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<u>Via E-Mail Only</u>

April 10, 2013

Oscar Biondi
State Water Resources Control Board
Division of Water Rights
1001 "I" Street
P.O. Box 2000
Sacramento, CA 95812-2000
obiondi@waterboards.ca.gov

Re: Eagle Mountain Pumped Storage Water Project, EIR (SCH #2009011010) and Section 401 Certification (FERC Project No. 13123)

Dear Mr. Biondi,

Thank you and the State Water Resource Control Board ("SWRCB" or "State Board") for considering this comment on the Eagle Mountain Pumped Storage Water Project and Section 401 certification. This letter follows up the earlier comment e-mailed to your office on March 27, 2013. My office has been retained by Gary Cruz, Hidaberto Sanchez, Ralph Figueroa, and Laborers International Union of North America, Local Union 1184 ("LIUNA") (collectively "commenters") to review the Project's Environmental Impact Report ("EIR") and certification document.

We have reviewed the Draft Final EIR ("FEIR") and certification with the assistance of:

1. Hydrogeologist, Matthew Hagemann, C.Hg., MS.
2. Biologist, Scott Cashen, M.S.

These experts have prepared written comments that are attached hereto, and which are incorporated in their entirety. The SWRCB should respond to the expert comments separately. These experts and our own independent review demonstrate that the EIR is inadequate and that a new supplemental EIR is required to be prepared and recirculated for public comment. In particular, the FEIR suffers from the following significant errors and omissions, among others:

- BASELINE: The FEIR applies an illegal baseline for greenhouse gas ("GHG") emissions rejected by *Communities for a Better Environment v. So Coast Air Qual. Mgmnt. Dist*. (2010) 48 Cal.4th 310. The FEIR also establishes an illegal baseline to its biological resources impacts analysis.

- WATER RESOURCES: The FEIR fails to adequately analyze and mitigate the Project's significant impacts to groundwater supply and groundwater quality.

- BIOLOGICAL RESOURCES: The FEIR fails to adequately analyze and mitigate the Project's impacts to sensitive biological resources. Many shortcomings in the biological analysis arise from the fact that the project applicant does not have access to the site in order to collect information critical to a reasonable baseline and environmental setting investigation.

- GREENHOUSE GAS EMISSIONS: The FEIR fails to adequately analyze and mitigate the potentially significant impacts of GHG emissions during the Project's construction and operation.

- HAZARDOUS MATERIALS: The FEIR fails to adequately analyze and mitigate the Project's significant impacts to construction workers from unexploded ordnances (UXOs).

- IMPROPER DELEGATION: The State Board's process improperly delegates the final approval of the Section 401 certification and the certification of the FEIR to its staff.

For these reasons, commenters request that the State Board revise the FEIR to cure the deficiencies referred to above. The State Board must then recirculate the EIR for public review and comment. Commenters also request that the State Board change the anticipated process to present the EIR and Section 401 certification for approval by a quorum of the State Board at a duly noticed public hearing.

I. PROJECT DESCRIPTION

The Project is a large scale pumped storage facility which proposes to store low-cost energy for use to provide peaking generation during periods of high power demand. (FEIR, pp. ES-2~3.) The Project proposes to pump water from the lower reservoir to the upper reservoir at off-peak hours and provide peaking generation during the day by releasing the pumped water from the upper reservoir through the reversible turbines to the lower reservoir. (*Id.*)

The Project site is located near the town of Eagle Mountain, just north of the unincorporated town of Desert Center, located within eastern Riverside County, California. (FEIR, p. ES-3.) The site is also located approximately 1.5 miles south and east of the Joshua Tree National Park ("JTNP"). (FEIR, p. 3.0-2). The JTNP encompasses more than half a million acres of land and attracts over 1 million visitors annually. (*Id.*)

The pumped storage project will use two existing mining pits, part of the former Eagle Mountain Mine. The Central Pit of the Eagle Mountain Mine will be used for the upper reservoir. (*Id*. at p. ES-6.) The East Pit will form the lower reservoir for the Project. (*Id.*) Both mining pits are currently empty. (*Id.*) The elevation difference between the Central and East pits is 1,410 ft. (FEIR, p. 2-9.) In addition to the two reservoirs, other Project facilities and components include (1) upper dams, (2) spillways at both Upper and Lower Reservoirs, (3) conduits, (4) a powerhouse, (5) an access tunnel, (6) a switchyard, (7) water supply and conveyance pipelines, (8) a reverse osmosis system, and (9) transmission lines. (FEIR, pp. 2-12~26.)

The Project will occupy 2,364 acres of land in total, a portion of which will be on federal lands (managed by the United States Bureau of Land Management or "BLM"). (*Id.*) The general Project area is located within the California portion of the western Sonoran Desert, or "Colorado Desert." (*Id.* at pp. ES-3~4.)

The Project goal is to provide an economical supply of peaking capacity, as well as load following, system regulation through spinning reserve, and immediately available standby generating capacity. (FEIR, p. 2-9.) The Project is expected to provide 1,300 MW of generating capacity and generate a maximum of 4,308 gigawatt hour (GWh) per year. (*Id.*; FEIR, p. 2-2.) In order to generate 4,308 GWh annually, the Project will consume 5,744 GWh annually to pump water back up to the upper reservoir. (FEIR, Vol. V, pdf p. 1114.) The amount of active storage at the Upper Reservoir will be 17,700 acre-feet and is expected to provide 18.5 hours of energy storage at the maximum continuous generating discharge. (*Id.*)

Portions of the Eagle Mountain Mine site will be developed for a major landfill. (FEIR, pp. 2-9~10.) The proposed Project has been formulated with the assumption that the landfill will exist as proposed by the landfill developers. (*Id.*) The Draft EIR concluded that the landfill and the Project are compatible and neither will interfere with the construction or operation of the other. (*Id.*)

II. STANDING

Gary Cruz, Hidaberto Sanchez, Ralph Figueroa, and members of Local Union No. 1184 ("commenters") live, work, and recreate in the immediate vicinity of the Project site. These commenters will suffer the impacts of a poorly executed or inadequately mitigated Project, just as would the members of any nearby homeowners association, community group, or environmental group. Commenters, along with hundreds of LIUNA Local Union No. 1184 members, live, recreate, and work in areas that will be affected by environmental impacts caused by the Project.

In addition, construction workers will suffer many of the most significant impacts from the Project as currently proposed, such as air emissions from poorly controlled construction equipment, possible risks related to hazardous materials on the Project site, and other impacts. Therefore, commenters have a direct interest in ensuring that the Project is adequately analyzed and that its environmental and public health impacts are mitigated to the fullest extent feasible.

III. LEGAL STANDARDS

A. EIR

CEQA requires that an agency analyze the potential environmental impacts of its proposed actions in an EIR (except in certain limited circumstances). (See, e.g., Pub. Resources Code, § 21100.) The EIR is the very heart of CEQA. (*Dunn-Edwards v. BAAQMD* (1992) 9 Cal.App.4th 644, 652.) "The 'foremost principle' in interpreting CEQA is that the Legislature intended the act to be read so as to afford the fullest possible protection to the environment within the reasonable scope of the statutory language." (*Communities for a Better Environment v. Cal. Resources Agency* (2002) 103 Cal.App.4th 98, 109 (*"CBE v. CRA"*).)

CEQA has two primary purposes. First, CEQA is designed to inform decision makers and the public about the potential, significant environmental effects of a project. (14 Cal. Code Regs. ("CEQA Guidelines") § 15002(a)(1).) "Its purpose is to inform the public and its responsible officials of the environmental consequences of their decisions before they are made. Thus, the EIR 'protects not only the environment but also informed self-government.'" (*Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal. 3d 553, 564.) The EIR has been described as "an environmental 'alarm bell' whose purpose it is to alert the public and its responsible officials to environmental changes before they have reached ecological points of no return." (*Berkeley Keep Jets Over the Bay v. Bd. of Port Comm'rs*. (2001) 91 Cal. App. 4th 1344, 1354 ("*Berkeley Jets*"); *County of Inyo v. Yorty* (1973) 32 Cal.App.3d 795, 810.)

Second, CEQA requires public agencies to avoid or reduce environmental damage when "feasible" by requiring "environmentally superior" alternatives and all feasible mitigation measures. (CEQA Guidelines, § 15002(a)(2) and (3); See also, *Berkeley Jets*, *supra*, 91 Cal. App. 4th at p. 1354; *Citizens of Goleta Valley, supra*, 52 Cal.3d at p. 564.) The EIR serves to provide agencies and the public with information about the environmental impacts of a proposed project and to "identify ways that environmental damage can be avoided or significantly reduced." (CEQA Guidelines, §15002(a)(2).) If the project will have a significant effect on the environment, the agency may approve the project only if it finds that it has "eliminated or substantially lessened all significant effects on the environment where feasible" and that any unavoidable significant effects on the environment are "acceptable due to overriding concerns." (Pub. Resources Code, § 21081; CEQA Guidelines, § 15092(b)(2)(A) & (B).)

While the courts review an EIR using an "abuse of discretion" standard, "the reviewing court is not to 'uncritically rely on every study or analysis presented by a project proponent in support of its position. A 'clearly inadequate or unsupported study is entitled to no judicial deference.'" (*Berkeley Jets*, 91 Cal. App. 4th at p. 1355 (emphasis added), quoting, *Laurel Heights Improvement Assn. v. Regents of University of California*, 47 Cal. 3d 376, 391 409, fn. 12 (1988).) As the court stated in *Berkeley Jets*, 91 Cal. App. 4th at p. 1355:

> A prejudicial abuse of discretion occurs "if the failure to include relevant information precludes informed decisionmaking and informed public participation, thereby thwarting the statutory goals of the EIR process." (*San Joaquin Raptor/Wildlife Rescue Center v. County of Stanislaus* (1994) 27 Cal.App.4th 713, 722; *Galante Vineyards v. Monterey Peninsula Water Management Dist*. (1997) 60 Cal. App. 4th 1109, 1117; *County of Amador v. El Dorado County Water Agency* (1999) 76 Cal. App. 4th 931, 946.)

B. SUPPLEMENTAL EIR

Recirculation of an EIR prior to certification is required "when the new information added to an EIR discloses: (1) a new substantial environmental impact resulting from the project or from a new mitigation measure proposed to be implemented (cf. CEQA Guidelines, § 15162, subd. (a)(1), (3)(B)(1)); (2) a substantial increase in the severity of an environmental impact unless mitigation measures are adopted that reduce the impact to a level of insignificance (cf. CEQA Guidelines, § 15162, subd. (a)(3)(B)(2)); (3) a feasible project alternative or mitigation measure that clearly would lessen the environmental impacts of the project, but which the project's proponents decline to adopt (cf. CEQA Guidelines, § 15162, subd. (a)(3)(B)(3), (4)); or (4) that the draft EIR was so fundamentally and basically inadequate and conclusory in nature that public comment on the draft was in effect meaningless." (*Laurel Heights Improvement Assn. v. Regents of University of California* (1993) 6 Cal. 4th 1112, 1130, citing *Mountain Lion Coalition v. Fish & Game Comm'n* (1989) 214 Cal.App.3d 1043.)

Significant new information requiring recirculation can include:

> (1) A new significant environmental impact would result from the project or from a new mitigation measure proposed to be implemented.
>
> (2) A substantial increase in the severity of an environmental impact would result unless mitigation measures are adopted that reduce the impact to a level of insignificance.
>
> (3) A feasible project alternative or mitigation measure considerably different from others previously analyzed would clearly lessen the significant environmental impacts of the project, but the project's proponents decline to adopt it.

> (4) The draft EIR was so fundamentally and basically inadequate and conclusory in nature that meaningful public review and comment were precluded.

(CEQA Guidelines, § 15088.5(a).)

The FEIR fails to analyze significant environmental impacts pertaining to the Project and to fully consider available mitigation measures to address those impacts. A revised EIR is required to be prepared and recirculated to address these deficiencies.

IV. THE DEIR FAILS TO ACCURATELY ESTABLISH THE PROJECT'S ENVIRONMENTAL SETTINGS OR "BASELINE."

A. CEQA BASELINE STANDARD

To facilitate its informational goals, an EIR must contain an accurate description of the project's environmental setting, or "baseline." The CEQA "baseline" is the set of environmental conditions against which to compare a project's anticipated impacts. (*Communities for a Better Environment v. So Coast Air Qual. Mgmnt. Dist*. ("*CBE v. SCAQMD*") (2010) 48 Cal. 4th 310, 321.) CEQA Guidelines section 15125(a) states, in pertinent part, that a lead agency's environmental review under CEQA:

> …must include a description of the physical environmental conditions in the vicinity of the project, as they exist at the time [environmental analysis] is commenced, from both a local and regional perspective. This environmental setting will normally constitute the baseline physical conditions by which a Lead Agency determines whether an impact is significant.

(See, *Save Our Peninsula Committee v. County of Monterey* (2001) 87 Cal.App.4th 99, 124-125 ("*Save Our Peninsula*").) As the court of appeal has explained, "the impacts of the project must be measured against the 'real conditions on the ground,'" and not against hypothetical permitted levels. (*Id.* at 121-123.) The Supreme Court has also ruled:

> An approach using hypothetical allowable conditions as the baseline results in "illusory" comparisons that "can only mislead the public as to the reality of the impacts and subvert full consideration of the actual environmental impacts," a result at direct odds with CEQA's intent.

(*CBE v. SCAQMD*, 48 Cal.4th at p. 322.)

Using a skewed baseline "mislead(s) the public" and "draws a red herring across the path of public input." (*San Joaquin Raptor Rescue Center v. County of Merced*

(2007) 149 Cal.App.4th 645, 656; *Woodward Park Homeowners v. City of Fresno* (2007) 150 Cal.App.4th 683, 708-711.)

B. THE EIR APPLIES A HYPOTHETICAL AND ILLUSORY BASELINE IN ITS GHG EMISSIONS ANALYSIS.

The FEIR admits that the Project will require 1.25 kWh for every 1 kWh of power the Project will generate. (FEIR, p. 2.1.) Thus, in order to generate the Project's capacity of 1,300 MW of power, the Project will need to use 1,600 MW of power to pump water from the lower to the upper reservoir. (*Id.* at p. 2.2.) Thus, the Project's use of 1,600 MW of power required to pump water to the upper reservoir would result in a significant new GHG emissions.

1. The FEIR Improperly Assumes Displacement of Peaker Plants that Do Not Currently Exist in its GHG Impacts Analysis.

The FEIR concludes that that the Project would have a beneficial impact on GHG production by offsetting CO2Ee production. (FEIR, p. 3.15-16.) The FEIR rationalizes that the vast majority of the power purchased at night from the grid to operate the Project's pumps will be generated by natural gas-fired combined-cycle power plants. (FEIR, p. 3.15-14.) The energy stored in the project would then be used, in large part, as a very large peaker plant that "displaces" power currently produced in large part by simple cycle natural gas generating plants (also known as "peaker plants"). (FEIR, p. 3.15-10.) During peak hours, the FEIR assumes that the Project would not emit directly or indirectly any GHGs, whereas simple cycle natural gas peaker plants of an equivalent size would emit about 1,115,000 metric tons/year of CO2e during those peak hours. (FEIR, pp. 3.15-10~11.)

The FEIR's analysis ignores the undisputed fact that the Project would nonetheless generate 1,066,156 metric tons of CO_2 per year (or, based on the maximum 4,308 GWh per year to be generated by the facility, 2,122,812 metric tons of CO_2 per year) by using power generated by combined-cycle gas-fired plants to pump water to the upper reservoir during off-peak hours. (FEIR, p. 3.15-15, Table 3.15-2.) However, because simple cycle natural gas peaker plants emit more GHGs and more CO_2 than the combined-cycle gas-fired plants that the Project would rely upon at off-peak hours to pump water pack up to the upper reservoir, the project claims an overall net reduction of about 50,000 metric tons of CO_2, assuming all of the pump-back power is from combined cycle gas plants. (FEIR, p. 3.15-15.) As a result, the FEIR concludes that the Project's emission of 1,066,156 tons per year of CO_2 during evenings and other off-peak hours has no GHG implications because of the peak hour "displacement" that will occur.

Commenters are concerned with this analysis because it does not clearly disclose whether the simple cycle peaker plants that it anticipates will be "displaced" by the project currently exist. It would appear from various statements found in the FEIR that the displaced peaker plants do not yet exist and, if the Project comes on-line, will not exist in the future. Thus, the FEIR states that "the proposed Project would eliminate the need for the regional transmission operator (California ISO) to dispatch up to 1,300 MW of fossil-fueled peaking plants … during peak periods…." (FEIR, p. 3.13-14.) Citing the Project's compatibility with the goals of AB 2514, the EIR states that "[t]he proposed Project would provide the energy storage benefits described in AB 2514, Including: … ***avoiding or deferring the need*** for ***new*** fossil fuel-powered peaking power plants and expansion of the transmission grid…." (FEIR, p. 2-2 [emphasis added].)

Likewise, the Final Environmental Impact Statement ("FEIS") prepared by the Federal Energy Regulatory Commission for the Project confirms that the peaker plants that will be displaced have yet to come on line:

> However, the variable output of wind and solar facilities can create an imbalance in the stability of the electric grid if sufficient facilities are not available to balance the system. The two primary alternatives ***being considered*** in the region to address these imbalances are pumped storage facilities and gas-fired combustion turbines.

(FEIS, p. 4 [emphasis added].) Additionally, the FEIS describes one of the benefits of the Project as offsetting peak-period pollution generated by future peaker plants:

> In addition to pumped storage facilities, California is seeing an increase in the number of applications to construct "peakers," which are typically natural gas-fired units that are not installed to act as base load units but to function solely as standby units until circumstances arise when their capacity and output is immediately needed to provide power during peak periods or to provide ancillary services. Obviously, natural gas-fired units have their own environmental effects and produce greater greenhouse gas emissions than those associated with a pumped storage facility, such as the Eagle Mountain Project.

(FEIS, p. A-18.) The Project applicant also indicates that the "displaced" peaker plants would otherwise be built in the future.[1] If the "displaced" peaker plants do not currently exist, then the Project is not displacing any emissions from the current GHG baseline. It is only adding 1,066,156 tons per year of CO2 or, applying FERC's maximum 4,308 GWh per year to be generated (and displaced) by the facility, 2,122,812 tons of CO_2 per year, levels of GHG emissions well above the State Board's preferred threshold of significance of 25,000 tons per year or any of the lower significance thresholds

[1] *See* http://www.eaglemountainenergy.net/ index2.html ("Eagle Mountain Pumped Storage will reduce the need for less efficient, fossil-fueled alternatives"); *Id*. ("Statewide peak demand is expected to grow by 890 MW per year for the next 10 years and beyond, according to the California Energy Commission").

proposed by several air districts around the State.

Mr. Hagemann agrees that the FEIR fails to provide details on the sources of power that it assumed in estimating the GHG emissions offsets. According to Mr. Hagemann,

> The FEIR concludes that Project operation would reduce or offset greenhouse gas emissions and have a less than significant impact. The FEIR assumes that power generation from the Project would displace simple cycle plant emissions plant during peak demands and utilize cleaner power sources including renewables for pump-back power during periods of low electricity demand. Through such a scheme, the FEIR estimates the Project will displace 49,955 Co2e metric tons when using combined cycle power plants and 1,115,751 Co2e metric tons if renewable sources are used for pump-back power.
>
> The FEIR provides no details on sources of the power that are assumed in estimating GHG emissions offsets. The FEIR bases offsets on the assumption that Project power needs are met with renewable and combined cycle sources that would displace simple cycle power generation. No documentation is provided in the FEIR to support the contention that power needs for pumping would displace energy supplied only by simple cycle plants. A revised FEIR should be prepared to identify what sources of power will be used by the Project and at what time, including renewable, combined cycle and simple cycle sources.
>
> A more appropriate estimate of GHG emissions should be developed based on power consumption needed for Project operation. The Project has an efficiency of 79 percent (FEIR, p. 2-1). Therefore, to generate power at the Project's stated capacity of 1,300 MW, 1,600 MW of energy will be required to pump water to the upper reservoir. A more appropriate baseline that should be considered in a revised FEIR would focus on the power consumed by the Project and determine the amount of greenhouse gasses that would be emitted by current sources of power available to the Project. A revised FEIR should incorporate published default CO2 emissions factors for the power consumed by the Project from currently available sources. The California Energy Commission specifies the use of a default CO2 emissions factor of 1000 lbs/MWh for "in-state unspecified sources."[2]

(Exhibit 1, pp. 5-6.)

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[2] http://www.arb.ca.gov/cc/ccei/presentations/OOS_EmissionFactors.pdf -- also see EPA's default emissions factor at http://www.epa.gov/cpd/pdf/brochure.pdf

Therefore, the FEIR's GHG baseline is "hypothetical" and "illusory" and plainly contravenes CEQA. CEQA's baseline must reflect "real conditions on the ground," and not hypothetical levels. (*Save Our Peninsula*, 87 Cal.App.4th at pp. 121-123; See *CBE v. SCAQMD*, 48 Cal.4th at p. 322.) The EIR's GHG analysis is based on an unlawful and hypothetical baseline – the DEIR compares the Project's GHG emissions to a hypothetical that the Project will displace future GHG emissions from speculative, yet-to-exist peaker plants.

Thus, because the peaker plants that the EIR states will be displaced by the Project do not yet exist, those plants cannot be part of the environmental baseline for the EIR's GHG or air quality analysis. The analysis of the Project's 1,066,156 tons per year of CO_2 and GHG emissions cannot be based on a recalculated net emissions subtracting out future peaker plants' emissions. Indeed, if the Project is constructed and operated, those displaced peaker plants will presumably never be built.

On the other hand, if the EIR has failed to adequately describe this aspect of the Project and the "displaced" peaker plants already exist, then the EIR's inadequate description and analysis must be cured so the public fully understands the significant impacts of the Project. For example, if that is the case, then the EIR would have to describe how many such plants would be decommissioned and contain some level of discussion of the environmental impacts that would ensue from "displacing," *i.e.* decommissioning many no longer needed peaker plants. No information about where such plants currently are located or their likely fate if rendered obsolete by the Project is provided by the EIR.

Further compounding the confusion, the EIR assumes that 100% of the energy "displaced" during the daytime would be from peaker plants. (FEIR, p. 3.15-14.) Given this extreme assumption, the EIR concludes that the Project would have a slight net positive GHG impact, despite the fact that the Eagle Mountain project will use 605 GWh/year more electricity than directly producing the same amount of energy. In fact, these assumptions are likely erroneous. It is likely that during the daytime, much of the "displaced" energy would otherwise be produced by a mixture of combined cycle plants, peaker plants, and renewable facilities (solar, wind, hydro) that produce no GHGs. Altering this mix from the worst-case scenario assumed in the EIR to a realistic scenario would likely result in a net negative GHG impact from the Eagle Mountain project. A revised EIR is required to accurately assess the Project's GHG impacts.

The confusion found in this critical component of the FEIR, at a minimum, has obscured a critical part of the State Board's impact analysis and stunted the public's ability to understand the potential impacts of the Project. The FEIR's use of a skewed baseline "mislead(s) the public" and "draws a red herring across the path of public input." (*San Joaquin Raptor Rescue Center,* 149 Cal.App.4th at 656; *Woodward Park* Homeowners,150 Cal.App.4th at pp. 708-711.) Because of this fundamental shortcoming in the EIR, the State Board must clarify this critical component in order to assure that the EIR's GHG and air quality baselines and resulting analyses are accurate and to assure that the public has an opportunity to understand and comment upon the true GHG and air quality impacts of the Project.

2. The EIR's GHG Emissions Calculations Underestimate the Project's Annual Generating Capacity.

Even if the FEIR's reliance on speculative displaced peaker plants in establishing its baseline were justified, the FEIR's GHG emissions calculations are nonetheless incorrect.

The FEIR acknowledges that the Project would have an installed capacity of 1,300 megawatts (MW) and generate a maximum of 4,308 gigawatt hours (GWh) per year. (FEIR, p. 2-2.) FERC also notes that while generating the 4,308 GWh annually, the Project will consume 5,744 GWh annually to pump water back up to the upper reservoir. (FEIR, Vol. V, pdf p. 1114.) However, the FEIR uses arbitrary numbers to calculate GHG emissions in Table 3.15-2 (2,883 GWh instead of 5,744 GWh and 2,278 GWh instead of 4,308.) (FEIR, p. 3.15-15, Table 3.15-2.) It is unclear from the FEIR and the appendices why the much lower numbers were used to calculate the GHG emissions. The FEIR then concludes that the Project would not contribute to an increase in GHG emissions. (FEIR, p. 3.15-17.)

The FEIR's use of lower GWh figures not only grossly underestimates the Project's GHG emissions, but also led to an erroneous conclusion. If the FEIR had used the actual figures of the Project's expected use of 5,744 GWh to generate 4,308 GWh for its calculations in Table 3.15-2, the Project would emit 2,122,812 metric tons of CO2 per year[3] and displace 2,109,205 metric tons of CO2 per year.[4] Thus, contrary to the FEIR's conclusion, the Project would <u>contribute</u> to an increase in GHG emissions of 13,607 metric tons of CO2 per year, even assuming that the FEIR can subtract displaced peaker power emissions from the GHG baseline. (See FEIR, p. 2-2; Vol. V, pdf p. 1114; p. 3.15-15, Table 3.15-2.) The Project's GHG emissions of 13,026 metric tons[5] would constitute a significant impact – it clearly exceeds both the interim 10,000 $MTCO_2e$/year threshold set by the SCAQMD[6] and the California Air Pollution Control Officers Association threshold of 900 $MTCO_2e$/year.

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[3] Calculated using the figures in Table 3.15-2 for Pump-back Power Used, using Combined Cycle: **5,744** GWh/Year x Emission Factor of **815,000** lbs/GWh +**360** SF_6 Emissions from Substation = 4.68×10^9 lbs/GWh. 4.68×10^9 lbs/GWh converted to metric tons equals **2,122,812** metric tons.
[4] Calculated using the figures in Table 3.15-2 for Generation Displaced, using Simple Cycle: **4,308** GWh/Year x Emission Factor of **1,080,000** lbs/GWh + **360** SF_6 Emissions from Substation = 4.65 x 10 lbs/GWh. 4.65 x 10 lbs/GWh converted to metric tons equals **2,109,205** metric tons.
[5] Subtracting 2,109,205 (emissions from Generation Displaced) from 2,122,812 metric tons (emissions from Pump-back Power Used) equals **13,026** metric tons.
[6] http://www.aqmd.gov/ceqa/handbook/signthres.pdf

Therefore, the FEIR must be revised by using the actual generation and consumption numbers to establish an accurate baseline, rather than using arbitrary, lower figures.

C. THE DEIR FAILS TO ESTABLISH AN ACCURATE BASELINE FOR BIOLOGICAL RESOURCES.

The FEIR also fails to establish an accurate baseline to adequately analyze the Project's impacts to biological resources. The fundamental flaw in the FEIR's entire biological resources analysis is that the FEIR has not conducted the necessary studies, evaluations and surveys of the Project site. The Project site is currently owned and controlled by a private entity who has not allowed access to anyone, including the State Board, project proponent, or any other consultants. (FEIR, Vol. IV, pdf p. 364-365.) Instead of relying on recent data, the FEIR relies on biological assessments from the proposed Landfill project which are over 20 years old. (FEIR, Vol. IV, pdf p. 13-14.) Without any recent data, the FEIR's current baseline for biological resources fails to reflect "real conditions on the ground" at the Project site. (See *Save Our Peninsula*, 87 Cal.App.4th at 121-123.)

Even the United States Fish and Wildlife Service (USFWS), the very agency which issued the 1992 biological assessment, commented on the lack of sufficient data from the Central Project Area and the need to defer project approval until such data could be obtained and analyzed. (FEIR, Vol. IV, pdf p. 13.)

The FEIR's biological resources baseline is merely hypothetical without the data from surveys covering the Project site. Therefore, the FEIR cannot adequately analyze and mitigate the Project's potentially significant impacts on biological resources.

Additionally, Mr. Cashen provides detailed reasons why the FEIR's baseline for biological resources is inaccurate. (Exhibit 2.) Some of the baseline issues Mr. Cashen highlights include, but are not limited to, the following:

(1) While admitting that several rare species of special-status bats are known to occur in the Project area which may be affected by the Project, the FEIR fails to adequately survey such bats to establish an accurate baseline.

(2) While acknowledging the abundance of perching, roosting, and nesting sites for ravens on the Project site, the FEIR fails to adequately survey the occurrence of raven population at the Project site.

(3) The FEIR failed to conduct late-season annual plant surveys to establish an accurate baseline for special-status plant species.

(4) The FEIR improperly dismisses the potential for Coachella Valley milkvetch to occur in the Project area, which was detected during a previous survey of the Project area.

(5) The FEIR fails to disclose the presence of all special-status plants detected during previous surveys, including federally endangered and rare plants. As such, the Project's biological resources baseline does not account for such species.

(Exhibit 2.) Mr. Cashen's comments are hereby incorporated in their entirety and the SWRCB should respond to his comments separately.

V. THE DEIR FAILS TO ANALYZE AND MITIGATE ALL POTENTIALLY SIGNIFICANT IMPACTS.

An EIR must disclose all potentially significant adverse environmental impacts of a project. (Pub. Resources Code, § 21100(b)(1); CEQA Guidelines, § 15126(a); *Berkeley Jets*, 91 Cal. App. 4th 1344, 1354.) CEQA requires that an EIR must not only identify the impacts, but must also provide "information about how adverse the impacts will be." (*Santiago County Water Dist. v. County of Orange* (1981) 118 Cal.App.3d 818, 831). The lead agency may deem a particular impact to be insignificant only if it produces rigorous analysis and concrete substantial evidence justifying the finding. (*Kings County Farm Bureau v. City of Hanford* (1990) 221 Cal.App.3d 692 ("*Kings County*").)

CEQA requires public agencies to avoid or reduce environmental damage when "feasible" by requiring mitigation measures. (CEQA Guidelines, § 15002(a)(2) and (3); See also, *Berkeley Jets*, *supra*, 91 Cal. App. 4th at p. 1354; *Citizens of Goleta Valley, supra,* 52 Cal.3d at p. 564.) The EIR serves to provide agencies and the public with information about the environmental impacts of a proposed project and to "identify ways that environmental damage can be avoided or significantly reduced." (CEQA Guidelines, §15002(a)(2).) If the project will have a significant effect on the environment, the agency may approve the project only if it finds that it has "eliminated or substantially lessened all significant effects on the environment where feasible" and that any unavoidable significant effects on the environment are "acceptable due to overriding concerns." (Pub. Resources Code, § 21081; CEQA Guidelines, § 15092(b)(2)(A) & (B).)

In general, mitigation measures must be designed to minimize, reduce, or avoid an identified environmental impact or to rectify or compensate for that impact. (CEQA Guidelines, § 15370.) Where several mitigation measures are available to mitigate an impact, each should be discussed and the basis for selecting a particular measure should be identified. (*Id.*, at § 15126.4(a)(1)(B).) A lead agency may not make the required CEQA findings unless the administrative record clearly shows that all uncertainties regarding the mitigation of significant environmental impacts have been resolved.

CEQA requires the lead agency to adopt feasible mitigation measures that will substantially lessen or avoid the Project's potentially significant environmental impacts (Pub. Resources Code, §§ 21002, 21081(a)), and describe those mitigation measures in the CEQA document. (Pub. Resources Code, § 21100(b)(3); CEQA Guidelines, § 15126.4.) A public agency may not rely on mitigation measures of uncertain efficacy or feasibility. (*Kings County, supra,* 221 Cal.App.3d at p. 727 (finding groundwater purchase agreement inadequate mitigation measure because no record evidence existed that replacement water was available).) "Feasible" means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social and technological factors. (CEQA Guidelines, § 15364.) To demonstrate economic infeasibility, "evidence must show that the additional costs or lost profitability are sufficiently severe as to render it impractical to proceed with the project." (*Citizens of Goleta Valley v. Board of Supervisors* (1988) 197 Cal.App.3d 1167, 1181.) The EIR must provide evidence and analysis to show a project alternative cannot be economically implemented. (*Kings County, supra*, 221 Cal.App.3d at pp. 734-737.) This requires not just cost data, but also data showing insufficient income and profitability. (*See Burger v. County of Mendocino* (1975) 45 Cal.App.3d 322, 327 (infeasibility claim unfounded absent data on income and expenditures showing project unprofitable); *San Franciscans Upholding the Downtown Plan v. City and County of San Francisco* (2002) 102 Cal.App.4th 656, 694 (upholding infeasibility finding based on analysis of costs, projected revenues, and investment requirements).) Mitigation measures must be fully enforceable through permit conditions, agreements, or other legally binding instruments. (CEQA Guidelines, § 15126.4, subd. (a)(2).)

A lead agency may not conclude that an impact is significant and unavoidable without requiring the implementation of all feasible mitigation measures to reduce the impacts of a project to less than significant levels. (CEQA Guidelines, §§ 15126.4, 15091.)

A. THE FEIR FAILS TO ADEQUATELY ANALYZE AND/OR MITIGATE THE PROJECT'S IMPACTS TO GROUNDWATER.

1. Impacts to Groundwater Supply May be Underestimated.

One of the vital elements of the Project is groundwater. A significant amount of groundwater is needed to (1) fill the Upper and Lower Reservoirs and be reused for power generation and (2) replace losses to evaporation and seepage. (FEIR, p. 3.2-6.) However, the FEIR fails to adequately analyze the extent of the Project's impacts to the groundwater supply by potentially underestimating the recharge rate of Chuckwalla Valley Groundwater Basin. According to Mr. Hagemann:

> Groundwater is the source of the water that will be used to fill the Project reservoirs. Groundwater will be pumped from alluvial sediments that fill

the Chuckwalla Valley Groundwater Basin to initially fill the reservoirs and to supply water lost to evaporation.

The Chuckwalla Valley Groundwater Basin is recharged by percolation of runoff from surrounding mountains, from precipitation, and by subsurface inflow from the Pinto Valley Groundwater Basin to the north and from Orocopia Valley Groundwater Basin to the west. The FEIR acknowledges that recharge to desert groundwater basins is difficult to estimate and that estimates of recharge to the Chuckwalla Valley Groundwater Basin vary widely, from 10,000 to 20,000 AFY (3.3-12). With input from the Metropolitan Water District, the FEIR estimated recharge of 12,700 AFY to the Chuckwalla Valley Groundwater Basin (FEIR, p. 3.3-14). The estimate of 12,700 AFY was adopted in the FEIR as the average of estimates that ranged from 6,600 AFY to 17,700 AFY. Other, lower estimates of recharge are presented in the FEIR, the lowest being 9,800 AF (Table 3.3-3).

The FEIR uses an estimate for groundwater recharge that is not as conservative as estimates made by other researchers and is not the most conservative of estimates made by the MWD. Use of a less-conservative estimate in the FEIR results in an underestimation of actual groundwater drawdown. As a result, impacts from groundwater drawdown from Project operation may be underestimated.

Local pumping impacts from Project operation are predicted to result in drawdown of groundwater by about four feet below the maximum historic drawdown in the Upper Chuckwalla Valley and Orocopia Valley Groundwater Basins and by about five feet at the mouth of the Pinto Valley Groundwater Basin (p. 3.3-28 and 3.3-29). Cumulative impacts on groundwater drawdown -- to include water use for the proposed landfill, water use for multiple proposed solar projects, and water use for prisons -- is estimated to be nine feet (p. 3.3-29).

The value used for estimating recharge is critical. If more conservative recharge estimates are used (i.e. lower amounts of recharge to the groundwater basin), predicted decreases in water levels will be greater than those estimated in the FEIR. If estimates of recharge to the Chuckwalla Valley Groundwater Basin is too high, drawdown of the aquifer for filling and maintenance of water levels in the reservoirs will be underestimated.

The FEIR concludes that Project groundwater pumping, in combination with cumulative pumping for other projects, could cause overdraft and declines in groundwater levels of nine feet and would contribute to a significant adverse cumulative effect (3.3-32). It is my opinion that

> impacts could be even more significant if actual groundwater recharge is not as high as predicted in the FEIR. Therefore, the FEIR should be revised to include consideration of additional more conservative estimates of groundwater recharge. The additional estimates should be developed by an independent agency, like the U.S. Geological Survey, with extensive experience in modeling recharge in the area. Results of the recharge estimates should be incorporated into the groundwater models to predict additional drawdown scenarios.

(Exhibit 1, p. 2.)

Additionally, the FEIR fails to set enforceable drawdown limits to mitigate potentially significant impacts to groundwater levels. According to Mr. Hagemann,

> The FEIR includes mitigation for monitoring groundwater levels (MM GW-1) during Project operation and during the initial filling of the reservoirs by installing a well network. If groundwater drawdowns exceed “maximum allowable changes” (Table 3-9), pumping rates will be reduced. Reference is also made to an “accounting surface” that would be established through “future legislation, rule-making or applicable judicial determination” (MM GW-1).
>
> The inclusion of “maximum allowable changes” and an “accounting surface” in MM GW-1 is a good first step, however these are not enforceable limits as proposed in the FEIR. The FEIR should be revised to include enforceable maximum drawdown limits. One such mechanism would be to enter into an agreement with Riverside County to establish a “floor” for the maximum amount of drawdown that would be acceptable. If the levels of the floor were exceeded, automatic management measures would be triggered such as a reduction in pumping until groundwater levels reached agreed-upon levels. Such management techniques were adopted and incorporated into a memorandum of understanding with San Bernardino County for the Cadiz Valley Water Conservation, Recovery, and Storage project located 40 miles to the north of the Project.

(Exhibit 1, pp. 3.)

2. The FEIR Fails to Adequately Disclose the Potential Impacts of Seepage on Groundwater Quality.

The FEIR admits that seepage from the Project may cause potentially significant impacts on groundwater quality. (FEIR, p. 3.3-31.) The metals in the bedrock beneath or near the Upper and Lower Reservoirs contain metal ore that could be mobilized by water seepage, migrate into the sediments of the Chuckwalla Valley Groundwater Basin, and eventually degrade the water in that Basin. (*Id.*) Especially because the estimated seepage from the reservoirs is expected to be considerable, 1,800 AFY, the FEIR should have analyzed and disclosed the true extent of impacts of contaminated seepage on groundwater quality.

> Mr. Hagemann agrees:
>
> The reservoirs are to be completed in former mining pits which were blasted and excavated into highly fractured bedrock. When filled, the reservoirs are estimated to lose up to 1,800 AFY of water through seepage (p. 3.3-31). The water that seeps from the reservoirs water will flow downgradient through fractured bedrock to mix with groundwater in the Chuckwalla Valley Groundwater Basin. Pumping wells are proposed to combat a rise of up to 12 feet in groundwater levels beneath the reservoir and up to 6 in the valley (p. 3.3-34). Seepage may also occur from the brine ponds that will contain wastes from the reverse osmosis system.
>
> The bedrock and tailing piles that forms the base of the reservoirs, contain metals that may be mobilized and transported by water seepage. Material excavated from bedrock during tunnel excavation may be placed at the base of the reservoirs (p. 2-19) and may impact water quality, especially when considering that increased surface area of the excavated rock will increased potential for acid generation.
>
> The FEIR acknowledges that seepage could affect water quality and that metals in seepage water could be transported into the Chuckwalla Valley Groundwater basin. The FEIR goes on to state that geochemical analyses indicate that metals present in the underlying rock are not likely to become mobile or produce acid leachate, however, “it is possible” (p. 3.3-31).
>
> As mitigation, the FEIR proposes PDF GW-1 which would identify methods to control seepage that include grouting, seepage blankets, soil cement treatment. Additionally, MM GW-6 would establish a groundwater monitoring program that will include sampling within the reservoirs, production wells, and in wells up gradient and downgradient of the reservoirs and brine disposal lagoon.
>
> No direct tests of the potential for water in the reservoir to generate acid was conducted in the preparation of the FEIR, presumably because of access restrictions to central areas of the Project site. No tests for the potential of the reservoir water to contain metals at high concentrations were conducted for inclusion in the FEIR. Failure to conduct these tests constitutes inadequate disclosure. Access to the pits to obtain samples of water and rock should be obtained and analyses of the samples should be

> included in a revised FEIR along with a complete analysis of the potential for seepage to affect water quality in the Chuckwalla Valley Groundwater Basin.

(Exhibit 1, pp. 3-4.)

Pursuant to Mr. Hagemann's recommendations, the FEIR must conduct tests to analyze the potential of the reservoir water to contain metals. Using such test results, the FEIR should be revised to update the Project's potentially significant impacts to groundwater quality and to mitigate such impacts to the extent feasible.

3. The FEIR Fails to Provide Adequate Details Using Brine Ponds as a Way to Mitigate Water Quality Impacts.

The FEIR incorporates a reverse osmosis system as a way to mitigate impacts to water quality and maintain levels of total dissolved solids ("TDS") in the reservoirs. (FEIR, p. 3.3-40.) In conjunction, the mitigation measure proposes a RO desalination system and brine disposal lagoon to remove waste salts and metals that the reverse osmosis system will produce. (*Id.* at pp. 3.3-40~41.) However, the FEIR fails to provide sufficient details on how to implement the reverse osmosis system and brine lagoon to adequately mitigate impacts to water quality. According to Mr. Hagemann,

> Water treatment through reverse osmosis is planned to maintain total dissolved solids concentrations in the reservoirs which otherwise would be increased through evaporation. Waste salts and metals produced by the reverse osmosis system will be sent to brine ponds. The brine ponds are planned to be double-lined to prevent seepage and a groundwater monitoring network will be constructed to detect potential seepage (p. 3.3-31). No details of the brine ponds are provided in the DEIR other than to show their location south of the reservoirs.
>
> Mitigation identified to prevent impacts from the brine ponds is identified in PDF GW-2 which states: (1) The salts will be regularly wetted for air quality considerations and; (2) salts from the brine disposal ponds will be removed and disposed at an offsite location when full, approximately every 10 years. Mitigation is also identified in MM GW-6 which provides for groundwater monitoring in association with the brine ponds.
>
> The FEIR acknowledges that if water which contains TDS and metals seeps through the liners of brine disposal ponds, it may degrade the groundwater quality in the basin (p. 3.3-31). Although the FEIR provides for mitigation, few details are provided to document how the ponds will be constructed and how monitoring will be conducted. Details that are lacking include: capacity of the ponds, freeboard of the ponds, the specific types of liners that will be used, the construction of the groundwater

> monitoring wells that will be installed, the location of the disposal facility that will be used and whether the brine will be classified as hazardous waste.
>
> Without this information, impacts to groundwater and surface water from the brine ponds cannot be evaluated. The FEIR should be revised to disclose this information in a draft Report of Waste Discharge which will be required by the Regional Water Quality Control Board for operation of the brine ponds.

