CALIFORNIA BAT MITIGATION
TECHNIQUES, SOLUTIONS, AND EFFECTIVENESS

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1.0 INTRODUCTION

The purpose of this project is to provide a critical review of mitigation options for bats in relation to Caltrans projects. This work has been administered through California State University Sacramento (CSUS), and conducted in cooperation with California Department of Transportation (Caltrans), California Department of Fish & Game (DFG), University of California, and private researchers.

This report has, therefore, been developed to provide Caltrans with the most effective possible mitigation strategies for the bats of California when maintenance of construction activities could potentially reduce, eliminate, or compromise bat populations and their habitats. Current laws protecting bats are discussed, and these laws form the foundation of mitigations. Because collective experience is far more valuable in developing guidelines for mitigation strategies, many persons were interviewed and many projects that included bat mitigations were reviewed. Data from twenty California bridges that recently mitigated for impacts to bats and bat habitat is incorporated into a table providing information about successful, and not so successful, mitigations. Thus, any conclusions about the effectiveness of mitigations would draw on the largest possible pool of knowledge. We also provide the details of nine case studies in the hope that these examples will help readers learn from the successes and failures of specific projects (Appendices A to I). The literature review also includes many other guidelines and examples that are searchable through EndNote, enabling the reader to search for specific species and situations. This document builds on, and should be considered a companion to, the Caltrans technical report, Bats and Bridges Technical Bulletin (Erickson 2003).

2.0 PROJECT GOALS

Part of the intent of this report is to incorporate this document into the transportation-related component of the California Bat Conservation Strategy currently being developed as part of the California Comprehensive Wildlife Plan. The intended outcome will facilitate communication between Caltrans and the Department of Fish and Game (DFG), consistent with the cooperative approach outlined in the 1991 MOU between the two agencies.

We approached this project with four goals in mind:

1. provide a synthesis of existing information regarding bats and mitigation efforts worldwide and throughout the United States, but with a particular focus on transportation issues in California;

2. evaluate a range of mitigation alternatives and their relative effectiveness in California;

3. provide mitigation guidelines for bats as they apply to Caltrans projects;

4. develop the transportation related components of the California Bat Conservation Strategy.

The first three goals are addressed in this document. Because the California Bat Conservation Strategy is still in an early phase of development, the transportation related component must necessarily be incorporated at a later stage, but will be largely an extrapolation from this document.

3.0 CONSERVATION STATUS OF BATS

3.1 CONTEXT

The California Department of Transportation is one of the largest property managers in California. Their property includes tens of thousands of miles of state and interstate highways, as well as associated structures, buildings, right-of-way easements, and connected parcels. The highway system crosses and interacts with nearly every bioregion and habitat type in California, a state containing some of the richest diversity of species and ecosystems in the nation.

Maintenance, rehabilitation, and improvements to California's transportation infrastructure are ongoing. Caltrans and other transportation agencies plan, design, and supervise changes to hundreds of miles of roads, railroads, and other transportation subsystems. They also team with other federal, state, and local agencies involved in infrastructure planning and repair, such as those involving bridges.

Bats often use many of the structures, buildings, mines, bridges, and surrounding habitats associated with these projects. Although our understanding of the ecological requirements of bats is far from complete, enough data are now available to generate predictions about those requirements and plan mitigation strategies that have a high probability of success.

3.2 MITIGATION FOR BATS: AN OVERVIEW AND INTRODUCTION TO THE URL SITES TABLE AND THE ENDNOTE LIBRARY

California has twenty-five bat species, eighteen of which are rare and/or considered Species of Special Concern by Department of Fish and Game, Species of Concern by the U.S. Fish and Wildlife Service or Sensitive by the U.S. Forest Service. All of these species are known to have behavioral and ecological interactions with the transportation system, and are potentially affected by transportation related projects.

As a part of this section, a library of references has been compiled, both as a searchable electronic library (EndNote) of specific pieces of literature relating to bat mitigation (Appendix J) and as a table of URL sites (Appendix K). The EndNote library is printed out as a table, but the usefulness of this program is not as a table to browse information, but rather, to be able to search for a specific keyword. For this particular electronic library, there are 10 fields (e.g., author, title, species, habitat, etc.) that can be used for searches. Information most germane to this report is incorporated in various parts of the text (e.g., Franklin Boulevard Bridge and Causeway bat mitigation project [a project not designed or affiliated with Caltrans] is referred to several times in this report). On the other hand, those references that are not particularly germane to bat mitigation measures associated with highway systems in California (e.g., a gift of 420,000 sterling pounds for the renovation of a 16th century English barn for the barbestelle [*Barbestella barbastellus*]) are included in the EndNote library of bat mitigation references but are not included anywhere else in this report. Therefore, there is no separate synthesis of the EndNote references because this would not necessarily provide the reader with particularly useful information.

All of the URL sites in the table are included in the EndNote library. However, the table provides the reader with a means to browse through comments and summaries before selecting a particular URL site for more information. The EndNote has some references, such as hard copy articles and books, which are not included in the table of URL sites.

In recent years there has been an increasing recognition of the importance to bats of transportation related structures and habitats as detailed in the references titled Bats and Bridges Technical Bulletin (Erickson 2003). As a result, an increasing number of projects have required mitigation. However, there has been no central repository of information regarding bat mitigation efforts, and little attempt to evaluate and track their collective effectiveness. Johnston (1999) suggested there are few guidelines addressing what situations should trigger mitigation, and what mitigation measures are appropriate. Furthermore, more information about the status of some populations and natural history aspects of some bat species is needed to develop the best possible mitigation strategies (Johnston 1999). While this document is not intended as a training manual, it is a first step toward compiling a database of mitigation efforts for bats, and offers a number of case studies to illustrate some measures that appear to work, and others that require further experimentation and research.

Proposed mitigation should be consistent with the impact that is being mitigated. Most typically, this impact involves the alteration or loss of a roosting site. In general, the closer the mitigation action comes to providing replacement habitat for that which is lost the more likely it is to be successful. This means that on-site and in-kind solutions have the highest probability of success. While experimental roost designs require further exploration, off-site solutions need to offer habitat conditions comparable to on-site roosts. In the case of bridges, caves and mines, replacement roosts should have comprable thermal stability and durability, the same or similar search image, and the same cryptic roosting conditions as those roosts they replace.

Bat houses in common use, even the largest "condominium" style, are generally made of wood. Consequently they lack durability and require ongoing, and sometimes costly, maintenance. Some medium and smaller-sized bat houses are being made of synthetic materials or wood coated in stucco, epoxy or other materials, but the performance of these materials is not proven, and known drawbacks exist for several of these alternative materials.

When mounted on poles, or even on other structures, bat houses are quite visible, which can make them a public nuisance or target for vandalism. Important from a biological viewpoint, they may not provide the same temperatures, or may not offer the same thermal buffering as large concrete structures like bridges, or subterranean habitat like caves and mines. These thermal limitations of bat houses can result in lack of, or reduced, occupancy by bats. Experimental designs incorporating bat habitat into structures without compromising structural integrity and designs offering off-structure habitat with all the required roost parameters are needed. Off-structure designs would almost certainly have to be far more substantial than those that have been most commonly attempted in the past.

Projects typically involve a fairly small site – *e.g.*, maintenance, alteration, or replacement of a bridge. In these cases, mitigation strategies have typically and appropriately focused primarily on the structure and whatever surrounding habitat is defined as being contained within the project boundaries. This approach is necessary but not sufficient, because it does not account for the regional importance of the site to the particular species in question. Specifically, what mitigation is appropriate, and how extensive these measures need to be, depends to some degree on the regional significance of the bat population located at the project site. Many North American vespertilionids have commuting distances of several kilometers or less between roosts and foraging areas (Brigham et al. 1997, Kunz and Lumsden 2003). However, recent radiotelemetry studies suggest a number of bat species, even in the absence of disturbance, can have home ranges of > 20 kilometers (Barclay 1989, Pierson 1998). Thus, the standard used in a number of recent transportation projects has been to survey bridges within a 25 km radius of a project site (Johnston 2004, Pierson 2000, Pierson and Rainey 2002, Pierson and Rainey 2004, Pierson et al. 2004). This approach has been used whether or not the target site is a bridge, because bridges offer a convenient and time efficient method for surveying a number of species (Pierson et al. 1996). This serves the dual purpose of identifying potential alternate habitat for a population, and offering some perspective on the regional significance of the target population – *e.g.*, whether it is the only colony of this species within the 25 km radius.

4.0 BATS AND TRANSPORTATION RELATED STRUCTURES

4.1 RELEVANT BIOLOGICAL AND ECOLOGICAL FACTORS

There are several features of bat biology and ecology that distinguish this group of small mammals that need to be considered when evaluating potential impacts to bat populations from human-related activities.

One significant factor is the tendency for many species of bats to aggregate in colonies – hibernating colonies in the winter and maternity colonies, composed of adult females and their young, from spring through early fall. Typical colony size varies from species to species. A few species form small colonies or are non-colonial, but most aggregate, with a few species forming large colonies (from several hundred to many thousand). The patterns of colony formation need to be considered when evaluating impacts, because the entire population for a large area may be concentrated in a single roost.

Additionally, bats are unusual for small mammals in that they are long-lived (up to 15 years is not uncommon), and have a low reproductive rate. Most species have only one young per year; only a few species have twins or multiple births. Females are often two years old before bearing their first young. Thus project impacts to a population can be potentially severe. It can take a colony many years to recover from activities that cause mortality or even temporary reduced fecundity.

Like most other long-lived mammals, bats have complex social systems. Maternity colonies are often matrilineal, with females returning to their natal roosts throughout their lives. For many species the nursery colonies show high fidelity to their chosen roost sites, particularly sites like caves, which typically have high structural stability. Breeding females are usually behaviorally sensitive to disturbance. Bats have few natural predators and few behavioral defenses against predation. Instead they rely on being able to find safe and cryptic roosts for raising their young.

Finally, bats are unusual mammals in that they have a labile body temperature. While they are capable of thermoregulating like other mammals (maintaining a constant body temperature in a fluctuating temperature environment), bats also have the capacity to allow their body temperature to track ambient temperatures. A primary criterion for roost selection is the diurnal and seasonal temperature pattern for a roost. In the summer, while raising young, they tend to seek very warm, but thermally buffered, environments – settings that provide enough thermal diversity that by moving around, bats can maintain a fairly constant and preferred temperature regime. In the winter, especially in areas where temperatures frequently drop below freezing, bats hibernate, seeking cool, thermally stable roosts (ideally just a couple of degrees above freezing). In areas with predominantly non-freezing temperatures, bats most typically seek cool roosts that allow them to save energy by using torpor.

4.2 ROOSTING ECOLOGY

4.2.1 An Overview

Bats use different roosts for different purposes, but common to all are an appropriate temperature regime and protection from predators and undesirable weather. During the summer when bats are most active and raising their young, they frequently use one roost during the day where they sleep and keep their young, and another roost at night for resting and digesting food. Day roosts tend to be cryptic and concealed; night roosts more open and exposed. Both day roosts and night roosts can be used by multiple species, and fidelity to both kinds of roosts can be very high.

Bats also change roosts seasonally. Although timing varies with species and with geographic location, in general bats form maternity colonies in the spring. These aggregations stay together until the young are independent in the late summer or early fall. During this time, adult males most typically roost singly or, less commonly, in bachelor colonies.

In the fall, some species, such as Mexican free-tailed bats, migrate to warmer climates, and may have roosts that they use for short periods as migratory stop-over sites (Johnston 1998). Other species, such as pallid bats, remain in the range of their summer roosts and hibernate or, in warmer areas, maintain a low level of activity throughout the winter (Johnston 2003). Although large hibernating aggregations are common in some parts of the United States, they are relatively rarer in California. Most California species, when found hibernating in the winter, roost singly or in small groups. The largest aggregations have been found only in caves and mines. However, large aggregations (>1,000) of non-hibernating Mexican free-tailed bats overwinter in bridges along the coast and portions of the Central Valley.

Some roosts are used primarily for the purposes of mating (Brown and Berry 1994). All the vespertilionids and *Macrotus californicus* mate in the fall, although the vespertilionid females do not actually become pregnant until the spring, and *M. californicus* has a delayed development. Molossids, on the other hand, usually mate in late winter or early spring.

4.2.2 Structural Features of Roosts

Bats use a variety of roost sites, which, for North American species, fall into three general categories: crevices, cavities, and foliage. In natural settings, cavity roosting species aggregate on open surfaces inside dark chambers, such as caves or large tree hollows; crevice roosting species occupy a variety of narrow "slots" (e.g., rock crevices, exfoliating tree bark, damaged wood in snags). While some species appear to be obligate cavity or crevice dwellers, there is a continuum between crevices and cavities, and many species use a range of roosts. With the exception of a few foliage roosting species, all North American bat species also roost in cave-like spaces and/or crevices in man-made structures, such as bridges, buildings, old mine workings, silos, towers, and tunnels.

Many of the habitats and structures associated with transportation projects are likely to be inhabited by bats. The most frequently encountered issue requiring mitigation involves bats roosting in bridges; and hence, most of this document focuses on that issue. There are, however, other related structures and habitat features that should be considered in an environmental evaluation, the loss of which could potentially trigger mitigation actions. All twenty-five bat species that occur in California use one or more of these structures (Table 4-1).

Fifteen of California's bat species are known to use bridges. Four species use bridges commonly, eight species use bridges more sporadically, and three species use bridges rarely. Of these 15, 10 have special status (SSC, FSS, or SC), and impacts to these species often trigger mitigation measures

Table 4-1. Roosting Patterns for California Bat Species.*

Species Name	Common Name	Status	Bridge	Cave/ Mine	Building	Cliff/ Rock Crevice	Tree Bark/ Hollow	Tree Foliage	Rip-Rap
Family Phyllostomidae (leaf-nosed bats)									
Choeronycteris mexicana	Mexican long-tongued bat	SSC, SC		1	2				
Leptonycteris curasoae	Lesser long-nosed bat	FE		1					
Macrotus californicus	California leaf-nosed bat	SSC, SC	3	1					
Family Molossidae (free-tailed bats)									
Eumops perotis	Western mastiff bat	SSC, SC			3	1			
Nyctinomops femorosaccus	Pocketed free-tailed bat	SSC				1			
Nyctinomops macrotis	Big free-tailed bat	SSC, SC				1			
Tadarida brasiliensis	Mexican free-tailed bat		1	2	1	1	3		
Family Vespertilionidae (mouse-eared bats)									
Antrozous pallidus	Pallid bat	FSS, SSC	1	2	1	2	1		
Corynorhinus townsendii	Townsend's big-eared bat	FSS, SSC, SC	2	1	2		3		
Eptesicus fuscus	Big brown bat		1	2	1	2	1		
Euderma maculatum	Spotted bat	SSC, SC				1			
Lasionycteris noctivagans	Silver haired bat		3				1		
Lasiurus blossevillii	Western red bat	FSS, PSSC						1	
Lasiurus cinereus	Hoary bat							1	
Lasiurus xanthinus	Western yellow bat	PSSC, SC						1	
Myotis californicus	California myotis		2	2	1	1	2		
Myotis ciliolabrum	Small-footed myotis	SC	2	2		1			
Myotis evotis	Long-eared myotis	SC	2	2	2	2	1		2
Myotis lucifugus	Little brown myotis		2	2	1	2	2		
Myotis occultus	Arizona myotis	SSC, SC	2		?		1		
Myotis thysanodes	Fringed myotis	PSSC, SC	2	1	2	2	1		
Myotis velifer	Cave myotis	SSC, SC	2	1	?				
Myotis volans	Long-legged myotis	PSSC, SC	2	2	2		1		
Myotis yumanensis	Yuma myotis	SC	1	2	1	3	2		
Pipistrellus hesperus	Western pipistrelle		3	2	3	1			

* 1 = use frequently; 2 = use sometimes; 3 = use rarely; Blank = not known to use

Status:

FE = Federally Endangered
FSS = USDA Forest Service Sensitive
SSC = California Department of Fish and Game, Mammal Species of Special Concern
PSSC= Proposed, California Department of Fish and Game, Mammal Species of Special Concern
SC = Former Candidate (Category 2) for listing under U.S. Endangered Species Act; Species of Concern

under CEQA and Best Management Practices (BMP) under a DFG Section 1600 Streambed Alteration Agreement. In many cases, when surveys are conducted within a 15 to 25 km radius of a bridge roost, the bridge supports the most significant, and in some cases the only, population for a particular species in the area. Many colonies have resided in chosen bridges for many years, and have come to depend on these resources. This is particularly true in areas where surrounding natural habitat (*e.g.*, the valley riparian forests of the Central Valley) has been lost.

Most of the species that roost on bridges also roost in buildings (particularly abandoned structures), mines, and caves. Mines and caves are especially important for several special-concern species – i.e., *Corynorhinus townsendii*, *Macrotus californicus*, *Myotis thysanodes*, and less frequently, *Antrozous pallidus*. Other species will roost in cliff faces and rock crevices often found along highway corridors in the Sierra Nevada and the Coast Ranges, particularly highways that follow major river drainages. Additionally, a number of species that roost in tree cavities or under flaking bark – the kinds of flaws that are commonly found in conifer snags and in live, mature cottonwoods, sycamores, and oaks. These roosts can occur within the highway right-of-way, particularly along stream and river corridors. Other species are foliage roosting, and are particularly concentrated in stands of mature riparian cottonwood and sycamore. Finally, *Myotis evotis* has been observed roosting in highway rip-rap (Rainey and Pierson 1996).

4.2.3 Why Bridges?

A number of factors converge to explain the disproportionate importance of bridges to bats. Bridges frequently have structural features that offer remarkably suitable analogs to natural roosts, and the large mass, particularly in concrete bridges, offers the kind of thermal buffering that these animals require. Also, bridges frequently serve to replace natural roosts in anthropogenically-altered landscapes.

Crevice roosts, suitable for day-roosting maternity colonies, are most frequently found in expansion and hinge joints, in abutment crevices, and in spaces formed at the junction between old and new portions of a widened bridge. Less commonly, crevices will occur where a bridge, or more typically a viaduct, interfaces with rock features in the road cut. Anomalous features such as crevices behind signs can also offer roosting habitat.

Bridges can also provide day roosts for cavity dwelling species. When there are access points, the interiors of closed box construction bridges can offer large cavities for bats. Also, cavities can often be found in many abutments, particularly where the slope meets the abutment in such a way that the created space is cave-like. Many older bridges have hollow piers with openings to the interior, and these cavities can accommodate large numbers of bats.

Night roosts are most commonly found in concrete girder bridges, where the girders create warm air pockets, and the temperature at the bridge deck is typically warmer, and more stable, than ambient (Perlmeter 1996, 2004, Pierson et al. 1996). These sites generally offer the protection from weather and predators that bats require. Additionally, because bats forage most frequently in association with water, and the majority of bridges cross water features, these sites have the distinct advantage of offering proximity to foraging areas.

When assessing the importance of a bat roost in a bridge, it is important to recognize that multiple species frequently use the same bridge, and to be aware that the species assemblage may vary seasonally (Pierson et al. 2001). Because the most common species may dominate, it is easy to miss the presence of rarer species. Thus documenting the full range of species using a bridge frequently requires that the bridge be examined both day and night, and that surveys be repeated seasonally.

A detailed discussion of bats and bridges, including a survey and evaluation protocol, can be found in The Bats and Bridges Technical Bulletin (Erickson et al. 2003).

4.3 FORAGING ECOLOGY

Twenty-three of the species found in California are predominantly insectivorous (with a few also consuming other arthropods such as scorpions and spiders). The two remaining species (*Choeronycteris mexicana* and *Leptonycteris curasoae*) are primarily nectarivorous. Both are confined to southern California and occur only seasonally (*C. mexicana*) or are known only from a few specimens likely to have been vagrants (*L. curasoae*) (Constantine 1998).

While bat species show some specialization for particular foraging styles and habitats, they also will opportunistically exploit locally abundant prey (Kunz 1982, Johnston and Fenton 2001, Whitaker 1994). Diet studies conducted in the upper Sacramento River drainage showed that, while there were marked differences in average diet composition across species, several species took advantage of substantial hatches of particular insects, such as winged termites and caddisflies (Rainey and Pierson 1996).

Nevertheless, species divide potential foraging space in ways that can be partially predicted from wing size and shape (which constrains flight speed and maneuverability). Recent studies in Canada (Grindal et al. 1999) and the Sierra Nevada (Pierson et al. 2001) are consistent with earlier work in finding that bat activity is concentrated over water in forested areas of western North America. Some species (e.g., *Myotis yumanensis*) feed largely on emergent aquatic insects by skimming near the surface of still or slow moving water. Others may feed higher over the water surface. Some forage primarily along the water edge in association with riparian vegetation. A number of species also forage, however, partially or exclusively away from water along dry creek channels, around the canopy of forest trees, or in oak savannah.

Thus bridge replacements, new bridge construction, highway realignments, and new highway corridors have the potential to impact bats' foraging habitat. An assessment of foraging patterns should be considered whenever a project has the potential to reduce or alter available foraging habitat, either by elimination of foraging areas (e.g., removal of riparian vegetation) or changes in density or diversity of insect prey (e.g., stream and floodplain restoration). For example, an assessment of bat foraging activity in the habitats associated with various route alternatives for the Hopland by-pass project documented more bats and greater species diversity (including special-concern species) in areas of oak savannah than in orchards or vineyards (Pierson and Rainey 2004).

5.0 LEGAL STATUS AND ITS IMPLICATIONS FOR PROJECTS

There are no specific laws in California protecting bats as a specific type of wildlife; however, various agencies and groups have established status designations providing guidelines for the most sensitive and threatened species without actually providing any extra legal protection. The National Forest Service, Bureau of Land Management, and the Western Bat Working Group have evaluated threats to bats of California and have rated them accordingly (Appendix L). Nine species are currently considered Species of Special Concern by the DFG, and three additional species are proposed for that status. Additionally, the Forest Service and the Bureau of Land Management lists some species as Sensitive and the Western Bat Working Group lists some as High Priority (for consideration of conservation measures). The following section provides a discussion of specific laws and how they may influence projects and reduce potential impacts to bats.

5.1 NO FEDERALLY-LISTED BAT SPECIES IN CALIFORNIA

No regularly occurring bats in the State of California are federally-listed species. Although records for the lesser long-nosed bat (*Leptonycteris curasoae*), a federally endangered species, occur rarely in various parts of Southern California, these bats were not part of the naturally occurring fauna until nectar producing plants were established in landscaped situations. Consequently, the Federal Endangered Species Act (FESA) does not normally apply to projects involving bat species in California. For states where federally listed bat species regularly occur, FESA provides legislated protection against loss (take) of any individuals, or the loss of any occupied habitat within designated Critical Habitat as published in the Federal Register. Because these federally-listed species are protected as such, other more common bat species in states with endangered bat species, likely receive better protection than bats in those states without significant populations of federally-listed species. Furthermore, FESA provides a mechanism to mitigate for the loss, or potential loss, of these affects to the species so that there are no adverse affects to the population. Additionally, FESA provides for heavy fines to enforce protective legislation. Because many bat species' habitats overlap, protection for many bat species is thus provided indirectly.

5.2 NO STATE-LISTED BAT SPECIES IN CALIFORNIA

There are also no California state-listed bat species. Under the California Endangered Species Act a state-listed species could be given additional protection. The California Endangered Species Act does not, however, provide as much protection as the Federal Endangered Species Act.

5.3 CALIFORNIA CODE, TITLE 14, §465.5: USE OF TRAPS AND EXISTING CCR 4152, 4180

The use of traps to kill or remove wildlife is regulated by the state in order to project wildlife. However, these laws do not necessarily protect wildlife when "loss of property" or "damage to property" by wildlife can be established.

State Assembly Bill 1645 for trapping animals has been under discussion for a couple of years. Previously trappers removing or eliminating "nuisance" wildlife were not required to be licensed. Originally the proposed law would require predator and "nuisance" control trappers to be licensed and regulated, and pass a competency tests and file an annual report. Although the recent bill was meant to help protect wildlife including bats, the bill does not protect the bats from being excluded from anthropomorphic situations. Because of objections raised by wildlife rehabilitation centers and members of the public regarding the lack of protection for bats in the final version of this bill, specific language to protect bats has been withdrawn because bats ultimately received no additional protection under the proposed law. This bill was in discussion as of October, 2004.

5.4 CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

Because no federal laws protect bats in California and the DFG code is limited in its ability to enforce general DFG statutes, the CEQA planning process becomes probably the single most important law protecting bat populations in California. Therefore, the driving legal force behind protecting bats on bridges and other structures is to avoid significant effects on the environment (See definitions for Significant effect on the environment and Mandatory Findings of Significance" in Appendix M). For a project to proceed, Caltrans' first approach to potential significant effects is avoidance, then minimization, and lastly, other forms of accommodation or habitat replacement. Caltrans' goal is to reduce the effects of a project below the level of significance, thereby removing the requirement for the preparation of an Environmental Impact Report (EIR) or an Environmental Impact Statement (EIS) and having the least impact to the environment as practicable. When no practical alternative can be found (or the project is controversial), Caltrans plans appropriate mitigation for significant impacts that require an EIR or EIS . The decision to produce an environmental document is not the decision of the Caltrans biologist, but that of the Environmental Planners and the Environmental Management team. However, a Caltrans or consulting biologist may recommend that an EIR/EIS or Negative Declaration (ND)/Findings of No Significant Impacts (FONSI), or other environmental document, be prepared.

When roosts and other important bat habitats are threatened because of a project, EIRs become the vehicle to protect bats and their habitats. Mitigation measures to eliminate, or reduce, impacts to less-than-significant levels become a part of the EIR. It is up to the biologist writing the EIR to ensure appropriate mitigation measures are written and up to the lead agency to adopt and implement these mitigations should the agency find them adequate. The Department of Fish and Game does not necessarily have to accept the lead agency's (or project proponent's) environmental document(s) and can require mitigation measures, as described below. CEQA requires monitoring of mitigation to ensure the success of mitigation measures. Unfortunately, too often there are no provisions for monitoring mitigation measures for wildlife; the assumption is that the mitigation will work if you provide the habitat. Even experienced bat biologists cannot guarantee when prescribed mitigation measures will work as intended.

5.5 STREAMBED ALTERATION AGREEMENTS §1600

The Department of Fish and Game also provides permits for Streambed Alteration Agreements §1600 of the Fish and Game Code. This permit process provides a vehicle to reduce impacts to bats when the project needs clearance from DFG because construction enters the low flow channel of a creek or stream. In such cases, the DFG can include conditions to reduce impacts to the wildlife associated with that project, including bats and birds. DFG is also required to comply with CEQA when issuing §Section 1600 Streambed Alteration Agreement permits, and can require the applicant to mitigate for impacts to bats and bat habitat. (Office of Planning and Research 2004)

5.6 PROPOSED DRAFT CALTRANS BAT POLICY

Caltrans staff has proposed a Draft Caltrans Bat Policy that will be reviewed prior to adoption. This study will provide information prior to internal review and approval. Caltrans has been, and will continue to be, exploring options for accommodating bats on transportation structures. For transportation structures known to be utilized by bats, accommodating these bats on the structures is the preferred approach; however, innovative design and construction are used as practicable. Innovative and effective mitigation strategies are a priority, including off-site efforts. Caltrans' goal is to maintain and operate structures for the purposes of transportation without adversely affecting bat populations, while also balancing the needs of bats with the safety of transportation workers.

6.0 ROLES AND RESPONSIBILITIES

6.1 CALTRANS

Caltrans, the Department of Fish and Game (DFG), environmental consultants, and Non-Governmental Organizations (NGO's) all play a role in the management of impacts to bats that may result from transportation projects in California. Caltrans, as one of the largest property owners and managers in California, is involved with other federal, state, and local agencies concerned with transportation projects. Many times projects require permits from, or interaction with, one or more of these agencies and groups; this section will introduce their roles, management and survey guidelines.

Many of the structures, roads, bridges and habitats provide important roosting and foraging habitat for bats. Large bridges can provide suitable roosting habitat for large colonies of bats over vast spatial and multiple temporal scales. As a result, the potential for negative impacts to bats resulting from transportation projects is high. However, at this time, there are no State or Federal listed Threatened or Endangered bat species in California. Eleven of the state's 25 bat species are California Special Concern species (CSC), and an additional three species, western red bat (*Lasiurus blossevillii*), long-legged myotis (*Myotis volans*) and fringed myotis (*Myotis thysanodes*) will soon be moved to this status (Bolster, pers. comm.). Although no recovery plan based on state or federally listed species exists for California, the California Bat Conservation Strategy is being developed in 2005 as a part of the California Comprehensive Wildlife Plan.

The following has been summarized, excerpted and adapted from the Bats and Bridges Technical Bulletin – A Hitchhiker's Guide to Bat Roosts (Erickson et al. 2003). Please refer to those documents for a more detailed discussion of the goals and policies of the Department.

Using an appropriate combination of structure inspection, sampling, exit counts, and acoustic surveys, a biologist with specific bats and bridges training is to survey each structure (and surrounding area) that may be affected by the project.

If bats are found, the biologist will identify them to species and evaluate the colony to determine the CEQA significance and/or NEPA effects by analyzing the potential impacts to bats and bat habitat. Typically, this is accomplished through a Natural Environmental Study (NES) which complies with CEQA and NEPA laws.

Caltrans is currently developing two documents; a "Bat Policy" and "Guidelines for Accommodating Bats in Transportation Projects," both of which are in draft form. In general, the draft policy suggests that Caltrans protects and enhances wildlife habitat in balance with environmental, economic and social goals of California. Projects are to "avoid, minimize, mitigate, and provide enhancement for potentially substantial adverse effects, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the Department of Fish & Game or U.S. Fish & Wildlife Service." Accommodation of bat populations utilizing transportation structures is the preferred approach; however, innovative design and construction are used as practicable. Innovative and effective mitigation strategies are a priority, including off-site efforts. This report presents an evaluation of a variety of innovative mitigation strategies for bats in California, and references mitigation strategies in the United States and other countries.

