metapopulation paradigm explicitly recognises and provides a conceptual tool for dealing with the interactions of within- (e.g. birth, death, competition) and among-population processes (e.g. dispersal, gene flow, colonisation/extinction). The ever-growing diversity of studies that demonstrate the importance of spatial structure in determining ecological and evolutionary trajectories also makes clear that conservation biology must focus on regional persistence and not local within-population persistence. Simply put, it is just not good enough to put fences around existing populations as all local sites are ephemeral at some temporal scale. Rather, we must explicitly recognise the importance of colonisation/extinction processes. Unfortunately, while the importance of spatial structure is now generally recognised, it is still only rarely incorporated into population viability analyses (Harrison, 1994).

But, given the fact that most reserves are already far too small to support intact communities, and in the context of the ever-increasing destruction of habitat with the simultaneous decrease in the number and size of larger reserves, does a metapopulation perspective really provide any greater hope than any other approach? It would be relatively easy to advocate the rather pessimistic perspective that since (1) maintaining many small patches is both more time-consuming and expensive than single large reserves, and (2) small patches will go extinct anyhow, we should simply let the small reserves go and focus on the largest remaining areas. Simberloff (1988) has suggested that the metapopulation paradigm does provide some encouragement in that it has demonstrated that a partially connected system of many small patches can indeed have long-term viability. Thus, if it is to have value for conservation, the clear challenge for metapopulation theory in the immediate (and foreseeable) future is to enable managers (1) to determine when there is sufficient between-patch migration for persistence under realistic conditions (and if not, how this could be achieved), and (2) to guide efforts in maintaining appropriate numbers and placement of cur-

rently unoccupied patches in a state that they could become occupied again and not just overrun by weeds. Integration of management efforts within a regional metapopulation framework is invaluable in that it forces a process-oriented, scale-appropriate strategy to conservation.

Review

Biological Consequences of Ecosystem Fragmentation: A Review

DENIS A. SAUNDERS

CSIRO Division of Wildlife and Ecology
LMB 4
P.O. Midland
Western Australia 6056, Australia

RICHARD J. HOBBS

CSIRO Division of Wildlife and Ecology
LMB 4
P.O. Midland
Western Australia 6056, Australia

CHRIS R. MARGULES

CSIRO Division of Wildlife and Ecology
P.O. Box 84
Lyneham
Australian Capital Territory 2602, Australia

Abstract: *Research on fragmented ecosystems has focused mostly on the biogeographic consequences of the creation of habitat "islands" of different sizes, and bas provided little of practical value to managers However, ecosystem fragmentation causes large changes in tbe physical environment as well as biogeographic changes Fragmentation generally resuitsina landscapethat consists of remnant areas of native vegetation surrounded by a matrix of agricultural or other developedland As a result, fluxes of radiation, momentum (i.e.,wind), water, and nutrients across the landscape are altered significantly. These in turn can haw important influences on the biota withinremnant areas, especially at or near the edge between the remnant and the surrounding matrix. The isolation of remnant areas by clearing also has important consequences* for *the biota. These consequences vary with tbe time since isolation, distance from other remnants, and degree of connectivitywith other remnants. The influences of physical and biogeographic changes are modified by the size, shape, and position in the landscape of individual remnants, with larger remnants being less adversely affected by the fragmentation process. The dynamics*

Resumen: *La investigacion sobre los ecosistemas fragmentados se ha enfocado principalmente en las consecuencias biogeograficas de la creacionde "islas" de habitatde diferentes tamanosy ha sido de muypoco valor practico para los manejadores del recurso. Como quieraque sea, la fragmentacionde los ecosistemas causa grandes cambiosen el medio ambiente fisico asi como en el ambito biogeografico. La fragmentacionresulta generalmente en terrenos que consisten de areas remanentes de vegetacion nativa rodeada de un amatrizde tierras agricolas u otrasformasde usode la tierra Como un resultado de esto, el flujo de la radiacion, del momentum (ej. el viento), del agua y de los nutrientes a traves de la tierra son alterados significativamente. Esto en su turno, puede influenciare la biota dentro de las areas remanentes, especialmenteen o cerca de los limitesentre los remanentesy la matrizque los rodea.El aislamientode las areas remanentes porlatala tambientiene importantes consecuencias parala biotay estas consecuenciasvarian con, el tiempo desde el momento del aislamiento, la distancia basta los otros remanentes y el grado de coneccion entre ellos. La influencia de los cambiosfisicosy biogeograficos es modificada porel tamanolo,formany la posicionen el terrenode remanentesindividualessiendolos remanentes grandes los menos afectados adversamante por el proceso de fragmentacion. La dinamicade las areas remanentes son dirigidas*

Paper submitted May 2, 1990; revised manuscript accepted September 20, 1990.

of remnant areas are predominantlydrivenby factors arisingin the surrounding landscape. Management of, and research on, fragmented ecosystems should be directed at understandingand controlling these external influences as much as at the biota of the remnants themselves. There is a strong need to develop an integrated approach to landscape management that places conservation reserves in the context of the overall landscape.

***predominantemente por factores que surgen en el terreno circundante. El manejo y la investigación de los ecosistemas** fragmentados deberia de dirigirse tanto a1 entendimiento y control de estas influencias externas como a las biotas remanentes en si. Hay una fuerte necesidad para el desarrollo de un enfoque integrado en el manejo de tierras que coloca a las reservas parala conservacion en el contexto del terreno en general.*

Introduction

Since the development of agriculture, the natural vegetation cover of every continent except Antarctica has been extensively modified. A cycle of agricultural development followed by overexploitation of the land has been repeated throughout recorded history. Forman (1987) quotes Plato's (ca. 2350 BP) description of how an area of ancient Greece was stripped of its soil following clearing and grazing, leaving "the mere skeleton of the land." Overexploitation and the use of inappropriate agricultural practices have led to desert encroachment, as in the Sahel region in North Africa (Le Houerou & Gillet 1986; Ehrlich & Ehrlich 1987), and to extensive loss of soil, often with disastrous and dramatic consequences, as in the Dust Bowl of the United States (Hudson 1981).

The process of land clearing and the consequent environmental degradation is continuing rapidly in many regions such as Southeast Asia and South America, particularly in areas of tropical rain forest (Myers 1988). Australia provides an example of recent agricultural development, with vast areas being cleared over the last 100 years for cereal cropping and stock grazing (Saunders & Hobbs 1989; Hobbs & Hopkins 1990; Saunders et al. 1990). In some regions over 93% of the native vegetation has been removed and the agricultural land that has replaced it is subject to extensive wind and water erosion or soil salinization, with consequent pollution of water supplies for drinking and irrigation.

One legacy of the extensive removal of native vegetation is that the remaining vegetation is usually in fragmented patches across the landscape. These patches or remnants are situated in different positions in the landscape and on different soil types, possess different vegetation types, and vary in their size, shape, isolation, and type of ownership. Over much of the world, conservation of regional biotas depends entirely on the retention and management of these remnants. Conservation managers are therefore faced with the dual issues of whether the remnants have any practical conservation values, and if they do, of how they must be managed to retain these values (Saunders et al. 1987a).

In this paper we use the word remnant to define any patch of native vegetation around which most or all of the original vegetation has been removed (Saunders et al. 1987a). Remnants often have been called habitat islands and the changes that result from the isolation of these islands have been the subject of considerable debate in the literature. This debate has centered mostly on the equilibrium theory of island biogeography (MacArthur & Wilson 1963, 1967) and its applicability to conservation. In particular, the importance of size, shape, and design of single reserves and reserve systems, extinction and colonization rates, and species-area relationships have been much discussed (Wilson & Willis 1975; Diamond 1975, 1976; May 1975; Terborgh 1976; Whitcomb et al. 1976; Simberloff & Abele 1976a, 1982; Pickett & Thompson 1978; Game 1980; Margules et al. 1982; Boecklen & Gotelli 1984). Particular attention has been paid to the question of whether one large reserve could preserve more species than several small reserves adding up to the equivalent area of the larger reserve (the so-called SLOSS, or "single large or several small" debate; Simberloff & Abele 1976b, 1984; Gilpin & Diamond 1980; Higgs & Usher 1980; Jarvinen 1982; Willis 1984).

These questions have been reviewed elsewhere (Simberloff 1988) and are not examined in detail here. While of theoretical interest, most of these issues are of little practical value in managing fragmented systems (Zimmerman & Bierragaard 1986; Margules 1987; Hobbs 1988; Margules & Stein 1989). The species-area equation, for example, may give a manager a rough idea of how many species will be maintained on a remnant of a given area, but will yield absolutely no information on the practical issue of which habitats contribute most to species richness or on which species are most likely to be lost from the remnant. Simberloff (1986) stated, "It is also sad that unwarranted focus on the supposed lessons of island biogeography theory has detracted from the main task of refuge planners, determining what habitats are important and how to maintain them." Margules (1986), in a discussion about two conservation evaluation exercises, notes that, "no panel members in either exercise considered the species-area relationship or the equilibrium theory of island biogeography in their evaluations; at least not explicitly." In addition, the debates about reserve design and SLOSS are of limited relevance because, with very few exceptions, managers of conser-

vation reserves are faced with a fait accompli. Conservation considerations have rarely been taken into account during the development of areas for agriculture, mining, forestry, or other such uses. Conservation managers must work with the remnants left followingthese developments and virtually never have the opportunity to design a reserve network before an area is frag mented. There is an increasing need to utilize design criteria to improve conservation networks in already fragmented areas, but this requires a clear understanding of the problems created by fragmentation in the first place.

Hence we believe that research and discussion should focus on practical issues relating to the impact of fragmentation on natural ecosystems and managing rem nants for conservation (Saunders et al. 1987b). We share the fear of Noss and Harris (1986) that conservation agencies have not realized the important biological consequences of ecosystem fragmentation and have therefore not developed policies to manage their remnants to maintain conservation values. The aim of this paper is to point out the physical effects of fragmentation, the biological consequences for natural ecosystems of these effects, and the options available for conservation research and management.

Characteristics of Fragmented Ecosystems

Fragmentation of the landscape produces a series of remnant vegetation patches surrounded by a matrix of different vegetation and/or land use. Two primary effects of this are an alteration of the *microclimate* within and surrounding the remnant and the *isolation* of each area from other remnant patches in the surrounding landscape. Thus, in a fragmented landscape there are changes in the physical environment as well as biogeographic changes. Most discussions of habitat fragmentation have concentrated on the biogeographic aspects, and the physical changes have received little attention. All remnants are exposed to these physical and biogeographic changes to a greater or lesser degree, but their effects are modified by the *size, shape,* and *position in the landscape* of individual remnants. We examine first the physical effects of fragmentation and then discuss the operation of the modifying factors.

Changes in Microclimate

Fragmentation of the landscape results in changes in the physical fluxes across the landscape. Alterations in fluxes of radiation, wind, and water can all have important effects on remnants of native vegetation.

1. RADIATION FLUXES

The energy balance of a fragmented landscape will differ markedly from one with a complete cover of native vegetation, especially where the native vegetation was dense before clearing. Removing native vegetation and replacing it with crop species with differing architecture and phenology alters the radiation balance by increasing the solar radiation reaching the ground surface during the day, changing the albedo, and increasing reradiation at night. These features vary depending on time of year; ploughing, crop growth, and harvesting produce an alternation of bare ground and varying degrees of vegetation cover (Geiger 1965; Milthorpe & Moorby 1974). In cleared areas, in general, daytime temperatures are higher and night temperatures lower than in naturally vegetated areas. This leads to greater temperature ranges both at the surface and in the upper layers of the soil, and an increased incidence of frost (Geiger 1965).

These changes in the cleared parts of the landscape impinge on the remnant native vegetation, especially at the edge between the two. Except near the equator, the orientation of the edge affects the degree to which solar radiation increases within a remnant at different times of year (Geiger 1965; Wales 1972; Ranney et al. 1981). Latitude also affectsradiation input, and at high latitudes especially, where solar angles are low, a remnant edge can receive significantly more solar radiation than unfragmented areas receive (De Walle & McGuire 1973; Hutchinson & Matt 1976,1977). Air temperatures at the edge of a forest remnant can be significantly higher than those found in either the interior of the remnant or the surrounding agricultural land (Geiger 1965; Kapos 1989).

The consequences of increasing solar radiation at the edges of remnants are not clear. The indications are, however, that a differentsuite of species may come to occupy this altered habitat. Lovejoy et al. (1986) report that fragmentation in tropical forests results in the rapid growth of vines and other secondary vegetation in a 10-25 m strip around the remnant edge. This may effectively seal off the remnant and maintain an environment within the remnant similar to that that existed prior to fragmentation (F. Crome, personal communication). This also occurs to some extent in temperate regions (Gysel 1951; Trimble& Tryon 1966; Ranney et al. 1981).

Shade-tolerantspecies may become restricted to the interior parts of the remnant, with differentspecies requiring differentdistances from the edge. The composition of remnant edges may be affected by edge aspect (Wales 1972; Palik & Murphy 1990). Distinct sets of "interior"and "edge"species have been recognized in landscapes that have been fragmented for a long time, for instance in the eastern United States (Ranney et al. 1981).

Nutrient cycling processes may be affected by in. creased soil heating and its effecton soil microorganism

and invertebrate numbers and activity (Klein 1989; Parker 1989), on litter decomposition, and on soil moisture retention. Changes in the radiation balance also affect larger fauna both directly and indirectly through altering resource availability (via changes in plant growth and phenology). Lovejoy et al. (1986) attribute changes in butterfly community composition in tropical forest fragments partly to increased insolation within small remnants. Increased radiation load and dessication rates may lead to reduced foraging opportunities. Saunders (1982) considered that elevated temperatures in fragmented landscapes reduced the foraging time available to adult Carnaby's cockatoos *(Calyptorhynchus funereus latirostrus)* and contributed to their local extinction. Alternatively, some species dependent on temperature thresholds may be able to forage for longer periods. For instance, the strongly dominant ants of the *Iridomyrmex* genus are known to forage only when insolation and temperatures are high, and other ant species forage only when *Iridomyrmex* is absent (Greenslade & Halliday 1983; Andersen 1987). Increased insolation and ambient temperatures could then increase the foraging time available to *Iridomyrmex* but reduce it for subordinate species.

Altered temperature regimes can also have the effect of destabilizing competitive, predator-prey, and parasitic interactions. Geiger (1965) quotes the example of the timber pest *Ocneria monacha,* which lays eggs on tree trunks. Elevated springtime temperatures on trunks at the forest edge allow larvae to emerge before their parasites, which emerge from the cooler forest floor. This gives the pest a head start and results in population buildups.

2. WIND

With the removal of surrounding vegetation, the entire pattern of momentum transfer over the landscape is altered. As air flows from one vegetation type to another, the wind profile adjusts to the new roughness characteristics. When air flowing over one vegetation type comes to a boundary with a new vegetation type, the upper part of the wind profile initially retains the characteristics of the previous vegetation type, but the lower part takes on new characteristics reflecting the roughness of the new vegetation type. The wind profile does not fully equilibrate with the new vegetation for some distance. Rules of thumb for wind profile measurements give the minimum "fetch" (i.e., the minimum distance from the vegetation boundary that will ensure that the profile has taken on the characteristics of the vegetation under study) as 100-200 times the height of the vegetation under study (Monteith 1975; Grace 1983; Jones 1983). Turbulent transfer is important for the transport of atmospheric gases, and gas fluxes above vegetation are controlled by these processes. It follows, then, that these processes must be significantly modified in rannant vegetation areas, where the wind profile will not be in equilibrium with the remnant vegetation (Jarvis & McNaughton 1986). Given the fetch requirements, a woodland with 20-m-tall trees would need to be at least 2-4 km wide before wind profiles would resemble those in an unfragmented situation. The implications of this for plant gas exchange and growth have not been examined, but could be significant.

A more obvious effect of landscape fragmentation is that remnants are subjected to increased exposure to wind. This may result in damage to the vegetation, either through direct physical damage (Moen 1974; Grace 1977), or by increasing evapotranspiration with reduced humidity and increased dessication (Tranquillini 1979; Lovejoy et al. 1986). Direct physical damage can take the form of wind pruning (Caborn 1957) or windthrow of trees. Distinct edge structures have been found to develop at the edges of tree plantations (Fraser 1972), and this is likely to be the case for remnantareas also (see Ranney et al. 1981 for a discussion of edge structures). Trees near the edge of recently isolated remnants are particularly at risk of windthrow since they have matured within a closed canopy and have therefore developed in the absence of strong winds and lack the necessary support mechanisms to deal with such winds. Windthrow of dominant trees results in changes in the vegetation structure and increased availability of regeneration gaps, allowing recruitment, particularly of pioneer or light-demanding species. Increased litter fall through tree damage is likely to alter soil surface characteristics and hence the habitat of ground-dwelling fauna. Similarly, increased exposure to wind may remove loose bark and reduce the substrate available for bark-dwelling invertebrates, and hence also reduce their availability as a food resource. Increased wind turbulence due to clearing has been shown to affect the breeding success of birds by creating difficulties in landing due to wind shear and vigorous canopy movement (Brett 1989; Reville et al. 1990). In the case of tropical forests, fragmentation can result in hot, dry winds blowing into remnant areas from the surrounding cleared areas, with the probable result of increased tree mortality (Lovejoy et al. 1986) and prevention of regeneration of species whose successful establishment requires humid conditions or persistent soil moisture (Janzen 1986). This may also be important in the regeneration of species in other areas, such as those with rnediterranean climates, where successful establishment requires adequate soil moisture (e.g., Gordon et al. 1989; Williams & Hobbs 1989). This effect will be lessened in cases where the edges of remnants are sealed off by rapid secondary growth.

Increased wind speeds at remnant edges have the secondary effect of increasing the transfer of material such as dust and seeds in from the surrounding matrix. Gei-

ger (1965) gives an example where particulate matter deposition at the edge of a forest remnant increased by 40% over that in the open. Transfer of nutrients by saltation of surface soil particles is also possible, and strong gradients in soil nutrient levels have been found at the edges of remnant areas (Muir 1979; Cale & Hobbs 1991). Wind can deposit seeds of nonnative species over considerable distances into remnant areas (Hobbs & Atkins 1988). Transfer of insects and disease organism into remnant areas may also be increased.

3. WATER FLUX

Fragmentation of the landscape results in modification of the local water regime by altering the various components of the hydrological cycle. Removal of native vegetation changes the rates of rainfall interception and evapotranspiration, and hence changes soil moisture levels (Kapos 1989). The pathways by which water penetrates the soil may also be markedly altered (Bormann & Likens 1979; Nulsen et al. 1986; Peck & Williamson 1987; Sharma et al. 1987; Bell 1988). Replacement of deep-rooted perennial species with herbaceous crop or pasture species leads to greatly reduced evapotranspiration and increased surface. and groundwater flows. The hydrological system in general becomes much less buffered with more extreme run-off events (Hornbeck 1973; Simons 1989). Increased surface water flows lead to increased erosion and transport of particulate matter (e.g., Bormann et al. 1974). Topsoil removed from high in the catchment ends up as sediment in the river system. Transport of nutrients into streams also increases (Likens et al. 1970). Rises in water tables can bring stored salts to the surface and cause secondary salinity, with considerable impacts on both remnant vegetation and the surrounding agricultural matrix (Peck 1978; Williamson et al. 1987). Movement of stored salts, nutrients, and pesticides washed from cleared land can have significant impacts on river systems (Kendrick 1976; Karr & Schlosser 1978).

The impact of these changes on an individual remnant depends greatly on its position in the landscape (Swanson et al. 1988). Remnants at the top of a catchment can be expected to be relatively little affected by changes in water flux, whereas remnants on midslopes and valley bottoms will be more affected. Remnants in run-off areas can be expected to experience more erosion, while those in run-on areas will experience more soil deposition, especially on the up-slope edge.

Further impacts on remnant areas can be expected following management operations in the surrounding matrix that alter hydrological processes. Thus irrigation, water storage, or drainage may affect remnant areas. An extreme example of this is found in the fens of eastern England, where drainage has led to peat shrinkage and a drop of 4 m in land level in 130 years. Remnant areas of natural wetland now require pumping systems to retain adequate water levels (Hutchinson 1980; Rowell 1986).

Changes in water fluxes and associated particulate and nutrient fluxes can have important influences on the biota of remnants. Altered patterns of erosion lead to changes in drainage patternsand the production of new substrates for plant colonization. Of particular importance is the deposition of nutrient-rich material in run-on areas, which can act as a focus for invasion by species requiring disturbance and/or nutrient enrichment for successful establishment (Hobbs & Atkins 1988). Changes in surface and soil moisture levels could also lead to changes in decomposition rates, altered seedbed characteristics, and changes in habitat for ground-dwelling fauna

Isolation

Landscape fragmentation has two important consequences for the biota. First, there is a reduction in the total area of habitat available, with possible increased densities of surviving fauna in the remnants, and second, the habitat that is left is broken up into remnants that are isolated to varying degrees (Lovejoy et al. 1984, 1986; Haila & Hanski 1984; Wilcove et al. 1986). The time since isolation, the distance between adjacent remnants, andthe degree of connectivity between them are all important determinants of the biotic response to fragmentation.

1. TIME SINCE ISOLATION

Upon isolation, a remnant is likely to have more species than it will be capable of maintaining, and species will be lost as the changes brought about by fragmentation take effect (Miller & Harris 1977; Miller 1978; Wilcox 1980; Harris 1984). This process of "species relaxation" is considered an inevitable consequence of area reduction and isolation, on the basis of island biogeographical predictions. However, the various mechanisms by which local extinctions occur will result from the physical changes discussed above and resulting changes in biotic interactions. The rate of species relaxation will differ among different taxa. The most rapid extinctions are likely in species that depend entirely on native vegetation, those that require large territories, and those that exist at low densities. Dispersal behavior and demography will determine the response of individual species to fragmentation (Karieva 1987).

Populations that are too small to be viable may persist for long periods simply because of the longevity of individuals, For example, in remnants in the Western Australian wheatbelt, female trapdoor spiders *Anidiops villosus* can live for at least 23 years (Main 1987), and small Australian passerines of about 25 g may live over 20 years (AustralianBird Banding Scheme records). It may take several hundred yearsto lose some species

such as long-lived trees, especially since adult plants are often less sensitive to changed environmental conditions than seedling and juvenile stages. Alterations in disturbance regime in remnant areas may prevent successful regeneration (Hobbs 1987; Bond et al. 1988). Presence of a species in a remnant is thus no guarantee of its continued existence there; successful reproduction and recruitment are required. Managers therefore may need to examine the age structure of species on remnants to identify vulnerable species to be targeted for special management.

Time since isolation will therefore determine how far down the "relaxation track" any given remnant has traveled. Recently isolated remnants can be expected to continue losing species; this process may continue for relatively long periods in the absence of interventive management (Soule et al. 1988; Saunders 1989). Long isolated remnants can be expected to have lost a proportion of the species originally present, and gained an additional component of invading species that are capable of establishing in the fragmented system. It is thus wrong to consider only species numbers and not species composition when discussing species diversity in remnant areas: species numbers can potentially increase in fragmented systems where invasive and edge species can establish, but the numbers of species originally found in the area may continue to decline (Verner 1986; Murphy 1989; Webb 1989; Harris & Scheck 1991).

It is commonly assumed that at some stage the remnant will reequilibrate with the surrounding landscape. It is, however, questionable whether a new stable equilibrium will be reached since the equilibration process is liable to be disrupted by changing fluxes from the surrounding matrix, disturbances, and influx of new invasive species. The final equilibrium can be likened to an idealized endpoint that is never likely to be reached, in much the same fashion as the climatic climax is now conceptualized in succession theory. Management of remnant areas will thus be an adaptive process directed at minimizing potential future species losses.

2. DISTANCE FROM OTHER REMNANTS

The ability of species to colonize a remnant depends to some extent on the distance of the remnant from other areas of native vegetation, be they other remnants or nearby uncleared areas. Colonizing ability is related to dispersal mode, with wind-dispersed and vagile species more likely to arrive at isolated remnants. However, whether such species become successful colonists depends on physical and biotic factors such as nutrient availability and competitive interactions (Vepsalainen & Pisarski 1982). Animal species may have the physical ability to disperse long distances, but lack the behavioral repertoire to traverse the matrix surrounding the remnant; the matrix becomes an effective barrier to movement. Organism size is also important, and 100 m over agricultural fields may be a complete barrier to dispersal for small organisms such as invertebrates (Mader 1984) and some species of bud (Saunders & de Rebeira 1991). The persistence of such species on a remnant would then depend entirely on the retention of enough suitable habitat to maintain sufficient numbers to withstand the risks of extinction (Soule 1987a; Ewenset al. 1987). Some evidence exists that fragmentation of large populations into subpopulations may decrease the risk of overall species extinction even though local extinctions may occur (Higgs 1981; Quinn & Hastings 1987). It seems likely that different species will respond ditferently to the creation of subpopulations and that knowledge of the details of an organism's behavior will be necessary to predict its response (Karieva 1987; Merriam 1991).

3. CONNECTIVITY

Associated with the effects of distance is the degree to which individual remnants are connected in some way to adjacent areas. The issue of connectivity and the usefulness of corridors connecting remnants has received increasing attention in the Literature (MacClintock et al. 1977; Wegner & Merriam 1979; Baudry 1984; Forman & Baudry 1984; Merriam 1984; Harris 1984, 1985; Fahrig & Merriam 1985; Noss & Harris 1986; Bridgewater 1987; Simberloff & Cox 1987; Nos 1987; Souleet al. 1988), and was the subject of a recent symposium (Hobbs et al. 1990; Saunders & Hobbs 1991a).Corridors are generally believed to provide benefits such as enhanced biotic movement, extra foraging areas, refuges during disturbances, and enhancement of the aesthetic appeal of the landscape. In some areas they significantly add to the area of native vegetation left following fragmentation.

Simberloff & Cox (1987) pointed out that most of the work on the value of corridors has not been sufficiently controlled to demonstrate an unequivocal role in increasing immigration and/or decreasing extinctions. An increasing number of studies, however, now indicate that corridors are of value for movement, at least for a subset of the biota (papers in Saunders & Hobbs, 1991a). Simberloff and Cox (1987) also discussed potential disadvantages of corridors, which include facilitation ofthe spread of disease, pests, and fire and other disturbances, increased predation, and high costs of maintaining linear remnants with high edge:area ratios. The relative merits of corridors and their required characteristics (i.e.,width, composition, etc.) will vary from place to place and will depend on the target species. Detailed predictions of corridor value in reducing isolation of remnant areas are not possible without information on the movement of individual species across the landscape. Such information is, however, difficult

and time-consuming to collect (Saunders & de Rebeira 1991). Nevertheless, while such data are being gathered, we need to take the approach that corridors do have value for biotic movement and attempt to retain a good corridor network wherever possible (Harris & Scheck 1991; Saunders & Hobbs 1991b).

4. CHANGES IN THE SURROUNDING LANDSCAPE

Removal of the vegetation from the area surrounding a remnant leads to the remnant becoming the only area of suitable habitat remaining for biota displaced by clearing. This may lead to the concentration of mobile elements of the biota in the remnants (Lovejoy et al. 1986). This concentration or crowding effect may be rapid and result in supersaturation of the remnant by some species. Crowding can alter intra- and interspecific interactions. Competition and predation, for example, can be increased, resulting in changes in fecundity and the potential ultimate collapse of the population. Resource availability is also affected by overexploitation; for instance, increased herbivory by large herbivores such as the elephant in African reserves can lead to quite dramatic changes in habitat (Spinage & Guiness 1971; Laws et al. 1975; Walker 1981).

Supersaturation results from the influx of species native to the area, but there are also potential influxes of new suites of species that have increased in abundance or established in the surrounding landscape following fragmentation. Such species include those that have been introduced in the process of agricultural develop ment (pasture and crop plant species and livestock), other deliberate and accidental introductions, and native or migrant species that can take advantage of the new habitat conditions caused by fragmentation.

Natural communities vary in their susceptibility to invasion, although there is still debate over which characteristics render one community more invasible than another (Fox & Fox 1986; MacDonald et al. 1986; Crawley 1987; Usher 1988; Rejmanek 1989). For vegetation, establishment of nonnative species seems to be enhanced by some form of disturbance, especially if this increases the availability of a limiting resource (Hobbs 1989; Panetta & Hopkins 199l). Thus the opening of light gaps in dense forests where light was limiting could enhance invasion, whereas in nutrient-limited systems, nutrient input signrftcantly increases the performance of nonnatives, especially in conjunction with soil disturbance (Hobbs & Atkins 1988). Invasion may be restricted to the edge of remnants if disturbance factors decline with distance from edge (Cale & Hobbs 1991; Panetta & Hopkins 1991), but species with wind- or animal-dispersed seeds can establish in suitable areas within a remnant, away from the edge. Invading species can establish, for example, from seeds carried in by, or deposited in feces of, animals that feed in the area surrounding the remnant but use the remnant for shelter. An example from Western Australia is the Wedge-tailed Eagle *(Aquila audax),* which breeds or roosts in remnants but forages on carrionin the surrounding farmland, bringing parts of sheep carcasses back to the roost to consume them. Wool from carcasses carries seed that is dropped under the roost tree. Nutrient input from eagle droppings and the disturbance caused by other scavanging animals provides a focus for the establishment of nonnative species (Saunders, personal observation). Thus, even in the absence of deliberate disturbance within remnant areas, invasions may occur.

Invasive species can have significant impacts on the plant communities within remnants; for instance, invading plant species can significantly alter the fuel structure and hence fire regime, and can inhibit the regeneration of native species (Wycherly 1984; Macdonald et al. 1989; Panetta & Hopkins 1991). Nonnative herbivores, including stock, can also dramatically change vegetation structure and prevent regeneration. Species that increase because of landscape modification can also have significantimpacts on the rest of the biota. For instance, in North America increased pressure from nest predators and parasites such as the Brownheaded Cowbird (*Molothrus ater*) has affected passerine bird populations in fragmented systems (Brittingham & Temple 1983; Wilcove 1985; Andren & Angelstam 1988). Similarly, the Galah (*Cacatua roseicapilla*) has moved into all agricultural areas in Australia as a result of the development of cereal cropping and the provision of watering points for stock (Saunders et al. 1985). It now roosts in remnant woodland areas, often competing with other indigenous hole nesters (Saunders & Ingram 1987; Saunders 1990), and can damage tree foliage and bark, in extreme examplescausing tree mortality.

Modifying Influences

1. REMNANT SIZE

The smaller a remnant is, the greater the influence external factors are likely to have. In small remnants, ecosystem dynamics are probably driven predominantly by external rather than internal forces. Of importance here are "edge effects"(Williamson 1975; Janzen 1983; Harris 1988; Yahner 1988). Larger remnants have a big ger core area that is unaffectedby the environmental and biotic changes associated with edges. Here, we regard edge effects as mainly detrimental; this is opposite to the traditional view that edges and ecotones are beneficial to wildlife (Harris 1988). The difference is that remnant edges are created by removal of the surrounding vegetation and place the remainder in juxtaposition with a completely altered surrounding matrix.

Noss and Harris (1986) have pointed out that we do not know the minimum critical size an ecosystem needs

to be to preserve its characteristic species diversity and species composition (Lovejoy & Oren 1981). In fact the "minimum dynamic area" of Pickett and Thompson (1978) or "the smallest area with a natural disturbance regime which maintains internal recolonization sources" would probably exist only in the largest conservation parks.

Larger remnants usually contain greater habitat diversity than smaller ones. A collection of smaller reserves may, however, cover a greater array of habitats than a single large one simply because a single large reserve will not contain all of the habitats likely to occur in a region. These arguments have been discussed in detail elsewhere and will not be pursued here. It is important, however, to recognize that the process of fragmentation is generally not random (Usher 1987). Land clearance usually occurs on a selective basis, with the best soil types being cleared first. For example, in southwest Western Australia, settlers selectively cleared woodlands because they occurred on the heavier soils best suited for agriculture. As a result, woodland communities are now poorly represented in conservation reserves and most woodland remaining on farms is in a highly degraded state (Saunders & Hobbs 1989). Few reserves in the area are large enough to contain representative samples of all preexisting vegetation types. Kitchener et al. (1980*a, b,* 1982) found, however, that even relatively small reserves (i.e., 30 ha) could be rich in some groups of fauna, but whether these populations are viable in the long term is debatable (see Saunders 1989).

Remnant size determines the potential size of populations of component species. Clearly, the number of individuals of any particular species that a given remnant will support depends on organism size and requirements. The larger the remnant, the more likely it is that populations will be large and more likely to resist chance extinctions (Gilpin & Soule 1986; Soule 1987a). Retaining populations in the long term may require large population sizes (of the order of hundreds or very much greater; Shaffer 1987), although the actual numbers required will depend on the life history and population growth rate of the species involved. Pimm et al. (1988) confirm that over a few decades extinction risk does decrease with population size, but they found no extinctions among British island birds numbering over 18 pairs. The issue of minimum population size has been discussed extensively in the literature (see Soule 1987b), but there is still no real resolution as to what constitutes a minimum viable population. There has been extensive modeling of the concept, but little experimental work

Larger populations tend to have higher levels of heterozygosity than small isolated populations. Current thinking is that heterozygosity is beneficial. Species that have gone through genetic "bottlenecks" are likely to suffer a reduction in heterozygosity with consequent loss of ability to adapt to changing conditions. Species isolated on remnants may go through such genetic bottlenecks because of small population sizes, and deliberate transfer of individuals between populations may be required (Boecklen & Bell 1987). However, the general assumption that heterozygosity is essential for long term population viability is still open to debate.

Large reserves may have some disadvantages; in particular, the possibility of disease spreading through entire populations on a large reserve has been discussed. However, there is a wide range of species' life histories and distribution patterns in the biota, and the effects of reserve size are largely species-specific. Species that have large area requirements or that require combinations of different habitats are likely to survive only in relatively large areas, whereas organisms with small, localized populations and simple habitat requirements can survive on smaller remnants. However, all will be affected by the disruption of physical ecosystem processes that result from fragmentation and were discussed earlier.

2. SHAPE

The shape of a remnant is important only for relatively small areas; there is some size beyond which shape does not really matter. However, for small remnants, shape determines the perimeter:core (or edge:interior) ratio. Long, thin remnants have proportionally much more edge than square or round remnants (Diamond 1975; Wilson & Willis 1975), and are more open to detrimental edge effects. However, some vegetation types, such as riparian strips, are naturally chin, and corridors are by definition generally long thin remnants (although the wider they are the more useful they may be to aid movement of biota; Saunders & Hobbs 1991b). Long, thin remnants may also, depending on their orientation, lie along environmental gradients and thus contain more vegetation types and habitats than a square reserve of similar area. Linear features are thus part of the natural and fragmented landscape, and there is no point in trying to develop optimal design principles that do not take them into account; the most important question is how to manage the remnants, whatever shape they are, so as to minimize external effects.

3. POSITION IN LANDSCAPE

The position of a remnant in the landscape has important influences on all the features so far discussed. It affects prefragmentation patterns of geomorphology, soil, and vegetation, and hence determines the structure and vegetation composition of any given remnant area. It also significantly affects postfragmentation processes.

For instance, there is an important distinction between remnants that are predominantly run-on versus those that are predominantly run-off. This influences not only the hydrological regime of the remnant, but also the movement of soil, nutrients, and seeds into and out of the remnant area

Lessons for Management

Management of fragmented ecosystems has two basic components: (1) management of the natural system, or the internal dynamics of remnant areas, and (2) Man. agement of the external influences on the natural system. For large remnant areas, the emphasis should be on managing the internal dynamics, including, for instance, the disturbance regime and population dynamics of key organisms. For small remnants, on the other hand, management should be directed primarily at controlling the external influences. Janzen (1983, 1986), however, has pointed out that external influences can be important whatever the remnant size.

Since most impacts on remnant areas originate from the surrounding landscape, there is clearly a need to depart from the traditional notions of reserve management, and look instead toward integrated landscape management. It will become increasingly difficult to maintain remnants of native vegetation if the management practices in the surrounding matrix have continuous adverse impacts on them. Traditional reserve management stops at the reserve boundary; fluxes of water, particulates, and organisms do not. Placing the conservation reserves firmly within the context of the surrounding landscape and attempting to develop complementary management strategies seems to be the only way to ensure the long term viability of remnant areas (Hobbs & Saunders 1991). This has important implications for land managers since it involves a radically new way of viewing management and requires that neighboring land uses, and hence neighboring landowners, interact in a positive way. This is difficult, but not impossible, and there are encouraging examples of attempts at this type of integrated management (e.g., Fitzgerald Biosphere Project 1989; Bradby 1991).

The landscape approach to management is also essential since several remnant areas taken together may rep resent a system over which components of the biota travel to meet habitat and food requirements. The loss of a single component of such a network could severely affect the capability of the remaining remnants to carry out the same functions, if for instance a particular species or habitat was lost. Such a network consists not only of the designated reserves, but also other remnant areas and linkages between them.

The goal of conservation management usually is to maintain species diversity, and the method of achieving thisis to attempt to maintain representative examples of each ecosystem or community type present before fragmentation. To do this, we need to know the distributions of species and communities and then select areas that represent them. In general, there are two possible scenarios. In the first, we have a system that is about to be fragmented and we have to design the ideal set of reserves for the area In the second, we have an already-fragmented system that we need to make the most of. Most theories in conservation biology, including virtually all the discussions of island biogeography in relation to reserves, have dealt with the first scenario, whereas it is the second scenario that we most frequently have to confront. Here we present a series of guidelines for management in this situation.

1. The initial step must be to determine the minimum subset of the existing remnants that are required to represent the diversity of a given region (Margules et al. 1988; Margules & Stein 1989). This requires that we have some knowledge of the distribution of species or ecosystem types. Clearly, it would be desirable to have all existing remnants available for this purpose, but in many cases this is not achievable, and there must be priorities for reserve retention or acquisition.

2. The system must then be managed to maintain the diversity of species or ecosystems. The question of whether management should be for individual species or whole ecosystems is largely irrelevant, because individual species require functioning ecosystems to survive. Management guidelines will be area-specific, but the need to manage external influences is universal.

3. Priorities for management must be established. Clearly there are many problems to be tackled, and usually there are limited resources available for the job. There must therefore be a clear priority ranking to ensure that resources are deployed optimally. Problems that are likely to disrupt ecosystem processes and hence threaten the viability of a remnant area should be given high priority for treatment.

4. Continuous management is needed to maintain remnant areas in their current state, due to the constant pressure of altered internal dynamics and external in. fluences. Here again, the allocation of Scarce management resources must be considered. Effort should go into maintaining some remnant areas in as near a "natural" state as possible, but it will not be feasible to do this for all remnants. There is a strong case to be made for letting some areas degrade so that they become less natural but are easier to manage and still retain some conservation value (Bridgewater 1990). This is not as radical as it may sound, since the process is ongoing in many remnant areas anyway. Once we accept that many remnants now contain "synthetic" communities that are not likely ever to return to their pristine state, management priorities become easier to set.

Research Requirements

Research to date on fragmented ecosystems has provided few answers on the issues of practical importance to management. It is just as important to set priorities for research as for management, and in the same way, research costs must be taken into account since resources for research are also limited. For instance, is it better to concentrate on single-species studies that can produce results with direct practical appiication but are very costly and time-consuming, or should we concentrate on the community/ecosystem approach that is cheaper but may yield more equivocal results? Clearly, balanced use of both approaches is needed. We have identified a number of priority areas that require research effort (see also Soule & Kohm 1989).

1. A major priority is to understand the effects of external factors. Comparisons of pre- and postfragmentation systems will be particularly useful (Lovejoy et al. 1986; Margules 1987). Effects of changes in radiation and water fluxes are particularly important, as is the biotic invasion process.

2. Changes in internal processes since fragmentation also require further investigation. In particular, the interaction between internal and external processes is likely to be of critical importance.

3. Isolation factors need to be better understood. In particular, rates of genetic change in isolated populations require study, as does the question of whether reduction in genetic variability is important. We also require more and better data on the role of corridors in allowing biotic (and hence genetic) movement in fragmented landscapes.

4. While theoretical studies have their place, there is an urgent need for field experimentation in both management and restoration. While such experiments are costly to set up, it is possible to make use of many situations that offer ready-made experiments. Our understanding of succession has benefited greatly from the study of abandoned old fields, and in the same way, we can use current or past management activities as large-scale experiments; there is plenty of experimental material around (McNab 1983; Hopkins & Saunders 1987; Pimm 1986; Jordan et al. 1987; Hobbs & Hopkins 1990). Research has much to gain from a close liaison with management, especially if management operations actually can be carried out as designed experiments and the results suitably monitored.

Conclusions

Emphasis in the literature has been on the design of nature reserves, but we are usually too late to do any. thing except try to maintain the remnants left following fragmentation. Emphasis alsohas been on biogeography explanations for the patterns of species Loss after fragmentation, whereas a whole suite of physical and biotic parameters are significantly altered in the fragmented system and have significant impacts on remnant biota. In particular, the switch from predominantly internally driven to predominantly externally driven dynamics is a key factor in the fragmented system. Management and research should focus on this factor. There is a pressing need for an integrated approach that treats the landscape as a whole instead of as a collection of separate biotic and legal entities.

Acknowledgments

We are grateful to Francis Crome, Harry Recher, Michael Soule, and two anonymous referees for their constructive comments on the manuscript.

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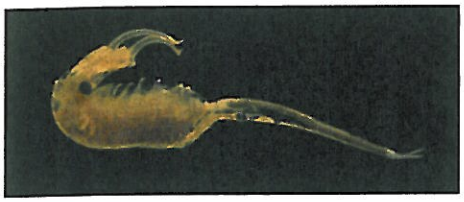
any ability of leaf cells to tolerate dehydration—they can remain active only as long as water uptake continues. Such leaves are "cheap" to produce, and therefore, their disposal in the face of drought represents only a small cost to the overall economy of the plant. So, there is a frenzy of physiological activity, but no expectation that these soft root and leaf tissues will be used for more than a few weeks. Once the soil water runs out, the cheap parts are shed and life recedes into the persistent, woody skeleton. Other weak storms in the same year can elicit other such frenzies, but an inch or so of rain is required for new stem growth and production of the bright profusion of tubular, red flowers.



An adult Alkali Fairy Shrimp, almost half an inch long, swims in the ephemeral waters that collect on a playa. (Hugh Clifford)

Alkali Fairy Shrimp

Embedded within the alkaline surface of the driest, dustiest playas of the central Mojave Desert are billions of eggs of Alkali Fairy Shrimp *(Branchinecta mackini)*. The eggs, only 1/125 of an inch across but numbering 50 to 600 per square foot, are dormant and waiting for the next good storm. The storm must produce enough standing water to last at least a week for the eggs to begin hatching. The "trigger " mechanism is unknown but could involve sensing oxygen, salinity, or temperature within the top inch of wetted sediment. It is known, however, that the duration of hatching is tightly controlled by the rate of increase in pond salinity—more and more eggs remain dormant as salts are concentrated by evaporation and lack of rain. But once stimulated to hatch, the shrimp grow rapidly (up to one inch) and become reproductive within one or two weeks, depending on temperature. During that time they establish a miniature food web of ephemeral organisms, including bacteria (feeding on clay particles and bits of organic matter), green and blue-green algae (primary producers), herbivores (the Alkali Fairy Shrimp), aquatic predators (*B. gigas*, the largest known fairy shrimp, three inches long), and migratory birds. Each female shrimp becomes an egg-laying machine, continuously laying up to 2,000 new eggs that settle into the drying but life-filled playa.

Desert Tortoise

As they emerge from burrows in early spring, Desert Tortoises *(Gopherus agassizii)* learn if the winter has been wet or dry. A wet winter in the Mojave Desert produces a bumper crop of lush, green annual herbs to eat and leaves behind small puddles of water to drink. The herbs, especially native buckwheats

The Desert Tortoise will drink from winter puddles and eat succulent native annuals to rehydrate. (Gerald and Buff Corsi)

(Eriogonum), lupines *(Lupinus)*, marigolds *(Baileya)*, and gilia *(Gilia)* replenish the long-hibernating animals with carbohydrates, fats, and proteins. New leaves, almost bursting with succulence, also supply water that toothless jaws squeeze from the tissues. The lumbering animals complete hydration by lapping at local puddles, when available. Uric acid crystals and potassium salts that have accumulated in bladders over the winter are finally flushed out, probably with great relief. From February to April or May, the primary activity of Desert Tortoises is grazing native annuals to obtain the fuel and water needed for mating, egg laying, hiding from predators, and improving their burrows. A full state of hydration allows them to extend their activities into the summer (including two or possibly three clutches of eggs until July) by browsing dead leaves and stems.