(Exhibit 1, pp. 4-5.)

Without considering and disclosing the details specified by Mr. Hagemann, it is unclear whether and how the brine ponds could successfully mitigate the significant impacts of seepage containing metals and total dissolved solids to water quality. Pursuant to Mr. Hagemann's recommendations, the FEIR must be revised to analyze and disclose details on how to successfully implement Mitigation Measure GW-2.

B. THE FEIR FAILS TO ADEQUATELY ANALYZE AND/OR MITIGATE THE PROJECT'S BIOLOGICAL RESOURCES IMPACTS.

As discussed in detail in Mr. Cashen's letter, the FEIR fails to adequately assess the Project's impacts to wildlife, especially sensitive species and native plants. As a result, the FEIR did not adequately mitigate the potential impacts to the extent feasible. (Exhibit 2.) Mr. Cashen's comments include, but are not limited to, the following issues:

(1) Due to lack of access, the FEIR failed to adequately survey the entire Project area to establish an accurate baseline for biological resources. Thus, the FEIR used an inaccurate biological resources baseline and the resulting analysis of impacts and mitigation measures are inadequate.

(2) The FEIR fails to adequately analyze and mitigate the Project's impacts to crucifixion thorn, Coachella Valley milkvetch, ravens and gulls, coyotes and feral dogs.

(3) The FEIR's proposed habitat compensation (MM BIO-22) is inconsistent with the CDFW's guidelines.

(4) The FEIR's Revegetation Plan, Weed Plan, and Predator Monitoring and Control Plan are insufficient to mitigate the significant impacts to biological resources.

(Exhibit 2.) Mr. Cashen's comments are hereby incorporated in their entirety and the SWRCB should respond to his comments separately.

Based on Mr. Cashen's comments, the FEIR must be revised to analyze and evaluate all potential impacts to biological resources and, where appropriate, propose adequate mitigation measures with definite terms and verifiable performance standards.

C. THE FEIR FAILS TO ADEQUATELY ANALYZE AND/OR MITIGATE THE PROJECT'S GHG EMISSIONS IMPACTS.

1. The FEIR's Finding of No Significant Impact for GHG Emissions during Project Construction is Unsupported by Substantial Evidence.

The FEIR concludes that the Project would not contribute to an increase in GHG emissions and that no mitigation would be required. (FEIR, p. 3.15-17.) However, the Project proposes to construct multiple facilities and components: (1) Upper Reservoir, (2) Lower Reservoir, (3) upper dams, (4) spillways at both Upper and Lower Reservoirs, (5) conduits, (6) a powerhouse, (7) an access tunnel, (8) a switchyard, (9) water supply and conveyance pipelines, (10) a reverse osmosis system, and (11) transmission lines. (FEIR, pp. 2-12~26.) Thus, the FEIR overlooks the potentially significant GHG emissions during Project construction and fails to analyze and mitigate such impacts.

The FEIR's error is twofold: (1) it fails to provide adequate analysis and substantial evidence to support its finding that the GHG emissions during Project construction would be 8,467 $MTCO_2e$ of CO2e and (2) even the 8,467 $MTCO_2e$ is considered significant under California Air Pollution Control Officers Association's threshold of significance for GHG emissions.

Mr. Hagemann agrees that the Project's extensive site preparation and construction activities may potentially emit significant amount of GHGs. According to Mr. Hagemann,

> *Construction emissions*
>
> Construction of the project will involve extensive site preparation activities over a period of four years. Construction will involve:

- Building two dams which will involve preparation of the foundation to remove waste materials from mining, overburden, and weathered rock;
- Construction of two spillways;
- Developing mining pits into reservoirs by preparing the base with grouting, a seepage blanket made from fine tailings;
- Creation of tunnel and shaft system with total lengths greater than two miles; and
- Development of a 72-feet-wide, 150-feet-high, and 360-feet-long, underground powerhouse (DEIR, pp. 2.12 to 2.20).

> Each of these activities will involve the use of heavy equipment that will emit greenhouse gasses.
>
> No estimate of construction GHG emissions was included in the FEIR other than to say "Project construction GHG emissions during the maximum year would be approximately 8,467 metric tons/year of CO2e" (FEIR, p. 3.15-10). No support for this statement is included in the FEIR or in the appendices. No documentation that modeling was done in support of this estimate is included in the FEIR and no quantification of the amount of GHGs produced by project construction components (e.g., dam and spillway construction, tunnel construction).
>
> The FEIR fails to adequately disclose Project GHG emissions over the four-year span of Project construction. A revised FEIR should be prepared to estimate construction GHG emissions using common models accepted by the SQAQMD, including URBEMIS and the California Emission Estimator Model (CalEEMod). The estimated construction GHG emission, based on the modeling efforts, should be compared to the interim 10,000 $MTCO_2e$/year threshold set by the SCAQMD[7] and the California Air Pollution Control Officers Association (CAPCOA) threshold of 900 $MTCO_2e$/year.[8]

(Exhibit 1, pp. 6-7.)

Based on Mr. Hagemann's recommendations, the FEIR must be revised to (1) disclose an adequate analysis of the Project's GHG emissions during construction by using (2) both the SCAQMD and CAPCOA thresholds of significance for GHG emissions.

2. The FEIR Fails to Adequately Mitigate the Project's GHG Impacts During Construction.

As discussed above, the FEIR fails to adequately analyze the Project's potentially significant GHG impacts during Project construction. Mr. Hagemann suggests the following ways to mitigate such impacts:

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[7] http://www.aqmd.gov/ceqa/handbook/signthres.pdf

[8] California Air Pollution Control Officers Association. CEQA & Climate Change, Evaluating and Addressing Greenhouse Gas Emissions from Projects Subject to the California Environmental Quality Act. http://www.capcoa.org/wp-content/uploads/downloads/2010/05/CAPCOA-White-Paper.pdf, p. 49.

> Considerations for mitigation for construction emissions in a revised FEIR should quantify emissions reductions with use of available mitigation[9] for construction and off-road equipment, including

- Use Alternative Fuels for Construction Equipment
- Use Electric and Hybrid Construction Equipment
- Limit Construction Equipment Idling beyond Regulation Requirements
- Institute a Heavy-Duty Off-Road Vehicle Plan
- Implement a Vehicle Inventory Tracking System
- Exclusive use of latest diesel technology.

(Exhibit 1, p. 7.)

Without adequately disclosing the potential GHG emissions during Project construction, it is impossible for the FEIR to mitigate potentially significant impacts to the extent feasible. Thus, pursuant to Mr. Hagemann's recommendations, the FEIR should be revised to adequately analyze and mitigate the potentially significant GHG emissions during Project construction.

3. The FEIR Fails to Adequately Analyze and Mitigate GHG Impacts During Project Operation.

By using an illegal baseline, discussed in Part IV.B, *supra*, the FEIR fails to adequately analyze the potential GHG impacts from the Project's emission of 1,066,156 tons per year of CO_2, up to as much as 2,122,812 tons per year from the Project's operation.

Additionally, the FEIR fails to adequately mitigate such potentially significant impacts. Mr. Hagemann provides specific ways to mitigate the Project's operational GHG impacts:

> Mitigation for operational emissions of GHGs in a revised FEIR should contemplate a mechanism to eliminate use of currently existing peaker plants[10] which rely on simple cycle technology. If peaker plants were to be eliminated though funding by the applicant, GHG impacts of the Project could truly be considered to be displaced.
>
> In accordance with draft SCAQMD policy[11] and widely referenced CAPCOA guidance[12], if emissions from a Project are significant after

[9] http://www.aqmd.gov/ceqa/handbook/mitigation/greenhouse_gases/CAPCOA-Quantification-Report-Final1.pdf – see CAPCOA fact sheet, Section 8
[10] http://www.energy.ca.gov/maps/powerplants/peaker_map.html
[11] http://www.aqmd.gov/ceqa/handbook/GHG/2008/oct22mtg/thresholdprop.pdf

> implementation of all feasible mitigation, carbon offsets or emissions reduction credits should be purchased for the amount of GHG emissions above thresholds. According to CAPCOA, high quality credits are based on projects that have permanent, verifiable, enforceable and demonstrated emission reductions and should be obtained after certification from reputable registries such as the American Carbon Registry and the Climate Action Reserve.

(Exhibit 1, pp. 7-8.)

Pursuant to Mr. Hagemann's recommendations, the revised FEIR must adequately analyze and mitigate the extent of GHG impacts during Project's operation by (1) actually displacing the Project's GHG impacts by limiting with enforceable restrictions and/or eliminating the use of currently existing peaker plants which rely on simple cycle technology, and (2) purchasing carbon offsets for any remaining, undisplaced GHG emissions.

D. THE FEIR FAILS TO ADEQUATELY ANALYZE AND/OR MITIGATE THE PROJECT'S SIGNIFICANT IMPACTS OF UNEXPLODED ORDNANCES TO CONSTRUCTION WORKERS.

The FEIR admits that the Project site was historically used for military training. (FEIR, p. 3.16-5.) Because live-fire training occurred throughout the Project area, the FEIR acknowledges "the potential for unexploded ordinance [sic] to be encountered during Project construction." (*Id.*) The FEIR concludes that the potential impacts to construction workers from unexploded ordnances (UXO) are significant. The FEIR then proposes Mitigation Measure HM-1, which includes a UXO plan. Through the implementation of the mitigation measure, the FEIR concludes that "risks to workers from UXO will be reduced to *less than* significant…." (FEIR, p. 3.16-8.)

However, the FEIR fails to sufficiently analyze the severity of impacts from UXOs. The FEIR did not analyze the precise types of military training activities that occurred on the Project site. The FEIR thus fails to disclose how many UXOs are present at the Project site and which portions of the Project site may contain them. Without fully assessing the extent of the Project's impacts from disturbing UXOs during construction, the proposed Mitigation Measure HM-1 is insufficient to support the conclusion of "less than significant" impact. According to Mr. Hagemann,

> The area of Desert Center was heavily used during WWII for training exercises under the command of General George S. Patton. Desert Center was chosen as the headquarters for the training area known as the California/Arizona Maneuver Area, the largest such operation in the world.

[12] http://www.capcoa.org/wp-content/uploads/downloads/2010/05/CAPCOA-White-Paper.pdf

Over one million troops were trained at the California/Arizona Maneuver Area, using live fire from tanks, planes, artillery and firearms.[13] Desert Center is located about 12 miles south of where Project reservoirs are proposed and water and transmission lines are proposed to cross just north of the community.

The FEIR mentions the training activities associated with the California/Arizona Maneuver Area only briefly, stating the routes of the transmission lines are close to the training camps and that there is a potential for unexploded ordnance (UXO) to pose hazards to workers (3.16-7). As mitigation, MM HM-1 states that a Project contractor and an environmental coordinator will implement a program to identify UXO and to prepare a UXO plan to properly train all site workers.

Disclosure of the potential for UXO in the FEIR is inadequate. The FEIR should be revised to include as much information as is available about the types of training activities that were conducted in the Project area and the potential for the specific types of UXO that may be found in association with those activities. For example, we obtained a map of the camp established at Desert Center from the Internet and overlaid it atop a map of the Project area, including the water and transmission lines (Attachment 1). The map shows that the route of the water and the transmission lines runs within a few thousand feet of what is mapped as an ammunition depot, near a maneuver area (where presumably live rounds were used in training) and within 2000 feet of the Desert Center Army Air Field.

In addition to conducting a review of the specific military activities conducted within Project boundaries, a survey of the Project site, using visual and geophysical techniques should be conducted by trained personnel. To provide for adequate disclosure and to best ensure worker safety, the results of the survey should be included in revised FEIR. Results of the survey should be disclosed in a FEIR to ensure adequate disclosure of the environmental setting at the Project site. If UXO is found on the Project site during the survey, construction should be delayed until all debris has been cleared.

Survey efforts should be undertaken with oversight by the BLM who manage acreage that will be utilized for transmission lines and water lines, areas that may be most likely to be underlain by UXO from WW II-era military operations (p 2-26). The survey should follow guidelines published by the BLM for UXO to reduce risks from explosive hazards.[14]

[13] http://www.blm.gov/ca/st/en/fo/needles/patton.html
[14] http://www.fws.gov/refuges/whm/pdfs/UXO_Handbook_8-9-06.pdf

(Exhibit 1, p. 4.)

Pursuant to Mr. Hagemann's recommendations, the FEIR should be revised to require a survey of the Project site to assess the occurrences of UXOs. Additionally, once the severity of the impacts is ascertained, the FEIR should adopt all feasible mitigation measures to address such impacts.

VI. THE STATE BOARD HAS NO AUTHORITY TO DELEGATE A SECTION 401 CERTIFICATION OR A CERTIFICATION OF A FEIR TO ITS STAFF.

The State Board has no authority to delegate to the Executive Director or other staff the Board's duties to issue water quality certifications pursuant to Water Code § 13160 or certify EIRs pursuant to CEQA Guidelines § 15090.

A. THE WATER CODE PROHIBITS DELEGATION OF A SECTION 401 CERTIFICATION.

The State Board has no authority to delegate to the Executive Director or other staff the Board's duties to issue water quality certifications pursuant to Water Code § 13160. It is Commenters' understanding that the final approval of the Section 401 certification and the certification of the FEIR will be completed by the State Board's Executive Director and that neither action is going to be agendized and approved by the State Board at a duly noticed Board meeting. However, our review of the Water Code does not disclose any authority granted to the State Board to delegate any of its decisionmaking powers to its staff, including its Executive Director. Hence, any issuance of a 401 certification or certification of the EIR must be done by the State Board, not the Executive Director.

Water Code § 186, subdivision (a), expressly provides that "[t]he board shall have any powers, and may employ any legal counsel and other personnel and assistance, that may be necessary or convenient for the exercise of its duties authorized by law." Under the Water Code, "'Board,' unless otherwise specified, means the State Water Resources Control Board." (Water Code § 25.) In the context of a water appropriation permit, the Court of Appeal has ruled that, pursuant to Section 186's grant of authority, "[a]lthough the Board may employ personnel to assist it (§ 186), it may not delegate the authority to determine the merits of an application for a permit to appropriate water, except as provided by statute." (*Central Delta Water Agency v. State Water Resources Control Bd.* (2004) 124 Cal.App.4th 245, 261-262.) The Court of Appeal noted that, in the water appropriations context, the Water Code specifically provided for only one category of decisions that the State Board was expressly authorized to delegate a specific determination to the Board's staff, in that case the Division of Water Rights. (*Id*.)

Section 186 is the source of the State Board's authority over water quality as well. There is no logical reason why the same rule does not apply to the State Board's authority to delegate decisions relating to the Board's water quality powers. Indeed, the Water Code is more explicit about the sole role of the State Board in rendering water quality decisions. The State Board, not its Executive Director or other staff, is expressly authorized to approve a Section 401 certification:

> The state board is designated as the state water pollution control agency for all purposes stated in the Federal Water Pollution Control Act and any other federal act, heretofore or hereafter enacted, and is (a) authorized to give any certificate or statement required by any federal agency pursuant to any such federal act that there is reasonable assurance that an activity of any person subject to the jurisdiction of the state board will not reduce water quality below applicable standards, and (b) authorized to exercise any powers delegated to the state by the Federal Water Pollution Control Act (33 U.S.C. 1251, et seq.) and acts amendatory thereto.

(Water Code, § 13160.) Only the State Board "succeeds to and is vested with all of the powers, duties, purposes, responsibilities, and jurisdiction vested in [various precursor agencies under the Water Code], or any other law under which permits or licenses to appropriate water are issued, denied, or revoked or under which the functions of water pollution and quality control are exercised." (Water Code, § 179.) The State Board consists solely of five members appointed by the Governor. The Board does not include any de facto additional members selected by the Board itself, even long-standing members of the Board's staff. (Water Code, § 175(a) ["There is in the California Environmental Protection Agency the State Water Resources Control Board consisting of five members appointed by the Governor"].) The State Board may only act with a quorum of at least three of the appointed Board members. (Water Code, § 181.) And "[a]ny hearing or investigation by the board may be conducted by ***any member upon authorization of the board***, and he shall have the powers granted to the board by this section, but any final action of the board shall be taken by a majority of all the members of the board, at a meeting duly called and held." (Water Code, § 183 [emphasis added].) Given these explicit directions in the Water Code, there can be no implied authority by the State Board to delegate water quality decisions with which it has been entrusted.

As was the case in *Central Delta Water Agency*, the Water Code expressly identifies those few occasions where decisions may be delegated to the Executive Director. Thus, the Water Code expressly provides that the Board's Executive Director may issue a complaint to initiate a proceeding to assess an administrative civil penalty. (Water Code, §§ 1055, 13323(c).) But only the State Board may assess such a penalty. (*Id.*, at §§ 1055(c), 13323(c).) The only other provisions allow the Board or "representatives authorized by the Board" to "call, conduct or attend conferences or hearings, official or unofficial, within or without this state…" and to attend meetings with the United States or its agencies. (Water Code, §§ 179.6, 179.7.) Likewise, Section 13223 expressly provides for delegation of authority by the regional water quality control boards and their unsalaried board members to each of their executive officers with a number of broad exceptions but no similar authority is provided for the State Board and its salaried members. (Water Code, § 13223.) By specifying only certain activities that the Board's Executive Director may conduct, and expressly identifying only the State Board as the entity authorized to render water quality decisions in the State above the Regional Board levels, the Water Code excludes any implication that the State Board's staff may be elevated to positions on the State Board by assigning them decisions earmarked for the State Board.

The delegation of authority to a deputy or authorized person provided at Section 7 of the Water Code does not apply to the State Board. Section 7 states that "[w]henever a power is granted to, or a duty is imposed upon, ***a public officer***, the power may be exercised or the duty may be performed by a deputy of the officer or by a person authorized, ***pursuant to law***, by the officer, unless this code expressly provides otherwise." (Water Code, § 7 (emphasis).) This provision applies "[u]nless the provision or the context otherwise requires…." (Water Code, § 5.) The Board and its five members cannot reasonably be construed as a "public officer." If anything, each Board member is a public officer. However, no Board member can act unilaterally, a quorum of three Board members being necessary to conduct business. (Water Code, § 181.) Nor can Section 7 be itself deemed the authority to delegate that meets Section 7's condition that any delegation be "pursuant to law." Such a circular reading of the section would in effect delete the condition that any delegation be pursuant to law. Nor is there a deputy to the State Board provided by the Water Code. Thus, any duties delegated to the Board by the Legislature are not duties of "a public officer" but of a board. Moreover, as explained above, pursuant to the Water Code, there is no authorization for the Board to delegate its decision-making functions and the context, as clarified by the Court of Appeal precludes reading any implicit authority for the State Board to delegate decisions to its staff. (*Central Delta Water Agency*, 124 Cal. App. 4th at pp. 261-262.)

To the extent State Board Resolution No. 2012-0061 purports to delegate Section 401 certification or CEQA approvals to the Executive Director, given the absence of authority for such a delegation, that resolution as applied to the Eagle Mountain Project is void. (*See Ocean Park Associates v. Santa Monica Rent Control Bd.* (2004) 114 Cal.App.4th 1050, 1062.) Likewise, to the extent 23 CCR § 3859 suggests that the Executive Director may serve as the State Board's designee for Section 401 certifications, that regulation also is void as applied to the Eagle Mountain Project. (23 CCR § 3859.)

B. CEQA LIKEWISE PROHIBITS DELEGATION OF EIR CERTIFICATION TO STAFF.

Likewise, the Executive Director of the State Board may not certify the EIR. CEQA itself emphasizes that an elected or appointed Board cannot delegate its CEQA responsibilities to its staff. Similar to Water Code § 186, the staff functions identified by CEQA are limited to assisting the Board in ***administering*** CEQA:

> (a) A public agency may assign specific functions to its staff to assist in administering CEQA. Functions which may be delegated include but are not limited to:
> (1) Determining whether a project is exempt.
> (2) Conducting an initial study and deciding whether to prepare a draft EIR or negative declaration.
> (3) Preparing a negative declaration or EIR.
> (4) Determining that a negative declaration has been completed within a period of 180 days.
> (5) Preparing responses to comments on environmental documents.
> (6) Filing of notices.
> (b) ***The decisionmaking body of a public agency shall not delegate the following functions***:
> (1) ***Reviewing and considering a final EIR or approving a negative declaration prior to approving a project.***
> (2) The making of findings as required by Sections 15091 and 15093.

(14 CCR § 15025 ["Delegation of Responsibilities"] [emphasis added]; *See also* 14 CCR 15090(a)(2) [decisionmaking body must review and consider the information contained in the final EIR prior to approving the project].)

Because only the State Board is the decisionmaking body pursuant to the Water Code, the Board may not delegate certification of the Eagle Mountain Project EIR to its staff, or the Executive Director. Final certification of the EIR and the Section 401 Certification should be scheduled for consideration by the State Board at a duly noticed public meeting.

VII. CONCLUSION

In conclusion, commenters hereby incorporate by reference the comments already submitted to the State Board by the National Parks Conservation Association, Kaiser Ventures, LLC, The County Sanitation Districts of Los Angeles County, the National Park Service, and The Sierra Club. Consistent with the above comments, commenters request that, rather than a non-public approval by the Executive Director, the State Board consider the final certification of the EIR and the approval of the Section 401 certification at a duly noticed public hearing. Commenters also request that the State Board substantially revise the EIR's environmental impacts analyses and identify a legally sufficient baseline for its analyses of those potential impacts. Finally, the revised EIR should be recirculated for public review and comment.

Please do not hesitate to call to discuss any of the above comments.

Sincerely,

Michael R. Lozeau
Cathy D. Lee
Lozeau Drury LLP
Attorneys for by Gary Cruz,
Hidaberto Sanchez, Ralph Figueroa
and Laborers International Union
of North America, Local Union 1184

EXHIBIT 1

SWAPE Technical Consultation, Data Analysis and Litigation Support for the Environment

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April 9, 2013

Cathy Lee
Lozeau | Drury LLP
410 12th Street, Suite 250
Oakland, CA 94607

Subject: Comments on the Eagle Mountain Pumped Storage Project, Riverside County, California

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Dear Ms. Lee:

We have reviewed the January 2013 Eagle Mountain Pumped Storage Project ("Project") Draft Final Environmental Impact Report (FEIR). The Project is located at a mining complex near Desert Center in Riverside County, California. The Project will initially fill two abandoned mining pits with groundwater. To generate energy, water will be pumped from a lower reservoir to an upper reservoir for storage during periods of low electrical demand. When demand warrants, energy will be generated by the release of water from the upper reservoir to the lower reservoir. Low demand periods are expected during weekday nights and throughout the weekend while high demand periods are expected in the daytime during weekdays.

Two earthen dams will be constructed to create the reservoirs. Two 29-foor diameter tunnels will be constructed to connect the reservoirs, and generating equipment will be located in an underground powerhouse constructed for the Project (p. 2.9).

Tunnel boring will generate an estimated be 1,772,000 cubic yards of waste rock which will be used for access roads and flood berms (p. 2-19). Construction is estimated to take place over four years and will involve development of access roads, a water pipeline, a transmission line, a powerhouse, brine ponds and the reservoirs.

We have reviewed the FEIR for issues associated with groundwater, water quality, hazardous waste, and greenhouse gasses. We have concluded these issue areas to have been inadequately addressed and inadequately mitigated. A revised FEIR should be prepared to address the deficiencies we identify as follow.

Declines in groundwater levels may be underestimated

Groundwater is the source of the water that will be used to fill the Project reservoirs. Groundwater will be pumped from alluvial sediments that fill the Chuckwalla Valley Groundwater Basin to initially fill the reservoirs and to supply water lost to evaporation.

The Chuckwalla Valley Groundwater Basin is recharged by percolation of runoff from surrounding mountains, from precipitation, and by subsurface inflow from the Pinto Valley Groundwater Basin to the north and from Orocopia Valley Groundwater Basin to the west. The FEIR acknowledges that recharge to desert groundwater basins is difficult to estimate and that estimates of recharge to the Chuckwalla Valley Groundwater Basin vary widely, from 10,000 to 20,000 AFY (3.3-12). With input from the Metropolitan Water District, the FEIR estimated recharge of 12,700 AFY to the Chuckwalla Valley Groundwater Basin (FEIR, p. 3.3-14). The estimate of 12,700 AFY was adopted in the FEIR as the average of estimates that ranged from 6,600 AFY to 17,700 AFY. Other, lower estimates of recharge are presented in the FEIR, the lowest being 9,800 AF (Table 3.3-3).

The FEIR uses an estimate for groundwater recharge that is not as conservative as estimates made by other researchers and is not the most conservative of estimates made by the MWD. Use of a less-conservative estimate in the FEIR results in an underestimation of actual groundwater drawdown. As a result, impacts from groundwater drawdown from Project operation may be underestimated.

Local pumping impacts from Project operation are predicted to result in drawdown of groundwater by about four feet below the maximum historic drawdown in the Upper Chuckwalla Valley and Orocopia Valley Groundwater Basins and by about five feet at the mouth of the Pinto Valley Groundwater Basin (p. 3.3-28 and 3.3-29). Cumulative impacts on groundwater drawdown -- to include water use for the proposed landfill, water use for multiple proposed solar projects, and water use for prisons -- is estimated to be nine feet (p. 3.3-29).

The value used for estimating recharge is critical. If more conservative recharge estimates are used (i.e. lower amounts of recharge to the groundwater basin), predicted decreases in water levels will be greater than those estimated in the FEIR. If estimates of recharge to the Chuckwalla Valley Groundwater Basin as too high, drawdown of the aquifer for filling and maintenance of water levels in the reservoirs will be underestimated.

The FEIR concludes that Project groundwater pumping, in combination with cumulative pumping for other projects, could cause overdraft and declines in groundwater levels of nine feet and would contribute to a significant adverse cumulative effect (3.3-32). It is my opinion that impacts could be even more significant if actual groundwater recharge is not as high as predicted in the FEIR. Therefore, the FEIR should be revised to include consideration of additional more conservative estimates of groundwater recharge. The additional estimates should be developed by an independent agency, like the U.S. Geological Survey, with extensive experience in modeling recharge in the area. Results of the recharge estimates should be incorporated into the groundwater models to predict additional drawdown scenarios.

The FEIR includes mitigation for monitoring groundwater levels (MM GW-1) during Project operation and during the initial filling of the reservoirs by installing a well network. If groundwater drawdowns exceed "maximum allowable changes" (Table 3-9), pumping rates will be reduced. Reference is also made to an "accounting surface" that would be established through "future legislation, rule-making or applicable judicial determination" (MM GW-1).

The inclusion of "maximum allowable changes" and an "accounting surface" in MM GW-1 is a good first step, however these are not enforceable limits as proposed in the FEIR. The FEIR should be revised to include enforceable maximum drawdown limits. One such mechanism would be to enter into an agreement with Riverside County to establish a "floor" for the maximum amount of drawdown that would be acceptable. If the levels of the floor were exceeded, automatic management measures would be triggered such as a reduction in pumping until groundwater levels reached agreed-upon levels. Such management techniques were adopted and incorporated into a memorandum of understanding with San Bernardino County for the Cadiz Valley Water Conservation, Recovery, and Storage project located 40 miles to the north of the Project.

Seepage may impact groundwater quality

The reservoirs are to be completed in former mining pits which were blasted and excavated into highly fractured bedrock. When filled, the reservoirs are estimated to lose up to 1,800 AFY of water through seepage (p. 3.3-31). The water that seeps from the reservoirs water will flow downgradient through fractured bedrock to mix with groundwater in the Chuckwalla Valley Groundwater Basin. Pumping wells are proposed to combat a rise of up to 12 feet in groundwater levels beneath the reservoir and up to 6 in the valley (p. 3.3-34). Seepage may also occur from the brine ponds that will contain wastes from the reverse osmosis system.

The bedrock and tailing piles that forms the base of the reservoirs, contain metals that may be mobilized and transported by water seepage. Material excavated from bedrock during tunnel excavation may be placed at the base of the reservoirs (p. 2-19) and may impact water quality, especially when considering that increased surface area of the excavated rock will increased potential for acid generation).

The FEIR acknowledges that seepage could affect water quality and that metals in seepage water could be transported into the Chuckwalla Valley Groundwater basin. The FEIR goes on to state that geochemical analyses indicate that metals present in the underlying rock are not likely to become mobile or produce acid leachate, however, "it is possible" (p. 3.3-31).

As mitigation, the FEIR proposes PDF GW-1 which would identify methods to control seepage that include grouting, seepage blankets, soil cement treatment. Additionally, MM GW-6 would establish a groundwater monitoring program that will include sampling within the reservoirs, production wells, and in wells up gradient and downgradient of the reservoirs and brine disposal lagoon.

No direct tests of the potential for water in the reservoir to generate acid was conducted in the preparation of the FEIR, presumably because of access restrictions to central areas of the Project site. No tests for the potential of the reservoir water to contain metals at high concentrations were conducted for inclusion in the FEIR. Failure to conduct these tests constitutes inadequate disclosure. Access to the pits to obtain samples of water and rock should be obtained and analyses of the samples should be included in a revised FEIR along with a complete analysis of the potential for seepage to affect water quality in the Chuckwalla Valley Groundwater Basin.

Hazardous waste impacts

The area of Desert Center was heavily used during WWII for training exercises under the command of General George S. Patton. Desert Center was chosen as the headquarters for the training area known as the California/Arizona Maneuver Area, the largest such operation in the world. Over one million troops were trained at the California/Arizona Maneuver Area, using live fire from tanks, planes, artillery and firearms.[1] Desert Center is located about 12 miles south of where Project reservoirs are proposed and water and transmission lines are proposed to cross just north of the community.

The FEIR mentions the training activities associated with the California/Arizona Maneuver Area only briefly, stating the routes of the transmission lines are close to the training camps and that there is a potential for unexploded ordnance (UXO) to pose hazards to workers (3.16-7). As mitigation, MM HM-1 states that a Project contractor and an environmental coordinator will implement a program to identify UXO and to prepare a UXO plan to properly train all site workers.

Disclosure of the potential for UXO in the FEIR is inadequate. The FEIR should be revised to include as much information as is available about the types of training activities that were conducted in the Project area and the potential for the specific types of UXO that may be found in association with those activities. For example, we obtained a map of the camp established at Desert Center from the Internet and overlaid it atop a map of the Project area, including the water and transmission lines (Attachment 1). The map shows that the route of the water and the transmission lines runs within a few thousand feet of what is mapped as an ammunition depot, near a maneuver area (where presumably live rounds were used in training) and within 2000 feet of the Desert Center Army Air Field.

In addition to conducting a review of the specific military activities conducted within Project boundaries, a survey of the Project site, using visual and geophysical techniques should be conducted by trained personnel. To provide for adequate disclosure and to best ensure worker safety, the results of the survey should be included in revised FEIR. Results of the survey should be disclosed in a FEIR to ensure adequate disclosure of the environmental setting at the Project site. If UXO is found on the Project site during the survey, construction should be delayed until all debris has been cleared.

Survey efforts should be undertaken with oversight by the BLM who manage acreage that will be utilized for transmission lines and water lines, areas that may be most likely to be underlain by UXO from WW II-era military operations (p 2-26). The survey should follow guidelines published by the BLM for UXO to reduce risks from explosive hazards.[2]

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[1] http://www.blm.gov/ca/st/en/fo/needles/patton.html

[2] http://www.fws.gov/refuges/whm/pdfs/UXO_Handbook_8-9-06.pdf

Water quality impacts

Water treatment through reverse osmosis is planned to maintain total dissolved solids concentrations in the reservoirs which otherwise would be increased through evaporation. Waste salts and metals produced by the reverse osmosis system will be sent to brine ponds. The brine ponds are planned to be double-lined to prevent seepage and a groundwater monitoring network will be constructed to detect potential seepage (p. 3.3-31). No details of the brine ponds is provided in the FEIR other than to show their location south of the reservoirs.

Mitigation identified to prevent impacts from the brine ponds is identified in PDF GW-2 which states: (1) The salts will be regularly wetted for air quality considerations and; (2) salts from the brine disposal ponds will be removed and disposed at an offsite location when full, approximately every 10 years. Mitigation is also identified in MM GW-6 which provides for groundwater monitoring in association with the brine ponds.

The FEIR acknowledges that if water which contains TDS and metals seeps through the liners of brine disposal ponds, it may degrade the groundwater quality in the basin (p. 3.3-31). Although the FEIR provides for mitigation, few details are provided to document how the ponds will be constructed and how monitoring will be conducted. Details that are lacking include: capacity of the ponds, freeboard of the ponds, the specific types of liners that will be used, the construction of the groundwater monitoring wells that will be installed, the location of the disposal facility that will be used and whether the brine will be classified as hazardous waste.

Without this information, impacts to groundwater and surface water from the brine ponds cannot be evaluated. The FEIR should be revised to disclose this information in a draft Report of Waste Discharge which will be required by the Regional Water Quality Control Board for operation of the brine ponds.

Greenhouse gasses

Operational emissions

The FEIR concludes that Project operation would reduce or offset greenhouse gas emissions and have a less than significant impact. The FEIR assumes that power generation from the Project would displace simple cycle plant emissions plant during peak demands and utilize cleaner power sources including renewables for pump-back power during periods of low electricity demand. Through such a scheme, the FEIR estimates the Project will displace 49,955 Co2e metric tons when using combined cycle power plants and 1,115,751 Co2e metric tons if renewable sources are used for pump-back power.

The FEIR provides no details on sources of the power that are assumed in estimating GHG emissions offsets. The FEIR bases offsets on the assumption that Project power needs are met with renewable and combined cycle sources that would displace simple cycle power generation. No documentation is provided in the FEIR to support the contention that power needs for pumping would displace energy supplied only by simple cycle plants. A revised FEIR should be prepared to identify what sources of power will be used by the Project and at what time, including renewable, combined cycle and simple cycle sources.

A more appropriate estimate of GHG emissions should be developed based on net power consumption needed for Project operation. The Project has an efficiency of 79 percent (FEIR, p. 2-1). Therefore, to generate power at the Project's stated capacity of 1,300 MW, 1,600 MW of energy will be required to pump water to the upper reservoir. A more appropriate baseline that should be considered in a revised FEIR would focus on the power consumed by the Project and determine the amount of greenhouse gasses that would be emitted by current sources of power available to the Project. A revised FEIR should incorporate published default CO2 emissions factors for the power consumed by the Project from currently available sources. The California Energy Commission specifies the use of a default CO2 emissions factor of 1000 lbs/MWh for "in-state unspecified sources."[3]

Construction emissions

Construction of the project will involve extensive site preparation activities over a period of four years. Construction will involve:

- Building two dams which will involve preparation of the foundation to remove waste materials from mining, overburden, and weathered rock;
- Construction of two spillways;
- Developing mining pits into reservoirs by preparing the base with grouting, a seepage blanket made from fine tailings;
- Creation of tunnel and shaft system with total lengths greater than two miles; and
- Development of a 72-feet-wide, 150-feet-high, and 360-feet-long, underground powerhouse (FEIR, pp. 2.12 to 2.20).

Each of these activities will involve the use of heavy equipment that will emit greenhouse gasses.

No estimate of construction GHG emissions was included in the FEIR other than to say "Project construction GHG emissions during the maximum year would be approximately 8,467 metric tons/year of CO2e" (FEIR, p. 3.15-10). No support for this statement is included in the FEIR or in the appendices. No documentation that modeling was done in support of this estimate is included in the FEIR and not quantification of the amount of GHGs produced by project construction components (e.g., dam and spillway construction, tunnel construction).

The FEIR fails to adequately disclose Project GHG emissions over the four-year span of Project construction. A revised FEIR should be prepared to estimate construction GHG emissions using common models accepted by the SQAQMD, including URBEMIS and the California Emission Estimator Model (CalEEMod). The estimated construction GHG emission, based on the modeling efforts, should be

[3] http://www.arb.ca.gov/cc/ccei/presentations/OOS_EmissionFactors.pdf -- also see EPA's default emissions factor at http://www.epa.gov/cpd/pdf/brochure.pdf

compared to the interim 10,000 MT CO2E/year threshold set by the SCAQMD[4] and the California Air Pollution Control Officers Association (CAPCOA) threshold of 900 $MTCO_2e$/year.[5]

Mitigation

A revised FEIR should be prepared to compare project operational and construction GHG emissions to the interim 10,000 MT CO2E/year threshold set by the SCAQMD. The estimates of GHG emissions should consider both unmitigated and mitigated scenarios.

Mitigation for operational emissions of GHGs in a revised FEIR should contemplate a mechanism to eliminate use of currently existing peaker plants[6] which rely on simple cycle technology. If peaker plants were to be eliminated though funding by the applicant, GHG impacts of the Project could truly be considered to be displaced.

Considerations for mitigation for construction emissions in a revised FEIR should quantify emissions reductions with use of available mitigation[7] for construction and off-road equipment, including

- Use Alternative Fuels for Construction Equipment
- Use Electric and Hybrid Construction Equipment
- Limit Construction Equipment Idling beyond Regulation Requirements
- Institute a Heavy-Duty Off-Road Vehicle Plan
- Implement a Vehicle Inventory Tracking System
- Exclusive use of latest diesel technology.

In accordance with draft SCAQMD policy[8] and widely referenced CAPCOA guidance[9], if emissions from a Project are significant after implementation of all feasible mitigation, carbon offsets or emissions reduction credits should be purchased for the amount of GHG emissions above thresholds. According to CAPCOA, high quality credits are based on projects that have permanent, verifiable, enforceable and demonstrated emission reductions and should be obtained after certification from reputable registries such as the American Carbon Registry and the Climate Action Reserve.

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[4] http://www.aqmd.gov/ceqa/handbook/signthres.pdf

[5] California Air Pollution Control Officers Association. CEQA & Climate Change, Evaluating and Addressing Greenhouse Gas Emissions from Projects Subject to the California Environmental Quality Act. http://www.capcoa.org/wp-content/uploads/downloads/2010/05/CAPCOA-White-Paper.pdf, p. 49.

[6] http://www.energy.ca.gov/maps/powerplants/peaker_map.html

[7] http://www.aqmd.gov/ceqa/handbook/mitigation/greenhouse_gases/CAPCOA-Quantification-Report-Final1.pdf – see CAPCOA fact sheet, Section 8

[8] http://www.aqmd.gov/ceqa/handbook/GHG/2008/oct22mtg/thresholdprop.pdf

[9] http://www.capcoa.org/wp-content/uploads/downloads/2010/05/CAPCOA-White-Paper.pdf

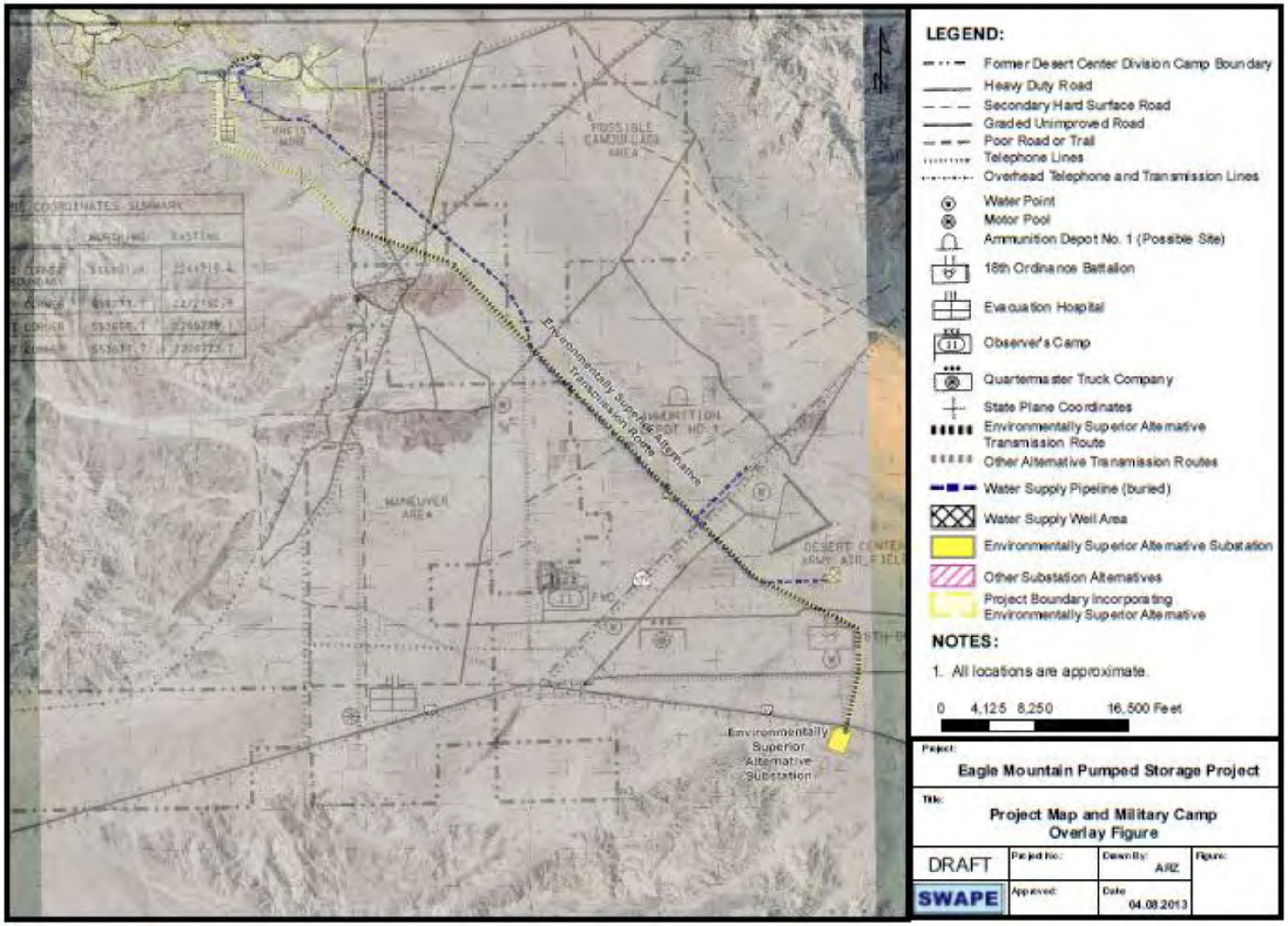
Sincerely,

Matt Hagemann, P.G., C.Hg.