Caltrans does not unlawfully take, harass or intentionally disturb bat activities, except as legal to prevent damage to private or public property. Movement and migratory corridors are not substantially interfered with, and impacts are avoided, minimized, mitigated, or habitat enhancement provided, for any candidate, sensitive or special-status species. Caltrans strives to provide ample time for the planning of bat surveys and mitigation measures, and to continuously train biologists so that they maintain a level of understanding of bat biology so that surveys, bat detection, exclusions, and mitigation can occur when seasonally appropriate to avoid take, harm, or harassment of roosting individuals.

Caltrans may enter into species recovery plans by the DFG or the US Fish and Wildlife Service (USFWS) in certain circumstances and where feasible.

6.2 DEPARTMENT OF FISH AND GAME (DFG)

The Mission Statement for the DFG, as shown on the agency's web site (http://www.dfg.ca.gov//html/dfgmiss.html) is as follows:

> "… to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public.
>
> "The Department of Fish and Game maintains native fish, wildlife, plant species and natural communities for their intrinsic and ecological value and their benefits to people. This includes habitat protection and maintenance in a sufficient amount and quality to ensure the survival of all species and natural communities. The department is also responsible for the diversified use of fish and wildlife including recreational, commercial, scientific and educational uses."

As a trustee agency, the DFG provides guidance to Caltrans regarding measures to avoid, minimize or mitigate project impacts to bat species. DFG maintains the California Natural Diversity Data Base (CNDDB), which although by no means a complete inventory of wildlife species in California, provides a basis for understanding of a species' local occurrences. Local wardens and biologists should be consulted when needed to provide site visits and guidance.

6.3 ENVIRONMENTAL CONSULTANTS

Environmental consultants can provide specialized expertise in bat capture and identification, species surveys, and field research such as mark-recapture and telemetry studies. In addition, bat-specialist consultants can propose a variety of possible mitigation measures that may not otherwise be readily available to the local state biologist, engineer, or planner.

Some bat specialists may have particular expertise with bats in anthropogenic roosts such as transportation projects, particular knowledge of landscape-level or regional habitat issues, and many specialize in rare bat species. Some bat specialists have extensive knowledge of artificial roost habitat. Consultants can provide agency coordination during the life of the project, as well as pre-project baseline population studies and post-project monitoring.

It is the responsibility of the consultant to be knowledgeable about the species, range and occurrence appropriate for the project. A thorough understanding of bat biology is critical, and it is recommended that consultants hold a Scientific Collection Permit and MOU for work with bats through the DFG. Consultants are responsible for providing useful and transportation project-appropriate advice on presence or absence of special-status bat species, survey design, and mitigation measures. Consultants should also be able to successfully coordinate with Caltrans and the other agencies and NGOs involved in a project.

6.4 NON-GOVERNMENTAL ORGANIZATIONS

The activities of NGO's involved with bats in California include education, rehabilitation, habitat enhancement, and other conservation efforts. The largest national organization, Bat Conservation International (BCI), has been active in California as well as in many other states. In its home state of Texas, the organization collaborated with the Texas Department of Transportation to protect a large population of bats in the Congress Avenue Bridge in Austin. BCI published the Bats in American Bridges and the Texas Bats and Bridges Handbook. BCI is also field testing new artificial roost designs for transportation projects (e.g., bat houses for interim bat roosting habitat at Franklin Causeway, Case Study Number 7).

Local groups such as the California Bat Conservation Fund and various wildlife rehabilitation centers provide general education about bats and bat rehabilitation, and can be an important resource in the event bats are injured or non-volant bats are displaced during project activities.

7.0 PERMIT REQUIREMENTS

Conducting a bat-roost-habitat assessment and some types of focused surveys at transportation projects usually does not entail capture or handling of bats. In these cases, no permits are required.

Specifically, no permits are generally required to conduct the following:

- Echolocation surveys.
- Exit counts that do not disturb bats.
- Remote sensing outside roosts.
- Radio telemetry tracking (not including attachment of transmitters).

Echolocation studies involve the use of one or more “bat detectors”, devices with ultrasonic-sensitive microphones and some type of signal processing hardware to store, compress, or convert ultrasonic signals for real-time or later analysis. Exit counts are conducted so that no visible light shines on the roost area or openings. Noise and other disturbance must be minimized or eliminated, so that bats will emerge normally from roosts. Remote sensing utilizes bat detectors, night-vision cameras or video cameras, telemetry receivers, or similar devices. Radio telemetry tracking involves reception of radio signals from tagged bats. Tracking can be passive (observer stationary) or active (observer following bat’s movements).

For all studies that do not satisfy these limitations, two permits are required from the California Department of Fish and Game (DFG); a Scientific Collecting Permit - and because bats are designated as standard exceptions to the Scientific Collecting Permit (SCP) - a Memorandum of Understanding (MOU). The MOU describes the type of surveys, methods, and species proposed, and purpose of bat captures.

Applicants must show that they possess experience with trapping and handling bats before they are issued an MOU. Such experience is usually accumulated by working with a licensed bat worker under their permits, and demonstrating the necessary skills and abilities to DFG.

The following text ***(requirements and wording subject to change at any time)*** is copied from the DRAFT document from DFG, titled:

SKILL LEVEL REQUIREMENTS FOR CALIFORNIA DEPARTMENT OF FISH AND GAME BAT PERMITS[1_/]

<u>Level 1 Permitee Requirements:</u>

-Familiarity with key literature on bat ecology and research techniques.

-Understanding of basic bat biology (e.g., torpor, reproduction, energy budgets) and ecology (e.g., maternity colonies, hibernation, foraging behavior, migration, night roosting).

-Ability to handle live bats without causing undue stress or injury.

-Ability to readily identify bats to species level with the exception of *Myotis lucifugus* versus *M. yumanensis* and *M. californicus* versus *M. ciliolabrum (=M. leibii, M. subulatus*).

-Ability to age and evaluate the reproductive condition of bats.

-Basic understanding of how to set and operate mist nets and harp traps. This includes the ability to remove bats (and expected birds) from nets in an efficient and humane fashion. Ability to use hand nets appropriately.

-Basic understanding of and ability to operate standard equipment typically used in bat research (e.g., bat detector, night vision, telemetry equipment).

Level II Permitee Requirements:[2_/]

-Meets all Level I criteria.

-Experience with banding bats and an understanding of the pros and cons of various band types and potential for injury to bats.

-Ability to attach temporary light tags to bats for one-night tracking.

-Ability to survey or sample night roosts.

-Ability to collect hair samples.

Level III Permitee Requirements:[3_/]

-Meets all Level II criteria.

-Experience with attachment of radio transmitters to bats.

-Ability to enter known day roosts, maternity roosts, and hibernacula.

-Ability to collect blood or tissue samples.

[1_/]Skill levels are not necessarily equivalent to permit authority, e.g., a DFG permit that authorizes radiotelemetry does not automatically authorize collection of blood or tissue samples. For new MOU applicants, skill levels must be supported by 3 letters of recommendation from Level II or Level III bat biologists who have personally observed the applicant perfoming those skills and will attest to the applicant's ability to perform them. Issuance of permits is at DFG's discretion.

[2_/]Experience at Level I to be obtained by working under the close supervision of a person with Level II or III experience.

[3_/]Experience at Level II and III to be obtained by working under the close supervision of a person with Level III experience.

The Scientific Collecting Permit is available online, at:
http://www.dfg.ca.gov/licensing/pdffiles/fg1379e.pdf

The DFG license and Revenue Branch can be accessed online at:
http://www.dfg.ca.gov/licensing/specialpermits/specialpermits.html

8.0 PREDICTING THE IMPACTS

8.1 INTRODUCTION

Applicable mitigation measures can only be provided after appropriate surveys are complete enough to provide the needed information on specific bat populations. This usually requires surveys conducted for a minimum of a 12-month period (See Erickson et al. 2003). Natural history parameters and ecological requirements vary considerably among species, making it critically important that individual species occurring at a project site be correctly identified, and that species assemblage be adequately characterized. Additionally, detailed plans with timelines, pre-development and post-development site layouts and roosts need to be incorporated into the assessment of impacts to the bat populations potentially affected. Scale is important when assessing impacts to bats; impacts need to be considered at the site level, the regional level, and on a cumulative level. Building a replacement roost that does not work or does not provide the intended habitat function (e.g., maternity roost) is not mitigation. Similarly, constructing a replacement roost and destroying it during a later phase of construction, or installing a replacement roost and allowing it to disintegrate, is not mitigation.

8.2 TEMPORARY IMPACTS: DISTURBANCE

Extra noise, vibration, increased lights or the reconfiguration of large objects can lead to the disturbance of roosting bats which may have a negative impact on the animals. Human disturbance can also lead to a change in humidity, temperatures, or the approach to a roost that could force the animals to change their mode of egress and/or ingress to a roost. Although temporary, such disturbance can lead to the abandonment of a maternity roost, which in most cases would be considered a significant impact.

8.3 TEMPORARY IMPACTS: SHORT-TERM LOSS OF THE USE OF A BAT ROOST

When the same, unaltered, roost is unavailable to a population of bats for a relatively short period of time, the loss can truly be called a temporary loss as long as it does not result in displacement or harm to the animals – *e.g.*, for a maternity colony with dependent young even a very brief disturbance could result in animals abandoning the roost and/or mortality to the young. However, in most situations when bats loose the use of a roost, significant impacts should be called out for the permanent loss of a roost. Some environmental documents have called out the temporary loss of bat roosts as less-than-significant impacts when the original roost is lost but a new roost will be built. Mitigation may be possible with replacement roosts, but these replacement roosts are provided as a result of lost roosting habitat and should only be considered fully successful mitigation when these new roosts are utilized with the same species in about the same numbers as the original roosts.

8.4 PERMANENT IMPACTS: MODIFICATION OF ROOSTS

Modifications to roost sites can have significant impacts on the bats' usability of the roost. The reduction or increase in size, material that partially occludes an entrance, or other modifications can change the airflow, temperature, and humidity of the roost. Such physical changes can be critical to the bats' fitness and survivability (Kunz 2004). Species are unique in their requirements and roosting preferences, so any changes to roosts, including entrances and flight paths, need to be carefully examined when determining potential impacts. Briggs (2002) found that some species deserted roosts during barn conversions although bats were not intended to be permanently evicted.

8.5 PERMANENT IMPACTS: LOSS OF ROOSTS

Generally, the loss of roosting habitat is considered one of the primary conservations issues facing bat populations (Fenton 2001, Pierson 1998). Roosts become focal points for conservation efforts possibly partly because roosting habitat is more readily defined than foraging habitat. However, the loss of a single roost is not well understood because many species of bats use several roosts. Some populations may or may not have adequate alternative roosts, so it is difficult to fully understand impacts resulting in roost loss. What may be a catastrophic loss for one population of bats may not be nearly as significant in another population. Usually the loss of a maternity roost is considered a significant impact and there needs to be concerted efforts to fully mitigate for the loss of these roosts. The importance of other roosts to fecundity and survivorship is not as well documented or understood. For example, little is known about winter roosts in California, and some have been overlooked even during initial surveys for bats (see Case Study Number 4). Such winter roosts may be far more important than biologists realize if these roosts serve many species from a wide geographic area. Because it is often difficult to assess the real importance of roosts to bat populations and natural roosts are becoming scarcer with expanding human development, every effort should be made to avoid the loss of a roost and there should be no overall loss of roosts. Permanent Impacts: Fragmentation and isolation

Foraging areas and roosts can become isolated by housing developments or other major changes in the landscape. Radio-tracking studies indicate that bats frequently use linear features in the landscape suggesting that bats use these features to help navigate between roosts and foraging areas. When these linear features (e.g., row of trees, road, waterway) are removed, an impact on bats is likely to occur. Additionally, when a night roost is eliminated, the energetic cost to the bats of commuting to the surrounding foraging area may be so greatly increased, that this habitat is effectively lost, too. Similarly, even though a maternity roost may be protected, important nearby foraging areas could be lost to development. As development expands over the foraging areas, the costs of the commuter distances to foraging areas may exceed the benefits of the roost. The latter situation likely contributes, for example, to the extirpation of pallid bats from valleys under development (Dave Johnston, unpublished data).

8.6 PERMANENT IMPACTS: FRAGMENTATION AND ISOLATION

Foraging areas and roosts can become isolated by housing developments or other major changes in the landscape. Radio-tracking studies indicated that bats frequently use linear features in the landscape suggesting that bats use these features to help navigate between roosts and foraging areas. When these linear features (e.g., row of trees, road, waterway) are removed, an impact on bats is likely to occur. Additionally, when a night roost is eliminated, the energetics for bats to successfully utilize the surrounding foraging area may be compromised or lost because it may no longer be economical for bats to use that foraging area given an increase in commuter costs. Similarly, a maternity roost may be protected but nearby foraging areas are lost to development.

As the development expands over the foraging areas, the costs of the commuter distances to foraging areas may exceed the benefits of the roost. The latter situation contributes to the continuing extirpation of pallid bats from valleys under development.

8.7 PERMANENT IMPACTS: INCREASE IN HUMAN ACTIVITY

The long-term impact of human activity (e.g., additional lighting, vibration, nearby foot traffic, etc.) near a roost should be considered when determining impacts and mitigation. So foot paths designed along streams and bridges should separate foot traffic, as much as possible, from roosts, and intense lights for cars or pedestrians should be directed away from roosts or possibly shaded by trees.

9.0 MITIGATION STRATEGIES*

Mitigation should always focus first on avoidance; if avoidance is not possible, then impacts should be minimized. Replacement should only be used as a last resort and must be species-specific, lest increased harm to the bat assemblage occur. The best solutions are usually simple and fit within the parameters of normal operations.

Accommodation and mitigation should use the following approach:

1) Existing roosts are to be accommodated to the extent feasible while, maintaining the safety, operation, maintenance, and inspection aspects of the structure.
   a. Impacts and interactions with the species are to be avoided whenever possible through timing of work, method selection, and retention of features that provide naturalized habitat.
   b. If avoidance is not possible, impacts are to be minimized by careful planning of activities to complement the life history of the animal. Measures might include items such as temporary humane exclusions at appropriate times of year to avoid take, and the retention of portions of the features that provide naturalized habitat.
   c. Where appropriate, measures to minimize accumulation of guano from existing roosts and to allow inspection without disturbance to the bats are to be incorporated into projects.

2) Cost effective and ecologically sound mitigation should be considered where impacts to the roost could:
   a. Affect substantial values for migration, breeding, rearing of young, hibernation, or scientific study;
   b. Result in substantial adverse effects on any species or habitat identified as candidate, sensitive, or special status in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or the U.S. Fish & Wildlife Service; or
   c. Cause a wildlife population to drop below self-sustaining levels that are based on careful analysis of the best scientific and commercially available data for the local population.

3) Options for mitigation are to be considered at the watershed scale and should include such measures as:
   a. Ecologically sound compensation and/or enhancement, integrated with regional habitat planning to offset affected functions and natural systems.
      i. Off-Structure measures that provide suitable replacement roosting opportunities, such as mine gate closures or enhancements of structures in wildlife areas, should be considered as the highest priority option where feasible and cost effective.
      ii. Off-Structure, out-of-kind habitat improvements should be considered as a preferred comprehensive solution, in coordination with appropriate resource agencies, where roosting is not necessarily the limiting factor for the species present, and where sufficient information is available to indicate that habitat enhancement would benefit the population to an equal or greater extent than in-kind enhancements. The

* Adapted and updated from Erickson et al. 2003

implementation of resource management measures can cumulatively offset impacts and rectify chronic issues through the application of proven resource management principles, such as riparian restoration to proportionally improve ecological system function and species production.

iii. On-structure measures may be considered where:
1. Offsite measures are not available, economically feasible or ecologically effective.
2. Structural integrity and safety are not compromised.
3. They are compatible with social, economic and environmental goals of the local area, such that
   (a) density and distribution of species is not increased in areas of human occupation, e.g., urban, residential, farms, and recreational areas;
   (b) presence of the colony complements the surrounding natural communities;
   (c) design is aesthetic and discourages vandalism or tampering;
   (d) the site is not in close proximity to homes, businesses, schools, or public areas.
4. A design detail or structural design selection is available from the designer that
   (a) does not compromise structural integrity or safety;
   (b) allows routine maintenance and inspection of the bridge structure with features to prevent
      (i) accumulation of guano and or/urine,
      (ii) deterioration of materials;
      (iii) wildlife contact by
         - temporary containment of animals if bats and people are present at the same time,
         - easy temporary removal of features during maintenance and inspection, or
         - placement of features, such as panels away from catwalks (<20') and other areas routinely used for inspection.
5. Related resource agencies accept the following disclaimer in any agreements in order to allow required operations:

   Disclaimer:

   The structural elements and features that facilitate the life history of bat species on a bridge or other transportation facility are subject to regular inspection, repair, rehabilitation, alteration, and/or replacement as part of normal operations and maintenance, and may on occasion reduce or eliminate the habitat values provided.

   The Department will take reasonable measures to avoid and minimize unnecessary disruptions to the animal's normal behavior patterns, which include, but are not limited to, breeding, feeding and sheltering. However, this accommodation does not preclude the Department from future engineering actions that are found to be necessary to meet the transportation needs of California, or from measures to ensure the safety of the public or Department personnel. Habitat values may be removed with little or no advanced notice in those situations where it is necessary to immediately prevent or inspect damage or where the stability of the structure is in question.

i. The recovery of information through focused research would result in more effective resource management techniques and contribute to the improvement of ecological function and production. In some cases, such research would be acceptable to offset impacts; however, participation and reimbursement by the Federal Highway Administration may be limited.

4) Enhancement of a structure where habitat does not currently exist should be considered where the following conditions are met:
   a. The need for a specific habitat, such as night roosting, is outlined in a species recovery plan or land-use plan provided by the Department of Fish and Game or U.S. Fish and Wildlife Service.
   b. The appropriate environmental and engineering managers concur that the proposal is consistent with operations and stewardship goals.
   c. The approach meets the criteria of these guidelines.

9.1 ON-SITE NIGHT ROOST AVOIDANCE, MINIMIZATION, MITIGATION MEASURES

Night roosts are typically utilized from the approach of sunset until sunrise. In most parts of the state, night-roost use will only occur from spring through fall. The following example measures apply when bats are present, the evaluation criteria are met, and where work cannot occur during the off-season, before the bats arrive or after the bats leave. Each site is unique and thus, potentially requires site-specific measures.

Each generic approach is designed to control disturbance to a specific level for the most sensitive species. Specific project measures may be less stringent once site conditions, species sensitivity, and relative significance of the impact are considered.

9.1.1 Avoidance (No Impact)

Work activities are not to occur within 100 feet of the bridge between sunset and sunrise. Airspace access to and from the bridge is to remain approximately the same. Bird-exclusion netting must not be used. No clearing and grubbing is to occur adjacent to the structure. Lighting is not to be used near the structure where it would shine on the structure. Combustion equipment, such as generators, pumps, and vehicles are not to be parked, nor operated, under or adjacent to the structure. Personnel are not to be present under the bridge during the evening or at night.

9.1.2 Minimization (Minor Impact)

Work activities are not to occur under the structure between 10:00 p.m. and sunrise. Airspace access is not to be severely restricted. Bird exclusion netting must not be used. Clearing and grubbing near the bridge is to be minimized. Lights are not to be used under the structure. Combustion equipment, such as generators, pumps, and vehicles, are not to be parked or operated under the structure. Personnel are not to be present under the bridge during the evening and at night.

9.1.3 Minimization (Moderate Impact)

Between 10:00 p.m. and sunrise, work activities are to be limited to one portion of the structure at a time. Airspace access is not to be eliminated. Constant (daily) exclusion is to be in place at the work areas. If netting is used, it is to be made of thick plastic and with no exposed overlap joints. Lighting is to focus very specifically on the portion of the bridge actively under construction. Combustion equipment, such as generators or pumps, are not to be parked nor operated under the structure unless they are required to be in contact with the structure. Use ESA flagging to delineate work active work areas from non-active work areas. Personnel are not to be present under the bridge during the evening and night in non-active areas.

9.1.4 Mitigation (Major Impact)

The configuration that supports night roosting should be retained where feasible. Bridge replacements should consider use of a similar bridge design when the roost is large, unique or supports a rare species.

Should an alternate design be used, consideration is to be given to minor modifications that will provide semi-open cavities. The cavities should have sidewalls that are at least 0.6 meters tall and hang from the underside of the structure. The longitudinal walls should be spaced approximately 2 meters apart. Transverse walls, which can double as shear walls, should be 4+ meters apart.

Other options could include surveying the surrounding area and improving other potential sites with minor modifications or careful brush removal.

9.2 ON-SITE DAY ROOST AVOIDANCE, MINIMIZATION, MITIGATION

Day-roost use usually only occurs during the spring, summer, and fall in California, except in coastal areas, the Central Valley, and some other areas where large, non-hibernating, winter colonies can be found. These measures apply to those circumstances where the bats are present. The most critical time, known as the non-volant period, occurs during the breeding season when young are present, but are not yet ready to fly. The non-volant period is generally May through July. Due to seasonal variation between sites, April and August (and sometimes the beginning of September) are to be avoided.

The best avoidance measure is to work when the colony is not present and to retain or restore the roost characteristics after work is complete. If this measure is not feasible, measures taken should be consistent with the general approach guidelines. As noted in the general guidelines, day-roost replacement is to be considered as a last resort for avoiding further impacts to the species when structures are regularly inspected, maintained, and replaced. Furthermore, on-structure day roosts are always preferred over off-structure day roost replacement. Each generic approach is designed to control disturbance to a specific level for the most sensitive species. Specific project measures may be less stringent after site conditions, species sensitivity, and the relative significance of the impacts are considered.

9.2.1 Avoidance (No Impact)

Work is not to occur within 100 feet of an active roost. The area around the bridge is to be designated as an ESA. Airspace access to and from the bridge should remain approximately the same. No clearing and grubbing is to occur adjacent to the structure. Combustion equipment, such as generators, pumps, and vehicles, are not to be parked nor operated under or adjacent to the structure. Personnel are not to be present under the colony, especially during the evening exodus.

9.2.2 Minimization (Minor Impact)

Work is not to occur directly under or adjacent to the roost. The area under the roost within visual sight of the bats is to be designated as an ESA. Airspace access to and from the bridge is not to be severely restricted. Clearing and grubbing is to be minimized wherever possible. Combustion equipment such, as generators, pumps, and vehicles, should not be parked nor operated under or adjacent to the structure. Personnel should are not to be present directly under the colony, especially during the evening exodus.

9.2.3 Minimization (Moderate Impact)

Where work must occur in the area of a seasonal colony:

> Bats are to be excluded from directly affected work areas prior to April 15 of the construction year. Exclusion is to be done selectively, and only to the extent necessary, to prevent morbidity or mortality to the colony. Expandable foam, steel wool, or other method is to be used. Exclusionary devices are to be removed between August 31 and April 15, once construction is complete.
>
> Airspace access to and from the bridge is not to be eliminated. Colony ventilation and protection is to remain the same. Clearing and grubbing is to be minimal, whenever possible. Combustion equipment, such as generators, pumps, and vehicles, are not be parked nor operated under or adjacent to the structure unless they are required to be in contact with the structure. The presence of personnel directly under the colony is to be minimized.
>
> Provision of alternative roost sites may be considered when a substantial portion of the colony is to be excluded for a season or more. However, this is very experimental and close monitoring and reporting of observations is needed to document performance strengths and weaknesses of this measure.

9.2.4 Mitigation (Major Impact)

The ideal situation is to replace the current roost habitat with an identical roost containing the same species-specific physical parameters. If this is not possible due to engineering requirements, e.g., safety, replacement habitat may be considered. Supplemental habitat may also be considered when exclusion will occur for more than one season.

If an alternate design is used, consideration of minor modifications to provide similar roost characteristics is important where feasible.

Critical issues include access, ventilation, and protection, search image and thermal conditions. Crevice roosts should be replaced with crevices of similar area and cavities should be replaced with cavities of similar parameters.

Note: All potential on-site measures must be coordinated in advance with the structural engineer and incorporated into the project planning process.

9.2.4.1. Replacement Cavity Roosts

Replacement cavities that make the roost compatible with the bridge design and operation must be closely coordinated with structural engineers in order to incorporate the physical and ecological parameters that are of key importance to the specific species affected.

9.2.4.2. Replacement Crevice Roosts

Crevice Modification. Within engineering limitations, minor modifications of existing or proposed expansion joints or similar crevices may provide adequate replacement habitat without compromising the structure.

The gap of the joint should be between 1.9 and 3.8 centimeters unless engineering considerations make it unfeasible. Ideally, the replacement gap should match the original gap. The larger end of the range is better for larger crevice dwellers, such as mastiff bats, pallid bats, and big brown bats. Smaller crevices tend to favor smaller species, such as Mexican free-tail bats and pocketed free-tail bats. The inside surface area of the replacement crevice should be located near the original roost. The replacement roost should have an equivalent inside surface area as close as possible to the same compass orientation.

The crevice should have good aerial access, such as a clear 2-meter drop below or a lateral launching pad, where bats can drop down out of the crevice. The top of the crevice should be protected from sunshine, precipitation, and debris, but should have a small shelf for the bats to tuck their babies. The cover may be made of metal, concrete, gasket material, or other nontoxic substances. Gasket material should be omitted from the bottom thirty or more centimeters of the joint. The surface should remain rough; it should not be smoothed.

The replacement crevice should be swabbed with bat guano and urine collected from the original roost and additional guano should be placed in a row under the new roost.

Add-on Panels. Supplemental panels made of lightweight concrete or wood may provide some habitat value. These panels have been successful in California, but are of limited size. The panels must be very carefully placed vertically to avoid compromising the structural integrity or the ability to inspect the structure. The design and placement is extremely critical to allow proper temperature control and variety, as well as to allow for routine bridge inspections and maintenance. Airspace access to an entrance at the bottom of the panel should also be considered. A small ledge must be provided at the top for the bats to place their young.

The 1-meter tall panels are bolted on to the structure and must be sealed at the top to prevent rain from entering. The opportunity for limited ventilation should be provided at the top to allow temperature control. The surface should remain rough; it should not be smoothed.

Figure 9-1. Add-on Panels (Brian Keeley)

Add-on Collars. Collars around large piers are similar to flat panels, with a broader internal temperature range. Since their design may hamper column inspections, use of this method must be coordinated with the structural engineer to ensure accessibility. Collars are to be at least one meter high and subdivided internally by vertical staves that extend a quarter of the way down the inside. These collars may be made of lightweight concrete or as simple sheet metal. The opportunity for limited ventilation should be provided at the top to allow temperature control. The surface should remain rough; it should not be smoothed.

Capped-edge Drains. Standard-edge drains can provide small day roosts. The 6-8 inch, steel, cylindrical drain is capped with the bottom of coffee can tin paved over with asphalt. This creates a tube about 18 inches deep with a ledge at the top. The bats can use the edge to grip and the ledge to rest upon or hold their young.

Wooden-backed Signs. Metal or wood signs with wooden backing that are bolted to chain-link fence and suspended more than two meters off the ground can provide small to medium crevice day roosts. These signs provide tight spaces, the signboards being kept apart approximately one inch, and they can also provide places for maternal bats to tuck their young.

Note: This has only been recorded being used by Yuma myotis from one record in Tuolumne County. Future observations might yield additional species use. This observation importantly illustrates that suitable crevices can be very deceiving and cryptic.

Bat Houses. Bat houses may provide limited habitat in some cases. There are a variety of designs and ready-made houses available. Bat Conservation International evaluates and approves bat houses for effectiveness and is a good source for information and approved designs. Important considerations include opportunities for behavioral thermal regulation, thermal mass, interior size, ventilation, maintenance, permanency, protection from vandalism, correlation with the original structure, and effectiveness. When mitigating for the loss of a bridge roost, bat "houses" are unlikely to provide a thermal environment comparable to the roosts being lost. Design and location also need to be compatible with the bats' search image of their original roost. Appropriate mitigation is likely to require a substantial structure, using materials comparable to those used in the original roost.

9.3 WINTERING AND HIBERNATION ROOSTS

Wintering-or hibernation-roosting usually occurs from late fall through early spring in California. In many cases, the sites are also used as day roosts during the balance of the year. These measures apply when the bats are present for wintering or hibernation purposes.

The critical time is when the temperatures are low and the bats are in hibernation or deep torpor. The metabolic cost of waking a bat from hibernation can be very high and could be enough to reduce their energy supply to the point where survival of the individual is not possible. It is especially costly to disturb bats during cold spells when the cost of maintaining body temperature is high.

The best avoidance measure is to schedule work when the colony is not present and to retain the roost characteristics when work is complete. If this cannot be done, the following measures are to be considered:

9.3.1 Avoidance (No Impact)

To avoid stimulating energy-draining arousal, several measures are essential. Designate the area around the bridge as an ESA site. No work will take place or occur within 100 feet of an active roost. Airspace access to and from the bridge should remain consistent. No clearing and grubbing should occur adjacent to the structure. Combustion equipment, such as generators, pumps, and vehicles are not to be parked or operated under or adjacent to the structure. Personnel are not to be present under the colony, especially during the evening exodus from day roosts.

9.3.2 Minimization (Minor Impact)

Work must not occur directly under or adjacent to the roost. Designate the area around the bridge as an ESA site. Airspace access to and from the bridge would not be severely restricted. Clearing and grubbing will be minimized wherever possible. Combustion equipment, such as generators, pumps, and vehicles will not be parked or operated under or adjacent to the structure. Personnel shall not be present directly under the colony, especially during the evening exodus. Vibration and noise will be avoided.

9.3.3 Minimization (Moderate Impact)

Exclusions, when needed, will be installed at directly effected sites in late August, after completion of the maternity season. Exclusion is to be done selectively and only to the extent necessary to prevent morbidity or mortality in the colony. An expandable foam or steel wool should be used. Remove exclusionary devices after November 1 when temperatures have dropped and the animals have relocated. After construction is complete, the exclusionary device is removed.

Airspace access to and from the bridge must not be eliminated. Colony ventilation and protection should remain the same. Clearing and grubbing will be minimized, where feasible. Combustion equipment, such as generators, pumps, and vehicles should not be parked or operated under or adjacent to the structure unless they are required to be in contact with the structure. Minimize presence of personnel directly under the colony. Minimize vibration, noise and light to the maximum extent possible.