After a dry winter, emerging animals learn how little their replenishment will be. Instead of native annuals (which remain dormant in the seedbank), much of the green material is composed of opportunistic, nonnative weeds. The Desert Tortoise will eat these unpalatable species, often low in protein and tough to chew, but the energy required for growth and reproduction may not be obtained. Native shrubs and cacti are the next preferred sources, but even new leaves and stems may not contain much water under drought conditions. These foods also contain large amounts of potassium, which become concentrated in blood plasma when urination does not occur. The water conserved in the bladder (up to 40 percent of body weight) is not used to flush uric acid and salts but kept as a reserve to allow further precipitation of metabolic waste. The tortoise must then tolerate the buildup of minerals because it lacks the nasal salt glands of chuckwallas and roadrunners that would allow excretion. Thus, water conservation becomes critical to sustaining the search for more plant resources. Travel outside of the burrow becomes confined to early morning and early evening. Shade cast by shrubs is used as temporary refuge from high temperatures and predators. The scale-covered shell and horny skin lose no water to the hot, dry wind, but refuge is frequently taken in burrows, where temperatures are 20 to 30°F cooler and the humidity is three or four times higher. If the spring remains dry, plants will "brown up" early and become indigestible to a dehydrated animal. Mating activities are then suspended, but some hard-shelled, waterproof eggs may be fertilized using one- or two-year-old sperm stored in the female cloaca (reproductive and excretory tract) since the last good spring. The eggs won't start hatching for another three or four months, but adults must still avoid the year's worst drought and heat. They are forced to retreat into burrows and enter into a state of summer hibernation (sometimes called aestivation). Heart rate, breathing, digestion, and waste disposal are all reduced in favor of minimizing water loss and maximizing the chances of surviving until the next good rain.

The Desert Tortoise is widely distributed across deserts in North America. A southern race of solitary, bajada-dwelling animals digs shallow burrows in rocky soils of the Sonoran Desert in Arizona and Northern Mexico. A northern race of communal, basin-dwelling animals digs extensive burrows (up to 35 feet long) in loamy soils of the Mojave Desert of California, southern Nevada, and southwestern Utah. Perhaps these races represent

two lineages that were affected in different ways by climate change during and after the Pleistocene. The southern race would have been minimally affected by distant glacial environments and thus remained similar to ancestral tortoises in its behaviors. The northern race, however, would have been exposed to the full brunt of changes in climate, hydrology, soils, and biotic communities. Vast areas of once suitable habitat became too cold, wet, and dominated by large, dangerous predators. Populations of tortoises shrank or were extirpated, leaving behind those that could endure Pleistocene conditions by sharing deep burrows at the lowest available elevations. Male aggressiveness would have been selected against, while fast and tenacious digging favored escape from predators and extreme temperatures. In the modern Mojave Desert, these same behaviors allow persistence under hot and dry environments at the northern edge of their range. Although speculative, this scenario explains much about the current distribution of the Desert Tortoise in California, where populations reach the highest densities known for the species—up to 578 per square mile.

Costa's Hummingbird depends on nectar-producing flowers to meet its metabolic energy requirements. (Stephen Dowlan)

Costa's Hummingbird

Many hummingbirds are capable of long-distance migration, but Costa's Hummingbird *(Calypte costae)* resides in the lower-elevation deserts of southern California, southern Nevada, Arizona, and northern Mexico. It is strongly attracted to tubular, red flowers that produce large amounts of nectar—the complex, watery, energy-rich reward produced by glands at the base of petals of beardtongues *(Penstemon)*, ocotillo, chuparosa *(Justicia)*, and boxthorn *(Lycium)*. Nectar and small insects comprise a high-octane diet that supports a supercharged metabolism and extraordinary flight capabilities. During their peak of spring activity, they daily consume 70 percent of their body weight in food and four to eight times their body weight in water. But how do these requirements relate to drought avoidance?

The energy requirements of these hummingbirds are best met during the spring and early summer, when nectar flowers are open and insects are most active and abundant. A food-producing window of five or six weeks is necessary to lay and incubate eggs, hatch and feed nestlings, and finally fledge the young. After the window closes, both adults and youth must take advantage of whatever meager resources are available during the rest of the year. Late-flowering plants and summer cohorts of insects provide less abundant and nutritious foods, but energy demands of the hummingbird body may greatly exceed the total energy supplied. Cold nights and long-distance flights are especially draining, so Costa's may enter a state of torpor. Torpor in a hummingbird is a temporary, nighttime reduction of metabolic activity. Body temperature drops 20 to 30°F (from 105°F), heart

MADROÑO, Vol. 53, No. 3, pp. 264–274, 2006

CONSERVATION OF PERIPHERAL PLANT POPULATIONS IN CALIFORNIA

GORDON LEPPIG
California Department of Fish and Game, Northern California-North Coast Region, Habitat Conservation Program, 619 Second St., Eureka, CA 95501
gleppig@dfg.ca.gov

JEFFREY W. WHITE
Department of Biological Sciences, Humboldt State University, Arcata, CA 95521
jww12@humboldt.edu

ABSTRACT

The conservation of peripheral plant populations is paradoxical. Populations occurring on the edge of a species' range tend to be smaller, more isolated, and more genetically and ecologically divergent than central populations. The combination of these characteristics can impart novel evolutionary potential and local ecological significance, thus heightening their conservation value, while also making them less viable and more prone to local extinction. Public policy supports the conservation of peripheral populations, despite the commonness of the species elsewhere. However, the conservation of significant peripheral populations of nonlisted plants has been arbitrary and ineffective. The absence of explicit criteria to determine the conservation value of peripheral plant populations, the lack of finer-scale data on plant distributions, and a general unawareness of their value have hindered efforts to conserve them. We review the conservation value of peripheral plant populations and, using California as an example, describe regulatory methods to improve their conservation. We also propose a scheme to assess a population's conservation value.

Key Words: California flora, CEQA, HCP, local rarity, NCCP, peripheral populations, rare plants.

Peripheral populations occur on the geographic edge of a species' range. Depending on the scale used to define them, peripheral populations can be completely isolated from conspecifics, and therefore considered disjunct, or can occur in closer proximity to other marginal populations. While the evolutionary significance of peripheral populations has long been recognized, other than for rare, threatened, or endangered species, their conservation value typically receives little attention.

In this paper, we review the conservation value of peripheral plant populations. Using California as an example, we highlight how regulatory policy can and should be utilized to conserve biologically and culturally significant peripheral populations of otherwise-common species. We also propose a scheme to assess the potential conservation value of peripheral populations.

Due to their geographically marginal location, peripheral populations tend to exhibit lower and more-variable densities and are more fragmented than central populations in a species' range (Fig. 1) (Mayr 1970; Lawton 1993; Channell and Lomolino 2000; Gaston 2003). For plants, peripheral populations are more likely to be influenced by different selective factors than central populations, including climate and soils, plant community assemblages, and disturbance regimes (e.g., fire intensity and interval). Ecologically distinct peripheral populations also can occur when geographically marginal populations occupy suboptimal or different habitats than more-central conspecifics (Soule 1973; Hoffmann and Blows 1994; Lesica and Allendorf 1995). Morphological or ecological divergence in peripheral populations resulting from differing geographic selection regimes is one form of clinal variation and can be a precursor to speciation (Mayr 1970; Garcia-Ramos and Kirkpatrick 1997). Due to the greater influence of population bottlenecks, founder effect, and genetic drift, peripheral populations can be genetically distinct from central populations. These differences in genetic structure can result in distinct genotypes and phenotypes and impart enhanced evolutionary potential for adaptation and speciation (Levin 1993; Garcia-Ramos and Kirkpatrick 1997; Lammi et al. 1999). Thus, the combination of geographic isolation and genetic divergence driven by directional selection can give peripheral populations novel evolutionary trajectories, in comparison to central populations (Lesica and Allendorf 1995; Nielsen et al. 2001; Gaston 2003). The isolation and decreased population size or abundance of peripheral populations, for instance, strongly favors the evolution of self-compatible breeding systems in otherwise self-incompatible species (Busch 2005).

Small, isolated populations, as often occur on the periphery of a species' range, also tend to have lower levels of heterozygosity and allelic variation than larger, more-central populations (Lesica and Allendorf 1992, 1995; Lawton 1993;

In comparison to core populations, peripheral populations tend to:

- be smaller,
- have more-variable densities,
- be ecologically distinctive,
- occur in marginal habitats,
- experience different selective regimes,
- have restricted gene flow,
- undergo greater rates of genetic drift,
- have less genetic variation,
- have increased population-level differentiation,
- have greater extirpation risk, and
- be morphologically similar

FIG. 1. Peripheral populations compared to core populations.

Lammi et al. 1999; Busch 2005) and thus may have decreased fitness and an increased risk of extirpation (Gaston 2003; Reed 2004). For this reason, the conservation of peripheral populations is controversial, because they tend to be less stable and are viewed by some as sink populations likely to be extirpated anyway, despite conservation efforts (Peterson 2001). By this rationale, the inclusion on state and federal endangered species lists of peripheral populations of species that are otherwise common and demonstrable secure elsewhere dilutes limited conservation resources that could be better focused on species with narrowly-restricted distributions or species of greater risk throughout their range (Peterson 2001).

However, the genetic diversity and structure and viability of a population is determined by many factors, including its degree of isolation and spatial pattern, gene flow, varying directional selection, and the species' reproductive strategies. Therefore, a population's viability can depend more on demographic structure and population dynamics (Bevill and Louda 1999) (e.g., whether the species is formerly common or historically rare [Brigham 2003]) than on its genetic structure. As well, lower levels of genetic diversity are not always associated with lower levels of fitness. For example, in a comparative study of central and peripheral populations of a rare European herb, *Lychnis viscaria* L. (Caryophyllaceae), Lammi et al. (1999) found that while genetic diversity was positively correlated with population size, no correlation was found between lower genetic diversity of peripheral populations and measured fitness characters such as seed set, seed germination, and seedling mass.

Contrary to Peterson (2001), under certain circumstances, geographic isolation actually predisposes peripheral populations to a greater survivorship than larger, more-central populations. In analyzing range contractions of 245 plant and animal species, Channell and Lomolino (2000) found that when species undergo catastrophic range contractions (>75%), populations on the edge of the range have significantly greater survivorship than core populations. This enhanced survivorship is the result of localized extinction events being primarily both anthropogenic and spatially autocorrelated. In other words, populations that persist the longest and act as refugia for a species tend to be those least (or last) affected by the spread of extinction forces (Channell and Lomolino 2000).

Thus, the conservation value of peripheral populations is paradoxical. On the one hand, peripheral populations can have enhanced ecological and evolutionary significance. On the other hand, this significance can be both a cause and a consequence of their isolation and small size and therefore correlated with reduced viability and increased extinction risk. While expert opinion is not unanimous about the conservation value of peripheral populations, the biological and intrinsic values of these populations are well documented and summarized as follows:

1) Their high potential for genetic distinctiveness and divergence can impart novel evolutionary pathways for future migration and speciation events (Levin 1993; Noss 1994; Lesica and Allendorf 1995; Garcia-Ramos and Kirkpatrick 1997; Nielsen et al. 2001; Gaston 2003).
2) The maintenance of genetic variation in the form of small, isolated populations contributes to long-term species survival and preservation of local genetic diversity (Millar and Libby 1991; Lesica and Allendorf 1992; Fiedler 1995; Lesica and Allendorf 1995; Lammi et al. 1999; Channell and Lomolino 2000; Caballos and Ehrlich 2002; Gapare and Aitken 2005; Gapare et al. 2005).
3) Even very widespread taxa (e.g., bison, sea otter, passenger pigeon, American elm, American chestnut) have been regionally extirpated or brought to the brink of extinction in a short time span (Nielsen et al. 2001).
4) Peripheral populations can have important local human values, (e.g., cultural, economic, and historical) regardless of how common the species may be elsewhere (Hunter and Hutchinson 1994; Gaston 2003).

Despite their conservation value, there are, at present, no explicit criteria to determine the conservation priority of peripheral populations. Lesica and Allendorf (1995) provide a useful theoretical framework for evaluating a population's conservation value that emphasizes the combination of geographic isolation and ecological distinctiveness as principal criteria. We agree that the degree of spatial isolation and ecological distinctiveness are the best criteria for assessing a population's conservation significance, especially in the absence of population genetics data. However, without some means to quantify or otherwise characterize spatial isolation or ecological distinctiveness, the conservation of these populations cannot be substantially improved during regional planning or the review of projects that may affect them. Furthermore, with the notable exception of Millar and Libby (1991), we find little guidance for conservation biologists on strategies to protect significant populations of widespread plants.

In this paper, we focus our discussion of conservation and land use planning strategies on California for the following reasons. First, California occupies a central biogeographic location and zone of ecological transition on the Pacific Coast of North America, so its floristic diversity includes many widespread taxa on the edge of their range. Second, California has the largest state flora in the nation and extraordinary topographic, geologic, and climatic habitat heterogeneity. Third, California has some of the strongest environmental regulations in the hemisphere, e.g., the California Environmental Quality Act (California Environmental Quality Act 2005) (CEQA), and the California Endangered Species Act; see Morey and Ikeda (2001) for an overview of state and federal laws and regulatory programs used to conserve California plants. Fourth, many of California's ecosystems and plant communities are highly threatened (Hobbs and Mooney 1998). California, for example, has a higher percentage of wetlands loss (an estimated 91 percent loss between the 1780's and 1980's) than any other state (Dahl 1990).

Reasons why Public Policy has been Arbitrary and Ineffective

Political Boundaries: a Conservation Tool and Impediment

Political boundaries, although not always arbitrary in their location, generally do not correspond with significant range boundaries for organisms. Interestingly, this lack of correspondence is less pronounced in the Old World, where political dynamics have more often coincided with constraints imposed by local terrain. In the New World, political boundaries were drawn after the onset of the Age of Reason and are more likely Cartesian or the results of formulistic procedures. As a result, political boundaries as a rule do not correspond with landscape discontinuities, with floristic provinces and districts, or with the conservation relevance of a population (Rodrigues and Gaston 2002).

Toward the periphery of many species' ranges, some populations are found to a lesser extent in the next political unit and are thus rare in that unit (Abbitt et al. 2000; Gaston 2003). A good example is *Sequoia sempervirens* (D. Don) Endl. (coast redwood) (Taxodiaceae), primarily a California species whose range extends into the state of Oregon, where it is rare. Other species exhibit the same pattern because the California Floristic Province extends into southwestern Oregon.

Because conservation efforts, both public and private, are primarily organized and managed within political units, conservation classification schemes routinely take differing geographic units into account in order to capture regional rarity as well as global rarity. Examples include the California Native Plant Society's (CNPS) Inventory of Rare and Endangered Plants, which includes List 2 (plants rare, threatened, or endangered in California, but more common elsewhere) and a RED code combination (i.e., rarity, endangerment, and distribution) that includes D = 1 (distribution is more or less widespread outside of California) (California Native Plant Society 2001). State heritage programs with ranks such as G5S1 (globally common and widespread, extremely rare and restricted in California) portray a similar geographic distribution (California Natural Diversity Database 2005). In these cases, the range of taxa extends into California to a sufficiently small degree that they are considered rare here.

Conservationists have typically accorded less concern to taxa in these circumstances than they have given to globally rare species. We agree with this general approach. Nevertheless, we contend that it is precisely those "state rare but globally widespread" species that provide the opportunity to reexamine peripheral populations for their conservation significance. Furthermore, a G5S1 RED code status illustrates an important consideration regarding the conservation of populations in these circumstances—namely, that they may warrant heightened conservation status, not because they happen to fall within a political boundary that makes them rare, but rather because they are much more likely to be peripheral populations having the attributes described earlier (Abbitt et al. 2000). Thus, conservationists seeking to preserve the unique and rare plants within their political boundaries also may be helping to conserve widespread species by focusing on their peripheral populations (see Hunter and Hutchinson 1994).

Conservation of Taxonomic Units Emphasizes Morphological Distinctiveness

Among the many important traits that allow plants to persist, morphological variation is crucial and is recognized for its importance. Coarse-level morphological variation is the preferred class of attributes used for plant identification and, before the advent of formal taxonomy, served as the basis for the so-called folk taxonomies. Moreover, morphological variation, in circumscribable and repeated patterns of distinctiveness, continues to be the primary basis for distinguishing among formal taxonomic units. In other words, variation among populations that results in morphological distinctness is more likely to lead to unique taxonomic status (Panchen 1992). Given that taxa (both species and subspecific taxa) are the principal units that are accorded conservation priority (when certain criteria are met), we argue that important classes of biologically significant variation are routinely overlooked as a basis for conservation efforts.

The significance of this issue is illustrated in the hypothetical examples shown in Figure 2. For these two scenarios, we consider the identical geographical distributions of populations: one large core range of populations in proximity to each other with an overall widespread geographic extent, and one small range of peripheral populations. In this case, the populations are also disjunct and largely isolated from the core. Under scenario A, disjunct populations are morphologically similar to the core populations, and thus given equal taxonomic status, called Taxon 1. In scenario B, while the populations also are closely related, the disjunct populations have distinctive morphological variation that leads to a unique taxonomic status, one for the core populations, Taxon 2, and one for the peripheral populations, Taxon 3. Thus, they are also sister species. These two scenarios portray the differing taxonomic results for two otherwise-equal geographic distributions of populations. What if the disjunct populations in scenario A (Taxon 1) have unique substrate or temperature tolerances? What if their underlying genomic variation is substantially different from the core population? What if they produce unique secondary compounds that afford them herbivore or disease resistance? All of these are possible and, indeed, are more likely in peripheral populations. Yet, they would not receive conservation status under scenario A, while they would under scenario B.

Assessing Conservation Criteria, Values, and Priorities

Although theoretical rationales for conserving peripheral populations are well developed, practical methods for evaluating their conservation value are compromised by the difficulty of collecting data, or by the fact that existing data are not organized specifically for this purpose. Nevertheless, a number of authors have proposed useful criteria for assessing the conservation value of peripheral or other special plant populations; these include isolation and distance, as well as genetic, environmental, evolutionary, life history, threat, and utilitarian attributes (Millar and Libby 1991; Holsinger 1992; Hunter and Hutchinson 1994; Schemske et al. 1994; Lesica and Allendorf 1995; Nielson et al. 2001).

Many of these categories overlap or are highly correlated. For example, environmentally distinctive populations are likely to be genetically distinctive, and thus may have greater evolutionary potential, depending on a number of other circumstances. Also, distantly isolated populations are more likely to be genetically distinctive, or occupy habitats that differ from core populations. As satisfying as these categories are biologically, they are not equal in terms of setting and implementing criteria for conservation.

Assessment of genetic distinctiveness should be a primary means for identifying peripheral populations of high conservation value. Indeed, because of the number of population genetic studies of plant populations, we have learned that significant levels of genetic variation often do not correlate with the features used for taxonomic demarcation. Genetic variation among populations is important because it is the basis for both environmental distinctiveness and evolutionary change. We agree that studies of these kinds should be conducted whenever possible. Unfortunately, genetic data are expensive and time consuming to retrieve and are not available for most California plant populations, with the exception perhaps of commercially important conifer species. Given the rate at which plant habitat is being lost and peripheral populations are disappearing, a practicable approach is needed to evaluate the conservation value of a given population.

Here, we propose three categories of criteria for evaluating the conservation significance of a peripheral population: 1) geographic isolation, 2) environmental distinctiveness, and 3) intrinsic human values. The first two criteria derive from Lesica and Allendorf (1995), who emphasize the importance of genetic drift and intensity of selection. The third criterion derives from many sources, but is well articulated by Hunter and Hutchinson (1994). These three attributes are the easiest to assess among all the criteria discussed above. Those populations that meet one or a combination of these criteria should be accorded a greater conservation value. Those that are also threatened or endangered should be given even greater value.

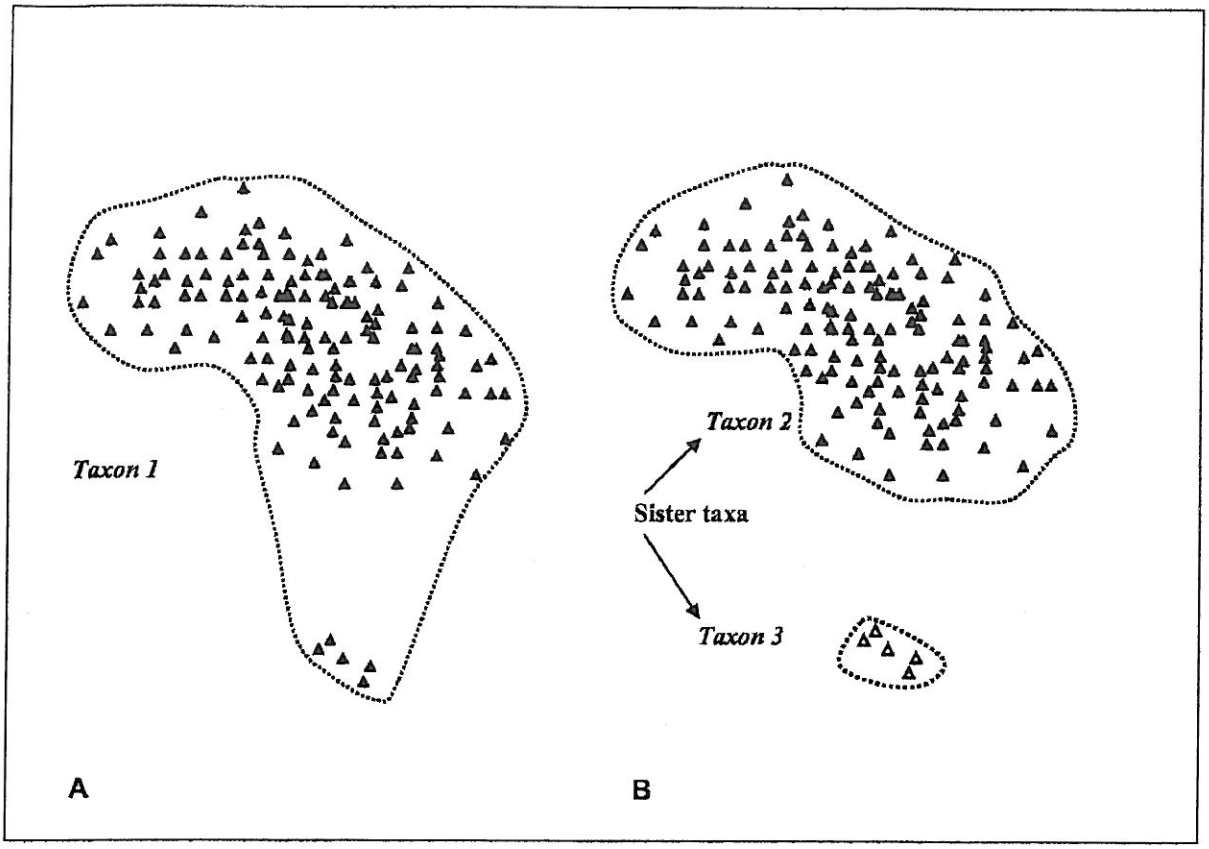


FIG. 2. Geographical distributions of two hypothetical scenarios that include a peripheral population. A) The peripheral populations are taxonomically part of *Taxon 1*. B) The peripheral populations, *Taxon 3*, are the sister species, or a closely related congener, to *Taxon 2*, the core population.

Geographic isolation criterion. Populations that are distant from core populations are, by definition, more likely to be on the periphery and thus be considered peripheral or, in some cases, disjunct populations. Also, the greater the distance from core populations, the more likely peripheral populations are to be genetically isolated and have distinctive traits with evolutionary importance. This criterion thus formalizes focusing on peripheral populations and has a significant biological rationale for inclusion.

This criterion should reflect distances that correspond to an evolutionarily significant degree of genetic isolation between peripheral and core populations. In some cases, nearest neighbor population distances will provide suitable comparative distances. However, consideration should be given to the overall geographic structure of the species' range and the specific methods used to characterize them (Gaston 2003; White 2004). The application of this criterion should also take into account life history attributes (e.g., mode of pollination, seed dispersal, life span). Because life histories vary greatly, no standard measure of geographic isolation can be utilized to assess the conservation significance of populations among diverse taxa.

Environmental distinctiveness criterion. Populations that occupy unusual or unique habitats are likely to have unique genetic traits, when compared to populations occupying core areas of the range (e.g., peripheral populations associated with community types, vegetation stands, or habitats that differ significantly from core populations). Populations in environmentally distinct locations are also more likely to have evolutionary significance. Thus, we consider environmental distinctiveness another critical category.

To more explicitly assess both environmental distinctiveness—and, to some degree, the functional spatial isolation of a peripheral population—we propose using the geographic subdivisions of Hickman (1993). Hickman utilizes a nested, four-tiered system of provinces, regions, subregions, and districts to divide California into meaningful biogeographic units. These subdivisions are, to the greatest extent possible, based on three main biologically relevant criteria: topography, climate, and vegetation type (Hickman 1993). For example, if a population is unique to a given subdivision or is isolated from conspecifics by one or more differing subdivisions, then this population would have, by definition, greater environmental and geographic distinctiveness

and isolation than would a peripheral population occurring in the same subdivision as the rest of its distribution. This approach benefits from being easily replicated outside of California by utilizing similar biogeographic subdivisions (e.g., those of Cronquist et al. 1972; Takhtajan 1986; Ricketts et al. 1999; Oregon Natural Heritage Program 2001).

Intrinsic human values criterion. Finally, conservation biology is highly value laden. The many, often idiosyncratic, and sometimes competing human values, ethics, and predilections play an important role in the conservation decision-making process (Noss 1994). There is general agreement that a population's cultural, economic, historic, and even aesthetic value enhances its conservation value. Local humans often assign important intrinsic values to local species, if for no other reason than they like having them on their landscape. Leopold (1949) captured this sentiment well: "Relegating grizzlies to Alaska is about like relegating happiness to heaven; one may never get there." Therefore, all things being equal, peripheral populations that have important human values would have greater conservation value than those that do not (see also Holsinger 1992). It is important to note that societal values change through time and that through education and effective public relations, the conservation community affects this change.

Examples of Populations that Merit Conservation

Here, we give three examples of taxa (Sitka spruce, lodgepole pine, and various orchid species) with relatively widespread California distributions possessing regionally significant populations with conservation value. Nomenclature follows Hickman (1993).

Picea sitchensis (Bong.) Carr. (Sitka spruce) (Pinaceae) is a Pacific Northwest coastal conifer and economically important timber tree, occurring from Alaska to northern California. Sitka spruce has a continuous distribution that terminates just south of Humboldt Bay in Humboldt County; however, a disjunct population occurs near Fort Bragg, Mendocino County, approximately 100 km to the south (Smith and Wheeler 1992; Lanner 1999).

In a comparative study of the genetic diversity of Sitka spruce throughout its range, Gapare et al. (2005) determined that peripheral and core populations have similar measures of heterozygosity; however, the only allele they classified as rare and localized was limited to disjunct and peripheral populations, including the Fort Bragg population. Gapare et al. (2005) demonstrate that peripheral and disjunct populations of this species have value for *in situ* conservation of rare alleles. In a related analysis, Gapare and Aitken (2005) found strong spatial genetic structure in peripheral populations, but not in core populations. This striking difference in the distribution of genetic variation among Sitka spruce population classes has important implications for size and location of *in situ* reserves and sampling strategies for *ex situ* conservation and research collections (Gapare and Aitken 2005).

Thus, this disjunct Fort Bragg Sitka spruce population has regional ecological, evolutionary, and economic significance because of its rare genetic geographic variation and dominance in local forest community structure.

Pinus contorta Dougl. ex Loud. (lodgepole pine) (Pinaceae) is a conifer widely distributed from the Yukon south to California and the Rocky Mountains, with a disjunct population in Baja California. It is extremely ecologically variable, with four named geographic subspecies (Critchfield 1957, 1980). It is a dominant tree species in many montane and coastal regions of western North America, and as such, is important both ecologically and economically. All four subspecies of lodgepole pine are represented in California, with northern California having much higher levels of heterozygosity and allelic diversity, compared to more northern and Rocky Mountain populations (Oliphant 1992).

In the Klamath Region of northern California, an undescribed lodgepole pine race, or ecotype, occurs on ultramafic substrates (serpentine soils). This race is referred to by Griffin and Critchfield (1972) as "an unnamed closed-cone race in the low mountains of Del Norte County" and by Critchfield (1980) as the "Del Norte race." Oliphant (1992) found that Del Norte race populations have low levels of expected heterozygosity and possess a suite of rare alleles; however, none are unique to the race. Kruckeberg (1967) demonstrated a differential growth response, with plants from non-ultramafic soils growing slower than plants from ultramafic soils when grown on an ultramafic substrate. Populations of the Del Norte race probably represent a distinct serpentine ecotype (Oliphant 1992). Though lodgepole pine is a common species in California and western North America, these Del Norte race populations occupy edaphically extreme sites and represent environmentally peripheral occurrences with unusual genotypes.

Coleman (1995) presents the county-wide and regional distribution and conservation implications of California's native orchid flora (Orchidaceae). Although many of California's orchid species are widely distributed, Coleman elucidates why marginal populations in southern California and the Santa Cruz Mountains are sufficiently isolated and threatened to warrant conservation efforts. These taxa all have geographic ranges that extend at least as far north as Washington.

According to Coleman (1995), orchid populations on the edge of their range in southern California are threatened for the following reasons: 1) populations are extremely rare in San Bernardino and San Diego Counties and large populations in San Luis Obispo and Santa Cruz Counties have been lost to urbanization (*Spiranthes romanzoffiana* Cham.); 2) recent attempts to locate southern California populations have been unsuccessful (*Spiranthes porrifolia* Lindley); 3) populations are so few and tiny that the species could be eliminated from an entire county by a single stochastic event or timber harvest (*Piperia leptopetala* Rydb.); and 4) species apparently have been extirpated from the Santa Cruz Mountains by habitat destruction (*Cypripedium fasciculatum* S. Watson and *C. montanum* Lindley).

Unlike the two previous examples, we have no data that indicates these orchid populations are genetically or environmentally distinct. Orchids are however one of the most charismatic components of the California flora and are revered by lay naturalists and biologists alike for their beauty and unusual reproductive biology. For example, southern and central California alone has over six orchid societies, and their importance in the horticultural trade is manifest. Therefore, we contend that given the intrinsic value placed upon these species, their regional rarity, and documented habitat loss and range contractions, these scarce southern California and Santa Cruz Mountains orchid populations warrant protection during regional conservation planning efforts and review of projects potentially impacting or eliminating them.

Regulatory Process

California Environmental Quality Act

Here we review certain regulatory programs that could be more effectively used to conserve significant peripheral plant populations. In doing so, we aim to better integrate current understandings about the biological attributes of peripheral and disjunct populations with the broader aims of the California regulatory framework.

CEQA, together with the California and federal Endangered Species Acts (CESA and FESA, respectively), is a principal tool used to conserve rare and endangered species in California. CEQA is landmark legislation that requires (with some exceptions) that potentially significant environmental impacts resulting from a proposed project (e.g., a housing development, dam installation, or timber harvesting plan) be disclosed to the public and reviewing state agencies. Furthermore, CEQA (section 21002) states that (again, with exceptions) public agencies should not approve projects that do not include feasible alternatives or mitigations that will avoid or substantially lessen significant effects, when such feasible alternatives or mitigations exist (California Environmental Quality Act 2005). Article 9 of CEQA, Contents of Environmental Impact Reports [section 15125 (c)], states "Knowledge of the regional setting is critical to the assessment of environmental impacts. Special emphasis should be placed on environmental resources that are rare or unique to that region and would be affected by the project."

CEQA is of fundamental importance to plant conservation, because it addresses potential impacts to any species that can be shown to meet the criteria for state or federal listing (section 15380[d]) (California Environmental Quality Act 2005), as well as to CESA and FESA listed species. Yet, to our knowledge, CEQA rarely has been utilized to protect peripheral or otherwise locally significant populations of widespread plant species if the species could not be considered endangered, rare, or threatened pursuant to CEQA (section 15380[d]). Despite this, a fair argument can be made by public agencies and conservationists that potentially significant impacts to these populations must be disclosed and avoided if: 1) the population is locally rare or unique (pursuant to CEQA section 15125 [c]) and therefore may have intraspecific variation and potential evolutionary significance; 2) the population has regionally significant ecological importance; and 3) the population has local cultural, economic, or historic value.

Regional Conservation Planning

In California, land use planning on nonfederal lands is done on the local scale—most commonly through municipal and county general plans. However, regional planning also occurs under the auspices of state Natural Community Conservation Plans (NCCPs) Natural Community Conservation Planning Act (2002) and federal Habitat Conservation Plans (HCPs). NCCPs and HCPs in California are regional conservation planning tools used to protect habitats of CESA and FESA listed and potentially listed species across a large area. A principal objective of NCCPs is to bring about species recovery by protecting natural communities on which the species depends. The principal federal objective of an HCP is to minimize and mitigate impacts to listed species to the maximum extent practicable. Land owners often enter into HCPs because it is the only means to receive an incidental take permit for a federally listed species. An incidental take permit is a permit to incidentally "take" (kill) a listed species during the course of an otherwise-legal activity.

NCCPs and HCPs both hold greater promise in conserving listed species and significant por-

tions of their habitat, or even entire ecosystems, than project-by-project mitigations (Noss et al. 1997; Rolfe 2001; Hopkins 2004). Regional conservation plans are also potentially much more effective in protecting habitats and species from large-scale, spatially autocorrelated threats such as urbanization, climate change, sea-level rise, and invasive species, most of which typically are not addressed or mitigated for effectively by smaller projects outside the HCP/NCCP realm. Regional conservation planning is potentially more effective in addressing cumulative impacts than are multiple, smaller-scale projects subjected to CEQA individually (Noss et al. 1997; Hopkins 2004). This is because cumulative impacts assessment is essentially a large-scale and rate-determined process not well suited to smaller, multiple, ongoing, regionally concentrated projects such as timber harvesting plans in a watershed or urban sprawl in the Central Valley.

However, as reviewed by Rolfe (2001), NCCPs and HCPs have significant shortcomings and incongruous objectives due to their reliance on take permits under FESA Section 10(a) and CESA Section 2835. Simply put, the FESA and CESA are reactive responses to species in jeopardy of extinction, while regional conservation plans are ostensibly a proactive approach to prevent the decline of species in the first place (Rolfe 2001). While NCCPs aim to promote multispecies and multihabitat management and the conservation of broad-based natural communities and species diversity, the impetus to initiate one is typically the conservation of listed or potentially listed species.

County general plans and ordinances are another important yet underutilized tool to conserve peripheral populations and other locally significant species and habitats. Santa Cruz County, for instance, has a "Sensitive Habitats Protection Ordinance" that requires that no development activities or land disturbance that results in disturbance to ". . . locally unique plants and animals or their habitats" can occur until a biotic review is conducted and necessary mitigation measures are developed to protect the habitat (Santa Cruz County Planning Department 2005). The Ventura County, California General Plan specifies that "locally important species/communities" are a significant biological resource to preserve and protect (Ventura County 1988).

Millar and Libby (1991) suggest that important populations of widespread species be conserved, in part, by the creation of "genetic resource management units" (GRMUs). These GRMUs can be, in essence, wilderness areas, botanical areas, or lands covered by a NCCP/HCP, if their management objective is the *in situ* conservation of biodiversity at the regional genetic-variation level. We agree with Millar and Libby (1991) on the necessity of creating GRMUs to conserve regional genetic diversity, and we recognize that simply by protecting large areas, NCCPs and HCPs can also protect significant peripheral populations. However, the full potential of regional conservation plans and other designated conservation areas in protecting regionally significant peripheral populations cannot be realized until their importance is better appreciated, actual populations are identified, and most importantly, their conservation priority is integrated into the management objectives of these regional plans.

Currently, there are 22 NCCPs being developed in California and nine that have been approved and permitted. All of these NCCPs are joined with an HCP and are typically 50-to 80-year agreements. Together, these 31 NCCPs cover over seven million acres (28,328 km^2), representing approximately seven percent of California. This is, therefore, a propitious time to emphasize the significance of peripheral populations during regional planning.

Need for more Accurate Delineation of Local Floras

Closer scrutiny of local floras and phytogeographic patterns is required to identify peripheral populations having significant conservation value. A principal impediment to the conservation of locally significant peripheral populations is the relative absence of finer-scale data on species distributions. Presently, the general geographic distribution of common species, such as those not tracked by CNPS, is understood only at the county-level scale, (for example Munz 1959, 1968), and therefore is of limited use in conservation planning because the spatial scale is too coarse.

Recently, however, CNPS chapters and others have begun compiling regional lists of peripheral, disjunct, or what has been termed "locally rare" taxa, in an effort to conserve them (Lake 2004; Magney 2004). Other regional and county floras (such as Thomas 1961; Hoover 1970; Smith and Wheeler 1992), although outdated, provide important data on peripheral populations (many now extirpated). Thomas (1961), for instance, lists 181 taxa with their southern geographic limits and 61 taxa with their northern limits in the Santa Cruz Mountains. We encourage the continued documentation and compilation of local floras and peripheral populations and otherwise regionally significant plant lists as a first step in understanding their conservation value and protecting them where appropriate.

Local floras are also important tools for identifying where concentrations of regionally and locally significant populations occur (i.e., biodiversity hotspots, potential reserve sites,

and finer-scale ecological boundaries) (Araujo 2002; Leppig 2004). Heckard and Hickman (1984), for example, demonstrate how a detailed local flora can highlight the conservation significance of a location due to its high concentration of peripheral plant populations. In the absence of more-spatially explicit data on plant species distributions, locally significant peripheral plant populations will continue to be unknowingly extirpated with no attempt to conserve them.

Lastly, the variation in size of county-level political units—both within California and among states—hampers effective comparative analyses and uniform application of conservation criteria. To ameliorate this problem, we advocate the use of methodologies based on 5 km × 5 km grids for characterizing plant distributions. Although some limitations and cautionary notes should be considered when using these methodologies (White 1999, 2004), they have been used effectively elsewhere (IUCN 2001; Pearman and Dines 2002) to accurately describe plant spatial patterns.

Summary Considerations

The evolutionary significance—and therefore conservation value—of peripheral populations is well documented, as is the greater threat of their extirpation. However, in our opinion, their value has yet to enter the zeitgeist of the conservation community. Peripheral populations have remained, at best, a marginal component of conservation planning since Millar and Libby (1991) first called attention to the conservation of significant populations of widespread species 15 years ago. In this paper, we emphasize populations rather than taxa, genetic diversity over taxonomic diversity, and evolutionary potential and processes over floristic maintenance. Thus, we have attempted to change how conservationists view rarity and commonness, and the scale and structure at which rarity typically is assessed. We hope to have also stimulated discussion and debate on this subject.

Our goal here is not to throw out the existing conservation structure, with its emphasis on listed, endangered, and narrowly endemic species, but rather to shift the conservation paradigm to include a different and typically overlooked suite of rare plants—those on the frontiers of their range. Endangered species and species rare throughout their range should, of course, be accorded high conservation priority. However, to optimize conservation planning and the long-term persistence of floristic diversity, conservationists also need to look beyond rare and endangered species and their habitats. Not all peripheral populations are worthy of conservation, but many clearly are. Identifying which populations warrant conservation efforts poses a continuing challenge. More genetic data, a better understanding of how metapopulation theory applies to these populations, and an even more-explicit approach than we present here for assessing conservation significance will clearly help.

We acknowledge that conservation resources are scarce, and will likely remain so. However, in our view, placing greater conservation emphasis on certain important peripheral populations will not necessarily take scarce resources away from species in perhaps greater need; rather, it will enhance current conservation efforts and large-scale regional planning.

Acknowledgments

This paper stemmed from discussions of the California Native Plant Society Locally Rare Working Group. We thank that group, the California Department of Fish and Game Botanical Working Group, and the members of the Biodiversity Research and Education Center at Humboldt State University for helpful conversations about these ideas and for providing many useful comments, information, and insight. John C. Hunter and two anonymous reviewers provided numerous suggestions and careful review that greatly improved this manuscript.

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Exhibit #1003

PUBLIC RESOURCES CODE
SECTION 21000-21177

21000. The Legislature finds and declares as follows:

(a) The maintenance of a quality environment for the people of this state now and in the future is a matter of statewide concern.

(b) It is necessary to provide a high-quality environment that at all times is healthful and pleasing to the senses and intellect of man.

(c) There is a need to understand the relationship between the maintenance of high-quality ecological systems and the general welfare of the people of the state, including their enjoyment of the natural resources of the state.

(d) The capacity of the environment is limited, and it is the intent of the Legislature that the government of the state take immediate steps to identify any critical thresholds for the health and safety of the people of the state and take all coordinated actions necessary to prevent such thresholds being reached.

(e) Every citizen has a responsibility to contribute to the preservation and enhancement of the environment.

(f) The interrelationship of policies and practices in the management of natural resources and waste disposal requires systematic and concerted efforts by public and private interests to enhance environmental quality and to control environmental pollution.

(g) It is the intent of the Legislature that all agencies of the state government which regulate activities of private individuals, corporations, and public agencies which are found to affect the quality of the environment, shall regulate such activities so that major consideration is given to preventing environmental damage, while providing a decent home and satisfying living environment for every Californian.

21001. The Legislature further finds and declares that it is the policy of the state to:

(a) Develop and maintain a high-quality environment now and in the future, and take all action necessary to protect, rehabilitate, and enhance the environmental quality of the state.

(b) Take all action necessary to provide the people of this state with clean air and water, enjoyment of aesthetic, natural, scenic, and historic environmental qualities, and freedom from excessive noise.

(c) Prevent the elimination of fish or wildlife species due to man' s activities, insure that fish and wildlife populations do not drop below self-prepetuating levels, and preserve for future generations representations of all plant and animal communities and examples of the major periods of California history.

(d) Ensure that the long-term protection of the environment, consistent with the provision of a decent home and suitable living environment for every Californian, shall be the guiding criterion in public decisions.

(e) Create and maintain conditions under which man and nature can exist in productive harmony to fulfill the social and economic requirements of present and future generations.

(f) Require governmental agencies at all levels to develop standards and procedures necessary to protect environmental quality.

(g) Require governmental agencies at all levels to consider qualitative factors as well as economic and technical factors and long-term benefits and costs, in addition to short-term benefits and costs and to consider alternatives to proposed actions affecting the environment.

21001.1. The Legislature further finds and declares that it is the policy of the state that projects to be carried out by public agencies be subject to the same level of review and consideration under this division as that of private projects required to be approved by public agencies.

21002. The Legislature finds and declares that it is the policy of the state that public agencies should not approve projects as proposed if there are feasible alternatives or feasible mitigation measures available which would substantially lessen the significant environmental effects of such projects, and that the procedures required by this division are intended to assist public agencies in systematically identifying both the significant effects of proposed projects and the feasible alternatives or feasible mitigation measures which will avoid or substantially lessen such significant effects. The Legislature further finds and declares that in the event specific economic, social, or other conditions make infeasible such project alternatives or such mitigation measures, individual projects may be approved in spite of one or more significant effects thereof.

21002.1. In order to achieve the objectives set forth in Section 21002, the Legislature hereby finds and declares that the following policy shall apply to the use of environmental impact reports prepared pursuant to this division:

(a) The purpose of an environmental impact report is to identify the significant effects on the environment of a project, to identify alternatives to the project, and to indicate the manner in which those significant effects can be mitigated or avoided.

(b) Each public agency shall mitigate or avoid the significant effects on the environment of projects that it carries out or approves whenever it is feasible to do so.

(c) If economic, social, or other conditions make it infeasible to mitigate one or more significant effects on the environment of a project, the project may nonetheless be carried out or approved at the discretion of a public agency if the project is otherwise permissible under applicable laws and regulations.

(d) In applying the policies of subdivisions (b) and (c) to individual projects, the responsibility of the lead agency shall differ from that of a responsible agency. The lead agency shall be responsible for considering the effects, both individual and collective, of all activities involved in a project. A responsible agency shall be responsible for considering only the effects of those activities involved in a project which it is required by law to carry out or approve. This subdivision applies only to decisions by a public agency to carry out or approve a project and does not otherwise affect the scope of the comments that the public agency may wish to make pursuant to Section 21104 or 21153.

(e) To provide more meaningful public disclosure, reduce the time and cost required to prepare an environmental impact report, and focus on potentially significant effects on the environment of a proposed project, lead agencies shall, in accordance with Section 21100, focus the discussion in the environmental impact report on those potential effects on the environment of a proposed project which the lead agency has determined are or may be significant. Lead agencies may limit discussion on other effects to a brief explanation as to why those effects are not potentially significant.

21003. The Legislature further finds and declares that it is the policy of the state that:

(a) Local agencies integrate the requirements of this division with planning and environmental review procedures otherwise required by law or by local practice so that all those procedures, to the maximum feasible extent, run concurrently, rather than consecutively.

(b) Documents prepared pursuant to this division be organized and written in a manner that will be meaningful and useful to decisionmakers and to the public.

(c) Environmental impact reports omit unnecessary descriptions of projects and emphasize feasible mitigation measures and feasible alternatives to projects.

(d) Information developed in individual environmental impact reports be incorporated into a data base which can be used to reduce delay and duplication in preparation of subsequent environmental impact reports.

(e) Information developed in environmental impact reports and negative declarations be incorporated into a data base which may be used to make subsequent or supplemental environmental determinations.