Attachment 1

Overlay of Desert Center Division Camp and Project Features

(Overlay of Desert Center Division Camp obtained at http://skytrail.info/new/picture_library/DESERTcenterlayout1943.GIF)



POSSIBLE CAMOUFLAGE AREA
MANEUVER AREA
AMMUNITION DEPOT NO. 1
DESERT CENTER ARMY AIR FIELD
Environmentally Superior Alternative Transmission Route
Environmentally Superior Alternative Substation
LEGEND:
Former Desert Center Division Camp Boundary
Heavy Duty Road
Secondary Hard Surface Road
Graded Unimproved Road
Poor Road or Trail
Telephone Lines
Overhead Telephone and Transmission Lines
Water Point
Motor Pool
Ammunition Depot No. 1 (Possible Site)
18th Ordinance Battalion
Evacuation Hospital
Observer's Camp
Quartermaster Truck Company
State Plane Coordinates
Environmentally Superior Alternative Transmission Route
Other Alternative Transmission Routes
Water Supply Pipeline (buried)
Water Supply Well Area
Environmentally Superior Alternative Substation
Other Substation Alternatives
Project Boundary Incorporating Environmentally Superior Alternative
NOTES:
1. All locations are approximate.
0 4,125 8,250 16,500 Feet
Project:
Eagle Mountain Pumped Storage Project
Title:
Project Map and Military Camp Overlay Figure
DRAFT
Project No.:
Drawn By: ARZ
Figure:
SWAPE
Approved:
Date 04.08.2013

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CEQA Review
Investigation and Remediation Strategies
Litigation Support and Testifying Expert

Education:

M.S. Degree, Geology, California State University Los Angeles, Los Angeles, CA, 1984.
B.A. Degree, Geology, Humboldt State University, Arcata, CA, 1982.

Professional Certification:

California Professional Geologist
California Certified Hydrogeologist
Qualified SWPPP Developer and Practitioner

Professional Experience:

Matt has 25 years of experience in environmental policy, assessment and remediation. He spent nine years with the U.S. EPA in the RCRA and Superfund programs and served as EPA's Senior Science Policy Advisor in the Western Regional Office where he identified emerging threats to groundwater from perchlorate and MTBE. While with EPA, Matt also served as a Senior Hydrogeologist in the oversight of the assessment of seven major military facilities undergoing base closure. He led numerous enforcement actions under provisions of the Resource Conservation and Recovery Act (RCRA) while also working with permit holders to improve hydrogeologic characterization and water quality monitoring.

Matt has worked closely with U.S. EPA legal counsel and the technical staff of several states in the application and enforcement of RCRA, Safe Drinking Water Act and Clean Water Act regulations. Matt has trained the technical staff in the States of California, Hawaii, Nevada, Arizona and the Territory of Guam in the conduct of investigations, groundwater fundamentals, and sampling techniques.

Positions Matt has held include:

- Founding Partner, Soil/Water/Air Protection Enterprise (SWAPE) (2003 – present);
- Geology Instructor, Golden West College, 2010 – present;
- Senior Environmental Analyst, Komex H2O Science, Inc (2000 -- 2003);

- Executive Director, Orange Coast Watch (2001 – 2004);
- Senior Science Policy Advisor and Hydrogeologist, U.S. Environmental Protection Agency (1989–1998);
- Hydrogeologist, National Park Service, Water Resources Division (1998 – 2000);
- Adjunct Faculty Member, San Francisco State University, Department of Geosciences (1993 – 1998);
- Instructor, College of Marin, Department of Science (1990 – 1995);
- Geologist, U.S. Forest Service (1986 – 1998); and
- Geologist, Dames & Moore (1984 – 1986).

Partner, SWAPE:

With SWAPE, Matt's responsibilities have included:

- Lead analyst and testifying expert in the review of numerous environmental impact reports under CEQA that identify significant issues with regard to hazardous waste, water resources, water quality, air quality, greenhouse gas emissions and geologic hazards.
- Stormwater analysis, sampling and best management practice evaluation at industrial facilities.
- Lead analyst and testifying expert in the review of environmental issues in license applications for large solar power plants before the California Energy Commission.
- Technical assistance and litigation support for vapor intrusion concerns.
- Manager of a project to evaluate numerous formerly used military sites in the western U.S.
- Manager of a comprehensive evaluation of potential sources of perchlorate contamination in Southern California drinking water wells.
- Manager and designated expert for litigation support under provisions of Proposition 65 in the review of releases of gasoline to sources drinking water at major refineries and hundreds of gas stations throughout California.
- Expert witness on two cases involving MTBE litigation.
- Expert witness and litigation support on the impact of air toxins and hazards at a school.
- Expert witness in litigation at a former plywood plant.

With Komex H2O Science Inc., Matt's duties included the following:

- Senior author of a report on the extent of perchlorate contamination that was used in testimony by the former U.S. EPA Administrator and General Counsel.
- Senior researcher in the development of a comprehensive, electronically interactive chronology of MTBE use, research, and regulation.
- Senior researcher in the development of a comprehensive, electronically interactive chronology of perchlorate use, research, and regulation.
- Senior researcher in a study that estimates nationwide costs for MTBE remediation and drinking water treatment, results of which were published in newspapers nationwide and in testimony against provisions of an energy bill that would limit liability for oil companies.
- Research to support litigation to restore drinking water supplies that have been contaminated by MTBE in California and New York.
- Expert witness testimony in a case of oil production-related contamination in Mississippi.
- Lead author for a multi-volume remedial investigation report for an operating school in Los Angeles that met strict regulatory requirements and rigorous deadlines.
- Development of strategic approaches for cleanup of contaminated sites in consultation with clients and regulators.

Executive Director:

As Executive Director with Orange Coast Watch, Matt led efforts to restore water quality at Orange County beaches from multiple sources of contamination including urban runoff and the discharge of wastewater. In reporting to a Board of Directors that included representatives from leading Orange County universities and businesses, Matt prepared issue papers in the areas of treatment and disinfection of wastewater and control of the dischrge of grease to sewer systems. Matt actively participated in the development of countywide water quality permits for the control of urban runoff and permits for the discharge of wastewater. Matt worked with other nonprofits to protect and restore water quality, including Surfrider, Natural Resources Defense Council and Orange County CoastKeeper as well as with business institutions including the Orange County Business Council.

Hydrogeology:

As a Senior Hydrogeologist with the U.S. Environmental Protection Agency, Matt led investigations to characterize and cleanup closing military bases, including Mare Island Naval Shipyard, Hunters Point Naval Shipyard, Treasure Island Naval Station, Alameda Naval Station, Moffett Field, Mather Army Airfield, and Sacramento Army Depot. Specific activities were as follows:

- Led efforts to model groundwater flow and contaminant transport, ensured adequacy of monitoring networks, and assessed cleanup alternatives for contaminated sediment, soil, and groundwater.
- Initiated a regional program for evaluation of groundwater sampling practices and laboratory analysis at military bases.
- Identified emerging issues, wrote technical guidance, and assisted in policy and regulation development through work on four national U.S. EPA workgroups, including the Superfund Groundwater Technical Forum and the Federal Facilities Forum.

At the request of the State of Hawaii, Matt developed a methodology to determine the vulnerability of groundwater to contamination on the islands of Maui and Oahu. He used analytical models and a GIS to show zones of vulnerability, and the results were adopted and published by the State of Hawaii and County of Maui.

As a hydrogeologist with the EPA Groundwater Protection Section, Matt worked with provisions of the Safe Drinking Water Act and NEPA to prevent drinking water contamination. Specific activities included the following:

- Received an EPA Bronze Medal for his contribution to the development of national guidance for the protection of drinking water.
- Managed the Sole Source Aquifer Program and protected the drinking water of two communities through designation under the Safe Drinking Water Act. He prepared geologic reports, conducted public hearings, and responded to public comments from residents who were very concerned about the impact of designation.

- Reviewed a number of Environmental Impact Statements for planned major developments, including large hazardous and solid waste disposal facilities, mine reclamation, and water transfer.

Matt served as a hydrogeologist with the RCRA Hazardous Waste program. Duties were as follows:

- Supervised the hydrogeologic investigation of hazardous waste sites to determine compliance with Subtitle C requirements.
- Reviewed and wrote "part B" permits for the disposal of hazardous waste.
- Conducted RCRA Corrective Action investigations of waste sites and led inspections that formed the basis for significant enforcement actions that were developed in close coordination with U.S. EPA legal counsel.
- Wrote contract specifications and supervised contractor's investigations of waste sites.

With the National Park Service, Matt directed service-wide investigations of contaminant sources to prevent degradation of water quality, including the following tasks:

- Applied pertinent laws and regulations including CERCLA, RCRA, NEPA, NRDA, and the Clean Water Act to control military, mining, and landfill contaminants.
- Conducted watershed-scale investigations of contaminants at parks, including Yellowstone and Olympic National Park.
- Identified high-levels of perchlorate in soil adjacent to a national park in New Mexico and advised park superintendent on appropriate response actions under CERCLA.
- Served as a Park Service representative on the Interagency Perchlorate Steering Committee, a national workgroup.
- Developed a program to conduct environmental compliance audits of all National Parks while serving on a national workgroup.
- Co-authored two papers on the potential for water contamination from the operation of personal watercraft and snowmobiles, these papers serving as the basis for the development of nation-wide policy on the use of these vehicles in National Parks.
- Contributed to the Federal Multi-Agency Source Water Agreement under the Clean Water Action Plan.

Policy:

Served senior management as the Senior Science Policy Advisor with the U.S. Environmental Protection Agency, Region 9. Activities included the following:

- Advised the Regional Administrator and senior management on emerging issues such as the potential for the gasoline additive MTBE and ammonium perchlorate to contaminate drinking water supplies.
- Shaped EPA's national response to these threats by serving on workgroups and by contributing to guidance, including the Office of Research and Development publication, Oxygenates in Water: Critical Information and Research Needs.
- Improved the technical training of EPA's scientific and engineering staff.
- Earned an EPA Bronze Medal for representing the region's 300 scientists and engineers in negotiations with the Administrator and senior management to better integrate scientific principles into the policy-making process.
- Established national protocol for the peer review of scientific documents.

Geology:

With the U.S. Forest Service, Matt led investigations to determine hillslope stability of areas proposed for timber harvest in the central Oregon Coast Range. Specific activities were as follows:

- Mapped geology in the field, and used aerial photographic interpretation and mathematical models to determine slope stability.
- Coordinated his research with community members who were concerned with natural resource protection.
- Characterized the geology of an aquifer that serves as the sole source of drinking water for the city of Medford, Oregon.

As a consultant with Dames and Moore, Matt led geologic investigations of two contaminated sites (later listed on the Superfund NPL) in the Portland, Oregon, area and a large hazardous waste site in eastern Oregon. Duties included the following:

- Supervised year-long effort for soil and groundwater sampling.
- Conducted aquifer tests.
- Investigated active faults beneath sites proposed for hazardous waste disposal.

Teaching:

From 1990 to 1998, Matt taught at least one course per semester at the community college and university levels:

- At San Francisco State University, held an adjunct faculty position and taught courses in environmental geology, oceanography (lab and lecture), hydrogeology, and groundwater contamination.
- Served as a committee member for graduate and undergraduate students.
- Taught courses in environmental geology and oceanography at the College of Marin.

Matt currently teaches Physical Geology (lecture and lab) to students at Golden West College in Huntington Beach, California.

Invited Testimony, Reports, Papers and Presentations:

Hagemann, M.F., 2008. Disclosure of Hazardous Waste Issues under CEQA. Presentation to the Public Environmental Law Conference, Eugene, Oregon.

Hagemann, M.F., 2008. Disclosure of Hazardous Waste Issues under CEQA. Invited presentation to U.S. EPA Region 9, San Francisco, California.

Hagemann, M.F., 2005. Use of Electronic Databases in Environmental Regulation, Policy Making and Public Participation. Brownfields 2005, Denver, Coloradao.

Hagemann, M.F., 2004. Perchlorate Contamination of the Colorado River and Impacts to Drinking Water in Nevada and the Southwestern U.S. Presentation to a meeting of the American Groundwater Trust, Las Vegas, NV (served on conference organizing committee).

Hagemann, M.F., 2004. Invited testimony to a California Senate committee hearing on air toxins at schools in Southern California, Los Angeles.

Brown, A., Farrow, J., Gray, A. and **Hagemann, M.**, 2004. An Estimate of Costs to Address MTBE Releases from Underground Storage Tanks and the Resulting Impact to Drinking Water Wells. Presentation to the Ground Water and Environmental Law Conference, National Groundwater Association.

Hagemann, M.F., 2004. Perchlorate Contamination of the Colorado River and Impacts to Drinking Water in Arizona and the Southwestern U.S. Presentation to a meeting of the American Groundwater Trust, Phoenix, AZ (served on conference organizing committee).

Hagemann, M.F., 2003. Perchlorate Contamination of the Colorado River and Impacts to Drinking Water in the Southwestern U.S. Invited presentation to a special committee meeting of the National Academy of Sciences, Irvine, CA.

Hagemann, M.F., 2003. Perchlorate Contamination of the Colorado River. Invited presentation to a tribal EPA meeting, Pechanga, CA.

Hagemann, M.F., 2003. Perchlorate Contamination of the Colorado River. Invited presentation to a meeting of tribal repesentatives, Parker, AZ.

Hagemann, M.F., 2003. Impact of Perchlorate on the Colorado River and Associated Drinking Water Supplies. Invited presentation to the Inter-Tribal Meeting, Torres Martinez Tribe.

Hagemann, M.F., 2003. The Emergence of Perchlorate as a Widespread Drinking Water Contaminant. Invited presentation to the U.S. EPA Region 9.

Hagemann, M.F., 2003. A Deductive Approach to the Assessment of Perchlorate Contamination. Invited presentation to the California Assembly Natural Resources Committee.

Hagemann, M.F., 2003. Perchlorate: A Cold War Legacy in Drinking Water. Presentation to a meeting of the National Groundwater Association.

Hagemann, M.F., 2002. From Tank to Tap: A Chronology of MTBE in Groundwater. Presentation to a meeting of the National Groundwater Association.

Hagemann, M.F., 2002. A Chronology of MTBE in Groundwater and an Estimate of Costs to Address Impacts to Groundwater. Presentation to the annual meeting of the Society of Environmental Journalists.

Hagemann, M.F., 2002. An Estimate of the Cost to Address MTBE Contamination in Groundwater (and Who Will Pay). Presentation to a meeting of the National Groundwater Association.

Hagemann, M.F., 2002. An Estimate of Costs to Address MTBE Releases from Underground Storage Tanks and the Resulting Impact to Drinking Water Wells. Presentation to a meeting of the U.S. EPA and State Underground Storage Tank Program managers.

Hagemann, M.F., 2001. From Tank to Tap: A Chronology of MTBE in Groundwater. Unpublished report.

Hagemann, M.F., 2001. Estimated Cleanup Cost for MTBE in Groundwater Used as Drinking Water. Unpublished report.

Hagemann, M.F., 2001. Estimated Costs to Address MTBE Releases from Leaking Underground Storage Tanks. Unpublished report.

Hagemann, M.F., and VanMouwerik, M., 1999. Potential Water Quality Concerns Related to Snowmobile Usage. Water Resources Division, National Park Service, Technical Report.

VanMouwerik, M. and **Hagemann, M.F**. 1999, Water Quality Concerns Related to Personal Watercraft Usage. Water Resources Division, National Park Service, Technical Report.

Hagemann, M.F., 1999, Is Dilution the Solution to Pollution in National Parks? The George Wright Society Biannual Meeting, Asheville, North Carolina.

Hagemann, M.F., 1997, The Potential for MTBE to Contaminate Groundwater. U.S. EPA Superfund Groundwater Technical Forum Annual Meeting, Las Vegas, Nevada.

Hagemann, M.F., and Gill, M., 1996, Impediments to Intrinsic Remediation, Moffett Field Naval Air Station, Conference on Intrinsic Remediation of Chlorinated Hydrocarbons, Salt Lake City.

Hagemann, M.F., Fukunaga, G.L., 1996, The Vulnerability of Groundwater to Anthropogenic Contaminants on the Island of Maui, Hawaii. Hawaii Water Works Association Annual Meeting, Maui, October 1996.

Hagemann, M. F., Fukanaga, G. L., 1996, Ranking Groundwater Vulnerability in Central Oahu, Hawaii. Proceedings, Geographic Information Systems in Environmental Resources Management, Air and Waste Management Association Publication VIP-61.

Hagemann, M.F., 1994. Groundwater Characterization and Cleanup at Closing Military Bases in California. Proceedings, California Groundwater Resources Association Meeting.

Hagemann, M.F. and Sabol, M.A., 1993. Role of the U.S. EPA in the High Plains States Groundwater Recharge Demonstration Program. Proceedings, Sixth Biennial Symposium on the Artificial Recharge of Groundwater.

Hagemann, M.F., 1993. U.S. EPA Policy on the Technical Impracticability of the Cleanup of DNAPL-contaminated Groundwater. California Groundwater Resources Association Meeting.

Hagemann, M.F., 1992. Dense Nonaqueous Phase Liquid Contamination of Groundwater: An Ounce of Prevention... Proceedings, Association of Engineering Geologists Annual Meeting, v. 35.

<u>Other Experience:</u>

Selected as subject matter expert for the California Professional Geologist licensing examination, 2009-2011.

EXHIBIT 2

April 10, 2013

Ms. Cathy D. Lee
Lozeau-Drury, LLP
410 12th Street, Suite 250
Oakland, CA 94607

Subject: Comments on the Draft Final Environmental Impact Report prepared for the Eagle Mountain Pumped Storage Hydroelectric Project

Dear Ms. Lee:

This letter contains my comments on the Draft Final Environmental Impact Report ("DFEIR") prepared for Eagle Crest Energy Company's ("Applicant") Eagle Mountain Pumped Storage Hydroelectric ("Project"). The Project is located near the town of Eagle Mountain (approximately 12 miles northwest of the unincorporated town of Desert Center), in eastern Riverside County, California.

I am an environmental biologist with 20 years of professional experience in wildlife ecology, forestry, and natural resource management. I have served as a biological resources expert for over 50 development projects. My experience in this regard includes testifying before the California Energy Commission and California Public Utilities Commission, and assisting various clients with evaluations of biological resource issues. My educational background includes a B.S. in Resource Management from the University of California at Berkeley, and a M.S. in Wildlife and Fisheries Science from the Pennsylvania State University.

I have gained particular knowledge of the biological resource issues associated with the Project through studies I have conducted in Riverside County, and through my work on other projects in the Project region. The subsequent comments are based on my review of the environmental documents prepared for the Project, a review of scientific literature pertaining to biological resources known to occur in the Project area, consultations with biological resource experts, and the knowledge and experience I have acquired during more than 20 years of working in the field of natural resources management.

Special-Status Bats

The DFEIR acknowledges that several species of special-status bats are known to occur in the Central Project Area, and that those species may be affected by the Project. The DFEIR states:

> With the exception of bats, population impacts are generally expected to be both minor and highly localized for those wildlife species that might be affected by habitat loss, temporary loss of use of the construction area, or loss of individuals during construction.[1]

The DFEIR does not provide any further discussion or analysis of the population-level impacts that may occur to bats as a result of the Project.

Some of the bat species that occur in the Project Area are extremely rare. For example, the available data indicate that the California leaf-nosed bat may be Threatened or Endangered according to criteria defined by the California Endangered Species Act.[2] The species appears to be limited to a fraction of its former range, and it is currently known to occur primarily in the mountain ranges bordering the Colorado River basin.[3] The Eagle Mountains represent the westernmost portion of the current range.[4]

The primary factors responsible for the decline of California leaf-nosed bat populations are roost disturbance, the closure of mines for renewed mining and hazard abatement, and the destruction of foraging habitat.[5] The combination of limited distribution, restrictive roosting requirements, and the tendency to form large but relatively few roosting aggregations make this species especially vulnerable.[6]

The California leaf-nosed bat and most other bat species are very sensitive to human disturbance. Drilling and blasting activities causes impacts to roosting bats.[7] Project-related disturbance and habitat loss could cause bats to permanently abandon their roosts. Although the DFEIR requires bat surveys and impact minimization measures (e.g., eviction from roosts outside of the maternity season), it does not provide any mitigation measures to mitigate the loss of maternity colonies and/or significant roost sites. As a

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[1] DFEIR, p. 3.5-38.
[2] Bolster, B.C., editor. 1998. Terrestrial Mammal Species of Special Concern in California. Draft Final Report prepared by P.V. Brylski, P.W. Collins, E.D. Pierson, W.E. Rainey and T.E. Kucera. Report submitted to California Department of Fish and Game Wildlife Management Division, Nongame Bird and Mammal Conservation Program for Contract No. FG3146WM.
[3] *Ibid.*
[4] *Ibid.*
[5] NECO Plan, Appendix N.
[6] Bolster, B.C., editor. 1998. Terrestrial Mammal Species of Special Concern in California. Draft Final Report prepared by P.V. Brylski, P.W. Collins, E.D. Pierson, W.E. Rainey and T.E. Kucera. Report submitted to California Department of Fish and Game Wildlife Management Division, Nongame Bird and Mammal Conservation Program for Contract No. FG3146WM.
[7] Western Bat Working Group. 2005 [updated]. Species accounts. *Macrotus californicus.* Available at: http://www.wbwg.org/species_accounts.

result, it is my professional opinion that the Project would have an unmitigated, significant impact on one or more special-status bat species.

Common Ravens

The DFEIR states "[e]xisting perching, roosting, and nesting sites for ravens are plentiful under existing conditions within the Project area."[8] The Draft EIR further states "neither food nor water are limiting factors for raven populations in the area under existing conditions."[9] To the best of my knowledge, these two statements eliminate all factors that may limit the population size of ravens in the Project area. Scientific data do not support the DFEIR's assertion that none of the aforementioned factors is the limiting factor.

The fundamental premise of the DFEIR's analysis pertaining to the effects of the Project on the common raven population is that "[a] simple increase in the quantity of water when it is already fully available does not change the availability to opportunistic predators."[10] Scientific literature does not support that premise.

As the Project's Predator Monitoring and Control Plan acknowledges, (a) nesting ravens generally forage close to the nest site; and (b) raven densities tend to decline with increasing distance from point subsidies.[11] Raven use of human resource subsidies increases fledgling success and juvenile survivorship (Kristan et al. 2003, Webb et al. 2004).[12] Whereas ravens will fly to water sources when water is lacking at nest sites, flying is energetically costly, which results in reduced survivorship of adults and young. Thus, new sources of water near nest sites make long distance flights unnecessary, and increases survivorship and recruitment. Based on my review of available scientific literature, the creation of two new and very large water sources will undoubtedly benefit the raven population.

There is a direct relationship between raven reproductive success, raven population size, and the risk of predation by ravens on desert tortoises.[13] The threat level that increased predation pressure poses to the desert tortoise population in the vicinity of the Central Project Area cannot be evaluated because the DFEIR does not provide any data pertaining to the demographics of the tortoise population in that region. Similarly, although Joshua Tree National Park is within the typical foraging radius of roosting (non-breeding) ravens, the threat to desert tortoises in the Park cannot be evaluated because the

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[8] DFEIR, Response to Comments on July 2010 Draft Environmental Impact Report, p. CCV-7.
[9] DEIR, p. 5-25.
[10] DFEIR, p. 3.5-42.
[11] PMCP, p. 5.
[12] Boarman, W.I., and W. B. Kristan, III. 2006. Trends in common raven populations in the Mojave and Sonoran deserts: 1968-2004. Conservation Science Research and Consulting and Department of Biological Sciences, California State University, San Marcos. Report to U.S. Fish and Wildlife Service, Ventura, CA. Contract No. 814405M055. 36 pages.
[13] Kristan, W.B. and W. I. Boarman. 2003. Spatial pattern of risk of common raven predation on desert tortoises. Ecology 84:2432–2443.

DFEIR provides no data on the demographics of the tortoise population(s) that occur there.

Interaction Effects

Boarman (2002) reported:

> Because ravens move about seasonally, and individuals eat a varied diet, birds from landfills are likely to forage in tortoise habitat many miles away and may feed on juvenile tortoises. Furthermore, water is a critical resource for ravens in the desert. Any water source close to a landfill will be heavily used by ravens and may make that landfill highly attractive to ravens (Boarman et al. 1995, unpubl. data). Finally, coyotes at landfills benefit ravens in two ways, they (i) tear open otherwise inaccessible food containers (pers. obs.), and (ii) readily dig through end-of-day cover thus exposing garbage to ravens (pers. obs.).[14]

The DFEIR failed to disclose, analyze, or consider these interaction effects—even though it assumes the Eagle Mountain Landfill will exist as proposed. In my opinion, the interaction effect between the Project and the landfill undermines the ability of the DFEIR to rely on conclusions presented in the 1992 Biological Opinion for the Landfill.

Predator Monitoring and Control Plan

It is well accepted that anthropogenic development throughout various locations in the California desert have benefited the common raven, a predator of the desert tortoise. It is also well accepted that to be effective, raven management efforts need to be implemented at both the local and regional levels.

The Predator Monitoring and Control Plan ("PMCP") prepared for the Project provides inconsistent information on whether the Applicant will make a monetary payment to the USFWS Raven Management Program. It first states: "[t]he Project owner will pay in-lieu fees to [the UFWS Raven Management Plan]."[15] However, it subsequently states: "[t]he Project PMCP *may include* this in-lieu fee if it is determined that ravens may increase over current levels due to the Project."[16] The DFEIR must clarify whether the Applicant will be required to make a payment to the UFWS Raven Management Plan.

The fundamental hypothesis presented in the PMCP is that:

> …because of the baseline condition of continuous subsidies, it is likely that predators already exist in the Central Project Area. A simple increase in the quantity of water when it is already fully available does not change the availability to opportunistic predators. As such, it is not likely that there would be a measurable change in the density of predators, or, as a result, a significant

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[14] Boarman, W.I. 2002. Reducing predation by common ravens on desert tortoises in the Mojave and Colorado Deserts. U.S. Geological Survey, Western Ecological Research Center, Sacramento, CA. Technical Report

[15] PMCP, p. 7.

[16] *Ibid.*

> change in impacts to local fauna.[17]

As a result, the PMCP identifies its primary purpose as being "to ensure that predator increases due to the Project, if any, will not cause a biologically significant impact to the local fauna."[18] The PMCP fails in this regard.

First, the likelihood that the PMCP will succeed hinges on the ability to implement remedial actions in the event outcomes are not as predicted. This is acknowledged in the PMCP: one of the stated objectives is to "[d]efine triggers for modification of management and control measures using adaptive management principles."[19] The PMCP, however, fails to define any triggers (or success criteria) for adaptive management. This makes the Applicant's ability to mitigate the effects of the Project on predator populations uncertain and unenforceable.

Second, none of the survey methods described in the PMCP provide measures of *density*. Furthermore, the PMCP does not incorporate any strategies (e.g., surveys) to measure the response of the "local fauna." As a result, the Applicant will be incapable of meeting the primary purpose of the PMCP (i.e., to ensure that predator increases due to the Project, if any, will not cause a biologically significant impact to the local fauna).

<u>Ravens and Gulls</u>

A portion of the PMCP is dedicated to describing the methods that will be used to establish the "predator population baseline."[20] Although gulls are identified as a focal species, the PMCP does not include any measures to assess the baseline gull population or changes in the gull population over time.

The PMCP indicates the Applicant will conduct two post-nesting season surveys to establish the baseline population of ravens in the Project area prior to ground disturbance.[21] The surveys would entail searching the Project area for raven nests or evidence of predation at nests.[22] Data from the surveys would apparently then be compared against data from point count surveys conducted during the construction and operation phases of the Project.

The proposed approach is fatally flawed in two respects. First, the Applicant will be incapable of making any scientifically meaningful comparisons due to the difference in survey methods pre- and post-construction. Second, the proposed pre-construction surveys do not incorporate any measures of population size, and thus the Applicant will be incapable of determining whether the raven population increases as a result of Project construction and operation.

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[17] *Ibid*, p. 4.
[18] *Ibid.*
[19] *Ibid*.
[20] *Ibid*, Section 4.1.
[21] *Ibid*, p. 11.
[22] *Ibid.*

Coyotes and Feral Dogs

The PMCP proposes sampling stations (e.g., track plates or remote cameras) and transect surveys to assess the effect of the Project on canine predators. The PMCP states:

> These data will be analyzed by normalizing the count of predation sign on each transect based on transect length. Differences in the mean number of predation counts across transects will then be compared across surveys using a t-test.[23]

The PMCP does not identify the significance level that will be applied to the t-test. However, the small sample size will result in low statistical power, and likely precludes the ability to identify any effect of the Project on canine populations.

The PMCP states: "[i]f monitoring data show a potential increase in coyote/dog activity and associated desert tortoise predation, ECE will consult with FWS and California DFG to determine whether control measures are needed for these predators."[24] The PMCP does not identify (a) who would be responsible for the control measures; (b) the type of control methods that might be applied; or (c) whether control methods have proven feasible and effective in comparable environments. Moreover, the PMCP fails to establish an enforcement mechanism that conveys authority to the USFWS and CDFW to mandate canine control in response to the monitoring data.

Prior to approving the PMCP, staff should convene with a biometrician such that (a) the PMCP contains an appropriate experimental design; (b) data can be collected in a rigorous, standardized manner; and (c) the data have a reasonable chance of detecting a treatment (i.e., Project) effect should one occur.

Avian Collision

The DFEIR states:

> The transmission line will be the first such structure along this route. As such, the elevated structures and wires will be new to birds in the area, which could experience losses through collisions with wires or electrocution. Project design features, which increase the distance between wires so that birds cannot touch the ground wire and "hot" wires simultaneously will eliminate electrocutions.[25]

Although the DFEIR acknowledges the potential for birds to collide with the Project's transmission line, it provides virtually no analysis of the collision risk and the threat transmission lines pose to local bird populations. The golden eagle is one of several species that is highly susceptible to collisions with power lines.[26] There are numerous

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[23] *Ibid*, p. 12.
[24] *Ibid*, p. 17.
[25] DFEIR, p. 3.5-42. [emphasis added].
[26] Avian Power Line Interaction Committee (APLIC). 2012. *Reducing Avian Collisions with Power Lines: The State of the Art in 2012.* Edison Electric Institute and APLIC. Washington, D.C. Available at:

golden eagle territories in the Project region.[27]

The DFEIR indicates the Applicant will develop an Avian Protection Plan in consultation with the U.S. Fish and Wildlife Service ("USFWS").[28] Although the mitigation measure requires the Applicant to prepare the plan "in consultation with the USFWS," it does not establish an enforcement mechanism that ensures the final plan meets USFWS approval.

The DFEIR does not require the Applicant to implement measures to compensate for Project-related mortality to eagles. Moreover, preparation of an Avian Protection Plan does not ensure compliance with the Bald and Golden Eagle Protection Act ("Eagle Act").
To DFEIR needs to identify whether the Applicant will seek a permit from the USFWS for the incidental take of golden eagles, or how else it intends to comply with the Eagle Act given the threat transmission lines pose to eagles.

Special-Status Plants

EXISTING CONDITIONS

The Project area experiences bimodal rainfall patterns such that some of the special-status plant species that have the potential to occur in the Project area may only be identifiable after late summer/early fall monsoonal rains.[29] Survey protocols issued by the California Department of Fish and Wildlife ("CDFW"), the Bureau of Land Management ("BLM"), and the California Native Plant Society ("CNPS") describe the need for spring *and* fall surveys to document the presence of special-status plant species.[30]

Surveys for late-season annual plants have not been conducted for the Project. This is especially problematic for two reasons. First, some of the special-status plant species that occur (or may occur) in the region are only identifiable in the summer or fall following monsoonal rains.[31] Second, the DFEIR does not require surveys for late-season annual plants prior to construction of the Project.[32] Project impacts to special-status plant species cannot be properly analyzed or mitigated until the Applicant collects appropriately timed surveys throughout the entire Project area during both the spring and fall.

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http://www.aplic.org/
[27] DFEIR, Phase 1 Golden Eagle Aerial Surveys for Eagle Mountain Pumped Storage Project in the Mojave Desert Region, California.
[28] *Ibid*, p. 3.5-48.
[29] *See CNPS list available at:* http://www.cnps.org/cnps/rareplants/pdf/desert-fallsummer_flower_021210.pdf
[30] Bureau of Land Management. 2009. Survey Protocols Required for NEPA/ESA Compliance for BLM Special Status Plant Species. *See also* CDFG. 2009. Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities. Available at: http://www.dfg.ca.gov/wildlife/nongame/survey_monitor.html#Plants.
[31] *See CNPS list available at:* http://www.cnps.org/cnps/rareplants/pdf/desert-fallsummer_flower_021210.pdf
[32] *See* DFEIR, PDF BIO-2.

The DFEIR Lacks a Reliable Assessment of Existing Conditions Pertaining to Coachella Valley Milkvetch (*Astragalus lentiginosus* var. *coachellae*)

The DFEIR dismisses the potential for Coachella Valley milkvetch to occur in the Project area. However, according to Appendix B in the DFEIR (*Fish and Wildlife Observed in Project Area* (*Karl 2004a*)), Coachella Valley milkvetch was one of the species detected during surveys of the Project area.

The DFEIR Fails to Disclose the Presence of All Special-Status Plants Detected During Project Surveys

Based on Appendix B in the DFEIR, the DFEIR did not disclose the presence of, or analyze Project impact to, all of the special-status plant species that were detected in the Project area. These include:

- *Astragalus lentiginosus* var. *coachellae* (Federally Endangered)
- *A. insularis* var. *harwoodii* (Rare Plant Rank 2.2)
- *Psorothamnus fremontii* var. *attenuatus* (Rare Plant Rank 2.3)[33]

In addition, *Abronia villosa* was detected in the Project area, but the DFEIR does not identify it to the taxonomic level necessary to determine rarity (i.e., var. *aurita* or var. *villosa*).

IMPACTS AND MITIGATION

Special-status plant surveys have not been completed across the entire Project area. However, the DFEIR rationalizes the omission of surveys by requiring pre-construction surveys after Project approval. This is not a reliable mitigation strategy. First, without reliable information on the species that occur—and as a result, the level and types of Project impacts on those species—the DFEIR cannot conclude the proposed mitigation would reduce Project impacts to less-than-significant levels. A conclusion of this nature would rely on the presumption that all impacts can be mitigated to a less than significant level. Such a presumption is unrealistic. The flora of the Desert Floristic Province is poorly understood, and surveys may yield completely unexpected results that cannot be mitigated by standard conditions.

Second, the DFEIR lacks a mechanism for disclosing and vetting the results of the surveys prior to Project construction. As a result, the DFEIR lacks a mechanism for ensuring Project impacts to special-status plants are avoided, minimized, and mitigated; and that the Project complies with regulations governing sensitive botanical resources.

Crucifixion thorn is one of the special-status plant species known to occur in the Project area. The DFEIR concludes that population-level effects to crucifixion thorn "are likely

[33] Appendix B does not identify the specific variety of *Psorothamnus fremontii;* however, the variety can be inferred based on California Consortium of Herbaria database records.

to be minor" because very few individuals (<5) will be affected and plants can *probably* be avoided. [34] The DFEIR needs to identify whether crucifixion thorn plants will be avoided by the Project or not. Crucifixion thorn is relatively rare and sparsely distributed throughout the region and most of its range in California.[35] Indeed, only 13 crucifixion thorn plants were detected during surveys for the Project.[36] Consequently, in my opinion, impacts to any crucifixion thorn plants constitutes a significant impact that is not mitigated by the measures proposed in the DFEIR.

The DFEIR states "pre-construction surveys will be conducted to insure that no Coachella Valley Milkvetch will be disturbed (PDF BIO-2)," and that "PDF BIO-2 would result in a *less than significant* impact to the Coachella Valley Milkvetch."[37] These statements are unfounded. PDF BIO-2 does not mandate avoidance. It indicates avoidance areas in construction zones will be established; however, where avoidance is not feasible, plants will be transplanted.[38] The DFEIR provides no evidence that the buffer (of unspecified distance) would be effective in maintaining the primary constituent elements ("PCEs") for the potentially afflicted plants. Furthermore, the DFEIR provides no evidence that Coachella Valley milkvetch can be transplanted successfully.

Although salvage and relocation have some merits as a last resort, it is generally not an effective means of mitigating impacts. Fiedler (1991) conducted a thorough review of mitigation-related transplantation, relocation and reintroduction attempts involving special-status plants in California.[39] The author reported only 8 of the 53 (15%) attempts reviewed in her study should be considered fully successful.[40] Although Fiedler reported several causes for the failed attempts, the common result was that the plants died.

The aforementioned issues are exacerbated because:

1. The level of effort and rigor associated with the pre-construction plant surveys described in PDF BIO-2 are unclear. The mitigation measure does not specify the survey area (including any buffer zone) or protocol.
2. The mitigation measure does not provide a framework that establishes the various mitigation requirements should previously unidentified special-status species be detected in the Project area. There is a relatively high probability that previously unidentified special-status species will be detected during pre-construction surveys because late-season surveys were not conducted, and because a considerable amount of the Project area was not surveyed at all.
3. The DFEIR fails to establish success criteria for the proposed mitigation

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[34] DFEIR, p. 3.5-36.
[35] Data provided by the participants of the Consortium of California Herbaria (ucjeps.berkeley.edu/consortium/; Tue Apr 9 20:48:34 2013).
[36] DFEIR, p. 3.5-22.
[37] *Ibid*, pp. 3.6-24 and -31.
[38] *Ibid*, p. 3.5-47.
[39] Fiedler PL. 1991. Mitigation-related transplantation, relocation and reintroduction projects involving endangered and threatened, and rare plant species in California. Final Report. Available at: nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=3173.
[40] *Ibid*.

measures.

4. The DFEIR fails to require mitigation for plant species that cannot be transplanted, or for species that are not transplanted successfully (i.e., die).

Burrowing Owl

Consistent with CDFW guidelines, passive relocation is a potentially significant impact under CEQA that must be analyzed.[41] Specifically, the temporary or permanent closure of burrows may result in: (a) significant loss of burrows and habitat for reproduction and other life history requirements; (b) increased stress on burrowing owls and reduced reproductive rates; (c) increased depredation; (d) increased energetic costs; and (e) risks posed by having to find and compete for available burrows.[42] The DFEIR must thoroughly analyze the effects of passive relocation if it may be implemented at the Project site.

The need for full analysis of potential impacts from passive relocation is further supported by research that indicates most translocation projects have resulted in fewer breeding pairs of burrowing owls at the mitigation site than at the original site, and that translocation projects generally have failed to produce self-sustaining populations.[43] Investigators attribute the limited success of translocation to: (a) strong site tenacity exhibited by burrowing owls, and (b) potential risks associated with forcing owls to move into unfamiliar and perhaps less preferable habitats.[44]

Burrow exclusion-

In accordance with CDFW guidelines, burrowing owls should not be excluded from burrows unless or until the Applicant:

1. develops a Burrowing Owl Exclusion Plan that is approved by the CDFW;
2. secures off-site compensation habitat and constructs artificial burrows in close proximity (< 100 m) to the eviction sites;
3. mitigates the impacts of temporary exclusion according to the methods outlined by CDFW;
4. conducts site monitoring prior to, during, and after exclusion of burrowing owls from their burrows; and,
5. documents excluded burrowing owls using artificial or natural burrows on an adjoining mitigation site.[45]

[41] CDFG. 2012. Staff Report on Burrowing Owl Mitigation, p. 10.
[42] *Ibid.*
[43] Smith BW, JR Belthoff. 2001. Burrowing owls and development: short-distance nest burrow relocation to minimize construction impacts. J. Raptor Research 35:385-391.
[44] *Ibid.*
[45] CDFG. 2012 Mar 7. Staff Report on Burrowing Owl Mitigation. Available at: www.dfg.ca.gov/wildlife/nongame/docs/BUOWStaffReport.pdf, pp. 10 and 11.

Habitat compensation-

The DFEIR proposes habitat compensation for Project impacts to the burrowing owl. The proposed compensation is based on outdated guidelines. The CDFW no longer accepts the mitigation standards recommended in the California Burrowing Owl Consortium guidelines or in CDFW's 1995 Staff Report on Burrowing Owl Mitigation—because those standards have proven ineffective in the conservation of burrowing owl populations.[46] CDFW's 1995 Staff Report has been superseded by its 2012 Staff Report on Burrowing Owl Mitigation, which incorporates a considerable amount of new information pertaining to burrowing owl impacts and mitigation. The DFEIR must require mitigation consistent with CDFW's 2012 Staff Report.[47]

Significance Level of Impacts to Biological Resources

The DFEIR ultimately concludes "[a]ll potential biological impacts can be mitigated to less than significant levels, and therefore, there are no significant impacts after the implementation of mitigation measures."[48] It is impossible for the DFEIR to make this conclusion until surveys have been completed across the entire Project area, and the data have been analyzed and vetted by the resources agencies and public.

Revegetation Plan

The Revegetation Plan prepared for the Project acknowledges that "[s]uccessful revegetation in the desert is difficult because of low and unpredictable rainfall."[49] It subsequently states that success standards used in more mesic environments cannot be used in the desert, and that success criteria will be developed in consultation with the Technical Advisory Team ("TAT"). According to the Revegetation Plan, success criteria will include, at a minimum, the establishment of native shrubs and the minimization of exotic weed populations.[50] The likelihood that the Revegetation Plan will mitigate Project impacts cannot be evaluated until specific success criteria are identified.

The proposed TAT would consist of "Licensee's Environmental Coordinator and consultants, and staff from the resource managing agencies (BLM, USFWS, and CDFW)."[51] Although I support the formation of a TAT, there is an inherent conflict of interest if it is comprised of the Applicant's consultants. To ensure the proposed mitigation measures are properly implemented (especially those measures that have been deferred), the TAT must be comprised of an independent panel of experts. In addition, although the various mitigation plans (e.g., Revegetation Plan) defer the need for adaptive management or remedial measures to the TAT, the DFEIR does not establish a

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[46] *Ibid.*
[47] *Ibid.*
[48] DFEIR, p. 3.5-57.
[49] Revegetation Plan, p. 8.
[50] *Ibid.*
[51] DFEIR, p. 3.5-49.

mechanism that gives the TAT authority to enforce those actions.

Sincerely,

Scott Cashen, M.S.
Senior Biologist

Scott Cashen, M.S.

Senior Biologist / Forest Ecologist

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Scott Cashen has 20 years of professional experience in natural resources management. During that time he has worked as a field biologist, forester, environmental consultant, and instructor of Wildlife Management. Mr. Cashen currently operates an independent consulting business that focuses on CEQA/NEPA compliance issues, endangered species, scientific field studies, and other topics that require a high level of scientific expertise.

Mr. Cashen has knowledge and experience with many taxa, biological resource issues, and environmental regulations. This knowledge and experience has made him a highly sought after biological resources expert. To date, he has been retained as a biological resources expert for over 40 projects. Mr. Cashen's role in this capacity has encompassed all stages of the environmental review process, from initial document review through litigation support and expert witness testimony.