Provision of alternative roost sites is to be considered when a substantial portion of the colony will be excluded for a season or more.

9.3.4 Mitigation (Major Impact)

The magnitude of impacts to hibernation and wintering roosts can be substantial from a species and wildlife perspective. Therefore, major impacts, such as removal, must only be considered when there are no other alternatives. In such a case, a bat expert familiar with the particular species must be consulted.

10.0 MITIGATION RESULTS FOR RECENT PROJECTS IN CALIFORNIA

10.1 OVERVIEW

Table 10-1 summarizes information for 22 Caltrans bat mitigation projects, with more detailed information on each of these projects provided in Appendix N – Master Table. Nine of these projects were selected for a more in-depth analysis, and are presented as Case Studies (see Appendices A - I).

All projects were in some phase of development over the past five years. At the time of our assessment, two were still in the planning phase, five were under construction, and 15 were completed.

These projects fall primarily into two general categories: seismic retrofit or bridge replacement. We have evaluated five seismic retrofit projects and 16 bridge replacement projects. There was one additional project in which the original bridge, scheduled for removal, was left intact as mitigation. Mitigation was provided on site for 20 of these projects; for one mitigation was off site, and for one the decision regarding on versus off site has not yet been made. Off-site mitigation was used as a temporary measure during the construction phase in five projects.

Bat mitigation structures fall into several categories, and are discussed in more detail below. For all five seismic-retrofit projects, , bats were (or will be) allowed to return to their original roost (which in all cases was a hinge, expansion joint, concrete girder or abutment cavity), with additional habitat provided on one bridge in the form of applied concrete panels.

In one bridge replacement project the mitigation solution was to leave a portion of the old bridge in place, retaining original roosting habitat. Bat habitat was constructed for the fifteen other bridge replacement projects. One project involved installing a concrete bunker installed at the site of the original bridge alignment; fourteen were incorporated into the structure, or applied to the surface of the new bridge. These can be characterized as cast-in place crevices, concrete or wooden panels applied to the inside of a closure pour or some other surface, bat houses applied to some bridge surface, a bat box recessed into the ventral surface of the deck, expanded weep holes, and/or an open hinge. The distribution of these structural types and an evaluation of their effectiveness are summarized in Table 10-2.

10.2 BAT MITIGATION STRUCTURES

10.2.1 Original Habitat Retained

10.2.1.1. No Action

Sometimes the easiest mitigation measure is simply to take no action. The abandoned Hicks Haul Bridge was originally scheduled for demolition as a part of a development plan. Because a large colony of bats occupied the bridge expansion joints, the most effective mitigation measure to conserve bat habitat was to retain the bridge and incorporate it in a county-owned pedestrian trail.

Table 10-1. Bat Mitigation Results

10.2.1.2. A Portion of Original Bridge Retained

In bridge replacement projects, the alignment for the new bridge is frequently different from that for the old bridge, offering the opportunity to mitigate for bats by retaining all or part of the old bridge. This option has a high probability of success because the bats do not need to accommodate new habitat. Although it may also be the most cost effective solution, safety and liability issues must be addressed. This option was used successfully for the Auberry Road Bridge over the upper San Joaquin River (Case Study #1).

10.2.1.3. Seismic Retrofit – Temporary Exclusion

For seismic retrofit projects, the portions of the bridge used by bats (most typically expansion joints, hinges, abutment cavities, and/or concrete girders) are typically only impacted during construction. For those bat colonies roosting in hinges or expansion joints, it is important that neither Styrofoam, nor any other filler, is used to fill these hinges and joints during construction as is often called for in retrofitting plans. Examples of this type of mitigation, and problems that may arise, are discussed in more detail in Case Studies #2 (I-880 over Patterson Slough), #3 (Monterey Bridge No. 450 over Salinas River), and #4 (Hacienda Road over Arroyo de la Laguna).

Seismic retrofit projects often impose a risk of disturbance to bats during construction. There are two obvious ways to try to mitigate this impact. One is to schedule the construction during a time of year when bats are not present (winter in most, but not all, localities – see Case Study #2). However, due to other wildlife constraints (generally fish protection) winter construction is frequently not an option (see Case Study #4).

Another approach is to limit construction to one portion of the bridge at a time – e.g., one end of the bridge, as for Monterey Bridge No. 450 (Case Study #3), or one half of the lanes, as for I-800 (Case Study #2). By using this approach, at least half of the roosting habitat remains in place during construction. In both of these situations, bats were humanely excluded, outside of the maternity season, using one-way doors when known roosts of the same species occurred in those other areas of the bridge away from the construction area (1000 feet for Monterey Bridge No. 450 and about 200 feet for the I-880 bridge). In both these projects, the bat biologist requested a change order to the existing plans so that Styrofoam was not inserted into the spaces created by the hinges and expansion joints. Two of three species present in the Monterey Bridge No. 450 prior to construction were present in post-construction surveys. The pallid bat, present prior to construction in this bridge, and the species considered the most sensitive to disturbance, had not returned to the bridge four years after construction. Although bats did move from the eastern portion of the bridge to the western portion of the bridge as a result of using one-way doors, the I-880 Bridge has not been evaluated for the post construction return of over-wintering bats.

Another mitigation option is to humanely exclude (also with one-way doors) bats from the entire structure, and offer temporary off-site habitat. For example, bat boxes were mounted on a near-by bridge for the Hacienda Road project (Case Study #4). Although these were not successful, bats have returned to the retrofitted bridge in the same or greater numbers than before construction. The necessity to supply interim habitat for bats should be assessed on a case by case basis, and will depend on both, the species of bats being affected, and on the characteristics of the surrounding habitat (i.e., whether alternative roosting habitat is available in the vicinity of the project). To date, interim roosts have met with only very limited success and are reviewed in Section 10.2.3.1 below.

10.2.2 Original Habitat Lost; New On-Site Habitat Provided

In bridge-replacement projects, the structures used as roost sites by bats are inevitably lost. Depending on the number of bats, the species of bats, and/or the type of roost (*e.g.*, maternity roost), mitigation, particularly the provision of new roost sites, may be needed. New roost sites that come closest to replicating the original roost site will offer the greatest potential for success. Important parameters include roost dimensions, roost temperature, proximity to the original site, and physical similarity to the original roost, which may provide a familiar search image for returning bats. All these requirements are more easily met with on-site mitigation structures. Such structures can either be applied to a surface of the bridge after construction or, with careful coordination with engineers, be incorporated into the bridge structure. They can be constructed of lightweight concrete or wood (generally plywood).

10.2.2.1. Bat Roost Applied to Bridge Surface

Ten of the on-site mitigation structures considered in our review involve bat roosts applied to bridge surfaces. Seven of these are either still in the planning stage or have not yet been evaluated (see Table 10-2). The measure that appears to have the greatest potential for occupancy and require the least maintenance is the application of lightweight concrete panels to create roosting crevices inside closure pours. An example of this approach is supplied in Case Study # 5 (Appendix E, Saint John's River Bridge). A comparable approach using wooden panels has only been partially successful (Mill Creek Bridge, see Table 10-1 and Appendix N).

Significantly, pallid bats were originally present in day roosts and night roosts at the Saint John's River Bridge and Mill Creek Bridge. Although both bridges are still used as night roosts for either big brown bats or Mexican free-tailed bats, only the Saint John's River Bridge is occupied as a day roost, and only Saint John's River Bridge has roosting pallid bats. This comparison has its limitations because the dimensions of the wooden slots for the Mill Creek mitigation roost may have been inappropriate at 2" wide. Nevertheless, given its greater durability and thermal stability, concrete is likely to be more successful than wood for roost panels that are applied to a bridge surface. Concrete panels have also been successful at another bridge (South Fork Cottonwood #8-21, see Table 10-1 and Appendix N).

An additional experiment in roost design was implemented for a temporary roost during the construction phase of the Main Street Cottonwood Creek project (Case Study #6). In this project, because thousands of bats belonging to three species were to be displaced during construction, interim roosts – collars constructed of plywood panels – were installed near the tops of four round piers on the adjacent I-5 Bridge. Mexican free-tailed bats occupied these collar roosts almost immediately; big brown bats used them to a limited extent, and pallid bats never used them. Although collar roosts were highly effective for Mexican free-tailed bats as temporary roosting habitat, collars cannot be used as permanent roosting habitat because of structural inspection issues. Bat houses applied to a bridge surface as an interim measure during construction also failed to work for pallid bats in the Hacienda Bridge project (Case Study #4).

10.2.2.2. Bat Roost Incorporated into Bridge Structure

Incorporating bat roosts into the structure of a new bridge requires design assistance from bridge engineers to insure that the roost does not interfere with the structural integrity of the bridge. Engineers have approved two experimental roost designs. One, the inclusion of deep, cast-in-place, tight-grain redwood or plywood crevices has been tried for two projects: the Franklin Causeway (Case Study #7) and the Main Street Bridge over Cottonwood Creek (Case Study #6). Details regarding the placement and design of these roost structures are provided in the case studies. Both projects have been highly successful for Mexican free-tailed bats. Because the Mexican free-tailed bat was the only species involved in the Franklin Causeway project, this mitigation can be considered effective. The Main Street Bridge project involved three to four species, including the pallid bat. In the first season after completion of construction, two species occupied the new roosts, but the pallid bat, a target species for mitigation, was not present. This project is still under evaluation.

A second experimental roost design calls for the inclusion of an open bat box recessed into underside of a closed-box girder. Such a structure has already been included in the new Skaggs Bridge over the San Joaquin River (Table 10-1, Appendix N), and is included in the design for the replacement bridge on SR104 over Dry Creek (Case Study #8). Because the new Skaggs Bridge was completed late in the summer of 2004, it is too soon to evaluate its effectiveness. The the lack of bats when it was surveyed in September 2004 does not mean the project was not successful. Because both these bridges had pallid bats roosting in the original structures, it will be especially important to monitor the success of these projects.

In another project for which only limited data were available, the I-5 Cottonwood Creek Bridge #6-0204 (Table 10-1, Appendix N), vent covers were enlarged for 15 weep holes, with the intention that bats could be provided access to the interior of the box beam. Although bat use of the hinge in this bridge was considered in the context of another project (Main Street Cottonwood Creek project, Case Study #6), to our knowledge, the effectiveness of the enlarged vents has not been evaluated.

10.2.3 Original Habitat Lost; New Off-Site Habitat Provided

Off-site mitigation was attempted as a temporary measure (*i.e.*, offering interim habitat during construction) in five of the projects we reviewed, and as the proposed permanent solution in only one (Pieta Creek, Case Study #9). Two of these interim roosts were applied to a nearby bridge structure and thus are discussed in Section 10.2.2.1 above.

10.2.3.1. Freestanding Bat Houses

Freestanding bat houses were available to bats during construction for three projects. In two cases they were part of the mitigation plan (Appendix G, Franklin Causeway, Case Study # 7 and Mojave River Bridge [see Table 10-1 and Appendix N]). For the I-880 project (Case Study #2) a bat house already existed approximately 70 m from the project bridge. Although small numbers of bats occupied the bat houses installed for Mojave River, in no case did the bat houses adequately replace the habitat lost, and these free-standing bat houses should generally be considered failures. Even the fairly large, condominium-style bat houses installed for the Franklin Causeway project were used only to a limited degree, whereas the cast-in-place crevices of that project were occupied as soon as they were available. Freestanding bat houses likely fail to provide the thermal stability that bats seek in a roost, and are particularly inadequate for very large colonies. Also, because they are highly visible they have the potential to become an attractive nuisance, increasing the chances that bats will be harassed by and/or come in contact with humans.

10.2.3.2. Bunker

Case Study #9 describes an attempt on SR 101 over Pieta Creek to construct a roost for pallid bats. In this project a bunker, known to meet the size qualifications for a pallid bat roost, was installed in the bank, within the alignment of the old bridge. This roost had not been occupied after one season, and thus, so far has not been effective. We have suggested some minor modifications to this design, which should be tried before the project is considered a failure.

10.3 CONCLUSIONS AND RECOMMENDATIONS

Researching and assembling information on bat mitigation projects in California has illuminated certain problems and resulted in a series of recommendations.

10.3.1 Problems with Bat Mitigation Projects

10.3.1.1. Initial Evaluation

Because such a large percentage of bridges are used by bats and because bats have come to rely on these structures, bat surveys should always be included in the environmental assessment process for bridge projects. Planning appropriate and successful mitigation requires that the person conducting the environmental evaluation be able to determine whether or not bats are using the bridge, what species are present, what structural features are being used as roosts, and for what roosting purpose (e.g., day or night, maternity) the bridge is being used. Caltrans biologists are often put in the untenable position of being asked to make these determinations without adequate background and training. Consequently, there are cases in which bats were discovered too late to provide adequate mitigation measures, and cases in which mitigation is proposed even though the species of bats and function of the roost is unknown.

10.3.1.2. Mitigation Planning Process

It was apparent from our review that the mitigation planning process was frequently flawed and led to unnecessary problems. It is critical, particularly for all on-site mitigation projects, that engineers and biologists engage in a cooperative planning process. Engineers and biologists should consult with each other early enough in the planning process that an ecologically successful, cost-effective, and structurally satisfactory solution can be worked out.

Once Caltrans biologists and engineers have agreed upon a mitigation solution, clear instructions need to be given to the contractors. Furthermore, a biological monitor should be used to insure mitigation measures are adhered to and that bats are not harmed.

10.3.1.3. Evaluation of Mitigation Measures

Of the fifteen completed projects included in our review, monitoring mitigation measures has generally been inadequate. For six projects, the only monitoring of the effectiveness of the mitigation measure was a single visit by one of our team in the context of this project. For six other projects, consulting biologists had been involved, and some follow up evaluation was conducted, although in a couple of cases, the monitoring was not adequate (*e.g*., limited to a single visit). No monitoring had occurred for two completed projects. Generally, Caltrans biologists recognize the need for monitoring, and try to work it into their schedules, but when such measures are not mandated, it is difficult for them to justify the time expenditure.

10.3.1.4. Special Considerations for Pallid Bats

It is evident from this review that mitigation is far easier for some species than for others. Three species commonly found in bridges, the Mexican free-tailed bat (*Tadarida brasiliensis*), the big brown bat (*Eptesicus fuscus*), and the Yuma myotis (*Myotis yumanensis*) are fairly adaptable. In general, mitigation measures have worked for these species. Accommodating the pallid bat (*Antrozous pallidus*), a California species of special concern, which also relies heavily on bridge roosts, is far more challenging. Pallid bats were identified in seven of the 22 projects we reviewed. Two of these projects are still in the planning or construction phase, so the effectiveness of the proposed mitigation cannot yet be evaluated. For the five completed projects, the mitigation appears to have failed in three cases, and been successful in two.

The two projects that appeared to be successful for pallid bats were a seismic retrofit in which the bats were excluded during construction and then allowed to return to their original roost (Hacienda Bridge, Case Study #4) and the Saint John's River Bridge replacement (Case Study #5) in which pallid bats have occupied the crevices provided by concrete panels installed inside a closure pour.

There were also three attempts to mitigate for pallid bats that to date have failed. Although the original roosting habitat is virtually unchanged on Monterey Bridge No. 450 (Case Study #3), pallid bats have not been observed in this roost for four years since the construction disturbance for a seismic retrofit. In this case, the construction contractor did not follow mitigation guidelines, and there is the possibility that the pallid bat colony was disturbed to such an extent that it has not returned. Pallid bats also have not occupied the cast-in-place crevices provided on the new Main Street Cottonwood Creek Bridge (Case Study #7), despite attempts to duplicate the dimensions, location, and temperature conditions of the original roost. Additionally, pallid bats have not so far occupied a concrete bunker roost provided for them (Case Study # 9), using the dimensions and configuration of known roosts.

10.3.2 Recommendations

Based on a review of these 22 projects, our recommendations are:

1. A protocol for evaluating bat use of bridges, such as that proposed in Erickson et al. 2003, needs to be formally adopted and implemented as policy.

2. Caltrans biologists need to be given adequate training to conduct bat surveys and formulate biologically appropriate mitigation plans for bats. Because the effectiveness of most mitigation measures has not been adequately determined, and thus few guidelines are available, Caltrans biologists should have the flexibility to consult with bat specialists (*e.g.*, for highly significant roosts, or particularly challenging mitigation problems).

3. A procedure that insures adequate communication between Caltrans biologists, Caltrans engineers, and contractors should be established for biological consultation.

4. Future research should be conducted, including more experimental roost designs, to determine mitigation measures most appropriate for specific species. This approach is particularly critical for special-concern species like the pallid bat or Townsend's big-eared bat.

5. Monitoring should be an integral part of the mitigation process. The lack of monitoring data seriously hindered our ability to conduct a quantitative analysis of the mitigation measures already in place. Although we have made preliminary assessments regarding the effectiveness of various mitigation measures, there were no projects for which adequate quantitative data were available. For adequate evaluation, post-construction monitoring should occur seasonally (four time/year) for up to three years, or until the mitigation can be considered successful. Success would be defined as the mitigation roost or roosts being occupied by comparable numbers of bats belonging to the same species as were present pre-construction.

6. A central repository needs to be established for bat/bridge data. Such a data base should be made available to all Caltrans biologists, and should include information with respect to which bridges have been surveyed for bats, exactly when they were surveyed and under what conditions, which bridges have bats present, species if known, what features the animals are using, what mitigation measures have been tried, contact information, and the effectiveness of these measures.

7. On-structure mitigation roosts should be considered before off-site roosts, due to their greater effectiveness. At this time, designs such as the lightweight concrete panels mounted inside a closure pour may offer ease of design and implementation, with minimal maintenance and interference with bridge inspection and maintenance, while providing effective roost habitat for some species. Experimental designs should be continued until all species can be confidently mitigated for all situations.

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Appendix A.

Case Study 1
San Joaquin River Bridge, #42C0003
(Auberry Road Bridge)

San Joaquin River Bridge, #42C0003 (Auberry Road Bridge)
Dave Johnston, Bat Biologist
H.T. Harvey & Associates

Case Study 1. Replacing a Bridge While Allowing the Old Bridge with Bats to Remain.

Location	Madera/Fresno County line
Species Involved	Mexican free-tailed bat (*Tadarida brasiliensis*), and likely other species
Type of Work	Bridge replacement
Potential Impacts	Loss of maternity colony
Type of Roost	Maternity roost, day roosts, night roosts
Size of Colony before Construction	estimated at 200 + in 1999
Size of Colony after Mitigation	estimated at 200 + in 2004

Overview

The original bridge was composed of a steel trestle attached to wooden abutments. Public works was unable to provide roosting habitat on the new replacement bridge because of budgetary constraints. Consequently, public works was willing to leave the wooden abutments as roosting habitat for bats. The wooden abutments were retrofitted with additional safety rails and structures were strengthened. The number of bats in the colony was estimated based on the guano pile below roosts and a single count in 1999.

Location and Ownership

The Auberry Road Bridge is located on the Madera/Fresno County line over the upper San Joaquin River, seven miles north of Auberry on Powerhouse Road (222) and 6.5 miles south of North Fork on Auberry Road. The steel and wooden bridge is owned and maintained by the counties of Madera and Fresno.

Background

The Fresno County Public Works and Development and Madera County Road Department had proposed removing the existing bridge and replacing it with a new bridge at a site downstream several hundred feet. Because the new bridge would provide no potential for bat roosting habitat, members of the local community requested that mitigation for the bats be provided. The bat biologist first suggested that the old bridge should remain so that bats were not disturbed. County and Caltrans engineers had already decided to remove the old bridge for liability reasons after a replacement was completed. The engineers therefore believed it was better to remove the old bridge with its roosts and simply build new roosts off the site or incorporate new roosts on the new bridge. However, none of the proposed bat roosting habitats to be added to the new bridge were acceptable to both engineers and the bat biologist. Consequently, the steel trestle was removed, but the old bridge abutments were reinforced and safety rails were installed at the ends of the abutments. With very little additional work, these structures could be handicap or wheel chair accessible.

Features Important to Bats

The Auberry Road Bridge and nearby Powerhouse plant has been a well-known roost for large numbers of Mexican free-tailed bats. Additionally, smaller numbers of other species, such as the big-brown bat and the Yuma myotis, also likely bred in these wooden abutments. The spaces or crevices between the large wooden beams provide day roosting habitat for bats. Additionally, the warm surfaces generated by the heat from the bridge decking provides bats with night roost habitat.

Photo 1. Image taken from under wooden abutment of original Auberry Road Bridge. Notice the urine staining on the concrete beam. Photo by Dave Johnston.

Project Approach and Design

Initially, the wildlife biologist assigned to conduct reconnaissance-level wildlife surveys did not observe the bats roosting on the bridge structure. Public comment for the Natural Environmental Study suggested that bats roosted on the bridge and such roosting habitat would be lost when the steel and wood bridge was removed. A bat biologist made a daytime survey of the bridge on October 30, 1996 and found evidence of roosting Mexican free-tailed bats. Because this project included destroying the original bridge, Caltrans offered to add features in the new bridge to provide bat roosting habitat. However, any design provided by the bat biologist was too expensive to incorporate into the bridge design. The bat biologist suggested leaving the wooden abutments and removing only the steel trestle. Although initially the Caltrans engineers rejected the idea of leaving the wooden abutments, that was the most economical solution to mitigate for lost habitat. For safety reasons, guard railing was installed at the raw ends of the abutments to help prevent visitors from falling off the bridge. The abutments should ultimately become wheelchair accessible and the public also has platforms above the water's edge that provide excellent views of the river as well as fishing platforms.

Photo 2. Abutments left with new railing around top. If railing in the immediate foreground is removed, these structures could allow handicap access to a beautiful view of the river. Photo by Dave Johnston.

Photo 3. View of the abutments from the new Auberry Road Bridge. Photo by Dave Johnston.

Schedule of Work

1996 – Initial surveys of bat roosts and first draft for Natural Environmental Study

1997 – Final Draft for NES
1999 – Construction begins for the new bridge, the new bridge is finished, the steel trestle on the old bridge is removed and guard rails are installed.
2004 – Post construction survey of bats

Lessons Learned

If a lead agency proposes mitigation that, in the opinion of the bat biologist, will likely not mitigate impacts to bats, than that opinion needs to be established in hopes that planners and engineers will ultimately come to agreement to provide adequate mitigation with a high probability of working. In other words, sometimes a "compromise" in design for bat mitigation may never work until the replacement habitat meets some threshold acceptable by bats. The engineers' initially-proposed changes to the new bridge, as a compromise to recommended mitigation, to provide roosting habitat for bats was not, in the opinion of the consulting bat biologist, likely to work.

Additional input and pressure from citizens in the community helped facilitate the lead agency's decision to retain those parts of the bridge, the abutments, to continue to provide roosting habitat for bats in the area.

Although there was a cost benefit to leaving the abutments and not removing these structures from the low flow channel of the San Joaquin River, these abutments were reinforced for long-term stability that offset most potential savings derived from not removing the structures. Nonetheless, the net result of the outcome preserved bat roosting habitat situated in a relatively undisturbed environment.

The retained abutments, functioning as new features along a transportation route, may enhance the recreational activities of handicapped persons and other travelers.

Recommendations

Caltrans biologists need sufficient training to conduct complete and accurate bat surveys. Personnel inspecting bridges for bats should have enough knowledge to detect bats, and preferably, be able to conduct surveys for species identification. Such persons should have at least a level one Memmorandum of Understanding with the DFG

Biologists (state and consulting) should be involved in the early stages of planning in order to provide the best possible mitigation strategy.

Avoidance (of removing roosting habitat) should be considered first when deciding upon appropriate mitigation.

Appendix B.

Case Study 2
U.S. Interstate 880/Alameda Creek Bridge #33-0240

U.S. Interstate 880/Alameda Creek Bridge #33-0240
Dave Johnston, Bat Biologist
H.T. Harvey & Associates

Case Study 2. Mitigation Strategies for a Winter Roost

Location	U.S. Interstate 880 over Patterson Slough, Alameda County
Species Involved	Mexican free-tailed bat (*Tadarida brasiliensis*), and Yuma myotis (*Myotis yumanensis*).
Type of Work	Bridge Deck replacement and seismic retrofitting.
Potential Impacts	Loss of a bat hibernaculum for Mexican free-tailed bats; loss of a maternity colony of Yuma myotis.
Type of Roost	Permanent loss of Mexican free-tailed bat hibernaculum day roosts, night roosts
Size of Colony before Construction	estimated at 1000 for Mexican free-tailed bats
Size of Colony after Mitigation	unknown

Overview

The large U.S. Interstate 880/Alameda Creek Bridge over Patterson Slough comprises a box girder bridge with two large expansion joints occurring over the water. The northbound side of the bridge needed a replacement deck, the southbound side needed grinding and resurfacing of the top of the deck, and many piers needed reinforcing. Bats were not observed during the original biological surveys of the bridge; however, a bat biologist did not conduct these surveys. A colony of 1,000 Mexican free-tailed bats was observed in January 2004 when the construction contractor installed netting to prevent birds from nesting on the bridge. After a failure to find suitable alternative roosting habitat for these bats before they were excluded from the bridge, approximately 950 of the Mexican free-tailed bats left the winter roost. The approximate fifty individuals left were not likely breeding (at least all those examined were either non-breeding males or females, or compromised physically because of old injuries). Although the contractor preferred to exclude all bats and birds from the bridge, bat biologists suggested that to move bats without knowing if other roosts occurred in the area could lead to the loss of those individuals and possible the loss of a maternity colony of Yuma bats. Netting was pulled back from known roosts on the southbound side of the bridge to provide roosts to bats that were about to be excluded from the northbound side. One-way doors were then installed on the northbound roosts, and bats were observed in southbound roosts thereafter. Bat biologists argued that the abandonment of filling expansion joints with Styrofoam for the Monterey Bridge #450 (Bradley Road Bridge) should set a precedence. In Spring of 2004 Caltrans engineers approved leaving the expansion joints void of any filler, such as Styrofoam.

Photo 1. U.S. Interstate 880/Alameda Creek Bridge over Patterson Slough in Alameda County.

Location and Ownership

The U.S. Interstate 880/Alameda Creek Bridge in Alameda County comprises is located approximately one mile north of the Alvarado Boulevard overpass on U.S. Interstate 880. The Caltrans-owned-bridge is situated over Patterson Slough, a flood control channel bypass for Alameda Creek.

Features Important to Bats

The U.S. Interstate 880/Alameda Creek Bridge in Alameda County provided an important winter roost for the Mexican free-tailed bat. Johnston (1998) studied fluctuating populations of Mexican free-tailed bats and reviewed recapture data in Central California that suggested that populations that breed in the Central Valley over-winter along the coast. The bridge roost is located approximately five miles from edge of the San Francisco Bay suggesting this roost site provides bats with a cool but even temperature during winter months. No maternity colony of the Mexican free-tailed bats occurred during the spring or summer of 2004; however, Yuma myotis likely breed on this bridge. Bats did not appear to use roosts for only night roosting; rather, bats that day-roosted appeared to also night roost in these expansion joints.

Photo 2. About 200 feet from the bridge, a bat box had been placed in a wetlands mitigation site. No bats or any evidence that there were bats, were observed in the bat box. Bat biologists rejected the concept that this bat box could provide habitat for the over-wintering bats in the bridge. Photo by Dave Johnston.

Project Approach and Design

This project had only generalized mitigation in the environmental documents to protect bats and resources (roosting habitat) for bats. Although no bats had been observed during initial surveys by biologists, mitigation measures did require a biologist to monitor the bridge as netting was attached to the underside of the bridge. These nets were used to prevent birds and bats from forming breeding colonies and the monitor was needed to prevent animals from being trapped.

Because the biology monitor subcontracted to the construction contractor, all communications and decisions had to be made through the contractor, as opposed to Caltrans. Ultimately, as the situation became more complicated, decisions were made with a combination of the Caltrans biologist, Caltrans engineers, administrators, the contractor and the consulting biologist as a subcontractor.

After bats were found to roost in the bridge in January, plans were drawn to exclude all bats from the bridge. However, no alternative roosts, or even suitable roosts, were found within a few miles. Plans to retrofit nearby bridges failed because other government agencies would not provide permission to alter bridges in anyway. After much discussion, nets were pulled back to a point that bats could re-enter a roost on the southernmost expansion joint on the southbound side of the bridge. Bats in the northbound expansion were then excluded with one-way door devices. In March, approximately 80 Yuma myotis occupied a section of the northbound bridge and were excluded and moved from this impact area. Both Yuma bats and Mexican free-tailed bats occurred in the westernmost sections of the expansion joints (in the southbound bridge).

Photo 3. One of several one-way doors (designed by Dave Johnston) used to move bats away from the impact areas of a bridge to another side of the bridge. Photo by Dave Johnston.

Part of the description of the bridge included the filling of all hinges and joints with Styrofoam. The filling of these crevices would have permanently eliminated breeding habitat for birds and bats. Because Caltrans engineers decided there were no negative effects from not filling in joints and hinges (and because of the precedent established when such crevices were not filled on Bradley Road Bridge in Monterey) joints and hinges were not to be filled.

Results of Post Construction Monitoring

Although bats were monitored at various times during construction when bats were moved, no post construction surveying has taken place. A survey of the bats in January is needed to better understand possible changes to the wintering Mexican free-tailed bat population. Likewise, the Yuma myotis population in May and June has not been surveyed since bats were moved.

Lessons Learned

1. Biologists inspecting bridges may not be trained enough to detect bats, or the evidence of bats, on bridges.

2. Partly because bats were not initially detected on the bridge, adequate funding was not available to mitigate for bats in ways preferred by the bat biologist (i.e., a better job of mitigation could have been provided if bats were discovered prior to the contractor bidding the job so mitigation for bats would have been budgeted.)

3. Bridges may provide important roosting habitat for wintering bats (i.e., bridges may provide a winter roost).

4. The bat biologist was in a subordinate position to the contractor; and therefore, the bat biologist did not have full control over some bat excluding activities.

5. Although surveys were conducted to ensure bats were not in impact areas prior to construction and the exclusion devices used to move bats worked well, no follow-up surveys were conducted to determine if bats returned to the original roosts.