(f) All persons and public agencies involved in the environmental review process be responsible for carrying out the process in the most efficient, expeditious manner in order to conserve the available financial, governmental, physical, and social resources with the objective that those resources may be better applied toward the mitigation of actual significant effects on the environment.

21003.1. The Legislature further finds and declares it is the policy of the state that:

(a) Comments from the public and public agencies on the environmental effects of a project shall be made to lead agencies as soon as possible in the review of environmental documents, including, but not limited to, draft environmental impact reports and negative declarations, in order to allow the lead agencies to identify, at the earliest possible time in the environmental review process, potential significant effects of a project, alternatives, and mitigation measures which would substantially reduce the effects.

(b) Information relevant to the significant effects of a project, alternatives, and mitigation measures which substantially reduce the effects shall be made available as soon as possible by lead agencies, other public agencies, and interested persons and organizations.

(c) Nothing in subdivisions (a) or (b) reduces or otherwise limits public review or comment periods currently prescribed either by statute or in guidelines prepared and adopted pursuant to Section 21083 for environmental documents, including, but not limited to, draft environmental impact reports and negative declarations.

21004. In mitigating or avoiding a significant effect of a project on the environment, a public agency may exercise only those express or implied powers provided by law other than this division. However, a public agency may use discretionary powers provided by such other law for the purpose of mitigating or avoiding a significant effect on the environment subject to the express or implied constraints or limitations that may be provided by law.

21005. (a) The Legislature finds and declares that it is the policy of the state that noncompliance with the information disclosure provisions of this division which precludes relevant information from being presented to the

public agency, or noncompliance with substantive requirements of this division, may constitute a prejudicial abuse of discretion within the meaning of Sections 21168 and 21168.5, regardless of whether a different outcome would have resulted if the public agency had complied with those provisions.

(b) It is the intent of the Legislature that, in undertaking judicial review pursuant to Sections 21168 and 21168.5, courts shall continue to follow the established principle that there is no presumption that error is prejudicial.

(c) It is further the intent of the Legislature that any court, which finds, or, in the process of reviewing a previous court finding, finds, that a public agency has taken an action without compliance with this division, shall specifically address each of the alleged grounds for noncompliance.

21006. The Legislature finds and declares that this division is an integral part of any public agency's decisionmaking process, including, but not limited to, the issuance of permits, licenses, certificates, or other entitlements required for activities undertaken pursuant to federal statutes containing specific waivers of sovereign immunity.

21050. This division shall be known and may be cited as the California Environmental Quality Act.

21060. Unless the context otherwise requires, the definitions in this chapter govern the construction of this division.

21060.1. (a) "Agricultural land" means prime farmland, farmland of statewide importance, or unique farmland, as defined by the United States Department of Agriculture land inventory and monitoring criteria, as modified for California.

(b) In those areas of the state where lands have not been surveyed for the classifications specified in subdivision (a), "agricultural land" means land that meets the requirements of "prime agricultural land" as defined in paragraph (1), (2), (3), or (4) of subdivision (c) of Section 51201 of the Government Code.

21060.3. "Emergency" means a sudden, unexpected occurrence, involving a clear and imminent danger, demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property, or essential public services. "Emergency" includes such occurrences as fire, flood, earthquake, or other soil or geologic movements, as well as such occurrences as riot, accident, or sabotage.

21060.5. "Environment" means the physical conditions which exist within the area which will be affected by a proposed project, including land, air, water, minerals, flora, fauna, noise, objects of historic or aesthetic significance.

21061. "Environmental impact report" means a detailed statement setting forth the matters specified in Sections 21100 and 21100.1; provided that information or data which is relevant to such a statement and is a matter of public record or is generally available to the public need not be repeated in its entirety in such statement, but may be specifically cited as the source for conclusions stated therein; and provided further that such information or data shall be briefly described, that its relationship to the environmental

impact report shall be indicated, and that the source thereof shall be reasonably available for inspection at a public place or public building. An environmental impact report also includes any comments which are obtained pursuant to Section 21104 or 21153, or which are required to be obtained pursuant to this division. An environmental impact report is an informational document which, when its preparation is required by this division, shall be considered by every public agency prior to its approval or disapproval of a project. The purpose of an environmental impact report is to provide public agencies and the public in general with detailed information about the effect which a proposed project is likely to have on the environment; to list ways in which the significant effects of such a project might be minimized; and to indicate alternatives to such a project. In order to facilitate the use of environmental impact reports, public agencies shall require that such reports contain an index or table of contents and a summary. Failure to include such index, table of contents, or summary shall not constitute a cause of action pursuant to Section 21167.

21061.1. "Feasible" means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors.

21061.2. "Land evaluation and site assessment" means a decisionmaking methodology for assessing the potential environmental impact of state and local projects on agricultural land.

21061.3. "Infill site" means a site in an urbanized area that meets either of the following criteria:

(a) The immediately adjacent parcels are developed with qualified urban uses or at least 75 percent of the perimeter of the site adjoins parcels that are developed with qualified urban uses and the remaining 25 percent of the site adjoins parcels that have previously been developed for qualified urban uses, and the site has not been developed for urban uses and no parcel within the site has been created within the past 10 years.

(b) The site has been previously developed for qualified urban uses.

21062. "Local agency" means any public agency other than a state agency, board, or commission. For purposes of this division a redevelopment agency and a local agency formation commission are local agencies, and neither is a state agency, board, or commission.

21063. "Public agency" includes any state agency, board, or commission, any county, city and county, city, regional agency, public district, redevelopment agency, or other political subdivision.

21064. "Negative declaration" means a written statement briefly describing the reasons that a proposed project will not have a significant effect on the environment and does not require the preparation of an environmental impact report.

21064.3. "Major transit stop" means a site containing an existing rail transit station, a ferry terminal served by either a bus or rail transit service, or the intersection of two or more major bus routes with a frequency of service interval of 15 minutes or less during the morning and afternoon peak commute periods.

21064.5. "Mitigated negative declaration" means a negative declaration prepared for a project when the initial study has identified potentially significant effects on the environment, but (1) revisions in the project plans or proposals made by, or agreed to by, the applicant before the proposed negative declaration and initial study are released for public review would avoid the effects or mitigate the effects to a point where clearly no significant effect on the environment would occur, and (2) there is no substantial evidence in light of the whole record before the public agency that the project, as revised, may have a significant effect on the environment.

21065. "Project" means an activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment, and which is any of the following:

(a) An activity directly undertaken by any public agency.
(b) An activity undertaken by a person which is supported, in whole or in part, through contracts, grants, subsidies, loans, or other forms of assistance from one or more public agencies.
(c) An activity that involves the issuance to a person of a lease, permit, license, certificate, or other entitlement for use by one or more public agencies.

21065.3. "Project-specific effect" means all the direct or indirect environmental effects of a project other than cumulative effects and growth-inducing effects.

21065.5. "Geothermal exploratory project" means a project as defined in Section 21065 composed of not more than six wells and associated drilling and testing equipment, whose chief and original purpose is to evaluate the presence and characteristics of geothermal resources prior to commencement of a geothermal field development project as defined in Section 65928.5 of the Government Code. Wells included within a geothermal exploratory project must be located at least one-half mile from geothermal development wells which are capable of producing geothermal resources in commercial quantities.

21066. "Person" includes any person, firm, association, organization, partnership, business, trust, corporation, limited liability company, company, district, county, city and county, city, town, the state, and any of the agencies and political subdivisions of those entities, and, to the extent permitted by federal law, the United States, or any of its agencies or political subdivisions.

21067. "Lead agency" means the public agency which has the principal responsibility for carrying out or approving a project which may have a significant effect upon the environment.

21068. "Significant effect on the environment" means a substantial, or potentially substantial, adverse change in the environment.

21068.5. "Tiering" or "tier" means the coverage of general matters and environmental effects in an environmental impact report prepared for a policy, plan, program or ordinance followed by narrower or site-specific environmental impact reports which incorporate by reference the discussion in any prior environmental impact report and which concentrate on the environmental effects which (a) are capable of being mitigated, or (b) were not analyzed as significant effects on the environment in the prior environmental impact report.

21069. "Responsible agency" means a public agency, other than the lead agency, which has responsibility for carrying out or approving a project.

21070. "Trustee agency" means a state agency that has jurisdiction by law over natural resources affected by a project, that are held in trust for the people of the State of California.

21071. "Urbanized area" means either of the following:
(a) An incorporated city that meets either of the following criteria:
(1) Has a population of at least 100,000 persons.
(2) Has a population of less than 100,000 persons if the population of that city and not more than two contiguous incorporated cities combined equals at least 100,000 persons.
(b) An unincorporated area that satisfies the criteria in both paragraph (1) and (2) of the following criteria:
(1) Is either of the following:
(A) Completely surrounded by one or more incorporated cities, and both of the following criteria are met:
(i) The population of the unincorporated area and the population of the surrounding incorporated city or cities equals not less than 100,000 persons.
(ii) The population density of the unincorporated area at least equals the population density of the surrounding city or cities.
(B) Located within an urban growth boundary and has an existing residential population of at least 5,000 persons per square mile. For purposes of this subparagraph, an "urban growth boundary" means a provision of a locally adopted general plan that allows urban uses on one side of the boundary and prohibits urban uses on the other side.
(2) The board of supervisors with jurisdiction over the unincorporated area has previously taken both of the following actions:
(A) Issued a finding that the general plan, zoning ordinance, and related policies and programs applicable to the unincorporated area are consistent with principles that encourage compact development in a manner that does both of the following:
(i) Promotes efficient transportation systems, economic growth, affordable housing, energy efficiency, and an appropriate balance of jobs and housing.
(ii) Protects the environment, open space, and agricultural areas.
(B) Submitted a draft finding to the Office of Planning and Research at least 30 days prior to issuing a final finding, and allowed the office 30 days to submit comments on the draft findings to the board of supervisors.

21072. "Qualified urban use" means any residential, commercial, public institutional, transit or transportation passenger facility, or retail use, or any combination of those uses.

21080. (a) Except as otherwise provided in this division, this division shall apply to discretionary projects proposed to be carried out or approved by public agencies, including, but not limited to, the enactment and amendment of zoning ordinances, the issuance of zoning variances, the issuance of conditional use permits, and the approval of tentative subdivision maps unless the project is exempt from this division.

(b) This division does not apply to any of the following activities:

(1) Ministerial projects proposed to be carried out or approved by public agencies.

(2) Emergency repairs to public service facilities necessary to maintain service.

(3) Projects undertaken, carried out, or approved by a public agency to maintain, repair, restore, demolish, or replace property or facilities damaged or destroyed as a result of a disaster in a disaster-stricken area in which a state of emergency has been proclaimed by the Governor pursuant to Chapter 7 (commencing with Section 8550) of Division 1 of Title 2 of the Government Code.

(4) Specific actions necessary to prevent or mitigate an emergency.

(5) Projects which a public agency rejects or disapproves.

(6) Actions undertaken by a public agency relating to any thermal powerplant site or facility, including the expenditure, obligation, or encumbrance of funds by a public agency for planning, engineering, or design purposes, or for the conditional sale or purchase of equipment, fuel, water (except groundwater), steam, or power for a thermal powerplant, if the powerplant site and related facility will be the subject of an environmental impact report, negative declaration, or other document, prepared pursuant to a regulatory program certified pursuant to Section 21080.5, which will be prepared by the State Energy Resources Conservation and Development Commission, by the Public Utilities Commission, or by the city or county in which the powerplant and related facility would be located if the environmental impact report, negative declaration, or document includes the environmental impact, if any, of the action described in this paragraph.

(7) Activities or approvals necessary to the bidding for, hosting or staging of, and funding or carrying out of, an Olympic games under the authority of the International Olympic Committee, except for the construction of facilities necessary for the Olympic games.

(8) The establishment, modification, structuring, restructuring, or approval of rates, tolls, fares, or other charges by public agencies which the public agency finds are for the purpose of (A) meeting operating expenses, including employee wage rates and fringe benefits, (B) purchasing or leasing supplies, equipment, or materials, (C) meeting financial reserve needs and requirements, (D) obtaining funds for capital projects necessary to maintain service within existing service areas, or (E) obtaining funds necessary to maintain those intracity transfers as are authorized by city charter. The public agency shall incorporate written findings in the record of any proceeding in which an exemption under this paragraph is claimed setting forth with specificity the basis for the claim of exemption.

(9) All classes of projects designated pursuant to Section 21084.

(10) A project for the institution or increase of passenger or commuter services on rail or highway rights-of-way already in use, including modernization of existing stations and parking facilities.

(11) A project for the institution or increase of passenger or commuter service on high-occupancy vehicle lanes already in use, including the modernization of existing stations and parking facilities.
(12) Facility extensions not to exceed four miles in length which are required for the transfer of passengers from or to exclusive public mass transit guideway or busway public transit services.
(13) A project for the development of a regional transportation improvement program, the state transportation improvement program, or a congestion management program prepared pursuant to Section 65089 of the Government Code.
(14) Any project or portion thereof located in another state which will be subject to environmental impact review pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. Sec. 43 21 et seq.) or similar state laws of that state. Any emissions or discharges that would have a significant effect on the environment in this state are subject to this division.
(15) Projects undertaken by a local agency to implement a rule or regulation imposed by a state agency, board, or commission under a certified regulatory program pursuant to Section 21080.5. Any site-specific effect of the project which was not analyzed as a significant effect on the environment in the plan or other written documentation required by Section 21080.5 is subject to this division.
(c) If a lead agency determines that a proposed project, not otherwise exempt from this division, would not have a significant effect on the environment, the lead agency shall adopt a negative declaration to that effect. The negative declaration shall be prepared for the proposed project in either of the following circumstances:
(1) There is no substantial evidence, in light of the whole record before the lead agency, that the project may have a significant effect on the environment.
(2) An initial study identifies potentially significant effects on the environment, but (A) revisions in the project plans or proposals made by, or agreed to by, the applicant before the proposed negative declaration and initial study are released for public review would avoid the effects or mitigate the effects to a point where clearly no significant effect on the environment would occur, and (B) there is no substantial evidence, in light of the whole record before the lead agency, that the project, as revised, may have a significant effect on the environment.
(d) If there is substantial evidence, in light of the whole record before the lead agency, that the project may have a significant effect on the environment, an environmental impact report shall be prepared.
(e) (1) For the purposes of this section and this division, substantial evidence includes fact, a reasonable assumption predicated upon fact, or expert opinion supported by fact.
(2) Substantial evidence is not argument, speculation, unsubstantiated opinion or narrative, evidence that is clearly inaccurate or erroneous, or evidence of social or economic impacts that do not contribute to, or are not caused by, physical impacts on the environment.
(f) As a result of the public review process for a mitigated negative declaration, including administrative decisions and public hearings, the lead agency may conclude that certain mitigation measures identified pursuant to paragraph (2) of subdivision (c) are infeasible or otherwise undesirable. In those circumstances, the lead agency, prior to approving the project, may delete those mitigation measures and substitute for them other mitigation measures that the lead agency finds, after holding a public hearing on the matter, are equivalent or more effective in mitigating significant effects on the environment to a less than significant level and that do not cause any potentially significant effect on the environment. If those new mitigation measures are made conditions of project approval or are otherwise made part of the project approval, the deletion of the former measures and the

substitution of the new mitigation measures shall not constitute an action or circumstance requiring recirculation of the mitigated negative declaration.

(g) Nothing in this section shall preclude a project applicant or any other person from challenging, in an administrative or judicial proceeding, the legality of a condition of project approval imposed by the lead agency. If, however, any condition of project approval set aside by either an administrative body or court was necessary to avoid or lessen the likelihood of the occurrence of a significant effect on the environment, the lead agency's approval of the negative declaration and project shall be invalid and a new environmental review process shall be conducted before the project can be reapproved, unless the lead agency substitutes a new condition that the lead agency finds, after holding a public hearing on the matter, is equivalent to, or more effective in, lessening or avoiding significant effects on the environment and that does not cause any potentially significant effect on the environment.

21080.01. This division shall not apply to any activity or approval necessary for the reopening and operation of the California Men's Colony West Facility in San Luis Obispo County.

21080.02. This division shall not apply to any activity or approval necessary for or incidental to planning, design, site acquisition, construction, operation, or maintenance of the new prison facility at or in the vicinity of Corcoran in Kings County as authorized by the act that enacted this section.

21080.03. This division shall not apply to any activity or approval necessary for or incidental to the location, development, construction, operation, or maintenance of the prison in the County of Kings, authorized by Section 9 of Chapter 958 of the Statutes of 1983, as amended, and of the prison in the County of Amador (Ione), authorized by Chapter 957 of the Statutes of 1983, as amended.

21080.04. (a) Notwithstanding paragraph (10) of subdivision (b) of Section 21080, this division applies to a project for the institution of passenger rail service on a line paralleling State Highway 29 and running from Rocktram to Krug in the Napa Valley. With respect to that project, and for the purposes of this division, the Public Utilities Commission is the lead agency.

(b) It is the intent of the Legislature in enacting this section to abrogate the decision of the California Supreme Court "that Section 21080, subdivision (b)(11), exempts Wine Train's institution of passenger service on the Rocktram-Krug line from the requirements of CEQA" in Napa Valley Wine Train, Inc. v. Public Utilities Com., 50 Cal. 3d 370.

(c) Nothing in this section is intended to affect or apply to, or to confer jurisdiction upon the Public Utilities Commission with respect to, any other project involving rail service.

21080.05. This division does not apply to a project by a public agency to lease or purchase the rail right-of-way used for the San Francisco Peninsula commute service between San Francisco and San Jose, together with all branch and spur lines, including the Dumbarton and Vasona lines.

21080.07. This division shall not apply to any activity or approval necessary for or incidental to planning, design, site acquisition, construction, operation, or maintenance of the new prison facilities located in any of the following places:

(a) The County of Riverside.

(b) The County of Del Norte.

21080.08. This division shall not apply to any activity or approval necessary for or incidental to project funding, or the authorization for the expenditure of funds for the project, by the Rural Economic Development Infrastructure Panel pursuant to Article 5 (commencing with Section 15373.6) of Chapter 2.5 of Part 6.7 of Division 3 of Title 2 of the Government Code.

21080.09. (a) For purposes of this section, the following definitions apply:

(1) "Public higher education" has the same meaning as specified in Section 66010 of the Education Code.

(2) "Long range development plan" means a physical development and land use plan to meet the academic and institutional objectives for a particular campus or medical center of public higher education.

(b) The selection of a location for a particular campus and the approval of a long range development plan are subject to this division and require the preparation of an environmental impact report. Environmental effects relating to changes in enrollment levels shall be considered for each campus or medical center of public higher education in the environmental impact report prepared for the long range development plan for the campus or medical center.

(c) The approval of a project on a particular campus or medical center of public higher education is subject to this division and may be addressed, subject to the other provisions of this division, in a tiered environmental analysis based upon a long range development plan environmental impact report.

(d) Compliance with this section satisfies the obligations of public higher education pursuant to this division to consider the environmental impact of academic and enrollment plans as they affect campuses or medical centers, provided that any such plans shall become effective for a campus or medical center only after the environmental effects of those plans have been analyzed as required by this division in a long range development plan environmental impact report or tiered analysis based upon that environmental impact report for that campus or medical center, and addressed as required by this division.

21080.1. (a) The lead agency shall be responsible for determining whether an environmental impact report, a negative declaration, or a mitigated negative declaration shall be required for any project which is subject to this division. That determination shall be final and conclusive on all persons, including responsible agencies, unless challenged as provided in Section 21167.

(b) In the case of a project described in subdivision (c) of Section 21065, the lead agency shall, upon the request of a potential applicant, provide for consultation prior to the filing of the application regarding the range of actions, potential alternatives, mitigation measures, and any potential and significant effects on the environment of the project.

21080.2. In the case of a project described in subdivision (c) of Section 21065, the determination required by Section 21080.1 shall be made within 30 days from the date on which an application for a project has been received and accepted as complete by the lead agency. This period may be extended 15 days upon the consent of the lead agency and the project applicant.

21080.3. (a) Prior to determining whether a negative declaration or environmental impact report is required for a project, the lead agency shall consult with all responsible agencies and trustee agencies. Prior to that required consultation, the lead agency may informally contact any of those agencies.

(b) In order to expedite the requirements of subdivision (a), the Office of Planning and Research, upon request of a lead agency, shall assist the lead agency in determining the various responsible agencies and trustee agencies, for a proposed project. In the case of a project described in subdivision (c) of Section 21065, the request may also be made by the project applicant.

21080.4. (a) If a lead agency determines that an environmental impact report is required for a project, the lead agency shall immediately send notice of that determination by certified mail or an equivalent procedure to each responsible agency, the Office of Planning and Research, and those public agencies having jurisdiction by law over natural resources affected by the project that are held in trust for the people of the State of California. Upon receipt of the notice, each responsible agency, the office, and each public agency having jurisdiction by law over natural resources affected by the project that are held in trust for the people of the State of California shall specify to the lead agency the scope and content of the environmental information that is germane to the statutory responsibilities of that responsible agency, the office, or the public agency in connection with the proposed project and which, pursuant to the requirements of this division, shall be included in the environmental impact report. The information shall be specified in writing and shall be communicated to the lead agency by certified mail or equivalent procedure not later than 30 days after the date of receipt of the notice of the lead agency's determination. The lead agency shall request similar guidance from appropriate federal agencies.

(b) To expedite the requirements of subdivision (a), the lead agency, any responsible agency, the Office of Planning and Research, or a public agency having jurisdiction by law over natural resources affected by the project that are held in trust for the people of the State of California, may request one or more meetings between representatives of those agencies and the office for the purpose of assisting the lead agency to determine the scope and content of the environmental information that any of those responsible agencies, the office, or the public agencies may require. In the case of a project described in subdivision (c) of Section 21065, the request may also be made by the project applicant. The meetings shall be convened by the lead agency as soon as possible, but not later than 30 days after the date that the meeting was requested.

(c) To expedite the requirements of subdivision (a), the Office of Planning and Research, upon request of a lead agency, shall assist the lead agency in determining the various responsible agencies, public agencies having jurisdiction by law over natural resources affected by the project that are held in trust for the people of the State of California, and any federal agencies that have responsibility for carrying out or approving a proposed project. In the case of a project described in subdivision (c) of Section 21065, that request may also be made by the project applicant.

(d) With respect to the Department of Transportation, and with respect to any state agency that is a responsible agency or a public agency having jurisdiction by law over natural resources affected by the project that are held in trust for the people of the State of California, subject to the requirements of subdivision (a), the Office of Planning and Research shall ensure that the information required by subdivision (a) is transmitted to the lead agency, and that affected agencies are notified regarding meetings to be held upon request pursuant to subdivision (b), within the required time period.

21080.5. (a) Except as provided in Section 21158.1, when the regulatory program of a state agency requires a plan or other written documentation containing environmental information and complying with paragraph (3) of subdivision (d) to be submitted in support of an activity listed in subdivision (b), the plan or other written documentation may be submitted in lieu of the environmental impact report required by this division if the Secretary of the Resources Agency has certified the regulatory program pursuant to this section.

(b) This section applies only to regulatory programs or portions thereof that involve either of the following:

(1) The issuance to a person of a lease, permit, license, certificate, or other entitlement for use.

(2) The adoption or approval of standards, rules, regulations, or plans for use in the regulatory program.

(c) A regulatory program certified pursuant to this section is exempt from Chapter 3 (commencing with Section 21100), Chapter 4 (commencing with Section 21150), and Section 21167, except as provided in Article 2 (commencing with Section 21157) of Chapter 4.5.

(d) To qualify for certification pursuant to this section, a regulatory program shall require the utilization of an interdisciplinary approach that will ensure the integrated use of the natural and social sciences in decisionmaking and that shall meet all of the following criteria:

(1) The enabling legislation of the regulatory program does both of the following:

(A) Includes protection of the environment among its principal purposes.

(B) Contains authority for the administering agency to adopt rules and regulations for the protection of the environment, guided by standards set forth in the enabling legislation.

(2) The rules and regulations adopted by the administering agency for the regulatory program do all of the following:

(A) Require that an activity will not be approved or adopted as proposed if there are feasible alternatives or feasible mitigation measures available that would substantially lessen a significant adverse effect that the activity may have on the environment.

(B) Include guidelines for the orderly evaluation of proposed activities and the preparation of the plan or other written documentation in a manner consistent with the environmental protection purposes of the regulatory program.

(C) Require the administering agency to consult with all public agencies that have jurisdiction, by law, with respect to the proposed activity.

(D) Require that final action on the proposed activity include the written responses of the issuing authority to significant environmental points raised during the evaluation process.

(E) Require the filing of a notice of the decision by the administering agency on the proposed activity with the Secretary of the Resources Agency. Those notices shall be available for public inspection, and a list of the notices shall be posted on a weekly basis in the Office of the Resources Agency. Each list shall remain posted for a period of 30 days.

(F) Require notice of the filing of the plan or other written documentation to be made to the public and to a person who requests, in writing, notification. The notification shall be made in a manner that will provide the public or a person requesting notification with sufficient time to review and comment on the filing.

(3) The plan or other written documentation required by the regulatory program does both of the following:

(A) Includes a description of the proposed activity with alternatives to the activity, and mitigation measures to minimize any significant adverse effect on the environment of the activity.

(B) Is available for a reasonable time for review and comment by other public agencies and the general public.

(e) (1) The Secretary of the Resources Agency shall certify a regulatory program that the secretary determines meets all the qualifications for certification set forth in this section, and withdraw certification on determination that the regulatory program has been altered so that it no longer meets those qualifications. Certification and withdrawal of certification shall occur only after compliance with Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code.

(2) In determining whether or not a regulatory program meets the qualifications for certification set forth in this section, the inquiry of the secretary shall extend only to the question of whether the regulatory program meets the generic requirements of subdivision (d). The inquiry may not extend to individual decisions to be reached under the regulatory program, including the nature of specific alternatives or mitigation measures that might be proposed to lessen any significant adverse effect on the environment of the activity.

(3) If the secretary determines that the regulatory program submitted for certification does not meet the qualifications for certification set forth in this section, the secretary shall adopt findings setting forth the reasons for the determination.

(f) After a regulatory program has been certified pursuant to this section, a proposed change in the program that could affect compliance with the qualifications for certification specified in subdivision (d) may be submitted to the Secretary of the Resources Agency for review and comment. The scope of the secretary's review shall extend only to the question of whether the regulatory program meets the generic requirements of subdivision (d). The review may not extend to individual decisions to be reached under the regulatory program, including specific alternatives or mitigation measures that might be proposed to lessen any significant adverse effect on the environment of the activity. The secretary shall have 30 days from the date of receipt of the proposed change to notify the state agency whether the proposed change will alter the regulatory program so that it no longer meets the qualification for certification established in this section and will result in a withdrawal of certification as provided in this section.

(g) An action or proceeding to attack, review, set aside, void, or annul a determination or decision of a state agency approving or adopting a proposed activity under a regulatory program that has been certified pursuant to this section on the basis that the plan or other written documentation prepared pursuant to paragraph (3) of subdivision (d) does not comply with this section shall be commenced not later than 30 days from the date of the filing of notice of the approval or adoption of the activity.

(h) (1) An action or proceeding to attack, review, set aside, void, or annul a determination of the Secretary of the Resources Agency to certify a regulatory program pursuant to this section on the basis that the regulatory program does not comply with this section shall be commenced within 30 days from the date of certification by the secretary.

(2) In an action brought pursuant to paragraph (1), the inquiry shall extend only to whether there was a prejudicial abuse of discretion by the secretary. Abuse of discretion is established if the secretary has not proceeded in a manner required by law or if the determination is not supported by substantial evidence.

(i) For purposes of this section, a county agricultural commissioner is a state agency.

(j) For purposes of this section, an air quality management district or air pollution control district is a state agency, except that the approval, if any, by a district of a nonattainment area plan is subject to this section only if, and to the extent that, the approval adopts or amends rules or regulations.

(k) (1) The secretary, by July 1, 2004, shall develop a protocol for reviewing the prospective application of certified regulatory programs to evaluate the consistency of those programs with the requirements of this division. Following the completion of the development of the protocol, the secretary shall provide a report to the Senate Committee on Environmental Quality and the Assembly Committee on Natural Resources regarding the need for a grant of additional statutory authority authorizing the secretary to undertake a review of the certified regulatory programs.

(2) The secretary shall provide a significant opportunity for public participation in developing the protocol described in paragraph (1) including, but not limited to, at least two public meetings with interested parties. A notice of each meeting shall be provided at least 10 days prior to the meeting to a person who files a written request for a notice with the agency.

21080.8. This division does not apply to the conversion of an existing rental mobilehome park to a resident initiated subdivision, cooperative, or condominium for mobilehomes if the conversion will not result in an expansion of or change in existing use of the property.

21080.9. This division shall not apply to activities and approvals by any local government, as defined in Section 30109, or any state university or college, as defined in Section 30119, as necessary for the preparation and adoption of a local coastal program or long-range land use development plan pursuant to Division 20 (commencing with Section 30000); provided, however, that certification of a local coastal program or long-range land use development plan by the California Coastal Commission pursuant to Chapter 6 (commencing with Section 30500) of Division 20 shall be subject to the requirements of this division. For the purpose of Section 21080.5, a certified local coastal program or long-range land use development plan constitutes a plan for use in the California Coastal Commission's regulatory program.

21080.10. This division does not apply to any of the following:

(a) An extension of time, granted pursuant to Section 65361 of the Government Code, for the preparation and adoption of one or more elements of a city or county general plan.

(b) Actions taken by the Department of Housing and Community Development or the California Housing Finance Agency to provide financial assistance or insurance for the development and construction of residential housing for persons and families of low or moderate income, as defined in Section 50093 of the Health and Safety Code, if the project that is the subject of the application for financial assistance or insurance will be reviewed pursuant to this division by another public agency.

21080.11. This division shall not apply to settlements of title and boundary problems by the State Lands Commission and to exchanges or leases in connection with those settlements.

21080.13. This division shall not apply to any railroad grade separation project which eliminates an existing grade crossing or which reconstructs an existing grade separation.

21080.17. This division does not apply to the adoption of an ordinance by a city or county to implement the provisions of Section 65852.1 or Section 65852.2 of the Government Code.

21080.18. This division does not apply to the closing of any public school in which kindergarten or any of grades 1 through 12 is maintained or the transfer of students from that public school to another school if the only physical changes involved are categorically exempt under Chapter 3 (commencing with Section 15000) of Division 6 of Title 14 of the California Administrative Code.

21080.19. This division does not apply to a project for restriping of streets or highways to relieve traffic congestion.

21080.21. This division does not apply to any project of less than one mile in length within a public street or highway or any other public right-of-way for the installation of a new pipeline or the maintenance, repair, restoration, reconditioning, relocation, replacement, removal, or demolition of an existing pipeline. For purposes of this section, "pipeline" includes subsurface facilities but does not include any surface facility related to the operation of the underground facility.

21080.22. (a) This division does not apply to activities and approvals by a local government necessary for the preparation of general plan amendments pursuant to Section 29763, except that the approval of general plan amendments by the Delta Protection Commission is subject to the requirements of this division.

(b) For purposes of Section 21080.5, a general plan amendment is a plan required by the regulatory program of the Delta Protection Commission.

21080.23. (a) This division does not apply to any project which consists of the inspection, maintenance, repair, restoration, reconditioning, relocation, replacement, or removal of an existing pipeline, as defined in subdivision (a) of Section 51010.5 of the Government Code, or any valve, flange, meter, or other piece of equipment that is directly attached to the pipeline, if the project meets all of the following conditions:

(1) (A) The project is less than eight miles in length.

(B) Notwithstanding subparagraph (A), actual construction and excavation activities undertaken to achieve the maintenance, repair, restoration, reconditioning, relocation, replacement, or removal of an existing pipeline are not undertaken over a length of more than one-half mile at any one time.

(2) The project consists of a section of pipeline that is not less than eight miles from any section of pipeline that has been subject to an exemption pursuant to this section in the past 12 months.
(3) The project is not solely for the purpose of excavating soil that is contaminated by hazardous materials, and, to the extent not otherwise expressly required by law, the party undertaking the project immediately informs the lead agency of the discovery of contaminated soil.
(4) To the extent not otherwise expressly required by law, the person undertaking the project has, in advance of undertaking the project, prepared a plan that will result in notification of the appropriate agencies so that they may take action, if determined to be necessary, to provide for the emergency evacuation of members of the public who may be located in close proximity to the project.
(5) Project activities are undertaken within an existing right-of-way and the right-of-way is restored to its condition prior to the project.
(6) The project applicant agrees to comply with all conditions otherwise authorized by law, imposed by the city or county planning department as part of any local agency permit process, that are required to mitigate potential impacts of the proposed project, and to otherwise comply with the Keene-Nejedly California Wetlands Preservation Act (Chapter 7 (commencing with Section 5810) of Division 5), the California Endangered Species Act (Chapter 1.5 (commencing with Section 2050) of Division 3 of the Fish and Game Code), and other applicable state laws, and with all applicable federal laws.
(b) If a project meets all of the requirements of subdivision (a), the person undertaking the project shall do all of the following:
(1) Notify, in writing, any affected public agency, including, but not limited to, any public agency having permit, land use, environmental, public health protection, or emergency response authority of the exemption of the project from this division by subdivision (a).
(2) Provide notice to the public in the affected area in a manner consistent with paragraph (3) of subdivision (b) of Section 21092.
(3) In the case of private rights-of-way over private property, receive from the underlying property owner permission for access to the property.
(4) Comply with all conditions otherwise authorized by law, imposed by the city or county planning department as part of any local agency permit process, that are required to mitigate potential impacts of the proposed project, and otherwise comply with the Keene-Nejedly California Wetlands Preservation Act (Chapter 7 (commencing with Section 5810) of Division 5), the California Endangered Species Act (Chapter 1.5 (commencing with Section 2050) of Division 3 of the Fish and Game Code), and other applicable state laws, and with all applicable federal laws.
(c) Prior to January 1, 1999, this section shall not apply to ARCO Pipeline Company's crude oil pipelines designated as Crude Oil Line 1, from Tejon Station south to its terminus, and Crude Oil Line 90.
(d) This section does not apply to either of the following:
(1) A project in which the diameter of the pipeline is increased.
(2) A project undertaken within the boundaries of an oil refinery.

21080.24. This division does not apply to the issuance, modification, amendment, or renewal of any permit by an air pollution control district or air quality management district pursuant to Title V, as defined in Section 39053.3 of the Health and Safety Code, or pursuant to a district Title V program established under Sections 42301.10, 42301.11, and 42301.12 of the Health and Safety Code, unless the issuance, modification, amendment, or renewal authorizes a physical or operational change to a source or facility.

(b) Nothing in this section is intended to result in the application of this division to any physical or operational change which, prior to January 1, 1995, was not subject to this division.

21080.26. This division does not apply to minor alterations to utilities made for the purposes of complying with Sections 4026.7 and 4026.8 of the Health and Safety Code or regulations adopted thereunder.

21080.29. (a) A project located in Los Angeles County that is approved by a public agency before the effective date of the act adding this section is not in violation of any requirement of this division by reason of the failure to construct a roadway across the property transferred to the state pursuant to subdivision (c) and to construct a bridge over the adjacent Ballona Channel in Los Angeles County, otherwise required as a mitigation measure pursuant to this division, if all of the following conditions apply:

(1) The improvements specified in this subdivision are not constructed, due in whole or in part, to the project owner's or developer's relinquishment of easement rights to construct those improvements.

(2) The easement rights in paragraph (1) are relinquished in connection with the State of California, acting by and through the Wildlife Conservation Board of the Department of Fish and Game, acquiring a wetlands project that is a minimum of 400 acres in size and located within the coastal zone.

(b) Where those easement rights have been relinquished, any municipal ordinance or regulation adopted by a charter city or a general law city shall be inapplicable to the extent that the ordinance or regulation requires construction of the transportation improvements specified in subdivision (a), or would otherwise require reprocessing or resubmittal of a permit or approval, including, but not limited to, a final recorded map, a vesting tentative map, or a tentative map, as a result of the transportation improvements specified in subdivision (a) not being constructed.

(c) (1) If the Wildlife Conservation Board of the Department of Fish and Game acquires property within the coastal zone that is a minimum of 400 acres in size pursuant to a purchase and sale agreement with Playa Capital Company, LLC, the Controller shall direct the trustee under the Amendment to Declaration of Trust entered into on or about December 11, 1984, by First Nationwide Savings, as trustee, Summa Corporation, as trustor, and the Controller, as beneficiary, known as the HRH Inheritance Tax Security Trust, to convey title to the trust estate of the trust, including real property commonly known as Playa Vista Area C, to the State of California acting by and through the Wildlife Conservation Board of the Department of Fish and Game for conservation, restoration, or recreation purposes only, with the right to transfer the property for those uses to any other agency of the State of California.

(2) This subdivision shall constitute the enabling legislation required by the Amendment to Declaration of Trust to empower the Controller to direct the trustee to convey title to the trust estate under the HRH Inheritance Tax Security Trust to the State of California or an agency thereof.

(3) The conveyance of the trust estate to the Wildlife Conservation Board pursuant to this subdivision shall supersede any duty or obligation imposed upon the Controller under the Probate Code or the Revenue and Taxation Code with respect to the disposition or application of the net proceeds of the trust estate.

21080.32. (a) This section shall only apply to publicly owned transit agencies, but shall not apply to any publicly owned transit agency created pursuant to Section 130050.2 of the Public Utilities Code.

(b) Except as provided in subdivision (c), and in accordance with subdivision (d), this division does not apply to actions taken on or after July 1, 1995, by a publicly owned transit agency to implement budget reductions caused by the failure of agency revenues to adequately fund agency programs and facilities.

(c) This section does not apply to any action to reduce or eliminate a transit service, facility, program, or activity that was approved or adopted as a mitigation measure in any environmental document authorized by this division or the National Environmental Policy Act (42 U.S.C. Sec. 43 21 et seq.) or to any state or federal requirement that is imposed for the protection of the environment.

(d) (1) This section applies only to actions taken after the publicly owned transit agency has made a finding that there is a fiscal emergency caused by the failure of agency revenues to adequately fund agency programs and facilities, and after the publicly owned transit agency has held a public hearing to consider those actions. A publicly owned transit agency that has held such a hearing shall respond within 30 days at a regular public meeting to suggestions made by the public at the initial public hearing. Those actions shall be limited to projects defined in subdivision (a) or (b) of Section 21065 which initiate or increase fees, rates, or charges charged for any existing public service, program, or activity; or reduce or eliminate the availability of an existing publicly owned transit service, facility, program, or activity.

(2) For purposes of this subdivision, "fiscal emergency," when applied to a publicly owned transit agency, means that the agency is projected to have negative working capital within one year from the date that the agency makes the finding that there is a fiscal emergency pursuant to this section. Working capital shall be determined by adding together all unrestricted cash, unrestricted short-term investments, and unrestricted short-term accounts receivable and then subtracting unrestricted accounts payable. Employee retirement funds, including Internal Revenue Code Section 457 deferred compensation plans and Section 401(k) plans, health insurance reserves, bond payment reserves, workers' compensation reserves, and insurance reserves, shall not be factored into the formula for working capital.

21080.33. This division does not apply to any emergency project undertaken, carried out, or approved by a public agency to maintain, repair, or restore an existing highway, as defined in Section 360 of the Vehicle Code, except for a highway designated as an official state scenic highway pursuant to Section 262 of the Streets and Highways Code, within the existing right-of-way of the highway, damaged as a result of fire, flood, storm, earthquake, land subsidence, gradual earth movement, or landslide, within one year of the damage. This section does not exempt from this division any project undertaken, carried out, or approved by a public agency to expand or widen a highway damaged by fire, flood, storm, earthquake, land subsidence, gradual earth movement, or landslide.

21080.35. For the purposes of Section 21069, the phrase "carrying out or approving a project" shall include the carrying out or approval of a plan for a project that expands or enlarges an existing publicly owned airport by any political subdivision, as described in Section 21661.6 of the Public Utilities Code.

21081. Pursuant to the policy stated in Sections 21002 and 21002.1, no public agency shall approve or carry out a project for which an environmental impact report has been certified which identifies one or more significant effects on the environment that would occur if the project is approved or carried out unless both of the following occur:

(a) The public agency makes one or more of the following findings with respect to each significant effect:

(1) Changes or alterations have been required in, or incorporated into, the project which mitigate or avoid the significant effects on the environment.

(2) Those changes or alterations are within the responsibility and jurisdiction of another public agency and have been, or can and should be, adopted by that other agency.

(3) Specific economic, legal, social, technological, or other considerations, including considerations for the provision of employment opportunities for highly trained workers, make infeasible the mitigation measures or alternatives identified in the environmental impact report.

(b) With respect to significant effects which were subject to a finding under paragraph (3) of subdivision (a), the public agency finds that specific overriding economic, legal, social, technological, or other benefits of the project outweigh the significant effects on the environment.

21081.5. In making the findings required by paragraph (3) of subdivision (a) of Section 21081, the public agency shall base its findings on substantial evidence in the record.

21081.6. (a) When making the findings required by paragraph (1) of subdivision (a) of Section 21081 or when adopting a mitigated negative declaration pursuant to paragraph (2) of subdivision (c) of Section 21080, the following requirements shall apply:

(1) The public agency shall adopt a reporting or monitoring program for the changes made to the project or conditions of project approval, adopted in order to mitigate or avoid significant effects on the environment. The reporting or monitoring program shall be designed to ensure compliance during project implementation. For those changes which have been required or incorporated into the project at the request of a responsible agency or a public agency having jurisdiction by law over natural resources affected by the project, that agency shall, if so requested by the lead agency or a responsible agency, prepare and submit a proposed reporting or monitoring program.

(2) The lead agency shall specify the location and custodian of the documents or other material which constitute the record of proceedings upon which its decision is based.

(b) A public agency shall provide that measures to mitigate or avoid significant effects on the environment are fully enforceable through permit conditions, agreements, or other measures. Conditions of project approval may be set forth in referenced documents which address required mitigation measures or, in the case of the adoption of a plan, policy, regulation, or other public project, by incorporating the mitigation measures into the plan, policy, regulation, or project design.

(c) Prior to the close of the public review period for a draft environmental impact report or mitigated negative declaration, a responsible agency, or a public agency having jurisdiction over natural resources affected by the project, shall either submit to the lead agency complete and detailed performance objectives for mitigation measures which would address the significant effects on the environment identified by the responsible agency

or agency having jurisdiction over natural resources affected by the project, or refer the lead agency to appropriate, readily available guidelines or reference documents. Any mitigation measures submitted to a lead agency by a responsible agency or an agency having jurisdiction over natural resources affected by the project shall be limited to measures which mitigate impacts to resources which are subject to the statutory authority of, and definitions applicable to, that agency. Compliance or noncompliance by a responsible agency or agency having jurisdiction over natural resources affected by a project with that requirement shall not limit the authority of the responsible agency or agency having jurisdiction over natural resources affected by a project, or the authority of the lead agency, to approve, condition, or deny projects as provided by this division or any other provision of law.

21081.7. Transportation information resulting from the reporting or monitoring program required to be adopted by a public agency pursuant to Section 21081.6 shall be submitted to the transportation planning agency in the region where the project is located and to the Department of Transportation for a project of statewide, regional, or areawide significance according to criteria developed pursuant to Section 21083. The transportation planning agency and the Department of Transportation shall adopt guidelines for the submittal of those reporting or monitoring programs.

21082. All public agencies shall adopt by ordinance, resolution, rule, or regulation, objectives, criteria, and procedures for the evaluation of projects and the preparation of environmental impact reports and negative declarations pursuant to this division. A school district, or any other district, whose boundaries are coterminous with a city, county, or city and county, may utilize the objectives, criteria, and procedures of the city, county, or city and county, as may be applicable, in which case, the school district or other district need not adopt objectives, criteria, and procedures of its own. The objectives, criteria, and procedures shall be consistent with the provisions of this division and with the guidelines adopted by the Secretary of the Resources Agency pursuant to Section 21083. Such objectives, criteria, and procedures shall be adopted by each public agency no later than 60 days after the Secretary of the Resources Agency has adopted guidelines pursuant to Section 21083.

21082.1. (a) Any draft environmental impact report, environmental impact report, negative declaration, or mitigated negative declaration prepared pursuant to the requirements of this division shall be prepared directly by, or under contract to, a public agency.

(b) This section is not intended to prohibit, and shall not be construed as prohibiting, any person from submitting information or other comments to the public agency responsible for preparing an environmental impact report, draft environmental impact report, negative declaration, or mitigated negative declaration. The information or other comments may be submitted in any format, shall be considered by the public agency, and may be included, in whole or in part, in any report or declaration.

(c) The lead agency shall do all of the following:

(1) Independently review and analyze any report or declaration required by this division.

(2) Circulate draft documents that reflect its independent judgment.