Mr. Cashen is a recognized expert on the environmental impacts of renewable energy development. He has been involved in the environmental review process for 28 renewable energy projects, and he has been a biological resources expert for more of California's solar energy projects than any other private consultant. In 2010, Mr. Cashen testified on 5 of the Department of the Interior's "Top 6 Fast-tracked Solar Projects" and his testimony influenced the outcome of each of these projects.

Mr. Cashen is a versatile scientist capable of addressing numerous aspects of natural resource management simultaneously. Because of Mr. Cashen's expertise in both forestry and biology, Calfire had him prepare the biological resource assessments for all of its fuels treatment projects in Riverside and San Diego Counties following the 2003 Cedar Fire. Mr. Cashen has led field studies on several special-status species, including plants, fish, reptiles, amphibians, birds, and mammals. Mr. Cashen has been the technical editor of several resource management documents, and his strong scientific writing skills have enabled him to secure grant funding for several clients.

AREAS OF EXPERTISE

- CEQA, NEPA, and Endangered Species Act compliance issues
- Comprehensive biological resource assessments
- Endangered species management
- Renewable energy
- Forest fuels reduction and timber harvesting
- Scientific field studies, grant writing and technical editing

EDUCATION

M.S. Wildlife and Fisheries Science - The Pennsylvania State University (1998)
B.S. Resource Management - The University of California, Berkeley (1992)

PROFESSIONAL EXPERIENCE

Litigation Support / Expert Witness

As a biological resources expert, Mr. Cashen reviews CEQA/NEPA documents and provides his client(s) with an assessment of biological resource issues. He then prepares written comments on the scientific and legal adequacy of the project's environmental documents (e.g., EIR). For projects requiring California Energy Commission (CEC) approval, Mr. Cashen has submitted written testimony (opening and rebuttal) in conjunction with oral testimony before the CEC.

Mr. Cashen can lead field studies to generate evidence for legal testimony, and he can incorporate testimony from his deep network of species-specific experts. Mr. Cashen's clients have included law firms, non-profit organizations, and citizen groups.

REPRESENTATIVE EXPERIENCE

Solar Energy Facilities

- Abengoa Mojave Solar Project
- Avenal Energy Power Plant
- Beacon Solar Energy Project
- Blythe Solar Power Project
- Calico Solar Project
- Calipatria Solar Farm II
- Carrizo Energy Solar Farm
- Catalina Renewable Energy Project
- Fink Road Solar Farm
- Genesis Solar Energy Project
- Heber Solar Energy Facility
- Imperial Valley Solar Project
- Ivanpah Solar Electric Generating
- Maricopa Sun Solar Complex
- Mt. Signal and Calexico Solar
- San Joaquin Solar I & II
- Solar Gen II Projects
- SR Solis Oro Loma
- Vestal Solar Facilities
- Victorville 2 Power Project

Geothermal Energy Facilities

- East Brawley Geothermal
- Mammoth Pacific 1 Replacement
- Western GeoPower Plant and

Wind Energy Facilities

- Catalina Renewable Energy Project
- Ocotillo Express Wind Energy
- San Diego County Wind Ordinance
- Tres Vaqueros Repowering Project
- Vasco Winds Relicensing Project

Biomass Facilities

- Tracy Green Energy Project

Development Projects

- Alves Ranch
- Aviano
- Chula Vista Bayfront Master Plan
- Columbus Salame
- Concord Naval Weapons Station
- Faria Annexation
- Live Oak Master Plan
- Napa Pipe
- Roddy Ranch
- Rollingwood
- Sprint-Nextel Tower

Project Management

Mr. Cashen has managed several large-scale wildlife, forestry, and natural resource management projects. Many of these projects have required hiring and training field crews, coordinating with other professionals, and communicating with project stakeholders. Mr. Cashen's experience in study design, data collection, and scientific writing make him an effective project manager, and his background in several different natural resource disciplines enable him to address the many facets of contemporary land management in a cost-effective manner.

REPRESENTATIVE EXPERIENCE

Wildlife Studies

- Peninsular Bighorn Sheep Resource Use and Behavior Study: (*CA State Parks*)
- "KV" Spotted Owl and Northern Goshawk Inventory: (*USFS, Plumas NF*)
- Amphibian Inventory Project: (*USFS, Plumas NF*)
- San Mateo Creek Steelhead Restoration Project: (*Trout Unlimited and CA Coastal Conservancy, Orange County*)
- Delta Meadows State Park Special-status Species Inventory: (*CA State Parks, Locke*)

Natural Resources Management

- Mather Lake Resource Management Study and Plan – (*Sacramento County*)
- Placer County Vernal Pool Study – (*Placer County*)
- Weidemann Ranch Mitigation Project – (*Toll Brothers, Inc., San Ramon*)
- Ion Communities Biological Resource Assessments – (*Ion Communities, Riverside and San Bernardino Counties*)
- Del Rio Hills Biological Resource Assessment – (*The Wyro Company, Rio Vista*)

Forestry

- Forest Health Improvement Projects – (*CalFire, SD and Riverside Counties*)
- San Diego Bark Beetle Tree Removal Project – (*SDG&E, San Diego Co.*)
- San Diego Bark Beetle Tree Removal Project – (*San Diego County/NRCS*)
- Hillslope Monitoring Project – (*CalFire, throughout California*)

Biological Resources

Mr. Cashen has a diverse background with biological resources. He has conducted comprehensive biological resource assessments, habitat evaluations, species inventories, and scientific peer review. Mr. Cashen has led investigations on several special-status species, including ones focusing on the foothill yellow-legged frog, mountain yellow-legged frog, desert tortoise, steelhead, burrowing owl, California spotted owl, northern goshawk, willow flycatcher, Peninsular bighorn sheep, red panda, and forest carnivores.

REPRESENTATIVE EXPERIENCE

Avian

- Study design and Lead Investigator - Delta Meadows State Park Special-Status Species Inventory *(CA State Parks: Locke)*
- Study design and lead bird surveyor - Placer County Vernal Pool Study *(Placer County: throughout Placer County)*
- Surveyor - Willow flycatcher habitat mapping *(USFS: Plumas NF)*
- Independent surveyor - Tolay Creek, Cullinan Ranch, and Guadacanal Village restoration projects *(Ducks Unlimited/USGS: San Pablo Bay)*
- Study design and Lead Investigator - Bird use of restored wetlands research *(Pennsylvania Game Commission: throughout Pennsylvania)*
- Study design and surveyor - Baseline inventory of bird species at a 400-acre site in Napa County *(HCV Associates: Napa)*
- Surveyor - Baseline inventory of bird abundance following diesel spill *(LFR Levine-Fricke: Suisun Bay)*
- Study design and lead bird surveyor - Green Valley Creek Riparian Restoration Site *(City of Fairfield: Fairfield, CA)*
- Surveyor - Burrowing owl relocation and monitoring *(US Navy: Dixon, CA)*
- Surveyor - Pre-construction raptor and burrowing owl surveys *(various clients and locations)*
- Surveyor - Backcountry bird inventory *(National Park Service: Eagle, Alaska)*
- Lead surveyor - Tidal salt marsh bird surveys (*Point Reyes Bird Observatory: throughout Bay Area*)
- Surveyor – Pre-construction surveys for nesting birds (*various clients and locations)*

Amphibian

- Crew Leader - Red-legged frog, foothill yellow-legged frog, and mountain yellow-legged frog surveys *(USFS: Plumas NF)*

- Surveyor - Foothill yellow-legged frog surveys *(PG&E: North Fork Feather River)*
- Surveyor - Mountain yellow-legged frog surveys *(El Dorado Irrigation District: Desolation Wilderness)*
- Crew Leader - Bullfrog eradication *(Trout Unlimited: Cleveland NF)*

Fish and Aquatic Resources

- Surveyor - Hardhead minnow and other fish surveys *(USFS: Plumas NF)*
- Surveyor - Weber Creek aquatic habitat mapping (*El Dorado Irrigation District: Placerville, CA*)
- Surveyor - Green Valley Creek aquatic habitat mapping *(City of Fairfield: Fairfield, CA)*
- GPS Specialist - Salmonid spawning habitat mapping *(CDFG: Sacramento River)*
- Surveyor - Fish composition and abundance study (*PG&E: Upper North Fork Feather River and Lake Almanor*)
- Crew Leader - Surveys of steelhead abundance and habitat use *(CA Coastal Conservancy: Gualala River estuary)*
- Crew Leader - Exotic species identification and eradication *(Trout Unlimited: Cleveland NF)*

Mammals

- Principal Investigator – Peninsular bighorn sheep resource use and behavior study (*California State Parks: Freeman Properties*)
- Scientific Advisor –Study on red panda occupancy and abundance in eastern Nepal *(The Red Panda Network: CA and Nepal)*
- Surveyor - Forest carnivore surveys *(University of CA: Tahoe NF)*
- Surveyor - Relocation and monitoring of salt marsh harvest mice and other small mammals *(US Navy: Skagg's Island, CA)*
- Surveyor – Surveys for Monterey dusky-footed woodrat. Relocation of woodrat houses (*Touré Associates: Prunedale*)

Natural Resource Investigations / Multiple Species Studies

- Scientific Review Team Member – Member of the science review team assessing the effectiveness of the US Forest Service's implementation of the Herger-Feinstein Quincy Library Group Act.
- Lead Consultant - Baseline biological resource assessments and habitat mapping for CDF management units *(CDF: San Diego, San Bernardino, and Riverside Counties)*

- Biological Resources Expert – Peer review of CEQA/NEPA documents (*Adams Broadwell Joseph & Cardoza: California)*
- Lead Consultant - Pre- and post-harvest biological resource assessments of tree removal sites *(SDG&E: San Diego County)*
- Crew Leader - T&E species habitat evaluations for Biological Assessment in support of a steelhead restoration plan *(Trout Unlimited: Cleveland NF)*
- Lead Investigator - Resource Management Study and Plan for Mather Lake Regional Park *(County of Sacramento: Sacramento, CA)*
- Lead Investigator - Biological Resources Assessment for 1,070-acre Alfaro Ranch property *(Yuba County, CA)*
- Lead Investigator - Wildlife Strike Hazard Management Plan *(HCV Associates: Napa)*
- Lead Investigator - Del Rio Hills Biological Resource Assessment *(The Wyro Company: Rio Vista, CA)*
- Lead Investigator – Ion Communities project sites (*Ion Communities: Riverside and San Bernardino Counties*)
- Surveyor – Tahoe Pilot Project: Validation of California's Wildlife Habitat Relationships (CWHR) Model *(University of California: Tahoe NF)*

Forestry

Mr. Cashen has five years of experience working as a consulting forester on projects throughout California. Mr. Cashen has consulted with landowners and timber operators on forest management practices; and he has worked on a variety of forestry tasks including selective tree marking, forest inventory, harvest layout, erosion control, and supervision of logging operations. Mr. Cashen's experience with many different natural resources enable him to provide a holistic approach to forest management, rather than just management of timber resources.

REPRESENTATIVE EXPERIENCE

- Lead Consultant - CalFire fuels treatment projects *(SD and Riverside Counties)*
- Lead Consultant and supervisor of harvest activities – San Diego Gas and Electric Bark Beetle Tree Removal Project *(San Diego)*
- Crew Leader - Hillslope Monitoring Program *(CalFire: throughout California)*
- Consulting Forester – Forest inventories and timber harvest projects *(various clients throughout California)*

Grant Writing and Technical Editing

Mr. Cashen has prepared and submitted over 50 proposals and grant applications. Many of the projects listed herein were acquired through proposals he wrote. Mr. Cashen's clients and colleagues have recognized his strong scientific writing skills and ability to generate technically superior proposal packages. Consequently, he routinely prepares funding applications and conducts technical editing for various clients.

PERMITS

U.S. Fish and Wildlife Service Section 10(a)(1)(A) Recovery Permit for the Peninsular bighorn sheep

CA Department of Fish and Game Scientific Collecting Permit

PROFESSIONAL ORGANIZATIONS / ASSOCIATIONS

The Wildlife Society (Conservation Affairs Committee member)

Cal Alumni Foresters

Mt. Diablo Audubon Society

OTHER AFFILIATIONS

Scientific Advisor and Grant Writer – *The Red Panda Network*

Scientific Advisor – *Mt. Diablo Audubon Society*

Grant Writer – *American Conservation Experience*

Scientific Advisor and Land Committee Member – *Save Mt. Diablo*

TEACHING EXPERIENCE

Instructor: Wildlife Management - The Pennsylvania State University, 1998

Teaching Assistant: Ornithology - The Pennsylvania State University, 1996-1997

Attachment A

Western Bat Working Group
http://www.wbwg.org

Species Accounts
Developed For the 1998 Reno Biennial Meeting
Updated at the 2005 Portland Biennial Meeting

Macrotus californicus
CALIFORNIA LEAF-NOSED BAT

Prepared by: Patricia E. Brown

I. DISTRIBUTION: *Macrotus californicus* is the most northerly representative of the Phyllostomidae (a predominantly Neotropical family). It occurs in the Lower Sonoran life zone in the deserts of California, southern Nevada, Arizona and south into Baja California and Sonora, Mexico.

II. STATUS: Global Rank - G4. State Ranks: AZ - S3S4; CA - S2S3; NV - S?; UT - SP. It is is included in Arizona Game and Fish Department's Wildlife of Special Concern in Arizona, and listed as a Mammal of Special Concern in California. It is a former Category 2 (C2) candidate.

III. IDENTIFYING CHARACTERISTICS AND LIFE HISTORY: *M. californicus* can be distinguished from all other western bat species by a combination of large ears (>25 mm), grey pelage and a distinct leaflike projection from tip of the nose. Its tail extends slightly beyond the tip of the interfemoral membrane. This species neither hibernates nor migrates, and it is incapable of lowering its body temperature to become torpid. It has a relatively narrow thermal-neutral zone, with the lower critical temperature near 34°C and the upper near 37°C . No special physiological adaptations occur in Macrotus for desert existence, and behavioral adaptations such as foraging methods and roost selection contribute to their successful exploitation of the temperate zone desert. Although longevity in this species does not approach the 30 or more years of temperate zone vespertilionid bats, banded *Macrotus* in California have been recaptured after 14 years.

Macrotus feeds primarily on moths and immobile diurnal insects such as butterflies and katydids which it locates by vision, even at low ambient light levels. The culled, inedible remains of these prey items can be found beneath night roosts. In total darkness, *Macrotus* utilizes echolocation, an energetically more costly method of sensory localization. The strategy of gleaning larger prey from the substrate as compared to aerial insectivory appears to reduce the total time and energy necessary for foraging. Radio-telemetry studies of *Macrotus* in the California desert show that the bats forage almost exclusively among desert wash vegetation within 10 km of their roost. The bats emerge from their roosts 30 or more minutes after sunset, and fly near the ground or vegetation in slow, maneuverable flight. Shallow caves and short mine prospects are used by both sexes as night roosts between foraging bouts at all seasons, except for the coldest winter months.

To remain active yearlong in the temperate deserts of California, Arizona and Southern Nevada, *Macrotus* uses warm diurnal roosts in caves, mines and buildings with temperatures that often exceed 28°C. Depending on the season, they roost singly or in groups of up to several hundred individuals, hanging separately from the ceiling, rather than clustering. Often the bats hang from one foot, using the other to scratch or groom themselves. Most diurnal winter roosts are in warm mine tunnels at least 100 meters long. At this season, the large colonies of over 1000 bats may contain both males and females, although the sexes may also roost separately. The consistent feature of the areas in the mines used by the bats is warmth and high humidity with no circulating air currents. The temperature of the mines is usually warmer than the annual mean temperature, and the mines appear to be located in geothermally-heated rock formations. Except for the approximately two hour-nightly foraging period, in winter *Macrotus* inhabits a stable warm environment.

Females congregate in large (~100-200 bats) maternity colonies in the spring and summer, utilizing different mines or areas within a mine separate from those occupied in the winter. A few males are found in these colonies, although large roosts of only males also form. Apparently, the males in the maternity colonies try to maintain separate harem groups of females. The single young is born between mid-May and early July, following a gestation of almost 9 months. This species exhibits "delayed development" following ovulation, insemination and fertilization in September. In March, with increased temperatures and insect availability, embryonic development accelerates. Since the newborn bats are poikilothermic, the maternity colony is located fairly close to the entrance, where temperatures exceed 30°C and daytime outside temperatures can reach 50°C in the summer. This allows the bats to use shallow natural rock caves that would be too cold for a winter roost. In the fall, the males attempt to attract females with a courtship display consisting of wing-flapping and vocalizations. Aggression between males occurs at this time. The mines used as "lek" sites are usually in or near a mine that had been occupied by a maternity colony.

IV. THREATS: Human entry into mine or cave roosts and closure of mines for hazard abatement and renewed mining are the primary threats to *Macrotus*. Loss of desert riparian habitat (as in the development of golf courses and housing areas in the Coachella Valley) are also responsible for population declines.

V. GAPS IN KNOWLEDGE: Identifying mines used as roosts (maternity, winter and courtship) within the range of *Macrotus*, establishing the effectiveness of different bat gate designs, and determining the distance at which exploratory drilling and blasting in renewed mining activities causes impacts to roosting bats.

VI. SELECTED LITERATURE:

Anderson, S. 1969. *Macrotus waterhousii*. American Society of Mammalogists, Mammalian Species, 1:1-4.

Barbour, R. W. & Davis, W. H. 1969. Bats of America. Lexington, Ky: University of Kentucky Press.

Bell, G. P. 1985. The sensory basis of prey location by the California leaf-nosed bat *Macrotus californicus* (Chiroptera: Phyllostomidae). Behavioral Ecology and Sociobiology 16: 343-347.

Bell, G. P., G.A. Bartholomew, and K.A. Nagy. 1986. The roles of energetics, water economy, foraging behavior, and geothermal refugia in the distribution of the bat, *Macrotus californicus*. Journal of Comparative Physiology B 156: 441-450.

Berry, R.D. and P.E. Brown. 1995. [ABS]. Natural history and reproductive behavior of the California leaf-nosed bat (*Macrotus californicus*). Bat Research News 36(4): 49-50.

Brown, P. E., R. D. Berry, and C. Brown. 1993. [ABS].Foraging behavior of the California leaf-nosed bat, *Macrotus californicus* as determined by radiotelemetry. Bat Research News 34(4):104.

Brown, P. E., Berry, R. D. & Brown, C. 1995. The California leaf-nosed bat (*Macrotus californicus*) and American Girl Mining joint venture - impacts and solutions. Pp. 54-56 in Proceedings VI:Issues and technology in the management of impacted wildlife. Thorne Ecological Institute, Boulder, CO.

Hoffmeister, D. F. 1986. The mammals of Arizona. University of Arizona Press, Tucson, AZ. 602 pp.

More bat species accounts available at: http://www.wbwg.org/species_accounts

Attachment B

Trends in Common Raven Populations in the Mojave and Sonoran Deserts: 1968-2004

By

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Draft Report to
U.S. Fish and Wildlife Service
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Contract No: 814405M055

June 12, 2006

Executive Summary.—Predation by common ravens (*Corvus corax*) on juvenile desert tortoises (*Gopherus agassizii*), a threatened species in the deserts of the southwest United States, is one factor preventing the recovery of tortoise populations. The U.S. Fish and Wildlife Service (USFWS) and other agencies are embarking on efforts to reduce the effects of ravens on tortoise populations. To better understand raven population dynamics and the current level of threat ravens pose to tortoise populations, it is important characterize recent population trends in raven populations within tortoise range. Since 1968, the Breeding Bird Survey, managed by the USFWS and U.S. Geological Survey (USGS), have been collecting data on bird abundance throughout the United States, including in the deserts of the southwest. We performed an extensive analysis of those data to determine identify spatial and temporal variation in raven populations in the Mojave and Sonoran Deserts. We divided the deserts into four subregios: West Mojave, East Mojave, Colorado, and Sonoran Deserts and evaluated for trends among and within the subregions as well as evaluating more small-scale variation within subregions.

Subregions varied in raven abundance, dispersion, and population growth rates. Ravens were in the greatest abundance in the West Mojave Desert and were most widely dispersed throughout the area. The Sonoran and Colorado Deserts had the lowest numbers and the birds were more narrowly distributed. East Mojave raven numbers and distribution were intermediate but still relatively low. The West Mojave raven population has been increasing, perhaps at rates as high as 6% per year (795% over 37 years). The growth rate of the Sonoran Desert raven population is probably higher (1377%), but their overall abundance is much lower and they are not spreading nearly as much into the desert. Even within subregions, there is considerable variation. All of these differences likely reflect spatial variation in anthropogenic resources, to which ravens are tightly linked, and recent historical differences in colonization and distribution of ravens. Inconsistencies in coverage of BBS methods, particularly year-to-year coverage of routes, and high annual variation in raven abundance and number of stops with ravens make it difficult to track raven trends below the regional level using BBS data. These results suggest that management priorities could vary among subregions. The high numbers coupled with high dispersion of ravens in the West Mojave supports aggressive management at the local and regional scales. Whereas, areas with lower levels of dispersion (e.g., Sonoran and East Mojave Deserts) could probably benefit most by local-level management targeted at birds known to be preying on tortoises or areas where such predation might be particularly critical to tortoise recovery, and reducing raven use of specific human development sites. We recommend that long-term monitoring of raven populations associated with raven management programs not rely solely on BBS data. Rather, a combination of more frequent targeted surveys, nest use surveys, and indices of predation pressure would yield more reliable and useful results. Research comparing raven population dynamics in different subregions of the desert could yield important insights into how human activities facilitate the spread and growth of raven populations.

INTRODUCTION

The management of native predator species is fast becoming a more common tool for aiding the recovery of threatened and endangered animal populations. Subsidized predator populations, those that subsist and sometimes increase due to resource subsidies provided by humans (Soule et al. 1988), are an especially common cause for such actions. Resource managers need to know recent trends in subsidized predator population levels to determine the level of threat posed by the population, to identify appropriate management actions, and to monitor for the effects of predator management.

In the western United States, common ravens (*Corvus corax*) are one such subsidized predator that subsists on human effluence while also preying on threatened desert tortoises (*Gopherus agassizii*; Boarman 2003). In the Mojave Desert, they feed on refuse, drink irrigation water, nest on power towers, and roost in shade structures. Their use of human resource subsidies increases fledgling success and juvenile survivorship (Kristan et al. 2003, Webb et al. 2004). Hyperpredation and spillover predation are two processes by which predator populations, sustained by abundant food, prey on rare species. The elevated predator numbers, facilitated by human-provided subsidies, place increased predation pressure on desert tortoise populations near and away from human habitations (Kristan and Boarman 2003).

Raven population reduction is now the focus of management efforts to reduce their effects on desert tortoises and other threatened and endangered prey populations (Boarman 2003, U.S. Fish and Wildlife Service [USFWS] in prep.). Current efforts in California are focused on reducing the availability of human subsidized resources to help reduce the number of ravens that survive each year, thereby lowering the number of ravens that may prey on desert tortoises. These actions are predicated on the notion that raven population increases in recent years (Boarman and Berry 1995, Boarman 2003) have led to increased predation pressure on desert tortoises. A portion of the proposed management efforts includes the lethal removal of birds known to prey on tortoises. The USFWS requires that lethal removals not threaten the persistence of raven populations.

Regional raven populations have not been evaluated since 1995. At that time Boarman and Berry (1995) demonstrated that raven abundance increased in the Mojave and Colorado Deserts by over 1000% between 1968 and 1992. We report herein on an updated analysis of Breeding Bird Survey (BBS) data to provide the information necessary to complete plans and monitor the effectiveness of a proposed management program to reduce raven predation on desert tortoises in the Mojave and Colorado deserts of California. We report on a new and more in-depth analysis of 37 years of BBS data (1968-2004). We investigated how average raven numbers, distribution (measured by number of stops on which ravens were found), and annual trends in those numbers differed by subregions of the desert tortoise's range, and whether trends within subregions varied fundamentally at the local, route level.

METHODS

The BBS, originally started by the USFWS but now managed by U.S. Geological Survey, consists of approximately 2900 transects throughout the United States and Canada (http://www.mbr-pwrc.usgs.gov/bbs/genintro.html). Surveyed once each spring (if possible) by well qualified volunteers, each route follows a road 24.5 miles long. Stops are made every 0.5 mile where three-minute point counts are taken of all bird species seen or heard within 0.25 mile of the stop.

The BBS groups their routes into 99 physiographic strata, which represent a combination of physiographic and vegetation characteristics of the area (Robbins et al. 1986). We used all routes for the Mojave and Sonoran Desert strata as identified by the BBS (Fig. 1). We were interested in a finer-scale subregional grouping, specifically West Mojave, East Mojave, Colorado, and Sonoran Deserts, but BBS did not make these distinctions. We coded the data by subregion as follows. All Sonoran Desert routes were coded as Colorado Desert if they were in California and Sonoran Desert if they were in Arizona (Table 1, Fig. 1, Appendix A). In the Mojave Desert, we used a map of desert tortoise recovery units to identify whether a route occurred in West or East Mojave (Tracy et al. 2004). Because of the relatively small number of routes, we did not partition East Mojave into smaller subunits (e.g., northeast Mojave, etc.).

Statistical Analyses.— For overall annual trends, we used two methods: the route-regression models, developed by the BBS office (http://www.mbr-pwrc.usgs.gov/bbs/trendin.html), and linear regression (which we will refer to as "linear models" hereafter). Route regression is a method specifically developed for BBS data analysis and is considered the technique most appropriate for the data. However, it is generally applied to large regions and requires a greater number of routes than were available for it to be applied rigorously to a sub-regional analysis. In contrast, linear models (such as regression, ANOVA, and ANCOVA) are simpler, but do not explicitly account for all of the complexities of BBS data, including the complication of spatial and temporal autocorrelation. To determine the relative contributions of individual routes, regions, and subregions to raven population patterns, we generated a series of ANOVA and ANCOVA models using total number of ravens per route and total number of stops with ravens per route as the dependent variables. Given that neither approach could be applied without qualification to this data set, we employed both techniques, but consider the results to be valuable primarily as a guide to additional, more intensive study.

For all linear models we set alpha at 0.05, but used extreme caution when interpreting the results because of low homoscedasticity. Transformations did not improve the situation, so we present here the results from non-transformed data to make the interpretation more straightforward. We therefore refer to all results as trends, even when the probability level was below alpha.

Effect of Subregion—To test if subregions differed in overall raven numbers counted on surveys, we conducted one-way ANOVAs on the mean number of ravens counted per route and the mean number of stops per route on which ravens were observed, with routes categorized by subregion (West Mojave, East Mojave, Sonoran, and Colorado deserts).

We summarized the differences among subregions by classifying routes as having either "high" or "low" numbers of ravens and numbers of stops with raven detections. As a cutoff, we chose the number that most closely divided the routes into equal groups, which for number of stops was ≤ 3, and for number of ravens was ≤ 5. The proportion of routes in each subregion that had a "high" number of stops with raven detections and total ravens detected was then tabulated.

Effect of Year (Annual Population Trends).—We tested for region-wide population trends using two methods. The route-regression models, developed by the BBS office, were generated for various year spans beginning with 1968 (18, 12, 9, 7, 6, 5, 4, 3, and 2). The BBS office (http://www.mbr-pwrc.usgs.gov/bbs/trendin.html) recommends a minimum of 14 data points (i.e., routes) to obtain a statistically significant result. Unfortunately, this was rarely obtained for the Mojave and Sonoran desert strata separately. Therefore, with one exception, we were forced to consider the results from analyses consisting of a suboptimal sample size, so the results are tenuous. We also conducted a linear regression to test for the effect of year on relative abundance estimates.

Effect of Route.— Human-subsidized resources are thought to influence raven population increases; human developments are patchily distributed throughout the desert southwest. Ravens may also decrease locally if the availability of these subsidies decreases due to land use changes. We expect that new populations of ravens will be established by spreading out from already established areas. Consequently, as ravens expand through the desert, we expect that proximity to and distribution of human-subsidized resources that benefit ravens will influence their abundances in a site-specific way, and raven abundance among routes are expected to vary substantially within a subregion. The relative strength of variation among subregions compared to among routes within subregions, can shed light on whether raven population management can be effective at the subregion level or it should only be implemented at the regional level. To determine at what scale the greatest amount of variation occured, we considered routes separately and nested routes within subregions in an ANOVA to measure the relative variation in raven numbers among routes within subregions, and among subregions.

Combined Effects.—We tested whether considering each route individually explained the data better than the one that treated routes within subregions collectively. We also allowed the regression line for counts at each route over time to have a different slope by allowing year and route to interact, but removed subregion from the model. This model therefore allowed every route to have a different change over time, which would be necessary if routes within subregions did not exhibit similar patterns of change. Routes with fewer than 5 years of surveys were removed for this analysis to reduce the chances of spurious results from small numbers of observations.

Models that allowed change in raven numbers to differ between subregions could represent a case in which the same rate of change in raven numbers occurred among subregions but with different overall abundances (subregion and year without an interaction), or a case in which different rates of change occurred for each subregion (region, year, and the interaction between them). However, these models did not account for the smaller-scaled, site-specific variability among routes. For example, if ravens have been colonizing different areas over time, then the process of colonization and population growth may have different starting dates for each route. Including route as a factor in the model would represent this process by allowing a series of parallel lines (one for each route) with different intercepts to be fit to the data. To test for this, we analyzed a model that took route-level variation into account by including year, subregion, and route nested within subregion.

Finally to better understand patterns within subregions, we split the data into different subregions, and examined differences among routes under the assumption that they all exhibited the same rates of change, but with different starting dates (that is, we included year and route with no interaction). Although subsetting the data has the disadvantage of reducing the sample size, the model structure is simplified, and easier to interpret.

RESULTS

Effect of Subregion.—We conducted a one-way ANOVA of total ravens per route by subregion (West Mojave, East Mojave, Sonoran Desert, Colorado Desert) (Table 2). Routes in the West Mojave on average had more than twice the number of ravens than the next closest subregion (East Mojave), and nearly three times as many as Sonoran Desert over the 37-year study period. Similarly, ravens were observed at twice as many stops within routes in the West Mojave than the East Mojave, and nearly three times as many stops in the West Mojave than in the Sonoran and Colorado Deserts.

When we classified routes as having either "high" or "low" numbers of ravens, or numbers of stops with raven detections, a similar pattern emerged (Table 3). More routes had high numbers of ravens in the West Mojave followed by the East Mojave, Sonoran, and Colorado. Similarly, more stops on routes with ravens were found in the West Mojave than East Mojave, fewer still in the Sonoran, with the lowest level of distribution being in the Colorado Desert.

Effect of Year (Annual Population Trends).—The route-regression method yielded few significant results (although the sample sizes were almost always too low; n = 7-10). In the Mojave and Sonoran Deserts combined, there was a significant increase in relative raven abundance of 1.9% per year ($p = 0.0003$, $n = 56$) over the 37-year period, which is equivalent to a 21% increase over 10 years, and 100% increase over the 37 years. In the Mojave, there tended to be an increase of 14-42% per year in the late 1970s followed by a decrease of 13-18% per year somewhere between 1999 and 2004 (probably between 2001 and 2002), but the sample sizes were too low to yield any certainty (n = 6-10), and the routes often varied from year to year. The routes containing fewer ravens were generally recorded more in later years (Table 1, Appendix B, C).

The linear regression method revealed a small, negative change in total ravens over time (Table 4). The tiny R^2 (<0.01) suggests that, although statistically significant, the pattern is very slight. The number of stops with ravens did not significantly change over time ($F_{1, 480} = 0.63$, p = 0.426).

Effect of Route.--Subregions had a much larger F-value than did routes within a subregion, indicating that although there was significant variation in number of ravens among routes within a subregion, large differences among subregions were also present (Table 5a, Fig. 1). The West Mojave had a greater abundance of ravens overall, although not all routes had large raven numbers (Appendix B). Similarly, the West Mojave has more stops with ravens than the other subregions, even when variability among routes is addressed (Table 5b, Fig. 2, Appendix C).

Combined Effects.— The model consisting of route, year, and their interaction was significant for all three effects (Table 6). The site-specificity of changes in raven abundance can be seen by the wide range in slopes among routes (Appendix B), from a 2 raven per year increase for Lenwood to a 0.74 raven per year decrease for Tecopa. The total number of ravens increased significantly in the entire study area over time, by 0.4 ravens per year, which was an increase of approximately 4.3% per year, or 375% over 37 years (Table 7). When variability in the timing of increases is accounted for by including route in the model (nested within subregion), the differential in predicted number of ravens in the West Mojave becomes even greater than the East Mojave. A similar pattern was seen in the number of stops with ravens. There was a significant increase in raven numbers over time, at a rate of 0.2 more stops per year, or approximately 3.8% per year, or 297% over 37 years. Although the model that allowed each route to have a different slope had the greatest R^2 (0.66, Table 6), the large R^2 of this model (0.55) was also high, indicating that substantial similarities in patterns of increase among routes within subregions. In a separate model, there was no significant change over time in total number of ravens (effect test for year: t = 0.14, p = 0.88) or number of stops with ravens (effect test for year: t = 1.91, p = 0.057) when only subregion is taken into account. None of the interactions was significant.

When analyzing the effects of year and route within each subregion separately, all models were significant (p< 0.05) with the exception of number of ravens in the Colorado Desert (p > 0.10). West Mojave showed the most rapid absolute increases in ravens and number of stops, the other subregions showed less increases in raven numbers (Table 8). The West Mojave also showed a high increase in number of stops with ravens, which was intermediate in the East Mojave and Colorado Deserts and negligible in the Sonoran Deserts.

DISCUSSION

Differences in rates and timings of spread of ravens among subregions, and among routes within subregions, can both help identify areas that have the greatest raven populations, and can help identify potential natural limiting factors for raven population growth. Breeding bird survey data were used for this analysis simply because they are the only data available that provide the needed information to address these questions. However, caution must be used when interpreting the results of BBS data, as there are many known sources of uncontrolled variation within the data set. For example, there is high variation among years along each route, and considerable inconsistency among years in which transects are surveyed. Also, observer bias is frequently a significant factor, and most BBS analyses go to great lengths to control for observer bias. Not only is there variation among individuals in their ability to see (or hear), identify, and count species, but a marked year-to-year improvement in individuals' abilities. As suggested to us by Bruce Perterjohn (USGS BBS Office, pers. comm.), we believe this not an issue for raven surveys because they are large, highly visible birds in the open desert environment, and, being the only large black bird in the area, cannot be confused with any other species.

BBS experts recommend that a minimum of 14 routes are necessary to yield valid estimates of changes in bird population sizes, which, if followed, would limit use of BBS data to regional analyses. Route regression approaches were designed specifically for use with BBS data, and are able to account for many of the known sources of error provided that sufficient data are available. Traditional linear models are simpler in structure, and by omitting parameters that control for various sources of error in the BBS, they can be applied to smaller data sets. When sample sizes permit their use, route regressions are superior analytical methods for BBS data compared to traditional linear models. We had the additional difficulty that the residuals from the regression analyses showed that we violated the homogeneity of variance assumption, and transformations failed to fix the problem. Although the BBS is the only data set currently available to address whether the rates and timings of raven increases have differed among subregions, if we strictly adhered to standard statistical criteria we would be unable to use these data. We present the results of this analysis with the caveat that the patterns uncovered should be considered to be suggestive but not confirmatory, as an encouragement to conducting more reliable research to explain the subregional differences we detected. In other words, these results should be viewed as hypotheses requiring further investigation before being accepted as fact.

Subregional differences.—The total number and distribution of ravens varied by subregion. Routes in the West Mojave had two to three times the number of ravens as the other subregions. The West Mojave also had the greatest number of stops with ravens, which shows that ravens are not only more abundant where they occur, but they are more evenly distributed spatially within the West Mojave than in other subregions. Colorado Desert sites had the fewest ravens and the fewest stops with ravens, suggesting that comparisons between Colorado Desert and West Mojave Desert raven populations might be fruitful for understanding potential limiting factors for rave n populations.

Change over time.—The change in raven populations over time depended strongly on which analysis we used, because of the peculiarities of the data set. According to the BBS's route regression method, raven populations increased nearly 2% per year in the Mojave and Sonoran Deserts combined over the 37-year study period. We were unable to reduce this trend with statistical certainty to specific regions or time frames, but an interesting, non-significant trend emerged: there may have been a leveling off of the increases in the last four years. Unfortunately, the sample sizes (n = 6-10) were too low to yield any certainty. The changes may be caused by different routes surveyed or inconsistencies among years in which routes were surveyed. By analyzing data separately for each subregion, we found increases in raven abundance of 795% (which is equivalent to a 6% annual increase) in the West Mojave, but very little in the East Mojave Desert (Table 8).

One of the dominant patterns in the data is that timing of increases, and rates of change once increases begin, are highly site-specific. Combined with this heterogeneity among the routes and subregions, the uneven coverage of routes over time can lead to some very misleading results. For example, the linear regression method revealed a small, negative change in total ravens over time in the Mojave and Sonoran Deserts combined over the entire 37-year period when differences among routes or subregions were not accounted for (Table 4). The tiny R^2 (<0.01) suggests that, although statistically significant, the pattern is very slight, but even a slight decline would be a very surprising result to desert biologists. However, the apparent decline was due to an increase in later years of the study in relative number of routes surveyed in areas that had few ravens. For example, in recent years routes have been added in the Sonoran Desert, where raven abundance is lower (Tables 2 & 3), and routes have not been surveyed in the West Mojave where abundance is higher (Table 1). Analysis by subregion helps to prevent this change in coverage from producing a spurious regional decrease in raven numbers.

Spread of a population expanding its range into new locations or new habitats can be thought of as a two-stage process, with first a colonization of a new area followed by an increase in abundance. Expansions are contagious, in the sense that new populations will generally be founded by immigrants from existing, nearby populations. We expect under these circumstances for different subregions of the desert to have started this process at different times, and to be in different degrees of completion. Even if the subregions are equally good raven habitat, we may still find subregional differences due to these differences in timing. For example, if the West Mojave has the greatest number of ravens because it was colonized first, then the East Mojave may have fewer ravens simply because it has more recently been colonized. Subregional differences would need to be considered in this case to improve the estimate of rate of change, but would not necessarily imply that subregions with more ravens are better raven habitat. If this were the case, however, we would expect that rates of change among subregions would be the same, or if differences did occur that subregions with more ravens would have lower rates of change if they are reaching carrying capacity. In fact, we found the West Mojave has both the greatest number of ravens and a rapid rate of change in raven numbers and numbers of stops. The East Mojave is also increasing in numbers of stops, but not in numbers of ravens. This may mean either that ravens are spreading through the East Mojave Desert, but have not yet started to rapidly increase in population size, or that ravens can disperse into the area but are not able to increase in abundance. The Colorado Desert had the smallest sample sizes, and thus the relatively rapid increase in abundance observed was not significant. The Sonoran Desert was increasing slowly both in numbers of stops and rapidly in abundance of ravens. This heterogeneity among subregions in the characteristics of their raven expansion suggest that the subregions differ in their suitability for ravens, and it may be fruitful to study raven population dyna mics among subregions to improve our understanding of the reasons for these differences.

We were not able to use linear regression to formally test for a change in direction or intensity of the trends at a particular point in time, in part, because we did not have sufficient data for a purely exploratory analysis, and did not have an *a-priori* hypothesis for when to look for a change in rate. However, the residual plots did not show evidence of nonlinearities which would have led us to suspect that a straight line is a poor representation of the data.

Small-scale, site specific variation.—There was a high level of variation among routes both among and within subregions. The differences among routes were caused by both differences in timing (revealed by the inclusion of "route" as a factor in our models) and differences in rates of change (revealed by the "route x year" interactions). This is not surprising, because the desert is not uniformly high-quality habitat for ravens, and their populations tend to cluster around human developments and the resources they receive from them. Routes that are near anthropogenic sources of food and water are expected to experience rapid raven population growth, whereas more remote routes should generally lack large numbers of ravens, even within the populous West Mojave Subregional differences were still detectable, however, even when this site specificity was accounted for.

Management Recommendations.— Although much of the variation in raven numbers is site-specific, the subregional differences in raven population growth suggests that management needs to focus at both the local and the regional level. Furthermore, ravens are both more numerous and more widely dispersed in the West Mojave than in other subregions, suggesting that anthropogenic resources are also more widely dispersed there. Consequently, the West Mojave subregion may require a broader multi -scale management effort than other subregions where more localized efforts may be sufficient to control raven populations. We recommend that, particularly in the West Mojave Desert, management focus both on localized measures such as targeted removal of known offenders (birds known by evidence to prey on tortoises) and aggressive removal of even relatively minor sources of human-subsidized food and water; and regional methods such as reduction of garbage availability at landfills and perhaps broader removal of birds (Boarman 2003). In the Colorado, Sonoran, and East Mojave Deserts, efforts should be focused more at specific locations where predation is known or suspected of occurring or affecting tortoise recovery. Regional-level management may be wise for all subregions, but may not need to be as aggressive at this point in time for the Sonoran, Colorado, and East Mojave subregions.

Monitoring and Research Recommendations.—We recommend that the BBS surveys not be relied upon solely to determine the effectiveness of or need for raven management in the Mojave and Sonoran Deserts. There is too much variation and too little consistency in coverage of routes. Instead, the best approach would be a multifaceted one with the following components, in roughly descending order of importance:

1. Subregional road surveys;

2. Point counts at selected human subsidized resource sites, randomly selected non-resource sites, and other sites of specific interest to the raven management program;

3. Use of an index of change in predation pressure, such as styrotorts (Styrofoam tortoises; Kristan and Boarman 2003) placed randomly throughout the areas of interest; and

4. Surveys of raven nests and predation activity during the breeding season.

Before developing detailed designs of the surveys, a thorough analysis should be conducted of existing data to determine the optimal timing, best methods, and minimum adequate sample sizes to ensure a cost effective, scientifically credible program is implemented. Some experimentation with styrotorts, or some other index of predation pressure, is warranted to understand the limits of the method and to determine the frequency and timing of deployment. Whereas it is essential to measure the effect of raven management on tortoise populations, such monitoring is costly and difficult to accomplish, due to the challenges of working with juvenile desert tortoises in the wild. We believe this aim can be most practically attained by monitoring predation pressure (Item 3, above) plus evaluating long-term results of line distance sampling being conducted by the Desert Tortoise Recovery Office of the USFWS.

Differences among subregions in the characteristics of their raven population expansions may be in part due to differences in suitability of the subregions for raven habitation. Comparative studies of the population dynamics of ravens in subregions that are experiencing the greatest and least increase in ravens could help focus management actions on the areas that are most at risk of experiencing raven population increases in the future.