6. Although the hinges and joints of many bridges are designed with a filler (e.g., Styrofoam), Caltrans engineers have approved not filling these crevices for retrofits.

Recommendations

1. Personnel inspecting bridges for bats should have enough knowledge to detect bats, and preferably, be able to conduct surveys for species identification. Such persons should have at least a level one Memorandum of Understanding (MOU) with the DFG.

2. Construction contractors should not be able to claim they can manage bird and bat exclusion without the oversight of qualified biologists. When known populations of wildlife exists in bridges, qualified biologists should be required as part of the Statement of Qualifications (i.e., if a contractor bids on a project with bats that could potentially be

in harms way or at risk, the contractor should be required to either subcontract out to a bat biologist as a part of his/her proposal, or otherwise provide proof of a qualified bat biologist (as defined by an MOU with DFG).

3. Surveys should be conducted enough times during the year that the environmental documents can safely determine if impacts could potentially occur to bats or bat habitat (e.g., a single survey determining there are no maternity roosts associated with a project may not adequately address potential impacts to wintering bats).

4. Bat biologists should not be placed in a subordinate position to construction contractors, particularly when little or no money was budgeted to manage bats.

5. There should be adequate funding to follow up with surveying to determine if mitigation was effective.

6. Bridge retrofits should not be designed to include a filler, such as Styrofoam, if bats or other wildlife utilize hinges and joints as resources.

Literature Cited

Johnston, D. S. 1998. [ABS] Population fluctuations in Mexican free-tailed bats (*Tadarida brasiliensis*) in central California. Do some bats migrate? Bat Research News 39:4, p. 172

Appendix C.

Case Study 3
Salinas River Bridge #44C0051
(Monterey Bridge No. 450 – Bradley Road Bridge)

Salinas River Bridge #44C0051 (Monterey Bridge No. 450 – Bradley Road Bridge)
Dave Johnston, Bat Biologist
H.T. Harvey & Associates

Case Study 3. Maternity Colony Found during the Construction Period

Location	Southern Monterey County
Species Involved	Yuma myotis *Myotis yumanensis*, Mexican free-tailed bat (*Tadarida brasiliensis*), and pallid bat (*Antrozous pallidus*)
Type of Work	Bridge seismic retrofit
Potential Impacts	Loss of maternity colony
Type of Roost	Maternity roost, day roosts, night roosts
Size of Colony before Work	212 in 1999
Size of Colony after Work	200 in one cluster, about 40 in another expansion joint in 2004

Overview

The seismic retrofitting of this bridge required drilling through the concrete girders at the bridge hinges. Because day roosts and at least one maternity colony occurred in these hinges, drilling through these hinges could potentially disrupt active maternity colonies. The mitigation provided that only one half of the bridge was to be worked on at one time to allow bats to move to other roosts occurring in undisturbed portions of the bridge. After construction was completed in the first half of the bridge, construction could commence in the other half after the maternity season and under the direction of the bat biologist. The first work area would need to be free from bats and birds before construction commencement.

The contractor disregarded the written mitigation measures provided in the Natural Environmental Study (NES) and drilled through a maternity colony of Yuma myotis. Only after pressure from the Caltrans administration, Monterey County personnel instructed the contractor to hire the bat biologist to determine the best way to proceed, given the current situation. Although the Yuma myotis colony remained in place during and after drilling of the occupied hinge, construction was moved, and limited to, the easternmost ½ of the bridge. The bat biologist monitored the development of the young *Myotis yumanensis* to determine when they were volant and regularly leaving the roost so that one-way doors could be installed to “move” bats to other alternative bridge roosts. Instead of moving to another roost within the same bridge, the Yuma myotis colony moved to a different nearby bridge, at least initially.

Location and Ownership

The Bradley Road Bridge (Monterey County Bridge # 450) comprises a concrete box girder structure across the floodplain and concrete arched bridges over the low flow channels of the Salinas River. The county-owned bridge is located approximately 4 miles south of Bradley, Monterey County and immediately north of the northern boundary of the Camp Roberts Military Reservation in San Luis Obispo County.

Background

The Monterey County Department of Public Works had proposed retrofitting this approximately 1,110 foot- long bridge to meet current Caltrans seismic codes. Retrofits for this bridge include: construction of hinges and an abutment seat extension and strengthen pier walls and joints. Pier walls were strengthened by enlargement accomplished by drilling and jack hammering existing piers to add steel and concrete to the bases. Holes were drilling through the joints and bridge sections were tied together with large cables.

Features Important to Bats

The Bradley Road bridge (Monterey County bridge # 450) provided roosting habitat for hundreds of Mexican free-tailed bats, about 200 Yuma myotis and about 20 pallid bats (*Antrozous pallidus*). The majority of the bridge is box girder construction providing numerous night roosts. Over the water and between sections of the approaches, joints and hinges provide 7 large crevices of about 18 - 36 inches deep, depending on the amount of remaining cork, and of varying widths. Yuma bats form a maternity colony on this bridge, and although unconfirmed, Mexican free-tailed bats and pallid bats are suspected of also forming maternity colonies. This bridge does not have a history of being monitored for bats prior to 1999, but we believe populations here are stable based on recent surveys in 2004. Starting at this point and for six miles to the north comprises probably the most mature and unspoiled stand of valley riparian habitat along the Salinas River. A survey of Least Bell's Vireo (*Vireo bellii pusillus*), a federally- and state-listed endangered species, produced three singing males along this reach of the Salinas River in the early 1980s (Robertson 1985). Excellent foraging habitat occurs in adjacent areas and over this riparian habitat near the confluence of the San Antonio, Naciemento, and Salinas Rivers.

Project Approach and Design

To avoid significant impacts to a maternity colony of pallid bats, the project's mitigation measures suggested only one-half of the bridge be under construction at a time. This would allow bats movement among roosts of 4 hinges and joints while the other 3 hinges and joints were under construction and without bats. Because no mitigation for birds or bats was initially followed, and no biological monitors were initially present during the initial construction, it is unknown what impacts were made on these biological resources.

When contractors have the obligation to provide "adequate" biological monitoring, and Caltrans is not directing activities to conserve biological resources, it is easy for biological resources to be either unprotected or under-protected.

Part of the description of the bridge included the filling of all hinges and joints with Styrofoam. This was not disclosed with the initial description of the project design yet would certainly have a negative impact on breeding habitat for bats and birds. The bat biologist got the approval of Caltrans staff (and contract) engineers to agree that the Styrofoam was not necessary and the bridge would not be compromised if no material was inserted in the joints and hinges. The fact that this saved money and reduced the actual budget facilitated the decision not to fill these crevices.

Photo 1. Bradley Bridge located over the Salinas River at the southern end of Monterey County. Photo by Dave Johnston.

Photo 2. Bradley Bridge showing hinge providing day roosting and maternity colony habitat. The box girder construction to the left of the hinge provides night roosting habitat. Photo by Dave Johnston.

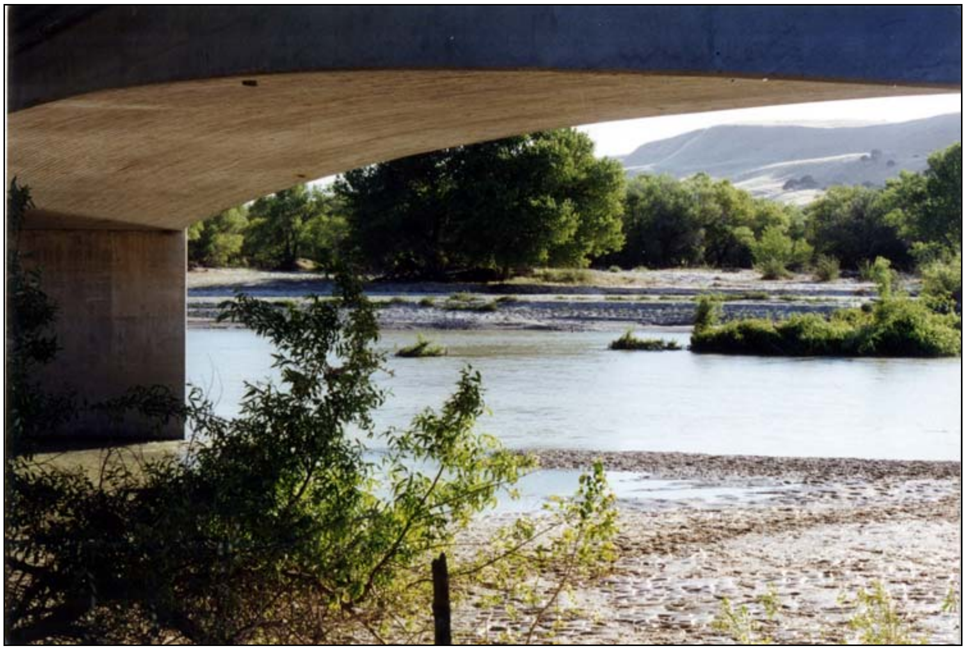

Photo 3. This view of an arched portion of the bridge looking north and across the Salinas River illustrates the adjacent habitats. Habitats occurring in the area were relatively undisturbed to the north and provided good foraging habitat for those species found roosting on the bridge. Yuma myotis forage over the Salinas River and in the well-developed mature cottonwood – willow riparian habitat and pallid bats likely forage in the grassland habitat covering the hills in the distance. Photo by Dave Johnston.

Photo 4. Location of a pallid bat colony in June 1999. Seen flying on the right side of the photograph is a White-thoated Swift (*Aeronautus saxatalis*) exiting from the crevice. Photo by Dave Johnston.

Photo 5. Detail of the roost site for pallid bats. White-throated Swifts were roosting only about 25 cm from the pallid bat colony. Notice urine staining and cork material falling out of the crevice. No animals were present at the time the photograph taken in August 1999. Photo by Dave Johnston.

Schedule of Work

1998 – Initial surveys of bat roosts and first draft for Natural Environmental Study
1999 – Final Draft for NES
1999 – Construction begins
August 1999 – Yuma myotis colony excluded after young are volant; relocated in another bridge
Winter 2004 – Caltrans approves hinges and joints to be left open and not filled with Styrofoam
August 2004 – Post mitigation survey of bats roosting on bridge

Results of Post Construction Monitoring

Field Notes for the Bradley Road Bridge Retrofit Project
8-20-04; 14:00 – 16:30; Sunny, light breeze, temp. 92º F
Dave Johnston (H. T. Harvey & Associates).

Table 1. Pre- and Post-construction Survey Results for Bradley Road Bridge (Monterey Bridge # 450) for Crevice Roosting Bats and Birds.

Hinge or joint	Species	Survey 1999	Survey 2004
#1 (Westernmost hinge)	*Myotis yumanensis*	212	~200
#2	*Tadarida brasiliensis*	Estimated at several hundred	Guano and staining but no bats present
#3	*Myotis yumanensis*	None present	~40
#4	White-throated Swifts Northern Rough-winged Swallows	Not specifically noted	2 Evidence but none present
#5	White-throated Swifts	Not specifically noted	1
#6	*Tadarida brasiliensis*	~100	~16
#7	Pallid bats White-throated Swifts	20 4	No recent evidence Evidence but none present

Lessons Learned

Because the burden of biological monitoring rested upon the contractor or subcontractor, no effective monitoring was conducted during the initial phases of construction. Most mitigation requires qualified personnel to monitor specific potential significant impacts or affects to endangered species. However, the burden of how often and when monitoring should occur is largely left up to the construction contractor, especially if a Streambed Alteration Agreement (1600) from DFG is not needed because work occurs when the low flow channel is dry. While projects in metropolitan areas are likely better monitored, bats occurring on projects in more remote areas, such as retrofitting Monterey Bridge #450, appear to be at greater risk. Thanks to Caltrans biologist, Kelley Phillips, and some supportive administrators, construction on a hinge with a maternity colony of bats was stopped until alternative roosts were located, all young were flying, and the colony was excluded from the construction zone.

For the Bradley Road Bridge, Yuma myotis were successfully "moved" from a maternity roosting site after all young were volant. Individuals were excluded and they relocated to an alternative nearby roost that had been previously located. When this colony was surveyed four years later, the colony approximated the same number of individuals (212 in 1999 and approximately 240 between two clusters in 2004).

Bat biologists requested that hinge and joint crevices not be filled with Styrofoam because doing so would eliminate the bridge's day roosting habitat. CalTrans engineers supported the idea when they determined amongst themselves that the lack of Styrofoam would not risk the integrity of the bridge structure and by allowing these crevices to remain open meant saving important bat and bird breeding habitat.

Recommendations

1. Personnel inspecting bridges for bats should have enough knowledge to detect bats, and preferably, be able to conduct surveys for species identification. Such persons should have at least a level one Memorandum of Understanding (MOU) with the DFG.

2. Construction contractors should not be able to claim they can manage bird and bat exclusion without the oversight of qualified biologists. When known populations of wildlife exists in bridges, qualified biologists should be required as part of the Statement of Qualifications (i.e., if a contractor bids on a project with bats that could potentially be in harms way or at risk, the contractor should be required to either subcontract out to a bat biologist as a part of his/her proposal, or otherwise provide proof of a qualified bat biologist (as defined by an MOU with DFG).

3. Styrofoam should not be used as filler for the expansion joints for bridges. Caltrans engineers have approved retrofitting bridges without filling in expansion joints with Styrofoam or some other filler.

Appendix D.

Case Study 4
Hacienda Bridge #33-0180

Hacienda Bridge over Arroyo De La Laguna Seismic Retrofit Project

Paul Heady assisted by Winifred Frick

Case Study 4. Hacienda Bridge over Arroyo De La Laguna Seismic Retrofit Project.

Location	Hacienda Bridge over Arroyo De La Laguna, Alameda County
Species Involved	Pallid bat (*Antrozous pallidus*), Townsend's big-eared bat (*Corynorhinus townsendii*), Yuma myotis (*Myotis yumanensis*), and Mexican free-tailed bat (*Tadarida brasiliensis*)
Type of Work	Seismic Retrofit
Potential Impacts	Loss of maternity roost for three species, loss of day roost for *C. townsendii*, and night roost for four species.
Type of Roost	Maternity roost, day roost, and night roost
Size of Colony before Work	*A. pallidus* – ca.>100, *M. yumanensis* – >150; *T. brasiliensis* – >100
Size of Colony after Work	*A. pallidus* – >150 ; *M. yumanensis* – >150; *T. brasiliensis* – >100

Overview

The primary objective of this project was to reduce impacts to bats by:

1. Excluding bats during construction to avoid direct and indirect take of bats during seismic retrofit construction activities; and maintain suitable bat day, night, and maternity roosting habitat at Hacienda Bridge following seismic retrofit construction activities.

2. Designing and installing alternative habitat.

3. Monitoring the effectiveness of this mitigation.

Location and Ownership

This bridge over Arroyo De La Laguna is located in Alameda County, in Pleasanton ½-mile west of Highway 680 on Hacienda Drive. The bridge is owned and maintained by the County of Alameda.

Background

This bridge was scheduled for seismic retrofit in the spring/summer of 2000. Harding Lawson and Associates, under contract for the County of Alameda, hired contract bat biologist Paul Heady to conduct a preliminary survey of the bridge to determine if any bats were using the bridge. The initial survey was conducted June 15th 1999. The cavity created by the east abutment showed signs of night roosting activity (guano and staining) by *Myotis* species as well as Townsend's big eared bat. The guano deposition suggested that a small to moderate-sized colony of bats roosted in an expansion joint. No bats were observed day roosting during the initial survey, but Yuma myotis were found night roosting in the west abutment cavity.

Surfaces below the east expansion joint showed signs of abundant bat activity (large historic and recent guano deposition and staining). The joint was occupied by Yuma myotis, pallid bats, and Mexican free-tailed bats. Yuma myotis pups were present. No pallid bat or Mexican free-tailed bat young were observed. Many of the pallid bats appeared to be pregnant.

The center expansion joint also showed signs of both current and historic high levels of bat use. Yuma myotis with young made up the majority of the bats. Pallid bats and Mexican free-tailed bats were also using the crevice.

The west expansion joint also showed signs of large numbers of Yuma myotis, pallid bats and Mexican free-tail bats. The cavity created by the west abutment also showed signs of night roosting by a myotis species and pallid bats.

An acoustic monitoring station was set up approximately 60 feet downstream of the bridge. Echolocation calls were recorded from 2040 to 2207 and 240 files were collected representing constant activity of bats leaving the bridge. The species recorded were Yuma myotis, pallid bats, and Mexican free-tailed bats.

Because of the presence of pregnant pallid bats, a follow-up survey was conducted in July to determine if the pallid bats were in fact using the bridge as a maternity roost. The follow-up visual survey was conducted on July 26, 1999. An inspection of the bridge revealed the presence of juvenile pallid bats, volant juvenile Yuma myotis, and newborn Mexican free-tailed bats. This confirmed the bridge as an active maternity roost for the three species.

A second acoustic survey station was established on July 26, 1999 approximately 50 feet upstream of the bridge. Bats began emerging from the bridge at approximately 2035 and constant activity was observed until 2140. Species recorded were Yuma Myotis, Mexican free-tailed bats, and Pallid bats. At 2155 Yuma myotis were observed night roosting in the east abutment cavity. The east expansion joint had juvenile pallid bats, and newborn Mexican free-tailed bats

The seismic retrofit work for the Hacienda Bridge was extensive. The area around the base of the central footing was excavated to expose the three columns resting on the base footing. The space between the columns was filled to create a monolithic pier. This work also involved installation of a water diversion barrier around the excavation area. Seat extenders were enlarged on both abutments and the central pier. The eastern abutment had extensive work involving excavation around the abutment to replace the dead-man anchor rods. The existing cross frame was replaced with all new high strength steel. Finally, the entire structure was sand-blasted, cleaned and painted which required tenting to contain all hazardous materials associated with the old paints and materials.

Features Important to Bats

The primary roosting features provided by this bridge are the three expansion joints. The Hacienda Bridge is constructed from two slabs that make up the deck resting on steel beams anchored at each end by abutments and supported in the middle by a central pier. The western expansion joint between the deck slab and the abutment is situated in an enclosed space that traps air and provides a stable environment around the roost. The central expansion joint above the central pier provides a very isolated roosting site. The east and west expansion joints are similar. Each abutment forms a cave like space that provides excellent night-roosting and day-roosting space. Townsend's big-eared bats were found day roosting in the west abutment and the space near the east expansion joint.

Extensive valley and live oak savannah as well as sycamore riparian near this site provide important foraging and day-roosting habitat for pallid bats.

Project Approach and Design

The initial survey of Hacienda Bridge illustrated the importance of this structure to the bat fauna of the surrounding area. A maternity roost of this size for three bat species required proper mitigation.

Ideally, scheduling of the work would avoid impact to the bats by working in the winter. However, the in-stream work around the central pier did not allow for work conducted between November and April due to fish protection constraints. This schedule meant bats would be disturbed during their breading season from late April through September.

It was decided that mitigation would involve safely excluding bats from the roosting features during construction to avoid direct and indirect loss of individuals during construction. The mitigation would also involve maintaining suitable day-roost, night-roost, and maternity-roost habitat on the Hacienda Bridge after the completion of the project. An alternate roost structure was constructed on the Verona Street Bridge, roughly 2/3-mile downstream from the Hacienda Bridge. Finally, monitoring was conducted at the Hacienda Bridge and the alternative roost on the Verona Street Bridge to determine the level of re-occupation of the Hacienda Bridge and use of the alternate roost structure.

Exclusion of the bats involved installing tubular foam pipe insulation in the crevices used by bats in January 2000. The abutment cavities were closed off in late April 2000 by gluing wood slats around the openings of the cavities and stapling sheet plastic in place.

The alternate roost was constructed as follows: Two boxes made up of six, 4-foot by 2-foot plywood baffles were mounted on the under side of the Verona Street Bridge at mid-span. These boxes were mounted on a cross beam tight against the cement deck in hopes of benefiting from the thermal mass of the deck.

Schedule of Work

15 June 1999 –Initial survey of bridge

26 July 1999 – Follow up survey of bridge to determine if pallid bats were in fact using the bridge as a maternity roost.

2 October 1999 – Fall survey of bridge.

2 December 1999 – Meeting with Alameda County staff, Harding Lawson staff, and Bat Biologist Paul Heady to discuss implementation of designed mitigation.

January 2000 –Installation of exclusion devices in roosting crevices

27 March 2000 – Construction and installation of alternate roost on the Verona Street Bridge.

Late April 2000 –Installation of exclusion sheeting on the abutments.

June 2000 – Emergence survey of alternate roost at the Verona Street Bridge and night survey of the Hacienda Bridge during construction to determine effectiveness of exclusion efforts

Late September 2000 – Removal of exclusion devices.

6 July 2001 – Monitoring of the Hacienda Bridge and the Verona Street Bridge structure post construction

Survey and Monitoring Results

The June 2000 survey of the Verona Street Bridge alternate roost at emergence found no sign of bat occupation of the structure. The night survey of the Hacienda Bridge to determine the effectiveness of the exclusion measures found that pallid bats were very active at the site despite the completely altered appearance of the structure due to exclusion measures and the construction tenting. Bats were continuously flying up to the blocked crevices emitting social calls.

July 06 2001 Monitoring

East Abutment. The cavity created by the east abutment showed signs of night roosting activity (guano and staining) by *Myotis* species The guano deposition was very light indicating light-to-moderate use.

East Expansion Joint. The crevice formed by the expansion joint was filled to capacity with pallid bats with young, Mexican free-tailed bats, and Yuma myotis.

Center Expansion Joint. Pallid bats and Mexican free-tailed bats were using the joint, although the majority of the bats were Yuma myotis.

West Expansion Joint. This joint had large numbers of Yuma myotis, pallid bats and Mexican free-tailed bats.

West Abutment. The cavity created by the west abutment showed signs of night roosting by myotis and pallid bats.

Verona Street Bridge. The roost structures placed under the bridge were visually surveyed and no bats were observed using the structures.

The first acoustic monitoring station was established in the rip-rap stones at the bridge abutment. Echolocation calls were recorded from 2040 to 2200 hours, and 93 files were collected representing constant activity of bats leaving the bridge. The species recorded were Yuma myotis, pallid bat, and Mexican free-tailed bat.

A second acoustic survey station was established under the Verona Street Bridge. Monitoring was conducted from 2040 until 21500. Species recorded were Yuma myotis and Mexican free-tailed bats. No bats were observed emerging from the roost structures under the bridge.

Bat occupation of the Hacienda Bridge appears to have increased slightly in the expansion joints, most notably in the center joint. This may be due to the fact that habitat was increased by the removal of historic guano build up. All three species have re-occupied the bridge in numbers equal to or exceeding pre-construction levels.

Evidence that Hacienda Bridge was being used as a maternity roost by the three species Yuma myotis, pallid bat, and Mexican free-tailed bat had been observed on July 06 2001. No further monitoring seemed necessary due to the fact that the bridge was being used at levels exceeding pre-construction levels.

The roost structures under the Verona Street Bridge had not shown use by the middle of maternity season 2001 and therefore were unlikely to be used later that season. These structures may be used in subsequent years and visual assessment should be conducted by county staff each summer season.

Discussion

The efforts to protect the pallid bat colony in the Hacienda Bridge were successful. Maintaining the original roost structure (the bridge expansion joints) is likely responsible for the successful re-establishment of the pallid bat maternity colony. Although the bats were excluded from their roost structure for an entire maternity season, bats were able to return to the original bridge features after construction was completed, rather than being forced to habituate to an unfamiliar alternative structure.

In an effort to provide available roosting habitat during the exclusion period, an alternative roost structure was built and placed under the adjacent Verona St. Bridge. The original intent behind the Verona St. bridge roost habitat was a temporary roosting structure for bats displaced by the exclusion. Bat biologists met with the Alameda County planning staff and gave a presentation about the roosting ecology of bats and the importance of the local bat fauna to the ecosystem.

After this brief educational presentation, the Alameda County planning staff agreed to allow the Verona St. Bridge roost structure to become permanent as a net gain of available bat habitat in the area. Although the Verona St. Bridge roost habitat was available, there was no evidence that pallid bats used this structure during the exclusion period. The Hacienda Bridge pallid colony must have had near-by alternative roost habitat because bats were seen active in the area during the exclusion period.

Lessons Learned and Recommendations

1. The timeline on this project were appropriate for determining and implementing proper mitigation efforts. The initial surveys were conducted a year in advance of the proposed construction which allowed bat biologists to observe bat behavior and seasonal usage of the roost structure. Exclusion devices were implemented prior to the arrival of the maternity colony in spring, so no bats were physically removed.

2. Bat banding and radio-tracking would have greatly benefited our understanding the local movements and fidelity of the bat colony. Radio-tracking would have permitted biologists to know if there were alternative roost structures that animals could have used during the exclusion period (and possible protect them during that critical period). Banding would have confirmed that the same individuals returned to the structure after a season of exclusion.

3. A timeline should be developed early in the planning stages to provide successful mitigation.

4. Radio-tracking will greatly facilitate understanding the importance of the roost(s) to any given colony. When providing successful mitigation measures, radio-tracking should be used as a method of determining if (and where) a colony has alternative roosts.

Appendix E.

Case Study 5
Saint John's River Bridge #46-0108

Saint John's River Bridge
Greg Tatarian

Case Study 5. Duplicating Roosting Habitat in a New Bridge.

Location	Bridge over Saint John's River, Tulare County, SR 216, PM 7.9
Species Involved	Pallid bat (*Antrozous pallidus*), Mexican free-tailed bat (*Tadarida brasiliensis*), and Myotis sp. (possibly *Myotis yumanensis* or other *Myotis* species)
Type of Work	Bridge replacement
Potential Impacts	Loss of roosting sites for maternity colony of at least one species, night roost for at least two species
Type of Roost	Maternity and night roost
Size of Colony before Work	*A. pallidus* – ?, *T. brasiliensis* – >?, *M. yumanensis* or other *Myotis* species – ?
Size of Colony after Work	*A. pallidus* – 30; *T. brasiliensis* – >500; *Myotis* species >20

Overview

The primary objectives of this project were to reduce impacts to bats by:

1. humanely exclude bats roosting in the original bridge's expansion joint, and

2. working with engineers to provide roosting habitat in the new bridge, similar to that being lost by demolition of the old bridge.

Location and Ownership

The Saint John's River Bridge on Route 216 is located in Tulare County, at Post Mile 7.9, and is represented on the U.S. Geological Survey Quadrangle for Exeter, at Township 18S, Range 25E, Section 24. The bridge is owned by Caltrans.

Background

The Saint John's River Bridge on Route 216 was an open girder design built in 1951, and a variety of upgrade plans were considered and rejected, in favor of replacement, which was conducted in stages to move both directions of traffic through one lane. The original 7.9 meter wide bridge was replaced with a new 12.0-meter-wide structure. Construction started in Spring 2000.

Bat surveys, conducted by Gregg Erickson, revealed that the old bridge served as a day and night roost for Mexican free-tailed bats (*Tadarida brasiliensis*), big brown bats (*Eptesicus fuscus*), and unidentified Myotis species. In addition, some evidence was observed of roosting by a CDFG Species of Special Concern, the pallid bat, *Antrozous pallidus.* Gregg Erickson and the district biologist then worked with the bridge engineers to design replacement habitat for incorporation into the new bridge.

Features Important to Bats

The Saint John's River Bridge on Route 216 served as a day and night roost for at least three species, and was likely used by one or more additional species. Bats primarily used the single expansion joint that spanned the width of the bridge.

Replacement Habitat in New Bridge

The replacement bridge was opened in the winter of 2003, and that spring, day and night roosting bats were observed. The replacement bridge design is being used increasingly for new bridges, and consists of two separate box girder structures, with a separation of several feet between the two structures, which is finally sealed with a closure pour. This closure pour connects the bridge deck, but not the bottom surface of the box girders, so a vertical recess remains between the two sections.

Photo 1. New bridge with closure pour recess and bat roost habitat panel at left. Photograph by Greg Tatarian.

A lightweight concrete panel approximately 2" thick, running the full height of the closure pour recess, was installed in the portion of the bridge that is situated mostly above the water. The roost area created by the panel provides 3-4 times that of the original expansion joint.

Photo 2. Closer view of roost panel, showing staining signs of bat roosting activity. Photograph by Greg Tatarian.

Monitoring Results

Post-Construction Surveys

Surveys conducted in the spring of 2004 by District biologist Morgan Kirk revealed that *T. brasiliensis* were day-roosting in the new habitat, and *A. pallidus* were observed night-roosting. A day survey conducted by Greg Tatarian on August 10, 2004, revealed roosting by *T. brasiliensis* along approximately 80% of the length of the panel, and ca. 30 *A. pallidus*. In addition, several Myotis individuals, tentatively identified as *Myotis yumanensis*, were observed.

Photo 3. Closeup of urine staining showing active roosting by bats. Photograph by Greg Tatarian.

Discussion

One of the species first observed in the old bridge, *E. fuscus*, was not observed in the new bat roost habitat on the new bridge. Despite this, the short interval between completion of construction and roosting by *T. brasiliensis*, and subsequent day-roosting by *A. pallidus*, is extremely encouraging, especially so because *A. pallidus* was not observed day-roosting in the old bridge.

The bottom of the new bridge is situated fairly low to the grade (ca. 5 m.), which brings the bat roost within reach of vandals. Graffiti was observed elsewhere within the closure pour, and over time, additional vandalism is likely to occur. The roost panel is made of material visually identical to the bridge, does not protrude from the closure pour, and appears to be an integral part of the vertical wall of the box girder, is extremely well-disguised. Additionally, the crevice requires viewing from directly below to discern any bats roosting inside, and the height of the panel allows bats to retreat to the upper portions of the roost crevice, which should protect them from all but the most determined vandals. One concern might be accumulation of smoke inside the crevice in the event of human campfire activity beneath the roost, but because most of the panel is situated above the water, this seems rather unlikely to occur.

Photo 4. Pallid bats day-roosting in the panel crevice. Photograph by Greg Tatarian.

In addition to the day-roost potential of the crevice, the closure pour design appears to offer significant potential night-roosting habitat. This design can be modified in future bridges to provide even better habitat – for example by casting in separating walls within the closure pour recess, perpendicular to the pour, creating additional roosting pockets that trap warm air and provide additional roosting surface area.