(3) As part of the adoption of a negative declaration or a mitigated negative declaration, or certification of an environmental impact report, find that the report or declaration reflects the independent judgment of the lead agency.
(4) Submit a sufficient number of copies of the draft environmental impact report, proposed negative declaration, or proposed mitigated negative declaration, and a copy of the report or declaration in an electronic form as required by the guidelines adopted pursuant to Section 21083, to the State Clearinghouse for review and comment by state agencies, if any of the following apply:
(A) A state agency is any of the following:
(i) The lead agency.
(ii) A responsible agency.
(iii) A trustee agency.
(B) A state agency otherwise has jurisdiction by law with respect to the project.
(C) The proposed project is of sufficient statewide, regional, or areawide environmental significance as determined pursuant to the guidelines certified and adopted pursuant to Section 21083.

21082.2. (a) The lead agency shall determine whether a project may have a significant effect on the environment based on substantial evidence in light of the whole record.
(b) The existence of public controversy over the environmental effects of a project shall not require preparation of an environmental impact report if there is no substantial evidence in light of the whole record before the lead agency that the project may have a significant effect on the environment.
(c) Argument, speculation, unsubstantiated opinion or narrative, evidence which is clearly inaccurate or erroneous, or evidence of social or economic impacts which do not contribute to, or are not caused by, physical impacts on the environment, is not substantial evidence. Substantial evidence shall include facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts.
(d) If there is substantial evidence, in light of the whole record before the lead agency, that a project may have a significant effect on the environment, an environmental impact report shall be prepared.
(e) Statements in an environmental impact report and comments with respect to an environmental impact report shall not be deemed determinative of whether the project may have a significant effect on the environment.

21083. (a) The Office of Planning and Research shall prepare and develop proposed guidelines for the implementation of this division by public agencies. The guidelines shall include objectives and criteria for the orderly evaluation of projects and the preparation of environmental impact reports and negative declarations in a manner consistent with this division.
(b) The guidelines shall specifically include criteria for public agencies to follow in determining whether or not a proposed project may have a "significant effect on the environment." The criteria shall require a finding that a project may have a "significant effect on the environment" if one or more of the following conditions exist:
(1) A proposed project has the potential to degrade the quality of the environment, curtail the range of the environment, or to achieve short-term, to the disadvantage of long-term, environmental goals.
(2) The possible effects of a project are individually limited but cumulatively considerable. As used in this paragraph, "cumulatively considerable" means that the incremental effects of an individual project are considerable when

viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.

(3) The environmental effects of a project will cause substantial adverse effects on human beings, either directly or indirectly.

(c) The guidelines shall include procedures for determining the lead agency pursuant to Section 21165.

(d) The guidelines shall include criteria for public agencies to use in determining when a proposed project is of sufficient statewide, regional, or areawide environmental significance that a draft environmental impact report, a proposed negative declaration, or a proposed mitigated negative declaration shall be submitted to appropriate state agencies, through the State Clearinghouse, for review and comment prior to completion of the environmental impact report, negative declaration, or mitigated negative declaration.

(e) The Office of Planning and Research shall develop and prepare the proposed guidelines as soon as possible and shall transmit them immediately to the Secretary of the Resources Agency. The Secretary of the Resources Agency shall certify and adopt the guidelines pursuant to Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code, which shall become effective upon the filing thereof. However, the guidelines shall not be adopted without compliance with Sections 11346.4, 11346.5, and 11346.8 of the Government Code.

(f) The Office of Planning and Research shall, at least once every two years, review the guidelines adopted pursuant to this section and shall recommend proposed changes or amendments to the Secretary of the Resources Agency. The Secretary of the Resources Agency shall certify and adopt guidelines, and any amendments thereto, at least once every two years, pursuant to Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code, which shall become effective upon the filing thereof. However, guidelines may not be adopted or amended without compliance with Sections 11346.4, 11346.5, and 11346.8 of the Government Code.

21083.1. It is the intent of the Legislature that courts, consistent with generally accepted rules of statutory interpretation, shall not interpret this division or the state guidelines adopted pursuant to Section 21083 in a manner which imposes procedural or substantive requirements beyond those explicitly stated in this division or in the state guidelines.

21083.2. (a) As part of the determination made pursuant to Section 21080.1, the lead agency shall determine whether the project may have a significant effect on archaeological resources. If the lead agency determines that the project may have a significant effect on unique archaeological resources, the environmental impact report shall address the issue of those resources. An environmental impact report, if otherwise necessary, shall not address the issue of nonunique archaeological resources. A negative declaration shall be issued with respect to a project if, but for the issue of nonunique archaeological resources, the negative declaration would be otherwise issued.

(b) If it can be demonstrated that a project will cause damage to a unique archaeological resource, the lead agency may require reasonable efforts to be made to permit any or all of these resources to be preserved in place or left in an undisturbed state. Examples of that treatment, in no order of preference, may include, but are not limited to, any of the following:

(1) Planning construction to avoid archaeological sites.

(2) Deeding archaeological sites into permanent conservation easements.

(3) Capping or covering archaeological sites with a layer of soil before building on the sites.
(4) Planning parks, greenspace, or other open space to incorporate archaeological sites.
(c) To the extent that unique archaeological resources are not preserved in place or not left in an undisturbed state, mitigation measures shall be required as provided in this subdivision. The project applicant shall provide a guarantee to the lead agency to pay one-half the estimated cost of mitigating the significant effects of the project on unique archaeological resources. In determining payment, the lead agency shall give due consideration to the in-kind value of project design or expenditures that are intended to permit any or all archaeological resources or California Native American culturally significant sites to be preserved in place or left in an undisturbed state. When a final decision is made to carry out or approve the project, the lead agency shall, if necessary, reduce the specified mitigation measures to those which can be funded with the money guaranteed by the project applicant plus the money voluntarily guaranteed by any other person or persons for those mitigation purposes. In order to allow time for interested persons to provide the funding guarantee referred to in this subdivision, a final decision to carry out or approve a project shall not occur sooner than 60 days after completion of the recommended special environmental impact report required by this section.
(d) Excavation as mitigation shall be restricted to those parts of the unique archaeological resource that would be damaged or destroyed by the project. Excavation as mitigation shall not be required for a unique archaeological resource if the lead agency determines that testing or studies already completed have adequately recovered the scientifically consequential information from and about the resource, if this determination is documented in the environmental impact report.
(e) In no event shall the amount paid by a project applicant for mitigation measures required pursuant to subdivision (c) exceed the following amounts:
(1) An amount equal to one-half of 1 percent of the projected cost of the project for mitigation measures undertaken within the site boundaries of a commercial or industrial project.
(2) An amount equal to three-fourths of 1 percent of the projected cost of the project for mitigation measures undertaken within the site boundaries of a housing project consisting of a single unit.
(3) If a housing project consists of more than a single unit, an amount equal to three-fourths of 1 percent of the projected cost of the project for mitigation measures undertaken within the site boundaries of the project for the first unit plus the sum of the following:
(A) Two hundred dollars ($200) per unit for any of the next 99 units.
(B) One hundred fifty dollars ($150) per unit for any of the next 400 units.
(C) One hundred dollars ($100) per unit in excess of 500 units.
(f) Unless special or unusual circumstances warrant an exception, the field excavation phase of an approved mitigation plan shall be completed within 90 days after final approval necessary to implement the physical development of the project or, if a phased project, in connection with the phased portion to which the specific mitigation measures are applicable. However, the project applicant may extend that period if he or she so elects. Nothing in this section shall nullify protections for Indian cemeteries under any other provision of law.
(g) As used in this section, "unique archaeological resource" means an archaeological artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

(1) Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.
(2) Has a special and particular quality such as being the oldest of its type or the best available example of its type.
(3) Is directly associated with a scientifically recognized important prehistoric or historic event or person.

(h) As used in this section, "nonunique archaeological resource" means an archaeological artifact, object, or site which does not meet the criteria in subdivision (g). A nonunique archaeological resource need be given no further consideration, other than the simple recording of its existence by the lead agency if it so elects.

(i) As part of the objectives, criteria, and procedures required by Section 21082 or as part of conditions imposed for mitigation, a lead agency may make provisions for archaeological sites accidentally discovered during construction. These provisions may include an immediate evaluation of the find. If the find is determined to be a unique archaeological resource, contingency funding and a time allotment sufficient to allow recovering an archaeological sample or to employ one of the avoidance measures may be required under the provisions set forth in this section. Construction work may continue on other parts of the building site while archaeological mitigation takes place.

(j) This section does not apply to any project described in subdivision (a) or (b) of Section 21065 if the lead agency elects to comply with all other applicable provisions of this division. This section does not apply to any project described in subdivision (c) of Section 21065 if the applicant and the lead agency jointly elect to comply with all other applicable provisions of this division.

(k) Any additional costs to any local agency as a result of complying with this section with respect to a project of other than a public agency shall be borne by the project applicant.

(l) Nothing in this section is intended to affect or modify the requirements of Section 21084 or 21084.1.

21083.3. (a) If a parcel has been zoned to accommodate a particular density of development or has been designated in a community plan to accommodate a particular density of development and an environmental impact report was certified for that zoning or planning action, the application of this division to the approval of any subdivision map or other project that is consistent with the zoning or community plan shall be limited to effects upon the environment which are peculiar to the parcel or to the project and which were not addressed as significant effects in the prior environmental impact report, or which substantial new information shows will be more significant than described in the prior environmental impact report.

(b) If a development project is consistent with the general plan of a local agency and an environmental impact report was certified with respect to that general plan, the application of this division to the approval of that development project shall be limited to effects on the environment which are peculiar to the parcel or to the project and which were not addressed as significant effects in the prior environmental impact report, or which substantial new information shows will be more significant than described in the prior environmental impact report.

(c) Nothing in this section affects any requirement to analyze potentially significant offsite impacts and cumulative impacts of the project not discussed in the prior environmental impact report with respect to the general plan. However, all public agencies with authority to mitigate the significant effects shall undertake or require the undertaking of any

feasible mitigation measures specified in the prior environmental impact report relevant to a significant effect which the project will have on the environment or, if not, then the provisions of this section shall have no application to that effect. The lead agency shall make a finding, at a public hearing, as to whether those mitigation measures will be undertaken.

(d) An effect of a project upon the environment shall not be considered peculiar to the parcel or to the project, for purposes of this section, if uniformly applied development policies or standards have been previously adopted by the city or county, with a finding based upon substantial evidence, which need not include an environmental impact report, that the development policies or standards will substantially mitigate that environmental effect when applied to future projects, unless substantial new information shows that the policies or standards will not substantially mitigate the environmental effect.

(e) Where a community plan is the basis for application of this section, any rezoning action consistent with the community plan shall be a project subject to exemption from this division in accordance with this section. As used in this section, "community plan" means a part of the general plan of a city or county which (1) applies to a defined geographic portion of the total area included in the general plan, (2) complies with Article 5 (commencing with Section 65300) of Chapter 3 of Division 1 of Title 7 of the Government Code by including or referencing each of the mandatory elements specified in Section 65302 of the Government Code, and (3) contains specific development policies adopted for the area included in the community plan and identifies measures to implement those policies, so that the policies which will apply to each parcel can be determined.

(f) No person shall have standing to bring an action or proceeding to attack, review, set aside, void, or annul a finding of a public agency made at a public hearing pursuant to subdivision (a) with respect to the conformity of the project to the mitigation measures identified in the prior environmental impact report for the zoning or planning action, unless he or she has participated in that public hearing. However, this subdivision shall not be applicable if the local agency failed to give public notice of the hearing as required by law. For purposes of this subdivision, a person has participated in the public hearing if he or she has either submitted oral or written testimony regarding the proposed determination, finding, or decision prior to the close of the hearing.

(g) Any community plan adopted prior to January 1, 1982, which does not comply with the definitional criteria specified in subdivision (e) may be amended to comply with that criteria, in which case the plan shall be deemed a "community plan" within the meaning of subdivision (e) if (1) an environmental impact report was certified for adoption of the plan, and (2) at the time of the conforming amendment, the environmental impact report has not been held inadequate by a court of this state and is not the subject of pending litigation challenging its adequacy.

21083.4. (a) For purposes of this section, "oak" means a native tree species in the genus Quercus, not designated as Group A or Group B commercial species pursuant to regulations adopted by the State Board of Forestry and Fire Protection pursuant to Section 4526, and that is 5 inches or more in diameter at breast height.

(b) As part of the determination made pursuant to Section 21080.1, a county shall determine whether a project within its jurisdiction may result in a conversion of oak woodlands that will have a significant effect on the environment. If a county determines that there may be a significant effect to oak woodlands, the county shall require one or more of the following oak

woodlands mitigation alternatives to mitigate the significant effect of the conversion of oak woodlands:

(1) Conserve oak woodlands, through the use of conservation easements.

(2) (A) Plant an appropriate number of trees, including maintaining plantings and replacing dead or diseased trees.

(B) The requirement to maintain trees pursuant to this paragraph terminates seven years after the trees are planted.

(C) Mitigation pursuant to this paragraph shall not fulfill more than one-half of the mitigation requirement for the project.

(D) The requirements imposed pursuant to this paragraph also may be used to restore former oak woodlands.

(3) Contribute funds to the Oak Woodlands Conservation Fund, as established under subdivision (a) of Section 1363 of the Fish and Game Code, for the purpose of purchasing oak woodlands conservation easements, as specified under paragraph (1) of subdivision (d) of that section and the guidelines and criteria of the Wildlife Conservation Board. A project applicant that contributes funds under this paragraph shall not receive a grant from the Oak Woodlands Conservation Fund as part of the mitigation for the project.

(4) Other mitigation measures developed by the county.

(c) Notwithstanding subdivision (d) of Section 1363 of the Fish and Game Code, a county may use a grant awarded pursuant to the Oak Woodlands Conservation Act (Article 3.5 (commencing with Section 1360) of Chapter 4 of Division 2 of the Fish and Game Code) to prepare an oak conservation element for a general plan, an oak protection ordinance, or an oak woodlands management plan, or amendments thereto, that meets the requirements of this section.

(d) The following are exempt from this section:

(1) Projects undertaken pursuant to an approved Natural Community Conservation Plan or approved subarea plan within an approved Natural Community Conservation Plan that includes oaks as a covered species or that conserves oak habitat through natural community conservation preserve designation and implementation and mitigation measures that are consistent with this section.

(2) Affordable housing projects for lower income households, as defined pursuant to Section 50079.5 of the Health and Safety Code, that are located within an urbanized area, or within a sphere of influence as defined pursuant to Section 56076 of the Government Code.

(3) Conversion of oak woodlands on agricultural land that includes land that is used to produce or process plant and animal products for commercial purposes.

(4) Projects undertaken pursuant to Section 21080.5 of the Public Resources Code.

(e) (1) A lead agency that adopts, and a project that incorporates, one or more of the measures specified in this section to mitigate the significant effects to oaks and oak woodlands shall be deemed to be in compliance with this division only as it applies to effects on oaks and oak woodlands.

(2) The Legislature does not intend this section to modify requirements of this division, other than with regard to effects on oaks and oak woodlands.

(f) This section does not preclude the application of Section 21081 to a project.

(g) This section, and the regulations adopted pursuant to this section, shall not be construed as a limitation on the power of a public agency to comply with this division or any other provision of law.

21083.5. (a) The guidelines prepared and adopted pursuant to Section 21083 shall provide that, when an environmental impact statement has been, or will be, prepared for the same project pursuant to the requirements of the National Environmental Policy Act of 1969 (42 U.S.C. Sec. 43 21 et seq.) and implementing regulations, or an environmental impact report has been, or will be, prepared for the same project pursuant to the requirements of the Tahoe Regional Planning Compact (Section 66801 of the Government Code) and

implementing regulations, all or any part of that statement or report may be submitted in lieu of all or any part of an environmental impact report required by this division, if that statement or report, or the part which is used, complies with the requirements of this division and the guidelines adopted pursuant thereto.

(b) Notwithstanding subdivision (a), compliance with this division may be achieved for the adoption in a city or county general plan, without any additions or change, of all or any part of the regional plan prepared pursuant to the Tahoe Regional Planning Compact and implementing regulations by reviewing environmental documents prepared by the Tahoe Regional Planning Agency addressing the plan, providing an analysis pursuant to this division of any significant effect on the environment not addressed in the environmental documents, and proceeding in accordance with Section 21081. This subdivision does not exempt a city or county from complying with the public review and notice requirements of this division.

21083.6. In the event that a project requires both an environmental impact report prepared pursuant to the requirements of this division and an environmental impact statement prepared pursuant to the requirements of the National Environmental Policy Act of 1969, an applicant may request and the lead agency may waive the time limits established pursuant to Section 21100.2 or 21151.5 if it finds that additional time is required to prepare a combined environmental impact report-environmental impact statement and that the time required to prepare such a combined document would be shorter than that required to prepare each document separately.

21083.7. (a) In the event that a project requires both an environmental impact report prepared pursuant to the requirements of this division and an environmental impact statement prepared pursuant to the requirements of the National Environmental Policy Act of 1969, the lead agency shall, whenever possible, use the environmental impact statement as such environmental impact report as provided in Section 21083.5.

(b) In order to implement this section, each lead agency to which this section is applicable shall do both of the following, as soon as possible:

(1) Consult with the federal agency required to prepare such environmental impact statement.

(2) Notify the federal agency required to prepare the environmental impact statement regarding any scoping meeting for the proposed project.

21083.8.1. (a) (1) For purposes of this section, "reuse plan" for a military base means an initial plan for the reuse of a military base adopted by a local government or a redevelopment agency in the form of a general plan, general plan amendment, specific plan, redevelopment plan, or other planning document, except that the reuse plan shall also consist of a statement of development policies, include a diagram or diagrams illustrating its provisions, and make the designation required in paragraph (2). "Military base" or "base" means a military base or reservation either closed or realigned by, or scheduled for closure or realignment by, the federal government.

(2) The reuse plan shall designate the proposed general distribution and general location of development intensity for housing, business, industry, open space, recreation, natural resources, public buildings and grounds, roads and other transportation facilities, infrastructure, and other categories of public and private uses of land.

(b) (1) When preparing and certifying an environmental impact report for a reuse plan, including when utilizing an environmental impact statement pursuant to Section 21083.5, the determination of whether the reuse plan may have a significant effect on the environment may be made in the context of the physical conditions that were present at the time that the federal decision became final for the closure or realignment of the base. The no project alternative analyzed in the environmental impact report shall discuss the existing conditions on the base, as they exist at the time that the environmental impact report is prepared, as well as what could be reasonably expected to occur in the foreseeable future if the reuse plan were not approved, based on current plans and consistent with available infrastructure and services.

(2) For purposes of this division, all public and private activities taken pursuant to, or in furtherance of, a reuse plan shall be deemed to be a single project. However, further environmental review of any such public or private activity shall be conducted if any of the events specified in Section 21166 have occurred.

(c) Prior to preparing an environmental impact report for which a lead agency chooses to utilize the provisions of this section, the lead agency shall do all of the following:

(A) Hold a public hearing at which is discussed the federal environmental impact statement prepared for, or in the process of being prepared for, the closure of the military base. The discussion shall include the significant effects on the environment examined in the environmental impact statement, potential methods of mitigating those effects, including feasible alternatives, and the mitigative effects of federal, state, and local laws applicable to future nonmilitary activities. Prior to the close of the hearing, the lead agency may specify the baseline conditions for the reuse plan environmental impact report prepared, or in the process of being prepared, for the closure of the base. The lead agency may specify particular physical conditions that it will examine in greater detail than were examined in the environmental impact statement. Notice of the hearing shall be given as provided in Section 21092. The hearing may be continued from time to time.

(B) Identify pertinent responsible agencies and trustee agencies and consult with those agencies prior to the public hearing as to the application of their regulatory policies and permitting standards to the proposed baseline for environmental analysis, as well as to the reuse plan and planned future nonmilitary land uses of the base. The affected agencies shall have not less than 30 days prior to the public hearing to review the proposed reuse plan and to submit their comments to the lead agency.

(C) At the close of the hearing, the lead agency shall state in writing how the lead agency intends to integrate the baseline for analysis with the reuse planning and environmental review process, taking into account the adopted environmental standards of the community, including, but not limited to, the applicable general plan, specific plan, and redevelopment plan, and including other applicable provisions of adopted congestion management plans, habitat conservation or natural communities conservation plans, integrated waste management plans, and county hazardous waste management plans.

(D) At the close of the hearing, the lead agency shall state, in writing, the specific economic or social reasons, including, but not limited to, new job creation, opportunities for employment of skilled workers, availability of low- and moderate-income housing, and economic continuity, which support the selection of the baseline.

(d) (1) Nothing in this section shall in any way limit the scope of a review or determination of significance of the presence of hazardous or toxic wastes, substances, or materials including, but not limited to, contaminated soils and groundwater, nor shall the regulation of hazardous or toxic wastes,

substances, or materials be constrained by prior levels of activity that existed at the time that the federal agency decision to close the military base became final.

(2) This section does not apply to any project undertaken pursuant to Chapter 6.5 (commencing with Section 25100) of, or Chapter 6.8 (commencing with Section 25300) of, Division 20 of the Health and Safety Code, or pursuant to the Porter-Cologne Water Quality Control Act (Division 7 (commencing with Section 13000) of the Water Code).

(3) This section may apply to any reuse plan environmental impact report for which a notice of preparation pursuant to subdivision (a) of Section 21092 is issued within one year from the date that the federal record of decision was rendered for the military base closure or realignment and reuse, or prior to January 1, 1997, whichever is later, if the environmental impact report is completed and certified within five years from the date that the federal record of decision was rendered.

(e) All subsequent development at the military base shall be subject to all applicable federal, state, or local laws, including, but not limited to, those relating to air quality, water quality, traffic, threatened and endangered species, noise, and hazardous or toxic wastes, substances, or materials.

21083.9. (a) Notwithstanding Section 21080.4, 21104, or 21153, a lead agency shall call at least one scoping meeting for either of the following:

(1) A proposed project that may affect highways or other facilities under the jurisdiction of the Department of Transportation if the meeting is requested by the department. The lead agency shall call the scoping meeting as soon as possible, but not later than 30 days after receiving the request from the Department of Transportation.

(2) A project of statewide, regional, or areawide significance.

(b) The lead agency shall provide notice of at least one scoping meeting held pursuant to paragraph (2) of subdivision (a) to all of the following:

(1) Any county or city that borders on a county or city within which the project is located, unless otherwise designated annually by agreement between the lead agency and the county or city.

(2) Any responsible agency.

(3) Any public agency that has jurisdiction by law with respect to the project.

(4) Any organization or individual who has filed a written request for the notice.

(c) For any entity, organization, or individual that is required to be provided notice of a lead agency public meeting, the requirement for notice of a scoping meeting pursuant to subdivision (b) may be met by including the notice of a scoping meeting in the public meeting notice.

(d) A scoping meeting that is held in the city or county within which the project is located pursuant to the National Environmental Policy Act (42 U.S.C. Sec. 43 21 et seq.) and the regulations adopted pursuant to that act shall be deemed to satisfy the requirement that a scoping meeting be held for a project subject to paragraph (2) of subdivision (a) if the lead agency meets the notice requirements of subdivision (b) or subdivision (c).

21084. (a) The guidelines prepared and adopted pursuant to Section 21083 shall include a list of classes of projects which have been determined not to have a significant effect on the environment and which shall be exempt from this division. In adopting the guidelines, the Secretary of the Resources Agency shall make a finding that the listed classes of projects referred to in this section do not have a significant effect on the environment.

(b) No project which may result in damage to scenic resources, including, but not limited to, trees, historic buildings, rock outcroppings, or similar resources, within a highway designated as an official state scenic highway, pursuant to Article 2.5 (commencing with Section 260) of Chapter 2 of Division 1 of the Streets and Highways Code, shall be exempted from this division pursuant to subdivision (a). This subdivision does not apply to improvements as mitigation for a project for which a negative declaration has been approved or an environmental impact report has been certified.
(c) No project located on a site which is included on any list compiled pursuant to Section 65962.5 of the Government Code shall be exempted from this division pursuant to subdivision (a).
(d) The changes made to this section by Chapter 1 212 of the Statutes of 1991 apply only to projects for which applications have not been deemed complete on or before January 1, 1992, pursuant to Section 65943 of the Government Code.
(e) No project that may cause a substantial adverse change in the significance of an historical resource, as specified in Section 21084.1, shall be exempted from this division pursuant to subdivision (a).

21084.1. A project that may cause a substantial adverse change in the significance of an historical resource is a project that may have a significant effect on the environment. For purposes of this section, an historical resource is a resource listed in, or determined to be eligible for listing in, the California Register of Historical Resources. Historical resources included in a local register of historical resources, as defined in subdivision (k) of Section 5020.1, or deemed significant pursuant to criteria set forth in subdivision (g) of Section 5024.1, are presumed to be historically or culturally significant for purposes of this section, unless the preponderance of the evidence demonstrates that the resource is not historically or culturally significant. The fact that a resource is not listed in, or determined to be eligible for listing in, the California Register of Historical Resources, not included in a local register of historical resources, or not deemed significant pursuant to criteria set forth in subdivision (g) of Section 5024.1 shall not preclude a lead agency from determining whether the resource may be an historical resource for purposes of this section.

21085.7. (a) (1) If an environmental impact report for a project at an airport that is owned by a city and county and that is located in another county identifies as a proposed mitigation measure the acquisition, enhancement, and restoration of salt ponds and the lead agency proposes the payment of funds to one or more public agencies to mitigate the impacts of the proposed project and the public agency or agencies propose to use those funds to acquire, enhance, and restore land, the lead agency shall include in the environmental impact report on the proposed project a detailed statement of the mitigation measure, including all of the following:
(A) An analysis of the relationship between the impacts of the proposed project and the benefits of the proposed acquisition, enhancement, and restoration of land that the payment of funds would allow.
(B) An analysis of the feasibility of the proposed acquisition, enhancement, and restoration.
(C) A discussion of the expected impacts of the proposed acquisition, enhancement, and restoration.
(2) The detailed statement of the mitigation measure shall consist of the following:

(A) Information in existence at the time the environmental impact report is prepared, including the restoration goals specific to salt ponds as identified in the San Francisco Estuary Baylands Ecosystem Goals Report published in 1999.
(B) Information that is reasonably obtainable, including, but not limited to, a hydrodynamic analysis of potential flood impacts, and analyses regarding the potential for the following:
(i) Changes to the waters and tidal currents of the southern portions of the San Francisco Bay.
(ii) Potential alterations to the San Francisco Bay floor.
(iii) Related impacts on water quality.
(3) If, at the time of the publication of the draft environmental impact report, a restoration plan has not been adopted by a public agency with jurisdiction to carry out the restoration project, the lead agency for the airport project need not prepare a detailed restoration plan or analyze the impacts of a restoration plan for the lands proposed for acquisition, enhancement, and restoration; however, the lead agency shall evaluate a conceptual restoration plan, and shall fully evaluate a potentially feasible alternate mitigation measure that does not depend on the salt ponds.
(b) If the lead agency for the airport project approves the proposed project and approves the payment of funds for the acquisition, enhancement, and restoration of land as a mitigation measure, it shall make both such approvals contingent upon an agreement between the lead agency and the public agency or agencies wherein the public agency or agencies agree to use the funds solely for the following purposes:
(1) The acquisition, enhancement, and restoration of the lands identified by the lead agency in its detailed statement of the mitigation measure.
(2) The preparation and implementation of a restoration plan that, at a minimum, mitigates the significant impact that would be substantially lessened or avoided by implementation of the mitigation measure as identified in the final environmental impact report certified by the lead agency.
(c) The agreement described in subdivision (b) shall identify a feasible alternative mitigation measure to be implemented if the restoration of all or a portion of the salt ponds proves to be infeasible, as determined by the lead agency.
(d) Nothing in this section shall be interpreted to assess or assign liability with respect to the salt ponds.
(e) Funds for the costs of mitigation shall include the costs of the environmental reviews conducted by a state agency of the restoration plan prepared by a state agency.
(f) This section shall only apply to the acquisition, enhancement, and restoration of salt ponds located in the southerly portion of the San Francisco Bay.
(g) As used in this section, "acquisition, enhancement, and restoration" also includes acquisition, enhancement, or restoration.
(h) This section shall remain in effect only until January 1, 2008, and as of that date is repealed, unless a later enacted statute, that is enacted before January 1, 2008, deletes or extends that date.

21086. (a) A public agency may, at any time, request the addition or deletion of a class of projects, to the list designated pursuant to Section 21084. That request shall be made in writing to the Office of Planning and Research and shall include information supporting the public agency's position that the class of projects does, or does not, have a significant effect on the environment.
(b) The Office of Planning and Research shall review each request and, as soon as possible, shall submit its recommendation to the Secretary of the Resources

Agency. Following the receipt of that recommendation, the Secretary of the Resources Agency may add or delete the class of projects to the list of classes of projects designated pursuant to Section 21084 that are exempt from the requirements of this division.

(c) The addition or deletion of a class of projects, as provided in this section, to the list specified in Section 21084 shall constitute an amendment to the guidelines adopted pursuant to Section 21083 and shall be adopted in the manner prescribed in Sections 21083 and 21084.

21088. The Secretary of the Resources Agency shall provide for the timely distribution to all public agencies of the guidelines and any amendments or changes thereto. In addition, the Secretary of the Resources Agency may provide for publication of a bulletin to provide public notice of the guidelines, or any amendments or changes thereto, and of the completion of environmental impact reports prepared in compliance with this division.

21089. (a) A lead agency may charge and collect a reasonable fee from any person proposing a project subject to this division in order to recover the estimated costs incurred by the lead agency in preparing a negative declaration or an environmental impact report for the project and for procedures necessary to comply with this division on the project. Litigation expenses, costs, and fees incurred in actions alleging noncompliance with this division under Section 21167 are not recoverable under this section.

(b) The Department of Fish and Game may charge and collect filing fees, as provided in Section 711.4 of the Fish and Game Code. Notwithstanding Section 21080.1, a finding required under Section 21081, or any project approved under a certified regulatory program authorized pursuant to Section 21080.5 is not operative, vested, or final until the filing fees required pursuant to Section 711.4 of the Fish and Game Code are paid.

21090. (a) An environmental impact report for a redevelopment plan may be a master environmental impact report, program environmental impact report, or a project environmental impact report. Any environmental impact report for a redevelopment plan shall specify the type of environmental impact report that is prepared for the redevelopment plan.

(b) If the environmental impact report for a redevelopment plan is a project environmental impact report, all public and private activities or undertakings pursuant to, or in furtherance of, a redevelopment plan shall be deemed to be a single project. However, further environmental review of any public or private activity or undertaking pursuant to, or in furtherance of, a redevelopment plan for which a project environmental impact report has been certified shall be conducted if any of the events specified in Section 21166 have occurred.

21090.1. For all purposes of this division, a geothermal exploratory project shall be deemed to be separate and distinct from any subsequent geothermal field development project as defined in Section 65928.5 of the Government Code.

21091. (a) The public review period for a draft environmental impact report may not be less than 30 days. If the draft environmental impact report is submitted to the State Clearinghouse for review, the review period shall be at least 45

days, and the lead agency shall provide a sufficient number of copies of the document to the State Clearinghouse for review and comment by state agencies.

(b) The public review period for a proposed negative declaration or proposed mitigated negative declaration may not be less than 20 days. If the proposed negative declaration or proposed mitigated negative declaration is submitted to the State Clearinghouse for review, the review period shall be at least 30 days, and the lead agency shall provide a sufficient number of copies of the document to the State Clearinghouse for review and comment by state agencies.

(c) (1) Notwithstanding subdivisions (a) and (b), if a draft environmental impact report, proposed negative declaration, or proposed mitigated negative declaration is submitted to the State Clearinghouse for review and the period of review by the State Clearinghouse is longer than the public review period established pursuant to subdivision (a) or (b), whichever is applicable, the public review period shall be at least as long as the period of review and comment by state agencies as established by the State Clearinghouse.

(2) The public review period and the state agency review period may, but are not required to, begin and end at the same time. Day one of the state agency review period shall be the date that the State Clearinghouse distributes the document to state agencies.

(3) If the submittal of a CEQA document is determined by the State Clearinghouse to be complete, the State Clearinghouse shall distribute the document within three working days from the date of receipt. The State Clearinghouse shall specify the information that will be required in order to determine the completeness of the submittal of a CEQA document.

(d) (1) The lead agency shall consider comments it receives on a draft environmental impact report, proposed negative declaration, or proposed mitigated negative declaration if those comments are received within the public review period.

(2) (A) With respect to the consideration of comments received on a draft environmental impact report, the lead agency shall evaluate comments on environmental issues that are received from persons who have reviewed the draft and shall prepare a written response pursuant to subparagraph (B). The lead agency may also respond to comments that are received after the close of the public review period.

(B) The written response shall describe the disposition of each significant environmental issue that is raised by commenters. The responses shall be prepared consistent with Section 15088 of Title 14 of the California Code of Regulations, as those regulations existed on June 1, 1993.

(3) (A) With respect to the consideration of comments received on a draft environmental impact report, proposed negative declaration, proposed mitigated negative declaration, or notice pursuant to Section 21080.4, the lead agency shall accept comments via e-mail and shall treat e-mail comments as equivalent to written comments.

(B) Any law or regulation relating to written comments received on a draft environmental impact report, proposed negative declaration, proposed mitigated negative declaration, or notice received pursuant to Section 21080.4, shall also apply to e-mail comments received for those reasons.

(e) (1) Criteria for shorter review periods by the State Clearinghouse for documents that must be submitted to the State Clearinghouse shall be set forth in the written guidelines issued by the Office of Planning and Research and made available to the public.

(2) Those shortened review periods may not be less than 30 days for a draft environmental impact report and 20 days for a negative declaration.

(3) A request for a shortened review period shall only be made in writing by the decisionmaking body of the lead agency to the Office of Planning and Research. The decisionmaking body may designate by resolution or ordinance a

person authorized to request a shortened review period. A designated person shall notify the decisionmaking body of this request.

(4) A request approved by the State Clearinghouse shall be consistent with the criteria set forth in the written guidelines of the Office of Planning and Research.

(5) A shortened review period may not be approved by the Office of Planning and Research for a proposed project of statewide, regional, or areawide environmental significance as determined pursuant to Section 21083.

(6) An approval of a shortened review period shall be given prior to, and reflected in, the public notice required pursuant to Section 21092.

(f) Prior to carrying out or approving a project for which a negative declaration has been adopted, the lead agency shall consider the negative declaration together with comments that were received and considered pursuant to paragraph (1) of subdivision (d).

21091.5. Notwithstanding subdivision (a) of Section 21091, or any other provision of this division, the public review period for a draft environmental impact report prepared for a proposed project involving the expansion or enlargement of a publicly owned airport requiring the acquisition of any tide and submerged lands or other lands subject to the public trust for commerce, navigation, or fisheries, or any interest therein, shall be not less than 120 days.

21092. (a) Any lead agency that is preparing an environmental impact report or a negative declaration or making a determination pursuant to subdivision (c) of Section 21157.1 shall provide public notice of that fact within a reasonable period of time prior to certification of the environmental impact report, adoption of the negative declaration, or making the determination pursuant to subdivision (c) of Section 21157.1.

(b) (1) The notice shall specify the period during which comments will be received on the draft environmental report or negative declaration, and shall include the date, time, and place of any public meetings or hearings on the proposed project, a brief description of the proposed project and its location, the significant effects on the environment, if any, anticipated as a result of the project, and the address where copies of the draft environmental impact report or negative declaration, and all documents referenced in the draft environmental impact report or negative declaration, are available for review.

(2) This section shall not be construed in any manner that results in the invalidation of an action because of the alleged inadequacy of the notice content, provided that there has been substantial compliance with the notice content requirements of this section.

(3) The notice required by this section shall be given to the last known name and address of all organizations and individuals who have previously requested notice and shall also be given by at least one of the following procedures:

(A) Publication, no fewer times than required by Section 6061 of the Government Code, by the public agency in a newspaper of general circulation in the area affected by the proposed project. If more than one area will be affected, the notice shall be published in the newspaper of largest circulation from among the newspapers of general circulation in those areas.

(B) Posting of notice by the lead agency on- and off-site in the area where the project is to be located.

(C) Direct mailing to the owners and occupants of contiguous property shown on the latest equalized assessment roll.

(c) For any project involving the burning of municipal wastes, hazardous waste, or refuse-derived fuel, including, but not limited to, tires, meeting the qualifications of subdivision (d), notice shall be given to all organizations and individuals who have previously requested notice and shall also be given by at least the procedures specified in subparagraphs (A), (B), and (C) of paragraph (3) of subdivision (b). In addition, notification shall be given by direct mailing to the owners and occupants of property within one-fourth of a mile of any parcel or parcels on which is located a project subject to this subdivision. This subdivision does not apply to any project for which notice has already been provided as of July 14, 1989, in compliance with this section as it existed prior to July 14, 1989.
(d) The notice requirements of subdivision (c) apply to both of the following:
(1) The construction of a new facility.
(2) The expansion of an existing facility which burns hazardous waste which would increase its permitted capacity by more than 10 percent. For purposes of this paragraph, the amount of expansion of an existing facility shall be calculated by comparing the proposed facility capacity with whichever of the following is applicable:
(A) The facility capacity approved in the facility's hazardous waste facilities permit pursuant to Section 25200 of the Health and Safety Code or its grant of interim status pursuant to Section 25200.5 of the Health and Safety Code, or the facility capacity authorized in any state or local agency permit allowing the construction or operation of a facility for the burning of hazardous waste, granted before January 1, 1990.
(B) The facility capacity authorized in the facility's original hazardous waste facilities permit, grant of interim status, or any state or local agency permit allowing the construction or operation of a facility for the burning of hazardous waste, granted on or after January 1, 1990.
(e) The notice requirements specified in subdivision (b) or (c) shall not preclude a public agency from providing additional notice by other means if the agency so desires, or from providing the public notice required by this section at the same time and in the same manner as public notice otherwise required by law for the project.

21092.1. When significant new information is added to an environmental impact report after notice has been given pursuant to Section 21092 and consultation has occurred pursuant to Sections 21104 and 21153, but prior to certification, the public agency shall give notice again pursuant to Section 21092, and consult again pursuant to Sections 21104 and 21153 before certifying the environmental impact report.

21092.2. The notices required pursuant to Sections 21080.4, 21083.9, 21092, 21108, and 21152 shall be mailed to every person who has filed a written request for notices with either the clerk of the governing body or, if there is no governing body, the director of the agency. If the agency offers to provide the notices by e-mail, upon filing a written request for notices, a person may request that the notices be provided to him or her by e-mail. The request may also be filed with any other person designated by the governing body or director to receive these requests. The agency may require requests for notices to be annually renewed. The public agency may charge a fee, except to other public agencies, that is reasonably related to the costs of providing this service. This section may not be construed in any manner that results in the invalidation of an action because of the failure of a person to receive a requested notice, provided that there has been substantial compliance with the requirements of this section.

21092.3. The notices required pursuant to Sections 21080.4 and 21092 for an environmental impact report shall be posted in the office of the county clerk of each county in which the project will be located and shall remain posted for a period of 30 days. The notice required pursuant to Section 21092 for a negative declaration shall be so posted for a period of 20 days, unless otherwise required by law to be posted for 30 days. The county clerk shall post the notices within 24 hours of receipt.

21092.4. (a) For a project of statewide, regional, or areawide significance, the lead agency shall consult with transportation planning agencies and public agencies which have transportation facilities within their jurisdictions which could be affected by the project. Consultation shall be conducted in the same manner as for responsible agencies pursuant to this division, and shall be for the purpose of the lead agency obtaining information concerning the project's effect on major local arterials, public transit, freeways, highways, and rail transit service within the jurisdiction of a transportation planning agency or a public agency which is consulted by the lead agency. A transportation planning agency or public agency which provides information to the lead agency shall be notified of, and provided with copies of, environmental documents pertaining to the project.

(b) As used in this section, "transportation facilities" includes major local arterials and public transit within five miles of the project site and freeways, highways, and rail transit service within 10 miles of the project site.

21092.5. (a) At least 10 days prior to certifying an environmental impact report, the lead agency shall provide a written proposed response to a public agency on comments made by that agency which conform with the requirements of this division. Proposed responses shall conform with the legal standards established for responses to comments on draft environmental impact reports. Copies of responses or the environmental document in which they are contained, prepared in conformance with other requirements of this division and the guidelines adopted pursuant to Section 21083, may be used to meet the requirements imposed by this section.

(b) The lead agency shall notify any public agency which comments on a negative declaration, of the public hearing or hearings, if any, on the project for which the negative declaration was prepared. If notice to the commenting public agency is provided pursuant to Section 21092, the notice shall satisfy the requirement of this subdivision.

(c) Nothing in this section requires the lead agency to respond to comments not received within the comment periods specified in this division, to reopen comment periods, or to delay acting on a negative declaration or environmental impact report.

21092.6. (a) The lead agency shall consult the lists compiled pursuant to Section 65962.5 of the Government Code to determine whether the project and any alternatives are located on a site which is included on any list. The lead agency shall indicate whether a site is on any list not already identified by the applicant. The lead agency shall specify the list and include the information in the statement required pursuant to subdivision (f) of Section 65962.5 of the Government Code, in the notice required pursuant to Section 21080.4, a negative declaration, and a draft environmental impact report.

The requirement in this section to specify any list shall not be construed to limit compliance with this division.

(b) If a project or any alternatives are located on a site which is included on any of the lists compiled pursuant to Section 65962.5 of the Government Code and the lead agency did not accurately specify or did not specify any list pursuant to subdivision (a), the California Environmental Protection Agency shall notify the lead agency specifying any list with the site when it receives notice pursuant to Section 21080.4, a negative declaration, and a draft environmental impact report. The California Environmental Protection Agency shall not be liable for failure to notify the lead agency pursuant to this subdivision.

(c) This section applies only to projects for which applications have not been deemed complete pursuant to Section 65943 of the Government Code on or before January 1, 1992.

21093. (a) The Legislature finds and declares that tiering of environmental impact reports will promote construction of needed housing and other development projects by (1) streamlining regulatory procedures, (2) avoiding repetitive discussions of the same issues in successive environmental impact reports, and (3) ensuring that environmental impact reports prepared for later projects which are consistent with a previously approved policy, plan, program, or ordinance concentrate upon environmental effects which may be mitigated or avoided in connection with the decision on each later project. The Legislature further finds and declares that tiering is appropriate when it helps a public agency to focus upon the issues ripe for decision at each level of environmental review and in order to exclude duplicative analysis of environmental effects examined in previous environmental impact reports.

(b) To achieve this purpose, environmental impact reports shall be tiered whenever feasible, as determined by the lead agency.

21094. (a) Where a prior environmental impact report has been prepared and certified for a program, plan, policy, or ordinance, the lead agency for a later project that meets the requirements of this section shall examine significant effects of the later project upon the environment by using a tiered environmental impact report, except that the report on the later project need not examine those effects which the lead agency determines were either (1) mitigated or avoided pursuant to paragraph (1) of subdivision (a) of Section 21081 as a result of the prior environmental impact report, or (2) examined at a sufficient level of detail in the prior environmental impact report to enable those effects to be mitigated or avoided by site specific revisions, the imposition of conditions, or by other means in connection with the approval of the later project.

(b) This section applies only to a later project which the lead agency determines (1) is consistent with the program, plan, policy, or ordinance for which an environmental impact report has been prepared and certified, (2) is consistent with applicable local land use plans and zoning of the city, county, or city and county in which the later project would be located, and (3) is not subject to Section 21166.

(c) For purposes of compliance with this section, an initial study shall be prepared to assist the lead agency in making the determinations required by this section. The initial study shall analyze whether the later project may cause significant effects on the environment that were not examined in the prior environmental impact report.

(d) All public agencies which propose to carry out or approve the later project may utilize the prior environmental impact report and the environmental

impact report on the later project to fulfill the requirements of Section 21081.

(e) When tiering is used pursuant to this section, an environmental impact report prepared for a later project shall refer to the prior environmental impact report and state where a copy of the prior environmental impact report may be examined.

21095. (a) The Resources Agency, in consultation with the Office of Planning and Research, shall develop an amendment to Appendix G of the state guidelines, for adoption pursuant to Section 21083, to provide lead agencies an optional methodology to ensure that significant effects on the environment of agricultural land conversions are quantitatively and consistently considered in the environmental review process.

(b) The Department of Conservation, in consultation with the United States Department of Agriculture pursuant to Section 658.6 of Title 7 of the Code of Federal Regulations, and in consultation with the Resources Agency and the Office of Planning and Research, shall develop a state model land evaluation and site assessment system, contingent upon the availability of funding from non-General Fund sources. The department shall seek funding for that purpose from non-General Fund sources, including, but not limited to, the United States Department of Agriculture.

(c) In lieu of developing an amendment to Appendix G of the state guidelines pursuant to subdivision (a), the Resources Agency may adopt the state model land evaluation and site assessment system developed pursuant to subdivision (b) as that amendment to Appendix G.