Summary.—Common raven populations clearly have increased in the Mojave and Sonoran Deserts over the past 37 years. Subregions vary in raven abundance, dispersion, and population growth rates, with the West Mojave Desert having the most ravens and experiencing the large increases. Even within subregions, there is considerable variation. All of these differences likely reflect spatial variation in anthropogenic resources and recent historical differences in colonization and distribution of ravens. Inconsistencies in coverage of BBS methods, particularly year-to-year coverage of routes, and high annual variation in raven abundance and number of stops with ravens make it difficult to track raven trends below the regional level using BBS data. We recommend that long-term monitoring of raven populations associated with raven management programs not rely solely on BBS data. Rather, a combination of more frequent targeted surveys, nest use surveys, and indices of predation pressure would yield more reliable and useful results.

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Table 1. Official BBS routes included in our analysis, the desert subregion we assigned to each (CD = Colorado Desert, SD = Sonoran Desert, EM = East Mojave Desert, and WM = West Mojave Desert), and the total number of routes surveyed per year. Years each route was surveyed are represented by an 'X.' Refer to Figures A and B for location of each route.

Region	Route	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total years
CD	ANZA BORREGO	X	X	X	X	X	X	X					X																			X		X			X		11
	BLYTHE												X																								X		2
	CADIZ																					X			X														2
	COACHELLA CN						X		X		X									X	X	X												X					7
	COTTONWOOD								X	X				X	X					X	X				X	X	X	X	X	X	X				X		X	X	16
	ESSEX																						X		X		X	X	X										5
	FLYNN																					X	X			X	X	X	X	X									7
	GLAMIS										X																		X										2
	HAVASU LAKE						X					X																									X		3
	IMPERIAL DAM																									X													1
	IRON MTNS																																	X					1
	PARKER DAM						X		X																												X		3
SD	AJO	X								X			X											X					X		X		X	X	X				9
	ALAMO RES.																										X	X	X	X	X	X		X	X	X	X		10
	ARABY																														X				X				2
	BATES WELL																												X								X		2
	CABEZA PRIETA																													X			X				X	X	4
	CASA GRANDE																						X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	15
	CATUS FOREST																								X		X			X	X	X	X	X	X	X		X	10
	CIBOLA LAKE																										X		X				X						3
	COOLIDGE														X		X		X																				3
	CUTTER																									X	X		X	X	X	X	X	X					8

	FLORENCE			X	X	X	X	X	X	X												X																	8
	GILA BEND																												X				X	X			X		4
	HOPE																							X	X	X	X	X		X							X	X	8
	LAGUNA	X																				X																X	3
	LUKEVILLE								X	X		X	X	X	X																								6
	NEW RIVER										X															X	X	X	X	X		X	X	X	X	X	X	X	13
	ORGAN PIPE																							X	X	X		X									X		5
	PALO VERDE																														X		X			X	X		4
	PISINIMO																									X	X												2
	QUARTZSITE															X			X		X	X	X								X				X				7
	RED ROCK																									X	X				X	X	X	X	X				7
	RIVIERA																									X	X			X	X	X					X	X	7
	WIKIEUPP																									X	X	X	X		X	X		X	X	X		X	10
EM	BEATTY																				X	X	X	X	X	X	X	X	X	X	X								11
	CIMA						X				X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X							21
	IVANPAH																						X					X	X	X	X	X	X	X	X	X	X	X	12
	JEAN LAKE									X													X		X	X	X	X	X		X	X	X		X	X			12
	NELSON																																	X					1
	OATMAN																					X				X	X		X	X	X	X	X	X	X			X	11
	SQUAW PEAK	X																																					1
	TECOPA													X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							19
	TRONA										X																		X		X								3
	VAL OF FIRE																		X	X	X	X	X	X	X	X	X	X	X		X			X	X				14
	VALLEY WELLS																						X				X	X	X	X								X	6
	WALKER CAN		X		X	X			X		X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	30
	WILLOW BEACH																						X	X		X	X	X	X	X	X								8
	WLLWLBCH 2																																			X			1
WM	BARSTOW		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	X	X							23
	CALIF CITY										X	X	X	X															X	X	X								7
	FT IRWIN								X			X	X	X	X	X																							6
	GOLDSTONE																			X	X	X			X	X	X	X	X	X	X	X		X	X		X	X	15

INYOKERN									X	X											X	X	X	X	X	X	X	X	X	X	X	X	X		X		16
JOSHUA TREE			X			X	X	X	X	X	X		X	X					X	X	X			X				X	X	X	X	X	X		X			20
LENWOOD								X			X	X	X	X	X	X	X	X							X	X	X	X										13
LUCERNE VAL							X				X										X	X		X	X	X	X	X	X	X	X	X						13
WILLOW SPGS	X	X	X	X	X	X	X	X						X																								9
TOTAL	**5**	**4**	**5**	**4**	**5**	**9**	**6**	**11**	**8**	**10**	**9**	**9**	**10**	**11**	**7**	**6**	**5**	**8**	**9**	**11**	**15**	**15**	**11**	**16**	**23**	**27**	**22**	**31**	**24**	**28**	**20**	**17**	**20**	**17**	**11**	**19**	**14**	**482**

Table 2. One-way ANOVA of total ravens by region (West Mojave, East Mojave, Sonorant Desert, Colorado Desert).

a) Mean number of ravens per route (R^2 = 0.16).

ANOVA

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
region	3	12189.609	4063.20	29.9943	<.0001
Error	478	64752.615	135.47		
C. Total	481	76942.224			

Means for ANOVA

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Sonoran Desert	150	6.1600	0.9503	4.293	8.027
Colorado Desert	60	5.2500	1.5026	2.298	8.202
East Mojave	150	7.3000	0.9503	5.433	9.167
West Mojave	122	17.9508	1.0537	15.880	20.021

b) Mean number of stops per route containing ravens (R^2 = 0.21).

ANOVA

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
region	3	2870.180	956.727	43.1879	<.0001
Error	478	10588.959	22.153		
C. Total	481	13459.139			

Means for ANOVA

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Sonoran Desert	150	3.70000	0.38430	2.9449	4.455
Colorado Desert	60	3.15000	0.60763	1.9560	4.344
East Mojave	150	4.52000	0.38430	3.7649	5.275
West Mojave	122	9.46721	0.42612	8.6299	10.305

Table 3. Differences among subregions when classified as having either "high" or "low" numbers of ravens, or numbers of stops with raven detections.

		Proportion with high:	
Region	N	Ravens	Stops
Sonoran Desert	150	0.41	0.39
Colorado Desert	60	0.37	0.28
East Mojave	150	0.57	0.53
West Mojave	122	0.70	0.72

Table 4. Regression analysis of total ravens per route by year in the Mojave and Sonoran Deserts combined. Model $R^2 < 0.01$.

ANOVA

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	1	622.773	622.773	3.9168	0.0484
Error	480	76319.451	158.999		
C. Total	481	76942.224			

Parameter Estimate

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	249.70549	121.43	2.06	0.0403
Year	-0.120739	0.061007	-1.98	0.0484

Table 5a. One-way ANOVA for total number of ravens with routes treated as main effects and nested within regions to account for the variation among routes that was explained by subregional differences in raven numbers. $R^2 = 0.50$

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	58	7903.553	136.268	10.3754	<.0001
Error	423	5555.586	13.134		
C. Total	481	13459.139			

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Subregion	3	3	2915.5588	73.9965	<.0001
Route[Subregion]	55	55	5033.3728	6.9680	<.0001

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
Sonoran Desert	3.366534	0.35516308	3.70000
Colorado Desert	2.535354	0.66205780	3.15000
East Mojave	4.019767	0.52914755	4.52000
West Mojave	10.044895	0.35951394	9.46721

Table 5b. One-way ANOVA for total number stops per route with ravens with routes treated as main effects and nested within regions to account for the variation among routes that was explained by subregional differences in raven numbers. $R^2 = 0.59$

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	58	38407.879	662.205	7.2692	<.0001
Error	423	38534.345	91.098		
C. Total	481	76942.224			

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Subregion	3	3	12888.320	47.1593	<.0001
Route[Subregion]	55	55	26218.270	5.2328	<.0001

Least Squares Means Table

Level	Least Sq Mean		Std Error	Mean
Sonoran Desert	5.602086		0.9353774	6.1600
Colorado Desert	4.064683		1.7436325	5.2500
East Mojave	6.250591		1.3935926	7.3000
West Mojave	19.539684		0.9468360	17.9508

Table 6. ANOVA model for total number of ravens with year and route independent of region (R^2 = 0.66).

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	75	48792.232	650.563	9.0971	<.0001
Error	359	25673.179	71.513		
C. Total	434	74465.411			

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Route	37	37	30506.710	11.5294	<.0001
Year	1	1	1024.777	14.3299	0.0002
Route*Year	37	37	8660.484	3.2731	<.0001

Table 7a. Results of ANOVA of total number of ravens for model for effect of route, region, and year. $R^2 = 0.55$

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	59	42139.222	714.224	8.6602	<.0001
Error	422	34803.002	82.472		
C. Total	481	76942.224			

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Year	1	1	3731.343	45.2440	<.0001
Subregion	3	3	16271.718	65.7670	<.0001
Route[Subregion]	55	55	29946.957	6.6022	<.0001

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
Sonoran Desert	4.232683	0.9129788	6.1600
Colorado Desert	4.711137	1.6618078	5.2500
East Mojave	5.682936	1.3286543	7.3000
West Mojave	21.519062	0.9477360	17.9508

Table 7b. Results of ANOVA of number of stops ravens for model for effect of route, region, and year. $R^2 = 0.66$

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	59	8890.735	150.690	13.9198	<.0001
Error	422	4568.404	10.826		
C. Total	481	13459.139			

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Year	1	1	987.1816	91.1895	<.0001
Subregion	3	3	3778.7880	116.3534	<.0001
Route[Subregion]	55	55	5940.1874	9.9767	<.0001

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
Sonoran Desert	2.662170	0.33077646	3.70000
Colorado Desert	2.867863	0.60208069	3.15000
East Mojave	3.727789	0.48137765	4.52000
West Mojave	11.063005	0.34336918	9.46721

Table 8. Summary of effect of year on variation in numbers of ravens and numbers of stops with ravens within each subregion. The value represents the change in number of ravens and number of stops with ravens per year (% change over 37 years).

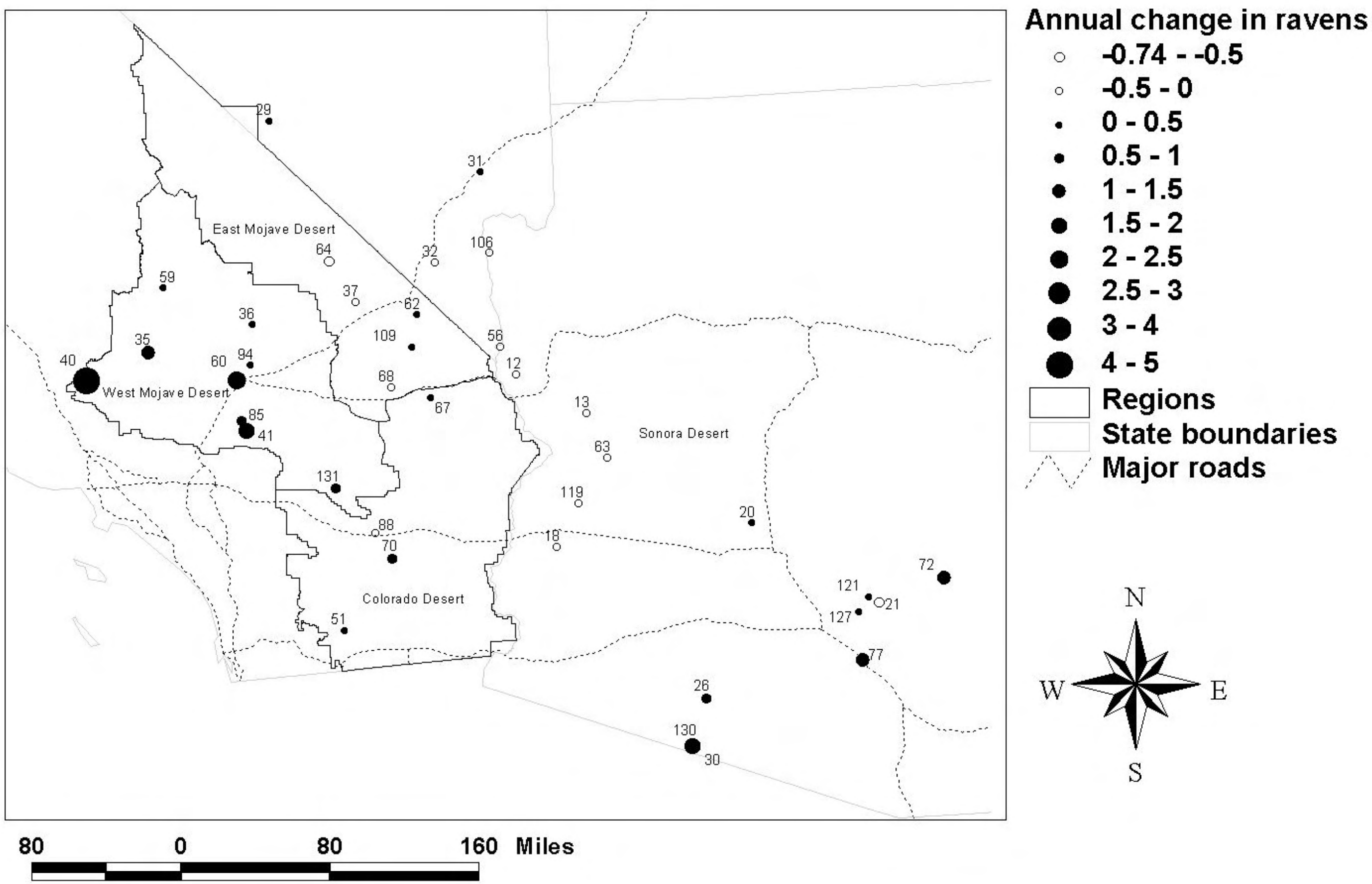
	Change over time			
Subregion	Ravens		Stops	
Sonoran Desert	0.38	(1377%)	0.07	(136%)
Colorado Desert	0.21*	(762%)	0.13	(486%)
East Mojave	0.09	(78%)	0.16	(588%)
West Mojave	0.88	(795%)	0.39	(431%)

* not significant

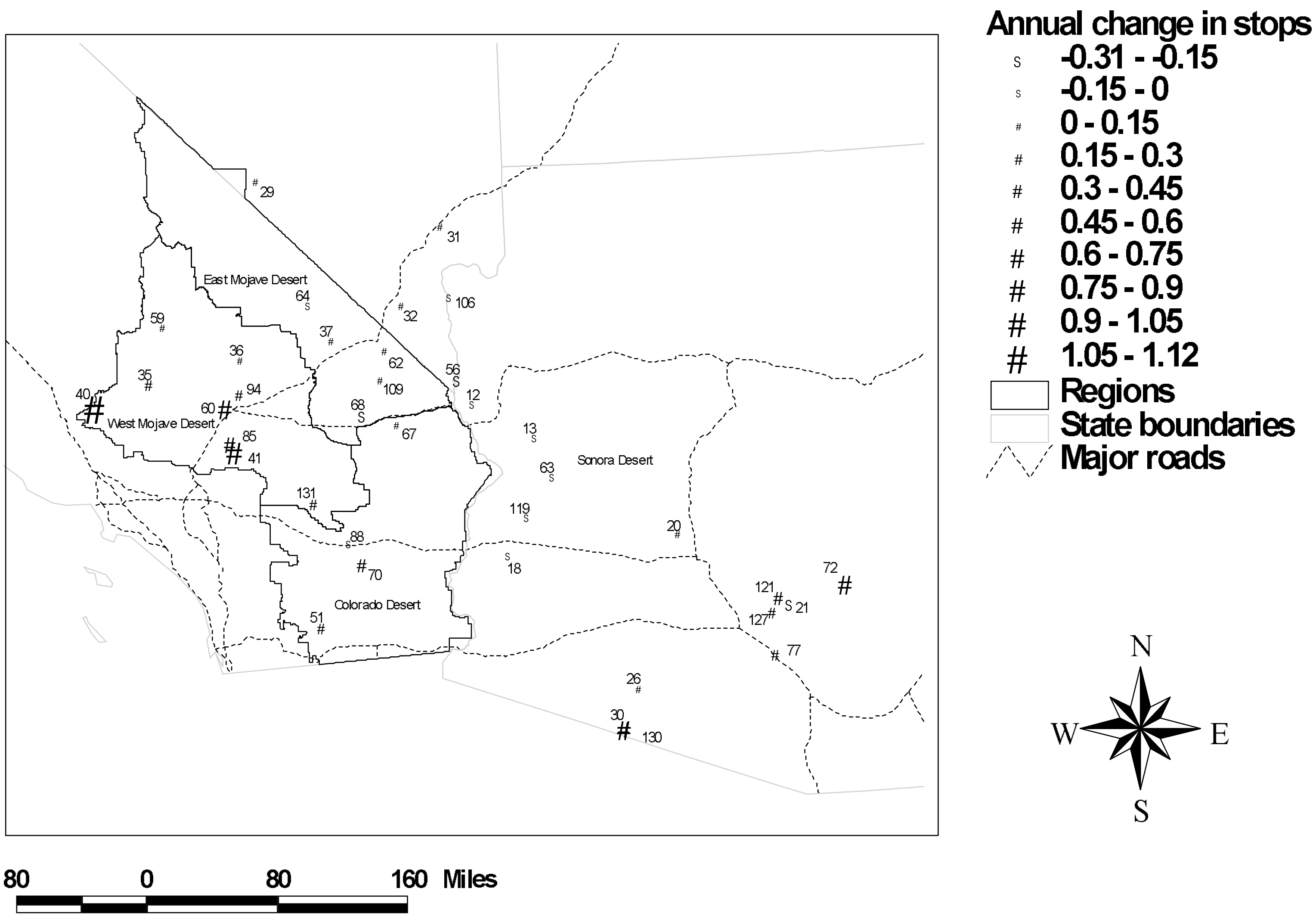
Figure 1. Map showing all routes included in survey indicating direction and intensity of average annual changes in number of ravens on each route by size and type of symbol. Key to route numbers appears in Appendix A.

Figure 2. Map showing all routes included in survey indicating direction and intensity of average annual changes in number of stops at which ravens were observed on each route by size and type of symbol.

Changes in raven numbers over time



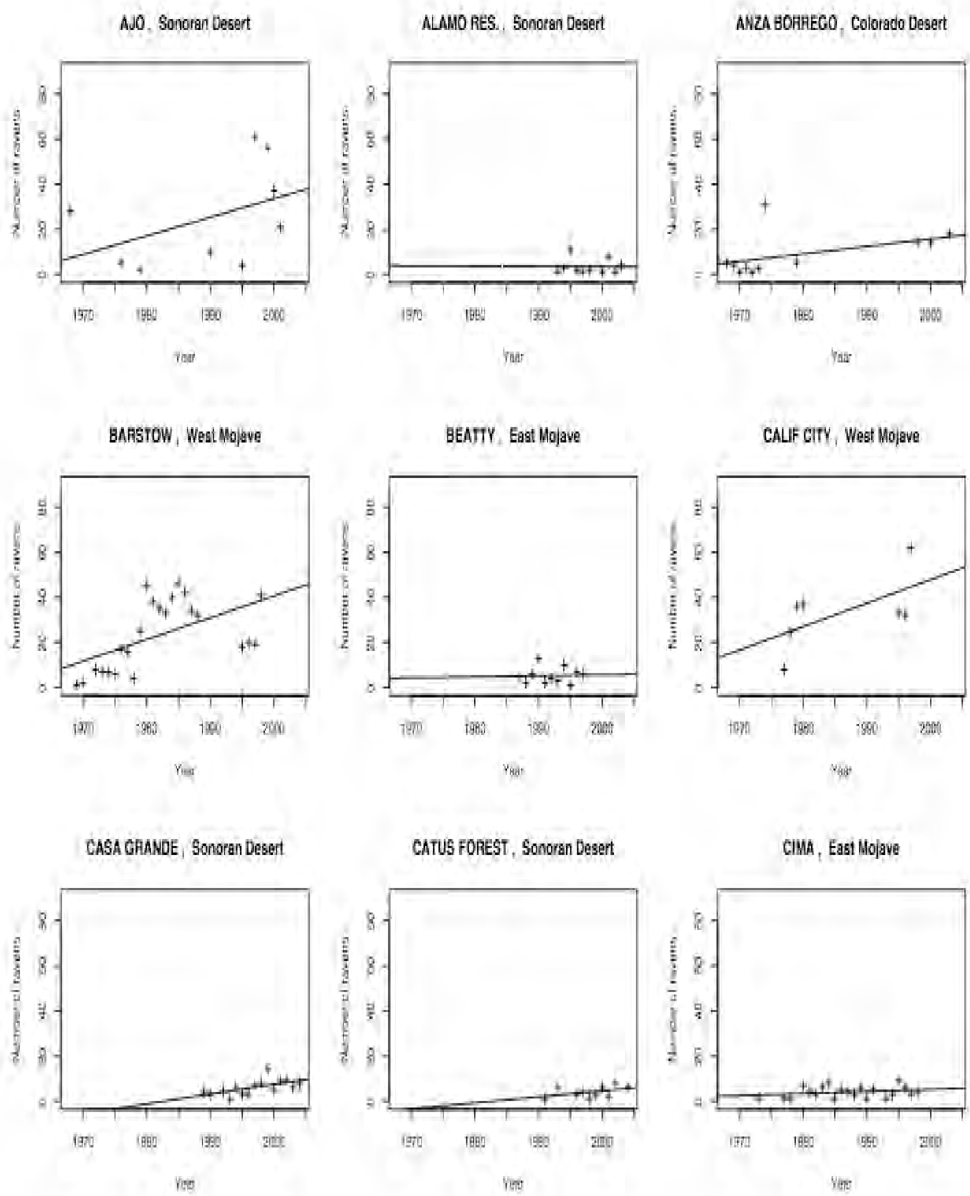
Changes in number of stops with raven detections over time

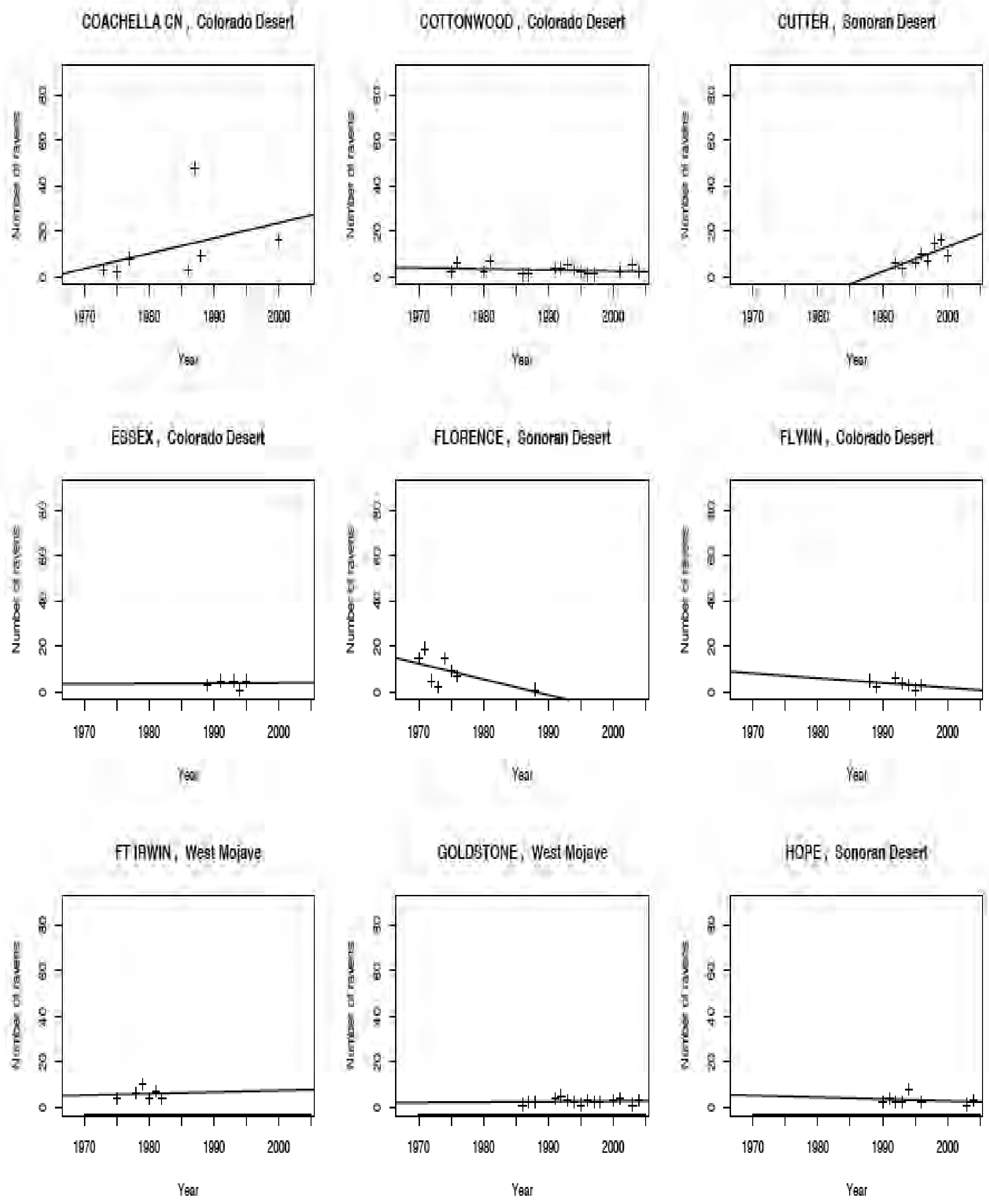


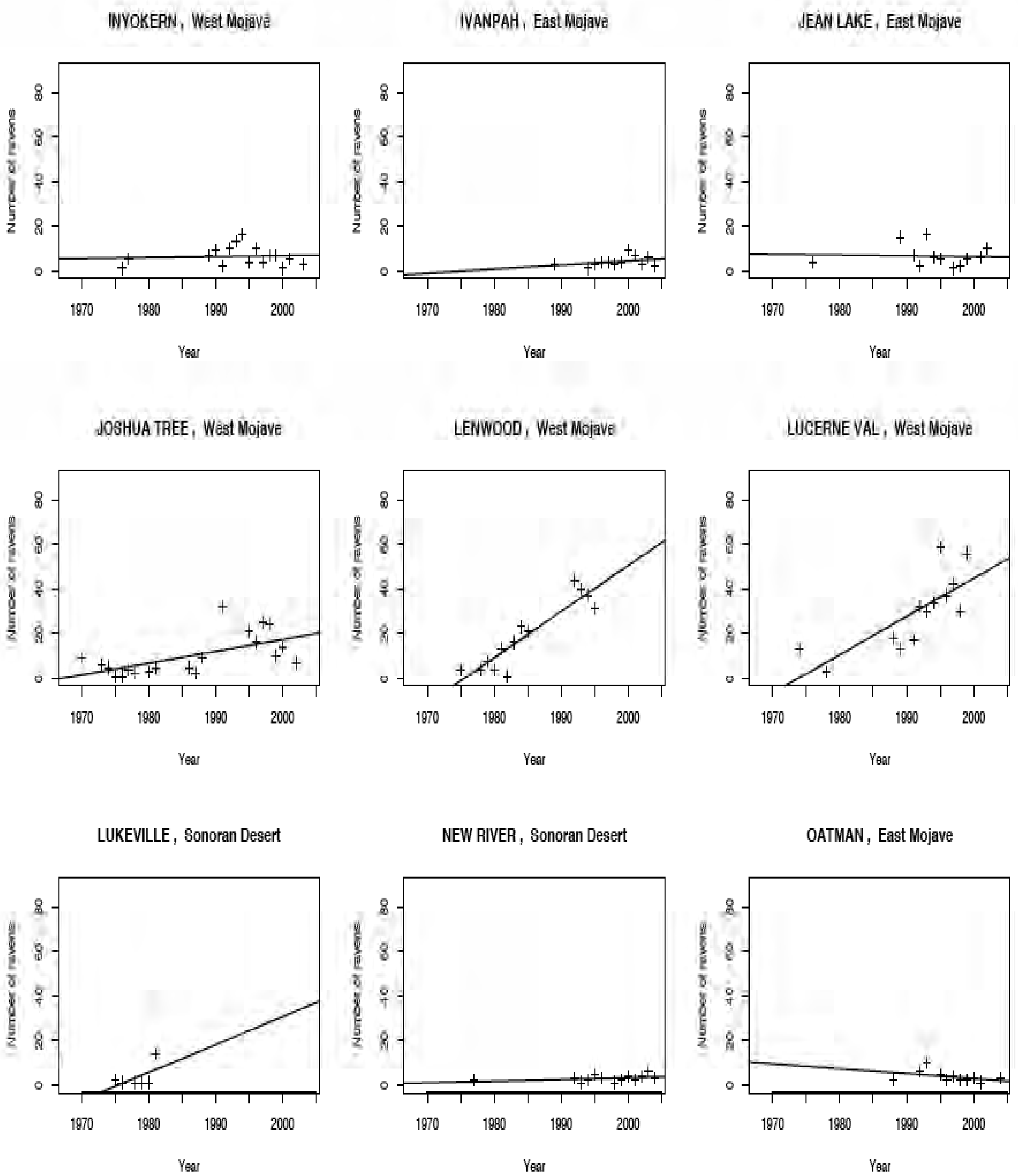
Appendix A. Route names and official BBS route numbers as represented in Figures 1 & 2. See Table 1 for subregion and years each route was surveyed.

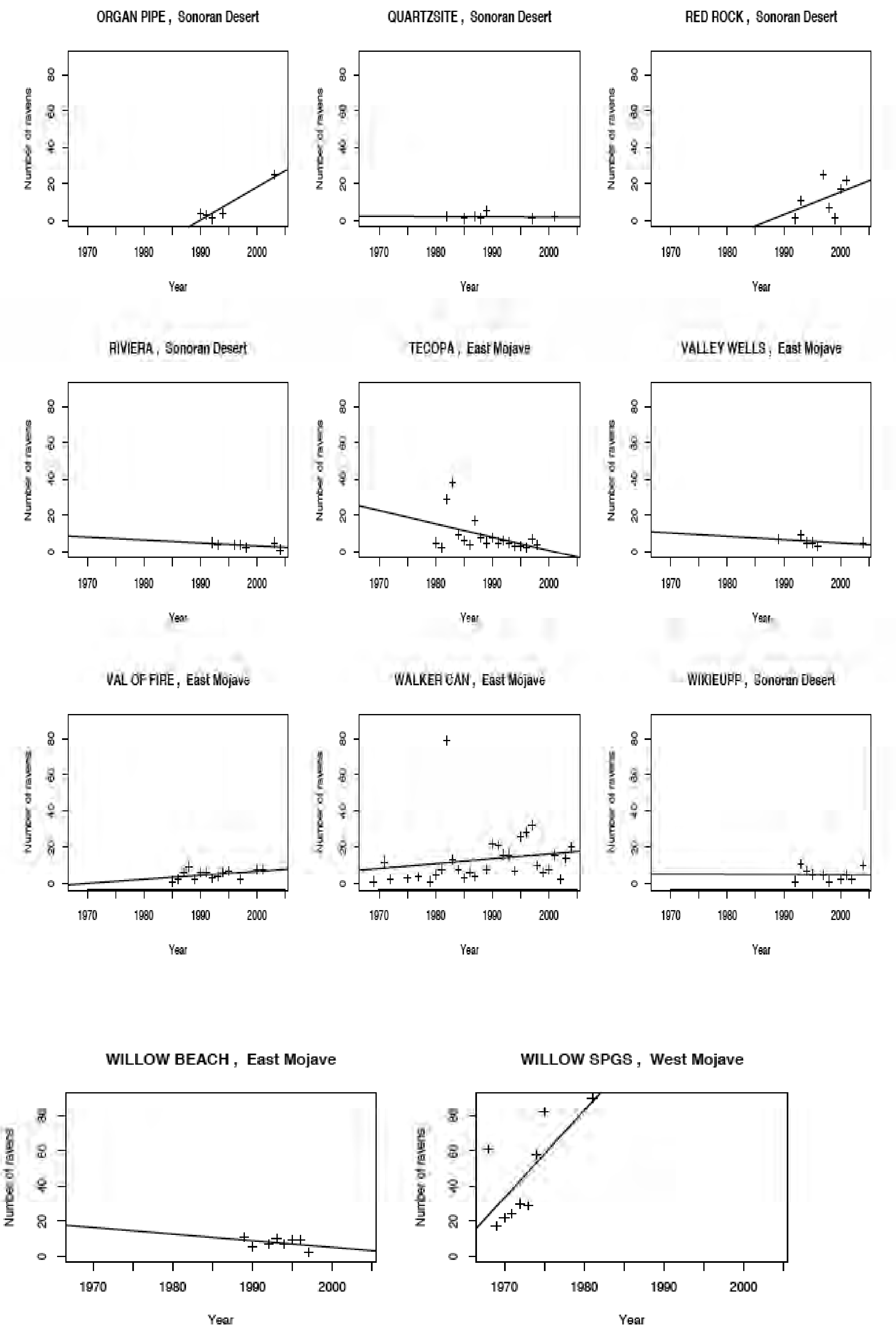
Route name	Route number	Route name	Route number
SQUAW PEAK	6	ALAMO RES.	63
WALKER CAN	11	TRONA	63
OATMAN	12	TECOPA	64
WIKIEUPP	13	ESSEX	67
QUARTZSITE	18	FLYNN	68
QUARTZSITE	19	CIBOLA LAKE	68
NEW RIVER	20	IRON MTNS	69
FLORENCE	21	GILA BEND	69
LAGUNA	24	PALO VERDE	70
AJO	26	COACHELLA CN	70
COOLIDGE	27	CUTTER	72
BEATTY	29	ARABY	74
LUKEVILLE	30	PISINIMO	76
VAL OF FIRE	31	RED ROCK	77
JEAN LAKE	32	CABEZA PRIETA	80
NELSON	33	LUCERNE VAL	85
CALIF CITY	35	HAVASU LAKE	86
GOLDSTONE	36	COTTONWOOD	88
VALLEY WELLS	37	BLYTHE	90
WILLOW SPGS	40	IMPERIAL DAM	93
BARSTOW	41	FT IRWIN	94
CADIZ	43	WILLOW BEACH	106
PARKER DAM	44	CIMA	109
GLAMIS	48	HOPE	119
ANZA BORREGO	51	CASA GRANDE	121
RIVIERA	56	CATUS FOREST	127
INYOKERN	59	ORGAN PIPE	130
LENWOOD	60	JOSHUA TREE	131
IVANPAH	62	BATES WELL	176
		WLLWLBCH 2	206

Appendix B. Graphs showing number of ravens per year for each route separately.

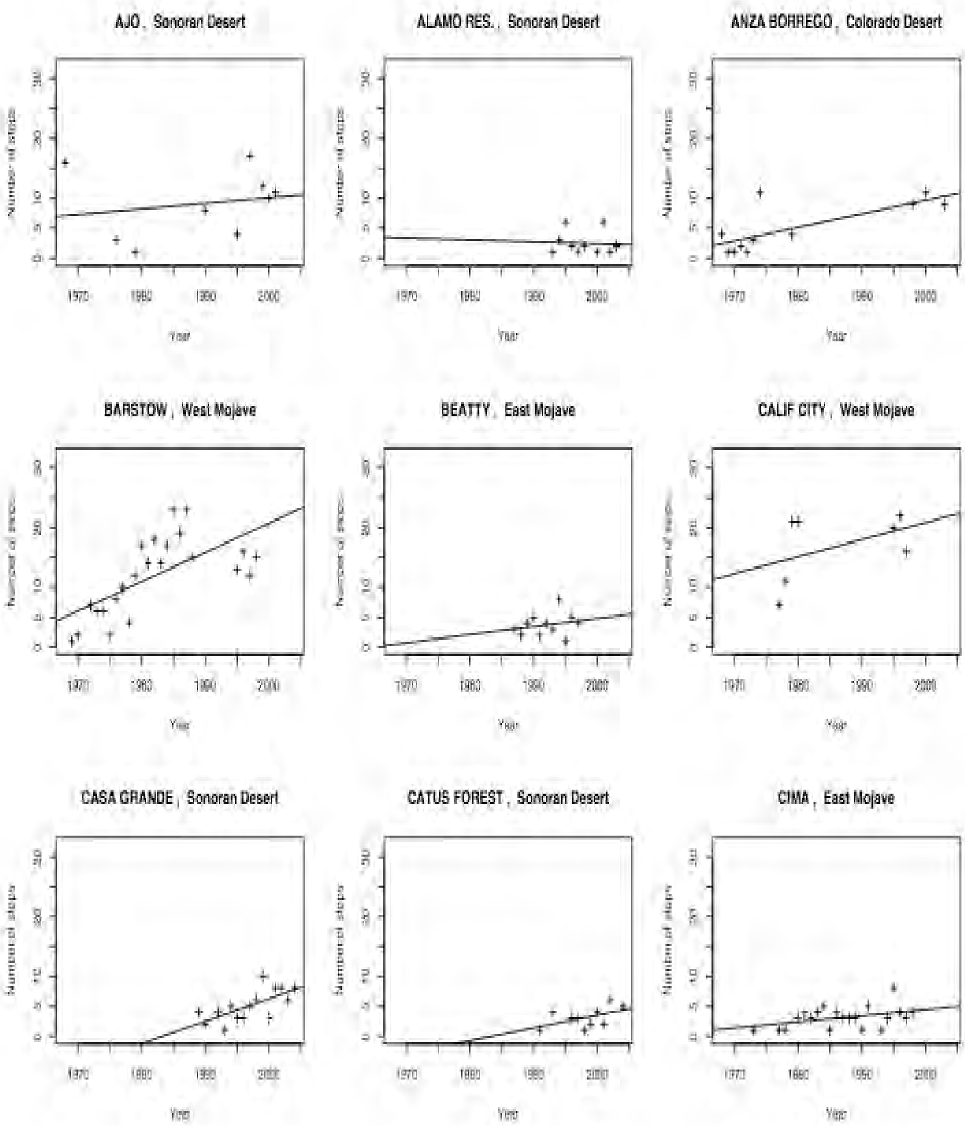


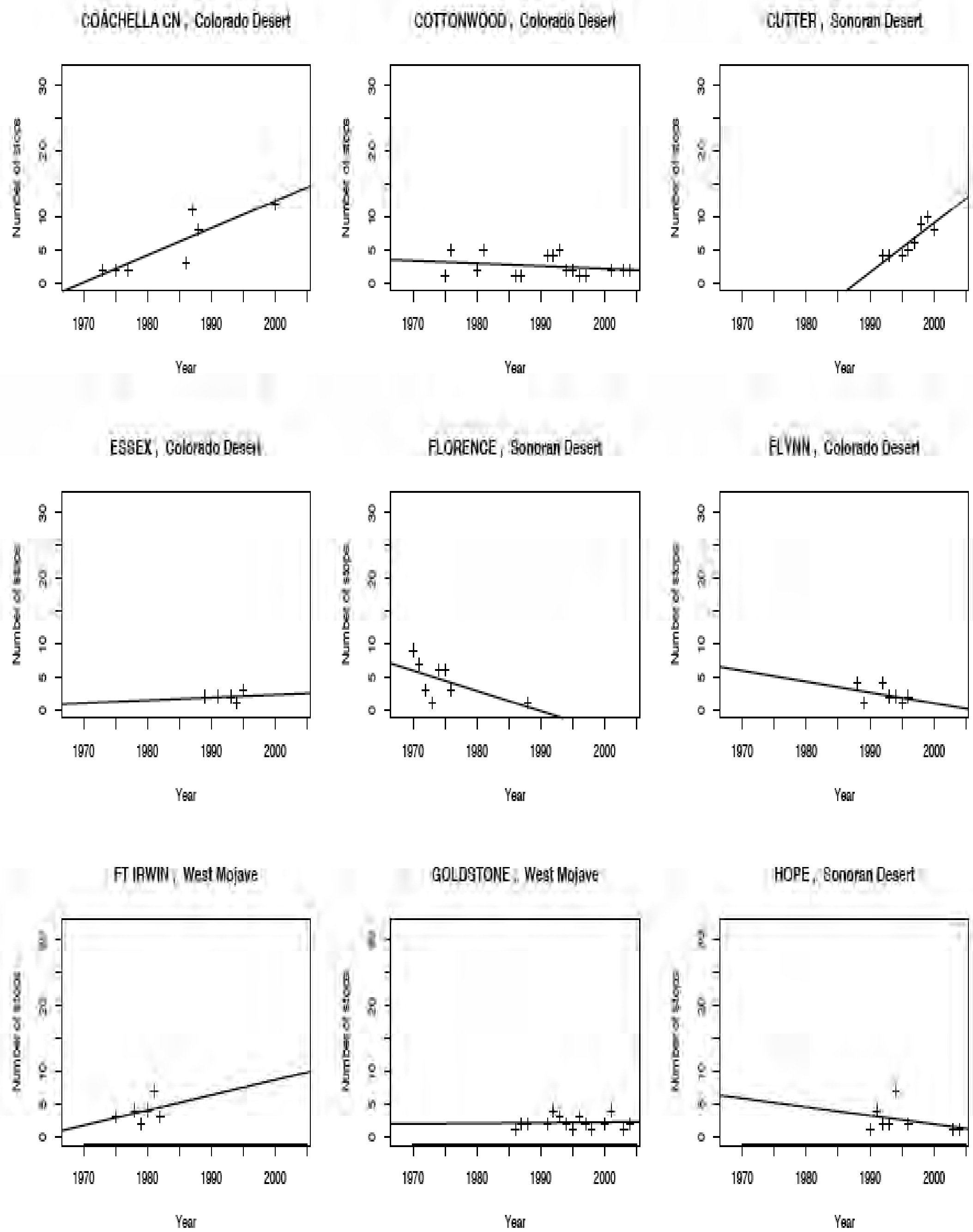

COACHELLA CN , Colorado Desert
COTTONWOOD , Colorado Desert
CUTTER , Sonoran Desert
ESSEX , Colorado Desert
FLORENCE , Sonoran Desert
FLYNN , Colorado Desert
FT IRWIN , West Mojave
GOLDSTONE , West Mojave
HOPE , Sonoran Desert
Number of ravens
Year
0
20
40
60
80
1970
1980
1990
2000