Lessons Learned and Recommendations

The design of the replacement bat roost habitat panel has been successful to date, and offers significant advantages over other designs, and especially so compared to off-structure mitigation roosts such as bat houses. Although there is an interest by Caltrans engineers and maintenance staff in exploring off-structure alternatives, panels such as this can be constructed at relatively low cost, and are inherently inconspicuous. In addition, with this design the panel is attached to a portion of the bridge that does not require the same degree of inspection and maintenance, and impacts to sensitive portions of the bridge, such as expansion joints and abutments, are minimized. This design would provide an excellent platform for experimentation with subtle variations to accommodate different species, and its use should be strongly encouraged for future closure pour bridge mitigation roosts.

Appendix F.

Case Study 6
Main Street Bridge over Cottonwood Creek

Main Street Bridge over Cottonwood Creek
Elizabeth D. Pierson and William E. Rainey

Case Study 6. Duplicating Roosting Habitat in a New Bridge with Other nearby Bridge Roosts

Location	Main Street Bridge over Cottonwood Creek, Cottonwood, Shasta-Tehama County line
Species involved	Pallid bat (*Antrozous pallidus*), Mexican free-tailed bat (*Tadarida brasiliensis*), big brown bat (*Eptesicus fuscus*), and Yuma myotis (*Myotis yumanensis*) or other *Myotis* species
Type of Work	Bridge replacement
Potential impacts	Loss of roosting sites for large maternity colonies for three species
Type of Roost	Maternity roost
Size of colony before work	*A. pallidus*– >100, *T. brasiliensis* –>1,000, and *E. fuscus*– >300; *M. yumanensis* or other *Myotis* species – a few individuals
Size of colony after work	*A. pallidus* – 0; *T. brasiliensis* – >1,000, *E. fuscus* 0; *Myotis* species >200

Overview

The primary objectives of this project were to reduce impacts to bats by:

1. installing exclusion devices in the bridge during the winter prior to construction, at a time when no bats were present;

2. working with engineers and the Department of Public Works to design and install temporary roosting habitat during demolition of the old bridge and construction of the new bridge; and

3. working with engineers and the Department of Public Works to provide roosting habitat in the new bridge, similar to that being lost by demolition of the old bridge.

Additionally, in cooperation with the engineers, the replacement habitat was designed to test the roosting requirements of the species present by providing crevices of differing widths.

Location and Ownership

The Main Street Bridge over Cottonwood Creek is located on the Shasta-Tehama County line, just south of the town of Cottonwood, and just east of the I-5 crossing of Cottonwood Creek. The bridge is under the jurisdiction of Shasta County, and the project was administered by the Shasta County Department of Public Works in Redding.

Background

The Main Street Bridge over Cottonwood Creek, just south of the Town of Cottonwood, was built in 1930, and was replaced for structural reasons (Photo 1).

Photo 1. Old bridge early in demolition. Piers for new bridge are being installed under the old bridge. Photo by William E. Rainey.

This bridge was located approximately 100 m east of, and parallel to, an I-5 crossing of the same creek. Also, a few hundred meters to the west is a railroad trestle that also crosses Cottonwood Creek. A large sand bar on the south shore and ready access to the north shore make the area around this bridge an attractive recreational site for swimming, fishing, and picnicking by local residents.

Bat surveys, initiated by Shasta County in the summer of 2000, revealed that the old bridge served as a significant maternity roost for three bat species, including a CDFG Species of Special Concern, the pallid bat, Antrozous pallidus. The consulting bat biologists then worked with the bridge engineers to design replacement habitat for incorporation into the new bridge.

Features Important to Bats

The Main Street Bridge over Cottonwood Creek served as an important day roost and maternity site for three species, and was used by occasional individuals of one or two additional species. Bats primarily used the expansion joints, each extending about 2 meters deep and located over each of the 20 bents that supported the bridge deck (Photo 2). Some night-roosting also took place among the concrete girders under the deck.

Photo 2. Corbel used by bats as entry point to expansion joint roost in the old bridge. Photo by William E. Rainey.

The depth of these expansion joints offered a thermal gradient to the animals, allowing them to be near the sun-warmed surface of the bridge deck when ambient temperatures were cool, and to move down into cooler areas when temperatures on the deck got too hot. Temperature monitors, placed at a range of depths in the crevices, indicated that temperatures in the expansion joints were less variable than ambient air temperature, and lagged behind air temperature as a consequence of the mass and diurnal warming of the deck. Temperatures near the deck surface often exceeded 120^{o}F during the summer afternoons and remained higher than ambient throughout much of the night.

The expansion joints, edged on the deck by metal angle stock, were open both top and bottom, allowing inspection of these crevices from the bridge deck. While this structural feature was convenient for an evaluation of bat use, it offered no shelter to the animals in the case of rain. Expansion joints were consequently not usually occupied in fall and winter subsequent to the seasonal onset of rain.

Two other nearby bridges were used by bats prior to the removal of the old bridge, and used more extensively after that roost structure was removed. The roost in the I-5 structure is located in a single large expansion joint (Photo 3). Use of this site varied seasonally, and at times was only used as a night roost.

Photo 3. Bat roost located in expansion joint on U.S. Interstate 5 Bridge. Photograph by William E. Rainey.

The railroad trestle, to the west of the I-5 Bridge, is composed of a series of four longitudinal pre-cast beams and has three longitudinal crevices that run the length of the trestle within each segment. The upper portion of each crevice had been previously filled with foam, so that the crevices were largely sealed against precipitation from above. While this structure is used year-round by bats, it is the only local winter roost currently known in the area for Mexican free-tailed bats (Photo 4).

Photo 4. Railroad trestle showing longitudinal crevices used as bat roosts. Photography by William E. Rainey.

The gravel and cobble-bedded creek, the broad flood plain, and the adjacent cottonwood riparian corridor in the vicinity of the bridge offers foraging habitat to bats roosting on the bridge.

Project Approach and Design

Bat surveys were initiated by Shasta County in the summer of 2000. It was immediately evident that this was a very significant roost, both in terms of total numbers of animals and in species diversity – particularly the presence of a large colony of pallid bats, a CDFG Species of Special Concern.

The Shasta County Department of Public Works then initiated a project in which the consulting bat biologists (E.D. Pierson and W. E. Rainey) worked cooperatively with the engineers (CH2M Hill) to design replacement habitat. This involved bat roosts to be incorporated into the structure of the new bridge and an interim roost for the one season when the old bridge would be unavailable and the new bridge would not yet be completed.

The existing bridge was monitored nine times between July 2000 and August 2001 to establish seasonal patterns of bat use, and gather data for planning effective mitigation. In two capture efforts (May and August), 106 *E. fuscus* and 71 *A. pallidus* were captured upon emergence from the roost, and banded with numbered, colored bands. Both commercial harp traps and custom traps designed to fit the corbel were used in the capture (Photo 5).

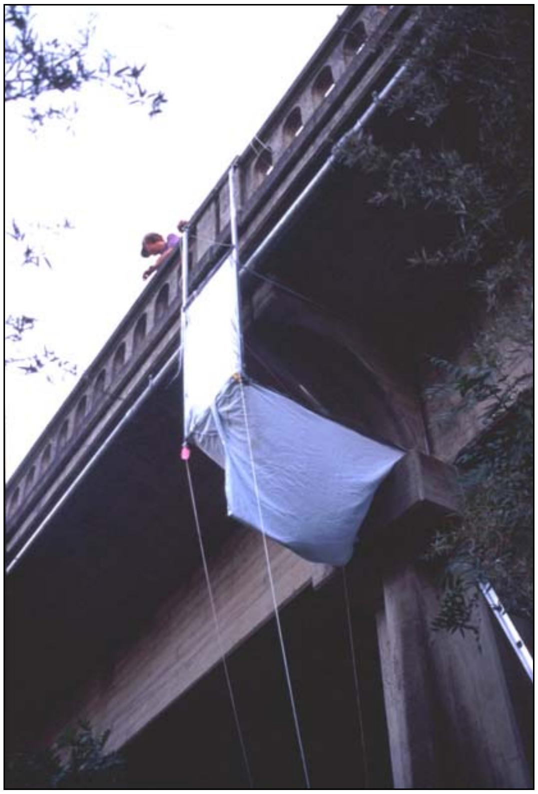

Photo 5. Custom adapted harp trap installation, designed for capturing pallid bats. Photograph by William E. Rainey.

In early January 2002, when no bats were present in the bridge, foam backer rod was installed in the deck crevices by the consulting biologists and plywood panels were installed on the bents by the contractor to exclude access to roosting areas (Photo 6). These installations were subsequently checked by the consulting biologists and bat activity around the structure was evaluated during deck demolition.

Photo 6. Plywood panels installed over bents to exclude bats from expansion joints. Photograph by William E. Rainey.

Temporary Roost. Four temporary roosts were installed at the tops of four round piers on the adjacent I-5 structure (Photo 7). These were collars made of fitted plywood sections, lined with polyurethane mesh, and positioned one to two inches from the column surface by wood spacers.

Photo 7. Interim collar roost installed on U.S. Interstate 5 bridge piers. Photograph by William E. Rainey.

Replacement Habitat in New Bridge. The bats had used 18 of the 20 expansion joints at the bents in the old Main Street Bridge, but the new bridge design provided for only eight bents. To generate a comparable amount of roosting habitat, twelve pre-constructed bat crevices, each made of plywood, with wooden spacers, and lined with polyurethane mesh, were installed in each bent cap – six to the north of the piers, and six to the south, for a total of 96 bat roosts (Photos 8 and 9).

The width of the crevice was varied – 1/3 were 1.0", 1/3 were 1.5", and 1/3 were 2.0" while the length remained a constant 39 inches long and depths varied only slightly, from 59 to 70 inches deep. Each roost was constructed such that one wall of the roost was longer than the other, thus creating a landing platform for the bats. The goal was to obtain quantitative data on the preferred crevice width for the species in question. Because of the north -south orientation of the bridge solar exposure of the sides varied daily and seasonally. Thus, the position of the crevices of differing width classes was varied so that preference for both crevice width and solar exposure might be evaluated statistically.

Schematic for Allocation of Bat Crevices.

	Eastern Bay		Middle Bay		Western Bay	
Pier 1	2.0"	2.0"	1.5"	1.5"	1.0"	1.0"
S. End	2.0"	2.0"	1.5"	1.5"	1.0"	1.0"
Pier 2	1.5"	1.5"	1.0"	1.0"	2.0"	2.0"
	1.5"	1.5"	1.0"	1.0"	2.0"	2.0"
Pier 3	1.0"	1.0"	2.0"	2.0"	1.5"	1.5"
	1.0"	1.0"	2.0"	2.0"	1.5"	1.5"
Pier 4	2.0"	2.0"	1.5"	1.5"	1.0"	1.0"
	2.0"	2.0"	1.5"	1.5"	1.0"	1.0"
Pier 5	1.5"	1.5"	1.0"	1.0"	2.0"	2.0"
	1.5"	1.5"	1.0"	1.0"	2.0"	2.0"
Pier 6	1.0"	1.0"	2.0"	2.0"	1.5"	1.5"
	1.0"	1.0"	2.0"	2.0"	1.5"	1.5"
Pier 7	2.0"	2.0"	1.5"	1.5"	1.0"	1.0"
	2.0"	2.0"	1.5"	1.5"	1.0"	1.0"
Pier 8	1.5"	1.5"	1.0"	1.0"	2.0"	2.0"
N. End	1.5"	1.5"	1.0"	1.0"	2.0"	2.0"

Photo 8. Bat crevice forms prior to incorporation into structure of new bridge. Photograph by William E. Rainey.

Photo 9. Bat crevices as installed in bents of new bridge. Photograph by William E. Rainey.

Schedule of Work

Surveys to document seasonal patterns of bat use were conducted at the old bridge between July 2000 and August 2001.

In early January 2002, when no bats were present in the bridge, modifications were made to exclude bats from returning to the bridge, and four interim roosts were installed on adjacent I-5 bridge. The deck of the old bridge was removed in the spring of 2002, and the new bridge was completed in the winter of 2003.

Monitoring Results

Table 1 summarizes the bat survey results between 2000 and 2004, including the surveys of both old and new bridges, the interim mitigation roost, and the other available structures (I-5 expansion joint and RR trestle).

Bat Use of Old Bridge. Repeated surveys of the old bridge revealed seasonal patterns of use by the three dominant species.

A nursery colony of 150 reproductive female pallid bats (*A. pallidus*) occupied the bridge from spring through fall, and with that year's young the colony increased to >300 in August. This species was absent from the bridge from late fall until spring.

Similarly there was a nursery colony of ca. 300 big brown bats (*E. fuscus*) that occupied the bridge during their reproductive season (May through July). Their numbers declined in August, and they were absent from the bridge in the winter.

A large population of Mexican free-tailed bats (*T. brasiliensis*) occupied the old bridge, plus the nearby I-5 Bridge and railroad trestle. The animals appeared to move among these structures, be present year round, with a local numbers in the range of 4,000-8,000. It was difficult to get an accurate count for a colony of this size since there were typically few observers, and the bats were distributed among multiple narrow roost crevices. Movement patterns of Mexican free-tailed bats in the Central Valley, and in California as a whole, are poorly understood. Thus, it should not be assumed that the same bats are present year-round.

Bat Roosting Patterns during Construction. Although specific population counts of the railroad trestle and I-5 structure roosts were not made prior to the demolition of the old bridge, the number of bats in these structures increased after the old bridge was removed.

While there was no evidence of big brown bats using the I-5 Bridge prior their exclusion from the old bridge, individuals identifiable as big brown bats were observed with a spotlight and binoculars in the expansion joint after exclusion had taken place, and recorded emerging and returning to this roost with an infra-red video system. Also, a few banded big brown bats were observed roosting in the railroad trestle after exclusion.

Table 1. Monitoring Data for Main Street Bridge over Cottonwood Creek Project

Date	Number of Bats					Number of Bats				Number of Bats					Number of Bats	
	Anpa	*Epfu*	*Tabr*	*Mysp*	**Notes**	*Anpa*	*Epfu*	*Tabr*	*Mysp*	*Anpa*	*Epfu*	*Tabr*	*Mysp*	**Notes**	*Epfu*	*Tabr*
	OLD MAIN STREET BRIDGE									**RR TRESTLE**					**I-5 EXPANSION JOINT**	
09-Jul-00	ca. 150	>300	>700	1								>,1000				
19-Jul-00	ca. 200	>300	ca. 1,000	0												
21-Aug-00	>300	30	>1,000	0												
11-Sep-00	ca. 300	60	>1,000	2								>1,000				Present
27-Nov-00	0	0	0	0							1	>1,000				Present
17-Mar-01	13	ca. 35	ca. 20	0								WER emerg		Water too high		
10-Apr-01	0	ca. 12	ca. 1,000	0										Water too high		
17-May-01	>100	>300	>1,000	0										Water too high		
21-May-01		106	16		Capture effort											
13-Aug-01	ca. 85	ca.35	>800	0												
13-Aug-01	55				Capture effort											
08-Jan-02	0	0	0	0	Exclusion performed											
	BATS EXCLUDED FROM OLD BRIDGE					**I-5 MITIGATION ROOST**										
11-Mar-02	0	0	0	0		0	0	0	0	0	1 cluster	0		Water too high for 60% structure		
18-May-02	0	0	0	0		0	0	0	little guano	0	35	>200		Water too high for 60% structure	>50	Present

Date	Number of Bats					Number of Bats				Number of Bats					Number of Bats	
	Anpa	***Epfu***	***Tabr***	***Mysp***	**Notes**	***Anpa***	***Epfu***	***Tabr***	***Mysp***	***Anpa***	***Epfu***	***Tabr***	***Mysp***	**Notes**	***Epfu***	***Tabr***
	OLD BRIDGE REMOVED															
05-Jul-02	NA	NA	NA	NA	NA	0	2	0	little guano	1	ca. 200	>8,000	1		Guano	Exit count-550
26-Aug-02	NA	NA	NA	NA	NA	0	0	>200	0	0	37	>4,000	6		0	Exit count - 1186
	NEW MAIN STREET BRIDGE															
11-Jul-03	0	0	0	1		NA	NA	NA	Removed earlier	0	>200	>8,000	3	4 banded *Epfu*	Guano	0-Day Roost Hundreds - Night Roost
10-Jun-04	0	0	ca. 500	> 125						0	ca. 100	ca. 5	0	2 banded *Epfu*		Guano

The numbers of Mexican free-tailed bats greatly increased in both the railroad trestle and the I-5 expansion joint after the old bridge was removed. Although a few pallid bats were detected in evening acoustic surveys conducted during the construction period, only one roosting pallid bat was seen (in the RR trestle in July 2002, subsequent to the removal of the old bridge).

U.S. Interstate 5 Interim Mitigation Roost. The four interim collar roosts installed on the I-5 bridge were modeled after an artificial roost design that had proven effective for *Myotis* species in the southeastern United States (Clawson and Gardner 1992, 1993). Because it can take up to three years for bats to occupy a new roost (Tuttle and Hensley 1993), the fact that bats were present within 5 months indicates this roost design has considerable potential (Photo 10). *E. fuscus*, *T. brasiliensis*, and a *Myotis* species roosted in these collars during the first year of installation. By the end of August, there were >200 *T. brasiliensis* using these sites. These roosts were removed once the new bridge was completed during the winter of 2002.

Photo 10. Guano below U.S. Interstate 5 collar roost, showing evidence of bat use. Photo by William E. Rainey.

Bat Use of the New Bridge. The new bridge was completed during the winter of 2002-2003. In July 2003, the first summer after construction, only one bat was observed using the bridge, but by June 2004, the numbers had increased dramatically, with about 500 *T. brasiliensis* and about 125 *M. yumanensis*. Roosting patterns in the old bridge and the railroad trestle indicated that *T. brasiliensis* preferred roosts over water. There was no evidence of roosting pallid bats or big brown bats. Because 12 out of 96 roosts in the new bridge occurred above high water, many *T. brasiliensis* roosting above water could have been missed in surveys.

Of the 84 bat crevices in the new structure that could be surveyed, in June 2004 – 5 were used by a *Myotis* species and 6 were used by *T. brasilliensis*. One bat was observed roosting in a 2" crevice. Four 1" crevices were being used and 6 1.5" crevices. The majority of the *Myotis* were in 1" crevices, and the majority of *T. brasiliensis* in the 1.5" crevices.

Two minor problems were evident after installation. The contractor lined the bat boxes with a more open mesh material and used a lower density of staples for attachment than recommended by the consulting biologists. Consequently, in some cases, the mesh buckled into the cavity interior, partly occluding it. Also, a few of the refuge sites had experienced compression during installation (Photo 11).

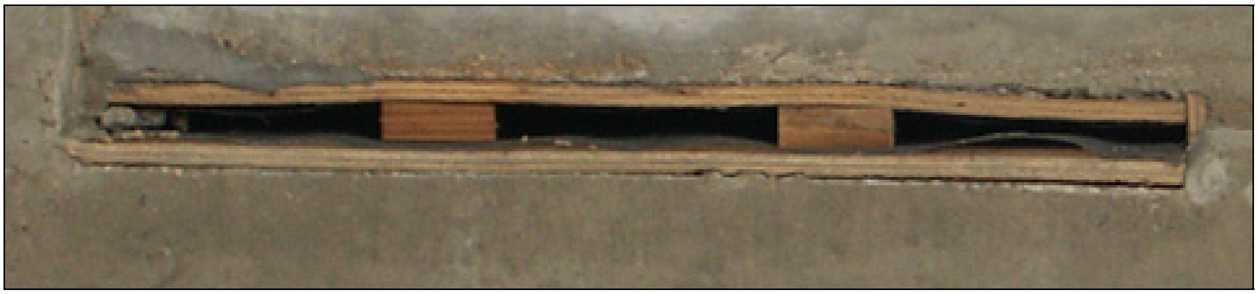

Photo 11. Bat crevice showing compression of plywood and buckling of polyurethane mesh. Photo by William E. Rainey.

Discussion

It is still too soon to evaluate fully the effectiveness of this mitigation. It is not surprising that *T. brasiliensis* is one of the first species to colonize the bridge. This species is known to be quite adaptable in its roosting requirements and is locally the most abundant species. It was evident in the both the July 2003 and June 2004 surveys that a number of *T. brasiliensis* were also using the I-5 structure (as a night roost in July 2003 and as a day-roost or night roost, based on the deposition of fresh guano below the roost, in June 2004).

While *M. yumanensis* occupies the new bridge roosts in much higher numbers than those in the old bridge the reason is unclear. The new roosts might be more attractive, but where were these bats before the new bridge was constructed? Was a nearby colony recently evicted from a roost?

It would appear, based on the June 2004 surveys, that the big brown bats, which had moved to the I-5 Bridge and railroad trestle when the old bridge was removed, were still occupying one or both of these structures. No big brown bats were observed in the new bridge, but the observation of 2 banded bats in the railroad trestle indicated that at least some of the bats that had originally used the old bridge, were now using the RR trestle. We do not know why the new bridge roosts are unoccupied by this species, but additional years of surveys may reveal the answer to this question.

The issue of greatest concern is the apparent disappearance of pallid bats. No *A. pallidus* have been observed using the interim roost or the new bridge. Only one individual (not banded) was observed in the railroad trestle. A working hypothesis for the design of the mitigation roosts had been that the 2.0" crevices would attract pallid bats. Because this species is considerably larger than *T. brasiliensis* or *M. yumanensis*, we hypothesized it would require and prefer wider crevices than either of the other species. In the old bridge, the expansion joints used by the A. *pallidus* had been slightly larger than those used by *Tadarida*.

Although the mandate for the consulting biologists on this project was to evaluate bridge use and mitigate for loss of bridge roosting habitat, there was an associated riparian restoration project that involved extensive planting on cottonwoods on the floodplain. Mature cottonwood riparian habitat is preferred habitat for western red bats, *L. blossevillii*, a species that is proposed for CDFG Species of Special Concern status. This foliage roosting species is not known to use bridges, but it was detected acoustically in the vicinity of the bridge. Western red bats will likely benefit from the cottonwood riparian restoration.

Lessons Learned and Recommendations

This project demonstrated the importance of having all the concerned parties work together from the beginning of the project. The cooperation between the engineers and consulting biologists allowed for the accommodation of the biological concerns in a cost effective way, without compromising the structural requirements for the bridge. There was also frequent communication between the construction foreman and the biologist, insuring, for example, that the exclusion devices were closely monitored during the early construction phase when bats could have still reoccupied the old bridge. The construction crew went out of its way to monitor the exclusion devices, and correct problems as they arose. Closer communication during the construction of the bat boxes, however, could have insured that the proper mesh was used.

This project also demonstrates the need for long-term monitoring before the effectiveness of mitigation measures can be fully evaluated. It is still possible that both *E. fuscus* and *A. pallidus* will occupy the new bridge. The failure of *A. pallidus* to reoccupy the bridge indicates that more research and experimentation are needed to understand the roosting requirements of this species. One measure that could be taken at this site would be the installation of temperature probes in a subset of crevices to determine if a temperature regime comparable to that observed at the old bridge has been achieved. The bent caps receive no direct solar exposure and likely remain significantly cooler that the old bridge roost.

Seasonal monitoring of this site should continue for several years to evaluate the effectiveness of this mitigation.

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Appendix G.

Case Study 7
Franklin Boulevard Causeway

Franklin Boulevard Causeway
Dave Johnston, Bat Biologist
H.T. Harvey & Associates

Case Study 7. Duplicating Roosting Habitat in a New Bridge.

Location	Southern Sacramento County
Species involved	Mexican free-tailed bat (*Tadarida brasiliensis*) Likely much smaller populations of Yuma myotis *Myotis yumanensis* and big brown bat *Eptesicus fuscus*
Type of Work	Bridge replacement
Potential impacts	Loss of a very large maternity colony
Type of Roost	Maternity roost
Size of colony before works	Estimated at 60,000
Size of colony after works	15,500 two months after construction completed. (Bridge should be completed by end of 2004.)

Overview

The primary mitigation objective was to a) reduce impacts to bats by excluding all bats prior to the development of the seasonal maternity colony, b) provide temporary roosting habitat during the bridge demolition and construction of the new bridge, and c) provide new permanent roosting habitat as similar as possible to the lost habitat.

Location and Ownership

The Franklin Boulevard Causeway comprises a timber trestle structure across the overflow floodplain north of the Mokelumne River and a steel truss swing bridge over the Mokelumne River. The steel truss bridge is jointly owned by San Joaquin County to the south and Sacramento County to the north; whereas the causeway extends over private lands with public easement.

Background

Franklin Boulevard and Thorton Road serve as an alternate route for Interstate 5 (U.S. INTERSTATE 5) and acts as a collector highway for rural areas east of I 5 in the region. The trestle bridge consisted of a 230-foot long steel truss swing bridge with a concrete slab bridge on the north and south approaches and the causeway consisted of a timber trestle 1700 feet long. The timber trestle bridge was closed to traffic in 1997 due to extensive scour and substructure damage from flooding that year. The trestle bridge crosses through species rich valley riparian habitat and is home to one of the largest maternity colonies of bats in Northern California.

Features Important to Bats

The Franklin Boulevard Causeway over the Mokelumne River was a well-known roost for tens of thousands of Mexican free-tailed bats. Additionally, smaller numbers of other species, such as the big-brown bat and the Yuma myotis, also likely bred in this wooden structure. Excellent foraging habitat occurs in adjacent areas over wetlands and riparian habitat near the confluence of the Mokelumne and Consumnes Rivers owned by The Nature Conservancy and other private landowners.

Project Approach and Design

To avoid significant impacts to bats and bat habitat, the project incorporated mitigation measures into the project design over the course of several years. The first phase included bat surveys conducted in 1999. To reduce impacts from the temporary loss of bridge roosting habitat, bat houses were placed over open grassland alongside riparian vegetation to the east of the bridge about 100 yards. These "Maberry" style bat houses were installed with the consultation of DFG and Bat Conservation International. Three were installed on the Kirkham property and three installed on The Nature Conservancy's (TNC) Cosumnes River Preserve. Each house was capable of housing 14,000 to 16,000 bats. Additionally, Bob Wisecarver, a private wildlife habitat restoration enthusiast, installed an additional bat house on the TNC property. All seven houses were to be monitored for up to six years or until the new bridge was completed. The three houses on private property have now been removed, and the remaining four bridges are to remain on the TNC preserve indefinitely.

In an effort to exclude the existing population from using the bridge as a maternity colony roost or day roosting habitat, the plan was to seal crevices after the bats left in October. Bats were reported to begin roosting in February and March, so exclusion had to take place between November 1 and early February. Data from banded bats and winter observations suggest that these bats over-winter along central coastal California (unpubl. data, Phil Leitner and Dave Johnston).

Photo 1. Bat House #6 at the Cosumnes Preserve, before modifications, used as temporary mitigation for lost roosting habitat. Photo by Eric Stackhouse.

Photo 2. Bat House #6, with experimental modifications as of April 3, 2002 to hopefully increase use by bats for more successful mitigation results. Photo by Eric Stackhouse.

The new bridge design incorporated bat roosting habitat within the underside of the bridge decking. The old redwood timbers were sawn on-site to 1" by 12" planks. Each bat roosting unit was assembled and then incorporated into the deck forms for concrete pouring (Photo 3). The bridge and causeway were rebuilt in 2004, and in July 2004, some of the first sections of built-in bat habitat were available to crevice roosting bats.

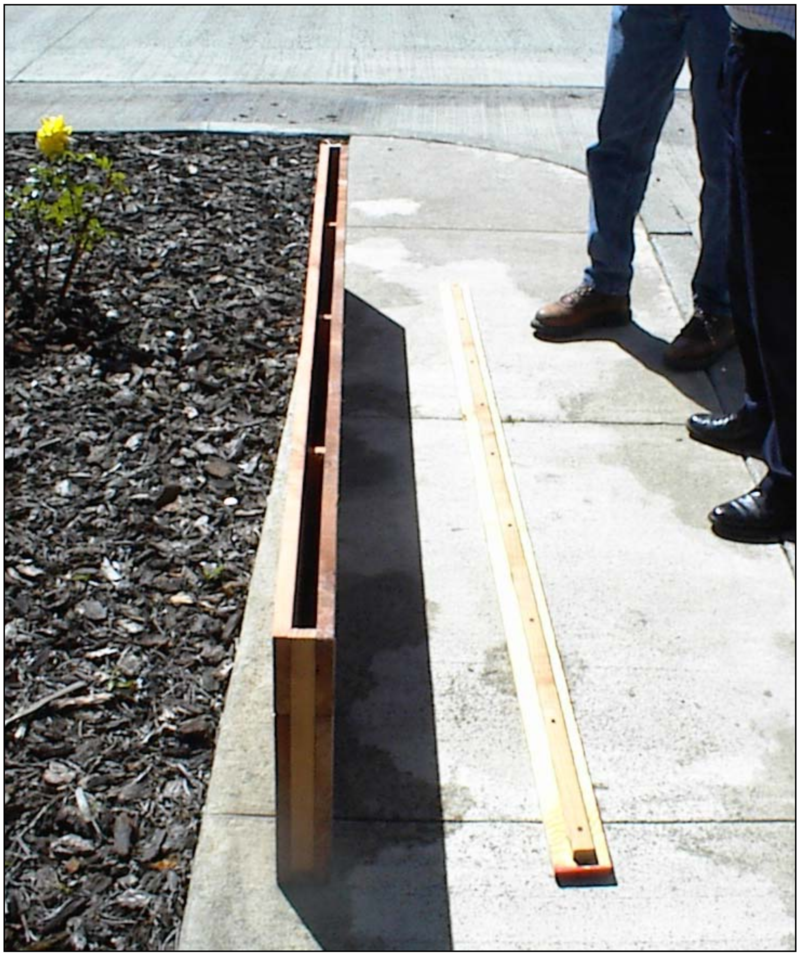

Photo 3. Permanent replacement habitat to be installed as part of the new bridge and causeway. The strip of plywood attached to the roosting habitat above helped maintain its location during the pour. Photo by Tom Barnard.