21096. (a) If a lead agency prepares an environmental impact report for a project situated within airport land use compatibility plan boundaries, or, if an airport land use compatibility plan has not been adopted, for a project within two nautical miles of a public airport or public use airport, the Airport Land Use Planning Handbook published by the Division of Aeronautics of the Department of Transportation, in compliance with Section 21674.5 of the Public Utilities Code and other documents, shall be utilized as technical resources to assist in the preparation of the environmental impact report as the report relates to airport-related safety hazards and noise problems.

(b) A lead agency shall not adopt a negative declaration for a project described in subdivision (a) unless the lead agency considers whether the project will result in a safety hazard or noise problem for persons using the airport or for persons residing or working in the project area.

21098. (a) For the purposes of this section, the following terms have the following meanings:

(1) "Low-level flight path" includes any flight path for any aircraft owned, maintained, or that is under the jurisdiction of the United States Department of Defense that flies lower than 1,500 feet above ground level, as indicated in the United States Department of Defense Flight Information Publication, "Area Planning Military Training Routes: North and South America (AP/1B)" published by the United States National Imagery and Mapping Agency.

(2) "Military impact zone" includes any area, including airspace, that meets both of the following criteria:

(A) Is within two miles of a military installation, including, but not limited to, any base, military airport, camp, post, station, yard, center, homeport facility for a ship, or any other military activity center that is under the jurisdiction of the United States Department of Defense.

(B) Covers greater than 500 acres of unincorporated land, or greater than 100 acres of city incorporated land.
(3) "Military service" means any branch of the United States Armed Forces.
(4) "Special use airspace" means the land area underlying the airspace that is designated for training, research, development, or evaluation for a military service, as that land area is established by the United States Department of Defense Flight Information Publication, "Area Planning: Special Use Airspace: North and South America (AP/1A)" published by the United States National Imagery and Mapping Agency.
(b) If the United States Department of Defense or a military service notifies a lead agency of the contact office and address for the military service and the specific boundaries of a low-level flight path, military impact zone, or special use airspace, the lead agency shall submit notices, as required pursuant to Sections 21080.4 and 21092, to the military service if the project is within those boundaries and any of the following apply:
(1) The project includes a general plan amendment.
(2) The project is of statewide, regional, or areawide significance.
(3) The project is required to be referred to the airport land use commission, or appropriately designated body, pursuant to Article 3.5 (commencing with Section 21670) of Chapter 4 of Part 1 of Division 9 of the Public Utilities Code.
(c) The requirement to submit notices imposed by this section does not apply to any of the following:
(1) Response actions taken pursuant to Chapter 6.8 (commencing with Section 25300) of Division 20 of the Health and Safety Code.
(2) Response actions taken pursuant to Chapter 6.85 (commencing with Section 25396) of Division 20 of the Health and Safety Code.
(3) Sites subject to corrective action orders issued pursuant to Section 25187 of the Health and Safety Code.
(d) (1) The effect or potential effect that a project may have on military activities does not itself constitute an adverse effect on the environment for the purposes of this division.
(2) Notwithstanding paragraph (1), a project's impact on military activities may cause, or be associated with, adverse effects on the environment that are subject to the requirements of this division, including, but not limited to, Section 21081.

21100. (a) All lead agencies shall prepare, or cause to be prepared by contract, and certify the completion of, an environmental impact report on any project which they propose to carry out or approve that may have a significant effect on the environment. Whenever feasible, a standard format shall be used for environmental impact reports.
(b) The environmental impact report shall include a detailed statement setting forth all of the following:
(1) All significant effects on the environment of the proposed project.
(2) In a separate section:
(A) Any significant effect on the environment that cannot be avoided if the project is implemented.
(B) Any significant effect on the environment that would be irreversible if the project is implemented.
(3) Mitigation measures proposed to minimize significant effects on the environment, including, but not limited to, measures to reduce the wasteful, inefficient, and unnecessary consumption of energy.
(4) Alternatives to the proposed project.
(5) The growth-inducing impact of the proposed project.

(c) The report shall also contain a statement briefly indicating the reasons for determining that various effects on the environment of a project are not significant and consequently have not been discussed in detail in the environmental impact report.
(d) For purposes of this section, any significant effect on the environment shall be limited to substantial, or potentially substantial, adverse changes in physical conditions which exist within the area as defined in Section 21060.5.
(e) Previously approved land use documents, including, but not limited to, general plans, specific plans, and local coastal plans, may be used in cumulative impact analysis.

21100.1. The information described in subparagraph (B) of paragraph (2) of subdivision (b) of Section 21100 shall be required only in environmental impact reports prepared in connection with the following:
(a) The adoption, amendment, or enactment of a plan, policy, or ordinance of a public agency.
(b) The adoption by a local agency formation commission of a resolution making determinations.
(c) A project which will be subject to the requirement for preparing an environmental impact statement pursuant to the requirements of the National Environmental Policy Act of 1969.

21100.2. (a) (1) For projects described in subdivision (c) of Section 21065, each state agency shall establish, by resolution or order, time limits that do not exceed the following:
(A) One year for completing and certifying environmental impact reports.
(B) One hundred eighty days for completing and adopting negative declarations.
(2) The time limits specified in paragraph (1) shall apply only to those circumstances in which the state agency is the lead agency for a project. These resolutions or orders may establish different time limits for different types or classes of projects, but all limits shall be measured from the date on which an application requesting approval of the project is received and accepted as complete by the state agency.
(3) No application for a project may be deemed incomplete for lack of a waiver of time periods prescribed in state regulations.
(4) The resolutions or orders required by this section may provide for a reasonable extension of the time period in the event that compelling circumstances justify additional time and the project applicant consents thereto.
(b) If a draft environmental impact report, environmental impact report, or focused environmental impact report is prepared under a contract to a state agency, the contract shall be executed within 45 days from the date on which the state agency sends a notice of preparation pursuant to Section 21080.4. The state agency may take longer to execute the contract if the project applicant and the state agency mutually agree to an extension of the time limit provided by this subdivision.

21101. In regard to any proposed federal project in this state which may have a significant effect on the environment and on which the state officially comments, the state officials responsible for such comments shall include in their report a detailed statement setting forth the matters specified in Section 21100 prior to transmitting the comments of the state to the federal government. No report shall be transmitted to the federal government unless

it includes such a detailed statement as to the matters specified in Section 21100.

21102. No state agency, board, or commission shall request funds, nor shall any state agency, board, or commission which authorizes expenditures of funds, other than funds appropriated in the Budget Act, authorize funds for expenditure for any project, other than a project involving only feasibility or planning studies for possible future actions which the agency, board, or commission has not approved, adopted or funded, which may have a significant effect on the environment unless such request or authorization is accompanied by an environmental impact report. Feasibility and planning studies exempted by this section from the preparation of an environmental impact report shall nevertheless include consideration of environmental factors.

21104. (a) Prior to completing an environmental impact report, the state lead agency shall consult with, and obtain comments from, each responsible agency, trustee agency, any public agency that has jurisdiction by law with respect to the project, and any city or county that borders on a city or county within which the project is located unless otherwise designated annually by agreement between the state lead agency and the city or county, and may consult with any person who has special expertise with respect to any environmental impact involved. In the case of a project described in subdivision (c) of Section 21065, the state lead agency shall, upon the request of the applicant, provide for early consultation to identify the range of actions, alternatives, mitigation measures, and significant effects to be analyzed in depth in the environmental impact report. The state lead agency may consult with persons identified by the applicant who the applicant believes will be concerned with the environmental effects of the project and may consult with members of the public who have made a written request to be consulted on the project. A request by the applicant for early consultation shall be made not later than 30 days after the determination required by Section 21080.1 with respect to the project.

(b) The state lead agency shall consult with, and obtain comments from, the State Air Resources Board in preparing an environmental impact report on a highway or freeway project, as to the air pollution impact of the potential vehicular use of the highway or freeway.

(c) A responsible agency or other public agency shall only make substantive comments regarding those activities involved in a project that are within an area of expertise of the agency or that are required to be carried out or approved by the agency. Those comments shall be supported by specific documentation.

21104.2. The state lead agency shall consult with, and obtain written findings from, the Department of Fish and Game in preparing an environmental impact report on a project, as to the impact of the project on the continued existence of any endangered species or threatened species pursuant to Article 4 (commencing with Section 2090) of Chapter 1.5 of Division 3 of the Fish and Game Code.

21105. The state lead agency shall include the environmental impact report as a part of the regular project report used in the existing review and budgetary process. It shall be available to the Legislature. It shall also be available for inspection by any member of the general public, who may secure

a copy thereof by paying for the actual cost of such a copy. It shall be filed by the state lead agency with the appropriate local planning agency of any city, county, or city and county which will be affected by the project.

21106. All state agencies, boards, and commissions shall request in their budgets the funds necessary to protect the environment in relation to problems caused by their activities.

21108. (a) Whenever a state agency approves or determines to carry out a project that is subject to this division, the state agency shall file notice of that approval or that determination with the Office of Planning and Research. The notice shall indicate the determination of the state agency whether the project will, or will not, have a significant effect on the environment and shall indicate whether an environmental impact report has been prepared pursuant to this division.

(b) Whenever a state agency determines that a project is not subject to this division pursuant to subdivision (b) of Section 21080 or Section 21172, and the state agency approves or determines to carry out the project, the state agency or the person specified in subdivision (b) or (c) of Section 21065 may file notice of the determination with the Office of Planning and Research. Any notice filed pursuant to this subdivision by a person specified in subdivision (b) or (c) of Section 21065 shall have a certificate of determination attached to it issued by the state agency responsible for making the determination that the project is not subject to this division pursuant to subdivision (b) of Section 21080 or pursuant to Section 21172. The certificate of determination may be in the form of a certified copy of an existing document or record of the state agency.

(c) All notices filed pursuant to this section shall be available for public inspection, and a list of these notices shall be posted on a weekly basis in the Office of Planning and Research. Each list shall remain posted for a period of 30 days. The Office of Planning and Research shall retain each notice for not less than 12 months.

21150. State agencies, boards, and commissions, responsible for allocating state or federal funds on a project-by-project basis to local agencies for any project which may have a significant effect on the environment, shall require from the responsible local governmental agency a detailed statement setting forth the matters specified in Section 21100 prior to the allocation of any funds other than funds solely for projects involving only feasibility or planning studies for possible future actions which the agency, board, or commission has not approved, adopted, or funded.

21151. (a) All local agencies shall prepare, or cause to be prepared by contract, and certify the completion of, an environmental impact report on any project that they intend to carry out or approve which may have a significant effect on the environment. When a report is required by Section 65402 of the Government Code, the environmental impact report may be submitted as a part of that report.

(b) For purposes of this section, any significant effect on the environment shall be limited to substantial, or potentially substantial, adverse changes in physical conditions which exist within the area as defined in Section 21060.5.

(c) If a nonelected decisionmaking body of a local lead agency certifies an environmental impact report, approves a negative declaration or mitigated negative declaration, or determines that a project is not subject to this division, that certification, approval, or determination may be appealed to the agency's elected decisionmaking body, if any.

21151.1. (a) Notwithstanding paragraph (6) of subdivision (b) of Section 21080, or Section 21080.5 or 21084, or any other provision of law, except as provided in this section, a lead agency shall prepare or cause to be prepared by contract, and certify the completion of, an environmental impact report or, if appropriate, a modification, addendum, or supplement to an existing environmental impact report, for any project involving any of the following:
(1) (A) The burning of municipal wastes, hazardous waste, or refuse-derived fuel, including, but not limited to, tires, if the project is either of the following:
(i) The construction of a new facility.
(ii) The expansion of an existing facility that burns hazardous waste that would increase its permitted capacity by more than 10 percent.
(B) This paragraph does not apply to any project exclusively burning hazardous waste, for which a final determination under Section 21080.1 has been made prior to July 14, 1989.
(2) The initial issuance of a hazardous waste facilities permit to a land disposal facility, as defined in subdivision (d) of Section 25199.1 of the Health and Safety Code.
(3) The initial issuance of a hazardous waste facilities permit pursuant to Section 25200 of the Health and Safety Code to an offsite large treatment facility, as defined pursuant to subdivision (d) of Section 25205.1 of the Health and Safety Code.
(4) A base reuse plan as defined in Section 21083.8 or 21083.8.1. The Legislature hereby finds that no reimbursement is required pursuant to Section 6 of Article XIIIB of the California Constitution for an environmental impact report for a base reuse plan if an environmental impact report is otherwise required for that base reuse plan pursuant to any other provision of this division.
(b) For purposes of clause (ii) of subparagraph (A) of subparagraph (B) of paragraph (1) of subdivision (a), the amount of expansion of an existing facility shall be calculated by comparing the proposed facility capacity with whichever of the following is applicable:
(1) The facility capacity authorized in the facility's hazardous waste facilities permit pursuant to Section 25200 of the Health and Safety Code or its grant of interim status pursuant to Section 25200.5 of the Health and Safety Code, or the facility capacity authorized in any state or local agency permit allowing the construction or operation of a facility for the burning of hazardous waste, granted before January 1, 1990.
(2) The facility capacity authorized in the facility's original hazardous waste facilities permit, grant of interim status, or any state or local agency permit allowing the construction or operation of a facility for the burning of hazardous waste, granted on or after January 1, 1990.
(c) For purposes of paragraphs (2) and (3) of subdivision (a), the initial issuance of a hazardous waste facilities permit does not include the issuance of a closure or postclosure permit pursuant to Chapter 6.5 (commencing with Section 25100) of Division 20 of the Health and Safety Code.
(d) Paragraph (1) of subdivision (a) does not apply to any project that does any of the following:
(1) Exclusively burns digester gas produced from manure or any other solid or semisolid animal waste.

(2) Exclusively burns methane gas produced from a disposal site, as defined in Section 40122, that is used only for the disposal of solid waste, as defined in Section 40191.
(3) Exclusively burns forest, agricultural, wood, or other biomass wastes.
(4) Exclusively burns hazardous waste in an incineration unit that is transportable and that is either at a site for not longer than three years or is part of a remedial or removal action. For purposes of this paragraph, "transportable" means any equipment that performs a "treatment" as defined in Section 66216 of Title 22 of the California Code of Regulations, and that is transported on a vehicle as defined in Section 66230 of Title 22 of the California Code of Regulations.
(5) Exclusively burns refinery waste in a flare on the site of generation.
(6) Exclusively burns in a flare methane gas produced at a municipal sewage treatment plant.
(7) Exclusively burns hazardous waste, or exclusively burns hazardous waste as a supplemental fuel, as part of a research, development, or demonstration project that, consistent with federal regulations implementing the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. Sec. 6901 et seq.), has been determined to be innovative and experimental by the Department of Toxic Substances Control and that is limited in type and quantity of waste to that necessary to determine the efficacy and performance capabilities of the technology or process; provided, however, that any facility that operated as a research, development, or demonstration project and for which an application is thereafter submitted for a hazardous waste facility permit for operation other than as a research, development, or demonstration project shall be considered a new facility for the burning of hazardous waste and shall be subject to subdivision (a) of Section 21151.1.
(8) Exclusively burns soils contaminated only with petroleum fuels or the vapors from these soils.
(9) Exclusively treats less than 3,000 pounds of hazardous waste per day in a thermal processing unit operated in the absence of open flame, and submits a worst-case health risk assessment of the technology to the Department of Toxic Substances Control for review and distribution to the interested public. This assessment shall be prepared in accordance with guidelines set forth in the Air Toxics Assessment Manual of the California Air Pollution Control Officers Association.
(10) Exclusively burns less than 1,200 pounds per day of medical waste, as defined in Section 117690 of the Health and Safety Code, on hospital sites.
(11) Exclusively burns chemicals and fuels as part of firefighter training.
(12) Exclusively conducts open burns of explosives subject to the requirements of the air pollution control district or air quality management district and in compliance with OSHA and Cal-OSHA regulations.
(13) Exclusively conducts onsite burning of less than 3,000 pounds per day of fumes directly from a manufacturing or commercial process.
(14) Exclusively conducts onsite burning of hazardous waste in an industrial furnace that recovers hydrogen chloride from the flue gas if the hydrogen chloride is subsequently sold, distributed in commerce, or used in a manufacturing process at the site where the hydrogen chloride is recovered, and the burning is in compliance with the requirements of the air pollution control district or air quality management district and the Department of Toxic Substances Control.
(e) Paragraph (1) of subdivision (a) does not apply to any project for which the State Energy Resources Conservation and Development Commission has assumed jurisdiction under Chapter 6 (commencing with Section 25500) of Division 15.
(f) Paragraphs (2) and (3) of subdivision (a) shall not apply if the facility only manages hazardous waste that is identified or listed pursuant to Section 25140 or 25141 on or after January 1, 1992, but not before that date, or only

conducts activities that are regulated pursuant to Chapter 6.5 (commencing with Section 25100) of Division 20 of the Health and Safety Code on or after January 1, 1992, but not before that date.

(g) This section does not exempt any project from any other requirement of this division.

(h) For purposes of this section, offsite facility means a facility that serves more than one generator of hazardous waste.

21151.2. To promote the safety of pupils and comprehensive community planning the governing board of each school district before acquiring title to property for a new school site or for an addition to a present school site, shall give the planning commission having jurisdiction notice in writing of the proposed acquisition. The planning commission shall investigate the proposed site and within 30 days after receipt of the notice shall submit to the governing board a written report of the investigation and its recommendations concerning acquisition of the site. The governing board shall not acquire title to the property until the report of the planning commission has been received. If the report does not favor the acquisition of the property for a school site, or for an addition to a present school site, the governing board of the school district shall not acquire title to the property until 30 days after the commission's report is received.

21151.4. An environmental impact report shall not be certified and a negative declaration shall not be approved for any project involving the construction or alteration of a facility within 1/4 of a mile of a school that might reasonably be anticipated to emit hazardous air emissions, or that would handle an extremely hazardous substance or a mixture containing extremely hazardous substances in a quantity equal to or greater than the state threshold quantity specified pursuant to subdivision (j) of Section 25532 of the Health and Safety Code, that may pose a health or safety hazard to persons who would attend or would be employed at the school, unless both of the following occur:

(a) The lead agency preparing the environmental impact report or negative declaration has consulted with the school district having jurisdiction regarding the potential impact of the project on the school.

(b) The school district has been given written notification of the project not less than 30 days prior to the proposed certification of the environmental impact report or approval of the negative declaration.

21151.5. (a) (1) For projects described in subdivision (c) of Section 21065, each local agency shall establish, by ordinance or resolution, time limits that do not exceed the following:

(A) One year for completing and certifying environmental impact reports.

(B) One hundred eighty days for completing and adopting negative declarations.

(2) The time limits specified in paragraph (1) shall apply only to those circumstances in which the local agency is the lead agency for a project. These ordinances or resolutions may establish different time limits for different types or classes of projects and different types of environmental impact reports, but all limits shall be measured from the date on which an application requesting approval of the project is received and accepted as complete by the local agency.

(3) No application for a project may be deemed incomplete for lack of a waiver of time periods prescribed by local ordinance or resolution.

(4) The ordinances or resolutions required by this section may provide for a reasonable extension of the time period in the event that compelling circumstances justify additional time and the project applicant consents thereto.

(b) If a draft environmental impact report, environmental impact report, or focused environmental impact report is prepared under a contract to a local agency, the contract shall be executed within 45 days from the date on which the local agency sends a notice of preparation pursuant to Section 21080.4. The local agency may take longer to execute the contract if the project applicant and the local agency mutually agree to an extension of the time limit provided by this subdivision.

21151.7. Notwithstanding any other provision of law, a lead agency shall prepare or cause to be prepared by contract, and certify the completion of, an environmental impact report for any open-pit mining operation that is subject to the permit requirements or reclamation plan requirements of the Surface Mining and Reclamation Act of 1975 (Chapter 9 (commencing with Section 2710) of Division 2) and utilizes a cyanide heap-leaching process for the purpose of producing gold or other metallic minerals.

21151.8. (a) An environmental impact report or negative declaration may not be approved for any project involving the purchase of a schoolsite or the construction of a new elementary or secondary school by a school district unless all of the following occur:

(1) The environmental impact report or negative declaration includes information that is needed to determine if the property proposed to be purchased, or to be constructed upon, is any of the following:

(A) The site of a current or former hazardous waste disposal site or solid waste disposal site and, if so, whether the wastes have been removed.

(B) A hazardous substance release site identified by the Department of Toxic Substances Control in a current list adopted pursuant to Section 25356 of the Health and Safety Code for removal or remedial action pursuant to Chapter 6.8 (commencing with Section 25300) of Division 20 of the Health and Safety Code.

(C) A site that contains one or more pipelines, situated underground or aboveground, that carries hazardous substances, acutely hazardous materials, or hazardous wastes, unless the pipeline is a natural gas line that is used only to supply natural gas to that school or neighborhood, or other nearby schools.

(D) A site that is within 500 feet of the edge of the closest traffic lane of a freeway or other busy traffic corridor.

(2) The school district, as the lead agency, in preparing the environmental impact report or negative declaration has notified in writing and consulted with the administering agency in which the proposed schoolsite is located, pursuant to Section 2735.3 of Title 19 of the California Code of Regulations, and with any air pollution control district or air quality management district having jurisdiction in the area, to identify both permitted and nonpermitted facilities within that district's authority, including, but not limited to, freeways and busy traffic corridors, large agricultural operations, and railyards, within one-fourth of a mile of the proposed schoolsite, that might reasonably be anticipated to emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste. The notification by the school district, as the lead agency, shall include a list of the locations for which information is sought.

(3) The governing board of the school district makes one of the following written findings:

(A) Consultation identified no facilities of this type or other significant pollution sources specified in paragraph (2).
(B) The facilities or other pollution sources specified in paragraph (2) exist, but one of the following conditions applies:
(i) The health risks from the facilities or other pollution sources do not and will not constitute an actual or potential endangerment of public health to persons who would attend or be employed at the proposed school.
(ii) Corrective measures required under an existing order by another agency having jurisdiction over the facilities or other pollution sources will, before the school is occupied, result in the mitigation of all chronic or accidental hazardous air emissions to levels that do not constitute an actual or potential endangerment of public health to persons who would attend or be employed at the proposed school. If the governing board makes a finding pursuant to this clause, it shall also make a subsequent finding, prior to occupancy of the school, that the emissions have been so mitigated.
(iii) For a schoolsite with a boundary that is within 500 feet of the edge of the closest traffic lane of a freeway or other busy traffic corridor, the governing board of the school district determines, through analysis pursuant to paragraph (2) of subdivision (b) of Section 44360 of the Health and Safety Code, based on appropriate air dispersion modeling, and after considering any potential mitigation measures, that the air quality at the proposed site is such that neither short-term nor long-term exposure poses significant health risks to pupils.
(C) The facilities or other pollution sources specified in paragraph (2) exist, but conditions in clause (i), (ii) or (iii) of subparagraph (B) cannot be met, and the school district is unable to locate an alternative site that is suitable due to a severe shortage of sites that meet the requirements in subdivision (a) of Section 17213 of the Education Code. If the governing board makes this finding, the governing board shall adopt a statement of Overriding Considerations pursuant to Section 15093 of Title 14 of the California Code of Regulations.
(4) Each administering agency, air pollution control district, or air quality management district receiving written notification from a lead agency to identify facilities pursuant to paragraph (2) shall provide the requested information and provide a written response to the lead agency within 30 days of receiving the notification. The environmental impact report or negative declaration shall be conclusively presumed to comply with this section as to the area of responsibility of any agency that does not respond within 30 days.
(b) If a school district, as a lead agency, has carried out the consultation required by paragraph (2) of subdivision (a), the environmental impact report or the negative declaration shall be conclusively presumed to comply with this section, notwithstanding any failure of the consultation to identify an existing facility or other pollution source specified in paragraph (2) of subdivision (a).
(c) As used in this section and Section 21151.4, the following definitions shall apply:
(1) "Hazardous substance" means any substance defined in Section 25316 of the Health and Safety Code.
(2) "Acutely hazardous material" means any material defined pursuant to subdivision (a) of Section 25532 of the Health and Safety Code.
(3) "Hazardous waste" means any waste defined in Section 25117 of the Health and Safety Code.
(4) "Hazardous waste disposal site" means any site defined in Section 25114 of the Health and Safety Code.
(5) "Hazardous air emissions" means emissions into the ambient air of air contaminants that have been identified as a toxic air contaminant by the

State Air Resources Board or by the air pollution control officer for the jurisdiction in which the project is located. As determined by the air pollution control officer, hazardous air emissions also means emissions into the ambient air from any substances identified in subdivisions (a) to (f), inclusive, of Section 44321 of the Health and Safety Code.

(6) "Administering agency" means an agency designated pursuant to Section 25502 of the Health and Safety Code.

(7) "Handle" means handle as defined in Article 1 (commencing with Section 25500) of Chapter 6.95 of Division 20 of the Health and Safety Code.

(8) "Facilities" means any source with a potential to use, generate, emit or discharge hazardous air pollutants, including, but not limited to, pollutants that meet the definition of a hazardous substance, and whose process or operation is identified as an emission source pursuant to the most recent list of source categories published by the California Air Resources Board.

(9) "Freeway or other busy traffic corridors" means those roadways that, on an average day, have traffic in excess of 50,000 vehicles in a rural area, as defined in Section 50101 of the Health and Safety Code, and 100,000 vehicles in an urban area, as defined in Section 50104.7 of the Health and Safety Code.

21151.9. Whenever a city or county determines that a project, as defined in Section 10912 of the Water Code, is subject to this division, it shall comply with Part 2.10 (commencing with Section 10910) of Division 6 of the Water Code.

21151.10. (a) If an environmental impact report is prepared for a project at an airport that is owned by a city and county and that is located in another county that includes more than one acre of fill in the San Francisco Bay, the environmental impact report shall analyze, as an alternative to the project, a form of joint management of that airport owned by the city and county and the Oakland International Airport. This joint management alternative shall separately analyze an underground high-speed rail transit connection and a high-speed ferry connection between the two airports and shall utilize in both analyses all technological enhancements reasonably expected to be available. The analysis of the joint management alternative shall include a meaningful evaluation, analysis, and comparison of the alternative with the proposed project, and shall assess the feasibility of the alternative notwithstanding that changes in state law may be required for its implementation. The environmental impact report shall identify any changes in state law that would be required in order to implement this alternative.

(b) Nothing in this section or in Section 21085.7 shall be interpreted in a manner that alters the lead agency's obligation to comply with this division in connection with proposed mitigation measures other than the mitigation measure described in Section 21085.7.

(c) This section shall remain in effect only until January 1, 2008, and as of that date is repealed, unless a later enacted statute, that is enacted before January 1, 2008, deletes or extends that date.

21152. (a) Whenever a local agency approves or determines to carry out a project that is subject to this division, the local agency shall file notice of the approval or the determination within five working days after the approval or determination becomes final, with the county clerk of each county in which the project will be located. The notice shall indicate the determination of the local agency whether the project will, or will not, have a significant effect on the environment and shall indicate whether an environmental impact

report has been prepared pursuant to this division. The notice shall also include certification that the final environmental impact report, if one was prepared, together with comments and responses, is available to the general public.

(b) Whenever a local agency determines that a project is not subject to this division pursuant to subdivision (b) of Section 21080 or pursuant to Section 21172, and the local agency approves or determines to carry out the project, the local agency or the person specified in subdivision (b) or (c) of Section 21065 may file a notice of the determination with the county clerk of each county in which the project will be located. A notice filed pursuant to this subdivision by a person specified in subdivision (b) or (c) of Section 21065 shall have a certificate of determination attached to it issued by the local agency responsible for making the determination that the project is not subject to this division pursuant to subdivision (b) of Section 21080 or Section 21172. The certificate of determination may be in the form of a certified copy of an existing document or record of the local agency.

(c) All notices filed pursuant to this section shall be available for public inspection, and shall be posted within 24 hours of receipt in the office of the county clerk. A notice shall remain posted for a period of 30 days. Thereafter, the clerk shall return the notice to the local agency with a notation of the period it was posted. The local agency shall retain the notice for not less than 12 months.

21152.1. (a) When a local agency determines that a project is not subject to this division pursuant to Section 21159.22,

21159.23, or 21159.24, and it approves or determines to carry out that project, the local agency or the person specified in subdivision (b) or (c) of Section 21065, shall file notice of the determination with the Office of Planning and Research.

(b) All notices filed pursuant to this section shall be available for public inspection, and a list of these notices shall be posted on a weekly basis in the Office of Planning and Research. Each list shall remain posted for a period of 30 days.

(c) Failure to file the notice required by this section does not affect the validity of a project.

(d) Nothing in this section affects the time limitations contained in Section 21167.

21153. (a) Prior to completing an environmental impact report, every local lead agency shall consult with, and obtain comments from, each responsible agency, trustee agency, any public agency that has jurisdiction by law with respect to the project, and any city or county that borders on a city or county within which the project is located unless otherwise designated annually by agreement between the local lead agency and the city or county, and may consult with any person who has special expertise with respect to any environmental impact involved. In the case of a project described in subdivision (c) of Section 21065, the local lead agency shall, upon the request of the project applicant, provide for early consultation to identify the range of actions, alternatives, mitigation measures, and significant effects to be analyzed in depth in the environmental impact report. The local lead agency may consult with persons identified by the project applicant who the applicant believes will be concerned with the environmental effects of the project and may consult with members of the public who have

made written request to be consulted on the project. A request by the project applicant for early consultation shall be made not later than 30 days after the date that the determination required by Section 21080.1 was made with respect to the project. The local lead agency may charge and collect a fee from the project applicant in an amount that does not exceed the actual costs of the consultations.

(b) In the case of a project described in subdivision (a) of Section 21065, the lead agency may provide for early consultation to identify the range of actions, alternatives, mitigation measures, and significant effects to be analyzed in depth in the environmental impact report. At the request of the lead agency, the Office of Planning and Research shall ensure that each responsible agency, and any public agency that has jurisdiction by law with respect to the project, is notified regarding any early consultation.

(c) A responsible agency or other public agency shall only make substantive comments regarding those activities involved in a project that are within an area of expertise of the agency or that are required to be carried out or approved by the agency. Those comments shall be supported by specific documentation.

21154. Whenever any state agency, board, or commission issues an order which requires a local agency to carry out a project which may have a significant effect on the environment, any environmental impact report which the local agency may prepare shall be limited to consideration of those factors and alternatives which will not conflict with such order.

21156. It is the intent of the Legislature in enacting this chapter that a master environmental impact report shall evaluate the cumulative impacts, growth inducing impacts, and irreversible significant effects on the environment of subsequent projects to the greatest extent feasible. The Legislature further intends that the environmental review of subsequent projects be substantially reduced to the extent that the project impacts have been reviewed and appropriate mitigation measures are set forth in a certified master environmental impact report.

21157. (a) A master environmental impact report may be prepared for any one of the following projects:

(1) A general plan, element, general plan amendment, or specific plan.

(2) A project that consists of smaller individual projects which will be carried out in phases.

(3) A rule or regulation which will be implemented by subsequent projects.

(4) Projects which will be carried out or approved pursuant to a development agreement.

(5) Public or private projects which will be carried out or approved pursuant to, or in furtherance of, a redevelopment plan.

(6) A state highway project or mass transit project which will be subject to multiple stages of review or approval.

(7) A regional transportation plan or congestion management plan.

(8) A plan proposed by a local agency for the reuse of a federal military base or reservation that has been closed or that is proposed for closure.

(9) Regulations adopted by the Fish and Game Commission for the regulation of hunting and fishing.

(b) When a lead agency prepares a master environmental impact report, the document shall include all of the following:

(1) A detailed statement as required by Section 21100.

(2) A description of anticipated subsequent projects that would be within the scope of the master environmental impact report, that contains sufficient information with regard to the kind, size, intensity, and location of the subsequent projects, including, but not limited to, all of the following:
(A) The specific type of project anticipated to be undertaken.
(B) The maximum and minimum intensity of any anticipated subsequent project, such as the number of residences in a residential development, and, with regard to a public works facility, its anticipated capacity and service area.
(C) The anticipated location and alternative locations for any development projects.
(D) A capital outlay or capital improvement program, or other scheduling or implementing device that governs the submission and approval of subsequent projects.
(3) A description of potential impacts of anticipated subsequent projects for which there is not sufficient information reasonably available to support a full assessment of potential impacts in the master environmental impact report. This description shall not be construed as a limitation on the impacts which may be considered in a focused environmental impact report.
(c) Lead agencies may develop and implement a fee program in accordance with applicable provisions of law to generate the revenue necessary to prepare a master environmental impact report.

21157.1. The preparation and certification of a master environmental impact report, if prepared and certified consistent with this division, may allow for the limited review of subsequent projects that were described in the master environmental impact report as being within the scope of the report, in accordance with the following requirements:
(a) The lead agency for a subsequent project shall be the lead agency or any responsible agency identified in the master environmental impact report.
(b) The lead agency shall prepare an initial study on any proposed subsequent project. This initial study shall analyze whether the subsequent project may cause any significant effect on the environment that was not examined in the master environmental impact report and whether the subsequent project was described in the master environmental impact report as being within the scope of the report.
(c) If the lead agency, based on the initial study, determines that a proposed subsequent project will have no additional significant effect on the environment, as defined in subdivision (d) of Section 21158, that was not identified in the master environmental impact report and that no new or additional mitigation measures or alternatives may be required, the lead agency shall make a written finding based upon the information contained in the initial study that the subsequent project is within the scope of the project covered by the master environmental impact report. No new environmental document nor findings pursuant to Section 21081 shall be required by this division. Prior to approving or carrying out the proposed subsequent project, the lead agency shall provide notice of this fact pursuant to Section 21092 and incorporate all feasible mitigation measures or feasible alternatives set forth in the master environmental impact report which are appropriate to the project. Whenever a lead agency approves or determines to carry out any subsequent project pursuant to this section, it shall file a notice pursuant to Section 21108 or 21152.
(d) Where a lead agency cannot make the findings required in subdivision (c), the lead agency shall prepare, pursuant to Section 21157.7, either a mitigated negative declaration or environmental impact report.

21157.5. (a) A proposed mitigated negative declaration shall be prepared for any proposed subsequent project if both of the following occur:

(1) An initial study has identified potentially new or additional significant effects on the environment that were not analyzed in the master environmental impact report.

(2) Feasible mitigation measures or alternatives will be incorporated to revise the proposed subsequent project, before the negative declaration is released for public review, in order to avoid the effects or mitigate the effects to a point where clearly no significant effect on the environment will occur.

(b) If there is substantial evidence in light of the whole record before the lead agency that the proposed subsequent project may have a significant effect on the environment and a mitigated negative declaration is not prepared, the lead agency shall prepare an environmental impact report or a focused environmental impact report pursuant to Section 21158.

21157.6. (a) The master environmental impact report shall not be used for the purposes of this chapter if either of the following has occurred:

(1) The certification of the master environmental impact report occurred more than five years prior to the filing of an application for the subsequent project.

(2) The filing of an application for the subsequent project occurs following the certification of the master environmental impact report, and the approval of a project that was not described in the master environmental impact report, may affect the adequacy of the environmental review in the master environmental impact report for any subsequent project.

(b) A master environmental impact report that was certified more than five years prior to the filing of an application for the subsequent project may be used for purposes of this chapter to review a subsequent project that was described in the master environmental impact report if the lead agency reviews the adequacy of the master environmental impact report and does either of the following:

(1) Finds that no substantial changes have occurred with respect to the circumstances under which the master environmental impact report was certified or that no new information, which was not known and could not have been known at the time that the master environmental impact report was certified as complete, has become available.

(2) Prepares an initial study and, pursuant to the findings of the initial study, does either of the following:

(A) Certifies a subsequent or supplemental environmental impact report that has been either incorporated into the previously certified master environmental impact report or references any deletions, additions, or any other modifications to the previously certified master environmental impact report.

(B) Approves a mitigated negative declaration that addresses substantial changes that have occurred with respect to the circumstances under which the master environmental impact report was certified or the new information that was not known and could not have been known at the time the master environmental impact report was certified.

21158. (a) A focused environmental impact report is an environmental impact report on a subsequent project identified in a master environmental impact report. A focused environmental impact report may be utilized only if the lead agency finds that the analysis in the master environmental impact report of cumulative impacts, growth inducing impacts, and irreversible significant effects on the environment is adequate for the subsequent project. The focused environmental impact report shall incorporate, by reference, the master environmental impact report and analyze only the subsequent project's

additional significant effects on the environment, as defined in subdivision (d), and any new or additional mitigation measures or alternatives that were not identified and analyzed by the master environmental impact report.

(b) The focused environmental impact report need not examine those effects which the lead agency finds were one of the following:

(1) Mitigated or avoided pursuant to paragraph (1) of subdivision (a) of Section 21081 as a result of mitigation measures identified in the master environmental impact report which will be required as part of the approval of the subsequent project.

(2) Examined at a sufficient level of detail in the master environmental impact report to enable those significant environmental effects to be mitigated or avoided by specific revisions to the project, the imposition of conditions, or by other means in connection with the approval of the subsequent project.

(3) Subject to a finding pursuant to paragraph (2) of subdivision (a) of Section 21081.

(c) A focused environmental impact report on any subsequent project shall analyze any significant effects on the environment where substantial new or additional information shows that the adverse environmental impact may be more significant than was described in the master environmental impact report. The substantial new or additional information may also show that mitigation measures or alternatives identified in the master environmental impact report, which were previously determined to be infeasible, are feasible and will avoid or reduce the significant effects on the environment of the subsequent project to a level of insignificance.

(d) For purposes of this chapter, "additional significant effects on the environment" are those project specific effects on the environment which were not addressed as significant effects on the environment in the master environmental impact report.

(e) Nothing in this chapter is intended to limit or abridge the ability of a lead agency to focus upon the issues that are ripe for decision at each level of environmental review, or to exclude duplicative analysis of environmental effects examined in previous environmental impact reports pursuant to Section 21093.

21158.1. When a lead agency is required to prepare an environmental impact report pursuant to subdivision (d) of Section 21157.1 or is authorized to prepare a focused environmental impact report pursuant to Section 21158, the lead agency may not rely on subdivision (a) of Section 21080.5 for that purpose even though the lead agency's regulatory program is otherwise certified in accordance with Section 21080.5.

21158.5. (a) Where a project consists of multiple-family residential development of not more than 100 units or a residential and commercial or retail mixed-use development of not more than 100,000 square feet which complies with all of the following, a focused environmental impact report shall be prepared, notwithstanding that the project was not identified in a master environmental impact report:

(1) Is consistent with a general plan, specific plan, community plan, or zoning ordinance for which an environmental impact report was prepared within five years of the certification of the focused environmental impact report.

(2) The lead agency cannot make the finding described in subdivision (c) of Section 21157.1, a negative declaration or mitigated negative declaration cannot be prepared pursuant to Section 21080, 21157.5, or 21158, and Section 21166 does not apply.

(3) Meets one or more of the following conditions:

(A) The parcel on which the project is to be developed is surrounded by immediately contiguous urban development.
(B) The parcel on which the project is to be developed has been previously developed with urban uses.
(C) The parcel on which the project is to be developed is within one-half mile of an existing rail transit station.
(b) A focused environmental impact report prepared pursuant to this section shall be limited to a discussion of potentially significant effects on the environment specific to the project, or which substantial new information shows will be more significant than described in the prior environmental impact report. No discussion shall be required of alternatives to the project, cumulative impacts of the project, or the growth inducing impacts of the project.

21159. (a) An agency listed in Section 21159.4 shall perform, at the time of the adoption of a rule or regulation requiring the installation of pollution control equipment, or a performance standard or treatment requirement, an environmental analysis of the reasonably foreseeable methods of compliance. In the preparation of this analysis, the agency may utilize numerical ranges or averages where specific data is not available; however, the agency shall not be required to engage in speculation or conjecture. The environmental analysis shall, at minimum, include, all of the following:
(1) An analysis of the reasonably foreseeable environmental impacts of the methods of compliance.
(2) An analysis of reasonably foreseeable feasible mitigation measures.
(3) An analysis of reasonably foreseeable alternative means of compliance with the rule or regulation.
(b) The preparation of an environmental impact report at the time of adopting a rule or regulation pursuant to this division shall be deemed to satisfy the requirements of this section.
(c) The environmental analysis shall take into account a reasonable range of environmental, economic, and technical factors, population and geographic areas, and specific sites.
(d) Nothing in this section shall require the agency to conduct a project level analysis.
(e) For purposes of this article, the term "performance standard" includes process or raw material changes or product reformulation.
(f) Nothing in this section is intended, or may be used, to delay the adoption of any rule or regulation for which an analysis is required to be performed pursuant to this section.

21159.1. (a) A focused environmental impact report may be utilized if a project meets all of the following requirements:
(1) The project consists solely of the installation of pollution control equipment required by a rule or regulation of an agency listed in Section 21159.4 and other components necessary to complete the installation of that equipment.
(2) The agency certified an environmental impact report on the rule or regulation or reviewed it pursuant to a certified regulatory program, and, in either case, the review included an assessment of growth inducing impacts and cumulative impacts of, and alternatives to, the project.
(3) The environmental review required by paragraph (2) was completed within five years of certification of the focused environmental impact report.
(4) An environmental impact report is not required pursuant to Section 21166.
(b) The discussion of significant effects on the environment in the focused environmental impact report shall be limited to project-specific potentially

significant effects on the environment of the project which were not discussed in the environmental analysis of the rule or regulation required pursuant to subdivision (a) of Section 21159. No discussion of growth-inducing impacts or cumulative impacts shall be required in the focused environmental impact report, and the discussion of alternatives shall be limited to a discussion of alternative means of compliance, if any, with the rule or regulation.

21159.2. (a) If a project consists solely of compliance with a performance standard or treatment requirement imposed by an agency listed in Section 21159.4, the lead agency for the compliance project shall, to the greatest extent feasible, utilize the environmental analysis required pursuant to subdivision (a) of Section 21159 in the preparation of a negative declaration, mitigated negative declaration, or environmental impact report on the compliance project or in otherwise fulfilling its responsibilities under this division. The use of numerical averages or ranges in an environmental analysis shall not relieve a lead agency of its obligations under this division to identify and evaluate the environmental effects of a compliance project.

(b) If the lead agency determines that an environmental impact report on the compliance project is required, the lead agency shall prepare an environmental impact report which addresses only the project-specific issues related to the compliance project or other issues that were not discussed in sufficient detail in the environmental analysis to enable the lead agency to fulfill its responsibilities under Section 21100 or 21151, as applicable. The mitigation measures imposed by the lead agency for the project shall relate only to the significant effects on the environment to be mitigated. The discussion of alternatives shall be limited to a discussion of alternative means of compliance, if any, with the rule or regulation.

21159.3. In the preparation of any environmental impact report pursuant to Section 21159.1 or 21159.2, the following deadlines shall apply:

(a) A lead agency shall determine whether an environmental impact report should be prepared within 30 days of its determination that the application for the project is complete.

(b) If the environmental impact report will be prepared under contract to the lead agency pursuant to Section 21082.1, the lead agency shall issue a request for proposals for preparation of the environmental impact report as soon as it has enough information to prepare a request for proposals, and in any event, not later than 30 days after the time for response to the notice of preparation has expired. The contract shall be awarded within 30 days of the response date for the request for proposals.

21159.4. This article shall apply to the following agencies: the State Air Resources Board, any district as defined in Section 39025 of the Health and Safety Code, the State Water Resources Control Board, a California regional water quality control board, the Department of Toxic Substances Control, and the California Integrated Waste Management Board.

21159.9. The Office of Planning and Research shall implement, utilizing existing resources, a public assistance and information program, to ensure efficient and effective implementation of this division, to do all of the following:

(a) Establish a public education and training program for planners, developers, and other interested parties to assist them in implementing this division.

(b) Establish and maintain a data base to assist in the preparation of environmental documents.
(c) Establish and maintain a central repository for the collection, storage, retrieval, and dissemination of notices of exemption, notices of preparation, notices of determination, and notices of completion provided to the office, and make the notices available through the Internet. The office may coordinate with another state agency for that agency to make the notices available through the Internet.
(d) Commencing January 1, 2003, copies of any documents submitted in electronic format to the Office of Planning and Research pursuant to this division shall be furnished by the office to the California State Library. The California State Library shall be the repository for those electronic documents, which shall be made available for viewing by the general public upon request.

21159.20. For the purposes of this article, the following terms have the following meanings:
(a) "Census-defined place" means a specific unincorporated land area within boundaries determined by the United States Census Bureau in the most recent decennial census.
(b) "Community-level environmental review" means either of the following:
(1) An environmental impact report certified on any of the following:
(A) A general plan.
(B) A revision or update to the general plan that includes at least the land use and circulation elements.
(C) An applicable community plan.
(D) An applicable specific plan.
(E) A housing element of the general plan, if the environmental impact report analyzed the environmental effects of the density of the proposed project.
(2) Pursuant to this division and the implementing guidelines adopted pursuant to this division that govern subsequent review following a program environmental impact report, or pursuant to Section 21157.1, 21157.5, or 21166, a negative declaration or mitigated negative declaration was adopted as a subsequent environmental review document, following and based upon an environmental impact report on any of the projects listed in subparagraphs (A), (C), or (D) of paragraph (1).
(c) "Low-income households" means households of persons and families of very low and low income, as defined in Sections 50093 and 50105 of the Health and Safety Code.
(d) "Low- and moderate-income households" means households of persons and families of low or moderate income, as defined in Section 50093 of the Health and Safety Code.