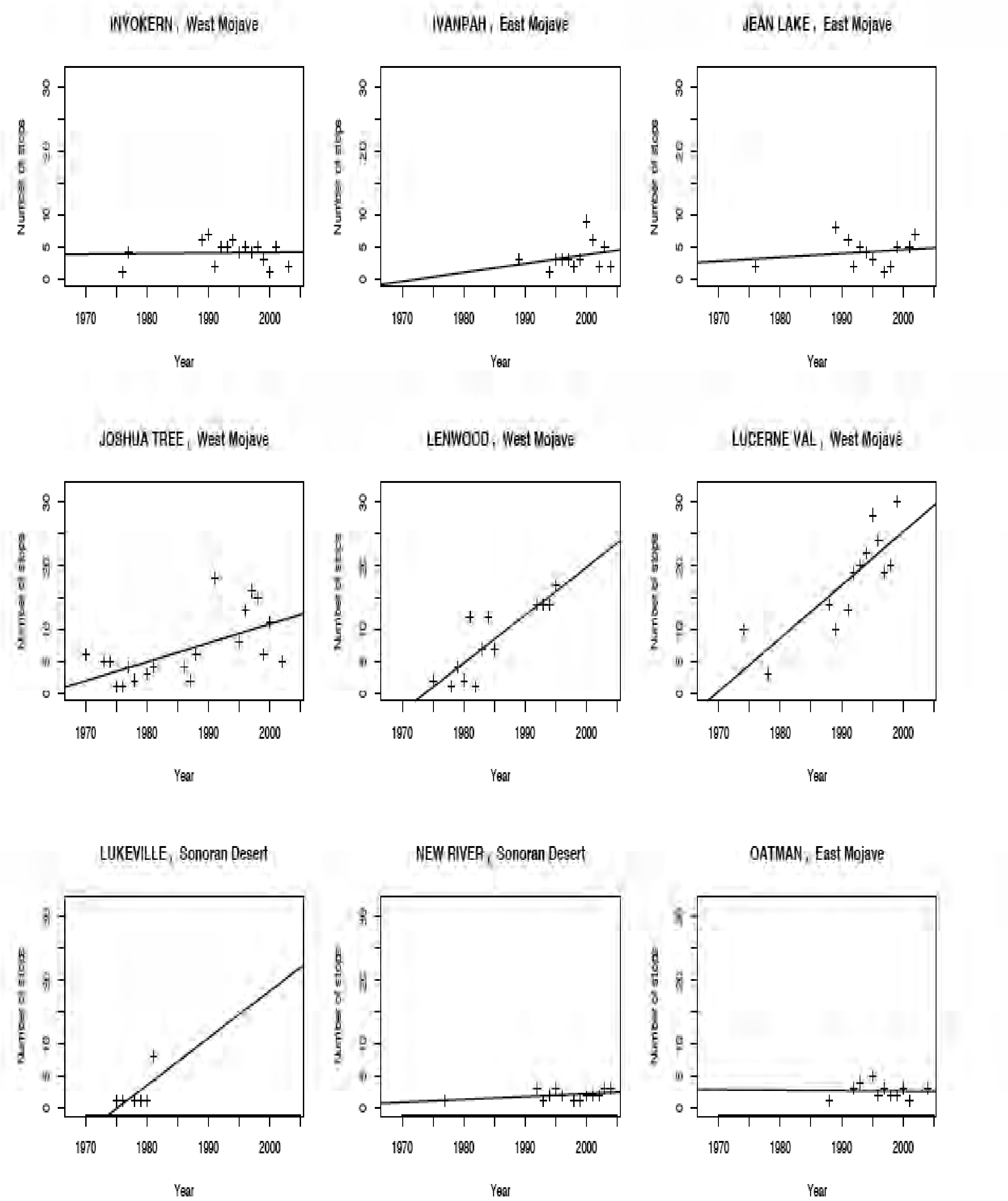

INYOKERN , West Mojave
IVANPAH , East Mojave
JEAN LAKE , East Mojave
JOSHUA TREE , West Mojave
LENWOOD , West Mojave
LUCERNE VAL , West Mojave
LUKEVILLE , Sonoran Desert
NEW RIVER , Sonoran Desert
OATMAN , East Mojave
Number of ravens
0
20
40
60
80
Year
1970
1980
1990
2000

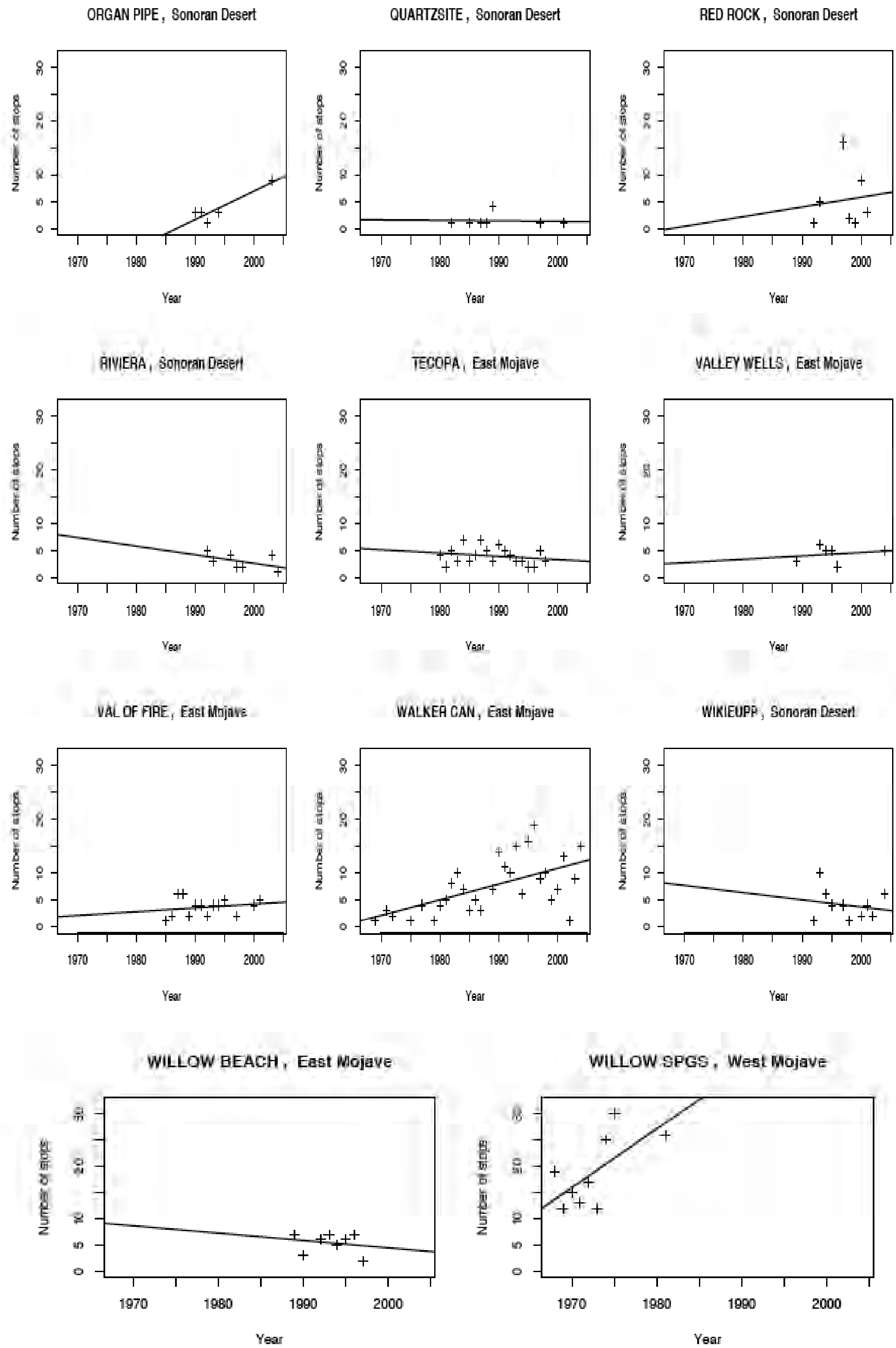

ORGAN PIPE , Sonoran Desert
QUARTZSITE , Sonoran Desert
RED ROCK , Sonoran Desert
RIVIERA , Sonoran Desert
TECOPA , East Mojave
VALLEY WELLS , East Mojave
VAL OF FIRE , East Mojave
WALKER CAN , East Mojave
WIKIEUPP , Sonoran Desert
WILLOW BEACH , East Mojave
WILLOW SPGS , West Mojave
Number of ravens
Year
1970
1980
1990
2000
0
20
40
60
80

Appendix C. Graphs showing number of stops on which ravens were observed per year for each route separately.




COACHELLA CN , Colorado Desert
COTTONWOOD , Colorado Desert
CUTTER , Sonoran Desert
ESSEX , Colorado Desert
FLORENCE , Sonoran Desert
FLYNN , Colorado Desert
FT IRWIN , West Mojave
GOLDSTONE , West Mojave
HOPE , Sonoran Desert
Number of stops
0
5
10
20
30
1970
1980
1990
2000
Year


INYOKERN , West Mojave
IVANPAH , East Mojave
JEAN LAKE , East Mojave
JOSHUA TREE , West Mojave
LENWOOD , West Mojave
LUCERNE VAL , West Mojave
LUKEVILLE , Sonoran Desert
NEW RIVER , Sonoran Desert
OATMAN , East Mojave
Number of stops
0 5 10 20 30
1970 1980 1990 2000
Year


ORGAN PIPE , Sonoran Desert
QUARTZSITE , Sonoran Desert
RED ROCK , Sonoran Desert
RIVIERA , Sonoran Desert
TECOPA , East Mojave
VALLEY WELLS , East Mojave
VAL OF FIRE , East Mojave
WALKER CAN , East Mojave
WIKIEUPP , Sonoran Desert
WILLOW BEACH , East Mojave
WILLOW SPGS , West Mojave
Number of stops
Year
0
5
10
20
30
1970
1980
1990
2000

Attachment C

Ecology, 84(9), 2003, pp. 2432–2443

SPATIAL PATTERN OF RISK OF COMMON RAVEN PREDATION ON DESERT TORTOISES

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Abstract. Common Ravens (*Corvus corax*) in the Mojave Desert of California, USA are subsidized by anthropogenic resources. Large numbers of nonbreeding ravens are attracted to human developments and thus are spatially restricted, whereas breeding ravens are distributed more evenly throughout the area. We investigated whether the spatial distribution of risk of predation by ravens to juveniles of the threatened desert tortoise (*Gopherus agassizii*) was determined by the spatial distribution of (1) nonbreeding ravens at human developments (leading to "spillover" predation) or (2) breeding individuals throughout developed and undeveloped areas (leading to "hyperpredation"). Predation risk, measured using styrofoam models of juvenile desert tortoises, was high near places attracting large numbers of nonbreeding ravens, near successful nests, and far from successful nests when large numbers of nonbreeding ravens were present. Patterns consistent with both "spillover" predation and "hyperpredation" were thus observed, attributed to the nonbreeding and breeding segments of the population, respectively. Furthermore, because locations of successful nests changed almost annually, consistent low-predation refugia for juvenile desert tortoises were nearly nonexistent. Consequently, anthropogenic resources for ravens could indirectly lead to the suppression, decline, or even extinction of desert tortoise populations.

Key words: anthropogenic resources; California; Common Raven; Corvus corax; *desert tortoise;* Gopherus agassizii; *hyperpredation; Mojave Desert; prey decoy; spatial distribution of risk; spillover predation.*

INTRODUCTION

Common Ravens (*Corvus corax*) in the west Mojave Desert of California, USA are strongly associated with human developments (Boarman 1993, Kristan 2001). Ravens nest preferentially near anthropogenic features like housing developments and landfills, and raven reproduction is poor in isolated desert habitat, far from anthropogenic resource subsidies (Kristan 2001, Webb 2001). Large numbers of this native species are only consistently found at anthropogenic sites in the Mojave (Knight et al. 1993; W. I. Boarman, *unpublished data*), and raven numbers have increased 1500% over the last several decades, concomitant with urban growth in the region (Boarman 1993, Sauer et al. 2000). Strong association with, and apparent reliance on, human resources in the Mojave Desert makes the common Raven a human commensal in this habitat (Knight et al. 1993).

Although raven populations are most dense in rural and urban areas (Knight and Kawashima 1993, Knight et al. 1993; W. I. Boarman, *unpublished data*), the limited availability of urban nest sites in lightly populated parts of the Mojave Desert means that 62% of ravens nest >2 km from human resource subsidies in undeveloped desert (Kristan 2001). Ravens scavenge when refuse and carrion are available, but they are also capable hunters that prey on small vertebrates and invertebrates, including the threatened desert tortoise (*Gopherus agassizii*; Camp et al. 1993, Boarman and Berry 1995, Boarman and Heinrich 1999). Ravens have been observed to attack and kill juvenile tortoises from within experimental enclosures (Morafka et al. 1997). Juvenile tortoise shells are also commonly found beneath raven nests in this area (W. I. Boarman, *unpublished data*). Because of their large numbers and conspicuous predation of tortoises, ravens have been implicated as a contributor to tortoise population declines, and as a potential impediment to tortoise recovery (Boarman 1993, USFWS 1994).

Predators reduce prey numbers and, in some circumstances, can contribute to their extinction (Smith and Quinn 1996, Polis et al. 1997, Sinclair et al. 1998, Namba et al. 1999). The greatest predatory impact should come from subsidized generalist predators such as corvids (Andrén et al. 1985, Andrén 1992), whose numbers remain high when prey populations decline, and which continue to depredate a species that is at very low densities (Polis et al. 1997, Sinclair et al. 1998). However, differences in the spatial distributions and behavior of breeding and nonbreeding ravens in the Mojave complicate predictions of their impacts on

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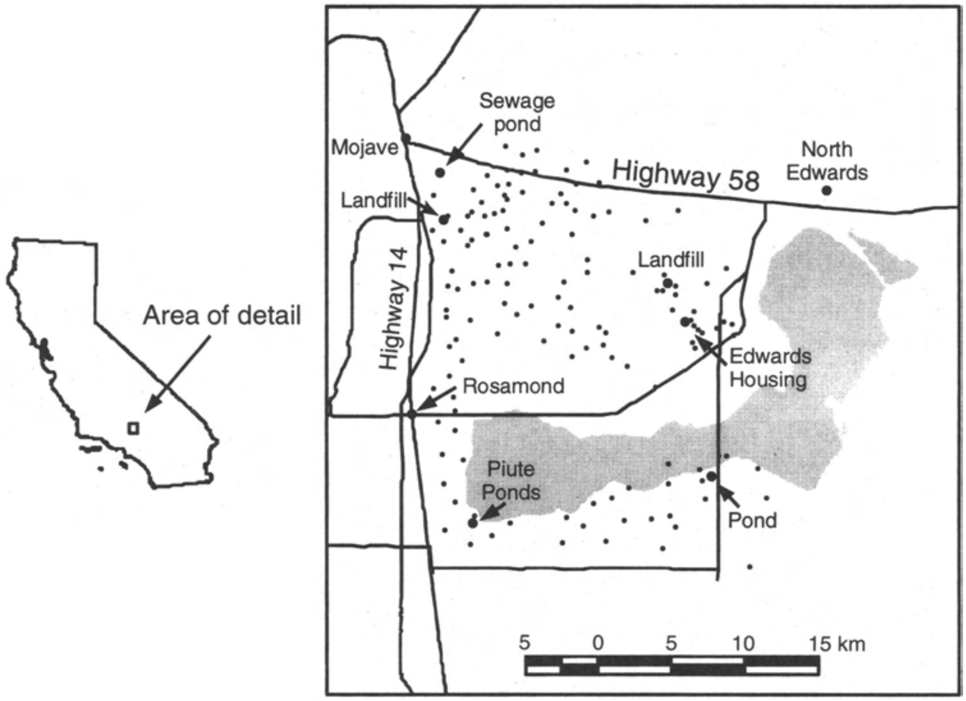

FIG. 1. Study area map. The gray area is a dry lake bed, which is non-habitat for both ravens and desert tortoises. The small solid circles are the locations of sampling points.

prey. Anthropogenic sites such as landfills provide superabundant, continuously replenished food (Restani and Marzluff 2001), and the large groups of well-fed ravens found at landfills may not need to hunt in surrounding lands. However, if these groups of ravens do hunt, they are most likely to impact prey populations through "spillover" predation into adjacent undeveloped areas (Holt 1984, Chapman et al. 1996, Schneider 2001). In contrast, breeding ravens are broadly distributed throughout both developed and undeveloped habitats. Although territorial behavior keeps breeding densities low compared with densities of nonbreeding birds, most breeding ravens do not have anthropogenic subsidies within their territories, and they may be forced to hunt rather than scavenge. The large breeding population throughout undeveloped habitats would produce a pattern of predation consistent with "hyperpredation" (Erlinge et al. 1983, Crooks and Soulé 1999, Courchamp et al. 2000). Both patterns of subsidized predation have the potential to contribute to tortoise population declines. However, spillover predation would remain spatially restricted as long as anthropogenic sites remain spatially restricted, whereas hyperpredation could affect prey throughout the prey's habitat. These different effects suggest different remediation strategies. Thus, understanding patterns of predation is important for understanding the population biology of, and appropriate conservation strategies for, their prey.

Predation risk, the probability of being killed by a predator in a given interval of time (Lima and Dill 1990), is an important determinant of predation pressure. Attack rates are good measures of predation risk for species that have a limited ability to escape an attack, such as juvenile desert tortoises. We investigated whether the different spatial distributions of breeding and nonbreeding ravens are associated with differences in predation risk for their prey. We measured predation risk using artificial juvenile desert tortoise models as bait, placed throughout a 770 km^2 area, and related raven attacks on baits to the distribution of ravens, raven nests, and anthropogenic developments. Based on these relationships, we mapped predation risk throughout the study area to examine its spatial variation and to evaluate whether there are areas of low predation that could act as refugia for raven prey.

METHODS

Study area

The primary study area was within the western half of Edward Air Force Base (EAFB), and in lands immediately surrounding the base, in the western Mojave Desert of California (Fig. 1). The study area covered ~770 km^2. The small number of human developments, such as towns, artificial water bodies, and landfills, were distributed throughout the area, surrounded by undeveloped shrublands. Shrubland vegetation was composed of creosotebush (*Larrea tridentata*) and saltbush (*Atriplex* spp.) scrub, often forming a sparse woodland in association with joshua tree (*Yucca brevifolia*).

Artificial, permanent water bodies were sources of water, food, and riparian vegetation. The larger body (Piute Ponds) was an artificial wetland within EAFB that contained well-developed riparian vegetation, including willows (*Salix* spp.), cattails (*Typha* spp.), and rushes (*Juncus* spp.). Piute Ponds supported breeding populations of waterfowl, waders, and shorebirds as well as amphibians, such as the African clawed frog (*Xenopus laevis*), which were potential raven prey. A small park with a permanent pond was located in the southeast corner of the study area. Open sewage treatment facilities were also present near two towns in the study area, Mojave (population 3763) and Rosamond (population 7430).

Lands within the EAFB boundary were used by the U.S. Air Force primarily for recreation rather than military exercises, and the vegetation was not heavily disturbed. Undeveloped lands outside of the EAFB boundary were used for a variety of purposes, including recreation and sheep grazing. The housing area within EAFB (population 7423) and the towns of Rosamond and Mojave consisted of single-family homes, apartment complexes, and commercial developments (e.g., restaurants, grocery stores, etc.). Solid waste disposal sites (landfills) were present near EAFB housing and southeast of Mojave.

Raven populations

During the spring, the raven population consisted of breeding birds distributed throughout the study area and nonbreeding birds that aggregated in conspicuous flocks near anthropogenic developments. Most of the known nests were in Joshua trees (57%), but were also found in telephone and electrical utility poles (27%), trees (ornamental landscaping; 13%), buildings (1.5%), and cliffs (1.5%). Nests were located by searching the study area each spring in the years 1996–2000. Nests were commonly reused between seasons, but new nests were discovered each year. By 2000, we were monitoring 305 nest sites within the study area, of which 225 were occupied by ravens for at least part of the nesting season (between March and early July).

Experimental protocol

Selection of sampling points.—We established sampling points (n = 100) in scrub habitat throughout the study area in March 2000. Points were selected to provide even coverage of the region. Distances between sampling points averaged 1497 m, which is slightly greater than the average spacing between occupied territories (1134 m). Because breeding ravens spend 90% of their time within 400 m of their nests (Sherman 1993), the spacing between points prevented double-counting of individuals during raven counts, and prevented individual ravens from encountering multiple baits during predation risk trials. No points were placed in the dry lake bed (Fig. 1) because we considered it unsuitable habitat for ravens and desert tortoises. At each point, we collected data on the number of ravens present, distance to anthropogenic sites and raven nests, and raven predation. Sampling points were embedded within the area where we searched for raven nests in order to avoid introducing edge effects into our distance measures.

Raven distributions.—Locations of raven nests were known because of concommittant reproductive monitoring. We characterized the distribution of raven individuals using 10-minute unlimited-radius point counts, conducted within four hours of dawn (Ralph et al. 1995). Both the total number of ravens observed and the number observed within 200 m of the sampling point were recorded. Counts were conducted on either the first or the last day of a predation risk trial to ensure that they accurately represented the distribution of raven individuals at the time of the trial. All counts were conducted between 30 March 2000 and 25 May 2000.

Predation risk trials.—We wished to measure in a standardized way the relative risk of attack by ravens across a large area. We chose to use baits, placed throughout the study area, as our measure of relative predation risk. This had the advantage that we did not have to rely on error-prone estimates of the distribution of particular prey to estimate predation risk. Because ravens have flexible foraging behaviors (including both hunting and scavenging; Boarman and Heinrich 1999) and an eclectic diet (including refuse, small mammals, arthropods, birds, plants, reptiles, and carrion of all kinds; Camp et al. 1993; Kristan, W. B. III, W. I. Boarman, and J. Crayon, *unpublished manuscript*), we considered attacks on baits to be a reasonable approximation of predation risk to any vulnerable animal encountered by a raven.

Artificial baits were selected following attempts in 1999 to use baits made of foods (dog biscuits) that were disrupted by nontarget species, such as canids and small mammals. We selected styrofoam models of the desert tortoise as our baits because tortoises were known to occur on the study area, are eaten by ravens (Boarman 1993), and are a threatened species. Desert tortoises are diurnal, and their most active season coincides with the raven breeding season (Berry and Turner 1986, Ernst et al. 1994). We obtained the baits from the USDI Bureau of Land Management, which originally made them to study tortoise trampling by livestock by placing known numbers of models in areas of grazed desert scrub. During that study, ravens were observed attacking the models (G. Goodlett and P. Frank, *personal communication*), leading us to believe that the models could be used to estimate raven attack rates. The models were shaped like tortoise shells and were painted to resemble desert tortoises. Ravens are only known to depredate juvenile desert tortoises with carapace lengths <100 mm, usually by piercing the carapace with their bills or biting at the head or limbs (Boarman and Heinrich 1999). Our models were made from a single mold and were 62 mm long, which is within this vulnerable size range. Raven attacks on the baits left distinctive punctures in the top or long cuts around the sides. Red-tailed Hawks (*Buteo jamaicensis*) were also present in the area at much lower numbers than ravens, but raptors have sufficiently different bill morphology and eating modes that misidentification was unlikely. None of the models used in this study showed signs of attack from other species, avian or mammalian.

Styrofoam tortoise baits were attached to 10-inch (25.4-cm) spikes in the ground with pieces of adhesive-backed industrial Velcro (Velcro USA, Manchester, New Hampshire, USA). Baits were placed within the shrub habitat at the sampling point, in areas that provided an unobstructed view from above. Each week between 27 March and 25 May 2000, single baits were placed at 10–15 sampling points and were left for four nights. This period is in the middle of the raven nesting season, with 63% of initiated breedings occurring after 27 March and 71% of successful fledging occurring after 25 May 2000 (Kristan 2001). The points were not visited during the four-day sampling interval to avoid affecting the behavior of the ravens, and each point was sampled only once to avoid conditioning ravens to avoid the inedible baits. The spacing between sampling points (see *Selection of sampling points*) minimized the chances that individual ravens would encounter multiple baits and learn to avoid them. At the end of the interval, the models were retrieved and scored by whether they had raven bill impressions.

Anthropogenic sites.—Point sources of anthropogenic resources, such as towns, landfills, and water bodies, were identified from USGS Geographical Names Information System data, augmented by sites that we identified in the field. Roads were associated with increased raven reproductive success (Kristan 2001); because road-killed carrion potentially could also attract individual ravens, we considered roads to be potential risk factors for raven prey. Locations of paved roads with high traffic volume on the study area were taken from USGS digital maps. Roads used for this analysis were the major travel corridors between towns and through EAFB, which were most likely to produce enough carrion to subsidize raven reproduction (Kristan 2001).

Distance measurements.—Distances from sampling points to anthropogenic sites and nests were measured using a geographic information system (ArcView 3.2 [ESRI 2000]; GRASS 5.0 [Neteler and Mitasova 2002]). We scored each nest by whether it was occupied (adults present in the territory), whether breeding was initiated (presence of eggs, incubation, etc.), and whether successful fledging was observed. Mean distances to the five nearest occupied nests or nests with breeding initiated were calculated for further analyses, but the distance to the single nearest successful nest was used because of the smaller number of successful nests. Finally, we also scored each point by the number of chicks fledged from the closest successful nest.

Statistical Analysis

Distribution of raven individuals.—The association between counts of individual ravens and proximity to anthropogenic sites and raven nests was evaluated using Poisson regression (the most appropriate error structure for discrete count data; Venables and Ripley 1994). We modeled both the total number of ravens observed at a point and the subset of ravens that were within 200 m of the point. Distances to anthropogenic point subsidies and roads were used in all models. For this analysis, we wished to evaluate whether local breeding activity contributed to variation in raven numbers throughout the area, and whether one of the four alternative measures of local breeding activity was best at explaining variation in raven numbers. We addressed these questions by comparing the relative effects of the breeding status of the nearest nests (occupied, breeding initiated, successful, number fledged) on raven counts. We compared the statistical support for models that included nests of each breeding status to one model that included no measure of breeding activity (i.e., only roads and point subsidies). Model support was assessed using Akaike's Information Criterion values, AIC (Burnham and Anderson 1998). The strength of support for each model was evaluated using Akaike weights, w_i (Burnham and Anderson 1998). Akaike weights estimate the relative frequency with which a model would be best supported out of a set of alternatives if the experiment were repeated a large number of times (Burnham and Anderson 1998). A model with $w_i > 0.9$ is considered to be best supported, but lacking a best supported model, models that are within four AIC units of the model with the highest w_i are considered plausible explanations for the data, and worth further consideration. Lack of a model with $w_i > 0.9$ can occur either when different models make similar predictions or when sample sizes are inadequate to distinguish models that make distinct predictions.

Determinants of raven predation risk.—We modeled raven attacks on styrofoam tortoise baits by using logistic regression. We compared the AICs of models including different combinations of distances to anthropogenic sites, counts of raven individuals, distances to raven nests of different breeding status, or the number of chicks fledged from the nearest successful nest. The last variable was used to evaluate whether the risk of predation from breeding ravens was related to the food requirements of their brood. We constructed an initial set of models that included the number of ravens observed within 200 m of the sampling point, a measure of human development (either distance to roads or point subsidies), and a measure of raven breeding activity (territory occupied, breeding initiated, suc-

TABLE 1. The effects of point subsidies, roads, and distances to nests of ravens of different breeding status on numbers of ravens observed in unlimited-radius point counts.

Effect	Coefficient	1 SE	z	P	AIC†	ΔAIC‡	w_i§
Model 1					434.2	7.2	0.02
Occupied nests	-3.64×10^{-4}	1.69×10^{-4}	−2.16	0.031			
Point subsidies	-3.15×10^{-4}	4.36×10^{-5}	−7.23	<0.001			
Roads	4.92×10^{-5}	4.40×10^{-5}	1.12	0.264			
Model 2					430.7	3.7	0.13
Initiated nests	-2.53×10^{-4}	1.14×10^{-4}	−2.22	0.026			
Point subsidies	-2.91×10^{-4}	4.75×10^{-5}	−6.12	0.000			
Roads	4.99×10^{-5}	4.36×10^{-5}	1.15	0.252			
Model 3					434.7	7.6	0.02
Successful nests	-8.99×10^{-5}	8.27×10^{-5}	−1.09	0.277			
Point subsidies	-3.34×10^{-4}	4.30×10^{-5}	−7.77	<0.001			
Roads	5.73×10^{-5}	4.59×10^{-5}	1.25	0.212			
Model 4					433.9	6.8	0.03
Point subsidies	-3.45×10^{-4}	4.19×10^{-5}	−8.24	<0.001			
Roads	4.08×10^{-5}	4.37×10^{-5}	0.93	0.351			
Model 5					427.0	0.0	0.81
Number fledged	-2.26×10^{-1}	7.72×10^{-2}	−2.92	0.003			
Point subsidies	-3.48×10^{-4}	4.11×10^{-5}	−8.46	<0.001			
Roads	8.19×10^{-6}	4.50×10^{-5}	0.18	0.856			

† Akaike's Information Criterion.
‡ The difference between the model AIC and the smallest AIC in the set under consideration.
§ Akaike weights.

cessful breeding, number of chicks fledged). Additional models were then generated by omitting interaction terms and variables from the original set to see whether simpler models were better supported.

Spatial distribution of raven predation risk.—We mapped the probability of attack predicted from the best supported predation risk models to assess whether the spatial structure in anthropogenic sites and association of ravens with those sites resulted in areas of low predation risk within the study area. Values for each independent variable were derived using GIS. The number of ravens was estimated by interpolating point-count data using regularized spline with tension techniques (Mitášová and Mitáš 1993).

Consistency of breeding activity over time.—Although predation risk trials were only conducted during 2000, breeding activity at nests varies over time. The consistency of spatial variation in predation risk over time consequently could depend on the consistency of breeding activity at known raven nests over time. The number of years that territories were occupied and the number of years of successful reproduction were related to the number of years observed, distance from roads, and distance from anthropogenic subsidies. Because nests were observed for different numbers of years, regression models were used to predict the number of years that territories were occupied and the number of years they were successful out of five years of observation at the minimum (0 m) and maximum (10 500 m) observed distances from roads and at the minimum (0 m) and maximum (14 000 m) observed distances from anthropogenic subsidies.

RESULTS

Distribution of raven individuals

The number of ravens in unlimited-radius counts was 2.49 ± 3.55 individuals (mean ± 1 SD) and the number within 200 m of the sampling point was 0.55 ± 1.17 individuals. Raven numbers declined with increasing distance from point subsidies in all models, and no other variable made significant, unique contributions to raven numbers in all models for unlimited-radius counts (Table 1). The best supported overall model (i.e., the model with the lowest AIC) included the number of chicks fledged from the nearest successful nest, but distance to nests with breeding initiated received moderately strong support (i.e., the ΔAIC was within four units of the best model, and the w_i for the best model was less than 0.90; Burnham and Anderson 1998).

Although model R^2 values ranged from 0.24 for Model 4 to 0.28 for Model 1 for unlimited-radius counts, model R^2 values ranged from 0.07 for Model 4 to 0.09 for Model 1 for counts of ravens within 200 m. The best supported model of ravens within 200 m included mean distance to the five nearest nests with breeding activity initiated (Table 2, Model 2), but the model including the mean distance to the five nearest occupied nests resulted in similar AIC values (Table 2, Model 1). Distances to occupied nests and to initiated nests were strongly correlated (r = 0.91), and this redundancy is reflected in the similar statistical support; omitting Model 1 from the set raised the w_i for Model 2 to 0.84, with the next best supported model (Model 3) having w_i of 0.07. Ravens declined in number with

TABLE 2. The effects of point subsidies, roads, and distances to nests of ravens of different breeding status on numbers of ravens observed within 200 m of the sampling point.

Effect	Coefficient	1 SE	z	P	AIC†	ΔAIC‡	w_i§
Model 1					211.4	1.6	0.28
Occupied nests	−8.49	4.26×10^{-4}	−1.99	0.046			
Point subsidies	-2.76×10^{-4}	9.34×10^{-5}	−2.96	0.003			
Roads	-5.96×10^{-5}	1.01×10^{-4}	−0.59	0.554			
Model 2					209.8	0.0	0.61
Initiated nests	-7.01×10^{-4}	2.74×10^{-4}	−2.55	0.011			
Point subsidies	-2.03×10^{-4}	9.92×10^{-5}	−2.05	0.041			
Roads	-3.08×10^{-5}	9.91×10^{-5}	−0.31	0.756			
Model 3					214.8	5.0	0.05
Successful nests	-2.96×10^{-4}	1.89×10^{-4}	−1.56	0.118			
Point subsidies	-3.08×10^{-4}	9.07×10^{-5}	−3.40	0.001			
Roads	-1.68×10^{-5}	1.05×10^{-4}	−0.16	0.873			
Model 4					215.4	5.5	0.04
Point subsidies	-3.42×10^{-4}	9.00×10^{-5}	−3.81	<0.001			
Roads	-7.42×10^{-5}	1.01×10^{-4}	−0.74	0.462			
Model 5					216.2	6.4	0.02
Number fledged	1.65×10^{-1}	1.54×10^{-1}	1.07	0.287			
Point subsidies	-3.38×10^{-4}	9.12×10^{-5}	−3.71	<0.001			
Roads	-5.05×10^{-5}	1.03×10^{-4}	−0.49	0.625			

† Akaike's Information Criterion.
‡ The difference between the model AIC and the smallest AIC in the set under consideration.
§ Akaike weights.

increasing distance from point subsidies in each model. Distance from roads did not affect raven counts in any model.

Determinants of raven predation risk

Of the 100 baits used in this study, 29 were attacked by ravens. Attack rates declined slightly, but significantly, over time ($\chi^2 = 3.85$, df = 1, $P = 0.049$), and date was included as a nuisance covariate in subsequent analyses. Statistical support was moderately strong for two models, with all other models receiving ΔAIC greater than four units. The model with the largest w_i included the number of ravens counted within 200 m of the point, the distance from the nearest successful nest, and the interaction between these variables (Table 3). The next best supported model added distance to anthropogenic point subsidies to the first model, and all of the two-way interactions between the three variables. The interaction between distance from successful nests and numbers of ravens was well supported

TABLE 3. Comparison of models of the effects of roads, point subsidies, nests with different levels of breeding activity, and numbers of ravens observed on the probability of attack on artificial tortoises. All models include date of the predation risk trial as a nuisance covariate.

Model	df	P	AIC†	ΔAIC‡	w_i§
Close ravens × successful nest	4	0.01	115.19	0.0	0.57
Close ravens × subsidies + close ravens × successful nest + subsidies × successful nest	7	0.02	118.59	3.4	0.11
Close ravens × subsidies × successful nest	8	0.03	119.82	4.6	0.06
Close ravens × roads × successful nest	8	0.07	119.85	4.7	0.06
Close ravens × roads + close ravens × successful nest + roads × successful nest	7	0.07	120.03	4.8	0.05
Close ravens × roads × initiated nests	8	0.08	120.78	5.6	0.04
Successful nest	2	0.48	121.69	6.5	0.02
Subsidies	2	0.08	121.83	6.6	0.02
Close ravens × subsidies × fledged	8	0.03	121.94	6.8	0.02
Subsidies × successful nest	4	0.10	122.52	7.3	0.01
Close ravens	2	0.85	122.96	7.8	0.01
Close ravens + successful nest	3	0.59	123.12	7.9	0.01
Close ravens × subsidies × initiated nests	8	0.09	123.61	8.4	0.01
Close ravens × subsidies	4	0.15	123.67	8.5	0.01
Close ravens × roads × occupied nests	8	0.21	125.78	10.6	<0.01
Close ravens × subsidies × occupied nests	8	0.18	127.68	12.5	<0.01

† Akaike's Information Criterion.
‡ The difference between the model AIC and the smallest AIC in the set under consideration.
§ Akaike weights.

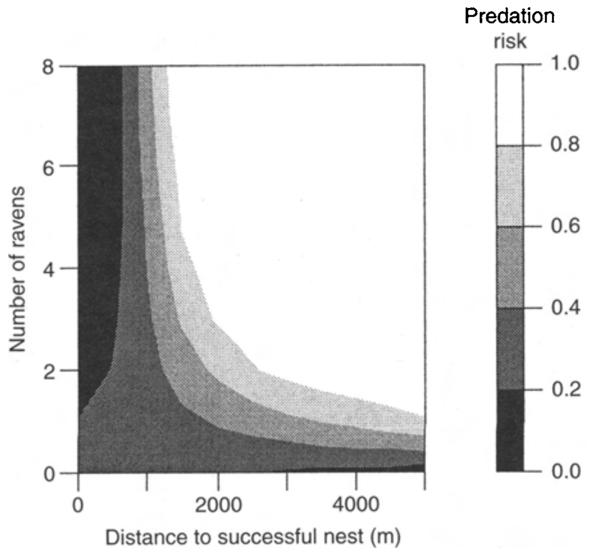

FIG. 2. The effects of distance to the nearest successful raven nest and number of ravens observed within 200 m of the sampling point on risk of predation (i.e., attack by a raven on a styrofoam tortoise model).

(i.e., the AIC increased substantially, and the model became nonsignificant when the interaction term was omitted) and indicated a nonlinear relationship between these variables and predation risk. All univariate models were poor predictors of predation risk. Models including nest success measures (i.e., distance to successful nest or number of chicks fledged) were better supported than models including breeding initiation or nest site occupancy.

The nonlinear relationship between predation risk and the number of ravens observed and the distance from successful nests is best displayed graphically (Fig. 2). Near successful nests (i.e., within 1 km), predation risk decreased as the number of ravens observed increased. Far from successful nests (i.e., >2–3 km), predation risk increased with an increasing number of ravens. Between these distances, predation risk became insensitive to variation in raven numbers. Within the range of variation observed in numbers of ravens and distance to successful nests, the predicted probability of attack changed from <0.1 to >0.9. The next best supported model included distance from anthropogenic point subsidies (Fig. 3). The greatest effect of point subsidies can be seen when few ravens were observed; being near point subsidies increased the probability of attack near successful nests (distance to subsidies = 0 km; Fig. 3A), and being far from point subsidies decreased the probability of attack near successful raven nests (distance to subsidies = 8 km; Fig. 3C).

Spatial distribution of raven predation

The largest area with maximum estimated numbers of ravens was near the Edwards housing area and landfill, with pockets of elevated numbers near other point subsidies, such as the ponds in the southeast and southwest and the Mojave landfill in the northwest (Fig. 4).

Predicted risk levels from the two best supported models were very similar (Figs. 5 and 6) and highly correlated ($r = 0.947$). Areas that had large numbers of ravens but were far from successful nests received the highest predicted risk, and these areas occurred near the landfills (Figs. 5 and 6). Pockets of elevated risk were also found in the vicinity of successful nests in remote areas. The predicted number of ravens at successful nests ranged from 0.012 to 7.119 individuals, which resulted in an estimated predation risk at successful nests (i.e., distance from successful nest = 0) that ranged from 0.004 to 0.442. Adding distance to subsidies did not change the locations of high and low risk, but reduced the probability of attack in the most isolated areas. At successful nests, the estimated probability of attack ranged from 0.004 to 0.595.

Consistency of breeding activity over time

The number of years that a territory was occupied was not affected by distance to roads or by distance to point subsidies (deviance = 3.44, df = 2, $P = 0.179$), but the number of years of successful reproduction was greater near roads and near subsidies (deviance = 38.31, df = 2, $P < 0.001$). Predictions of the number of years of occupation were therefore relatively similar across the distances to roads or subsidies, but the predicted number of years of success was greater near roads and subsidies, with subsidies having the larger effect (Table 4).

DISCUSSION

Determinants of raven numbers

Greater numbers of ravens were observed near human developments. Although our sampling was not stratified by land-use types, this result reflects the association of large groups of ravens in the Mojave Desert with anthropogenic sources of food and water (Knight et al. 1993; W. I. Boarman, *unpublished data*), such as landfills and artificial water bodies. However, because many developments did not attract ravens, regressions of raven counts on distance to human developments, independent of measures of nesting activity, were poorly supported (Model 4 in Tables 1 and 2) in spite of the consistent association of flocks of ravens with human developments. We believe that this is due to a strong influence of raven social structure on the distribution of individuals. Nonbreeding ravens are gregarious and use conspecifics as cues of food availability (Marzluff et al. 1996). In our study population, fledging chicks move to anthropogenic resources that have flocks of ravens, even if other anthropogenic resources are closer (Webb 2001). This conspecific attraction leaves some sites unoccupied in spite of the resources available.