Schedule of Work

1999 – Initial surveys
2000 – 2002 Installation of bat houses
2002 – Exclusion of bats from bridge
2003 – Final total exclusion of bats from bridge
2004 – Construction of new bridge and causeway
2004 – Begin long-term monitoring of bats roosting in bridge and causeway and bat houses on the Consumnes River Preserve.

Photo 4. Placement of the roosting habitat inserts just prior to the pour. Photo courtesy Sacramento County Public Works.

Photo 5. Section of completed bridge and causeway replacement with new roosting habitat. Three of the five rows of roosting habitat inserts are shown. The outer two rows of each side comprise two slots (crevices) and the third or middle cast-in-place insert has three slots. Photo by Dave Johnston.

Results of Post Construction Monitoring

Field Notes for the Franklin Bridge Construction Project (98-0362)
8-20-04; 14:00 – 16:30; Sunny, light breeze, temp. 92º F
Alison Cunningham and Eric Stackhouse (Sacramento County Department of Environmental Review and Assessment), Bob Wisecarver (volunteer), Scott Smith (Senior Construction Inspector County of Sacramento), Dave Johnston (HT Harvey & Associates).

Abutments 35 thru 13 of the new Franklin Boulevard Causeway, which is partially still under construction, was surveyed by the above personnel. The largest aggregation of bats occurred underneath the slough at approximately abutment 27 and on the south end of the bridge starting at abutment 19 thru to 13 (Table 1). This observation was also made during a bat survey by Scott Smith (Construction Inspector) previous to this survey. As expected this late in the season, no non-volant young were observed.

Table 1. Post-construction Survey for Franklin Boulevard Causeway. Middle row with 3 Slots. Outer two rows on each side with only 2 slots each.

Bridge Abutment	Middle row (3) and eastern most rows 4 and 5 (ELS & AC)	Bridge abutment	2nd Row from the West (Dave Johnston)	Western Most Row (Bob Wiscarver)*
35-28	100	35-30	0	
27-28 (est. over H20)	80	29-28	3	
26-24	150	28-27 (est over $H_2$0)	200	
23-21	5	27	78	
20-19	800	26	107	
19-18	2000	25	5	
18-17	1000	24	2	
17-16	2000	23	0	
15-16	1000	22	0	
15-14	2000	21	0	
14-13	4500	20	0	
		19	148	
		18	225	
		17	98	
		16	44	
		15	315	
		14-13	16	
Totals	13,635		1241	650
Total Bat estimate = 15,526				

* Did not tally by sections

Lessons Learned and Recommendations

Probably the single most important message learned about bat mitigation during the Franklin Road Causeway/Bridge project is that bat houses do not make the equivalent of a lost bridge habitat. Although the bat houses did provide habitat for many free-tailed bats, the completed bridge attracted ten-fold that number after only two months.

The importance of the tempering effects of a concrete bridge provided by its thermal mass should not be underestimated. This is not the only variable that changes when considering differences between bat houses and concrete bridges with crevices. However, the heat was so intense in this San Joaquin Valley site that the plastic inserts making crevices in the bat houses warped badly. A concrete bridge not only provides warmer than ambient temperatures in the evening, but these concrete roosts also prevent summer daytime temperatures in California from exceeding the tolerance levels of day roosting bats.

Search image and location of new roosting habitat likely contributes greatly to the success of anthropomorphic roosts used for mitigation. Over 15,000 bats roosted in the new bat roosts after only about two months after these new roosts were made available.

Excellent mitigation strategies need not necessarily cost more than inadequate or less desirable mitigation strategies. The cast-in-place concrete with bat roosts strategy saved $200,000 over the original plan to build the bridge with pre-cast concrete and off-bridge mitigation, bringing the total cost of the trestle and causeway price down from 9.2 million dollars to 9.0 million dollars.

This bridge project demonstrates how a cooperative community of environmental planners, engineers, and biologists can work together to plan and implement an outstanding, successful mitigation strategies for large numbers of bats.

Appendix H.

Case Study 8
Dry Creek Bridge #26-0007

Dry Creek Bridge, #26-0007

Elizabeth D. Pierson and William E. Rainey

Assisted by Paul A. Heady, Rhianna Lee, and Winifred Frick

Case Study 8. Bridge Replacement with Experimental On-site Mitigation Roost, and Radio-tracking to Locate Alternate Roosts

Location	SR104 Bridge over Dry Creek, Amador County
Species Involved	Pallid bat (*Antrozous pallidus*), Mexican free-tailed bat (*Tadarida brasiliensis*), and Yuma myotis (*Myotis yumanensis*)
Type of Project	Bridge replacement
Potential Impacts	Loss of night-roosting site for three species, including a maternity colony of *A. pallidus.*
Type of Roost	Night roost for maternity colony
Size of Colony before Construction	*A. pallidus* – ca. 45 adult females – ca. 100 w/ young; *T. brasiliensis*--hundreds; *M. yumanensis* – few
Size of Colony after Construction	Work in progress. Outcome unkown

Overview

The primary objective of this project was to reduce impacts to bats by gathering information on the behavior of the animals to help design appropriate mitigation, and to provide replacement roosting habitat by taking the following steps:

1. capturing and marking (with wing bands) bats at the old bridge prior to bridge removal;

2. radio-tracking pallid bats to locate day-roosts, alternate night-roosts, and gather information on foraging range;

3. monitoring seasonal patterns of bat occupancy at the old bridge with long-term acoustic monitoring and periodic collection of guano and culled insect parts;

4. surveying bridges for a 25 km radius around this site to identify other pallid bat roosts, identify potential alternate roosts for target colony, and gain a perspective on the regional importance of the study colony;

5. working with Caltrans to design and install replacement roosting habitat for *A. pallidus*; and

6. monitoring the effectiveness of this mitigation.

This project offered an important opportunity to evaluate the impact of roost loss. Because the location of day roosts was known, and occupancy of the primary roost could be monitored, it was possible to test the hypothesis that the loss of a night-roost had no effect on the choice of a day roost.

A more complete reporting on this project can be found in Pierson et al. 2004.

Location and Ownership

This bridge over Dry Creek is located in Amador County, 3.5 km north of the town of Ione on State Route 104 – Bridge #26-007) (Photo 1).

Photo 1. The SR104 Bridge over Dry Creek, Amador County. Photograph by Elizabeth D. Pierson.

Background

It was learned in the context of another project (Pierson and Rainey 2002) that the bridge on SR104 over Dry Creek, just north of Ione in Amador County, served as a night roost for a significant colony of pallid bats (*Antrozous pallidus*), considered a Mammal Species of Special Concern by California Department of Fish and Game. Thus, when plans to replace this bridge, built in 1960, were initiated, a bat survey and monitoring program were included in the environmental assessment process. A mitigation roost was designed and proposed by Caltrans for inclusion in the new bridge.

Features Important to Bats

The concrete girders found on this bridge, a dominant design style for bridges of this era, are one of the features most important for night-roosting bats (Photo 2).

Photo 2. Underside of Dry Creek Bridge showing the concrete girder construction. Photograph by Elizabeth D. Pierson.

Cottonwood riparian, oak savannah, and non-native grassland near this site provided habitat for pallid bats (Photo 3).

Photo 3. View of habitat looking north from the Dry Creek Bridge. Photograph by Elizabeth D. Pierson.

Project Approach and Design

Radio-tracking Study. Pallid bats were captured in the night roost in August 2003. Eleven post-lactating females were outfitted with radio-transmitters (Model Lb-2, Holohil Systems), and tracked for 6-7 days. Attempts were made each day to identify roost sites for all radio-tagged animals. The radio-tagged animals were also followed in the evening to investigate foraging range, and to determine whether any of the marked individuals used an alternate night roost.

Monitoring of Seasonal Patterns of Bat Use of Bridge. Seasonal patterns of bat activity at the bridge were monitored by two methods: an automated acoustic system and the collection of guano and culled prey. An Anabat detector and storage zcaim (Titley Electronics) were placed inside an ammo can, and concealed in the rip-rap slope or under a tarp (Photo 4). An external microphone was pointed at the night roost. This system was programmed to turn itself on before sunset and turn itself off at dawn, and to store bat calls on a compact flash card for later analysis.

Photo 4. Anabat detector is stored under protective covering, with external microphone exposed and oriented towards night roost. Photograph by Elizabeth D. Pierson.

Additionally, plastic sheeting was placed below the bat roosting areas at both ends of the bridge to collect guano and culled insect parts as an index of bat use (Photo 5). A Stowaway temperature logger (Onset Computing) was placed inside a small tin, sealed with silicone glue, and applied with Velcro to the under-surface of the bridge (Photo 6). It was located in the corner of one of the concrete girders to monitor roost temperature.

Photo 5. Plastic sheeting placed below night roost to collect guano and culled insect parts. Photograph by Elizabeth D. Pierson.

Photo 6. Temperature logger inside tin can, secured to bridge surface with Velcro, placed adjacent to stained area of night-roost. Photograph by Elizabeth D. Pierson.

Regional Bridge Survey. A log of state and county bridges was obtained from the Caltrans web-site. All state bridges, and any county bridges that appeared to have potential as bat roosts (based on bridge type as provided in the data base), and were located within a 25 km radius of the Dry Creek Bridge, were surveyed in March 2004. Each bridge was examined for the presence of bats, bat guano, staining created by bat roosting, or habitat suitable for roosting.

Those bridges determined to have potential as bat roosts, particularly for pallid bats, were revisited in May 2004.

Schedule of Work

17 July 2000 – Pallid bat night-roost originally identified under SR104 Bridge over Dry Creek

18-25 August 2003 – Radio-tracking study

9 March 2004 – plastic sheets for guano collection installed at north end of bridge

24 March 2004 – guano collected from north end of bridge; plastic sheets for guano collection installed at south end of bridge; bat detector system installed at north end of bridge.

1 April 2004 – CF card replaced. Very windy; guano blown off plastic; not collected

10 May 2004 – guano collected; CF card replaced

3 June 2004 – guano collected; CF card replaced

5 July 2004 – guano collected; detector removed in anticipation of start of construction

14 September 2004 – Installed detector at south end of bridge; reinstalled guano sheet at south end.

29 September 2004 – R. Lee, Caltrans biologist, collected guano; CF card replaced

4 November 2004 – R. Lee collected guano; detector removed

Survey and Monitoring Results

Radio-tracking Study. Five different day roosts were identified during the radio-tracking study: four trees (cottonwood and valley oak) and one private dwelling. All roosts were located between 0.15 and 2.8 km from the night-roost. The primary roost was an old cottonwood tree located about 150 m upstream from the bridge, where the bats were roosting in a cavity formed at a broken limb about 6 m above the ground (Photo 7).

Photo 7. Cottonwood tree that was the primary day roost for radio-tagged pallid bats. Photograph by Elizabeth D. Pierson.

Although the focus of this study was on locating roosts, animals were followed on their foraging beats from emergence until most had returned to the bridge night roost, generally by mid-night. In general, the bats remained within detection range, and appeared to be foraging in the dry creek bed and the surrounding grassland. The only night-roost that was identified during this study was the SR104 Bridge over Dry Creek where the animals had originally been captured.

A total of 61 pallid bats were captured and banded from this colony. While the primary purpose was to capture pallid bats, twenty *Tadarida brasiliensis* and one *Myotis yumanensis* were included in the captures.

Monitoring of Bat Activity at the Bridge Night Roost. Although the intent had been to monitor seasonal use of the bridge by pallid bats using the automated acoustic system and collected guano, this effort was compromised by the unexpected finding that the bridge was being used as a night roost by a significant number of Mexican free-tailed bats. Their guano deposits and their vocalizations in the night-roost overwhelmed the monitoring systems, making it inefficient (although not impossible) to separate out pallid bat guano, and impossible to distinguish pallid bat vocalizations from those of Mexican free-tails.

Nevertheless, night to night fluctuations in bat acoustic activity correlated with fluctuations in deck temperature. Because the amount of guano deposited by Mexican free-tailed bats greatly exceeded that deposited by pallid bats, these fluctuations in acoustic activity most likely reflected fluctuations in the number of Mexican free-tailed bats using the night-roost.

Because separating the pallid guano from the Mexican-free tailed guano (ca. 2 liters per month) was time inefficient, culled prey was used as an indicator of seasonal patterns of night-roosting by pallid bats (Figure 1). The presence of body parts (*e.g.*, legs, wings, tails) derived from

Jerusalem crickets (*Stenopelmatus fuscus*), long-horned beetles (*Prionus californicus*), and/or scorpions (Scorpionida) is considered diagnostic for pallid bats, as they are the only species known to take this relatively large, mostly ground-dwelling prey (Johnston and Fenton 2001). The amount of prey deposited by pallid bats increased consistently between March and July.

Regional Bridge Survey. A total of 69 bridges were surveyed. Twenty-three were state highway bridges; forty-six were on county roads. Nine bridges, including the study site bridge, were used by pallid bats. One was a day-roost; eight were night roosts. The closest known pallid bat roost to the study site bridge, also a night roost, was another bridge over Dry Creek, ca. 10 km upstream. Based on guano/culled prey deposits the SR 104 Dry Creek colony was one of the largest.

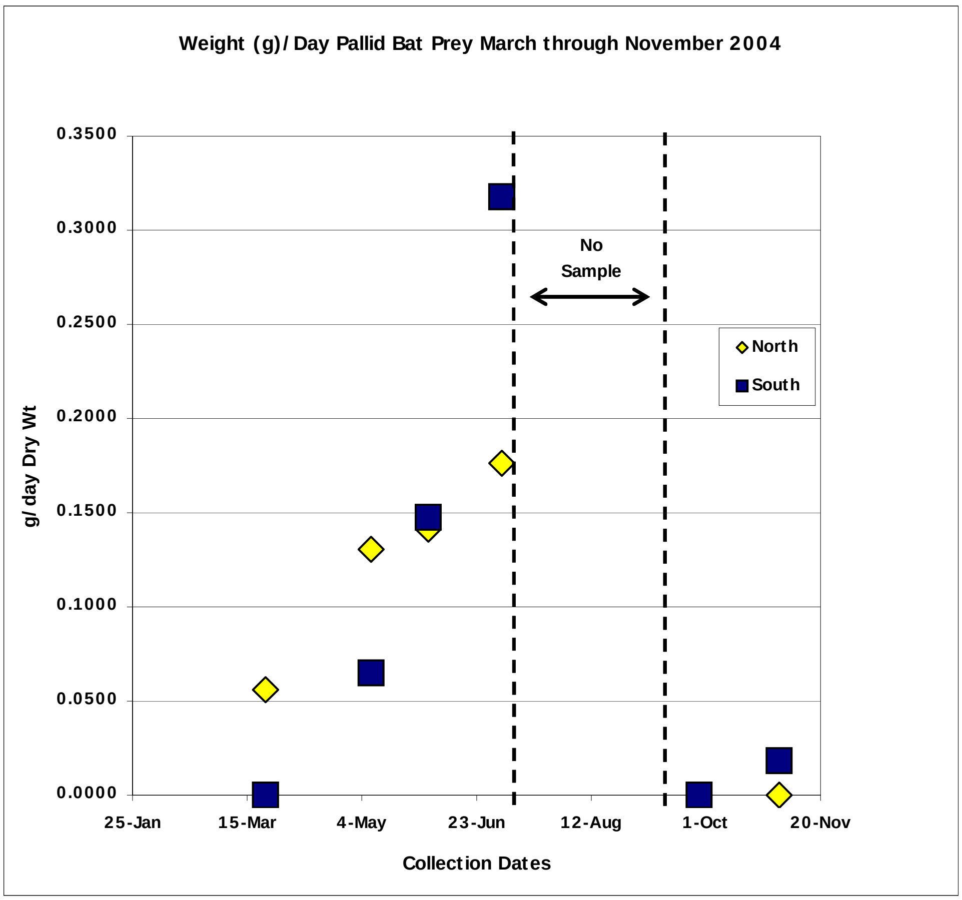

Figure 1. Scatter plot showing the g/day dry weight of prey items collected from beneath pallid bat roosting sites under Dry Creek Bridge. North and south ends of the bridge are depicted separately. The interval of no sampling reflects the removal of all sampling equipment on July 5 in anticipation of the beginning of construction. It was replaced at the south end of the bridge only on September 14.

Mitigation. Staff in the Caltrans Environmental Division recognized the significance of this bridge as early as July 2001 when a night-time survey of this site was included in a field training class for Caltrans biologists. Consequently, on the initiative of this department and with the cooperation of agency engineers, a mitigation roost was designed for incorporation in two locations in the new bridge. Each roost will be a plywood box 1180 mm wide X 800 mm wide X 850 mm tall, incorporated into the box beam. It will have an opening flush with the ventral surface of the box beam of 600 mm X 600 mm While it will not have the same open access as the concrete girder sites typically used by pallid bats, it is a worthwhile experiment, and because it will be surrounded by the concrete mass of the bridge, it will potentially maintain a temperature profile comparable to that of the original roost. Figure 2 shows the engineer's design for this roost.

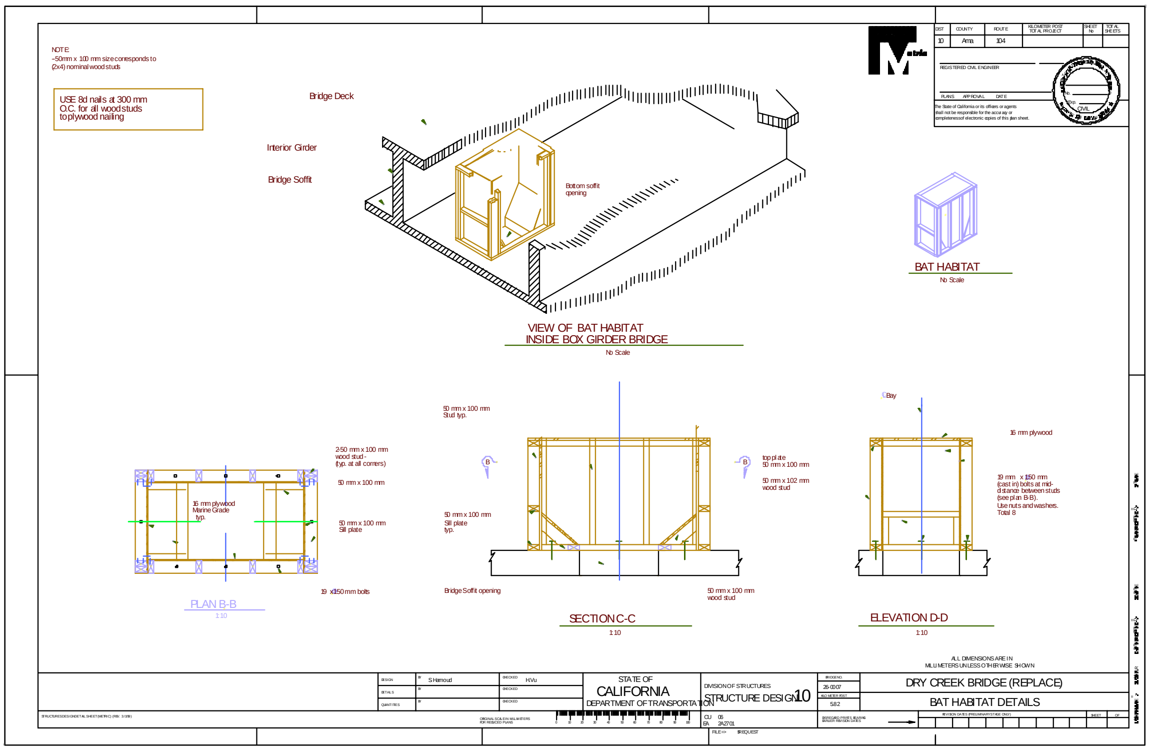

Figure 2. Caltrans engineers' design for bat box to be installed in new bridge.

Discussion

Monitoring Bat Activity at Project Bridge

This project used two independent methods for evaluating bat night-roosting activity at the project bridge: a passive acoustic detector system and collection of guano and culled prey. While the acoustic system served to show broad seasonal patterns of bat activity -- low in the spring, peaking in the summer, declining in the fall -- it did not serve to assess use of the bridge by pallid bats due to the presence of large numbers of Mexican free-tailed bats. Because it is common for bridges to be used by more than one species, acoustic monitoring may not serve to track the presence of the target species to the degree desired.

Collection of guano and culled prey items has been used in other settings as an index of levels of bat activity at roosting sites (Gellman and Zielinski 1996; Rainey et al 1992; Zielinski and Gellman 1999). In the non-desert regions of California, culled prey, distinctive to pallid bats, can be used to identify the presence of this species, and evaluate its levels of activity. While this may be less reliable in desert regions where there is prey overlap with the California leaf-nosed bat (*Macrotus californicus*), in northern and central California this technique can be highly effective.

Radio-tracking Study

This radio-tracking study provided the first record of pallid bats roosting in a cottonwood tree. The location of this day-roost (and the four other less used roosts) within a few kilometer radius of the night-roost is consistent with findings in other studies suggesting that night roosts for pallid bats are in fairly close proximity to day roosts, and that their foraging range is limited to a few kilometers around the roosts (Hermanson and O'Shea 1983; Orr 1954; Pierson et al. 2002; Rainey and Pierson 1996).

The radio-tracking study also strongly suggested that pallid bats from the study colony did not use any other bridges in the area. Although individuals in the colony moved among five day roosts, no animal used more than one night roost. This is consistent with findings in a study conducted on the upper Sacramento River showing very high fidelity to night roosts by a number of species (Pierson et al. 1996; Rainey and Pierson 1996).

Mitigation Options

This colony is of sufficient significance that a replacement roost is the appropriate mitigation, and two bat boxes have been approved by Caltrans for incorporation into the new bridge design. Having the new habitat incorporated into the new bridge has several advantages. The thermal mass of the new bridge will increase the likelihood that the new roost will have a temperature profile comparable to the old roost. Since roost temperature is a critical parameter in roost selection (Perlmeter 1996, 2004; Pierson et al.1996; Pierson et al. 2001), creating a new roost that meets the species temperature criteria is critical to success. Additionally, a roost incorporated into the bridge structure is more cryptic than an off-site roost would be, thus lessening the risk of human contact with the animals. Also, the animals are more likely to use a roost that fits their search image for a night roost – *i.e.*, one that is as close in location and structure to the one that was lost.

The significant finding of a pallid bat roost in a mature cottonwood tree high-lights the importance of cottonwood riparian habitat. Since many Caltrans bridges cross streams or rivers, cottonwood riparian is frequently found in the right-of-way and impacted by bridge projects. Restoration of cottonwood riparian, and when possible, the preservation of mature trees, will likely benefit many wildlife species, including pallid bats.

There is an implicit assumption in the literature that bats select day roosts and night roosts independently. This may well be true for those species that occupy night roosts located many kilometers from their day roosts. For pallid bats, however, the day roost and night roost are generally in close proximity, raising the question of a possible inter-relationship. When a pallid bat colony selects a day roost, does it also require having a night roost near by? Day roosts are assumed to be more critical to a maternity colony than night roosts, since that is where they shelter their young. Could it be, however, that when a colony loses its night roost, it also loses its day roost? The answers to these questions are not known, and yet are critical to evaluating project impacts. Thus monitoring seasonal occupancy of the cottonwood day roost was recommended as a critical component of evaluating the effectiveness of mitigation.

Lessons Learned and Recommendations

This project offered a number of useful lessons.

- This project illustrated both the power and the limitations of the two monitoring techniques used. Using acoustic monitoring systems can be very useful for tracking relative activity under a bridge, and for elucidating nightly and seasonal patterns. Because calls become distorted in a cluttered acoustic environment, because many of the calls recorded at a roost setting are social calls, and because multiple species frequently use the same roost, acoustic monitoring is of limited usefulness in assessing colony size for a particular species.

- Collecting guano at a roost is useful for tracking seasonal patterns and relative amounts of roosting activity, but in a multi-species situation it can be of limited use for monitoring individual species. This is particularly true when the species of interest is the rarer species.

- Collection of culled prey parts may be the most accurate and time efficient method for tracking activity by pallid bats at a night roost.

- This project demonstrated the importance of locating both the day roosts and the night roost for pallid bats when one or the other are known to be impacted by a transportation project. Although in this case the day roost will not be physically affected by project activities, it well could have been. Removal of cottonwood trees is frequently required with alterations in corridor alignment. Also, the radio-tracking data obtained in this project highlight the limited home range of pallid bat colonies, and raise the possibility of an inter-relationship between day roosts and night roosts.

- Distribution of bat species is sufficiently poorly known in California that regional surveys are required to determine the significance of a particular roost, and to located potential alternate roosts.

- The mitigation roost proposed for incorporation into the new bridge is an experimental design, and offers an opportunity to learn important lessons regarding the roosting requirements of pallid bats. It is extremely important that follow-up monitoring be conducted.

Because the mitigation phase of this project has not yet begun it is not possible to evaluate its effectiveness. It is critical that Caltrans engineers work together with bat biologists for the final design and installation of the proposed bat boxes, and that these mitigation roosts are monitored for at least three breeding seasons. Also, the primary day roost used by this colony should be monitored during the construction and post-construction phases of this project.

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Appendix I.

Case Study 9
S.R. 101 Bridge over Pieta Creek

S.R. 101 Bridge over Pieta Creek

Elizabeth D. Pierson and William E. Rainey

Case Study 9. Bridge Replacement with Experimental Off-structure Roost Design.

Location	SR101 Bridge over Pieta Creek, Mendocino County
Species involved	Pallid bat (*Antrozous pallidus*), California myoitis (*Myotis californicus*), Yuma myotis (*Myotis yumanensis*), and Mexican free-tailed bat (*Tadarida brasiliensis*)
Type of Work	Bridge replacement
Potential Impacts	Loss of night-roosting site for four species, including a maternity colony of *A. pallidus.*
Type of Roost	Night roost for maternity colony
Size of Colony Before Work	*A. pallidus*– ca. 100, *M. californicus* – >6; *M. yumanensis* – >6; *T. brasiliensis* – a few
Size of Colony After Work	*A. pallidus*–0; *M. californicus* – 0; *M. yumanensis* – 0; *T. brasiliensis* -0

Overview

The primary objective of this project was to reduce impacts to bats by:

1. capturing and marking bats at old bridge prior to bridge removal;

2. working with Caltrans engineers to design and install replacement roosting habitat for *A. pallidus*; and

3. monitoring the effectiveness of this mitigation.

Location and Ownership

This bridge over Pieta Creek is located in Menodcino County, 4.5 miles south of the town of Hopland on State Route 101 – MP 5.94.

Background

The removal of the SR 101 bridge over Pieta Creek (Br. 10-83, built in 1932) was part of a larger project to widen SR 10l, leading to a by-pass of the town of Hopland (Pierson and Rainey 2004). The original survey of this bridge was conducted by a Caltrans biologist who reported no sign of bat use at the bridge. A consulting biologist (E.D. Pierson) inspected this bridge on 4 July 2002 as part of the survey protocol for an evaluation of potential impacts to bats resulting from the proposed alternatives for the Hopland by-pass. Although this bridge was outside the immediate project area for the Hopland by-pass, it was surveyed in the context of an evaluation of bridge use by bats for a 25 km radius around the Hopland by-pass site.

Photo 1. SR101 Bridge 10-83 over Pieta Creek, showing surrounding oak habitat. Photograph by William E. Rainey

The July 4 survey documented large piles of bat guano with abundant Jerusalem cricket (*Stenopalnatus* sp.) parts (diagnostic for use by pallid bats), and extensive staining in the oblique corners of concrete girders on the underside of the bridge deck – an indication this was a significant roost that had been used for many years.

This bridge was scheduled for removal in early September, creating an unfortunate situation that required Caltrans biologists and engineers, the construction contractor, and the consulting biologist to design mitigation that was workable for all concerned on an emergency time-line.

Features Important to Bats

The concrete girders found on this bridge, a dominant design style for bridges of this era, are one of the features most important for night-roosting bats. The open chambers created by the girders provide reduced circulation, warm air-pockets where temperatures generally remain far warmer than ambient for most of the night. They also provide shelter from the wind, allow ready entry and exit, and are typically high enough above the ground to provide protection from predators. They also provide extensive accessible roosting areas.

Photo 2. Concrete girder construction, and urine staining from pallid bats.
Photograph by William E. Rainey

Extensive blue oak savannah near this site provided important foraging and day-roosting habitat for this species. There also were several old buildings within ca. 100 m of the bridge, which were not surveyed, and may have been the day-roost site for the night-roosting colony.

Project Approach and Design

The SR 101 Bridge over Pieta Creek was initially surveyed on 4 July 2002 in the context of regional bat surveys for the Hopland SR101 by-pass. It was discovered at that time that this bridge served as a significant night-roosting site for pallid bats. This conclusion was reached during a day-time survey based on patterns of staining and guano deposition; the morphological characteristics of the guano; and the association of Jerusalem cricket parts with the guano. Jerusalem cricket parts are diagnostic for the presence of pallid bats since this is the only bat species known to consume large numbers of this ground-dwelling arthropod.

This finding presented logistic challenges since the bridge had been cleared for removal by a Caltrans biologist who did not detect the bat roost. A bridge was under construction in a new alignment ca. 100 meters to the west, and the old bridge was scheduled for removal in early September. Caltrans was informed immediately regarding the significance of this roost – a large night roost for a special concern species – and the need for mitigation.

Ideally this roost would have been discovered early enough to work with bridge engineers and project planners to design a mitigation that had a maximum likelihood of success – either the inclusion of a roost on the new bridge or retention of a portion (*e.g.*, one of the abutments) of the old bridge. The eleventh hour compromise was to try an experimental roost to be installed in the slope of the southern abutment for the old bridge.

This roost, installed in early April 2003, is a small, poured concrete bunker – 8' deep, 8'10" tall, and 5'4" wide. It has a single opening 4' wide by 4" high, located 5' above the ground surface. There is a 1'10" high baffle located 1'8" back from the opening to provide darkness and protection for potential bat occupants.

Photo 3. Mitigation roost at site of old bridge abutment. Photograph by Caltrans Staff.