21159.21. A housing project qualifies for an exemption from this division pursuant to Section 21159.22, 21159.23, or 21159.24 if it meets the criteria in the applicable section and all of the following criteria:
(a) The project is consistent with any applicable general plan, specific plan, and local coastal program, including any mitigation measures required by a plan or program, as that plan or program existed on the date that the application was deemed complete and with any applicable zoning ordinance, as that zoning ordinance existed on the date that the application was deemed complete, except that a project shall not be deemed to be inconsistent with the zoning designation for the site if that zoning designation is inconsistent with the general plan only because the project site has not been rezoned to conform with a more recently adopted general plan.
(b) Community-level environmental review has been adopted or certified.

(c) The project and other projects approved prior to the approval of the project can be adequately served by existing utilities, and the project applicant has paid, or has committed to pay, all applicable in-lieu or development fees.
(d) The site of the project does not contain wetlands, does not have any value as a wildlife habitat, and the project does not harm any species protected by the federal Endangered Species Act of 1973 (16 U.S.C. Sec. 1531 et seq.) or by the Native Plant Protection Act (Chapter 10 (commencing with Section 1900) of Division 2 of the Fish and Game Code), the California Endangered Species Act (Chapter 1.5 (commencing with Section 2050) of Division 3 of the Fish and Game Code), and the project does not cause the destruction or removal of any species protected by a local ordinance in effect at the time the application for the project was deemed complete. For the purposes of this subdivision, "wetlands" has the same meaning as in Section 328.3 of Title 33 of the Code of Federal Regulations and "wildlife habitat" means the ecological communities upon which wild animals, birds, plants, fish, amphibians, and invertebrates depend for their conservation and protection.
(e) The site of the project is not included on any list of facilities and sites compiled pursuant to Section 65962.5 of the Government Code.
(f) The site of the project is subject to a preliminary endangerment assessment prepared by a registered environmental assessor to determine the existence of any release of a hazardous substance on the site and to determine the potential for exposure of future occupants to significant health hazards from any nearby property or activity.
(1) If a release of a hazardous substance is found to exist on the site, the release shall be removed, or any significant effects of the release shall be mitigated to a level of insignificance in compliance with state and federal requirements.
(2) If a potential for exposure to significant hazards from surrounding properties or activities is found to exist, the effects of the potential exposure shall be mitigated to a level of insignificance in compliance with state and federal requirements.
(g) The project does not have a significant effect on historical resources pursuant to Section 21084.1.
(h) The project site is not subject to any of the following:
(1) A wildland fire hazard, as determined by the Department of Forestry and Fire Protection, unless the applicable general plan or zoning ordinance contains provisions to mitigate the risk of a wildland fire hazard.
(2) An unusually high risk of fire or explosion from materials stored or used on nearby properties.
(3) Risk of a public health exposure at a level that would exceed the standards established by any state or federal agency.
(4) Within a delineated earthquake fault zone, as determined pursuant to Section 2622, or a seismic hazard zone, as determined pursuant to Section 2696, unless the applicable general plan or zoning ordinance contains provisions to mitigate the risk of an earthquake fault or seismic hazard zone.
(5) Landslide hazard, flood plain, flood way, or restriction zone, unless the applicable general plan or zoning ordinance contains provisions to mitigate the risk of a landslide or flood.
(i) (1) The project site is not located on developed open space.
(2) For the purposes of this subdivision, "developed open space" means land that meets all of the following criteria:
(A) Is publicly owned, or financed in whole or in part by public funds.
(B) Is generally open to, and available for use by, the public.
(C) Is predominantly lacking in structural development other than structures associated with open spaces, including, but not limited to, playgrounds, swimming pools, ballfields, enclosed child play areas, and picnic facilities.

(3) For the purposes of this subdivision, "developed open space" includes land that has been designated for acquisition by a public agency for developed open space, but does not include lands acquired by public funds dedicated to the acquisition of land for housing purposes.
(j) The project site is not located within the boundaries of a state conservancy.

21159.22. (a) This division does not apply to any development project that meets the requirements of subdivision (b), and meets either of the following criteria:
(1) Consists of the construction, conversion, or use of residential housing for agricultural employees, and meets all of the following criteria:
(A) Is affordable to lower income households, as defined in Section 50079.5 of the Health and Safety Code.
(B) Lacks public financial assistance.
(C) The developer of the development project provides sufficient legal commitments to the appropriate local agency to ensure the continued availability and use of the housing units for lower income households for a period of at least 15 years.
(2) Consists of the construction, conversion, or use of residential housing for agricultural employees and meets all of the following criteria:
(A) Is housing for very low, low-, or moderate-income households as defined in paragraph (2) of subdivision (h) of Section 65589.5 of the Government Code.
(B) Public financial assistance exists for the development project.
(C) The developer of the development project provides sufficient legal commitments to the appropriate local agency to ensure the continued availability and use of the housing units for low- and moderate-income households for a period of at least 15 years.
(b) (1) If the development project is proposed within incorporated city limits or within a census defined place with a minimum population density of at least 5,000 persons per square mile, it is located on a project site that is adjacent, on at least two sides, to land that has been developed, and consists of not more than 45 units, or is housing for a total of 45 or fewer agricultural employees if the housing consists of dormitories, barracks, or other group living facilities.
(2) If the development project is located on a project site zoned for general agricultural use, and consists of not more than 20 units, or is housing for a total of 20 or fewer agricultural employees if the housing consists of dormitories, barracks, or other group living facilities.
(3) The project satisfies the criteria in Section 21159.21.
(4) The development project is not more than five acres in area, except that a project site located in an area with a population density of at least 1,000 persons per square mile shall not be more than two acres in area.
(c) Notwithstanding subdivision (a), if a project satisfies the criteria described in subdivisions (a) and (b), but does not satisfy the criteria described in paragraph (1) of subdivision (b), this division does not apply to the project if the project meets all of the following criteria:
(1) Is located within either an incorporated city or a census-defined place.
(2) The population density of the incorporated city or census-defined place has a population density of at least 1,000 persons per square mile.
(3) The project site is adjacent on at least two sides to land that has been developed and the project consists of not more than 45 units, or the project consist of dormitories, barracks, or other group housing facilities for a total of 45 or fewer agricultural employees.
(d) Notwithstanding subdivision (c), this division shall apply to a project that meets the criteria described in subdivision (c) if a public agency that is carrying out or approving the project determines that there is a reasonable possibility that the project, if completed, would have a significant effect

on the environment due to unusual circumstances or that the cumulative impacts of successive projects of the same type in the same area, over time, would be significant. For the purposes of this section, "agricultural employee" has the same meaning as defined by subdivision (b) of Section 1140.4 of the Labor Code.

21159.23. (a) This division does not apply to any development project that consists of the construction, conversion, or use of residential housing consisting of 100 or fewer that is affordable to low-income households if both of the following criteria are met:

(1) The developer of the development project provides sufficient legal commitments to the appropriate local agency to ensure the continued availability and use of the housing units for lower income households, as defined in Section 50079.5 of the Health and Safety Code, for a period of at least 30 years, at monthly housing costs, as determined pursuant to Section 50053 of the Health and Safety Code.

(2) The development project meets all of the following requirements:

(A) The project satisfies the criteria described in Section 21159.21.

(B) The project site meets one of the following conditions:

(i) Has been previously developed for qualified urban uses.

(ii) The parcels immediately adjacent to the site are developed with qualified urban uses, or at least 75 percent of the perimeter of the site adjoins parcels that are developed with qualified urban uses and the remaining 25 percent of the perimeter of the site adjoins parcels that have previously been developed for qualified urban uses, and the site has not been developed for urban uses and no parcel within the site has been created within 10 years prior to the proposed development of the site.

(C) The project site is not more than five acres in area.

(D) The project site is located within an urbanized areaor within a census-defined place with a population density of at least 5,000 persons per square mile or, if the project consists of 50 or fewer units, within an incorporated city with a population density of at least 2,500 persons per square mile and a total population of at least 25,000 persons.

(b) Notwithstanding subdivision (a), if a project satisfies all of the criteria described in subdivision (a) except subparagraph (D) of paragraph (2) of that subdivision, this division does not apply to the project if the project is located within either an incorporated city or a census defined place with a population density of at least 1,000 persons per square mile.

(c) Notwithstanding subdivision (b), this division applies to a project that meets the criteria of subdivision (b), if there is a reasonable possibility that the project would have a significant effect on the environment or the residents of the project due to unusual circumstances or due to the related or cumulative impacts of reasonably foreseeable projects in the vicinity of the project.

(d) For the purposes of this section, "residential" means a use consisting of either of the following:

(1) Residential units only.

(2) Residential units and primarily neighborhood-serving goods, services, or retail uses that do not exceed 15 percent of the total floor area of the project.

21159.24. (a) Except as provided in subdivision (b), this division does not apply to a project if all of the following criteria are met:

(1) The project is a residential project on an infill site.

(2) The project is located within an urbanized area.

(3) The project satisfies the criteria of Section 21159.21.
(4) Within five years of the date that the application for the project is deemed complete pursuant to Section 65943 of the Government Code, community-level environmental review was certified or adopted.
(5) The site of the project is not more than four acres in total area.
(6) The project does not contain more than 100 residential units.
(7) Either of the following criteria are met:
(A) (i) At least 10 percent of the housing is sold to families of moderate income, or not less than 10 percent of the housing is rented to families of low income, or not less than 5 percent of the housing is rented to families of very low income.
(ii) The project developer provides sufficient legal commitments to the appropriate local agency to ensure the continued availability and use of the housing units for very low, low-, and moderate-income households at monthly housing costs determined pursuant to paragraph (3) of subdivision (h) of Section 65589.5 of the Government Code.
(B) The project developer has paid or will pay in-lieu fees pursuant to a local ordinance in an amount sufficient to result in the development of an equivalent number of units that would otherwise be required pursuant to subparagraph (A).
(8) The project is within one-half mile of a major transit stop.
(9) The project does not include any single level building that exceeds 100,000 square feet.
(10) The project promotes higher density infill housing. A project with a density of at least 20 units per acre shall be conclusively presumed to promote higher density infill housing. A project with a density of at least 10 units per acre and a density greater than the average density of the residential properties within 1,500 feet shall be presumed to promote higher density housing unless the preponderance of the evidence demonstrates otherwise.
(b) Notwithstanding subdivision (a), this division shall apply to a development project that meets the criteria described in subdivision (a), if any of the following occur:
(1) There is a reasonable possibility that the project will have a project-specific, significant effect on the environment due to unusual circumstances.
(2) Substantial changes with respect to the circumstances under which the project is being undertaken that are related to the project have occurred since community-level environmental review was certified or adopted.
(3) New information becomes available regarding the circumstances under which the project is being undertaken and that is related to the project, that was not known, and could not have been known, at the time that community-level environmental review was certified or adopted.
(c) If a project satisfies the criteria described in subdivision (a), but is not exempt from this division as a result of satisfying the criteria described in subdivision (b), the analysis of the environmental effects of the project in the environmental impact report or the negative declaration shall be limited to an analysis of the project-specific effect of the projects and any effects identified pursuant to paragraph (2) or (3) of subdivision (b).
(d) For the purposes of this section, "residential" means a use consisting of either of the following:
(1) Residential units only.
(2) Residential units and primarily neighborhood-serving goods, services, or retail uses that do not exceed 15 percent of the total floor area of the project.

21159.25. (a) For a project in the City of Oakland that consists of multiple-family residential development, or a residential and commercial or retail mixed-use

development with not more than 25 percent of the total floor area of the project utilized as retail space, a focused environmental impact report may be prepared, notwithstanding that the project was not identified in a master environmental impact report, if all of the following conditions are met:

(1) The Oakland City Council does both of the following:

(A) Authorizes the implementation of this section. The city council may authorize the implementation of this section only by voting to approve the practice of preparing focused environmental impact reports for projects in the central business district housing target areas specified in paragraph (11).

(B) Determines that the general plan, zoning ordinance, and related policies and programs are consistent with principles that encourage compact development in a manner that does both of the following:

(i) Promotes efficient transportation systems, economic growth, affordable housing, energy efficiency, and an appropriate balance of jobs and housing.

(ii) Protects the environment, open space, and agricultural areas.

(2) The city submits a draft determination to the Office of Planning and Research that the applicable general plan, zoning ordinance, and any related policies and programs are consistent with the principles described in subparagraph (B) of paragraph (1) prior to the city council making its determination regarding that consistency. The office may submit comments on the draft findings to the city council within 30 days from the date that the city submits the draft determination to the office.

(3) The city has an average population density of at least 5,000 persons per square mile.

(4) The project is consistent with the general plan, any applicable specific plan and community plan, and zoning ordinance, including any variance that is properly granted pursuant to that zoning ordinance, an environmental impact report was prepared for the general plan, and the application for the project is deemed complete pursuant to Section 65943 of the Government Code within three years of the date this section is effective.

(5) The lead agency cannot make the finding described in subdivision (c) of Section 21157.1, a negative declaration or mitigated negative declaration cannot be prepared pursuant to Section 21080, 21157.5, or 21158, and Section 21166 does not apply.

(6) The project meets one or both of the following conditions:

(A) The parcel on which the project is to be developed is surrounded by immediately contiguous urban development.

(B) The parcel on which the project is to be developed is, or has been previously, developed with urban uses.

(7) The density of the project is at least 40 units per net acre.

(8) The parcel on which the project is to be developed is within one-half mile of an existing rail transit station.

(9) The project can be adequately served by existing utilities and municipal services, and there will be adequate capacity for infrastructure, utilities, and services to serve other projects approved and proposed in the service area.

(10) The project does not include a single level building that exceeds 100,000 square feet.

(11) The project is located in one of the following central business district housing target areas:

(A) The Valdez cluster, which is bounded on the west by Telegraph Avenue, on the south by 23rd Street, on the east by Harrison Street, and on the north by 27th Street. A project located in this cluster that meets the condition described in paragraph (8) may include a portion up to one acre that does not meet that condition.

(B) The Uptown cluster, which is bounded on the west by Castro Street, on the south by 14th Street from Castro Street to Jefferson Street and 16th Street

and Broadway from 16th Street to 22nd Street, and on the north by 22nd Street.

(C) The 11th Street cluster, which is bounded by Franklin Street from 12th Street to 15th Street, by Webster Street from 11th Street to 12th Street, by Alice Street from 11th Street to 13th Street, by 12th Street from Franklin Street to Webster Street, by 11th Street from Webster Street to Alice Street and 13th Street from Alice Street to Madison Street, and on the east by Madison Street from 13th Street to 15th Street, and on the north by 15th Street from Franklin Street to Madison Street.

(D) The Old Oakland cluster, which is bounded on the west by Castro Street, on the south by 7th Street, on the east by Broadway, and on the north by 11th Street.

(b) A focused environmental impact report prepared pursuant to this section shall be limited to a discussion of potentially significant effects on the environment specific to the project. No discussion shall be required of alternatives to the project, cumulative impacts of the project, or the growth inducing impacts of the project.

(c) (1) On or before July 1, 2004, the city shall submit a report to the Office of Planning and Research that includes, but that is not necessarily limited to, all of the following information:

(A) The number of focused environmental impact reports prepared pursuant to this section.

(B) The types of projects for which focused environmental impact reports were prepared pursuant to this section.

(C) The time periods for preparing each of the focused environmental impact reports prepared pursuant to this section, and for acting on each project from the date that the application was deemed complete.

(D) A description of any alternatives to a project, cumulative impacts of a project, growth inducing impacts of a project, or other issues that may have been identified and analyzed if an environmental document, other than a focused environmental impact report, had been prepared for the project.

(2) Prior to submitting the report to the office pursuant to paragraph (1), the city shall hold at least one public hearing and shall respond to oral and written comments regarding the draft report. The city shall include the comments and responses in the final report.

(d) This section shall remain in effect only until January 1, 2008, and as of that date is repealed, unless a later enacted statute, that is enacted before January 1, 2008, deletes or extends that date.

21159.26. With respect to a project that includes a housing development, a public agency may not reduce the proposed number of housing units as a mitigation measure or project alternative for a particular significant effect on the environment if it determines that there is another feasible specific mitigation measure or project alternative that would provide a comparable level of mitigation. This section does not affect any other requirement regarding the residential density of that project.

21159.27. A project may not be divided into smaller projects to qualify for one or more exemptions pursuant to this article.

21160. Whenever any person applies to any public agency for a lease, permit, license, certificate, or other entitlement for use, the public agency may require that person to submit data and information which may be necessary to enable the public agency to determine whether the proposed project may have a

significant effect on the environment or to prepare an environmental impact report. If any or all of the information so submitted is a "trade secret" as defined in Section 6254.7 of the Government Code by those submitting that information, it shall not be included in the impact report or otherwise disclosed by any public agency. This section shall not be construed to prohibit the exchange of properly designated trade secrets between public agencies who have lawful jurisdiction over the preparation of the impact report.

21161. Whenever a public agency has completed an environmental impact report, it shall cause a notice of completion of that report to be filed with the Office of Planning and Research. The notice of completion shall briefly identify the project and shall indicate that an environmental impact report has been prepared. Failure to file the notice required by this section shall not affect the validity of a project.

21162. A copy of the notice of completion of an environmental impact report on a project shall be provided, by the State Clearinghouse, to any legislator in whose district the project has an environmental impact, if the legislator requests the notice and the State Clearinghouse has received it.

21165. (a) When a project is to be carried out or approved by two or more public agencies, the determination of whether the project may have a significant effect on the environment shall be made by the lead agency, and that agency shall prepare, or cause to be prepared by contract, the environmental impact report for the project, if a report is required by this division. In the event that a dispute arises as to which is the lead agency, any of the disputing public agencies, or in the case of a project described in subdivision (c) of Section 21065 the applicant for such project, may submit the question to the Office of Planning and Research, and the Office of Planning and Research shall designate, within 21 days of receiving the request, the lead agency, giving due consideration to the capacity of that agency to adequately fulfill the requirements of this division.

(b) For the purposes of this section, a "dispute" means a contested, active difference of opinion between two or more public agencies as to which of those agencies shall prepare any necessary environmental document. A dispute exists where each of those agencies claims that it either has or does not have the obligation to prepare that environmental document. The Office of Planning and Research shall not designate a lead agency in the absence of such a dispute.

21166. When an environmental impact report has been prepared for a project pursuant to this division, no subsequent or supplemental environmental impact report shall be required by the lead agency or by any responsible agency, unless one or more of the following events occurs:

(a) Substantial changes are proposed in the project which will require major revisions of the environmental impact report.

(b) Substantial changes occur with respect to the circumstances under which the project is being undertaken which will require major revisions in the environmental impact report.

(c) New information, which was not known and could not have been known at the time the environmental impact report was certified as complete, becomes available.

21166.1. The decision of a lead agency to prepare an environmental impact report with respect to environmental impacts within a geographic area or for a group of projects shall not be a basis for determining that an environmental document prepared for an individual project within that area or group is inadequate.

21167. An action or proceeding to attack, review, set aside, void, or annul the following acts or decisions of a public agency on the grounds of noncompliance with this division shall be commenced as follows:

(a) An action or proceeding alleging that a public agency is carrying out or has approved a project that may have a significant effect on the environment without having determined whether the project may have a significant effect on the environment shall be commenced within 180 days from the date of the public agency's decision to carry out or approve the project, or, if a project is undertaken without a formal decision by the public agency, within 180 days from the date of commencement of the project.

(b) An action or proceeding alleging that a public agency has improperly determined whether a project may have a significant effect on the environment shall be commenced within 30 days from the date of the filing of the notice required by subdivision (a) of Section 21108 or subdivision (a) of Section 21152.

(c) An action or proceeding alleging that an environmental impact report does not comply with this division shall be commenced within 30 days from the date of the filing of the notice required by subdivision (a) of Section 21108 or subdivision (a) of Section 21152 by the lead agency.

(d) An action or proceeding alleging that a public agency has improperly determined that a project is not subject to this division pursuant to subdivision (b) of Section 21080 or Section 21172 shall be commenced within 35 days from the date of the filing by the public agency, or person specified in subdivision (b) or (c) of Section 21065, of the notice authorized by subdivision (b) of Section 21108 or subdivision (b) of Section 21152. If the notice has not been filed, the action or proceeding shall be commenced within 180 days from the date of the public agency's decision to carry out or approve the project, or, if a project is undertaken without a formal decision by the public agency, within 180 days from the date of commencement of the project.

(e) An action or proceeding alleging that another act or omission of a public agency does not comply with this division shall be commenced within 30 days from the date of the filing of the notice required by subdivision (a) of Section 21108 or subdivision (a) of Section 21152.

(f) If a person has made a written request to the public agency for a copy of the notice specified in Section 21108 or 21152 prior to the date on which the agency approves or determines to carry out the project, then not later than five days from the date of the agency's action, the public agency shall deposit a written copy of the notice addressed to that person in the United States mail, first class postage prepaid. The date upon which this notice is mailed shall not affect the time periods specified in subdivisions (b), (c), (d), and (e).

21167.1. (a) In all actions or proceedings brought pursuant to Sections 21167, 21168, and 21168.5, including the hearing of an action or proceeding on appeal from a decision of a lower court, all courts in which the action or proceeding is pending shall give the action or proceeding preference over all other civil actions, in the matter of setting the action or proceeding for

hearing or trial, and in hearing or trying the action or proceeding, so that the action or proceeding shall be quickly heard and determined. The court shall regulate the briefing schedule so that, to the extent feasible, the court shall commence hearings on an appeal within one year of the date of the filing of the appeal.

(b) To ensure that actions or proceedings brought pursuant to Sections 21167, 21168, and 21168.5 may be quickly heard and determined in the lower courts, the superior courts in all counties with a population of more than 200,000 shall designate one or more judges to develop expertise in this division and related land use and environmental laws, so that those judges will be available to hear, and quickly resolve, actions or proceedings brought pursuant to Sections 21167, 21168, and 21168.5.

(c) In any action or proceeding filed pursuant to this chapter that is joined with any other cause of action, the court, upon a motion by any party, may grant severance of the actions. In determining whether to grant severance, the court shall consider such as matters judicial economy, administrative economy, and prejudice to any party.

21167.2. If no action or proceeding alleging that an environmental impact report does not comply with the provisions of this division is commenced during the period prescribed in subdivision (c) of Section 21167, the environmental impact report shall be conclusively presumed to comply with the provisions of this division for purposes of its use by responsible agencies, unless the provisions of Section 21166 are applicable.

21167.3. (a) If an action or proceeding alleging that an environmental impact report or a negative declaration does not comply with the provisions of this division is commenced during the period described in subdivision (b) or (c) of Section 21167, and if an injunction or stay is issued prohibiting the project from being carried out or approved pending final determination of the issue of such compliance, responsible agencies shall assume that the environmental impact report or the negative declaration for the project does comply with the provisions of this division and shall issue a conditional approval or disapproval of such project according to the timetable for agency action in Article 5 (commencing with Section 65950) of Chapter 4.5 of Division 1 of Title 7 of the Government Code. A conditional approval shall constitute permission to proceed with a project when and only when such action or proceeding results in a final determination that the environmental impact report or negative declaration does comply with the provisions of this division.

(b) In the event that an action or proceeding is commenced as described in subdivision (a) but no injunction or similar relief is sought and granted, responsible agencies shall assume that the environmental impact report or negative declaration for the project does comply with the provisions of this division and shall approve or disapprove the project according to the timetable for agency action in Article 5 (commencing with Section 65950) of Chapter 4.5 of Division 1 of Title 7 of the Government Code. Such approval shall constitute permission to proceed with the project at the applicant's risk pending final determination of such action or proceeding.

21167.4. (a) In any action or proceeding alleging noncompliance with this division, the petitioner shall request a hearing within 90 days from the date of filing the petition or shall be subject to dismissal on the court's own motion or on the motion of any party interested in the action or proceeding.

(b) The petitioner shall serve a notice of the request for a hearing on all parties at the time that the petitioner files the request for a hearing.
(c) Upon the filing of a request by the petitioner for a hearing and upon application by any party, the court shall establish a briefing schedule and a hearing date. In the absence of good cause, briefing shall be completed within 90 days from the date that the request for a hearing is filed, and the hearing, to the extent feasible, shall be held within 30 days thereafter. Good cause may include, but shall not be limited to, the conduct of discovery, determination of the completeness of the record of proceedings, the complexity of the issues, and the length of the record of proceedings and the timeliness of its production. The parties may stipulate to a briefing schedule or hearing date that differs from the schedule set forth in this subdivision if the stipulation is approved by the court.

21167.5. Proof of prior service by mail upon the public agency carrying out or approving the project of a written notice of the commencement of any action or proceeding described in Section 21167 identifying the project shall be filed concurrently with the initial pleading in such action or proceeding.

21167.6. Notwithstanding any other provision of law, in all actions or proceedings brought pursuant to Section 21167, except those involving the Public Utilities Commission, all of the following shall apply:
(a) At the time that the action or proceeding is filed, the plaintiff or petitioner shall file a request that the respondent public agency prepare the record of proceedings relating to the subject of the action or proceeding. The request, together with the complaint or petition, shall be served personally upon the public agency not later than 10 business days from the date that the action or proceeding was filed.
(b) (1) The public agency shall prepare and certify the record of proceedings not later than 60 days from the date that the request specified in subdivision (a) was served upon the public agency. Upon certification, the public agency shall lodge a copy of the record of proceedings with the court and shall serve on the parties notice that the record of proceedings has been certified and lodged with the court. The parties shall pay any reasonable costs or fees imposed for the preparation of the record of proceedings in conformance with any law or rule of court.
(2) The plaintiff or petitioner may elect to prepare the record of proceedings or the parties may agree to an alternative method of preparation of the record of proceedings, subject to certification of its accuracy by the public agency, within the time limit specified in this subdivision.
(c) The time limit established by subdivision (b) may be extended only upon the stipulation of all parties who have been properly served in the action or proceeding or upon order of the court. Extensions shall be liberally granted by the court when the size of the record of proceedings renders infeasible compliance with that time limit. There is no limit on the number of extensions that may be granted by the court, but no single extension shall exceed 60 days unless the court determines that a longer extension is in the public interest.
(d) If the public agency fails to prepare and certify the record within the time limit established in paragraph (1) of subdivision (b), or any continuances of that time limit, the plaintiff or petitioner may move for sanctions, and the court may, upon that motion, grant appropriate sanctions.
(e) The record of proceedings shall include, but is not limited to, all of the following items:
(1) All project application materials.

(2) All staff reports and related documents prepared by the respondent public agency with respect to its compliance with the substantive and procedural requirements of this division and with respect to the action on the project.
(3) All staff reports and related documents prepared by the respondent public agency and written testimony or documents submitted by any person relevant to any findings or statement of overriding considerations adopted by the respondent agency pursuant to this division.
(4) Any transcript or minutes of the proceedings at which the decisionmaking body of the respondent public agency heard testimony on, or considered any environmental document on, the project, and any transcript or minutes of proceedings before any advisory body to the respondent public agency that were presented to the decisionmaking body prior to action on the environmental documents or on the project.
(5) All notices issued by the respondent public agency to comply with this division or with any other law governing the processing and approval of the project.
(6) All written comments received in response to, or in connection with, environmental documents prepared for the project, including responses to the notice of preparation.
(7) All written evidence or correspondence submitted to, or transferred from, the respondent public agency with respect to compliance with this division or with respect to the project.
(8) Any proposed decisions or findings submitted to the decisionmaking body of the respondent public agency by its staff, or the project proponent, project opponents, or other persons.
(9) The documentation of the final public agency decision, including the final environmental impact report, mitigated negative declaration, or negative declaration, and all documents, in addition to those referenced in paragraph (3), cited or relied on in the findings or in a statement of overriding considerations adopted pursuant to this division.
(10) Any other written materials relevant to the respondent public agency's compliance with this division or to its decision on the merits of the project, including the initial study, any drafts of any environmental document, or portions thereof, that have been released for public review, and copies of studies or other documents relied upon in any environmental document prepared for the project and either made available to the public during the public review period or included in the respondent public agency's files on the project, and all internal agency communications, including staff notes and memoranda related to the project or to compliance with this division.
(11) The full written record before any inferior administrative decisionmaking body whose decision was appealed to a superior administrative decisionmaking body prior to the filing of litigation.
(f) In preparing the record of proceedings, the party preparing the record shall strive to do so at reasonable cost in light of the scope of the record.
(g) The clerk of the superior court shall prepare and certify the clerk's transcript on appeal not later than 60 days from the date that the notice designating the papers or records to be included in the clerk's transcript was filed with the superior court, if the party or parties pay any costs or fees for the preparation of the clerk's transcript imposed in conformance with any law or rules of court. Nothing in this subdivision precludes an election to proceed by appendix, as provided in Rule 5.1 of the California Rules of Court.
(h) Extensions of the period for the filing of any brief on appeal may be allowed only by stipulation of the parties or by order of the court for good cause shown. Extensions for the filing of a brief on appeal shall be limited to one 30-day extension for the preparation of an opening brief, and one 30-day

extension for the preparation of a responding brief, except that the court may grant a longer extension or additional extensions if it determines that there is a substantial likelihood of settlement that would avoid the necessity of completing the appeal.

(i) At the completion of the filing of briefs on appeal, the appellant shall notify the court of the completion of the filing of briefs, whereupon the clerk of the reviewing court shall set the appeal for hearing on the first available calendar date.

21167.6.5. (a) The petitioner or plaintiff shall name, as a real party in interest, any recipient of an approval that is the subject of an action or proceeding brought pursuant to Section 21167, 21168, or 21168.5, and shall serve the petition or complaint on that real party in interest, by personal service, mail facsimile, or any other method permitted by law, not later than 20 business days following service of the petition or complaint on the public agency.

(b) The public agency shall provide the petitioner or plaintiff, not later than 10 business days following service of the petition or complaint on the public agency, with a list of responsible agencies and any public agency having jurisdiction over a natural resource affected by the project.

(c) The petitioner or plaintiff shall provide the responsible agencies, and any public agency having jurisdiction over a natural resource affected by the project, with notice of the action or proceeding within 15 days of receipt of the list described in subdivision (b).

(d) Failure to name potential parties, other than those real parties in interest described in subdivision (a), is not grounds for dismissal pursuant to Section 389 of the Code of Civil Procedure.

(e) Nothing in this section is intended to affect an existing right of a party to intervene in the action.

21167.7. Every person who brings an action pursuant to Section 21167 shall comply with the requirements of Section 388 of the Code of Civil Procedure. Every such person shall also furnish pursuant to Section 388 of the Code of Civil Procedure a copy of any amended or supplemental pleading filed by such person in such action to the Attorney General. No relief, temporary or permanent, shall be granted until a copy of the pleading has been furnished to the Attorney General in accordance with such requirements.

21167.8. (a) Not later than 20 days from the date of service upon a public agency of a petition or complaint brought pursuant to Section 21167, the public agency shall file with the court a notice setting forth the time and place at which all parties shall meet and attempt to settle the litigation. The meeting shall be scheduled and held not later than 45 days from the date of service of the petition or complaint upon the public agency. The notice of the settlement meeting shall be served by mail upon the counsel for each party. If the public agency does not know the identity of counsel for any party, the notice shall be served by mail upon the party for whom counsel is not known.

(b) At the time and place specified in the notice filed with the court, the parties shall meet and confer regarding anticipated issues to be raised in the litigation and shall attempt in good faith to settle the litigation and the dispute which forms the basis of the litigation. The settlement meeting discussions shall be comprehensive in nature and shall focus on the legal issues raised by the parties concerning the project that is the subject of the litigation.

(c) The settlement meeting may be continued from time to time without postponing or otherwise delaying other applicable time limits in the litigation. The settlement meeting is intended to be conducted concurrently with any judicial proceedings.
(d) If the litigation is not settled, the court, in its discretion, may, or at the request of any party, shall, schedule a further settlement conference before a judge of the superior court. If the petition or complaint is later heard on its merits, the judge hearing the matter shall not be the same judge conducting the settlement conference, except in counties that have only one judge of the superior court.
(e) The failure of any party, who was notified pursuant to subdivision (a), to participate in the litigation settlement process, without good cause, may result in an imposition of sanctions by the court.
(f) Not later than 30 days from the date that notice of certification of the record of proceedings was filed and served in accordance with Section 21167.6, the petitioner or plaintiff shall file and serve on all other parties a statement of issues which the petitioner or plaintiff intends to raise in any brief or at any hearing or trial. Not later than 10 days from the date on which the respondent or real party in interest has been served with the statement of issues from the petitioner or plaintiff, each respondent and real party in interest shall file and serve on all other parties a statement of issues which that party intends to raise in any brief or at any hearing or trial.

21168. Any action or proceeding to attack, review, set aside, void or annul a determination, finding, or decision of a public agency, made as a result of a proceeding in which by law a hearing is required to be given, evidence is required to be taken and discretion in the determination of facts is vested in a public agency, on the grounds of noncompliance with the provisions of this division shall be in accordance with the provisions of Section 1094.5 of the Code of Civil Procedure. In any such action, the court shall not exercise its independent judgment on the evidence but shall only determine whether the act or decision is supported by substantial evidence in the light of the whole record.

21168.5. In any action or proceeding, other than an action or proceeding under Section 21168, to attack, review, set aside, void or annul a determination, finding, or decision of a public agency on the grounds of noncompliance with this division, the inquiry shall extend only to whether there was a prejudicial abuse of discretion. Abuse of discretion is established if the agency has not proceeded in a manner required by law or if the determination or decision is not supported by substantial evidence.

21168.6. In any action or proceeding under Sections 21168 or 21168.5 against the Public Utilities Commission the writ of mandate shall lie only from the Supreme Court to such commission.

21168.7. Sections 21168 and 21168.5 are declaratory of existing law with respect to the judicial review of determinations or decisions of public agencies made pursuant to this division.

21168.9. (a) If a court finds, as a result of a trial, hearing, or remand from an appellate court, that any determination, finding, or decision of a public agency has been made without compliance with this division, the court shall enter an order that includes one or more of the following:

(1) A mandate that the determination, finding, or decision be voided by the public agency, in whole or in part.

(2) If the court finds that a specific project activity or activities will prejudice the consideration or implementation of particular mitigation measures or alternatives to the project, a mandate that the public agency and any real parties in interest suspend any or all specific project activity or activities, pursuant to the determination, finding, or decision, that could result in an adverse change or alteration to the physical environment, until the public agency has taken any actions that may be necessary to bring the determination, finding, or decision into compliance with this division.

(3) A mandate that the public agency take specific action as may be necessary to bring the determination, finding, or decision into compliance with this division.

(b) Any order pursuant to subdivision (a) shall include only those mandates which are necessary to achieve compliance with this division and only those specific project activities in noncompliance with this division. The order shall be made by the issuance of a peremptory writ of mandate specifying what action by the public agency is necessary to comply with this division. However, the order shall be limited to that portion of a determination, finding, or decision or the specific project activity or activities found to be in noncompliance only if a court finds that (1) the portion or specific project activity or activities are severable, (2) severance will not prejudice complete and full compliance with this division, and (3) the court has not found the remainder of the project to be in noncompliance with this division. The trial court shall retain jurisdiction over the public agency's proceedings by way of a return to the peremptory writ until the court has determined that the public agency has complied with this division.

(c) Nothing in this section authorizes a court to direct any public agency to exercise its discretion in any particular way. Except as expressly provided in this section, nothing in this section is intended to limit the equitable powers of the court.

21169. Any project defined in subdivision (c) of Section 21065 undertaken, carried out or approved on or before the effective date of this section and the issuance by any public agency of any lease, permit, license, certificate or other entitlement for use executed or issued on or before the effective date of this section notwithstanding a failure to comply with this division, if otherwise legal and valid, is hereby confirmed, validated and declared legally effective. Any project undertaken by a person which was supported in whole or part through contracts with one or more public agencies on or before the effective date of this section, notwithstanding a failure to comply with this division, if otherwise legal and valid, is hereby confirmed, validated and declared legally effective.

21170. (a) Section 21169 shall not operate to confirm, validate or give legal effect to any project the legality of which was being contested in a judicial proceeding in which proceeding the pleadings, prior to the effective date of this section, alleged facts constituting a cause of action for, or raised the issue of, a violation of this division and which was pending and undetermined on the effective date of this section; provided, however, that Section 21169 shall operate to confirm, validate or give legal effect to any project to

which this subdivision applies if, prior to the commencement of judicial proceedings and in good faith and in reliance upon the issuance by a public agency of any lease, permit, license, certificate or other entitlement for use, substantial construction has been performed and substantial liabilities for construction and necessary materials have been incurred.

(b) Section 21169 shall not operate to confirm, validate or give legal effect to any project which had been determined in any judicial proceeding, on or before the effective date of this section to be illegal, void or ineffective because of noncompliance with this division.

21171. This division, except for Section 21169, shall not apply to the issuance of any lease, permit, license, certificate or other entitlement for use for any project defined in subdivision (c) of Section 21065 or to any project undertaken by a person which is supported in whole or in part through contracts with one or more public agencies until the 121st day after the effective date of this section. This section shall not apply to any project to which Section 21170 is applicable or to any successor project which is the same as, or substantially identical to, such a project. This section shall not prohibit or prevent a public agency, prior to the 121st day after the effective date of this section, from considering environmental factors in connection with the approval or disapproval of a project and from imposing reasonable fees in connection therewith.

21172. This division shall not apply to any project undertaken, carried out, or approved by a public agency to maintain, repair, restore, demolish or replace property or facilities damaged or destroyed as a result of a disaster in a disaster stricken area in which a state of emergency has been proclaimed by the Governor pursuant to Chapter 7 (commencing with Section 8550) of Division 1, Title 2 of the Government Code.

21172.5. Until the 121st day after the effective date of this section, any objectives, criteria and procedures adopted by public agencies in compliance with this division shall govern the evaluation of projects defined in subdivisions (a) and (b) of Section 21065 and the preparation of environmental impact reports on such projects when required by this division. Any environmental impact report which has been completed or on which substantial work has been performed on or before the 121st day after the effective date of this section, if otherwise legally sufficient, shall, when completed, be deemed to be in compliance with this division and no further environmental impact report shall be required except as provided in Section 21166.

21173. If any provision of this division or the application thereof to any person or circumstances is held invalid, such invalidity shall not affect other provisions or applications of this division which can be given effect without the invalid provision or application thereof, and to this end the provisions of this division are severable.

21174. No provision of this division is a limitation or restriction on the power or authority of any public agency in the enforcement or administration of any provision of law which it is specifically permitted or required to enforce or administer, including, but not limited to, the powers and authority granted

to the California Coastal Commission pursuant to Division 20 (commencing with Section 30000). To the extent of any inconsistency or conflict between the provisions of the California Coastal Act of 1976 (Division 20 (commencing with Section 30000)) and the provisions of this division, the provisions of Division 20 (commencing with Section 30000) shall control.

21175. In the event that a local agency formation commission, acting pursuant to the provisions of Chapter 6.6 (commencing with Section 54773) of Part 1 of Division 2 of Title 5 of, or pursuant to Division 1 (commencing with Section 56000) of Title 6 of, the Government Code, has approved a project without complying with this division, such approval is hereby confirmed, validated, and declared legally effective notwithstanding the failure to comply with this division; provided, that such approval shall have occurred prior to February 7, 1975.

21176. (a) Section 21175 shall not operate to confirm, validate, or give legal effect to any project, the legality of which was being contested in a judicial proceeding in which proceeding the pleadings, prior to February 7, 1975, alleged facts constituting a cause of action for, or raised the issue of, a violation of this division, and which was pending and undetermined on February 7, 1975.

(b) Section 21175 shall not operate to confirm, validate, or give legal effect to any project which had been determined in any judicial proceeding, on or before the effective date of this section, to be illegal, void, or ineffective because of noncompliance with this division.

21177. (a) No action or proceeding may be brought pursuant to Section 21167 unless the alleged grounds for noncompliance with this division were presented to the public agency orally or in writing by any person during the public comment period provided by this division or prior to the close of the public hearing on the project before the issuance of the notice of determination.

(b) No person shall maintain an action or proceeding unless that person objected to the approval of the project orally or in writing during the public comment period provided by this division or prior to the close of the public hearing on the project before the issuance of the notice of determination.

(c) This section does not preclude any organization formed after the approval of a project from maintaining an action pursuant to Section 21167 if a member of that organization has complied with subdivision (b).

(d) This section does not apply to the Attorney General.

(e) This section does not apply to any alleged grounds for noncompliance with this division for which there was no public hearing or other opportunity for members of the public to raise those objections orally or in writing prior to the approval of the project, or if the public agency failed to give the notice required by law.

POLICY ON MITIGATION GUIDELINES REGARDING
IMPACTS TO RARE, THREATENED, AND ENDANGERED PLANTS

California Native Plant Society Rare Plant Scientific Advisory Committee

(February 1991, revised April 1998)

This document is intended to guide in the assessment and mitigation of impacts to rare and endangered plants. It supports the California Native Plant Society Policy Regarding Mitigation of Impacts to Rare and Endangered Plants (Appendix A). The goals of the policy are to prevent decline of rare plants and their habitats and to ensure that effective rare plant preservation measures are implemented.

In California the right to develop land is subject to regulation by public agencies that have discretionary control over project approval. The National Environmental Policy Act of 1969 (NEPA) and the California Environmental Quality Act of 1970 (CEQA) require project applicants to disclose, consider and avoid or reduce significant project impacts to rare or endangered species. Environmental documents required under those laws contain the project disclosures and evaluations and are available for public review.

EVALUATION GUIDELINES

Before identifying mitigation options for a project, the vegetation types, rare plants and habitats, and specialized biotic resource areas must be identified and the project impacts described and assessed. The Society recommends following the Department of Fish and Game's Guidelines for Assessing Effects of Proposed Developments on Rare and Endangered Plants and Plant Communities (Appendix B). An important aspect of the evaluation is determining whether an impact is significant as defined by CEQA and NEPA. Under CEQA, for example, an significant impact is one which would produce a substantial, or potentially substantial, adverse change in the environment.

MITIGATION GUIDELINES

The Society endorses the mitigation concepts in the California Environmental Quality Act, Statutes and Guidelines (1986) because they may be applied specifically to rare plants. The types of mitigation for environmental impacts that are listed in CEQA (Section 15370) are:

(a) Avoiding the impact altogether by not taking a certain action.

(b) Minimizing impacts by limiting the degree or magnitude of the action.

(c) Rectifying the impact by repairing, rehabilitating or restoring the impacted environment.

(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the project.

(e) Compensating for the impact by replacing or providing substitute resources or environments.

These mitigation measures can be applied to a variety of environmental impacts but are not always appropriate to mitigating rare plant impacts. Mitigation measures should be developed on a site-specific basis in consultation with appropriate resources agencies. Under existing laws, a project applicant or a local lead agency may have the responsibility of consulting with public regulatory agencies on matters relating to project impacts on rare species.

For rare plants, effective mitigation options that can avoid or reduce impacts may be limited. The use of more than one measure may be necessary depending upon the type of project and the factors that make plant species rare (e.g., unusual soils, microclimates, or water regimes). Each project must be individually evaluated to determine which mitigation method or methods will avoid or reduce impacts defined by CEQA or NEPA as significant to a less than significant level. Because the life history and ecological

information needed to judge whether mitigation measures are adequate is often lacking, additional biological research may be necessary prior to mitigation design and/or implementation in order to determine which measures will be most appropriate.

Of the five mitigation types in the California Environmental Quality Act, the California Native Plant Society fully supports those which avoid net reduction of population size or species viability. For most plant species this requires the protection of habitat essential to the survival of the species. In some instances, this also requires that impacts be fully avoided in order to prevent a significant impact (i.e., a net loss of plant numbers, habitat, or genetic variability essential to the future existence and recovery of the species). Alternatives such as site restoration and off-site introduction are generally unproven, and usually unsuccessful.

Avoidance:

Impacts to rare plants may be avoided by: (1) pre-project planning and design; (2) reconfiguring an existing project design; or (3) adopting the no-project alternative. Project planning and design measures to avoid impacts may include arrangement of facilities on-site to avoid sensitive features. Additional measures are almost always required to protect avoided sites from impacts associated with construction and operation of the project. Such protection can include, but is not limited to, fencing, open space or conservation easements, and transfer of development rights. See Appendix C for a brief discussion of conservation easements.

Each of the other mitigation alternatives included in the CEQA guidelines involves the acceptance of a net loss and/or use of transplantation, artificial propagation, seed transfer, or habitat restoration. The Society believes that these methods do not fully mitigate for significant impacts to rare plants and their habitats for three reasons:

(1) These alternatives compromise and ultimately negate mitigation by allowing net losses of rare plant populations and habitat. Mitigation must, according to CEQA, fully offset or reduce significant impacts to a less than significant level.