The effect of breeding ravens on the distribution of individuals was well supported, although different

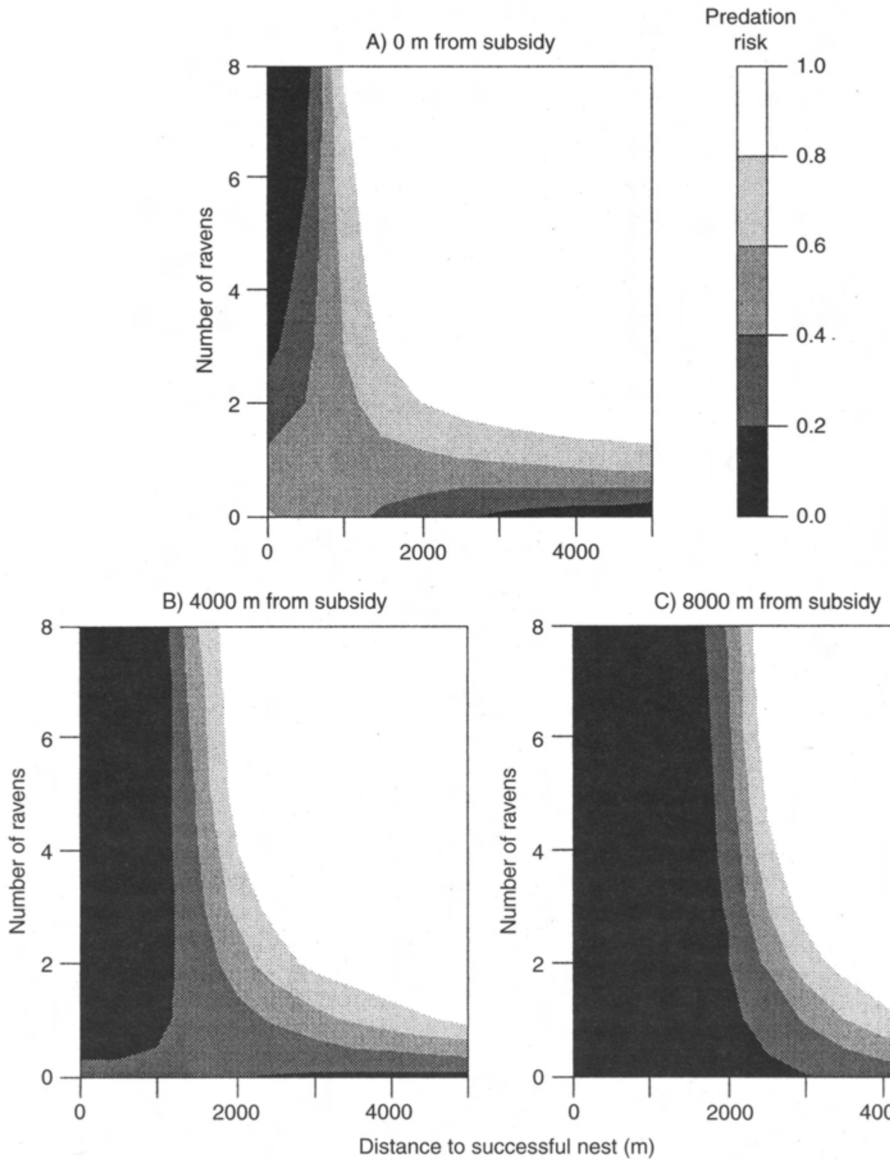

FIG. 3. The effects of distance to the nearest successful raven nest, number of ravens observed within 200 m of the sampling point, and distance from anthropogenic point subsidies (A–C) on predation risk.

measures of breeding activity were associated with ravens observed within 200 m of the sampling point than with those observed in an unlimited radius. Breeding ravens maintain large exclusive territories (5.1 km^2 in coastal southern California; Linz et al. 1992), but their territorial defense can be overcome by large numbers of intruders (Dorn 1972, Boarman and Heinrich 1999). In our study, breeding ravens apparently were not able to defend anthropogenic subsidies, even when the subsidies were small enough to fall entirely within a typical raven territory, such as the Mojave landfill. Furthermore, proximity to occupied nests had relatively little influence on observed numbers of ravens in an unlimited radius (Table 1), whereas proximity to both occupied nests and nests with initiated breeding influenced the numbers of ravens observed within 200 m (Table 2). We believe that this is because areas far from anthropogenic subsidies typically do not attract large groups of nonbreeding individuals, and the only ravens that are commonly observed in isolated parts of the study area are breeding individuals. Individuals that are outside of defended territories and at distant resource subsidies could be included in unlimited-radius counts, thereby weakening the effect of local breeding activity.

Determinants of raven predation risk

The effect of raven abundance on predation risk depended on distance from the nearest successful nest

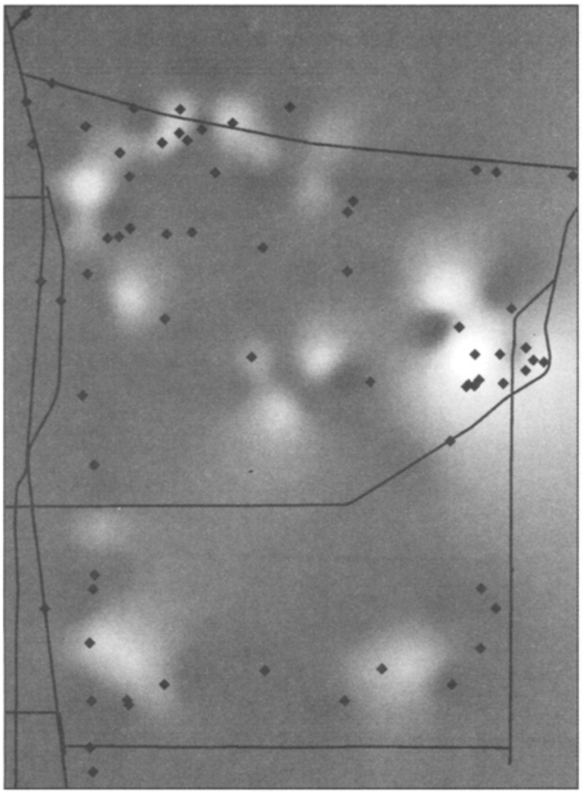

FIG. 4. Interpolated raven numbers, based on ravens observed within 200 m of sampling points. Pixel values range from 0 (black) to 8 (white). Locations of successful nests are marked with diamonds.

(Figs. 2 and 3). Proximity to successful nests was not strongly associated with variation in counts of ravens; thus, successful nests represented a source of predation risk distinct from the effect of raven abundance at a sampling point. Predation risk increased with increasing raven numbers far from successful nests, but decreased with increasing raven numbers close to successful nests. The nonlinear relationship between predation risk, raven numbers, and distance to successful nests can be understood in the context of the social structure of raven populations. Only the breeding adults would pose a predation risk within a successfully defended territory, with risk increasing closer to the nest. Counts of raven individuals typically would be low in most parts of a defended territory, because only the breeding adults would be present. Intruding birds could increase the numbers counted, but intruders are actively chased by the territory holders, and would therefore have little opportunity to contribute to predation risk. Under these circumstances, predation risk would be insensitive to the number of ravens observed, as was seen at intermediate distances from nests. Low predation risk in the presence of large numbers of intruders near successful nests could indicate that increased effort devoted to territorial defense reduced the time devoted to foraging by the territorial birds. However, the combination of close proximity to successful nests and large counts of ravens was rare, and this interpretation is thus tenuous. Points with large counts far from nests, and therefore outside of defended territories, would be subject to predation risk from all of the ravens observed; accordingly, we found that predation risk increased with increasing numbers of ravens when points were far from successful nests.

Although two models with different measures of breeding activity had similar effects on counts of ravens, the two models of predation risk with the greatest support both included distance to successful nests (Table 3). This result is consistent with the need for territorial, breeding ravens to rely more heavily on natural prey than on anthropogenic food subsidies. While chicks are in the nest, ravens behave like central-place foragers and spend most of their time within 400 m of their nests (Sherman 1993). Ravens that either did not initiate breeding, or initiated breeding and failed early in the nesting cycle, would be less strongly tied to a nest site and would be released from satisfying the food requirements of a brood. Thus, even though ravens were known to be present at nests classified as "occupied" and "breeding initiated," these nest sites did not represent predictable predation risk factors.

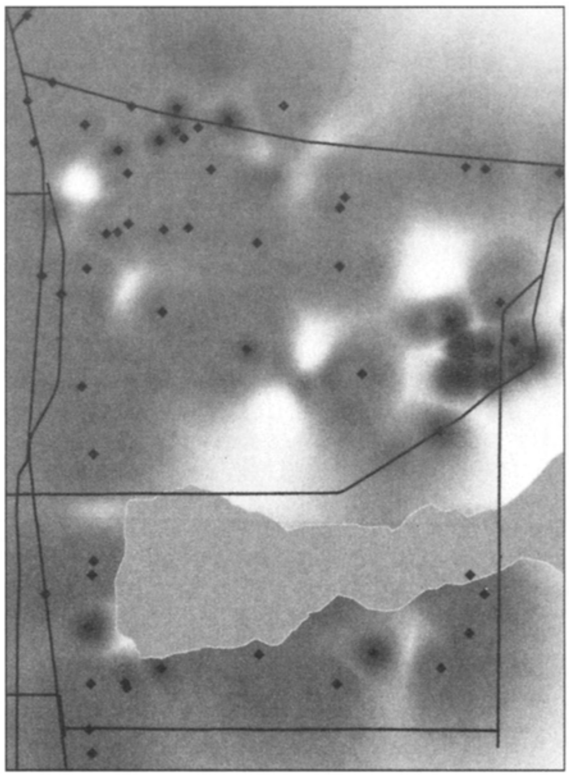

FIG. 5. Estimated predation risk, based on the number of ravens at each pixel (interpolated from point-count data) and distance from the nearest successful nest. Successful nests are marked with diamonds. Probability of attack ranges from 0 (black) to 1 (white). The dry lake (uniformly light gray area) is unsuitable habitat for ravens or tortoises.

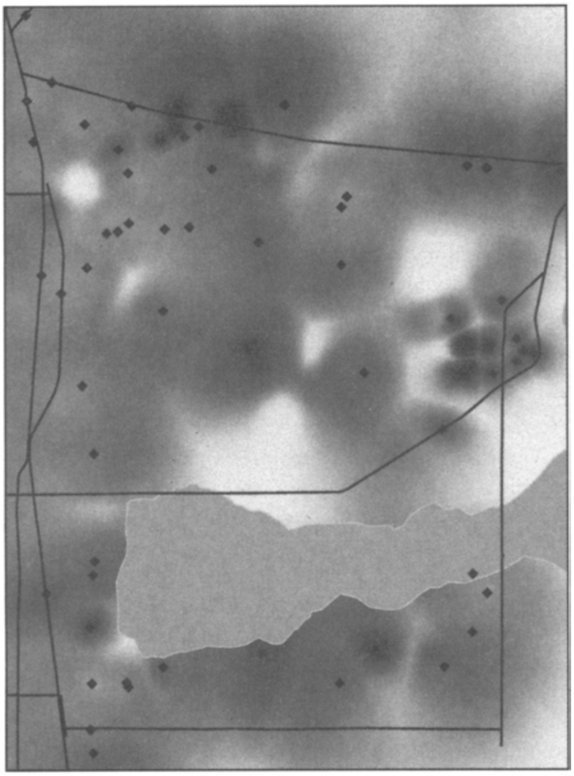

FIG. 6. Estimated predation risk, based on the number of ravens at each pixel (interpolated from point-count data), distance from the nearest successful nest, and distance from the nearest point subsidy. Successful nests are marked with diamonds. Probability of attack ranges from 0 (black) to 1 (white). The dry lake (uniformly light gray area) is unsuitable habitat for ravens or tortoises.

At the outset, we hypothesized that anthropogenic sites that only occasionally attracted small numbers of ravens, but did not consistently attract large flocks of birds, could still expose prey to elevated predation risks. However, we found that proximity to an anthropogenic site had a weak relationship with predation risk compared with the effects of large, persistent flocks of ravens. Although anthropogenic developments are a precondition for the presence of large populations of ravens in the region, not all developments attract large, conspicuous groups of ravens, and thus are not intrinsic risk factors for raven prey.

Predation risk is defined as the probability of being killed by a predator in some defined period of time (Lima and Dill 1990). Attack rates are a component of predation risk that includes both the probability that ravens will encounter the bait and the probability that they will attack it once they find it. The final component of predation risk, the probability that prey will be killed, given a raven attack, is not directly modeled by our methods. However, we assumed that attack rates on our artificial baits were a reasonable index of desert tortoise predation risk because of the varied diet and opportunistic foraging habits of ravens (Engel and Young 1989, Stiehl and Trautwein 1991, Camp et al. 1993, Sherman 1993, Nogales and Hernandez 1997), and because of the limited ability of juvenile tortoises to escape ravens during an attack (Ernst et al. 1994). Predation risk for other species may also be indexed by attacks on our baits, although encounter and attack rates vary by prey species, depending on crypsis and palatability (Brodie 1993). However, to derive quantitative estimates of predation risk for the desert tortoise or any other raven prey species (e.g., for use in predator–prey models), attack rates on artificial baits would need to be related to encounter, attack, and escape rates for living animals.

Spatial distribution of raven predation risk

Although proximity to anthropogenic subsidies was supported as an important factor in determining predation risk (Table 3), the effect was small and parallel to the effects of observed raven numbers. The predicted values from the models that included anthropogenic subsidies (Fig. 6) and excluded anthropogenic subsidies (Fig. 5) were so similar ($r = 0.95$) that we will hereafter discuss the two patterns simultaneously.

Areas of elevated predation risk occurred near large groups of ravens that were distant from successful nests, as well as near successful nests that had relatively small numbers of ravens in the vicinity (Figs. 5 and 6). Observed numbers of ravens had the greater effect, with probability of attack nearing 1.0 (100%) near the largest raven groups at landfills. However, the probability of raven attack at successful nests reached 0.44 and 0.59 for predictions that excluded or included distance from anthropogenic sites, respectively. Because human developments are maintaining such artificially

TABLE 4. Predicted occupation and success of territories (numbers of years out of five years) at two distances to point subsidies and two distances to roads.

Distance to roads (km)	Distance to point subsidies (km)	Territory predictions (mean ± 1 SE)	
		No. occupied	No. years successful†
0	0	3.92 ± 0.29	1.89 ± 0.23
10.5	0	2.99 ± 0.63	0.42 ± 0.18
0	14	3.14 ± 0.80	0.28 ± 0.14
10.5	14	2.40 ± 0.58	0.06 ± 0.03

† The number of years successful was significantly associated with both distance to roads and distance to point subsidies.

high raven populations (Boarman 1993), we considered predation risk that was attributable to ravens to be, by definition, an artificially elevated predation risk by a subsidized predator. Although both breeding and nonbreeding ravens were associated with elevated predation risk, the distinctly different patterns of predation risk from nonbreeding vs. breeding ravens suggest different patterns of effect on prey populations.

For a species such as the desert tortoise, which has limited ability to evade ravens, the spatial distribution of predation risk should be closely related to spatial variation in mortality and predation pressure. Different theories relate predation pressure from subsidized predators to prey population dynamics, depending on the degree of spatial segregation between predator and prey. The high predation risk observed near large, persistent flocks of ravens at anthropogenic sites is likely to act as "spillover" predation (Holt 1984, Schneider 2001). If the predator's habitat is sufficiently intermixed with the prey's habitat, then spillover predation can extirpate prey (Holt 1984, Schneider 2001). However, as long as the predator's habitat remains small relative to the area of habitat that is unsuitable for the predator, this pattern of predation will leave refugia of low predation risk (Chapman et al. 1996). Breeding ravens also appear to produce a spatially restricted risk of predation within a breeding season (Fig. 5). However, the spatial distribution of breeding activity is much less consistent over time than the spatial distribution of groups of nonbreeding ravens, and is less likely to leave prey refugia. For example, 62% of the 305 nests that we observed were occupied every year that they were observed (range 1–5 years of observation), but only 18% of the 54 nests observed in all five years of the study were occupied every year. None of the nests occupied for five years was successful every year, and only 10% were successful for four years out of the five (Kristan 2001). Our results suggest that as the spatial distribution of successful nests changes over time, the location of areas of high predation risk due to breeding ravens also changes from year to year. Juvenile desert tortoises have soft shells and are within the vulnerable size range for raven predation for 5–6 years (Ernst et al. 1994). Consequently, the effects of raven predation risk would average over several years, further reducing the effectiveness of refugia, and the only potential refugia would be in areas far from human developments and in habitat that is unattractive to ravens.

Predators that occupy the same habitat as the prey can still be subsidized if the prey base is sufficiently diverse (Erlinge et al. 1983), or if alternative prey species that are more tolerant of heavy predation are available to sustain a large predator population (Courchamp et al. 2000). This pattern of predation has been called "hyperpredation," because the predator population is insensitive to reductions in the target prey population size, and the predator can continue to depredate the target prey at very low prey population sizes. Ravens in the Mojave are supported by human resources, but breeding ravens occupy expanses of undeveloped habitat, where their predatory effects will more closely resemble hyperpredation than spillover predation. Models of the effects of predation pressure on prey populations usually make the simplifying assumption that all individuals of a predator species exhibit the same predatory behavior (Holt 1984, Courchamp et al. 2000, Schneider 2001). Our results suggest that behaviorally flexible species can simultaneously produce more than one pattern of predation, and may thus impose a greater threat of extinction for their prey.

Conservation implications

Anthropogenic point subsidies and roads affect raven breeding success (Kristan 2001), but do not increase predation risk unless these developments are associated with large groups of ravens. Maintaining large areas of undeveloped habitat should protect prey from these large groups of ravens. Single successful raven nests pose a comparatively smaller direct threat to prey, but raven nests are more evenly spread through the landscape, and over time may have similar overall impacts on a prey population. Decreasing the regional raven population size, or decreasing raven reproductive success in tortoise habitat, may be necessary to reduce the predation risk from breeding ravens.

We do not know that ravens have contributed to the decline of desert tortoises in our study area. However, abundant predators are capable of suppressing population growth of even highly productive prey such as rabbits when they are at low population levels (Newsome et al. 1989). Likewise, the commensal raven populations supported by human activities in the West Mojave Desert may inhibit recovery of desert tortoise populations. To the extent that human activities facilitate raven occupation of this area, the impacts of both breeding and nonbreeding Common Ravens on desert tortoises can be considered an indirect effect of human developments in the desert.

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Attachment D

Reducing Predation by Common Ravens on Desert Tortoises in the Mojave and Colorado Deserts

Prepared for:

Bureau of Land Management

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

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EXECUTIVE SUMMARY

Conflicts between humans and natural populations often result from habitat fragmentation and degradation that accompanies human activities. Common raven populations in the Mojave Desert have benefited by human-provided resources; they've expanded precipitously in recent years. Because ravens prey on juveniles of the threatened desert tortoise, they have become the focus of management concerns to help recover dwindling tortoise populations. I have outlined herein a series of management recommendations designed to reduce raven predation on desert tortoises thereby facilitating juvenile tortoise recruitment into the population of reproductive adults. The recommendations are based on the best available scientific information and are intended to provide a basis for a long-term reduction in raven impacts.

The recommendations fall into four basic categories. (1) Modify anthropogenic sources of food, water, and nesting substrates to reduce their use by ravens. This includes modifying landfill operations, septage containment practices, livestock management, and other commercial and private practices that help facilitate raven survival and dispersal by providing food and water. Most of these measures are long-term actions designed to reduce the carrying capacity of the desert for ravens. This action is critical and must be done over very large areas. (2) Lethal removal of ravens by shooting or euthanizing following live trapping. Specific ravens known to prey on tortoises would be targeted as well as all ravens found foraging within specific high-priority desert tortoise management zones (e.g., Desert Tortoise Natural Area, DTNA). These actions would primarily be deployed on a short-term emergency basis to give specific tortoises populations a necessary boost until other measures become fully implemented and achieve their goals. (3) Conduct research on raven ecology, raven behavior, and methods to reduce raven predation on tortoises. Results of these studies would be used to design future phases of the raven management program. (4) All actions should be approached within an adaptive management framework. As such monitor, actions should be designed as experiments so that monitoring of actions will yield reliable and scientifically sound results. Coordinating and oversight teams should be convened to facilitate cooperation and coordination among agencies and to ensure that the actions are being implemented effectively.

Recommendations made herein were developed to help recover tortoise populations by reducing raven predation on juvenile tortoises. If the recommendations made are implemented in concert with actions reducing other causes of mortality, ill health, and lowered reproductive output, they should aid in the long-term recovery of desert tortoise populations. Many important aspects of raven population dynamics, raven predation on tortoises, and how to manage raven populations and behavior are as yet unknown. Because of this, any raven management program must be implemented within an adaptive management framework. Doing so would allow for sufficient flexibility to modify the program as new information is gained.

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INTRODUCTION

As humans increasingly populate natural areas, more conflicts between people and animal populations arise and conservation actions become more common. Vertebrate populations can decrease and increase as a result of human-induced habitat alterations and degradations. Those vertebrate populations that increase, also known as "abundant vertebrates" (Goodrich and Buskirk 1995), sometimes cause problems for other native vertebrate populations through predation, competition, disease transmission, and hybridization. Predatory species whose populations thrive on human-provided resources (i.e., subsidized predators) may have particularly acute effects on some prey species. Management actions are often needed to reduce the effects, but the most effective actions in the long term are those that alter the root cause for population increase rather than attempting to directly control the predator population (Goodrich and Buskirk 1995).

Common Ravens (*Corvus corax)* in the Mojave and Colorado Deserts of California are classic subsidized predators. Their populations in the California deserts have increased by over 1000% over a recent 25-year period (Boarman and Berry 1995). These increases are a result of human-induced alterations, which have increased and stabilized food and water sources and have increased the number of nesting sites available to ravens (Boarman 1993a). Ravens make heavy use of garbage at landfills, water from many sources, and power towers, billboards, and other anthropogenic structures for nesting. Ravens prey on myriad food items including grains, carcasses, and live animals.

Ravens are a concern to resource managers because they prey on juvenile desert tortoises (*Gopherus agassizii*), a Federally- and state-listed threatened species, and this predation has resulted in reduced survival rates of juvenile tortoises (Boarman 1993a). The long-term consequence of the loss of juveniles is lowered recruitment of new individuals into the breeding population, which likely significantly affects the stability and recovery of some tortoise populations (Fish and Wildlife Service 1994). Many populations of the desert tortoise in California have declined drastically in recent years (Berry 1990, Fish and Wildlife Service 1994, Corn 1994). Contributing factors include disease, habitat loss and fragmentation, highway mortality, and predation by ravens. While many other human activities result in adverse impacts on adult components of tortoise populations, efforts to reduce these impacts will be fruitless unless tortoise populations can recruit young (Fish and Wildlife Service 1994, Congdon et al. 1993). Conversely, if little or nothing is done to reduce adult mortality, improve reproduction, and reverse declining health of adult tortoises, raven management will have little impact on long-term tortoise recovery (Frazer 1993, Doak et al. 1994). Without action to counter the losses of young individuals in tortoise populations, declines will continue.

A comprehensive, long-term program to reduce the effects of raven predation on tortoise and other animal populations should include the following six goals. (1) Reduce mortality of juvenile desert tortoises caused by raven predation. (2) Facilitate increased recruitment (i.e., survival) of juvenile desert tortoises into breeding age classes (i.e., subadult and adult). (3) Improve understanding of the ecology and behavior of raven populations through research and monitoring. (4) Acquire additional data on means of reducing raven predation of juvenile desert tortoises. (5) Implement those measures that are found to be effective for raven management and removal. (6) Monitor raven and tortoise populations using scientifically credible methods to determine the effectiveness of program actions at reducing rates of raven predation and facilitating recruitment of tortoises to breeding age.

BACKGROUND

PREDATORY BEHAVIOR OF RAVENS ON TORTOISES

Ravens are opportunistic feeders obtaining their food in three primary ways: scavenging, live hunting, and kleptoparasitism (stealing; Boarman and Heinrich 1999, Sherman 1993). In the Mojave desert, ravens are known to eat many things including lizards, rodents, invertebrates, grains, birds, snakes, and tortoises (Camp et al. 1993, Kristan et al. in prep.).

Evidence that ravens prey on juvenile desert tortoises (<100-mm midline carapace length [MCL]) comes from several direct observations and strong circumstantial evidence (Boarman

1993a, Morafka et al. 1997, Boarman and Hamilton ms). For instance, former Bureau of Land Management (BLM) employees Ted Rado and Jim Farrell and U. S. Navy employee, Tom Campbell, have all reported observing ravens attacking tortoises (BLM 1990a). Beneath an active raven nest, Dr. Richard L. Knight (Colorado State Univ.) found a juvenile tortoise that was missing two legs and had been eviscerated, but was still alive (Boarman 1993a).

Circumstantial evidence is mostly in the form of tortoise shells found beneath active raven nests and shells that bear evidence of raven predation being found beneath likely perch sites and lying on the desert floor. The primary way ravens eat tortoises is by pulling muscle and visceral material through a hole pecked in the shell (58%) or by pulling out a leg or head (35%; Boarman and Hamilton ms.; see also Berry 1985). The remains of juvenile desert tortoises have been found in many places including: the base of transmission towers, at isolated fence posts, at mining claim stakes, next to road barricades, under Joshua trees (*Yucca brevifolia*), at the bottom of wash embankments, and on hilltops (Campbell 1983, Berry 1985, Rado 1990, BLM 1990a, Boarman and Hamilton ms.). Such remains have been found throughout the California deserts (Boarman and Hamilton ms) and in the Eldorado and Piute Valleys, Nevada (McCullough 1995, pers. obs.).

An exceptionally high concentration of tortoise shells was found beneath a raven nest near the Kramer Hills in the West Mojave. In 1987, Woodman and Juarez (1988) collected remains of 190 juveniles killed between 1984 and 1987 and concluded that ravens accounted for 185 (97%) of the deaths. In the spring of 1988, they collected additional fresh remains of juvenile desert tortoises from the nest and perch area, bringing the total number of juveniles killed between approximately 1984 and 1988 to 250. Collections of 50 to 150 shells have been found at several other sites including at a cliff nest in Chemehuevi Valley (John Wear cited in Berry 1985; Jim Farrell 1989, cited in BLM 1990a; and Boarman unpubl. data.), two to three powerline nests in Ward Valley, and one powerline nest in Fenner Valley (BLM 1990a). Tortoise populations are difficult to estimate and the method most often used (stratified Lincoln Index using mark-recapture data) is highly questionable (Corn 1994). Furthermore the juvenile component of desert tortoise populations is notoriously difficult to sample (Berry and Turner 1986, Shields 1994) so it is difficult to place these numbers in the context of overall tortoise demography.

Estimates of total tortoise population densities in the 1980s ranged from 10 - 84/ 0.5 ha and estimates for all tortoise < 140 mm (MCL) ranged from 2 - 63/ 0.5 ha (from tables presented in Berry 1990). We used 0.5 ha because Sherman (1993) showed that ravens in the eastern Mojave Desert spent 75% of their foraging time within 400 m of their nest, which, assuming a round territory centered on the nest, equals 0.5 ha. So, a loss of 10 juvenile tortoises from around a single raven nest may represent approximately 15 to 100% of the juvenile component of the immediate population.

As ravens are well known as scavengers (Boarman and Heinrich 1999), it is likely that some of the shells reported above were scavenged rather than depredated. However, several lines of evidence suggest that predation is the main source of mortality for these shells (Boarman 1993a). First, many of the shells found beneath raven nests and at other locations show evidence of being pried open while the shell was still very soft (Boarman and Hamilton ms.). The shells of live tortoises younger than approximately seven years of age are soft, but they harden rapidly after death (Morafka pers. comm.). If a shell is pecked or pried open after hardening, it would crack, but most shells found are bent, not cracked.

Second, observations are rarely made of ill, moribund, or recently dead juveniles during the thousands of person hours spent surveying for tortoises each year since the mid-1970's. Observations of ill, moribund, and recently dead adults are relatively common in some areas. If juvenile tortoises are dying at rates high enough to be found in such large numbers beneath raven nests and perch sites, we would expect to find more ill, moribund or recently dead ones on tortoise surveys. Additionally, until 1988, very few sick or disabled tortoises were observed on 16 BLM study plots in the California deserts (Berry 1997). In 1988, two tortoise populations were discovered with diseases, one at the DTNA and the other at Chuckwalla Bench (Jacobson et al. 1991, 1994, Homer et al. 1998). These diseases may be the primary causes of mortality among those populations Berry 1997). However, large numbers of dead juvenile desert tortoises were found under raven perching and nesting sites in areas where incidence of diseased tortoises has not yet been documented (Berry 1985, Boarman ms). Thirdly, there are at least two instances of live, apparently healthy juveniles being marked as part of separate studies then being found dead one or two months later and showing typical signs of raven predation (Woodman and

Juarez 1988, Boarman unpubl.). Finally, ravens are opportunistic feeders and are unlikely to pass up a relatively defenseless food item when found.

However likely predation on juvenile tortoises is, there is no way of knowing for certain what proportion of tortoise shells found beneath raven nests were actually scavenged versus depredated. When managing a threatened or endangered species, we must rely on the best available data and, when little or no data are available, it may be best to err on the side of the threatened or endangered species rather than risk greater population declines due to inaction. Most management decisions can be reversed or relaxed as new information is obtained, but a slip to extinction or critical endangerment may be irreversible.

There is little reason to suspect that other predators are responsible for killing the large number of tortoises found. Other potential avian predators on juvenile desert tortoises in California include: golden eagles (*Aquila chrysaetos*), greater roadrunner (*Geococcyx californianus*), red-tailed hawk (*Buteo jamaicensis*), burrowing owl (*Athene cunicularia*), and loggerhead shrike (*Lanius ludovicianus*). Berry (1985) reported finding tortoise shells beneath 12 out of 34 golden eagle nests in tortoise habitat, but the shells were all larger (129 to 263 mm MCL) than those found beneath raven nests. Berry (1985) reports one freshly killed tortoise (50 mm MCL) found with roadrunner tracks around it. Jim Cornett (pers. comm.) photographed a roadrunner investigating, shaking, then leaving behind a live juvenile. Roadrunners apparently shake then swallow their prey, they do not peck at them. One tortoise shell was found beneath a red-tailed hawk nest in 1992 (Richard J. Camp, pers. comm.), and Fusari (1982) reported finding two shells beneath a probable red-tailed hawk perch. Boarman and Hamilton (ms) found no tortoise shells beneath 54 red-tailed hawk nests. Boarman (pers. obs) found an old juvenile shell, bearing signs typical of raven predation, next to an active burrowing owl nest in 1992. An unknown avian predator (based on holes poked into the shell) killed several hatchling tortoises, which were part of a study conducted by Morafka et al. (1997). Loggerhead shrike pellets were found nearby, but they did not appear to contain tortoise remains (R. Knight, pers. comm.). So, whereas other avian species may occasionally prey on tortoises, no bird species other than ravens are known to eat juvenile tortoises (<100 mm MCL) in any great quantities.

IMPACTS OF RAVEN PREDATION ON DESERT TORTOISE POPULATIONS

The best way to determine the effect raven predation has on tortoise populations is to evaluate data from actual tortoise populations. Data from permanent tortoise study plots provide a glimpse at the levels of raven predation likely occurring on juvenile desert tortoises in the California deserts (Berry 1985; BLM 1990a) and how those levels affect tortoise populations. They show apparent gaps in representation among juvenile and immature size classes in some populations, particularly in those where predation pressure from ravens is presumably high (e.g., West Mojave). Since the mid- to late 1970's and early 1980's, raven predation appears to have had significant adverse effects on desert tortoise populations. Specifically, ravens reportedly have contributed to: (1) reduced numbers of juvenile tortoises in the hatchling to eight-year classes, (2) reduced recruitment of tortoises into the larger and older size-age classes (e.g., tortoises from 9 to 20 years of age), (3) altered the size-age class composition of the population to favor adults, and (4) overall population declines from multiple sources (BLM 1990a). Examples of the degree and nature of the impacts at five permanent study plots in the Western Mojave Desert and at two study plots in the northeastern Colorado Desert are presented in BLM (1990a).

But these data have major limitations. Of greatest importance is that the methods used to survey for tortoises is best suited for larger ones (<140 mm MCL), so juveniles are underrepresented. Also of great importance, the method employed for determining tortoise density is imprecise (Corn 1994), yielding very weak estimates of age class structure, so little inference can be made from the data.

The next best way to evaluate the likely impact ravens have on tortoise populations is through modeling. When juveniles of long-lived animals such as tortoises, with delayed maturation approaching 20 years old, experience heavy mortality, the population becomes unstable (Dunham et al. 1989, Congdon et al. 1993). The problem is greatly exacerbated when mortality among adults is increased as evidenced in populations of Blanding's turtles (*Emydoidea blandingii*; Congdon et al. 1993) and snapping turtles (*Chelydra serpentina*; Brooks et al. 1991). To maintain stability, a desert tortoise population may require juvenile survivorship of approximately 75% per year. But, in populations where adult survival is depressed and the population is declining, juvenile survivorship must be about 95 to 97% for the population to recover (from figures in Congdon et al. 1993). In such populations where raven predation is high, a sufficient number of juvenile tortoises are probably not surviving to reach the larger size and older age categories. The probable lack of sufficient recruitment of young tortoises into the adult breeding population in some areas is of considerable concern.

Ray et al. (1993), presented a demographic model based on an increasing population (r=1.02) of tortoises at Goffs, California. Their stage-structured, space-structured model predicted that juvenile mortality in excess of 25% per year is required before the modeled population experiences a decline (r<1.00). If the modeled population were stable (r=1.00), excess juvenile mortality would have to be 15% or greater to maintain stability. Ray et al. (1993) concluded that ravens are not likely to be a major problem for tortoise populations. Their model as presented has limited applicability because most desert tortoise populations addressed in this plan are experiencing overall population declines (Berry 1990, Corn 1994), increased adult mortality from several sources, and juvenile mortality from causes other than just raven predation (Fish and Wildlife Service 1994). These are all factors that suggest raven predation may be an important cause for concern, one that may be both causing population declines and preventing recovery.

Finally, Doak et al. (1994) also modeled desert tortoise populations using a size-structured demographic model and incorporating important variability in demographic parameters and correlations among vital demographic rates. One of their conclusions was that conservation actions should focus on adult females rather than just juvenile tortoises. Whereas they did question the value of raven control, they state that "programs to reduce raven predation of small tortoises…are unlikely to significantly change current population trends unless combined with other, more effective, measures" (p. 458, Doak et al 1994).

These three demographic models make somewhat conflicting conclusions regarding the relative importance of reducing juvenile mortality. A critical evaluation of the three competing models using current data is needed. However, it is clear that reduction of raven predation will probably not work if efforts to increase adult survival are not implemented successfully.

RECOMMENDATIONS ACTIONS FOR REDUCING RAVEN PREDATION ON DESERT TORTOISES

The primary purpose of any comprehensive raven management program should be to increase survival of juvenile tortoises by reducing raven depredation, thereby facilitating recruitment of young tortoises into the reproductive population. Under such a program, raven management and removal should be undertaken to: (1) reduce mortality of juvenile desert tortoises caused by raven predation; (2) increase recruitment (e.g., survival) of juvenile desert tortoises into sub-adult and adult age-classes; (3) improve understanding of the ecology of the raven through research and monitoring; (4) acquire additional data on means of reducing raven predation of juvenile desert tortoises; (5) implement those measures that are found to be effective for raven management and removal; and (6) monitor tortoise and raven populations to determine the effectiveness of program actions at reducing raven predation rates. To achieve the latter, actions should be set up in an experimental fashion to compare areas with and without raven removal.

My recommendations consists of four sets of actions: alteration of raven habitat (7 proposed actions), lethal removal of individual ravens (2 proposed actions), research (6 proposed actions), and adaptive management (2 proposed actions). In a true adaptive management mode, the program would consist of multiple phases with successive phases depending on the outcome and success of earlier phases. Herein I discuss only a logical first phase.

ACTIONS TO ALTER RAVEN HABITAT

1. Reduce the population density of ravens and number of birds that may take tortoises by reducing the availability to ravens of solid wastes at sanitary landfills.—Landfills provide an important source of food year round for ravens (Boarman et al. 1995, Kristan and Boarman 2001a, b, in. prep.). This food subsidy is particularly important during times of normally low natural food availability and likely helps to increase survivorship of ravens resulting in an increased population. Landfills likely provide food for nestlings and breeding females in the spring, thus facilitating greater survival and reproductive success (Kristan and Boarman 2001a,

Webb 2001). Ravens are known to fly up to at least 65 km in a day (Engel and Young 1992, Boarman unpubl. data). Furthermore, throughout the year ravens may travel over several hundred kilometers (Stiehl 1978, Heinrich et al. 1994). Hence, any given landfill may influence raven populations over a broad area. Preliminary analysis of mtDNA data indicates that birds at Fort Irwin are genetically equivalent to those at Edwards Air Force Base (EAFB) 120-km away (Fleischer and Boarman in prep.). Because ravens move about seasonally, and individuals eat a varied diet, birds from landfills are likely to forage in tortoise habitat many miles away and may feed on juvenile tortoises. Furthermore, water is a critical resource for ravens in the desert. Any water source close to a landfill will be heavily used by ravens and may make that landfill highly attractive to ravens (Boarman et al. 1995, unpubl. data). Finally, coyotes at landfills benefit ravens in two ways, they (i) tear open otherwise inaccessible food containers (pers. obs.), and (ii) readily dig through end-of-day cover thus exposing garbage to ravens (pers. obs.).

Because of the heavy use of landfills by ravens, intense efforts must be placed on reducing raven access to organic wastes at landfills. This can best be accomplished by (i) ensuring effective cover of waste (either ≥ 6 inches cover or complete cover of garbage with tarps temporarily) multiple times each day, (ii) erecting coyote-proof fencing, (iii) rendering raven-proof all sources of standing water at the landfill, and (iv) keeping truck cleaning areas and temporary storage facilities clean and free from organic wastes and standing water. A combination of transfer stations, regional landfills, trash compaction, and alternative temporary covers (e.g., canvas tarps) may be an efficient way to manage landfills.

These recommended measures are not entirely foreign to the California deserts. California Integrated Waste Management Board and county departments of health are more strongly enforcing regulations requiring effective end of day coverage at some landfills (pers. obs.). Some counties (e.g., San Bernardino) and landfill operators (e.g., EAFB) are compacting garbage into blocks before depositing in the landfill and using alternative covers (i.e., tarps) to temporarily cover garbage until dirt can be used. This latter practice can significantly increase a landfill's waste capacity. Some landfills appear to be greatly reducing the number of ravens present by employing these methods (pers. obs.), but no scientific data have been collected except at EAFB (Boarman unpubl. data). An additional advance currently being employed in

San Bernardino County, California, is to reduce the number of landfills by collecting garbage in well-maintained trash bins at community transfer stations. The garbage is then transported to one of three regional landfills where it is permanently deposited.

2. Reduce the availability to ravens of organic wastes outside of landfills.--In addition to landfills, ravens obtain food from many different human-sources such as dumpsters behind restaurants and grocery stores, open garbage drums and plastic bags placed on the curb for garbage pickup, excess grain dropped from trains, and livestock carcasses at dairies (pers. obs.). Additionally, some ravens subsist on pet food left out all day for pet dogs and cats and on food intentionally left out for ravens (Goodlett pers. comm., Webb pers. comm.).

A number of measures can be taken to accomplish this objective. (i) Businesses and residents should be encouraged or required to use self-closing trash bins at transfer stations and roadside rest stops, and behind restaurants, gas stations, and grocery stores; use raven-proof garbage drums at houses and other facilities; and avoid use of plastic bags for curb-side pick up in residential areas. (ii) Livestock operators should be encouraged to reduce availability of cattle feed, carcasses, afterbirths, and insects at feedlots and dairy farms. (iii) Government and non-governmental organizations should implement public education programs and other means to reduce the number of citizens who purposely feed ravens or who inadvertently do so by leaving pet food out where ravens can easily access it. (iv) BLM and county governments need to aggressively clean up illegal dumpsites that contain organic wastes. It is not known what proportion of raven forage is received from these targeted sources nor what effect their reduction would have on raven populations. However, reproductive success is higher nearer to residential areas (Kristan and Boarman 2001a, Webb 2001). In a similar study in a very different habitat (Olympic Peninsula, Washington), Marzluff and Neatherlin (ms) showed that reproduction is higher near human sources as well, but not survivorship.

3. Reduce the availability of carcasses of road-killed animals along highways in tortoise habitat.— Ravens are well known for the habit of eating road-killed animals along highway edges (Boarman and Heinrich 1999). Road kills abound along highways in the deserts (Rosen and Lowe 1994, Boarman and Sazaki 1996). It is unknown what proportion of the entire diet

this food source comprises, but it may be substantial for birds nesting near highways. This food source may not be responsible for large increases in regional raven population size, but may help to facilitate successful nesting along roads where there otherwise may not be adequate food to support a raven family (Knight and Kawashima 1993, Kristan and Boarman 2001a). These nesting birds may also prey on tortoises in the vicinity of their nest, although few tortoises are found within approximately 0.8 km of heavily traveled highways (Boarman and Sazaki 1996) and proximity to roads does not increase predation risk to tortoises from ravens (Kristan and Boarman 2001b). In spite of these points, tortoise shells bearing evidence of being depredated by ravens have been found beneath raven nests along highways (Boarman and Hamilton in prep.).

If it is shown that some ravens derive most of their food from road kills, barrier fences (3- to 6–mm mesh hardware cloth; Boarman and Sazaki 1996) should be erected along major roads and highways to prevent animals from getting killed on roads. This would thereby reduce a steady source of food for ravens away from other sources of food such as landfills. Several highways in the southwest have already been equipped with fences to reduce tortoise mortality along roads, but in many cases the mesh size is inadequate to prevent most smaller reptiles and rodents from attempting to cross and subsequently dying on roads. Boarman and Sazaki (1996) found that 6-mm mesh barrier fence reduced vertebrate mortality by 90%. The fences should be built in concert with culverts to prevent further population fragmentation of tortoise and other animal populations.

4. Reduce the availability of water to ravens.— Water is exceptionally important to ravens in the desert. In the eastern Mojave Desert, Sherman (1993) found that breeding ravens left their territories everyday to drink water several miles away. Sewage containment sites, irrigation, stock tanks, golf course ponds, leaking faucets, and other sources of standing water provide ravens with a year-round water (pers. obs.). The only ravens Knight et al. (1998) found on a study of bird use of springs and stock tanks were recorded at stock tanks; 80% of them were drinking when first sighted. The presence of these unnatural sources of water may facilitate a higher raven population by providing water during periods of normally low availability. They also allow ravens to exist farther out in parts of the desert isolated from natural sources of water.

The large movements of ravens on a daily and seasonal basis means that human-based water sources may influence raven populations over a broad area.

Reducing availability to ravens of anthropogenic sources of water could be accomplished by modifying sewage and septage containment practices in four possible ways: (i) covering the water, (ii) altering the edge of the pond with vertical walls, (iii) placing monofilament line or screening over the entire pond, or (iv) adding methyl anthranilate, or other harmless taste aversive chemicals to standing water sources. (v) Availability of other sources of water (e.g., stock tanks, dripping water faucets, golf course ponds, tamarisk irrigation lines, etc.) could also be reduced. Emphasis should be placed on reducing availability of water during the spring, when ravens are nesting, and summer, when water demands for ravens are high but natural sources are low. The needs to reduce raven populations must be balanced against the need to provide water for other forms of wildlife that depend on anthropogenic sources of water (e.g., migratory birds), so a multispecies evaluation should be made before implementing this action (e.g., Knight et al 1998).

5. <u>Reduce the impact ravens have on tortoise populations at specific locations by removing raven nests.</u>--The majority of raven predation on tortoises probably occurs in the spring (April and May) when tortoises are most active and ravens are feeding young (Boarman and Heinrich 1999, Boarman and Hamilton ms). Parent ravens spend most of their time foraging within approximately 0.8 km of their nest (Sherman 1993); hence this is probably the zone of greatest impact on the tortoise population (Kristan and Boarman 2001b). Removing raven nests with eggs in them would probably have the greatest benefit because: (i) it is likely too late for the ravens to renest in the same year, and if they do they are less likely to be successful (Kristan and Boarman 2001a, Webb 2001; cf. Marzluff et al. 1995); (ii) it is before chicks have hatched, when ravens have 3 to 7 additional mouths to feed; and (iii) it is early enough that not too many tortoises would have been eaten (as opposed to waiting until after several tortoise shells are found). Marzluff et al. (1993) showed that ravens in Idaho often re-laid within two weeks after eggs were removed, but clutches were 12% smaller and number there were 58% fewer fledglings in those re-laid broods. Removing nests outside of the breeding season is likely to have less effect on the raven populations or their predation on tortoises since they may readily rebuild at

the beginning of the next nesting season. However, recent evidence from EAFB showed that birds with no nest in their territory at the beginning of the breeding season were less likely to commence nesting than those who already had an intact nest (Kristan and Boarman 2001). Hence, if experiments show that removing nests outside of the breeding season does reduce the probability of nest initiation in the next year, then nests should also be removed then.