In July 2002 the consulting biologist had also proposed that a radiotracking study be conducted to determine foraging patterns and identify day-roosting sites for this colony. Unfortunately, there was not sufficient lead-time to put such a project together. Thus the team settled for capturing as many bats as possible at the night roost, and banding all pallid bats that could be caught. This offered a way to track the fate of individuals from this roost and their occupation of the mitigation structure.

Since there was only a limited budget for monitoring, the plan to check bridges in the area for banded bats after demolition of the roost was not carried out. The new roost and its immediate area were monitored on 10 July 2003 and 21 September 2003. On both occasions the roost was observed with night-vision goggles at emergence time to check for day-roosting bats, and monitored with an infra-red camera and acoustic detector until after mid-night to record any night-roosting activity. At the same time mist-nets and four to six acoustic detectors were deployed in the area to check for the presence of pallid bats. The site was checked during the day on 11 June 2004.

Schedule of Work

4 July 2002 – Initial day-time survey of bridge

July 2002 – Consulting bat biologist initiates discussion with Caltrans regarding need for mitigation

9 August 2002 – Night-time survey of bridge

7 September 2002 – Capture of bats at night roost

15 September 2002 – First draft of Caltrans engineers plans for mitigation bat roost

28 March 2003 – Final plans for mitigation bat roost reviewed and approved by consulting biologist

Early April 2003 – Installation of roost

10 July 2003 – Monitor new roost; acoustic and mist-netting survey of area

21 September 2003 – Monitor new roost; acoustic and mist-netting survey of area

11 June 2004 – Monitor new roost

Survey and Monitoring Results

Capture and Marking of Bats at Original Roost. The original assessment that this was a significant pallid bat night roost was based on the large accumulations of fresh guano and Jerusalem cricket parts that were observed during a daytime survey on 4 July 2002. On the night of 9 August 2002 when a night-roost survey was conducted at 01:30 a.m. there were 11 pallid bats night-roosting under the bridge at the time of survey.

On 7 September 2002 a team of people constructed, and applied to the bridge surface, a pulley system for hanging curtains made of surplus parachute fabric. These curtains were hung on the pulleys prior to dark, and left in an open position until 1:00 a.m., when, on cue, team members pulled the curtains closed, with the goal of containing all night-roosting bats within the two land-based bridge bays. Three harp traps were set side by side to close off the bay that was over the creek. Additionally one 7' by 30' net was set at dusk over the creek.

Photo 4. Curtain made from parachute silk, used to contain bats within night roost and facilitate capture. Photograph by William E. Rainey

Table 1 documents the number of bats captured during the three netting efforts at this site.

Table 1. Numbers of Individuals Captured by Date And by Species at Pieta Creek.*

Date	**Locality**	***Anpa***	***Myca***	***Myyu***	***Tabr***	**# of bats**	**# of spp.**
Pieta Creek at SR 101 Crossing							
7-Sep-02	Night Roost at Old Bridge	34	8	6	5	**53**	**4**
7-Sep-02	Creek	10	0	0	1	**11**	**2**
TOTALS		**44**	**8**	**6**	**6**	**64**	**4**

* Anpa = *Antrozous pallidus*, Myca = *Myotis californicus*, Myyu = *Myotis yumanensis*, and Tabr = *Tadarida brasiliensis*.

A total of 64 bats of four species were captured, including 44 pallid bats. All the pallid bats were banded with numbered, lipped wing bands.

Table 2 gives the reproductive condition for the 64 bats captured September 7. All four species had post-lactating females, and three had juveniles, indicating that this bridge was used as a night-roost by reproductive populations of all four species.

Table 2. Capture Records for Pieta Creek by Species by Date, Including Information on Age, Sex, and Reproductive Condition when Known.†

Species	Date	Adult Males	Adult Females		Juveniles		Unk.	Total
			Pl	Nl	M	F		
Antrozous pallidus								
	7-Sep-02	18	13	5	3	5		44
Myotis californicus								
	7-Sep-02	2	4	1		1		8
Myotis yumanensis								
	7-Sep-02		2			2	2	6
Tadarida brasiliensis								
	7-Sep-02		5	1				6
TOTALS		**20**	**24**	**7**	**3**	**8**	**2**	**64**

† Pl = post-lactating; Nl = nulliparous; Unk = Sex and/or reproductive status unknown; M = male; F = female.

Monitoring of Mitigation Roost. The new concrete bunker roost was monitored on three occasions – 10 July 2003, 21 September 2003, and 11 June 2004. No bats were observed using the roost on any of the visits.

On the first two occasions the roost was monitored acoustically and visually for emergence and for possible night-roosting until after mid-night .Four bat detectors were depaloyed in the vicinity of the roost and run all night in both July and September. They detected very few pallid bats on either night.

Additionally, mist-nets were set over the creek, and four bat detectors were deployed in the vicinity of the roost. A total of ten bats of three species, including one pallid bat were captured. That pallid bat was an unbanded adult male. Tables 3 and 4 summarize the capture data.

Table 3. Numbers of Individuals Captured by Date and by Species at Pieta Creek.

Date	Locality	*Anpa*	*Myca*	*Myyu*	# of bats	# of spp.
Pieta Creek at SR 101 Crossing						
10-Jul-03	Creek	1	3	3	**7**	**3**
21-Sep-03	Creek	0	1	2	**3**	**2**
TOTALS		**1**	**4**	**5**	**10**	**4**

Table 4. Capture Records for Pieta Creek by Species by Date, Including Information on Age, Sex, and Reproductive Condition when Known.‡

Species	Date	Adult Males	Adult Females		Juveniles		Unk.	Total
			Lc	Pl	M	F		
Antrozous pallidus								
	10-Jul-03	1						1
	Subtotal	**1**	**0**	**0**	**0**	**0**		**1**
Myotis californicus								
	10-Jul-03	1	1			1		3
	21-Sep-03						1	1
	Subtotal	**1**	**1**	**0**	**0**	**1**		**4**
Myotis yumanensis								
	10-Jul-03					3		3
	21-Sep-03						2	2
	Subtotal	**0**	**0**	**0**	**0**	**3**		**5**
TOTALS		**2**	**1**	**0**	**0**	**4**	**3**	**10**

‡ Lc = lactating; Pl = post-lactating; Unk = Sex and reproductive condition not determined; M = male; F = female.

The inspection of the roost in June 2004 was done in the daytime by inserting a Sony F707 digital night shot camera into the roost.

Discussion

Although the dimensions and the materials selected for this mitigation roost were consistent with those found in known pallid bat roosts, no bats of any species have been found so far to be using this roost. It is not surprising that pallid bats have chosen not to use this site as a night roost, since night roosts are generally more open, like the concrete girder roost they lost. The decision to enclose this mitigation roost, making its design more appropriate for a day-roost, was based on the fact that this structure was so highly visible. In order to protect the structure and the bats from vandalism, a decision was made to enclose it, leaving an opening large enough for bats, but not large enough for most predators (including humans). G. Tatartian, who has had considerable success designing artificial roosts for pallid bats, has suggested that the addition of an open covering over the entrance (made of plywood, tile backer board, or roughened pre-cast concrete, and spaced 1" from the roost wall) might make the site more attractive to the bats.

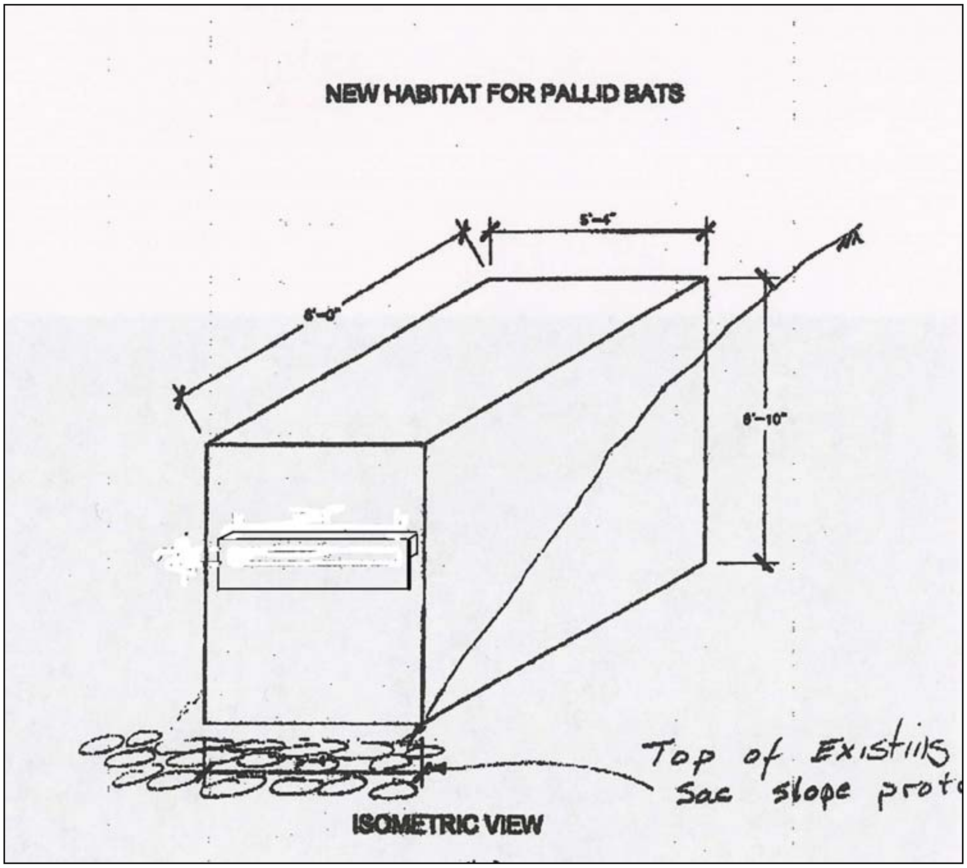

Figure 1. Possible Revised Mitigation Roost Design. Sketch by Greg Tatarian

It is notable that no pallid bats have been observed to use the mitigation roost, which in its overall dimensions is very similar to a known pallid bat night roost. Furthermore, there appeared to be few pallid bats in the area in the July and September 2003 surveys. This is in stark contrast to September 2002 when pallid bats were captured over the creek as well as in the night roost, and were detected repeatedly acoustically. Those animals that were captured in mist-nets in September 2002 were captured early in the evening, suggesting that their activity over the creek in the vicinity of the bridge was related to foraging activity, not night-roosting.

Radio-tracking studies and roost surveys have often shown that pallid bat night-roosts are typically close, often only 300-500 meters, from the day roost (Hermanson and O'Shea 1983). For example, a pallid bat nursery colony on Vandenberg Air Force Base night-roosts in a cave that is less than 500 m from its primary day roost (Pierson et al. 2002). In Amador County, pallid bats night-roosting on the SR104 Bridge over Dry Creek were shown by radio-tracking to be roosting primarily in a mature cottonwood tree located ca. 150 m from the bridge (Pierson et al. 2004).

Historically most of the known pallid bat maternity colonies were in roosts that could be readily located – *i.e.*, caves or mines, rock shelters, buildings, or bridges (Hermanson and O'Shea 1983, Orr 1954). More recently radio-tracking studies in California have revealed that pallid bat maternity colonies frequently roost in trees (Rainey et al. 1992, Rainey and Pierson 1996, Pierson et al. 2004), and are particularly associated with oaks.

The most likely day roosting sites for the Pieta Creek colony were either in blue oaks on the surrounding hillside or in a complex of old buildings that was in the highway right-of-way and ca. 100 m from the roost. Unfortunately, the proposed radio-tracking study did not take place, and the buildings, which were removed sometime between September 2002 and the spring of 2003, were not surveyed. The apparent absence of pallid bats in the area in the July and September 2003 surveys suggests this species may have been day-roosting in the buildings, and were either killed in the demolition or driven from the area when they lost their roost. It is unlikely that the loss of only the night-roost would cause them to abandon the area.

Lessons Learned and Recommendations

This project offered a number of useful lessons.

1. It illustrates the importance of training for Caltrans biologists. This situation became an emergency because the significance of the site was overlooked by the Caltrans biologist tasked with conducting the environmental assessment. Limited training could have averted this.

2. This project additionally illustrates the importance of identifying the bat issue early enough in the process that the biologists and engineers have the opportunity to work together to design a viable mitigation strategy.

3. When a night-roost for pallid bats is the survey target, the day-roost(s) should also be located. Given the typical proximity of the day-roost to the night-roost, there is some likelihood that both will occur within the project area, and be affected by the project. Although day-roosts in buildings or bridges can generally be located by visually inspecting the structures, many roosts, particularly tree roosts, can only be located by radio-tracking.

4. This project illustrates the need for more research regarding the roosting requirements of various bat species, and the challenge of getting animals to accept a roost that does not match the dimensions and conditions of the roost being lost.

5. As with so many projects, opportunities to learn lessons and correct mistakes are lost when long-term monitoring does not occur. This project ended in 2003. (The 2004 survey was conducted as part of the background research for this document). Thus, even though it often takes several years for artificial roosts to be occupied, leaving open the possibility that this roost may yet be occupied, there is no established procedure by which its fate will be tracked. Also, by not having any follow-up, an opportunity has been lost to look for banded animals at other bridges in the area, and thus to learn something about the response of this colony to the loss of its roost.

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Appendix J.

EndNote Records for
Literature Relating to Bat Mitigation

Insert Endnote print out (4 pgs)

Appendix K.

URL List

Publication/ Report Name	URL/Publisher	Type of Mitigation
A. J. Mitchell-Jones. 2004. English Nature. Bat Mitigation Guidelines.	http://www.english-nature.org.uk/pubs/publication/PDF/Batmitigationguide2.pdf	Detailed guidance for professionals; surveys, humane eviction, roost reconstruction, enhancement, bat houses, monitoring, case studies.
Indiana Office of Surface Mining Bat Gating Projects website	http://www.mcrcc.osmre.gov/Indianapolis/Bat%20Gate/Indiana%20Bat%20Gate.htm	Photo gallery of bat gating case histories.
FHWA Texas Bat Bridges website	http://www.tfhrc.gov/pubrds/winter96/p96w12.htm	Lay article re: Congress Ave. Bridge
Selah – Bamberger Ranch Chiroptorium website	http://www.bambergerranch.org/news.htm	Website for Bamberger Ranch constructed bat cave – constructed for habitat enhancement by enthusiast, using wire frame and gunnite.
Locke, Robert. 2003. Bats at Last! An artificial bat cave proves its worth. Bats. BCI. Fall.	http://www.batcon.org/	As many as 200,000 bats using Bamberger Cave in Central Texas. Mostly TABR, + ca. 7,000 possible MYVE.
Bat Gates Installed in Abandoned Mines. Lake Mead NRA website	http://www.nps.gov/lame/projects/000524.html	Mine tunnel gates at Lake Mead National Recreation Area.
Brian Keeley & Tuttle, M. Bats in American Bridges. Bat Conservation International	http://www.batcon.org/bridge/ambatsbridges/	Guidance for bat bridge mitigations, designs.
Conserving Bats. The Heritage Council, Ireland	http://www.countycarlow.ie/services/reportspublications/reports/ConservingBats.pdf	Layperson guidance for bat conservation.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Attachment A: Christopher Creek Highway Project Environmental Impact Mitigation Measures. Wildlife Crossings Toolkit website	http://www.wildlifecrossings.info/media/sa024.pdf http://www.wildlifecrossings.info/beta2.htm	Bridge habitat replacement/enhancement. Mitigation for bats: "Because there is an expected direct loss of roosting and foraging habitat for bats as a result of this project, opportunities to replace or enhance roosting habitat for bats will be identified and evaluated during final design. The practicality of the use of bridge designs that enhance bat roosting opportunities (e.g., box bean designs) or modification of wildlife culvert crossings to address the needs of roosting bats will be evaluated. The practicality of incorporating some structural device to the underside of new/old bridges along the highway for bats will be evaluated. Bat boxes/houses will be placed at intervals along the highway in the more remote, forested areas."
Mitigation Matrix. Lower Yosemite Fall Project Yosemite National Park. National Park Service	http://www.nps.gov/yose/planning/yfalls/LYFFONSIMitigation.htm	Pre-thinning surveys, seasonal avoidance.
Turning a Box Culvert Into a Bat Culvert. Keeping it Simple website. U.S. Department of Transportation. Federal Highway Administration	http://www.fhwa.dot.gov/environment/wildlifeprotection/index.cfm?fuseaction=home.viewArticle&articleID=54	Converting culverts into bat roosts, Webb County, Texas.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Herger-Fernstin Quincy Library Group Forest Recovery Act. Final Supplemental Environmental Impact Statement. Record of Decision. 2003. USDA Forest Service. Pacific Southwest Region.	http://www.fs.fed.us/r5/hfqlg/documents/HFQLG_SEIS/rod.pdf	Mitigation: "At the site-specific project level evaluate and implement the following design features, to the extent reasonably practicable, to reduce indirect and cumulative effects to the Western red bat, Townsend's big-eared bat and pallid bats from the following herbicides: hexazinone, sulfometuron methyl, picloram, or the NPE-based surfactant. Within suitable habitat, conduct acoustical, mist-net, and roost surveys for Western red bat, Townsend's big-eared bat and pallid bats when hexazinone, sulfometuron methyl, picloram, or the NPE-based surfactants are proposed for DFPZ maintenance or control of invasive and noxious weeds. If these bat species are located, consider: 1) alternative herbicides near roosts or within foraging areas; 2) no-herbicide buffers around bat roosts; 3) alternative forms of herbicides such as the pellet form of hexazinone; 4) alternative methods of herbicide application, such as "cut and dab", "hack and squirt", "spot-gun", or "basal spray", 5) limited operating periods (i.e. winter months when bats would be hibernating); and 6) reduced application rates. Monitoring of threatened, endangered, or sensitive wildlife."
Limiting Blasting Near Bat Caves Protects Baby Bats Keeping it Simple website. U.S. Department of Transportation. Federal Highway Administration	http://www.fhwa.dot.gov/environment/wildlifeprotection/index.cfm?fuseaction=home.viewArticle&articleID=24	Limiting blasting near caves so no vibration felt past 600 ft. from project area.
Rydell, Jens, and Baagoe, Hans J. 1996. Bats and Streetlamps in Bats Magazine. Bat Conservation International. Winter.	http://www.batcon.org/batsmag/v14n4-4.html	Lay article; negative effects on insects and bats from conversion from mercury vapor or sodium and mercury to orange sodium.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Nieland, Jim. Policies, Management and Monitoring: Protection of Habitat Using Bat Gates. U.S. Forest Service.	http://www.mcrcc.osmre.gov/PDF/Forums/Bat%20Gate/6-4.pdf	Professional guidance re: Federal Cave Resources Protection Act of 1988, bat cave-roost ecology, cave morphology, bat surveys, entrance gating, vegetation retention, equipment limitations, entrance retention, avoidance of drainage into mine or cave, limiting blasting within ¼ mi. when occupied.
The bat worker's manual A.J. Mitchell-Jones, ed. Nature Conservancy Council. 1987.	http://www.jncc.gov.uk/Publications/bat_workers/#download	Professional guidance on laws, handling, surveys, identification, banding, marking, handling, bat groups, public relations, timber treatment, pest control, caves, mines, hollow trees. Incl. adapting roof ridges and dormers for entry by bats, cave gating.
Bat Gate Design Forum EProceedings. 2002. Office of Surface Mining. Mid-Continent Region.	http://www.mcrcc.osmre.gov/PDF/Forums/Bat%20Gate/TOC.pdf	Proceedings of gate design forum.
Sherwin, Richard E., Altenbach, J.Scott, and Haymond, Shauna. 2002. The Responses of Bats to Gates *in* Bat Gate Design Forum. Office of Surface Mining. Mid-Continent Region.	http://www.mcrcc.osmre.gov/PDF/Forums/Bat%20Gate/6-1.pdf	Authors suggest lack of available data re: success of bat gates, propose further research, caution against gating as sole mitigation.
Environmental Program News. National Council of the Paper Industry for Air and Stream Improvement (NCASI). Mar. 11, 1998. Vol. 10 No. 5. Forestry	http://www.ncasi.org/forestry/ForestryNews/1998/fn-10-05.pdf	Collaborative plan with BCI to develop information on forest bats, including distribution, protection, ecology, forest management practices, identification of priorities and future research needs, develop planning and budgeting priorities.
Bridge Usage by Bats in County Leitrim and County Sligo. The Heritage Council. An Chomharirle Oidreachta. Ch. 6.	http://www.heritagecouncil.ie/publications/bats/	Day/night surveys, preconstruction surveys, pre-project planning, retain crevices, artificial roosts, tree planting, inform local authorities, training seminars, mitigation monitoring.

Publication/ Report Name	URL/Publisher	Type of Mitigation
The Highway Agency (UK) Biodiversity Action Plan	http://www.highways.gov.uk/aboutus/corpdocs/biodiversity/pdfs/wdland_feat_bats.pdf	Introductory professional guidance on bat protections, species concerns, mitigations.
Opening of the A41 Aston Clinton Bypass. The Highway Agency (UK)	http://www.highways.gov.uk/roads/projects/a_roads/a41/aston_clinton_bypass/a41_astonclinton_bp_oct_03/06.htm	Press release; bat houses around restored canal.
The New A11 Interchange. The Highway Agency (UK)	http://www.highways.gov.uk/roads/projects/a_roads/a11/interchange/a11_news/page03.htm	Press release; surveys, mature tree retention, landscaping to enhance road corridor.
A127 Polegate Bypass. The Highway Agency (UK)	http://www.highways.gov.uk/roads/projects/a_roads/a27/polegate_bypass/a27polegate/02.htm	Progress report; surveys.
A10 Wadesmill to Colliers End Bypass. The Highway Agency (UK)	http://www.highways.gov.uk/roads/projects/a_roads/a10/wadesmill_colliers_end/a10_wadesmill_sept_02/04.htm	Press release; underground mitigation bat cave, tree-mounted bat houses.
A36 Limpley Stoke Stabilisation and Resurfacing Update: Week 2. The Highway Agency (UK)	http://www.highways.gov.uk/roads/projects/a_roads/a36/limpley_stoke/a36_limpley/week_2.htm	Press release; tree bat surveys, tree retention.
Annual Report 2000-2001. Case study: Bat colonies on the A66 Stainburn/Great Clifton bypass. The Highway Agency (UK)	http://www.highways.gov.uk/aboutus/corpdocs/ann_rpt/2000_2001/page_07.htm	Case study: installation of camouflage netting linking intact and logged woodland to “fool” bat echolocation, causing them to continue to forage as if woodland unbroken.
Telephone Flat Geothermal Development Project Mitigation Monitoring and Reporting Program. Siskiyou County	http://www.co.siskiyou.ca.us/telephoneflat/pdf-files/notices/Telephone%20Flat.NOC-3.Exhibit%20A.MMRP.PDF	Preconstruction presence/absence surveys. 250-foot buffer. Snag avoidance. Bat roost management plan. Snag creation.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Planning & Building Inspection Condition Compliance and Mitigation Monitoring and/or Reporting Plan. Monterey County	http://www.co.monterey.ca.us/pbi/docs/resolutions/pc_2003/res_pc03017_MMRP.pdf	Pre-demolition surveys, buffer zones, eviction, and monitoring.
Summary of Environmental Impacts and Mitigations. City of Capitola	http://www.ci.capitola.ca.us/capcity.nsf/vlookup/RISPIN%20SUMMARY%20OF%20ENVIRONMENTAL%20IMPACTS%20AND%20MITIGATION/$file/RISPIN%20SUMMARY%20OF%20ENVIRONMENTAL%20IMPACTS%20AND%20MITIGATION.pdf	Preconstruction surveys, eviction, roost replacement (COTO?).
A507 Ridgmont Bypass Environmental Mitigation Proposals. Bedfordshire County Council	http://216.239.39.104/search?q=cache:uKNdd6OhhccJ:www.bedfordshire.gov.uk/BedsCC/SDroadworks.nsf/8979a9cced1e622d802568a9003dfbdf/7c38490c0c08cacc80256a7f0056da01/%24FILE/MITIGATI.doc+bats+mitigation&hl=en&ie=UTF-8	Presence/absence surveys, seasonal removal of trees and snags, retention, consultation, bat-friendly landscaping, bat-friendly bridge design, bat houses.
Final Environmental Assessment. Ch. 2.0 Alternatatives and Mitigation Measures. Tennessee Valley Authority	http://www.tva.gov/environment/reports/sunsetbay/chapter_2.pdf	Bioacoustic monitoring of tree roosts 1 night prior to removal, removal of <6” dbh between Oct. 15-Mar. 31.
Yosemite Lodge Area Redevelopment Environmental Assessment. National Park Service.	http://www.nps.gov/yose/planning/lodge/pdf/ylarpapdx_c.pdf	Surveys, seasonal avoidance (short spring?), snag retention, eviction.
Mitigation Monitoring and Reporting Program Verona Ridge Residential Development. City of San Mateo	http://www.ci.sanmateo.ca.us/downloads/planning/veronaridge/mitigation_monitoring_&_report.pdf	Seasonal avoidance, tree surveys <12”, eviction, opening tree roosts.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Mitigation Monitoring and Reporting Program, Building 49 Project. Lawrence Berkeley Lab	http://www.lbl.gov/Community/pdf/env-rev-docs/4-MMRP.pdf	Seasonal timing, surveys w/in 200 vertical ft. of construction using optics, acoustics, no-disturbance buffer.
Missouri River Mitigation Project. U.S. Army Corps of Engineers Kansas City District	http://www.nwk.usace.army.mil/projects/mitigation/projnews/2002-07-rocheportcave.htm	Cave gating, gray and Indiana bats.
Appendix D Mitigation Measures, Draft Environmental Impact Statement, Spring Creek Project. U.S. Forest Service	http://www.fs.fed.us/r9/allegheny/forest_management/projects/Springcreek/deis%20appendices/Appendix%20D%20Mitigation%20Measures.pdf	Tree retention, tree removal after consultation with USFWS, seasonal timing of tree, building removal.
Lower Yosemite Falls Project Mitigation Matrix. Yosemite National Park. National Park Service	http://www.nps.gov/yose/planning/yfalls/LYFFONSIMitigation.htm	Surveys, seasonal avoidance (short spring?), snag retention, eviction.
Bat Survey Requirements When Submitting Planning Applications. Staffordshire Moorlands District Council	http://www.staffsmoorlands.gov.uk/services/tourismandleisure/countryside/bats/Bat%20Surveys1.pdf	Public/professional guidance re: bat surveys. Full bat surveys required prior to development except for extension to existing dwelling (presence/absence survey required), reporting, mitigation, licensing, and assessment of structures.
Union Railways. Channel Tunnel Rail Link.	http://www.ctrl.co.uk/ecology/ecology.asp?L=5&SL=18	Press release; construction of bat cave, 78 artificial bat roosts.
Trunk Road Biodiversity Action Plan: Review for Discussion. Scottish Executive.	http://www.scotland.gov.uk/library2/doc11/tbap-12.asp	General discussion of impacts and mitigations for bats in bridges.
The TRIZ Journal website	http://www.triz-journal.com/	Theory of inventive problem solving, broad applications.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Agreement on the Conservation of Populations of European Bats (Eurobats). Report on the implementation of the Agreement in the United Kingdom. 2002. Inf. Eurobats.AC8.19.	http://www.eurobats.org/documents/pdf/nat_rep_UK_2003.pdf	Report of actions taken in UK in 2002 under Agreement. Includes information on studies and study methods, enforcement, education, training, management priorities, pesticide concerns, but not project-specific mitigations.
Public Roads. Website, U.S. Dept. of Transportation Federal Highway Administration	http://www.tfhrc.gov/pubrds/02nov/01.htm	"In October 2001, an interdisciplinary delegation of Federal, State, and conservation group representatives visited Slovenia, Switzerland, Germany, France, and the Netherlands. Although each country uses different approaches to address wildlife issues, they have formed an international network to share information. The Infra Eco Network Europe (IENE) brings together state-of-the-art information on wildlife and transportation. Through comprehensive research on wildlife and habitat-related issues, IENE ultimately will benefit all of Europe as well as the rest of the world."
Performing a Needs Assessment for Potentially Gating a Cave or Mine. Rick Olson. Division of Science and Resources Management. Mammoth Cave National Park	http://www.mcrcc.osmre.gov/PDF/Forums/Bat%20Gate/2-1.pdf	Determining whether or not a cave or mine requires a gate, based on safety, human activity, availability of the site, historical and cultural significance, historical and current biological significance, etc.
Finding of No Significant Impact. Bear Gulch Cave Management Plan. Pinnacles National Monument.	http://data2.itc.nps.gov/parks/pinn/ppdocuments/BGFONSI.pdf	Document in support of selection of combined access plan for Bear Gulch Cave. Mitigations: ongoing monitoring, expanded public education, gating, closing portions of cave during maternity and hibernation seasons.
Information Paper. Missouri River Fish and Wildlife Mitigation Project. Rocheport Cave, MO. 2002. U. S. Army Corps of Engineers, Kansas City District. July.	http://www.nwk.usace.army.mil/projects/mitigation/projnews/2002-07-rocheportcave.htm	World's largest cave gate, for Gray and Indiana bat.