(2) Most rare plants are restricted to their known locations because they have specialized, poorly understood, habitat requirements. Creating the exact environmental conditions that these plants require may not be possible.

(3) The Society does not endorse alteration of naturally occurring plant communities through transplantation because the methodology for most rare plants is untested and therefore unreliable and because most past attempts have ultimately failed.

Although the Society does not endorse significant net losses of rare plant numbers or habitat, we recognize that where such losses are allowed or are deemed unavoidable, off-site restoration, compensation, transplantation or other salvage methods should be attempted to enhance degraded populations or provide for partial survival of the sacrificed population. Such measures also provide additional knowledge of the species' horticultural and ecological requirements. Such measures should never be performed so that an otherwise unaffected population is in any way jeopardized, for example by genetic contamination.

Mitigation alternatives other than avoidance are discussed below. These should be used alone or in combination to reduce impacts to less than significant levels. They should also be used in conjunction with monitoring and long-term management agreements.

Reducing Impacts:

The significance of impacts may be minimized by reducing the size of the project (i.e., partial avoidance) and by locating the project in the least environmentally sensitive area. Areas where impacts are avoided should be surrounded by buffer zones where impacts are absorbed, and set aside and permanently protected in conservation or open space easements. Efforts should be made to salvage portions of the population that will be lost.

Restoration:

Restoration can be used to mitigate impacts from projects approved prior to environmental regulations, or impacts allowed through a "statement of overriding considerations."

Depending upon the degree of impact, habitat restoration may be as simple as removing debris and controlling public access. In more complex situations, however, partial or total restoration of degraded habitat may require extensive revegetation, and soil protection and stabilization programs. Restoration must be tailored to the specific project site based on the habitat and species involved. General guidelines for restoration projects involving rare plants are discussed in Appendix D.

Reduction Over Time:

Impacts may be significantly reduced or eliminated by controlling public access and by fencing or staking the habitat area to prevent accidental intrusion into the site. Monitoring rare plants and habitats during all phases of a project will help ensure that construction and operation activities do not encroach on protected habitat.

When project actions have ended, restraints may or may not be removed depending on the completed project's potential for long-term impacts on the sensitive area. In most instances, control of public access to sensitive habitat sites needs to be continued beyond the construction phase of an individual project, especially in moderate and high density development areas. Public education about the value of the protected resources should also be considered for these areas.

Attempts to reduce or eliminate impacts over the life of the project should be required for all projects if the potential exists for secondary impacts due to human access; mitigation agreements that require placement of a conservation or open space easement on the mitigation site should be considered to implement this measure.

Off-site Compensation:

Compensating for the impact by protecting substitute resources or environments has been used in some instances to mitigate unavoidable impacts. In most instances off-site compensation does not fully reduce impacts to an insignificant level because a net loss of individuals or habitat that supports a natural self-sustaining rare plant population results. In spite of this, off-site compensation is a useful tool under specific circumstances where other mitigation alternatives cannot be applied or do not fully mitigate significant impacts.

Off-site compensation has been approached in several different ways, including: 1) permanent protection of an existing off-site native population; 2) permanent protection of an off-site introduced population; 3) a combination of 1) and 2); or 4) mitigation banking.

Determining habitat value for off-site compensation is difficult. The size of the acquisition will vary depending upon the type, condition, extent and rarity of the habitat and species. In any case, the acquisition and permanent protection of an alternative parcel does not alter the fact that the loss of the

initial site brings the rare habitat and species one step closer to ultimate extinction. Species preservation is greatly enhanced when plants are protected at a number of separate sites. Although the permanent protection of a vigorous, self-sustaining population of the species tends to reduce the endangerment potential of the species at that particular site, it does not necessarily fully compensate for the loss of the habitat known to support a viable population. To further reduce the endangerment potential for the species and habitat, the ratio of acquisition to loss must in most cases exceed 1:1 for any species. The ratio should be higher for rarer species, particularly for those that occupy irreplaceable habitats. In addition, enhancing off-site compensation areas (e.g., reducing grazing or OHV impacts) can help to more fully compensate for the net loss of plants at a project site.

If transfer of the threatened population is being attempted, an ecological study of the site, including an inventory of rare species, is needed to identify the feasibility of introduction. Genetic contamination can occur by mixing of populations of the rare plants and needs to be avoided, as does hybridization between the rare plant and close relatives that could occur at the introduction site. In no case are unthreatened populations to be jeopardized by the transfer of genetic material from the threatened site. If the compensation site is considered suitable, acquisition or other permanent protection efforts are required to ensure adequate long-term protection, and therefore to mitigate for a net loss of rare plants or habitat. A propagation program should be developed for the salvage and transfer of rare plant populations from the initial parcel before initiating any activities. Permits may be required from California Department of Fish and Game (DFG) or the U.S. Fish and Wildlife Service. Propagation methods for the salvaged population must be developed on a case-specific basis. The propagation program schedule must provide adequate lead time to plan and carry out transfer at the correct time of the year. In order to serve as mitigation, the transfer must be successfully completed before the project's construction activities eliminate plants or habitats. Maintenance and monitoring programs which include the collection of data to document degree of success should also be developed for the compensation site to ensure the transplanted population is self-sufficient and thereby demonstrate success.

MITIGATION IMPLEMENTATION

The mitigation design, implementation techniques and reporting procedures must be clearly documented. Responsibilities of the landowner/applicant, contractors, and agencies, and criteria that define successful mitigation, should be placed in writing to prevent later confusion or disagreement. The DFG Plant Conservation Program has prepared a mitigation plan annotated outline that includes the basic information needed to develop a mitigation plan for State-listed plant species that would be acceptable to the DFG. This document discusses important considerations in designing appropriate mitigation and monitoring plans and establishing appropriate performance criteria, and should be consulted when developing mitigation for impacts to any rare plant species.

Mitigation agreements entered into as a condition of a discretionary permit must contain assurances of implementation, monitoring and maintenance. Permits for development generally require a mitigation plan prior to approval. Project construction is sometimes completed before mitigation is fully implemented, especially where restoration or revegetation is involved. In these and related instances mitigation commitments should be guaranteed by a negotiable performance security. The amount of the negotiable security should be large enough to complete the mitigation and to purchase other rare plant habitat in the event the applicant fails to successfully complete the work in accordance with the approved mitigation agreement.

Clear criteria should be included in the mitigation agreement to define the conditions under which the mitigation measures are to be considered complete or successful, so that the performance security may be returned. Any mitigation effort requiring manipulation of plants or of habitats should be monitored for success or failure for a minimum of five years before relinquishing the performance security. The duration of the evaluation period must be based on the biological constraints of the species involved.

MAINTENANCE AND MONITORING IMPLEMENTATION

Maintenance and monitoring of rare plant populations and habitats are essential even where these are "protected" by mitigation measures. Monitoring enables project applicants and regulatory agencies to document compliance with mitigation agreements. Monitoring also enables scientists to gather valuable knowledge on the effectiveness of rare plant mitigation methods. The financial responsibility for monitoring and maintenance of rare plant populations and habitat is typically that of the project applicant. In all cases, monitoring should be conducted by an experienced botanist. Maintenance responsibilities must be clearly stated in contractual agreements to eliminate any confusion during future maintenance and monitoring.

Maintenance must consider the ecological needs of the species and habitat and the types of mitigation used. Where undisturbed habitat is set aside, maintenance may consist of little more than controlling public access, maintaining fences, or periodic weed removal. Restoration and revegetation programs may require more complex maintenance programs. For example, invasive non-native plants may require specialized control measures to keep them from spreading; herbivores may also need to be controlled to protect the native vegetation.

Monitoring programs must be developed to meet the needs of the specific mitigation program. For example, it may be necessary to monitor the progress of construction activities, if these activities have the potential to damage rare plant habitat. Monitoring of restoration and revegetation projects is essential to document success or failure and identify areas where additional work is needed. Monitoring undisturbed sites that have been set aside and are not likely to suffer direct or cumulative impacts may require only periodic visits to determine if easement violations have occurred. Requirements to correct violations should be described in the conservation easement or mitigation agreement.

In the past, mitigation for many approved projects was not properly implemented and agencies failed to enforce compliance by project developers. To rectify this, legislation passed in 1989 (AB 3180, Cortese) amended CEQA by adding section 21081.6 to allow California agencies to require monitoring of mitigation measures that were defined for a given project. The features to be monitored must be outlined in a formal monitoring plan which must be sufficient to identify failures in mitigation throughout the life of the project, not just during the construction phase. Agencies can enforce compliance with monitoring plans through several means, including specifying penalties for failure to meet monitoring obligations, through the use of existing police power such as fines or restraining orders, and/or by requiring a performance security of the project applicant.

Monitoring a conservation easement is the responsibility of the easement holder, whether this is a nonprofit organization or a public agency. The easement holder is also responsible for seeking redress for violations of the conservation easement contract.

CONCLUSION

The Society supports project alternatives that completely avoid significant project impacts to rare and endangered plant species and their habitats. In cases where other mitigation alternatives are approved, mitigation plans should be designed based on the specific requirements of the species and habitat involved. Although the current limited understanding of the ecological requirements for most rare species makes this task difficult, the use of preliminary ecological studies in mitigation planning will help to develop successful mitigation programs. Emphasis must be placed on conserving not only the rare plant but its habitat. The increased awareness of the need for solutions to problems of human impact on the environment and endangered species is encouraging. This awareness and concern has led to the participation of many agencies, conservation organizations, and concerned individuals in an effort to develop the criteria needed for rare plant protection. The California Native Plant Society has dedicated itself to helping realize this goal, and is always available to assist private individuals, local governments, public agencies and others in designing truly effective mitigation measures. Some of the references cited

in the bibliography contain information relating to studies of specific rare plants and mitigation implementations for specific development projects.

ACKNOWLEDGEMENTS

The CNPS Mitigation Policy and Guidelines were produced through the dedicated effort of many individuals. Special thanks go to Betty Guggolz for her lead role in the production of this document and her patient endurance of innumerable modifications to the text. Others who contributed valuable advice, criticism and support were: Ken Berg, Roxanne Bittman, Fredrica Bowcutt, Susan Cochrane, Charlice Danielsen, Phyllis Faber, Jack Guggolz, James Jokerst, Tim Messick, Mary Meyer, James Nelson, Thomas Oberbauer, David Schonum, Teresa Sholars, Mark Skinner, James Payne Smith, Joan Vilms, Laurie Wickenheiser, and Vernal Yadon.

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California Native Plant Society
1722 J Street, Suite 17
Sacramento, CA 95814
(916) 447-2677

APPENDIX A

POLICY REGARDING MITIGATION OF IMPACTS TO RARE AND ENDANGERED PLANTS

Adopted by the CNPS Board of Directors: June 6, 1987

The policy of the California Native Plant Society is that all potential direct, indirect, and cumulative impacts to rare, threatened, or endangered plants and their habitats must be assessed and that appropriate measures be implemented to prevent such impacts resulting from projects. The policy of the Society is also that environmental documents and mitigation plans be based on complete, accurate and current scientific information. Viability of rare, threatened, or endangered plants and their habitats takes precedence over economic or political expediency. Because of the tremendous diversity of rare plant habitats in California, and the dependence of rare plants on their local habitats, it is imperative that mitigation measures be developed on a site specific basis. Local environmental conditions, species biology, land use patterns and other factors must be incorporated into the design of mitigation plans.

The goals of this policy are to prevent the decline of rare plants and their habitats and to ensure that effective rare plant preservation measures are implemented.

Of the mitigation measures listed in the California Environmental Quality Act, the Society fully endorses only that of avoiding the impact. Measures to minimize, to rectify, or to reduce or eliminate the impact over time are recognized by the Society as partial mitigation. The Society does not recognize off-site compensation as mitigation.

Guidelines for project review and evaluation of mitigation proposals are available from the California Native Plant Society. The Rare Plant Scientific Advisory Committee will revise the guidelines periodically so that they are easily used with the California Environmental Quality Act and other current legislation.

California Native Plant Society
1722 J Street, Suite 17
Sacramento, CA 95814
(916) 447-2677

APPENDIX B

GUIDELINES FOR ASSESSING THE EFFECTS OF PROPOSED DEVELOPMENTS ON RARE, THREATENED, AND ENDANGERED PLANTS AND PLANT COMMUNITIES

State of California
THE RESOURCES AGENCY
Department of Fish and Game
May 4, 1984
Revised August 15, 1997

The following recommendations are intended to help those who prepare and review environmental documents determine when a botanical survey is needed, who should be considered qualified to conduct such surveys, how field surveys should be conducted, and what information should be contained in the survey report. The Department may recommend that lead agencies not accept the results of surveys that are not conducted according to these guidelines.

1. Botanical surveys that are conducted to determine the environmental effects of a proposed development should be directed to all rare, threatened, and endangered plants and plant communities. Rare, threatened, and endangered plants are not necessarily limited to those species which have been "listed" by state and federal agencies but should include any species that, based on all available data, can be shown to be rare, threatened, and/or endangered under the following definitions:

   A species, subspecies, or variety of plant is "endangered" when the prospects of its survival and reproduction are in immediate jeopardy from one or more causes, including loss of habitat, change in habitat, over-exploitation, predation, competition, or disease. A plant is "threatened" when it is likely to become endangered in the foreseeable future in the absence of protection measures. A plant is "rare" when, although not presently threatened with extinction, the species, subspecies, or variety is found in such small numbers throughout its range that it may be endangered if its environment worsens.

   Rare plant communities are those communities that are of highly limited distribution. These communities may or may not contain rare, threatened, or endangered species. The most current version of the California Natural Diversity Database's List of California Terrestrial Natural Communities may be used as a guide to the names and status of communities.

2. It is appropriate to conduct a botanical field survey to determine if, or the extent that, rare, threatened, or endangered plants will be affected by a proposed project when:

   a. Based on an initial biological assessment, natural vegetation occurs on the site and it is unknown if rare, threatened, or endangered plants or habitats occur on the site; or

   b. Rare plants have historically been identified on the project site, but adequate information for impact assessment is lacking.

3. Botanical consultants should possess the following qualifications:

   a. Experience conducting floristic field surveys;

   b. Knowledge of plant taxonomy and plant ecology;

   c. Familiarity with the plants of the area, including rare, threatened, and endangered species; and

   d. Familiarity with the appropriate state and federal statutes related to plants and plant collecting.

4. Field surveys should be conducted in a manner that will locate any rare, threatened, or endangered species that may be present. Specifically, rare, threatened, or endangered plant surveys should be:

    a. Conducted in the field at the proper time of year when rare, threatened, or endangered species are both evident and identifiable. Usually, this is when the plants are flowering.

    Additionally, field surveys should be conducted with sufficient number of visits spaced throughout the growing season to accomplish a floristic survey of the site (see 4.b.).

    When rare, threatened, or endangered plants are known to occur in the type(s) of habitat present in the project area, nearby accessible occurrences of the plants (reference sites) should be observed to determine that the species are identifiable at the time of the survey.

    b. Floristic in nature. A complete species list should be included in every botanical survey report.

    c. Conducted in a manner that is consistent with conservation ethics. Collections of rare, threatened, or endangered species, or suspected rare, threatened, or endangered species (voucher specimens) should be made only when such actions would not jeopardize the continued existence of the population and in accordance with applicable state and federal permit requirements. A collecting permit from the Plant Conservation Program of DFG is required for collection of state-listed plant species. Voucher specimens should be deposited at recognized public herbaria for future reference. Photography should be used to document plant identification and habitat whenever possible, but especially when the population cannot withstand collection of voucher specimens.

    d. Conducted using systematic field techniques in all habitats of the site to ensure a thorough coverage of potential impact areas.

    e. Well documented. When a rare, threatened, or endangered plant (or rare plant community) is located, a California Native Species (or Community) Field Survey Form or equivalent written form, accompanied by a copy of the appropriate portion of a 72 minute topographic map with the occurrence mapped, should be completed and submitted to the Natural Diversity Data Base.

5. Reports of botanical field surveys should be included in or with environmental assessments, negative declarations and mitigated negative declarations, EIR's, and EIS's, and should contain the following information:

    a. Project description, including a detailed map of the project location and study area.

    b. A written description of biological setting referencing the community nomenclature used and a vegetation map.

    c. Detailed description of survey methodology.

    d. Dates of field surveys and total person-hours spent on field surveys.

    e. Results of field survey (including detailed maps).

    f. An assessment of potential impacts.

    g. Discussion of the importance of rare, threatened, or endangered plant populations with consideration of nearby populations and total species distribution.

h. Recommended measures to avoid impacts.

i. List of all species occurring on the project site.

j. Description of reference site(s) visited and phenological development of rare or endangered plant(s).

k. Copies of all California Native Species Field Survey Forms or Natural Community Field Survey Forms.

l. Name of field investigator(s).

m. References cited, persons contacted, herbaria visited, and disposition of voucher specimens.

APPENDIX C

CONSERVATION EASEMENTS

Open Space or Conservation Easements have been used in a number of jurisdictions throughout California. In open space or conservation easements the landowner transfers the rights to develop a parcel to a conservation organization or public agency. The legal basis for this action is found in Government Code Section 51050 et seq., particularly Section 51083.5 which describes the granting of easements to nonprofit organizations. Easements granted to an impartial third party, interested organization, or resource agency are the only secure types. Those granted to a local public jurisdiction can be eliminated or modified with a majority vote.

Determining the appropriate size of an easement is difficult. It must be large enough to support, in perpetuity, a biologically secure, reproducing population with an adequate buffer zone. The proposed land use surrounding the easement and current and future land uses of the conservation or open space easement area must also be taken into consideration. A land use or management plan that accounts for the type of rare plant habitat and the biology of the resident species needs to be developed for easement areas. The design of the protection area boundaries and management plan must be scientifically based, utilizing baseline studies and species biology information.

Conservation and open space easement contracts should include a legal description of the easement parcel, the purpose of the easement and describe the specific resources or conditions being protected by the easement. The contract should also include the rights of the grantee, the grantors rights and uses, restrictions of undesirable activities, and a general restriction of all uses inconsistent with the purposes of the easement. Language should be included that states that the conditions of the easement contract are binding not only on the grantor, but also on his heirs, assigns, and all other successors and interests so that the term of the easement runs with the land in perpetuity.

Conservation easement contracts should also include: (1) specific restrictions to protect the site from land use change, introduction of nonnative plant species and public access; and (2) the right of the grantee to enforce compliance with the terms of the easement and to require restoration of the habitat at the grantor's expense should damage to the habitat result from violation of the agreement by the grantor.

Maintenance and monitoring agreements and guideline documents for the conservation easement should be incorporated into the easement contract.

California Native Plant Society
1722 J Street, Suite 17
Sacramento, CA 95814
(916) 447-2677

APPENDIX D

BRIEF GUIDELINES FOR RESTORATION PROJECTS

General guidelines for restoration projects are as follows:

1. Prior to the development of a restoration program, the goals of the completed project must be established and a course of action developed to achieve that goal.

2. Pre-impact site conditions should be determined. Clues to this may be found in remnants of the existing habitat, in herbarium research, and from botanists who have collected in the area in the past. Local historical files or societies may be a source of information if the site is near an urban area.

3. Other site factors which may require study are land contours, soil types, erosion control, topsoil protection, and pre-impact hydrologic patterns.

4. An ecological study of the species being considered for reintroduction is necessary, including their total distribution, other habitat sites, associated species and pollinators.

5. Revegetation methodology research may include propagation techniques, material sources, propagule collection and preparation, planting densities, seedling protection, weed and invasive exotics control, site protection, public access and many other factors. The present knowledge of propagation requirements for rare plants is so limited that all efforts to propagate and reintroduce them in the wild should be carried out under the direct supervision of a specialist well versed in the cultural requirements of the genus.

6. A maintenance and monitoring program should also be included in the development of restoration/revegetation plans, and should utilize consistently documented data to further augment the existing knowledge of the species and to develop criteria for other revegetation projects.

California Native Plant Society
1722 J Street, Suite 17
Sacramento, CA 95814
(916) 447-2677

APPENDIX E

DEFINITIONS

The following definitions are used in this document:

Maintenance: the process of ensuring that rare plants and their habitats remain viable and in good condition.

Mitigation: actions taken to avoid or reduce significant adverse impacts. Impacts are less than significant if no net loss of population size or habitat quality results.

Mitigation banking: A large preserve or open space which individual developers buy into at a predetermined compensation ratio to satisfy their mitigation debt. Mitigation banking focuses mitigation efforts into significant amounts of habitat rather than permitting establishment of many smaller and less significant or less defensible preserves or open space areas.

Monitoring: periodic assessment of the status of a plant population or habitat to determine its condition and reveal trends in vigor and viability; should be conducted in a scientific and standardized fashion.

Off-site Compensation: preservation in perpetuity of alternate sites containing similar habitat types and species to offset or "compensate" for unavoidable losses. The ratio of acquisition to loss should be greater than one to one for any species. In lieu of this, an equitable sum of money may be paid for the purchase of an alternate site.

Preservation: the maintenance and protection of rare plants and habitats at levels that existed prior to the commencement of a project.

Rare Species: for the purpose of this policy, and to avoid undue repetition, the word "rare" is used to include "rare", "threatened", and "endangered" plant species as defined in Section 3(4)(15) of The Federal Endangered Species Act of 1973, and The California Environmental Quality Act Guidelines, Section 15380 (1986). The latter section is reproduced below:

> (b) A species of plant is:
>
> (1) "Endangered" when its survival and reproduction in the wild are in immediate jeopardy from one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, disease, or other factors; or
>
> (2) "Rare" when either:
>
> (A) Although not presently threatened with extinction, the species is existing in such small numbers throughout all or a significant portion of its range that it may become endangered if its environment worsens; or
>
> (B) The species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range and may be considered "threatened" as that term is used in the Federal Endangered Species Act.
>
> (c) A species of plant shall be presumed to be rare or endangered if it is listed in:
>
> (1) Sections 670.2 or 670.5, Title 14, California Administrative Code; or

(2) Title 50, Code of Federal Regulations, Section 17.11 or 17.12 pursuant to the Federal Endangered Species Act as threatened or endangered; or

(d) A species not included in any listing identified in subsection (c) shall nevertheless be considered to be rare or endangered if the species can be shown to meet the criteria in subsection (b).

Division 2, Chapter 1.5 of the California Fish and Game Code (California Endangered Species Act Section 2067) defines a "threatened" species as a native species or subspecies of a plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required in this chapter.

Transfer of Development Rights (TDR): Under this process, an applicant may gain density bonuses in designated development areas if rare plant populations and habitat are left in permanent open space. This alternative also requires an organized plan by a local agency identifying those areas to be left undisturbed and those that may be used by the applicant for density increases in return for protecting the areas to be left undisturbed. Protection in perpetuity is a necessary requirement of TDR proposals that are implemented to protect rare plant populations. TDR is being used increasingly as a mitigation tool for on-site rare plant protection.

Unavoidable significant impacts: impacts resulting from a "statement of overriding considerations" where the public benefits of a project have been determined to outweigh the significance of the environmental impact, or where an emergency situation or natural disaster may destroy, or has destroyed rare plant habitat and species.

California Native Plant Society
1722 J Street, Suite 17
Sacramento, CA 95814
(916) 447-2677

APPENDIX F

CNPS RARE PLANT LISTS (Skinner and Pavlik, 1994)

The California Native Plant Society currently tracks 1742 plant species, subspecies, and varieties as rare in California. They are assigned to one of five "lists" in an effort to categorize their degree of rarity.

List 1A: Plants Presumed Extinct in California

The 37 plants of List 1A are presumed extinct because they have not been seen or collected in the wild in California for many years. Although most of them are restricted to California, a few are found in other states as well. In many cases, repeated attempts have been made to rediscover these plants by visiting known historical locations. Even after such diligent searching, CNPS is constrained against saying that they are extinct, since for most of them rediscovery remains a distinct possibility. Note that care should be taken to distinguish between "extinct" and "extirpated." A plant is extirpated if it has been locally eliminated, but it may exist in abundance elsewhere in its range.

All of the plants constituting List 1A meet the definitions of Sec. 1901, Chapter 10 (Native Plant Protection Act [NPPA]) or Secs. 2062 and 2067 (California Endangered Species Act [CESA]) of the California Department of Fish and Game Code, and are eligible for state. Should these taxa be rediscovered, it is mandatory that they be fully considered during preparation of environmental documents relating to the California Environmental Quality Act (CEQA).

List 1B: Plants Rare, Threatened or Endangered in California and Elsewhere

The 857 plants of List 1B are rare throughout their range. All but a few are endemic to California. All of them are judged to be vulnerable under present circumstances or to have a high potential for becoming so because of their limited or vulnerable habitat, their low numbers of individuals per population (even though they may be wide ranging), or their limited number of populations. Most of the plants of List 1B have declined significantly since the arrival of non-indigenous humanity in California.

All of the plants constituting List 1B meet the definitions of Sec. 1901, Chapter 10 (NPPA) or Secs. 2062 and 2067 (CESA) of the California Department of Fish and Game Code, and are eligible for state listing. It is mandatory that they be fully considered during preparation of environmental documents relating to CEQA.

List 2: Plants Rare, Threatened, or Endangered in California, But More Common Elsewhere

Except for being common beyond the boundaries of California, the 272 plants of List 2 would have appeared on List 1B. From the federal perspective, plants common in other states or countries are not eligible for consideration under the provisions of the Endangered Species Act. Until 1979, a similar policy was followed in California. However, after the passage of the NPPA, plants were considered for protection without regard to their distribution outside the state.

All of the plants constituting List 2 meet the definitions of Sec. 1901, Chapter 10 (NPPA) or Secs. 2062 and 2067 (CESA) of the California Department of Fish and Game Code, and are eligible for state listing. It is mandatory that they be fully considered during preparation of environmental documents relating to CEQA.

List 3: Plants About Which We Need More Information -- A Review List

The 47 plants that comprise List 3 are united by one common theme -- CNPS lacks the necessary information to assign them to one of the other lists or to reject them. Nearly all of the plants remaining on

List 3 are taxonomically problematic. Data regarding distribution, endangerment, ecology, and taxonomic validity will be gratefully received by CNPS.

Some of the plants constituting List 3 meet the definitions of Sec. 1901, Chapter 10 (NPPA) or Secs. 2062 and 2067 (CESA) of the California Department of Fish and Game Code, and are eligible for state listing. CNPS recommends that List 3 plants be evaluated for consideration during preparation of environmental documents relating to CEQA.

List 4: Plants of Limited Distribution -- A Watch List

The 532 plants in this category are of limited distribution or infrequent throughout a broader area in California, and their vulnerability or susceptibility to threat appears low at this time. While CNPS cannot call these plants "rare" from a statewide perspective, they are uncommon enough that their status should be monitored regularly. Should the degree of endangerment or rarity of a List 4 plant change, we will transfer it to a more appropriate list.

Very few of the plants constituting List 4 meet the definitions of Sec. 1901, Chapter 10 NPPA) or Secs. 2062 and 2067 (CESA) of the California Department of Fish and Game Code, and few, if any, are eligible for state listing. Nevertheless, many of them are significant locally, and CNPS recommends that List 4 plants be evaluated for consideration during preparation of environmental documents relating to CEQA. This may be particularly appropriate for the type locality of a List 4 plant, for populations at the periphery of a species' range or in areas where the taxon is especially uncommon or has sustained heavy losses, or for populations exhibiting unusual morphology or occurring on unusual substrates.

California Native Plant Society
1722 J Street, Suite 17
Sacramento, CA 95814
(916) 447-2677

STATEMENT OPPOSING TRANSPLANTATION AS MITIGATION FOR IMPACTS TO RARE PLANTS

July 9, 1998

The California State Legislature enacted the Native Plant Protection Act (NPPA) in 1977. The NPPA identifies wide-ranging and broad categories of activities on private lands that could result in the take (killing) of state-listed plants. These activities include: (1) agricultural operations or management practices including clearing of land, (2) land clearing for fire control, (3) timber operations in accordance with a legal timber harvesting plan, (4) mining assessment work, (5) performance by a public agency or public utility of its obligation to provide service to the public, (6) removal of listed plants from (a) a canal, (b) lateral ditch, (c) building site, (d) road, or (e) other right of way by the owner of the land. Few land use or management activities fall outside of these categories. Under one interpretation of Section 1913 of the NPPA, landowners who wish to engage in any of the aforementioned activities, and who have been informed by the California Department of Fish and Game (Department) of the presence of state-listed plants on their property, need only provide 10 day notice and give the Department the opportunity to salvage the plants before proceeding. This would be the sole mitigation required for destruction of listed plants or their habitat in these cases.

Recent regulatory proposals by the Department, statements by the California Attorney General, and activities in the courts and the state legislature, signal that NPPA's provisions on transplantation may soon become the major, possibly the only, form of "protection" from unlimited take for all state-listed plant taxa. For these reasons, it has become necessary to review the reasons why reliance on transplantation to conserve state-listed plant species is not only unlikely to succeed, but is likely to contribute to further declines of these taxa, possibly to widespread extinctions.Transplantation is rarely successful in establishing rare plants at new locations. A study by the Department itself (Fiedler, 1991) found that, even under optimum conditions with ample time for planning, transplantation was effective in only 15% of cases studied. Other reviews (e.g. Allen, 1994; Howald, 1996) have found similar problems. There are many reasons for this poor success rate:

1. we often know very little about the biology of rare plants. We may not be aware of all the intricate habitat requirements of each listed species. Rare plants are often specialists that exploit a particular and unusual combination of habitat attributes. They may require a particular soil type, set of pollinators, mycorhizal fungi or other associate species, aspect, hydrological regime, microclimate or some combination of these or other factors for survival.

2. suitable transplantation or propagation sites may not be available, particularly with only 10 days notice.

3. digging up, transporting, and replanting plants, bulbs, rhizomes or seeds imposes a tremendous stress on a plant. They can easily die in the process.

4. scientifically-tested, reliable methods for salvage, propagation, translocation or transplantation are not available for many rare species.

5. areas where the impacted taxon is already present are often at the carrying capacity of the habitat, and the introduction of transplanted individuals into the existing population will disrupt the equilibrium of that population and will not increase the viability of the taxon.

6. the 10 day notice provision means that landowners can require the Department to salvage plants at any time of the year, including times that are inappropriate for physical disruption of the plant. Annual species may not even be visible at some times of the year.

Transplantation can also cause problems at the target site. Genetic contamination can occur if the plant being transplanted can exchange genetic material with local taxa. Disturbance at the target site may facilitate invasion by non-native invasive species.

For all of these reasons, the California Native Plant Society (CNPS) does not recognize off–site compensation as appropriate mitigation for project impacts and opposes the use of salvage and transplantation as mitigation for impacts to rare and listed plants (California Native Plant Society Rare Plant Scientific Advisory Committee, 1991).The undersigned individuals, botanical societies and organizations oppose the use of transplantation as the primary means of conservation of rare plant species.

Signed,

Lori Hubbart
President
California Native Plant Society

Barbara Ertter, Ph.D.
Chair, CNPS Rare Plant Scientific Advisory Committee
Curator of Western North American Flora*
University and Jepson Herbaria
University of California, Berkeley

Ann Dennis, Ph.D.
CNPS Vice President for Rare Plants
Plant Ecologist*
USGS Biological Resources Division

Carol C. Baskin, Ph.D.
President
Botanical Society of America

*Titles and affiliations are for identification purposes only. This letter does not necessarily represent the positions of the referenced institutions.

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Addendum

to CNPS comments on proposed regulations implementing Chapter 6, Article 2 of the California Endangered Species Act (CESA) pertaining to take of listed species incidental to routine and ongoing agricultural activities.

Regarding the definition of routine and ongoing agricultural activities, please note that a recent ruling by the U.S. Ninth Circuit Court of Appeals addressed "normal agricultural activity" in the context of federal regulation of wetland destruction on agricultural lands in California. The Court found that "normal agricultural activity" explicitly did not include (1) activities that bring an area into farming or (2) where modifications to the hydrological regime are necessary. (Borden Ranch Associates and Angelo K. Tsakopoulos v. U.S. Army Corps of Engineers and U.S. Environmental Protection Agency, summary Judgement finding for the U.S., Filed June 9, 1998). Although this occurred in a completely different jurisdiction and context than these regulations, the definition of "routine and ongoing" agricultural activities in the Proposal and the ED is clearly inconsistent with this court's interpretation of "normal agricultural activity".

California Native Plant Society
1722 J Street, Suite 17
Sacramento, CA 95814
(916) 447-2677

California Native Plant Society

POLICY ON TRANSPLANTING
Adopted December 1989

Native plants, plant communities and their habitats on public and private lands are subject to increasing development and use pressures. Little scientific information is available on the long-term success of transplanting to mitigate impacts on the plants. The preponderance of evidence to date demonstrates that transplanting naturally occurring wild plants does not represent a successful method of long-term conservation.

Therefore --The California Native Plant Society requests all responsible agencies and persons involved with the maintenance of biological diversity and rare plant protection to:

1. Develop and implement alternate strategies of plant and plant community protection that are realistic, well documented through long term monitoring, and aimed at the continued success of establishing and enhancing viable populations of rare plants, plant communities, and their habitats, and

2. Use transplanting of such plants **only** as a mitigation method of last recourse.

California Native Plant Society
1722 J Street, Suite 17
Sacramento, CA 95814
(916) 447-2677

Global Change Biology (2008) **14**, 1475–1487, doi: 10.1111/j.1365-2486.2008.01595.x

Large annual net ecosystem CO_2 uptake of a Mojave Desert ecosystem

GEORG WOHLFAHRT*, LYNN F. FENSTERMAKER† and JOHN A. ARNONE III‡

*Institut für Ökologie, Universität Innsbruck, Sternwartestr. 15, 6020 Innsbruck, Austria, †Division of Earth and Ecosystem Science, Desert Research Institute, 755 E. Flamingo Road, Las Vegas, NV 89119, USA, ‡Division of Earth and Ecosystem Science, Desert Research Institute, 2215 Raggio Parkway, Reno, NV 89512, USA

Abstract

The net ecosystem CO_2 exchange (NEE) between a Mojave Desert ecosystem and the atmosphere was measured over the course of 2 years at the Mojave Global Change Facility (MGCF, Nevada, USA) using the eddy covariance method. The investigated desert ecosystem was a sink for CO_2, taking up 102 ± 67 and $110 \pm 70\,g\,C\,m^{-2}$ during 2005 and 2006, respectively. A comprehensive uncertainty analysis showed that most of the uncertainty of the inferred sink strength was due to the need to account for the effects of air density fluctuations on CO_2 densities measured with an open-path infrared gas analyser. In order to keep this uncertainty within acceptable bounds, highest standards with regard to maintenance of instrumentation and flux measurement postprocessing have to be met. Most of the variability in half-hourly NEE was explained by the amount of incident photosynthetically active radiation (PAR). On a seasonal scale, PAR and soil water content were the most important determinants of NEE. Precipitation events resulted in an initial pulse of CO_2 to the atmosphere, temporarily reducing NEE or even causing it to switch sign. During summer, when soil moisture was low, a lag of 3–4 days was observed before the correlation between NEE and precipitation switched from positive to negative, as opposed to conditions of high soil water availability in spring, when this transition occurred within the same day the rain took place. Our results indicate that desert ecosystem CO_2 exchange may be playing a much larger role in global carbon cycling and in modulating atmospheric CO_2 levels than previously assumed – especially since arid and semiarid biomes make up >30% of Earth's land surface.

Keywords: eddy covariance, heterotrophic respiration, Mojave Global Change Facility (MGCF), photosynthesis, rain pulse, uncertainty analysis

Received 10 November 2006; revised version received 19 October 2007 and accepted 20 December 2007

Introduction

The extent to which deserts of the world currently modulate global atmospheric CO_2 levels is poorly understood. This is because of the worldwide paucity of empirical measurements of net ecosystem CO_2 exchange (NEE) in desert and semiarid biomes (Falge *et al*., 2002a, b; Law *et al*., 2002). This, in turn, is perhaps due to the perception that sparse vegetation cover and seemingly bare soil surfaces translate into a low net annual positive ecosystem CO_2 balance (net ecosystem productivity, NEP) or even to a neutral or negative balance. Certainly biomass carbon stocks of arid shrublands pale in comparison with forests hectare for hectare (Grace, 2004) and their net primary production (NPP) is considered among the lowest of any ecosystem type (Larcher, 2001). However, existing NEE and NEP data from sparsely covered (5–20% plant cover) arid shrublands – measured using repeated sampling with large static chambers over 2 full years (Jasoni *et al*., 2005; J. Arnone, personal communication), or using eddy covariance (Hastings *et al*., 2005; Scott *et al*., 2006; Luo *et al*., 2007) – indicate that deserts may rival or even exceed net CO_2 uptake by forests and grasslands, at least in some years (Baldocchi *et al*., 2001; Falge *et al*., 2002b). Thus, these high NEPs and the large global extent of the arid and semiarid biome (>30% of Earth's land surface; Lal, 2004) strongly suggest that deserts are playing a much larger role than previously expected in

Correspondence: Georg Wohlfahrt, tel. +43 512 5075977, fax +43 512 5072715, e-mail: Georg.Wohlfahrt@uibk.ac.at

modulating atmospheric CO_2 levels. Expansion of arid shrubland vegetation cover, similar to that observed in the Mojave Desert of the southwestern United States over the past three decades (Webb *et al*., 2003), or potential increases in the activity or land-area-based mass of cryptobiotic crust communities that cover large areas of desert soil (Evans & Johansen, 1999; Belnap *et al*., 2004) may be contributing to the large positive NEPs that have been measured.

Measurement of NEE in deserts can be challenging. The eddy covariance technique (Baldocchi, 2003), while providing potentially continuous data integrated over a representative spatial area, must, when an open-path infrared gas analyser (IRGA) is used to measure CO_2 concentrations, take into account significant corrections. The need for these corrections arises from fluctuations in air density brought about by large daylight sensible heat fluxes, which may even cause the CO_2 flux to change sign (Webb *et al*., 1980). In addition, it was recently discovered (Burba *et al*., 2006) that self-heating of open-path IRGAs results in an additional sensible heat flux, which up to date has been rarely taken into account (Grelle & Burba, 2007). Static chamber measurements, while providing direct and very sensitive estimates of ecosystem fluxes even with large chambers (Arnone & Obrist, 2003) are challenged by undesirably low spatial replication and discrete temporal sampling even when attempting to capture both diel and seasonal variation in NEE (cf. Jasoni *et al*., 2005). Gaps in NEE time series data, resulting from instrument failure and removal of inferior quality data through quality control of eddy covariance data, as well as discrete temporal sampling of NEE using chambers, necessitate imputation of missing values in order to derive daily and longer-term annual NEE estimates. Accurate gap-filling becomes all the more challenging because of uncertain responses of NEE to periodic rains of various amounts, intensities and frequencies that may define temporal variation in NEE (Huxman *et al*., 2004a, b; Ivans *et al*., 2006; Potts *et al*., 2006a, b) that ultimately determine annual NEP.

The objectives of our study were (1) to quantify the uncertainty of eddy covariance measurements of NEE over the course of 2 years in a typical Mojave Desert sparse shrubland ecosystem, (2) to integrate NEE over the study period to quantify current ecosystem CO_2 sink or source strength and (3) to elucidate the role that environmental factors, especially rainfall, plays in defining NEE.

Materials and methods

Site description

The Mojave Global Change Facility (MGCF) is located on a broad, gently sloping bajada in northern Mojave Desert on the Nevada Test Site, 120 km northwest of Las Vegas, NV, USA (36°49′N, 115°55′W). Vegetation, average cover is 18%, is dominated by the evergreen shrub *Larrea tridentata* (DC.) Cov., with subdominant drought–deciduous shrub species [*Lycium andersonii* (A. Gray) and *Ambrosia dumosa* (A. Gray)], perennial grasses [*Achnatherum hymenoides* (Roemer & Schultes) Barkwood and *Pleuraphis rigidia* Thurber] and several annual and perennial forbs (Jasoni *et al*., 2005). Soils have been classified as loamy sands (Meadows *et al*., 2006) and have a biological crust composed of cyanobacteria, lichens and moss. Wind at the MGCF originates for 80% of the time between 90 and 270°, which provides undisturbed, fairly homogenous fetch conditions for several kilometres. Average maximum upwind distances for the measured flux to represent 90% of the surface flux (based on calculations with the footprint model of Hsieh *et al*., 2000) range from 150 to 2300 m.

Previous research at the study site and the neighbouring Nevada Desert FACE Facility (NDFF) have examined plant gas exchange and soil respiration that are pertinent to the data reported here. These data show that the Mojave Desert has the capacity for multiple periods of biological uptake of carbon that is primarily determined by water availability and temperature. The evergreen species *L. tridentata* is photosynthetically active when air temperatures are above −5 °C and soil water is not limiting (Naumburg *et al*., 2004). Peak photosynthesis typically occurs in the spring and fall when soil water is available and plants are not under the more extreme vapour pressure deficits of summer (Hamerlynck *et al*., 2000a, b; Naumburg *et al*., 2003; Barker *et al*., 2006). Net photosynthetic rates for these studies ranged up to 20 $\mu mol\,m^{-2}\,s^{-1}$. Huxman & Smith (2001) show peak net assimilation occurred in mid March for an annual grass and an herbaceous perennial, but germination of some annual species has been observed to occur as early as January following a significant precipitation event(s). Soil respiration is generally lower in canopy interspaces and during dry periods; after rains and below the evergreen *L. tridentata* and deciduous *A. dumosa* shrub canopies peak respiration rates of 1.5 $\mu mol\,m^{-2}\,s^{-1}$ are observed (de Soyza *et al*., 2005).

Eddy covariance

Fluxes of CO_2, H_2O, energy and momentum were measured by means of the eddy covariance method (Aubinet *et al*., 2000; Baldocchi, 2003) starting in March 2005. Here, we report the first full 2 years of measurements up to February 2007 – for simplicity, we will refer to the first and second year of measurements as 2005 and 2006, respectively.

The three wind components and the speed of sound were measured using a three-dimensional sonic anemometer (CSAT3, Campbell, Logan, UT, USA), CO_2 (and H_2O) mole densities using an open-path IRGA (Li-7500, LI-COR, Lincoln, NE, USA), both instruments being mounted at 1.5 m above zero-plane displacement height or 2 m above ground. The head of the sonic anemometer pointed towards south, the predominating wind direction. The open-path IRGA was mounted 0.3 m to the east and 0.1 m below the sonic anemometer. Raw data of the three wind components, the speed of sound, and CO_2 and H_2O mole densities were acquired at 10 Hz by a data logger (CR5000, Campbell). Using the postprocessing software EDIRE (University of Edinburgh), eddy fluxes were calculated as the covariance between turbulent fluctuations of the vertical wind speed and the scalar densities derived from Reynolds (block) averaging of 30 min blocks of data. The sonic anemometer's coordinate system was rotated during each averaging period by applying a double rotation, aligning the longitudinal wind component into the main wind direction and forcing the mean vertical wind speed to zero (Wilczak *et al*., 2001). Frequency response corrections were applied to raw eddy fluxes accounting for low-pass (lateral and longitudinal sensor separation, sensor time response, scalar and vector path averaging) and high-pass (block averaging) filtering following Massman (2000, 2001) using a site-specific cospectral reference model (Massman & Clement, 2004; Wohlfahrt *et al*., 2005). Experimentally derived frequency response correction factors, according to Aubinet *et al*. (2000, 2001), were used to assess the validity of the theoretical low-pass filtering correction method, as detailed in Wohlfahrt *et al*. (2005). Finally, CO_2 fluxes were corrected for the effect of air density fluctuations following Webb *et al*. (1980). Net ecosystem exchange of CO_2 was then calculated as the sum of the corrected vertical eddy covariance term and the storage flux, the latter being estimated from the time-rate-of-change in CO_2 concentration at the reference height (Wohlfahrt *et al*., 2005). Negative flux densities represent transport towards the surface, positive values the reverse.

In May/June 2007 a closed-path IRGA (Li-6262, LI-COR) was operated at the study site during a 2-week campaign for measurement of CO_2 and H_2O fluxes using a closed-path approach. The inlet of a 2.7 m Teflon tube (0.004 m inner diameter) was mounted 0.06 m North of the sonic anemometer volume. Air was sucked through the tube and the analysis cell of the IRGA by a pump (Model MOA, GAST Mfg Corp., Benton Harbor, MI, USA) at a flow rate of 10 L min^{-1}, while the reference cell was flushed with 99.999 UHP N_2 from a gas cylinder which passed through a column of Drierite and Soda Lime at a flow rate of around 0.1 L min^{-1}. Linearized voltage signals of the CO_2 and H_2O mole fractions were sampled by data logger at 10 Hz as above. Data processing was identical to that employed for the open-path system except that (i) the tube induced time delay of the CO_2 (1.0 s) and H_2O (1.1 s) signals was determined by optimizing the correlation coefficient with the vertical wind velocity within a given time window, (ii) frequency response corrections accounted for the attenuation of concentration fluctuations down the sampling tube, and (iii) corrections for air density fluctuations following Webb *et al*. (1980) accounted only for water vapour induced effects, because temperature fluctuations were assumed to be completely dampened out upon arrival of air in the infrared cell (Aubinet *et al*., 2000).