Publication/ Report Name	URL/Publisher	Type of Mitigation
The Basingstoke Canal. From the Society Archives – Bats and tunnels. 2003. Surrey and Hampshire Canal Society	http://www.basingstokecanal1.freeserve.co.uk/acrb01.htm	Bat cave built in Kent in a disused chalk pit now part of Monkton Nature Reserve near Birchington. Cave = 50ft. length of 5ft. dia. Concrete pipe sections buried 4ft. with rough concrete shelving with brick and rubble crevices inside. Visited by some bats 10 weeks post-construction.
The Basingstoke Canal. From the Society Archives – Bats and tunnels. 2003. Surrey and Hampshire Canal Society	http://www.basingstokecanal1.freeserve.co.uk/acrb01.htm	Greywell Tunnel – winter breeding roost and hibernaculum. Boaters prohibited from using the tunnel during winter months, and a temporary partition maintains cave-like atmosphere. No results.
The Basingstoke Canal. From the Society Archives – Bats and tunnels. 2003. Surrey and Hampshire Canal Society	http://www.basingstokecanal1.freeserve.co.uk/acrb01.htm	Large bat roost built at Eastleigh. Huge concrete pipes buried in Eastleigh Valley Country Park to make artificial tunnel. No results.
University of Florida Bat House	http://www.wec.ufl.edu/extension/bat_house.htm http://www.afn.org/~ufbat/bathouse.2.html	Construction of large bat house adjacent to Lake Alice wetland for mitigation of lost habitat after stadium remodel. 60,000 (est.) TABR occupying since 1997.
Species Action Plan – Bats.	http://www.nottsbag.org.uk/species/bats.htm	General plan for species conservation, part of the UK species action plans.
Fenn, Peter. *In* Conserving Bats Living in Buildings. 2001. Bats. Bat Conservation International. Fall, Volume 19, No. 3.		Discussion of bat protections in UK, requirements for exclusion as a last resort, conducted by certified excluder. "Bat bricks" provide roost cavities. Some new housing developments include bat houses attached to exterior walls. Example of hotel with colony of *Rhinolophus hipposideros*, marketed as ecotourism attraction.
Lefevre, Alex.*In* Conserving Bats Living in Buildings. 2001. Bats. Bat Conservation International. Fall, Volume 19, No. 3.		Examples of bat roosts in underground quarries, ice-cellars, fortresses, bunkers, churches. Bat-friendly gates at quarries, and bat-friendly doors in ice-cellars. Army commando training facility now protected for bats, small fortress acquired for bat conservation. Church architects and congregations modifying roofs, providing holes for bats.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Altringham, John. D. 1998. Bat Houses in British Forests. Bats. Bat Conservation International. Spring, Vol. 16, No. 1.		Discussion of tree-mounted bat houses in UK: 1) 300+ boxes attached to trees, monitored 12 years, with 90% occupancy. 2) Dorset 20-year bat house and banding project.
Holmes, Mike. 1997. The Old Beech Tree Roost. Bats. Bat Conservation International. Summer, Vol. 15, No. 2.		Account of large beech snag beside road in Woolbeding Estate, West Sussex County, England, shedding branches. Author recommended removal of all limbs. No data regarding return of bats after trimming at time of article.
Habitat Conservation Plan for the Six Points Road Interchange and Associated Development Project No. DEM-070-3(196)68 Des. No.: 9500900. US Department of Transportation Federal Highway Administration Indiana Department of Transportation Indianapolis Airport Authority Indianapolis Department of Public Works Indianapolis Department of Metropolitan Development Hendricks County Board of County Commissioners September 19, 2001	http://midwest.fws.gov/nepa/SixPoints/hcpfinaldraft901.PDF	Trees will not be cleared between April 15 and September 15. Permanent replacement of roosting and foraging habitat includes planting 140 hectares (345 acres) of hardwood seedlings within the approximate area of the project. Approximately 54 hectares (134 acres) will be planted immediately adjacent to the interchange and the creek relocations. Remaining 86 hectares (211 acres) will be planted adjacent to or within the Conservation Management Area on land owned by the Airport. Purchase of proposed mitigation plantings (with USFWS and Task Force consult) immediately adjacent to interchange and creek relocations, or additional mitigation plantings provided within project vicinity. Development of the planting areas no later than the summer following initiation of construction activities. The planting effort will continue over approximately five -year period. The planting areas will have a deed restriction attached to the land title to preserve the planted habitat in perpetuity. The Indianapolis Airport Authority responsible for maintenance of the mitigation property. Provision to permit eventual transfer of land title with accompanying restrictions to appropriate conservation agency or land trust. No manipulation of vegetation will occur without concurrence from USFWS. Monitoring and reporting program to assess the success of seedling planting effort, continuing existence of the Indiana bat in study area, utilization of mitigation areas by Indiana bat, size of maternity

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		colony population, and location of any newly established or previously unknown primary maternity roost trees. Permanently protected buffer areas within area of HCP, with deed restrictions to preserve the replacement habitat in perpetuity. IAA responsible for maintenance of the mitigation property. No manipulation of vegetation will occur without concurrence from the USFWS. Approximately 80 hectares of existing Indiana bat habitat owned by IAA outside the HCP boundary but within foraging range of Indiana bats will be permanently protected with deed restriction. IAA responsible for maintenance of the mitigation property. $475,000 to $500,000 previously unprotected lands purchased and protected within vicinity of Indianapolis International Airport Conservation Management Area, after approved by the USFWS. Permanent deed restrictions. IAA responsible for maintenance of mitigation property. No manipulation of vegetation without concurrence from the USFWS. Where possible and appropriate, 50 ft. wide buffers around any existing woodlot or mitigation planting areas, maintained in perpetuity, planted in a naturalized herbaceous seed mix and allowed to revegetate naturally. All Project personnel instructed about the terms of this HCP and the restrictions imposed by it before construction, restrictions will be placed in the special provisions of the Construction Specifications. Informal public outreach program may be expanded into the Indianapolis International Airport terminal area and throughout the project area as feasible and appropriate. Additional 15 years of monitoring the same maternity colony.
Texas Department of Transportation Section 1309, TEA-21 Comprehensive Streamlining Efforts	http://www.dot.state.tx.us/env/pdf/july02.pdf	TxDOT now designs some drainage culverts and bridges to provide habitat for bats, in cooperation with BCI. In Central Texas there is a 94-percent chance that a structure built to accommodate bats will be occupied within five years. Laredo District engineered a drainage culvert to double as bat habitat.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Franklin Boulevard Bridge Replacement Bat Protection Program	http://www.sacdot.com/projects/bat/introduction.asp	Initially planned replacement of wood trestle bridge included temporary roost habitat for est. 30,000 TABR, Myotis sp., EPFU. Six Mayberry houses installed on adjoining private property and The Nature Conservancy Consumnes River Preserve. Bat roosts constructed with "steel structure covered with wood or stucco for strength and correct alignment. The wood is exterior quality, including plywood, redwood and cedar trim. The bat homes are caulked and have three coats of exterior grade paint. Heat transfer ducts located underneath the metal roof maintain proper roosting temperatures. Air vents on each end and on the sides aid in proper ventilation. Vents are shielded to reduce light entry. Plastic mesh is attached inside the wooden frame for additional roosting options and space. The bat homes were welded to support pipes that are cemented into the ground. The houses are 15 feet off the ground to provide an adequate drop zone for the bats and to protect the houses from floodwaters. The bat houses are all located in sunny locations in open areas. The bat house installation diagram is shown on the following page. The first 3 bat houses were installed on the Kirkham property during the summer of 1999. Installation of the first bat house began on June 21, 1999. The third house was installed in August 1999. The remaining 3 bat houses were installed on the TNC lands in October 1999. Fall monitoring of the first 3 bat houses revealed some guano on the ground, indicating use as a night roost. No bats were observed inside the bat houses." Eviction in Mar. 2000 using expanding foam, later netting. Not initially successful – mortality and trapped bats behind net, in crevices outside net, and caulking pulled away some areas, allowing bats inside. Est. 1,000 bats using bat house #2 as late as Oct. 14, 2000, 250 by Nov. 29. Only guano two other houses. Roofs of houses 2 and 5 painted black April 2001, paint on house 5 was extended 2 feet down from the roof. Early April, 2001, no bats present in bridge or at bat houses. Late

Publication/ Report Name	URL/Publisher	Type of Mitigation
		April 30-50 bats in bat houses 2 and 3, guano under house 1. Bats are observed roosting in the northern end of the bridge where caulking is absent. June, 2001, estimated that there are several hundred bats in the bridge. Guano is observed below bridge openings ¾ inch or smaller. Also heard in various bridge locations where they not seen. Pop. in bat houses 2 and 3 est. about 200 bats each. TABR, EPFU using bat houses and bridge. Late June, pups in the bridge crevices. Bat house pops. decreased to ~50 individuals in house 3, and 2 in house 2. Mid-July, est. a few thousand bats occupy bridge. Hundreds of TABR and EPFU pups observed in space that is both tiny (small rotted areas used to enter the hollow areas under the bents) and larger spans not used in previous years, in space up to a foot wide. Estimated 50 bats in house 1, at least 500 bats in house 2 and more than 1,000 bats in house 3. Early September bats completely out of house 2. The slats are warped and the netting is sagging, large yellow jacket nests on the outside of the house, wasps inside the bat houses One bat observed in house 4 at the TNC on September 5, 2001. On September 26, 2001, bats in center slats of house 3 for the first time. Est. 3,000 bats in house 1, wren nest in house 3. Side note: 360 linear feet of bat guano under the Alta Mesa Bridge, first bridge in Sacramento County to have bat habitat built in. Over 2 years for the bats to return and fully occupy the habitat created in that bridge. October 4, 2001, no bats observed in all bat houses and entire bridge. It was decided modifications be made to the houses to increase internal temperatures. October 15, 2001, data loggers were installed in bat house 1, house 6 and under bridge. These loggers ran two weeks, were removed and returned to BCI October 29, 2001. BCI will review the results of the temperature and offer additional recommendations. Any further modifications to the existing bat houses will be completed

Publication/ Report Name	URL/Publisher	Type of Mitigation
		prior to the 2002 bat season, which begins in March 2002. After data loggers were placed in houses, vents on all houses sealed, roof of house 1 was painted black. House 6 on the TNC property modified with new sloped cover over bottom of bat house. In addition to the above modifications, Marvin Maberry donated 1 additional bat house to Sacramento County, installed midway between bat house 1 and 2.
Blackwater Valley Countyside Partnership Bat Conservation Project	http://www.blackwater-valley.org.uk/bat_conservation.htm	Native tree replanting, network of open ditches and ponds for bat flyways and feeding areas, construction of large bat cave, six sites with 150 bat houses. Results: 6 species increased populations.
The Bat Conservation Trust	http://www.bats.org.uk/	UK national organization devoted to conservation of bats and habitats.
Bats settle in ravers' tunnel. BBC News UK Edition. 2003. April 23.	http://news.bbc.co.uk/1/hi/england/oxfordshire/2970557.stm	Conversion of former railway tunnel between Horspath and Littleworth in Oxfordshire.
Rare bats given £420,000 roost	http://news.bbc.co.uk/1/hi/england/2440423.stm	Renovation of 16th century barn, 50-year lease to English Nature for barbastelles.
Project Description – Bridge Replacement on County Road 99W over the Cache Creek (Bridge Number 22C-022). Yolo County	http://www.yolocounty.org/org/bos/agendas/2003/112503/29.pdf	Bat exclusion prior to demo. Bat houses on outside of new bridge. Architectural treatments to new bridge design to provide night-roost habitat for pallid bat. Mitigation monitoring.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Mitigation Monitoring and Reporting Program. Verona Ridge Residential Development. 2003. April	http://www.ci.sanmateo.ca.us/downloads/planning/veronaridge/mitigation_monitoring_&_report.pdf	Potential Impacts to Pallid Bats A pre-demolition survey for roosting bats would be conducted prior to any removal of trees greater than or equal to 12 inches in diameter at 4.5 feet above grade. The survey would be conducted by a qualified bat biologist (i.e., a biologist holding a CDFG collection permit and a Memorandum of Understanding with CDFG. No activities that would result in disturbance to active roosts would proceed prior to the completed surveys. If no active roosts are found, then no further action would be warranted. If a maternity roost is present, a qualified bat biologist would determine the extent of construction-free zones around active nurseries since these species are known to abandon young when disturbed. If either a maternity roost or hibernacula is present, the following mitigation measures shall be implemented. CDFG would also be notified of any active nurseries within the construction zone. - *Exclude Bats Prior to Demolition of Roosts*. If an active nursery roost is located and the project cannot be redesigned to avoid removal of the occupied tree, demolition of that tree shall commence before maternity colonies form (i.e., prior to March 1) or after young are volant (flying) (i.e., after July 31). The disturbance-free buffer zones described in the mitigation above would be observed during the maternity roost season (March 1 - July 31) - If a non-breeding bat hibernacula is found in a tree scheduled to be removed, the individuals can be safely evicted, under the direction of a qualified bat biologist (as determined by a Memorandum of Understanding with CDFG), by opening the roosting area to allow air flow through the cavity. Trees with roosts that need to be removed would first have bats evicted at dusk, just prior to tree removal, to allow bats to escape during the darker hours.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Summary of Impacts and Mitigation Measures Juvenile Justice Facility at the Existing San Leandro Site Alameda County, California FINAL EIS/EIR APPENDIX	http://projects.vanir.com/ajjf/html/Final%20EIS-EIR/Appendix%201-JJF%20Impacts%20and%20Mitigation.pdf	8.1.2b: Preconstruction Roosting Surveys. Preconstruction roosting surveys for pallid bat and Townsend's western big-eared bat shall be conducted prior to demolition of buildings on the site. The surveys shall be conducted by a qualified biologist no more than 30 days prior to demolition. If bat roosts are encountered, demolition shall be postponed until bats have been relocated. Roost entrances shall be fitted with one way doors that allow exits but prevent entrance for a period of several days to encourage bats to relocate. If maternity roosts are found, the structure with the maternity roost shall be avoided and bat relocation efforts postponed until the offspring have fledged. If avoidance is not feasible, mitigation shall be developed in consultation with the CDFG and shall meet with the approval of the County General Services Agency prior to any construction or grading. The results of the preconstruction survey and any required mitigation monitoring shall be submitted to the CDFG and County General Services Agency.
Artificial Roost Designs		
Author, Title, Publisher	**Link, if available**	**Description**
Acker, Elaine. 1999/2000. Backyard Bats. Cal Butchowski, Pennsylvania Game Commission. Petersburg, Pennsylvania. Bats Magazine. 1999/2000. Bat Conservation International. Winter. Vol. 17, No. 4.	http://www.batcon.org/	MYLU-focused large bat house design. Claimed overall success rate 91%. Has been successfully adapted for MYYU in Santa Clara County (Burr 2003, Tatarian, pers. Obs.)

Publication/ Report Name	URL/Publisher	Type of Mitigation
Kiser, Mark. 2002. North American Bat House Research Project. BCI's Volunteer Researchers Design Homes for Bats. Marvin Maberry. Bats. Summer/Fall. Bat Conservation International.	http://www.batcon.org/	Various designs from small to large, including houses fitted under bridges, eg. Sacramento County's Franklin Blvd. Bridge Replacement Project.
Noteman, Laurali. 1998. Hidden Housing. Artificial Bark for Bats. Bats. Bat Conservation International. Fall.	http://www.batcon.org/	Artificial bat bark made from polyurethane and/or fiberglass. PVC spacer at bottom, sealed top, and sides with silicone. Developed by Dan Garcia de la Cadena and Melissa Siders. Summer 1998 results: polyurethane bark = 24% usage, fiberglass bark = 42%. Fall 1998 results: no differential use.
Research Associates in Action: Bob Wisecarver Bat House Researcher. Spring 2002 V. 10 N 1	http://www.batcon.org/	44 houses, 64% occupied, 3,600 bats. Pardee reservoir, near Sacramento, EBMUD, converted one of 16 spillway tunnels into artificial bat cave. Added two 12-inch x 72-inch roost panels against concrete walls. Carpet panels, Maberry roost modules. Barn owl moved in, bats moved out. Modified opening, bats moved in. Est. 2500 TABR.
Kiser, Mark. Meet Myotis evotis. BHR. V. 9 N 1, Spring 2001	http://www.batcon.org/	Plywood panels, ½" spacing, rocket boxes after 2000. Omitted vents, caulked, painted dark blue. Bats in August. Five houses, 4 occupied, 1-10 bats. 6th box 4' tall, black. Bats used within 20 days. Frequent switching.
Burke, Harold S., Jr. Fall 1999. Maternity colony formation in *Myotis septentrionalis* using artificial roosts. The rocket box, a habitat enhancement for woodland bats? Bat Research News. V 40: n. 3.		3 of 3 boxes used. 3 additional boxes with canopy coverage of 50, 80, 100%. All boxes used, differentially.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Clawson, Richard L. and J.E. Gardner. Wood duck predator guards used as roosts by little brown bats. BRN V 33 N. 4.		Sheet metal collars around bald cypress standing in pools. MYKE, MYSO also.
Hampshire bat cave. 1985. Bat News. N. 16		3 precast concrete pipes, 8'l x 5' dia. In excavated trench N-S, set at curve angle. 8' x 2'6" pipes at openings of large pipe joints.
Voute, A.M, and P.H.C. Lina. 1986. Management effects on bat hibernacula in the Netherlands	WWI bunkers, old fortresses.	Previously used houses have 400% more immigration.Daubenton's.
Endangered species technical bulletin. 1994. Region 3. V XIX N4	Crab Orchard National Wildlife Refuge, Illinois.	Convert 2 WWII munitions bunkers. Altering ceilings, MYLU, MYGR, MYSO
BRN V 6 n 2 fall 1998, Observations from the Heat Wave of 1998, New Research Site Yields Valuable Information		
BRN v7 n1. Results from 1998 season		
Bat News N. 49 Spring 1998. Keeping Up the Cold War		Conversion of bomb storage depot into hibernacula
Bat News 47, Nov. 1997. Leicestershire's Gothic Bat Tower	8' dep, 4' wide, 20' from ground. Leicester Water Center. Slots 18 x 15 mm.	
Bat News 46, July 1997. Train	Brick sculpture of train emerging from tunnel, uses 20 bat bricks.	

Publication/ Report Name	URL/Publisher	Type of Mitigation
Kiser, Mark and S. Kiser. 2003. Innovative Homes for Bats That Shun Bat Houses. The Bat House Researcher. BCI. V. 11. No. 1. Spring	http://www.batcon.org/	Construction of artificial roost tree hollows using vertically stacked concrete culverts and manhole shaft sections, August 2000, in southern Georgia, for *Corynorhinus rafinesquii and Myotis austroriparius.* Additional roosts built at two North Carolina state parks – South Mountains State Park, 2001, and Lumber River State Park, 2002. Six of seven already occupied by CORA, including one reproductive female, and one EPFU. **Methods:** Georgia roosts: Finished height: 16 feet (4.9 meters) Roosts 1 & 2: Two 8-foot (2.4-meter) highway culverts. Inside diameter: 3 feet (0.9 meter). Roost 3: One 8-foot highway culvert base and two 4-foot (1.2-meter) manhole shaft sections Inside diameter: 4 feet (1.2 meter) Total cost (three roosts): $5,500 North Carolina roosts: Finished height: 14.5 feet (4.4 meters) Each roosts: Four to five manhole shaft sections Inside diameter: 4 feet (1.2 meters) Total cost (four roosts): $2,860 FOR EACH ROOST: The top five feet of soil was excavated, replaced with clay, and leveled. A concrete pad, six feet (1.8 meters) on a side and eight inches (20.3 centimeters) thick, was installed. Roost sections were stacked on the pads and topped with a concrete cap. An entrance hole was precut in each base section. These varied in size and shape, although most were about 2 x 2 feet (61 x 61 centimeters). One or two 1 x 3-inch (2.5 x 7.6-centimeter) vertical slots were cut 4 to 5 feet (1.2 to 1.5 meters) from the top to provide additional access and escape routes. Floors and lower interior walls were painted dark to reduce interior light. Upper walls and ceilings were roughened by adding lumps of concrete mix, attaching plastic mesh, or cutting grooves to provide footholds for bats.
McCreary, Ann. 2003. Bat House on a Truck. The Bat House Researcher. BCI. V. 11. No. 1. Spring.	http://www.batcon.org/	A dilapidated cabin in Washington was moved to a new location to protect it for Townsend's big-eared bats that had used it for years. To help the bats relocate, a second cabin (*right*) was built at the new site. Some bats used both cabins in the first year.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Arnett, Edward B. and J. P. Hayes. 2003. Oregon Flat-Bottom Bridge Bat House Study. The Bat House Researcher. BCI. V. 11. No. 1. Spring.	http://www.batcon.org/	Study in western Oregon Cascades included 15 flat-bottom bridges along five large streams in managed Douglas fir forests. Authors designed a wood box with no top or bottom, made of rough-cut cedar, installed one beneath bridge in 1996 and 1997. Each box is 2 feet long, 2 feet wide and 12 inches tall (61 x 61 x 30.5 centimeters), with eight boards placed one half or three-quarters of an inch (1.3 or 1.9 centimeters) apart to create roost crevices. Results: Bats used 10 of 15 boxes in 1997. Thirteen (87%) used by end of study. Boxes contained 1-8 bats each.
Kiser, Mark and S. Kiser. 2003. Free-tailed Bats in Rocket Boxes. News and Notes. The Bat House Researcher. BCI. V. 11. No. 1. Spring	http://www.batcon.org/	TABR confirmed using rocket-style bat houses first time, Jan. 2003. Eight species now confirmed using rocket boxes.
Research Papers and Summaries		
Citation	**Summary of Methods**	**Summary of Results**
Carol L. Chambers, Alm, V., Siders, M.S., and M.J. Rabe. 2002. *Use of artificial roosts by forest-dwelling bats in northern Arizona.* Wildlife Society Bulletin, 30(4):1085-1091.	Comparison of tempered hardboard, and fiberglas-reinforced resin curved tree-cover panels to natural snags. Wood panel: 0.6 x 0.6 m x 0.3 cm-thick, 1 smooth, 1 rough side, treated, with wood wedges at bottom to created 5 cm wide opening. FRP roosts: flexible isopthalic polyester resin on fiberglas mat, formed in rubber molds to resemble ponderosa pine snag bark. Both roosts screwed with washer head screws, sealed with brown caulk top and sides.	Presence determined by guano or visual of live bats. Natural snags: n=10, used= 5, unused = 5 Wood roost: n=10, used = 9, unused = 1 FRP roost: n=10, used = 8, unused =2

Publication/ Report Name	URL/Publisher	Type of Mitigation
Arnett, Edward B and J.P. Hayes. 2000. Bat use of roosting boxes installed under flat-bottom bridges in western Oregon. Wildlife Society Bulletin, 28(4):890-894.	Study of 15 flat-bottom bridges located along 5 large streams in Douglas-fir forests, 5-45 yrs. of age in western Oregon Cascades. Bridges ranged from 230-475 m in elevation, 4.9-6.6 m in width, 11.3-27.4 m in length, and 3.1-5.8 m above water. Stream width beneath bridges between 2.3 and 14.0 m. Bridges augmented with wooden boxes of rough-cut western red cedar, 60 x 60 cm long and wide and 30 cm deep, with 8 boards spaced 1.2 cm or 1.9 cm apart to create crevices. Used guano trap under each box, conducted 15 weekly diurnal surveys.	Guano collected at least once from 12 of 15 (80%) of boxes. Observed single bat in box with no guano. 10 boxes used w/in 1 yr. of installation, same 10 plus 3 the following year. Avg. bridge ht. slightly higher than unused sites (3.9 m vs. 3.5m), and stream width slightly larger than unused sites (7.0 m vs. 5.6 m).
Butchokoski, Calvin M. 2002. Surveying the Behavior of Bats Crossing a Two-lane Highway and an Open Field. Bat Research News. Abstracts of Presentations at the 32nd North American Symposium on Bat Research Convened at the University of Vermont, Burlington VT. V43: N. 4. Winter.	Setting: maternity roost, including 40 banded MYSO and ca. 20,000 MYLUO, located in old wood frame country church at Canoe Creek State Park, Blair County, PA, 0.5 km north of a major U.S. highway, Rte. 22. Trees and brush border both sides, bats must cross road many times each night. Methods: on ten evenings between 15 May and 26 July, 2001, surveyors, positioned along a 150-meter length of highway where most bats were crossing, counted bats by crossing height category. Evening counts ranged from 1,636 to 3,351 bat crosses during a 40-minute period. Second study: colony of MYLU travels across 55m mowed field from day roost to foraging site. Bats exit roosts at 8m high, travel 45 m along side of building, flying <4m, enter 15m high tree line. Then exit and cross 55m mowed field to a 14m tree line on other side.	Results: Height of tree canopy on each side of road influenced crossing heights of bats. Where canopy is high (>20m) bats cross well ablve traffic; where canopy is low (~15m), bats cross closer to traffic. Bats avoided lowest (~8m). Second Study Results: over 90% of bats flying lower than 4 meters as they crossed the opening. If over highway, most would be in danger.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Krusac, Dennis L. 2002. Proposed Forest Management Changes in Southern Appalachain Mountain National Forests Should Benefit Bat Conservation. Bat Research News. Abstracts of Presentations at the 32nd North American Symposium on Bat Research Convened at the University of Vermont, Burlington VT. V43: N. 4. Winter.	Five national forests in southern Appalachian Mountains of eastern U.S. are revising forest management plans.	COTO *virginianus*, CORA and MYLE will be protected with a 100 foot buffer above and a t220 foot buffer below cliff face. Only management to occur in buffer will be done to benefit cliffline dependent species. For caves or mines, buffer zones from ½ mi. to 5 mi., depending on species and season. Gates where needed. Mandatory surveys of anthropogenic roosts before modification or demolition. If significant roosting found, structures will be maintained or alternate roosts suitable for species and colony size will be provided before modification or destruction. Forested corridors maintained along watercourses including channeled ephemeral drains. All immediately suitable roost trees retained.
Pierson, Elizabeth D., W.E. Rainey, D.M Koontz. 1991. Bats and Mines: Experimental mitigation for Townsend's big-eared bat at the McLaughlin mine in California. In Proceedings V: Issues and Technology in the Management of Impacted Wildlife. Thorne Ecological Institute	Open pit gold mine – McLaughlin Mine. Surveys conducted 1987-1988, found two suitable alternative roosts – Soda Spring adit, and Reid adit. Both fitted with gates and bats excluded from main roost. Colony moved into gated Soda Spring adit, and has continued to use it as maternity roost since. Reid adit, colder and wetter, not occupied by large number. Bat activity, roost temperature and light levels monitored. Gates bar spacing = 15cm high x 62 cm wide, but also recommend 15 cm x 50 cm. Material =10.3 cm x 10.3 cm angle iron, with 1" reinforcing rod around sides and top. Door with 20.5 cm section of 10.3 cm dia. Pipe used for lock protection. Reid adit reinforced with series of 1.23 m x 1.23 m cement culvert sections, used conveyor belt laid on top, then backfilled with dirt.	Soda Spring adit used primarily as summer roost. Reid adit activity is markedly less. Peak of activity in May, but most used as night roost. Temperatures are suitable for hibernating, but has not been used by many.

Publication/ Report Name	URL/Publisher	Type of Mitigation
Materials Resources		
Coastal Netting Company	P.O. Box 1946, Bakersfield, CA 93303	Torex bird netting for ponds, large areas
Bird Guard bird control products	1-800-331-2973	
Larson Company 6701 S. Midvale Park Rd. Tucson, AZ		Artificial wildlife environments.
Uniek, Inc.	800-248-6435	Quick-Count 7 mesh Plastic Canvas, #57301, clear, stiff, or #57015 black. 10.5 x 13.5 sheets, \$0.30 or larger. Internet, Inc. XV-1670 1/8" or XV-1170 ¼"
Schwegler bird boxes and nature conservation products		Bird and bat houses
The Norfolk Bat Group	http://www.norfolk-bat-group.org.uk/	Bat Bricks – description of proper placement

Appendix L.

Western Bat Working Group
Threat Assessment Matrix

Insert 5 page WBWG PDF

Appendix M.

Guidelines for Implementation of the California Environmental Quality Act §15353 "Significant effect on the environment."

Under Chapter 3, Guidelines for Implementation of the California Environmental Quality Act, §15353 "Significant effect on the environment" is defined as a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project, including land, air, water, minerals, flora, fauna, ambient noise, and objects of historic or aesthetic significance. Under §15064, Determining the Significance of the Environmental Effects Caused by a Project, and Determining whether a project may have a significant effect plays a critical role in the CEQA process, are covered in detail (OPR 2004). More recently, an amendment to CEQA guidelines became law on 7 September 2004 that provides Mandatory Findings of Significance, Title 14, §15065 as follows:

15065. Mandatory Findings of Significance

(a) A lead agency shall find that a project may have a significant effect on the environment and thereby require an EIR to be prepared for the project where there is substantial evidence, in light of the whole record, that any of the following conditions may occur:

(1) The project has the potential to*:* substantially degrade the quality of the environment*;* substantially reduce the habitat of a fish or wildlife species*;* cause a fish or wildlife population to drop below self-sustaining levels,*;* threaten to eliminate a plant or animal community*;* substantially reduce the number or restrict the range of an endangered, rare or threatened species*;* or eliminate important examples of the major periods of California history or prehistory.

(2) The project has the potential to achieve short-term environmental goals to the disadvantage of long-term environmental goals.

(3) The project has possible environmental effects that are individually limited but cumulatively considerable. "Cumulatively considerable" means that the incremental effects of an individual project are significant when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.

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

(b) (1) Where, prior to the commencement of preliminary review of an environmental document, a project proponent agrees to mitigation measures or project modifications that would avoid any significant effect on the environment specified by subsection (a) or would mitigate the significant effect to a point where clearly no significant effect on the environment would occur, a lead agency need not prepare an environmental impact report solely because, without mitigation, the environmental effects at issue would have been significant.

(2) Furthermore, where a proposed project has the potential to substantially reduce the number or restrict the range of an endangered, rare or threatened species, the lead agency need not prepare an EIR solely because of such an effect, if:

(A) the project proponent is bound to implement mitigation requirements relating to such species and habitat pursuant to an approved habitat conservation plan or natural community conservation plan;

(B) the state or federal agency approved the habitat conservation plan or natural community conservation plan in reliance on an environmental impact report or environmental impact statement; and

(C) 1. such requirements avoid any net loss of habitat and net reduction in number of the affected species, or

2. such requirements preserve, restore, or enhance sufficient habitat to mitigate the reduction in habitat and number of the affected species to below a level of significance.

(c) Following the decision to prepare an EIR, if a lead agency determines that any of the conditions specified by subsection (a) will occur, such a determination shall apply to:

(1) the identification of effects to be analyzed in depth in the environmental impact report or the functional equivalent thereof,

(2) the requirement to make detailed findings on the feasibility of alternatives or mitigation measures to substantially lessen or avoid the significant effects on the environment,

(3) when found to be feasible, the making of changes in the project to substantially lessen or avoid the significant effects on the environment, and

(4) where necessary, the requirement to adopt a statement of overriding considerations.

Appendix N.

Bat Mitigation Results

Insert big, Excel table