Quality control of the half-hourly flux data was exercised in a three-step procedure: First, periods were identified when the eddy covariance system would not work properly due to adverse environmental conditions (usually rain) or instrument malfunction. These data were excluded from any further analysis if $<90\%$ of the 18 000 possible data sets during each averaging period were available. In a second step, data were subject to the integral turbulence test (Foken & Wichura, 1996) and accepted only on the condition that they did not exceed the target value by $>60\%$ (Foken *et al*., 2004). This occurred mostly for flow from the northern sector, where the instrument tower is located. In a third step, night-time CO_2 flux data were analysed for potential biases in ecosystem respiration during periods of low and high turbulence (Gu *et al*., 2005). As shown in Fig. 1, night-time ecosystem respiration was independent of friction velocity (u^*), a measure of turbulent mixing, between 0.1 and 0.5 m s^{-1}. Below and above these thresholds, flux measurements increased with u^*, which is currently understood to indicate advection and pressure pumping, respectively (Massman & Lee, 2002). As these processes, in particular the frequent flux underestimation during periods of low turbulence, would lead to a bias in night-time ecosystem respiration and, thus the daily and longer-term CO_2 balances (Goulden *et al*., 1996), data were excluded when u^* was outside these thresholds (17% of data).

Energy balance closure, quantified by regressing half-hourly available energy (net radiation minus soil heat flux) against the sum of latent and sensible energy fluxes, amounted to 82% ($r^2 = 0.72$; regression forced through origin), which is well within the range of values reported for most sites (cf. Wilson *et al*., 2002). Finally, quality-controlled mean daily NEE data were compared with NEE values measured using a large static chamber dome (Arnone & Obrist, 2003; Jasoni *et al*., 2005) at an adjacent site with the same plant community and ecosystem characteristics.

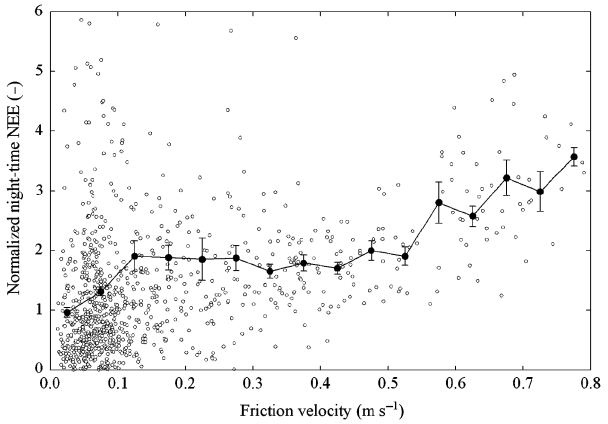

Fig. 1 Night-time ecosystem respiration normalised with a parametric model that relates soil temperature to ecosystem respiration, as a function of friction velocity. Open symbols represent half-hourly data from March–May 2005, closed symbols respective bin-averages of 0.05 m s^{-1} width. Error bars refer to ±1 standard error.

Ancillary data

Supporting environmental measurements of relevance for the present study included photosynthetically active radiation flux density (Li-190SA, LI-COR), air temperature and humidity (HMP45C, Campbell) at 2 m above ground, precipitation (TE525MM, Texas Electronics, Dallas, TX, USA), and two replicates of soil temperature (TCAV, Campbell) and water content (CS616, Campbell) at 0.04 m soil depth. These data were recorded by the data logger at 10 Hz and saved as half-hourly averages.

Gap-filling and uncertainty analysis

In order to derive continuous time series of NEE, required for calculating the annual CO_2 balance, the following procedure was employed to fill the gaps in the data resulting from instrument malfunction or quality control: Gaps <1 h were filled by linear interpolation. Larger gaps were filled by the mean diurnal variation method with a time window of one month (Falge *et al*., 2001). According to recent work by Moffat *et al*. (2007), who compared 15 different gap-filling methods, the mean diurnal variation method shows a moderate but consistent performance and, thus we did not attempt alternative gap-filling techniques. Altogether, 35% of the possible half-hourly NEE observations (49% and 21% in 2005 and 2006, respectively) were modelled this way during the 2-year study period. Gaps were distributed roughly equally between day and night; only 2% of the gaps occurred during rains.

An uncertainty analysis, accounting for both random and systematic errors (Moncrieff *et al*., 1996), was conducted in order to obtain confidence intervals for the annual CO_2 balance: The random uncertainty of the half-hourly CO_2 flux measurements was determined based on measurements under similar environmental conditions during adjacent days as devised by Hollinger & Richardson (2005) and Richardson & Hollinger (2005).

The systematic uncertainty of NEE was estimated by assessing the quality of the half-hourly flux measurements themselves, and issues related to postprocessing of data required for deriving annual CO_2 balances. When measuring CO_2 fluxes with open-path sensors under conditions of large sensible heat exchange, the largest source of uncertainty is due to the effect of concurrent air temperature and humidity fluctuations on CO_2 densities (ρ_c), which necessitate corrections after Webb *et al*. (1980):

$$F_c = \overline{w'\rho_c'} + \mu\frac{\rho_c}{\rho_a}\overline{w'\rho_v'} + \rho_c(1+\mu\delta)\frac{\overline{w'T'}}{T_a}, \qquad (1)$$

where μ and δ refer to the ratios of the molecular weights of air to water vapour and the densities of water vapour (ρ_v) to dry air (ρ_a), respectively; T_a to air temperature (°K); $\overline{w'\rho_c'}$, $\overline{w'T'}$ and $\overline{w'\rho_v'}$ to the CO_2, sensible and latent heat flux; F_c to the corrected CO_2 flux. The uncertainty introduced by applying Eqn (1) was estimated by defining a likely relative uncertainty for each independent input parameter and by applying this in turn to calculate annual NEE. Assuming that the various component uncertainties are independent, the combined uncertainty due to Eqn (1) was calculated by taking the square root of the sum of the squared individual uncertainties (the same approach was used to derive the overall random and systematic uncertainty).

Based on the manufacturers' specifications and on past experience with long-term sensor stability, the water vapour density, air temperature and static air pressure (which is required to derive ρ_a) were assigned uncertainties of 10% (Table 1). The measured CO_2 density was adjusted daily against the ambient CO_2 concentration measured at the nearby NDFF, which itself was calibrated monthly to a NIST traceable standard (Nor LAB, Boise, ID, USA), and thus we assigned a 5% uncertainty to ρ_c. Uncertainty in the sensible heat flux may arise from the fact that the sensible heat flux was measured based on speed of sound measurements, which has been shown by Loescher *et al*. (2005) to deviate from sensible heat flux derived from measurements of air temperature with a fast-response platinum resistance thermometer by up to 10% for this specific sonic model. On the other hand, Ham & Heilman (2003), again for the same sonic model used in this study, found extremely good correspondence between

Table 1 Estimates of random and systematic uncertainty of annual net ecosystem CO_2 exchange (NEE) ($g C m^{-2} yr^{-1}$)

Uncertainty analysis	2005	2006
Random uncertainty	1	1
Systematic uncertainty		
u^* (reference vs. no u^*-threshold)	22	19
Long gaps (1–2 months, summer-winter)	5*	NA
Precipitation (reference vs. exclude all)	3	1
Density correction Webb *et al*. (1980)		
T_{air} (10%)	6	6
ρ_v (10%)	4	2
P (10%)	1	1
ρ_c (5%)	36	37
F_H (5%)	34	36
F_{CO_2} and F_{H_2O} (5%)	39	42
Combined density corrections	63	67
Random and systematic uncertainty	67	70

*Assumed to equal the value determined for 2006.
Data in parenthesis give details on the assumptions (e.g. percentage error) under which uncertainties were derived. For further details refer to the text.

sonic- and thermocouple-derived sensible heat flux measurements. Additional uncertainty of the sensible heat flux arises from the choice of coordinate system (Lee *et al*., 2004) and from the necessary (small) frequency response corrections (Massman, 2001). Based on the evidence presented above and some preliminary sensitivity tests with different coordinate systems (data not shown), we have assumed a 5% uncertainty for the sensible heat flux. Uncertainties of the uncorrected latent heat and CO_2 flux are likely to be similar in magnitude because these are measured by the same instruments and were thus dealt with jointly. We have also assumed a 5% uncertainty for the latent heat and CO_2 flux, intended to reflect uncertainties due to choice of the coordinate system and frequency response corrections. We based our frequency response corrections on a site-specific cospectral reference model (cf. Massman & Clement, 2004; Wohlfahrt *et al*., 2005) that have been validated against experimentally derived frequency response correction factors following Aubinet *et al*. (2000, 2001) as described in Wohlfahrt *et al*. (2005). We, thus, believe our choice of 5% uncertainty to be justified, even if Massman & Clement (2004) report potential errors in frequency response correction factors of up to 30%. The systematic uncertainty associated with the choice of the u^* threshold was estimated by calculating annual NEE with and without filtering for u^* similar to the procedure used by Morgenstern *et al*. (2004). Long data gaps, as occurred during summer/autumn 2005 and winter 2006, may cause considerable uncertainty in annual NEE (Richardson & Hollinger, 2007). In order to quantify the uncertainty related to these gaps, we randomly introduced 1- and 2-month-long gaps to the July–December 2006 record (when the longest consecutive gap was <1 day). Eddy covariance measurements during and immediately after precipitation are unreliable because the quality of the data from the sonic anemometer and, particularly, from the open-path IRGA are compromised by the presence of water drops in the acoustic and optical paths. Because large emissions of CO_2 have been observed in semiarid ecosystems following precipitation events (Xu & Baldocchi, 2003; Veenendaal *et al*., 2004; Hastings *et al*., 2005; Kurc & Small, 2007), we quantified the resulting uncertainty by creating artificial gaps during and 2 h following precipitation events.

Another approach for determining the reliability of the open-path eddy covariance NEE flux measurements is to use independent methods for comparison. To this end we used NEE obtained concurrently with a closed-path eddy covariance system during a 2-week campaign in May/June 2007 (cf. Ocheltree & Loescher, 2007) and large geodesic ecosystem chambers at several occasions throughout 2005 (Arnone & Obrist, 2003; Jasoni *et al*., 2005). Data from the open-path eddy covariance system have been processed both with and without accounting for the additional sensible heat flux induced by self-heating of the open-path IRGA (Burba *et al*., 2006).

Results

Uncertainty analysis

The probability density distribution of the random CO_2 flux uncertainty, shown in Fig. 2a, was distributed in a double-exponential fashion, following a Laplace rather than a normal distribution. A good linear correlation between the random uncertainty and the magnitude of the CO_2 flux was found (Fig. 2b), which was subsequently used to estimate the random uncertainty of each valid half-hourly NEE measurement. Integration up to the annual scale resulted in a random NEE uncertainty of $1 g C m^{-2}$ for each of the 2 study years (Table 1).

The systematic uncertainty of annual NEE due to the density correction terms in Eqn (1) was estimated as 63 and $67 g C m^{-2}$ for 2005 and 2006, respectively (Table 1). The largest contributors to this overall uncertainty were the uncertainties in the quantification of the CO_2 density, the sensible heat and latent heat/CO_2 fluxes ($34–42 g C m^{-2}$), while air temperature, water vapour density and static air pressure accounted for $<6 g C m^{-2}$ uncertainty (Table 1). The systematic

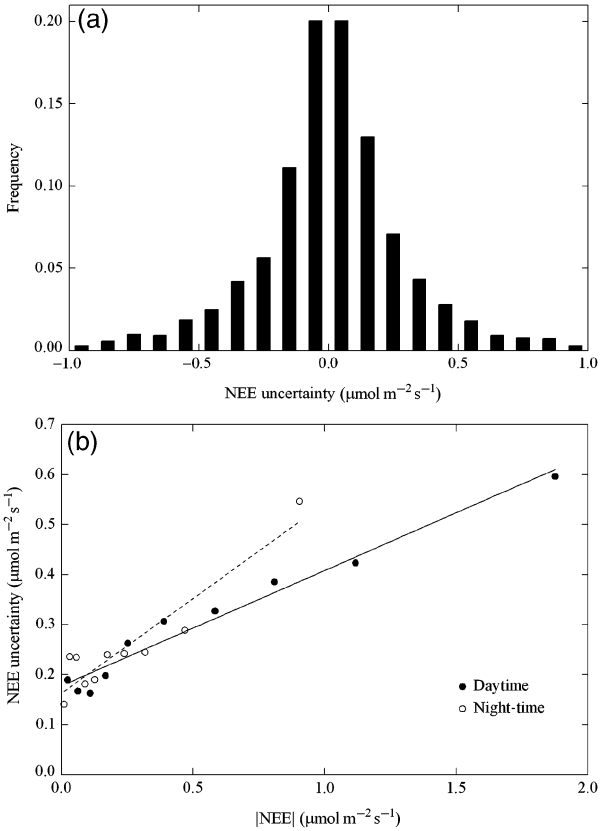

Fig. 2 Random uncertainty of the net ecosystem CO_2 exchange (NEE): Probability density distribution (a) and random uncertainty of NEE as a function of the absolute magnitude of NEE (b), separately for daytime (closed symbols) and night-time (open symbols) hours, calculated using the neighbouring days approach devised by Hollinger & Richardson (2005) and Richardson & Hollinger (2005). Lines in Fig. 2b represent linear best fits with the following equations: $y = -0.23x + 0.18$ (day, solid line, $r^2 = 0.98$) and $y = 0.38x + 0.16$ (night, dotted line, $r^2 = 0.88$).

uncertainty associated with the choice of the u^* threshold amounted to an uncertainty of 22 and 19 g C m^{-2} for 2005 and 2006, respectively; randomly introducing 1- and 2-month long gaps to the July–December 2006 record resulted in a maximum annual uncertainty of 5 g C m^{-2} (Table 1). Creating artificial gaps during and 2 h following rains yielded a total annual uncertainty of 3 and 1 g C m^{-2} for 2005 and 2006, respectively (Table 1). Assuming that these sources of systematic uncertainty are independent and combining these with the estimate of random uncertainty, we calculated an overall uncertainty of 67 and 70 g C m^{-2} for 2005 and 2006, respectively (Table 1).

NEEs obtained with the closed- and open-path IRGA systems – not accounting for self-heating of the open-path IRGA – corresponded very well (Fig. 3). NEE calculated using the closed-path IRGA were slightly higher than NEEs calculated using the open-path instrument. When integrated over 1 year, the difference

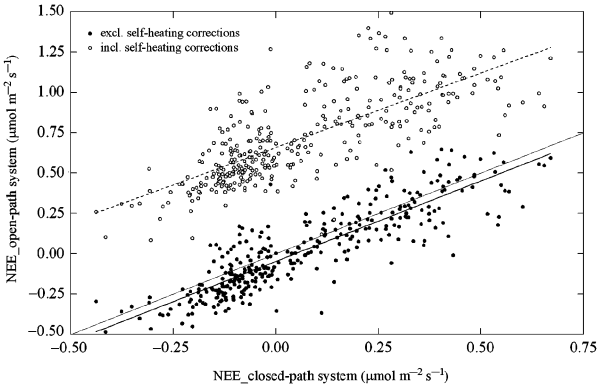

Fig. 3 Comparison between net ecosystem CO_2 exchange (NEE) measured by means of the eddy covariance technique using an closed- and an open-path IRGA connected to a common sonic anemometer. Flux data processing of the open-path system was conducted with and without taking into account the self-heating of the open-path IRGA (Burba *et al*., 2006). Bold lines represent linear best fits with the following equations: $y = 1.00x + 0.05$ (exclusive self-heating corrections, solid line, $r^2 = 0.77$) and $y = 0.93x + 0.66$ (inclusive self-heating corrections, dotted line, $r^2 = 0.57$). One-to-one correspondence is indicated by the thin solid line.

amounted to 19 g C m^{-2}. In contrast, including the corrections for self-heating of the open-path IRGA proposed by Burba *et al*. (2006) resulted in a gross underestimation of the closed-path NEE (Fig. 3) – when applied to the entire years of 2005 and 2006, the correction amounted to a shift towards net CO_2 release of 157 and 161 g C m^{-2}, respectively, and a change in the sign of cumulated annual NEE for both years. NEEs measured using the open-path IRGA also corresponded closely to NEEs measured with large geodesic ecosystem chambers in the ambient plots of the nearby NDFF during seven campaigns throughout 2005 (Fig. 4). Given that NEEs measured with the chambers were outside the footprint of the eddy covariance system and derived from a totally independent method, the correspondence between the two data sets is encouraging (means not statistically different; $P = 0.71$; Mann–Whitney-*U* test). When the small mismatch between chamber and open-path NEE determined for the year 2005 (Fig. 4) is applied to the entire years of 2005 and 2006, annual NEE changes by 25 and 26 g C m^{-2}, respectively. Because of the good correspondence of the open-path NEE exclusive the corrections proposed by Burba *et al*. (2006) and the closed-path (Fig. 3) and chamber-based NEE (Fig. 4), we chose not to apply these additional corrections.

Meteorological conditions during study period

PAR followed a clear sinusoidal pattern during the study period with maxima and minima of 64 and

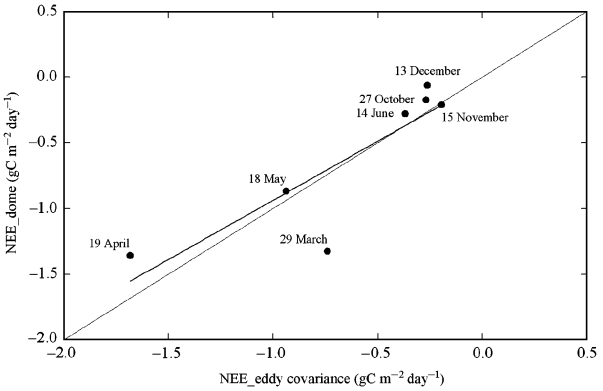

Fig. 4 Comparison between daily sums of net ecosystem CO_2 exchange (NEE) measured using eddy covariance at the MGCF site and large geodesic domes (Arnone & Obrist, 2003; Jasoni *et al*., 2005) in the ambient plots of the nearby Nevada face facility (NDFF) during 2005. The bold line represents a linear best fit with the following equation: $y = 0.90x–0.04$ ($r^2 = 0.74$). One-to-one correspondence is indicated by the thin solid line.

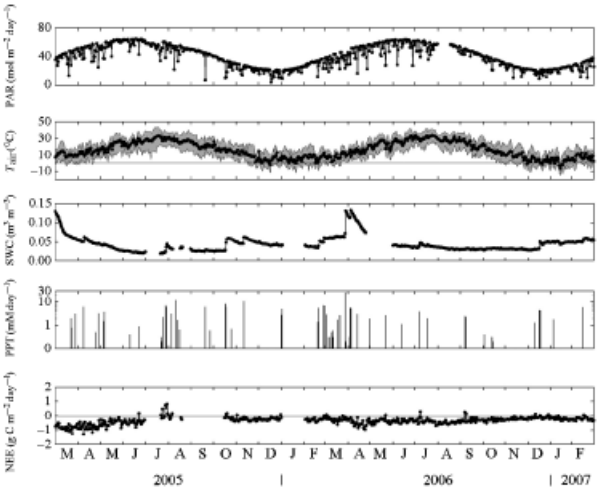

Fig. 5 Daily sums of photosynthetically active radiation (PAR), precipitation (PPT), the net ecosystem CO_2 exchange (NEE) and daily averages of air temperature (T_{air}) and soil water content (SWC) during the 2-year study period. Shaded areas in the second panel indicate the daily minimum to maximum temperature range.

22 mmol m^{-2} day^{-1} at summer and winter solstice, respectively, interrupted only by occasional cloud cover immediately surrounding rains (Fig. 5). Air temperature varied between 44 and −12 °C (Fig. 5), with annual averages of 15.8 and 15.9 °C in 2005 and 2006, respectively, which is close to the 1997–2005 mean of 15.4 °C measured at the nearby FACE site. During the 2-year study 74 discrete rainfall events were recorded at the eddy covariance site of which 55% delivered <2 mm

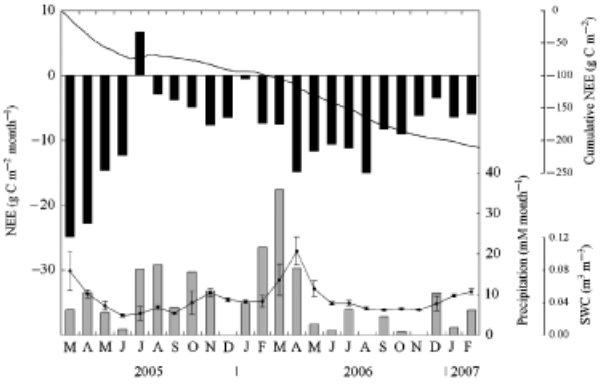

Fig. 6 Monthly net ecosystem CO_2 exchange (NEE, black bars), cumulative NEE (solid line), monthly precipitation (grey bars) and monthly averaged soil water content (solid line and filled symbols) during the 2-year study period. Error bars of the soil water content refer to the standard deviation around the mean.

and 22% >5 mm of rain (Fig. 5). Annual precipitation amounted to 120 and 86 mm in 2005 and 2006, respectively (1997–2005 annual average of 149 mm measured at the nearby FACE site). Following larger precipitation events, soil water content reached maximum values of 0.17 m^3 m^{-3} in spring, with minimum soil water contents down to 0.02 m^3 m^{-3} occurring during the summer months (Fig. 5). During summer, soil water content was less responsive to precipitation inputs (Fig. 5), indicating that parts of the rainfall evaporated before reaching 0.04 m soil depth.

Net ecosystem CO_2 exchange

Daily NEE during the 2-year study period (Fig. 5) ranged from an uptake of −1.7 g C m^{-2} day^{-1} (daily average NEE of −1.64 μmol m^{-2} s^{-1}) to a loss of 1.5 g C m^{-2} day^{-1} (daily average NEE of 1.45 μmol m^{-2} s^{-1}). The highest uptake rates were observed in March and April (Fig. 5), with NEE ranging between 1 and −4 μmol m^{-2} s^{-1}; the lowest uptake rates occurred between July and February, when daytime NEE hardly exceeded the range of 0.5 to −1.5 μmol m^{-2} s^{-1}. Days with a positive CO_2 balance occurred during any time of the year and were usually associated with rainfall events (Fig. 5). Gap-filled monthly NEE ranged from −25 g C m^{-2} month^{-1} in March 2005 to +7 g C m^{-2} month^{-1} in July 2005 (Fig. 6). Monthly NEE was significantly lower (i.e. more uptake) in March 2005 as compared with 2006, whereas July 2005 exhibited a significantly higher NEE ($P < 0.05$; Mann–Whitney-*U* test). The latter was associated with a series of rain events that delivered 16 mm of rain during the last week of July 2005 (Fig. 5). Annual NEE amounted to

Table 2 Regression statistics of independent variables against net ecosystem CO_2 exchange (NEE) for different integration periods (0.5 h to 20 days): Correlation coefficients of linear regression analysis are shown on the left and coefficients of determination of step-wise regression analysis on the right

		r					r^2
	n	PAR	T_{air}	T_{soil}	SWC	PPT	(step-wise regression)
0.5 h	22 292	−0.227***	−0.072***	−0.074***	−0.007	−0.003	0.05 (PAR, T_{air}, SWC)
1 day	530	−0.404***	0.058	−0.075*	−0.303***	0.116**	0.37 (PAR, T_{air}, SWC)
5 days	104	−0.454***	0.104	−0.105	−0.387***	0.164*	0.54 (PAR, SWC, PPT, T_{air})
10 days	51	−0.572***	0.239*	−0.224	−0.411***	0.066	0.58 (PAR, T_{soil}, SWC)
20 days	25	−0.605***	0.290	−0.256	−0.485**	−0.034	0.66 (PAR, SWC, T_{air})

Correlation coefficients are not significant except for: *$P<0.05$; **$P<0.01$; ***$P<0.001$; results of step-wise regression are significant at $P<0.001$ (n, number of samples).
PAR, photosynthetically active radiation; SWC, soil water content; PPT, precipitation.

−102 and −110 g C m^{-2} in 2005 and 2006, respectively (Fig. 6).

Half-hourly NEE was significantly correlated with all investigated environmental variables except soil water content and precipitation, but these relationships possessed poor predictive power (Table 2). The predictive power of PAR and soil water content for explaining variations in NEE increased with increasing integration time, air and soil temperature possessed no significant relationship with NEE beyond 1 day integration (except 10 days: T_{air}), and precipitation exhibited a significant relationship with NEE only between 1 and 5 days integration (Table 2). PAR, soil water content and temperature were inversely correlated with NEE at all integration levels, whereas air temperature and precipitation were negatively correlated with NEE only at 1 day (and 20 days for precipitation) integration (Table 2). A step-wise regression analysis included PAR and soil water content at all integration levels, air temperature at all but 10 days integration (where soil temperature was included instead), and precipitation at the 5 days integration level (Table 2). The proportion of explained variance increased greatly with increasing integration time, a linear model including PAR, soil water content and air temperature explaining a maximum of 66% of the variability in data at 20 days integration (Table 2).

A cross correlation analysis on daily averaged data revealed no lagged effects for NEE (data not shown) except for precipitation (Fig. 7), which switched from a positive to a negative correlation 1 and 3–4 days after a precipitation event during spring (April–May) and summer (June–July), respectively. Responses of NEE to rains varied with season and soil moisture present (Fig. 8). For example, a sustained decrease in NEE (i.e. higher rates of net CO_2 uptake) followed the first spring rains (Fig. 8a), while similar amounts of precipitation

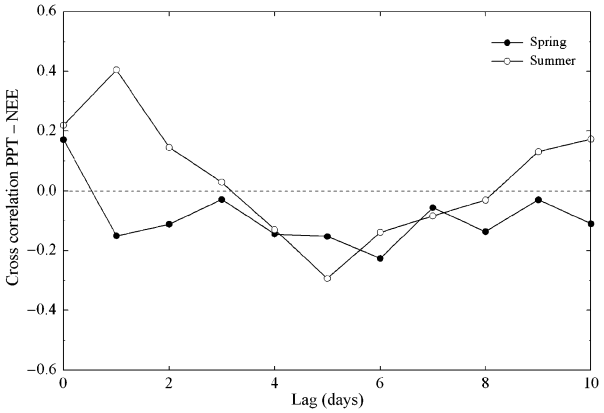

Fig. 7 Cross correlation of daily precipitation (PPT) and the net ecosystem CO_2 exchange (NEE) for spring (April–May 2006, closed symbols) and summer (June–July 2006, open symbols) conditions. Correlation coefficients are significant at $P<0.05$ when their absolute values exceed 0.25.

resulted in the ecosystem turning from neutral to a source of CO_2 and back to neutral despite an increased moisture availability within a week during summer (Fig. 8b). In winter, virtually no change in NEE was observed in response to rains (Fig. 8c).

Discussion

With annual NEE of −102 ± 67 and −110 ± 70 g C m^{-2}, the Mojave Desert ecosystem we studied was a significant net sink for CO_2 during the 2-year study, corroborating the annual net gains of 127 ± 17 g C m^{-2} measured in 2004 by Jasoni *et al*. (2005) and the 185 ± 15 g C m^{-2} measured in 2005 (J. Arnone, personal communication) in the nearby ambient CO_2 FACE plots using large static ecosystem chambers (Arnone & Obrist, 2003). These sink strength estimates are in line with the few other studies available in the literature: −212 g C m^{-2} (March–

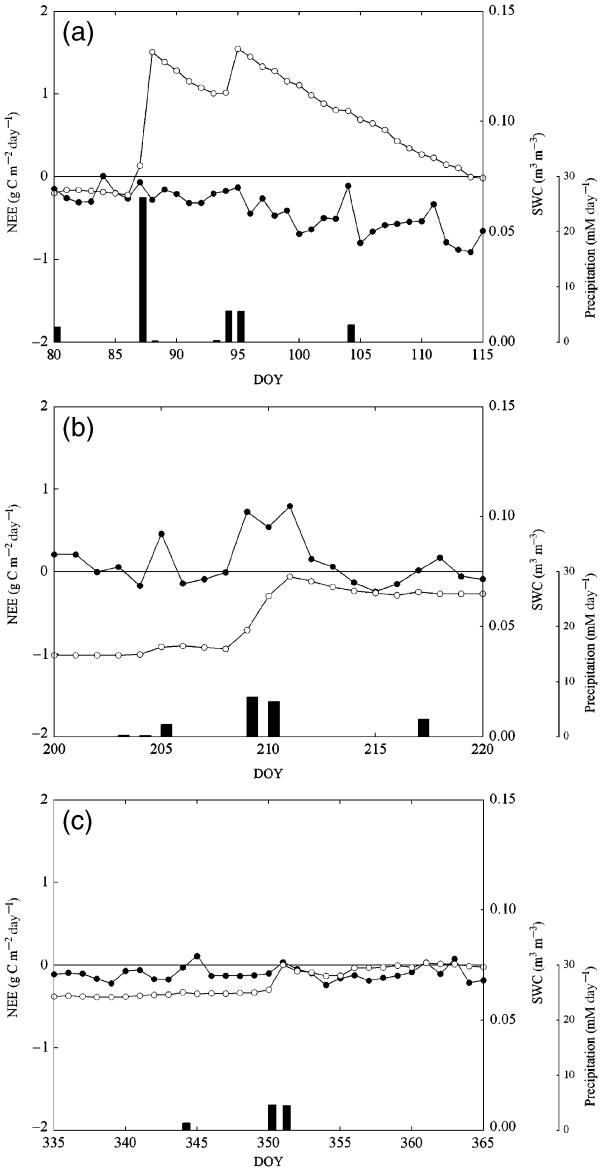

Fig. 8 Selected time series of daily sums of net ecosystem CO_2 exchange (NEE, filled symbols), daily precipitation (black bars) and daily average soil water content (SWC, open symbols) for illustrating precipitation effects on NEE. Time periods represent: March/April 2006 (a), July/August 2005 (b) and December 2006 (c).

December only) reported by Scott *et al*. (2006) for a semiarid riparian shrubland in Arizona (USA), −39 to $-52\,g\,C\,m^{-2}$ found by Hastings *et al*. (2005) for a desert shrub community in Baja California/Mexico, and −96 to $-155\,g\,C\,m^{-2}$ determined under normal weather conditions by Luo *et al*. (2007) for a mature semiarid chaparral ecosystem in California (USA). Emmerich (2003), though, reported a net annual loss of $144\,g\,C\,m^{-2}$ in a semiarid bush site in Arizona (USA), however this appears to stem from the large pool of soil inorganic carbon.

A comprehensive uncertainty analysis, accounting for both random and systematic sources of uncertainty (Moncrieff *et al*., 1996), showed that quantification of NEE in semiarid climates with open-path IRGAs is challenging because the required density correction [Eqn (1); Webb *et al*., 1980] is highly sensitive to uncertainties in the input parameters such as the CO_2 density, the sensible heat flux and the (uncorrected) CO_2 and latent heat fluxes. The resulting systematic uncertainty was an order of magnitude larger than the random uncertainty, and three times larger than the uncertainty resulting from the choice of the u^* threshold, which very often constitutes the major source of uncertainty in annual NEE estimates (e.g. Anthoni *et al*., 2004; Morgenstern *et al*., 2004). The causes for this relatively large systematic uncertainty in semiarid climates are the low CO_2 fluxes and the relatively large density corrections needed as a result of the large sensible heat fluxes (Webb *et al*., 1980). Both of these challenges require a high level of instrument/measurement accuracy (e.g. regular checks of the calibration of IRGAs) and a thorough postprocessing of EC data (especially frequency response corrections). The EC instrumentation used in our study was meticulously maintained and appropriately calibrated. Random uncertainty in our study was relatively small owing to the small magnitude of half-hourly NEEs at semiarid sites, compared with many mesic ecosystems that have larger CO_2 fluxes (Richardson *et al*., 2006). In accordance with Richardson & Hollinger (2007), the uncertainty resulting from long gaps in the CO_2 flux record was relatively small as long as the gaps occurred during periods with small temporal variability.

Supporting evidence of the validity of our NEE estimates comes from the comparison with NEE measured by means of a closed-path EC system and large geodesic ecosystem chambers (Arnone & Obrist, 2003; Jasoni *et al*., 2005), which showed close correspondence to the open-path system-based measurements. The comparison with the closed-path eddy covariance system revealed that the corrections for self-heating of the open-path IRGA proposed by Burba *et al*. (2006) seem to cause a significant underestimation of NEE at our site. This finding contrasts those reported by Grelle & Burba (2007) for a replanted forest site in Sweden. A possible reason for the apparent discrepancy between arid and high-latitude maritime forest sites might be that the parameterization of the gradients between air temperature and the open-path IRGA surface temperatures, to which the corrections are directly proportional and very sensitive and which were derived by Burba *et al*. (2006) with measurements in Nebraska (USA), does not hold for the climatic conditions in the Mojave Desert. Because our closed- vs. open-path IRGA comparison was

conducted only under warm conditions (7–37 °C in late May and early June 2007; Fig. 3), we were unable to evaluate the self-heating corrections for cold periods when they may be quantitatively more important (Burba *et al*., 2006). These unquantified corrections must be considered, at least qualitatively, as contributing to the uncertainty of estimating annual NEE for each year. Ongoing measurements at our Mojave site will include further comparisons between open- and closed-path EC systems (Burba *et al*., 2006; Ocheltree & Loescher, 2007) and direct measurements of density fluctuations in the optical path of open-path IRGAs (Grelle & Burba, 2007) under different climatic conditions to quantify sensitivities of EC estimates of NEE across seasonal and interannual time scales. However, given the close agreement of NEE values measured with the closed-path and open-path eddy covariance methods (Fig. 3), and the very comparable NEE values calculated using EC and the chamber methods (Fig. 4), and the fact that applying the correction for self-heating would have led to unreasonably large changes in annual NEE, we feel confident in not applying this correction to the present data set.

The magnitude of our NEE estimates for this arid ecosystem is comparable to NEEs reported for many temperate forest and grassland ecosystems (Baldocchi *et al*., 2001; Falge *et al*., 2002b), which are characterized by a much higher NPP than deserts have (Larcher, 2001). Because NEP is the residual of NPP and heterotrophic respiration (R_h, Larcher, 2001), this suggests soil heterotrophic microbial respiration (R_h) to be very low in desert ecosystems. This idea is supported by Austin *et al*. (2004), Belnap *et al*. (2004), Cable & Huxman (2004), de Soyza *et al*. (2005), Miller *et al*. (2005) and Sponseller (2007), who showed that microbial activity in desert ecosystems is essentially confined to short time periods following rains, when the sudden moisture availability may result in a pulse in nutrient and substrate availability and subsequently of CO_2 efflux (Huxman *et al*., 2004a, b; Veenendaal *et al*., 2004; Hastings *et al*., 2005; Potts *et al*., 2006a, b; Kurc & Small, 2007). In contrast to previous studies (e.g. Huxman *et al*., 2004b), it is now well established that the physical displacement of soil CO_2 by rain water plays a minor role for the observed CO_2 pulses (Jassal *et al*., 2005). The magnitude and duration of these CO_2 efflux episodes depends on the amount of precipitation (Huxman *et al*., 2004b), the time between consecutive precipitation events (Sponseller, 2007) and antecedent soil moisture conditions (Potts *et al*., 2006a) and reflects trade-offs between autotrophic (i.e net CO_2 uptake) and heterotrophic (i.e. net CO_2 release) contributions (Huxman *et al*., 2004b): for example, small precipitation events wet only the upper soil and may activate only autotrophic (cyanobacteria, lichens and mosses) and heterotrophic surface soil organisms, but do not supply water to the roots of vascular plants (Huxman *et al*., 2004b). The magnitude of the CO_2 efflux in this case depends strongly on the ratio of activated autotrophic to heterotrophic soil organisms and thus the actual wetting depth (autotrophic soil organisms are located exclusively at or just below the soil surface; Cable & Huxman, 2004). Larger rains, sufficient to increase water availability in deeper soil layers, can stimulate gross photosynthesis of vascular plants which can result in a lagged and sustained period of net ecosystem carbon gain following an initial pulse of CO_2 efflux (Huxman *et al*., 2004a, b; Potts *et al*., 2006a, b). Respiration rates are greatly reduced in deeper soil layers (Sponseller, 2007). These two general types of responses may be modulated by the antecedent moisture conditions (i.e. whether a precipitation pulse occurs during a period of low or high soil water availability; Ignace *et al*., 2007). For example, during periods of low soil water availability, even large rains may not translate into a corresponding increase in carbon gain because: (i) leaf area of drought–deciduous plants may be low (Hamerlynck *et al*., 2002), (ii) annual plants are absent (Smith *et al*., 2000) or senescent (Ivans *et al*., 2006), and (iii) photosynthesis of evergreen plants may be co-limited by biotic and environmental factors other than soil water availability (Potts *et al*., 2006a). In addition, the response of microbial respiration to wetting during periods of low soil water availability may be more intense because it involves the decomposition of accumulated labile soil organic matter and dead microbial biomass (Austin *et al*., 2004; Barker *et al*., 2005), but also the release of physically protected soil organic matter and the mineralization of microbial intracellular compounds (Fierer & Schimel, 2003). Particularly large CO_2 efflux episodes following rains after extended periods of low soil water availability have been reported by Hastings *et al*. (2005), Veenendaal *et al*. (2004) and Xu & Baldocchi (2003) and were observed in our study for July 2005 (Figs 5 and 8b). During these periods a lag of 3–4 days was observed before the correlation between NEE and precipitation switched from positive to negative, as opposed to conditions of high soil water availability when this transition occurred within the same day the rain took place (Fig. 7).

The large net annual carbon gains observed in this study and in the ambient CO_2 plots of the nearby FACE site (Jasoni et *al*., 2005; J. Arnone, personal communication) prompt the question of where the fixed carbon is accruing within the ecosystem. Continuing accretion of vascular plant cover (NPP) may account for some of this carbon (Webb *et al*., 2003; R. Nowak, personal communication from FACE site). However, expansion and growth of cryptobiotic crust organisms (lichens,

mosses, cyanobacteria) likely account for a significant portion of the carbon accretion. These organisms have, heretofore, been neglected as significant carbon pools in assessments of desert carbon pools. In fact, we could find no quantitative mass-based data on cryptobiotic crust productivity in the literature. In order to corroborate the inferred carbon sink strength of this Mojave Desert ecosystem using EC and chambers, however, changes in above- and below-ground carbon pools over time would need to be quantified.

Taken together, our results show that (i) during the 2-year study period Mojave Desert shrub ecosystem we investigated was a significant sink for CO_2 on an annual basis, corroborating earlier findings obtained with static chamber techniques at the nearby ambient CO_2 FACE site and several other studies of semiarid ecosystems; (ii) while the quality of our NEE measurements could be confirmed by two independent methods, our uncertainty analysis underlines the need for accurate instrument data (especially from the open-path IRGA) that are used to calculate the Webb *et al*. (1980) density corrections to NEE; (iii) seasonal variation in NEE primarily depends on soil moisture conditions and precipitation and their effects on vascular plant and cryptobiotic crust photosynthetic and respiratory activities and productivities; and (iv) desert shrubland ecosystems of the world may represent a potentially large global carbon sink that has been ignored until now and demands continuation of experimental studies (e.g. Jasoni *et al*., 2005) aimed at quantifying ecosystem responses of deserts to global environmental change factors.

Acknowledgements

We are very grateful to T. Huxman for his advice on configuring and installing the eddy covariance system, E. Knight for maintaining (calibrating) the tower and equipment and acquiring data and S. Smith and R. Nowak for generating funding that supports the Mojave Desert Global Change Facility and the Nevada Desert Research Center. We especially thank the US National Science Foundation (DEB-0213055), the US Department of Energy Program for Ecosystem Research (DE-FG03-02ER63361) and the A. W. Mellon Foundation for research funding, and UNLV, UNR and the Desert Research Institute for equipment purchases. JAA III thanks the DRI supporting his 1-year sabbatical stay at the University of Innsbruck. G. W. acknowledges travel support to Reno (NV, USA) by the Office of Foreign Affairs of the University of Innsbruck. D. Baldocchi and five anonymous reviewers are acknowledged for their critical comments on earlier versions of this paper.

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BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
1516 NINTH STREET, SACRAMENTO, CA 95814
1-800-822-6228 – WWW.ENERGY.CA.GOV

APPLICATION FOR CERTIFICATION FOR THE *IVANPAH SOLAR ELECTRIC GENERATING SYSTEM*

DOCKET NO. 07-AFC-5
PROOF OF SERVICE
(Revised 11/23/09)

APPLICANT
Solar Partners, LLC
John Woolard,
Chief Executive Officer
1999 Harrison Street, Suite #500
Oakland, CA 94612

Todd A. Stewart, Project Manager
Ivanpah SEGS
sdeyoung@brightsourceenergy.com
E-mail Preferred

Steve De Young, Project Manager
Ivanpah SEGS.
1999 Harrison Street, Ste. 2150
Oakland, CA 94612
tstewart@brightsourceenergy.com

APPLICANT'S CONSULTANTS
John L. Carrier, J. D.
2485 Natomas Park Dr. #600
Sacramento, CA 95833-2937
jcarrier@ch2m.com

COUNSEL FOR APPLICANT

Jeffery D. Harris
Ellison, Schneider
& Harris L.L.P.
2600 Capitol Avenue, Ste. 400
Sacramento, CA 95816-5905
jdh@eslawfirm.com

INTERESTED AGENCIES
California ISO
e-recipient@caiso.com

Tom Hurshman,
Project Manager
Bureau of Land Management
2465 South Townsend Ave.
Montrose, CO 81401
UUtom_hurshman@blm.gov

Raymond C. Lee, Field Manager
Bureau of Land Management
1303 South U.S. Highway 95
Needles, CA 92363
Raymond_Lee@ca.blm.gov

Becky Jones
California Department of
Fish & Game
36431 41st Street East
Palmdale, CA 93552
dfgpalm@adelphia.netUU

INTERVENORS

California Unions for Reliable Energy ("CURE")
Tanya A. Gulesserian
Marc D. Joseph
Adams Broadwell Joseph & Cardozo
601 Gateway Boulevard, Ste 1000
South San Francisco, CA 94080
tgulesserian@adamsbroadwell.com

Western Watersheds Project
Michael J. Connor, Ph.D.
P.O. Box 2364
Reseda, CA 91337-2364
mjconnor@westernwatersheds.org

Gloria Smith, Joanne Spalding
Sidney Silliman, Devorah Ancel
Sierra Club
85 Second Street, 2nd Fl.
San Francisco, CA 94105
E-mail Service Preferred
gloria.smith@sierraclub.org
joanne.spalding@sierraclub.org
gssilliman@csupomona.edu
devorah.ancel@sierraclub.org

*indicates change

INTERVENORS CONT.
Joshua Basofin, CA Rep.
Defenders of Wildlife
1303 J Street, Ste. 270
Sacramento, CA 95814
E-mail Service Preferred
HHjbasofin@defenders.orgHH

Basin and Range Watch
Laura Cunningham
Kevin Emmerich
P.O. Box 70
Beatty, NV 89003
atomictoadranch@netzero.net

Center for Biological Diversity
Lisa T. Belenky, Sr. Attorney
Ileene Anderson, Public Lands Desert Director
351 California Street, Ste. 600
San Francisco, CA 94104
E-mail Service Preferred
lbelenky@biologicaldiversity.org
ianderson@biologicaldiversity.org

California Native Plant Society
Greg Suba, Tara Hansen & Jim Andre
2707 K Street, Suite 1
Sacramento, California, 95816-5113
E-mail Service Preferred
gsuba@cnps.org
thansen@cnps.org
granites@telis.org

***County of San Bernardino**
385 N. Arrowhead Avenue, 4th Fl.
San Bernardino, California, 92415
bbrizzee@cc.sbcounty.gov

Bart W. Brizzee, Deputy Co. Counsel
ENERGY COMMISSION
JEFFREY D. BYRON
Commissioner and Presiding Member
jbyron@energy.state.ca.us

JAMES D. BOYD
Vice Chairman and
Associate Member
HHjboyd@energy.state.ca.usHH

Paul Kramer
Hearing Officer
pkramer@energy.state.ca.us

John Kessler
Project Manager
jkessler@energy.state.ca.us

Dick Ratliff
Staff Counsel
dratliff@energy.state.ca.us

Public Adviser
publicadviser@energy.state.ca.us

*indicates change

DECLARATION OF SERVICE

I, Greg Suba, declare that on 12/21, 2009, I served and filed copies of the attached, Exhibits dated, 12/18, 2009. The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at: **[www.energy.ca.gov/sitingcases/ivanpah]**.

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Attn: Docket No. 07-AFC-5
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
docket@energy.state.ca.us

I declare under penalty of perjury that the foregoing is true and correct.

Greg K. Suba

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