This objective can best be accomplished by removing raven nests (i) in specific areas where raven predation is high and tortoise populations are targeted for special management, and (ii) during the egg-laying phase of the raven's breeding cycle (any nestlings found should be euthanized using standard humane measures; Gaunt and Oring 1997). It would also be valuable to experimentally remove nests outside the breeding season to see if ravens fail to renest in the following year. If this is successful, then nest removal can occur outside the breeding season. Other species of raptors nest in raven nests (and vice versa) and raven nests often resemble other raptor nests, so caution should be taken not to greatly impact these other bird populations (e.g., great horned owls and red tail hawks).

6. Avoid constructing new nesting structures and reduce the number of existing nesting structures in areas where natural or anthropogenic substrates are lacking.--The majority of raven predation on tortoises takes place during the spring and is probably accomplished by breeding birds (Boarman and Hamilton ms). Because parent ravens spend most of their time foraging within approximately 0.8 km of their nests (Sherman 1993, see also Kristan and Boarman 2001a), structures that facilitate nesting in areas ravens otherwise could not nest in may pose a danger to nearby tortoise populations particularly if they are well away from other anthropogenic attractants. Whereas the majority of ravens nested in Joshua trees at and near EAFB, a significant number also nested on myriad anthropogenic structures (e.g., radar towers, high-tension power poles, telephone poles, buildings, etc.). Many of these structures can be modified to prevent raven nesting, but some cannot. Telephone and power towers of solid construction rather than lattice and with diagonal crossbars instead of horizontal ones would be harder for ravens to nest on. Because ravens hunt primarily from the wing and will readily perch on small shrubs and the ground, there is little value in modifying structures to prevent perching.

The availability of nesting sites can best be reduced by not erecting new structures (e.g., power towers, telephones, billboards, cell phone towers, open warehouses or shade towers, etc.) within tortoise management areas where alternative natural nesting substrates (e.g., Joshua trees, cliffs) do not already exist within approximately 3 km. If they must be built, structures should be designed to prevent ravens from building nests on them. Additional reductions in tortoise losses to ravens can be accomplished by removing unnecessary towers, abandoned buildings, vehicles, etc. that may serve as nesting substrates within tortoise management areas unless natural structures are in abundance.

7. Modify agricultural practices to reduce availability of food and water to ravens.—Ravens often make heavy use of agricultural activities for food and water (Engel and Young 1992, pers. obs.). They feed on grains at cattle feed lots and dairies, rodents and insects in alfalfa fields, and nuts and fruits in orchards and row crop fields (Boarman and Heinrich 1999). The majority of approximately 80 ravens radio tracked at EAFB spent some portion of their time at agricultural sites, which were a minimum of 20 km from where the birds were initially trapped (unpubl. data). Knight et al. (1993) found significantly more ravens in agricultural areas than in rangelands and desert controls in the Mojave Desert. Ravens also access water on farms and dairies by drinking from irrigation ditches, ponds, puddles, and sprinklers (G. C. Goodlett, pers. comm.; W. Webb pers. comm.; pers. obs.).

Facilitation of raven population growth by agricultural practices can be reduced by reducing the availability of food and water to ravens at agricultural sites. Agricultural Extension Agents should educate agricultural professionals about measures they can take to reduce raven access to crops, feed, waste, and byproducts. Effective measures need to be developed, tested, and compared in realistic settings. Possible measures that can be used include keeping unused grain covered and burying or rendering carcasses immediately. More difficult to control are sources of water.

LETHAL ACTIONS AGAINST INDIVIDUAL RAVENS

1. Remove birds that are known to prey on tortoises.--Evidence suggests that some ravens may be responsible for taking relatively large numbers of tortoises (BLM 1990a, Boarman and Hamilton ms). These individuals can be identified by the presence of juvenile tortoise shells beneath their nests, which are generally used year after year by the same individual breeding ravens (Boarman and Heinrich 1999). By removing those birds known to prey on tortoises, survival of juvenile tortoises in that vicinity will likely increase. However, it is very difficult to identify an offending bird with absolute certainty. Furthermore, it is even more difficult to find all tortoises likely killed by a raven, because the shells may be spread over a broad area. Therefore, any territorial bird should be targeted for removal if it is found within 1.6 km of at least one tortoise shell showing evidence of being killed by a raven within the prior 15 months. 1.6 km is a reasonable estimate of the radius of larger raven territories in the California desert (based on Sherman, 1993). Because most predation probably occurs in May, shells cannot generally be found until then. Therefore, it is necessary to allow shells found in one year to be used to target birds during the following year, hence the 15-month target window.

Individual territorial ravens should be selectively shot in areas of high tortoise predation if they are found with at lease one tortoise shell bearing evidence of raven predation within 1.6 km of their nest. Under this recommendation, targeted ravens would be shot by rifle or shotgun. Ravens should be trapped and humanely euthanized where shooting is not possible (e.g., on powerlines or in residential areas) or unsuccessful. Young ravens found in nests of removed adults should be euthanized humanely if they can be captured safely. Poisoning with DRC-1339, or other appropriate agents, may be used against targeted birds in these limited areas if it is shown to be safe for other animals. Poisoned carcasses should be removed when feasible.

BLM conducted two short-term, multi-agency projects that involved lethal removal of ravens for the benefit of tortoise populations. In 1989, a pilot program was conducted to selectively reduce raven populations at two sites: the DTNA (Kern County) and the landfill at the U.S. Marine Corps Air Ground Combat Center at Twentynine Palms (San Bernardino County; Rado 1993). Raven reduction involved using a combination of poisoning with the avicide DRC-1339 and shooting. An estimated 106 to 120 individual ravens were killed over a five-day period, but no effort was made to monitor the effectiveness of this truncated program on tortoise populations.

Some success at taking this approach was demonstrated in 1993 and 1994 when the BLM and National Biological Survey conducted an experimental program to determine the efficacy of shooting as a means of removing specific offending ravens. Forty-nine ravens were shot as part of this effort (Boarman, unpubl. data). The program demonstrated that it was possible to shoot ravens, but that it was often difficult, but not impossible, to shoot both members of a nesting pair (Boarman unpubl. data). Identifying, targeting, and successfully removing individuals was time consuming. Unfortunately, no effort was made to monitor the effect this limited program had neither on tortoise populations nor on territorial replacement by other ravens.

2. Remove ravens from specific areas where tortoise mortality from several sources is high, raven predation is known to occur, and the tortoise population has a chance of benefiting from raven removal.--Some localized populations of desert tortoises are experiencing high levels of mortality from various sources, including raven predation (Fish and Wildlife Service 1994). In such populations juvenile tortoises appear to be very rare suggesting that reproductive success is low and recruitment into the breeding population will rarely happen. In these populations, survival of any juvenile tortoise may be critical to the survival and recovery of the tortoise population, so any level of mortality of juveniles greater than perhaps 3% per year may be intolerable (Congdon et al. 1993). Because it is very difficult to find the carcasses of juvenile tortoises taken by ravens in such areas, it is extremely difficult to identify offending ravens. Therefore, rather than wait to discover the death of a rare juvenile, this action plays a proactive role by attempting to prevent the deaths of many juveniles in these highly critical populations.

This objective would consist of removal of all ravens foraging within specific limited areas (e.g., Desert Wildlife Management Areas, experimental captive release and translocation areas, DTNA, etc.) with historically high tortoise mortality and raven predation, particularly where demographic analyses indicate that juvenile survivorship has been unusually low. These must be areas where significant actions are being taken to reduce other causes of tortoise mortality. Areas near anthropogenic resources (e.g., landfills and towns) that meet these criteria could be targeted because they probably tend to facilitate a high level of predation pressure on tortoise populations (Kristan and Boarman 2001b). Ravens would be shot by rifle or shotgun if they were found foraging, hunting, roosting, or nesting within approximately 0.8 km of the specific targeted area. Where shooting is not possible (e.g., on powerlines or in recreation and residential areas), ravens should be poisoned (if shown in to be safe) or trapped and humanely euthanized. Again, young ravens found in nests of removed adults should be euthanized humanely if they can be captured safely.

There is no evidence that lethal removal will have a long-lasting effect on raven populations, raven foraging behavior, or survival of juvenile tortoises. In fact, there was no measurable reduction in numbers of breeding pairs following nine years of a large scale raven removal program in Iceland (Skarphedinsson et al. 1990). An average of 4116 ravens per year were killed, this represents an estimated 87% of the annual reproductive output of ravens in Iceland. Therefore, the lethal actions can only be implemented as a short-term solution in an effort to give the local tortoise population a small window of time without predation. Long-term habitat modifications proposed above must also be implemented in order for there to be a reasonable probability of success at reducing raven predation.

In addition to removing known offending birds, the experimental program from 1993 and 1994, discussed above, attempted to remove all birds found foraging within the DTNA. The program concluded that territorial individuals could be targeted and removed with some effort, but it was extremely difficult to shoot birds in wandering flocks (unpubl. data).

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RESEARCH ACTIONS

It is recommended that a program including the above actions also contain a strong research component because there are many uncertainties about how to reduce raven predation on tortoises. The research actions are designed to yield information necessary to develop future phases of a comprehensive raven management program.

1. <u>Determine behavior and ecology of ravens as they pertain to predation on tortoises</u>.--Information on the ecology and behavior of ravens in the California deserts is necessary to design and modify effective long-term management actions. Over the past seven years, data have been collected in the western Mojave Desert, mostly at EAFB, on several aspects of raven ecology. Most of that research has been focused on populations in moderately to heavily human-dominated landscapes, so information is spotty on raven ecology and behavior in more natural settings. To provide a clearer picture of raven ecology in the deserts, some future research needs to focus on birds in more natural landscapes (e.g., Joshua Tree National Park and Mojave National Preserve), particularly where predation on tortoises is occurring, as well as in areas dominated by agriculture. Other research is necessary to understand better raven demography and life history to identify where the population is most vulnerable and what factors facilitate its great increase.

There are several specific objectives that still need to be met to fully understand and manage raven predation on desert tortoises. (1) Discover how and where ravens forage on tortoises by studying individuals or pairs that are known to prey on tortoises. (2) Identify the preferred food items and foraging methods employed by ravens in different parts of the desert and determine if forage choice is learned in the nest, developed after fledging, or is simply an opportunistic behavior. (3) Identify the important sources of water of water for ravens in the Mojave. (4) Determine the extent of predation by ravens on tortoises and other animals and its effect on prey populations. (5) Investigate how raven territoriality affects raven populations and predation losses from tortoise populations. (6) Evaluate how concentrated anthropogenic food and water sources influence raven populations and behavior in tortoise habitat. (7) Characterize the nesting and foraging ecology of ravens living near highways to determine the relative importance of road kills to those birds. (8) Determine if alterations to the habitat (e.g., from livestock grazing) change tortoise vulnerability to raven predation. And (9) model age-specific mortality and reproduction in raven populations to better predict the effect various management options may have on raven populations.

The U. S. Geological Survey, in cooperation with the U.S. Air Force (EAFB) and U.S. Army (Fort Irwin), has been studying raven movements and nesting ecology in an effort to better understand their population dynamics. Preliminary results indicate that ravens use landfills significantly more often than sewage ponds and the latter more often than golf courses, towns, and the open desert (Boarman unpubl. data). They also make heavy use of agricultural fields and dairy farms (pers. obs.). Nestling and fledgling survival is higher when raised closer to anthropogenic resources, and this benefit continues until the birds are at least one year old (Kristan and Boarman 2001a, Webb 2001). Nesting very close to roads and railroads can be detrimental to the entire brood. Some ravens move about very little (1-4 km diameter) during the course of a year while others move considerable amounts (60-190 km diameter). Most movements by those in human-dominated landscapes (i.e., EAFB and vicinity) are between concentrated anthropogenic resources (e.g., landfills, dairy farms). Movements are greatest during the winter. As efforts are concentrated on two relatively heavily used military bases; the data collected will be of limited value in understanding the dynamics of raven ecology in more pristine areas (e.g., Ward Valley, Piute Valley, Pinto Basin).

Between 1991 and 1996, Boarman and Hamilton (ms) collected data from 304 raven nests from throughout the California deserts. Of those, 37 (12.2%) had a total of 266 tortoise shells beneath or near them, the remaining had none. An average of 7.2 shells was found per year beneath nests with shells. Although more raven nests were found in the West Mojave, a greater proportion of the nests in the East Mojave (40%) and Southern Colorado (40%) had tortoise shells beneath them (8.5% in the West Mojave). The results may partly reflect the non-uniform methods used to search for nests and may partly reflect lower tortoise densities in the West Mojave.

2. Conduct regional surveys of the California deserts to locate and map ravens and their nests and communal roosts. Information on the densities and distributions of ravens and their nest, perch, and roost sites are necessary to understand the causes of their increases, to direct and modify management efforts, and to monitor the effectiveness of management efforts. Desert-wide surveys were conducted in 1988-1989 (FaunaWest Consulting 1990). Localized surveys were conducted in the vicinity of Amboy, CA, in 1995 (Knight et al. 1999), Primm, NV, in 1991-1992 (McKernan 1992), Mesquite, CA, in 1994 (McKernan, pers. comm.), Fort Irwin, CA,

in 1996-1997 (Boarman et al. ms.), Joshua Tree National Monument (Boarman and Coe, in press) and EAFB (Boarman et al. 1995). These can all serve as baselines, but continuous information is necessary to monitor raven activities.

Objectives of this effort would be to: (i) characterize distribution, behavior, and ecology of raven populations in the California deserts; (ii) monitor changes in population levels and distribution of ravens as a result of management changes; and (iii) identify causative factors for changes in raven population levels and distribution. Inventories would include private and public lands. Project proponents and other interested parties would contribute funds to a coordinated surveying program that would concentrate both on specific sites and broad regional patterns.

Surveys were conducted between 1994 and 2000 in and around EAFB with the primary goals being to monitor for changes in raven numbers as landfill management changed and to determine which resource sites were used most by ravens (Boarman et al. 1995). These and the other surveys cited above could all be used to develop a broad-based statistically sound survey protocol. GIS-based maps of over 400 nest sites have been prepared for raven nests throughout the CDCA, but nest surveys were not intensive, effort was not proportional in all areas, and funding was very limited (Boarman and Hamilton in prep.).

3. <u>Develop, test, and implement methods for monitoring juvenile tortoises to determine effectiveness of and need for raven management efforts.</u>--The ultimate measure of success of reduction efforts is increased survival of juvenile tortoises and recruitment into the adult population. Because of their size and cryptic behavior, juvenile tortoises are difficult to find on standard surveys of tortoise populations making estimates tenuous at best (Berry and Turner 1986, Shields 1994). Although such surveys may be useful for tracking overall trends in populations, surveys must be developed and conducted that concentrate on monitoring the juvenile component of the populations. The methods must yield statistically valid results and use sufficient sample sizes to make valid inferences about population trends. Data on tortoise populations have been collected at 16 permanent study sites throughout California deserts (Berry 1997). Although the method is biased towards larger size classes and generally provides weak estimates of density, the data need to be evaluated to determine if their continued use can yield

the data required for monitoring the juvenile component of tortoise populations. Alternative methods using distance sampling (Buckland et al. 1993) could perhaps be used, particularly if workers focused on juveniles rather than adults.

4. Develop a demographic model of raven populations to predict the effect various management alternatives might have on raven populations.--It is difficult to be certain what long-term effect any management action will have on raven populations or their predation on tortoises. Modeling, when accompanied by statistically sound data, can provide valid predictions. Such a model can be used to predict the outcomes of alternative management strategies giving us a glimpse into the probable future. A study is needed to: (i) develop and validate a computer model of the dynamics of raven populations, incorporating age-specific mortality, natality, and dispersal; (ii) apply the model to alternative management scenarios (e.g., removal of nests, selected shooting of breeding birds, broad scale removal of birds at landfills) to determine the effect the actions would have on raven populations and their overall impact on tortoise populations. No demographic modeling has been accomplished to date, but data on clutch size and nestling and fledgling survivorship that have been collected at EAFB can be used in the models.

5. Develop and test various methods for managing raven populations and behavior.--Several possibilities exist to reduce ravens' impacts on tortoise populations, but few have been tested. Aversive chemicals, anti-perch devices, and noisemakers can keep birds away from specific places (e.g., landfills). Poisons, shooting, and relocating following live trapping, are all possible ways of removing ravens from specific areas. Removal of nests both during and outside the nesting season may reduce future nesting behavior. Tests are needed to determine the effectiveness of these and other measures with ravens in the Mojave Desert.

Several aversive chemicals have been used to keep various species of birds from eating economically important crops. Studies need to be conducted on captive and wild ravens to determine their utility for achieving the goals set out herein. Methyl anthranilate is a non-toxic, grape-flavored food additive, but it is disliked by several species of birds. For instance, it has proven effective against geese on golf courses, American robins feeding on fruits, and blackbirds feeding on rice (Avery et al. 1995). An experiment should be conducted to determine if: (i) ravens are repelled by the chemical; (ii) it can be applied efficiently at landfills and other raven concentration sites, and on sources of water used by ravens (e.g., septage ponds, stock tanks, etc.); (iii) its repeated application prevents ravens from using the resource (e.g., garbage, water, etc.), (iv) methiocarb (Avery et al. 1993, Conover 1984), carbachol (Avery and Decker 1994, Nicolaus et al. 1989), or other compounds work better than methyl anthranilate. Preliminary trials conducted in spring 2001 with three captive ravens indicated that ravens find methyl anthranilate to be distasteful, but showed no conditioned taste aversion under the conditions used in the trials (Boarman et al. 2002).

Human-provided nest and perch sites in areas where tall natural substrates are lacking may facilitate hunting, roosting, and nesting in areas where tortoises may otherwise have been immune to raven predation. If the nest and perch sites are removed or made unattractive to or unusable by the ravens, then ravens may be less apt to use or benefit by the resource or prey on nearby tortoises. The only published study on effectiveness of anti-perch devices indicates that ravens will choose alternatives perches, the ground, or may even perch on the anti-perch devices when no other perches are present (Young and Engel 1988). Furthermore, as ravens do the vast majority of their hunting while in flight, and will often perch and eat on low bushes or the ground, modifying human-provided perches is not likely to greatly reduce raven predation on tortoises. If, however, new nesting substrates are introduced to an area previously devoid of adequate nesting sites, then foraging on tortoises may be facilitated. A study should be conducted to determine if: (i) raven dependence on human-provided perches and nest sites aids hunting, nesting, and overall survival; (ii) modifying raven perches, roost sites, and nest sites on a localized basis is an effective way of reducing raven predation on tortoises; and (iii) removal of raven nests early in the breeding cycle will prevent ravens from renesting in that season.

Relocation may be considered a viable control measure if three conditions are met: (i) live trapping is cost effective, (ii) appropriate resource management agencies will agree to accept relocated birds, and (iii) the ravens will not return to the California desert, and particularly to tortoise habitat. A study should be conducted to determine: (i) if live trapping is a cost effective means of catching ravens, (ii) the relative effectiveness of different live trapping techniques, (iii) where ravens can be relocated practically and legally, and (iv) if relocated ravens will return to the capture site or other desert tortoise habitat. No work has been conducted on the response of ravens to being relocated, but some work has suggested that ravens can be trapped relatively easily, at least at concentration sites such as landfills. Recent work on the genetic relatedness of common raven populations worldwide indicates that ravens in the Southwest are a genetically distinct group, perhaps a separate species from those in the rest of the world (Omland et al. 2000). These results indicate that if ravens are to be relocated, they should not be moved to an area outside of the Southwest. Preliminary results on a smaller scale suggest that there is little population structuring within the Mojave Desert, which means that ravens move around and disperse over great distances within the Mojave (Fleischer and Boarman in prep.). Thus, they are not likely to be highly adapted to their specific locale and may be adaptable to new areas, but that they may readily move away from their newly adopted homes.

One of the most effective ways of killing ravens is with the highly specific avicide DRC-1339 (Seamans and Belant 1999). The task is effected by injecting hard-boiled eggs with the poison. The measure potentially poses an adverse impact to non-target species that may also eat the avicide-laced eggs. To determine conclusively whether DRC-1339 has an impact on non-target species, an experiment should be designed and conducted to determine what other species of animals in the California deserts might eat hard-boiled eggs. No animals other than ravens approached hard-boiled eggs during the 1989 pilot raven control program (Rado 1993), but a more comprehensive study would help to obtain more conclusive results.

6. Determine how humans use the desert, what practices might be amenable to change, and best to effect those changes.--We need to know what will cause changes in how people living in and use the desert. For example, what can we do to help or convince dairy farmers to change certain management practices; how can we reduce the number of people who leave food and water in various forms (e.g., open garbage cans, pet food, etc.) out where ravens can access them; how can we stop people from intentionally feeding large numbers of ravens.

ADAPTIVE MANAGEMENT ACTIONS

To work within a true adaptive management framework (Walters 1986), the plan must include and a scientifically based method for determining if the program's goals and objectives are being met. This method must include control and treatment areas to properly evaluate the action's effectiveness (Marzluff and Ewing 2001). If goals are not being met, there should be a coordinating body that can evaluate and make changes to the program.

1. Monitor both raven status and effectiveness of management actions at reducing predation rates on juvenile tortoises.--Implementation of some of the actions may be ineffective or insufficient to accomplish the plan's goals. To determine this, raven populations must be monitored using a scientifically sound protocol that will yield sufficient power to determine if desired changes occur. Monitoring should focus on population abundance, spatial distribution, and reproductive success. Furthermore, management actions should be implemented in a way that will facilitate scientifically-sound monitoring, such as use of treatment and control sites, replications where possible, and development and implementation of specific protocols (Marzluff and Ewing 2001). Several raven surveys have been conducted (cited in Research Action No. 2, above); their results should be used to develop a biologically and statistically valid protocol. Monitoring results may indicate that modifications to existing or implementation of additional actions may be necessary. Changes to the plan may also be indicated by additional information on raven and tortoise ecology derived from research and monitoring actions or from other relevant sources. This action is central to carrying out the proposed management plan because it provides the data necessary to evaluate and modify the program to determine the nature of Phase 2. To accomplish this, an effort must be made to monitor both raven status and effectiveness of management actions at reducing predation rates on juvenile tortoises, something that was done inadequately following the pilot and experimental programs discussed above.

2. Establish work groups to facilitate interagency coordination and cooperation.--Design and implementation of management actions requires continuous evaluation by knowledgeable biologists and coordination between several agencies. Management actions are broad in scope and may be difficult to fund and implement. Several agencies maintain jurisdictional authorities

over lands or permitting authorities over actions that require management. Increased coordination between these agencies will facilitate plan implementation. Furthermore, because the plan is dynamic and will occur in several phases, each one depending on new information obtained from previous phases, frequent evaluation by knowledgeable biologists and resource managers is necessary.

Two work groups should be established to oversee management direction, review information, coordinate with other agencies and groups, solicit funding for implementation of specific management measures, and distribute information. The work groups should meet annually or as needed to discuss raven management actions. One work group would be an interagency task force to coordinate implementation of the program. This group would identify specific areas where lethal removal would be implemented using the criteria outlined above. The other would be a technical and policy oversight team to evaluate the progress of the plan, interpretation of data, and recommend changes in the overall program based on scientific data. This group would help to determine what thresholds of predation and recruitment are necessary to trigger implementation or cessation of lethal action. The teams would ensure that adequate data sharing occurs among agencies and bioregional plans. The goals of the work groups would be to (i) increase efficiency, effectiveness, and scientific validity of raven management in the California deserts, and (ii) ensure that future phases are developed and implemented in accordance with results of research and monitoring outlined above.

A Technical Review Team (TRT) was formed in 1991 (Boarman 1993b). Through a series of meetings in 1991 and 1992 as well as numerous conversations between the author and TRT members, the TRT provided policy- and conceptual-level advice on the development and evolution of a BLM raven management plan that has evolved into this report. The TRT consisted of national and region representatives of conservation and animal welfare organizations as well as resource management and industry representatives. The team also helped to conceptualize the experimental program to shoot ravens that was conducted in 1993 and 1994. Biologists and managers representing several Federal and State agencies also participated in the development of various plans and helped to fund and implement the 1989 pilot control program and in development of the Draft Raven Management Plan (BLM 1990a) and Draft Environmental Impact Statement (BLM 1990b).

POSSIBLE ACTIONS FOR FUTURE PHASES

Other actions that could be considered in future phases of a raven management program include: poisoning groups of birds at concentration sites; applying conditioned taste aversion methods at landfills and other food and water sources; researching and implementing other specific control measures (e.g., use of monofilament line at landfills, ponds, etc), and in the West Mojave, evaluate the utility of head starting programs at facilitating recruitment by protecting young tortoises from falling prey to ravens. If various measures suggested herein fail, it may become necessary to employ more aggressive lethal removal at various important concentration sites (e.g., landfills, dairy farms, and agricultural fields). These actions could be proposed and evaluated as part of subsequent phases of a comprehensive raven management plan.

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Attachment E

This list contains summer and/or fall flowering rare plants of California's deserts as reported in the CNPS Inventory. This is by no means an exhaustive list, and full spring and summer/fall botanical surveys performed after suitable local rainfall may be necessary to assess a project's potential impacts to botanical resources. Desert rare plants that are reported to flower between July and November are included on this list. Plants that are known to flower only between late June/July and November receive a "yes" in the "Only flowers in summer/fall column?". Many of these plants are likely to go undetected in spring (March to mid-June) botanical surveys. All information in this table is publically available via the Online CNPS Inventory of Rare and Endangered Plants (7th edition) (http://www.cnps.org/cnps/rareplants/inventory/).

	CNPS LIST	Phenology	Fall / Summer Flowering?	Only Flowers in Summer / Fall?	Global Heritage Rank	State Heritage Rank	Low Elevation (meters)	High Elevation (meters)	Distribution in CA	Distribution outside CA
Abronia nana var. covillei	4.2	May-Aug	yes	no	G4T3	S3.2	1524	3100	Inyo (INY), Mono (MNO), San Bernardino (SBD)	Nevada (NV)
Abronia villosa var. aurita	1B.1	Jan-Sep	yes	no	G5T3T4	S2.1	80	1600	Imperial, Los Angeles, Orange*, Riverside, San Bernardino, San Diego, Ventura	Arizona, Baja California
Agave utahensis var. nevadensis	4.2	May-Jul	yes	no	G4T3Q	S3.2	900	1585	Inyo (INY), San Bernardino (SBD)	Nevada (NV)
Ageratina herbacea	2.3	Jul-Oct	yes	**Yes**	G5	S2.3	1525	2200	Inyo?, San Bernardino	Arizona, Baja California, New Mexico, Sonora-Mexico, Texas, Utah+
Aloysia wrightii	4.3	Apr-Oct	yes	no	G5	S3.3	900	1600	Riverside (RIV), San Bernardino (SBD)	Arizona (AZ), Baja California (BA), New Mexico (NM), Nevada (NV), Sonora - Mexico (SO), Texas (TX), Utah (UT)
Amaranthus watsonii	4.3	Apr-Sep	yes	no	G4G5	S3.3	20	1700	Imperial (IMP), Los Angeles (LAX), San Bernardino (SBD)	Baja California (BA), Sonora - Mexico (SO)
Argyrochosma limitanea var. limitanea	2.3	Apr-Oct	yes	no	G4G5T3T4	S2.3	1800	1800	San Bernardino	Arizona, Baja California, New Mexico, Sonora-Mexico, Utah
Asclepias asperula ssp. asperula	4.3	May-Sep	yes	no	G5T5	S3.3	915	2195	San Bernardino (SBD)	Arizona (AZ), Idaho (ID), New Mexico (NM), Nevada (NV), Sonora - Mexico (SO), Texas (TX), Utah (UT)+
Astragalus geyeri var. geyeri	2.2	May-Aug	yes	no	G4T4	S2.2	1160	1980	Inyo, Lassen, Mono	Arizona, Idaho, Nevada, Oregon, Utah, Washington+

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	CNPS LIST	**Phenology**	**Fall / Summer Flowering?**	**Only Flowers in Summer / Fall?**	**Global Heritage Rank**	**State Heritage Rank**	**Low Elevation (meters)**	**High Elevation (meters)**	**Distribution in CA**	**Distribution outside CA**
Astragalus gilmanii	1B.2	May-Aug	yes	no	G2G3	S2.2	2000	3050	Inyo	Nevada
Astragalus hornii var. hornii	1B.1	May-Oct	yes	no	G4G5T2T3	S2S3.1	60	850	Inyo, Kern, San Bernardino*, Tulare?	Nevada
Astragalus inyoensis	4.2	May-Jul	yes	no	G3	S3.2	1500	3050	Inyo (INY), Mono (MNO)	Nevada (NV)
Astragalus nutans	4.3	Mar-Jun(Oct)	yes	no	G3	S3.3	450	1950	Imperial (IMP), Inyo (INY), Riverside (RIV), San Bernardino (SBD), San Diego (SDG)	None
Astragalus platytropis	2.2	Jun-Sep	yes	**Yes**	G5	S1.2	2345	3550	Inyo, Mono, Idaho	Nevada, Oregon, Utah+
Astrolepis cochisensis ssp. cochisensis	2.3	Apr-Oct	yes	no	G5?T4	S2.3	900	1800	San Bernardino	Arizona, Baja California, New Mexico+
Atriplex argentea var. hillmanii	2.2	Jun-Sep	yes	**Yes**	G5T3?	S2.2	1200	1700	Inyo, Lassen, Modoc, Plumas	Nevada, Oregon
Azolla mexicana	4.2	Aug	yes	**Yes**	G5	S3.2?	30	100	Butte (BUT), Colusa (COL), Glenn (GLE), Inyo (INY), Kern (KRN), Lake (LAK), Modoc (MOD), Nevada (NEV), Plumas (PLU), San Bernardino (SBD), Santa Clara (SCL), San Diego (SDG), Tulare (TUL)	Arizona (AZ), Baja California (BA), Isla Guadalupe - Baja (GU), Id
Bouteloua eriopoda	4.2	May-Aug	yes	no	G5	S3.2	900	1900	San Bernardino (SBD)	Arizona (AZ), Baja California (BA), New Mexico (NM), Nevada (NV), Texas (TX), Utah (UT), Wyoming (WY), (++)
Bouteloua trifida	2.3	May-Sep	yes	no	G4G5	S2?	700	2000	Inyo, San Bernardino	Arizona, Nevada, Sonora-Mexico, ++

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Calochortus palmeri var. palmeri	1B.2	Apr-Jul	yes	no	G2T2	S2.1	1000	2390	Kern, Los Angeles, Riverside, Santa Barbara, San Bernardino, San Luis Obispo, Ventura	None
Calochortus panamintensis	4.2	Jun-Jul	yes	no	G3	S3.2	2040	3200	Inyo (INY)	Nevada (NV)
Camissonia arenaria	2.2	Nov-May	yes	no	G4?	S2	-70	915	Imperial, Riverside	Arizona, Sonora-Mexico
Camissonia boothii ssp. alyssoides	4.3	Apr-Aug	yes	no	G5T4	S3.3	600	1700	Inyo (INY), Lassen (LAS), Modoc (MOD)	Nevada (NV)
Camissonia boothii ssp. boothii	2.3	Apr-Sep	yes	no	G5T4	S2.3	900	2400	Inyo, Mono, San Bernardino	Arizona, Nevada, Washington
Castela emoryi	2.3	(Apr)Jun-Jul	yes	no	G3	S2.2	90	670	Imperial, Inyo, Riverside, San Bernardino	Arizona, Sonora-Mexico
Castilleja montigena	4.3	May-Aug	yes	no	G3	S3.3	1950	2800	San Bernardino (SBD)	None
Centromadia pungens ssp. laevis	1B.1	Apr-Sep	yes	no	G3G4T2	S2.1	0	480	Riverside, San Bernardino, San Diego	None
Chaenactis douglasii var. alpina	2.3	Jul-Sep	yes	**Yes**	G5T5	S2.3?	3000	3400	Alpine, El Dorado, Inyo, Mono, Siskiyou, Tuolumne	Nevada, Oregon, ++
Chaetadelpha wheeleri	2.2	Apr-Sep	yes	no	G4	S2.2	850	1900	Inyo, Lassen, Mono	Nevada, Oregon
Chamaesyce abramsiana	2.2	Sep-Nov	yes	**Yes**	G4	S1.2	-5	915	Imperial, Riverside, San Bernardino	Arizona, Baja California, Nevada, Sonora-Mexico
Chamaesyce parryi	2.3	May-Nov	yes	no	G5	S1.3	395	730	San Bernardino	Arizona, New Mexico, Nevada, Texas, Utah+
Chamaesyce platysperma	1B.2	Feb-Sep	yes	no	G3	S1.2?	65	100	Imperial, Riverside, San Bernardino?, San Diego	Arizona, Sonora-Mexico

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Chamaesyce revoluta	4.3	Aug-Sep	yes	**Yes**	G5	S3.3	1095	3100	Riverside (RIV), San Bernardino (SBD), San Diego (SDG)	Arizona (AZ), Baja California (BA), New Mexico (NM), Nevada (NV), Texas (TX)+
Chamaesyce vallis-mortae	4.2	May-Oct	yes	no	G3	S3.2	230	1460	Inyo (INY), Kern (KRN), San Bernardino (SBD)	None
Cheilanthes wootonii	2.3	May-Oct	yes	no	G5	S1.3	1600	1900	Inyo, San Bernardino	Arizona, Baja California, New Mexico, Nevada, Sonora-Mexico, Utah+
Chorizanthe parryi var. fernandina	1B.1	Apr-Jul	yes	no	G2T1	S1.1	150	1220	Los Angeles, Orange*, Ventura	None
Chorizanthe spinosa	4.2	Mar-Jul	yes	no	G3	S3.2	6	1300	Kern (KRN), Los Angeles (LAX), San Bernardino (SBD)	None
Chrysothamnus greenei	2.3	Oct	yes	**Yes**	G5	S3.2	1340	1830	Inyo, Mono	Arizona, New Mexico, Nevada, Utah+
Cirsium arizonicum var. tenuisectum	1B.2	Jun-Nov	yes	**Yes**	G5T2	S1.2	1500	2800	San Bernardino	Nevada
Cladium californicum	2.2	Jun-Sep	yes	**Yes**	G4	S2.2	60	600	Inyo, Los Angeles*, Riverside, Santa Barbara, San Bernardino?*, San Luis Obispo	Arizona, New Mexico, Nevada, Texas, Utah
Cleomella brevipes	4.2	May-Oct	yes	no	G3G4	S3.2	395	2195	Inyo (INY), Lassen (LAS), Mono (MNO), San Bernardino (SBD)	Nevada (NV)
Cordylanthus eremicus ssp. eremicus	4.3	Jul-Oct	yes	**Yes**	G3?T3?	S3?	1000	3000	Inyo (INY), San Bernardino (SBD)	None
Cordylanthus parviflorus	2.3	Aug-Oct	yes	**Yes**	G4G5	S1S2	700	2200	San Bernardino, San Diego	Arizona, Idaho, Nevada, Utah
Cordylanthus tecopensis	1B.2	Jul-Oct	yes	**Yes**	G2	S1.2	60	900	Inyo, San Bernardino	Nevada
Coryphantha chlorantha	2.1	Apr-Sep	yes	no	G2G3	S1	45	1525	Inyo, San Bernardino	Arizona, Nevada, Utah

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Crepis runcinata ssp. hallii	2.1	May-Jul	yes	no	G5T3?	S2?	1250	1978	Inyo, Lassen, Mono	Nevada
Cryptantha scoparia	4.3	Jun-Jul	yes	no	G4?	S3.3	1890	2745	Inyo (INY), Lassen (LAS), Nevada (NV), Oregon (OR), Washington (WA)+	Arizona (AZ), Baja California (BA), Nevada (NV), Sonora - Mexico (SO)
Cuniculotinus gramineus	2.3	Jun-Aug	yes	**Yes**	G4?	S2.3	2040	2900	Inyo	Nevada
Dedeckera eurekensis	1B.3	May-Aug	yes	no	G2	S2.2	1220	2200	Inyo, Mono	None
Deinandra arida	1B.2	Apr-Nov	yes	no	G1	S1.2	300	950	Kern	None
Deinandra mohavensis	1B.3	Jun-Oct(Jan)	yes	**Yes**	G2	S2.3	640	1600	Kern, Riverside, San Bernardino*, San Diego	None
Digitaria californica	2.3	Jul-Nov	yes	**Yes**	G5	S1.3	290	1490	San Bernardino, San Diego	Arizona, Baja California, New Mexico, SA, Texas
Ditaxis claryana	2.2	Oct-Mar	yes	**Yes**	G4G5	S1S2	0	465	Imperial, Riverside, San Bernardino	Arizona, Sonora-Mexico
Ditaxis serrata var. californica	3.2	Mar-Dec	yes	no	G5T2T3	S2.2	30	1000	Imperial, Riverside, San Bernardino, San Diego	Sonora-Mexico*
Dudleya saxosa ssp. saxosa	1B.3	(Apr)May-Sep	yes	no	G4T3	S3.3	960	2200	Inyo	None
Enceliopsis covillei	1B.2	Mar-Jun	yes	no	G3	S3.3	400	1830	Inyo	None
Enneapogon desvauxii	2.2	Aug-Sep	yes	**Yes**	G5	S1?	1275	1825	San Bernardino	Arizona, Colorado, New Mexico, Nevada
Ericameria albida	4.2	Jun-Nov	yes	**Yes**	G4	S3.2	300	1950	Inyo (INY), Kern (KRN), Mono (MNO)	Nevada (NV), Utah (UT)
Ericameria gilmanii	1B.3	Aug-Sep	yes	**Yes**	G1	S1.3	2100	3400	Inyo, Kern	None
Ericameria nana	4.3	Jul-Nov	yes	**Yes**	G5	S3.3	1465	2800	Inyo (INY), Mono (MNO), San Bernardino (SBD)	Idaho (ID), Nevada (NV), Oregon (OR), Utah (UT), Washington (WA)+
Erigeron parishii	1B.1	May-Aug	yes	no	G2	S2.1	800	2000	Riverside, San Bernardino	None
Erigeron uncialis var. uncialis	1B.2	May-Jul	yes	no	G3G4T2	S2.2	1900	2900	Inyo, San Bernardino	Nevada

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Erigeron utahensis	2.3	May-Jun	yes	no	G4	S1.3	1500	2320	San Bernardino	Arizona, Nevada, Utah+
Eriodictyon angustifolium	2.3	May-Aug	yes	no	G5	S2.3	1500	1900	San Bernardino	Arizona, Baja California, Nevada, Utah+
Eriogonum baileyi var. praebens	4.3	May-Sep	yes	no	G5T4	S3.3	1300	2900	Inyo (INY), Lassen (LAS), Mono (MNO), Plumas (PLU), Sierra (SIE)	Nevada (NV)
Eriogonum bifurcatum	1B.2	Apr-Jun	yes	no	G2	S1.2	700	810	Inyo, San Bernardino	Nevada
Eriogonum callistum	1B.1	May-Jul	yes	no	G1	S1	1400	1500	Kern	None
Eriogonum eremicola	1B.3	Jun-Sep	yes	**Yes**	G1	S1.3	2200	3100	Inyo	None
Eriogonum gilmanii	1B.3	May-Sep	yes	no	G2	S2.3	1220	2225	Inyo	None
Eriogonum heermannii var. floccosum	4.3	Aug-Oct	yes	**Yes**	G5T3	S3.3	900	2400	San Bernardino (SBD)	Nevada (NV)
Eriogonum hoffmannii var. hoffmannii	1B.3	Jun-Sep	yes	**Yes**	G3T2	S2.3	650	1700	Inyo	None
Eriogonum hoffmannii var. robustius	1B.3	Aug-Nov	yes	**Yes**	G3T2	S2.3	150	1680	Inyo	None
Eriogonum intrafractum	1B.3	May-Oct	yes	no	G2	S2.3	610	1950	Inyo	None
Eriogonum mensicola	1B.3	Jul-Sep	yes	**Yes**	G2G3	S2	1800	2805	Inyo	Nevada
Eriogonum microthecum var. lapidicola	4.3	Jul-Sep	yes	**Yes**	G5T3T4	S3.3	2600	3100	Inyo (INY)	Nevada (NV)
Eriogonum microthecum var. panamintense	1B.3	Jun-Oct	yes	**Yes**	G5T2	S2.3	1890	3250	Inyo	None
Eriogonum puberulum	2.3	May-Sep	yes	no	G3?	S1.3	1300	2900	Inyo	Nevada+
Eriogonum shockleyi var. shockleyi	4.3	May-Jul	yes	no	G5T4?	S3.3	1700	2700	Inyo (INY), Mono (MNO)	Arizona (AZ), Idaho (ID), Nevada (NV)+
Eriogonum thornei	1B.2	Jul-Aug	yes	**Yes**	G1	S1.1	1800	1830	San Bernardino	None
Eriogonum umbellatum var. juniporinum	2.3	Jul-Oct	yes	**Yes**	G5T3?	S1S2	1300	2500	San Bernardino	Nevada
Erioneuron pilosum	2.3	May-Jun	yes	no	G5	S2S3	1500	2010	Inyo, San Bernardino	Nevada, ++
Euphorbia exstipulata var. exstipulata	2.1	Sep	yes	**Yes**	G5T5?	S1.3	1800	2000	San Bernardino	Arizona, ++
Euphorbia misera	2.2	Dec-Aug	yes	no	G5	S3.2	10	500	Many Counties	Baja California
Fendlerella utahensis	4.3	Jun-Aug	yes	**Yes**	G5	S3.3	1300	2800	Inyo (INY), San Bernardino (SBD)	Arizona (AZ), Nevada (NV)+
Fimbristylis thermalis	2.2	Jul-Sep	yes	**Yes**	G4	S2.2	110	1340	Inyo, Kern*, Los Angeles, Mono, San Bernardino	Arizona, Nevada
Galium hilendiae ssp. carneum	1B.3	May-Aug	yes	no	G4T2	S2.3	1650	3400	Inyo	None

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Galium hypotrichium ssp. tomentellum	1B.3	Jun-Aug	yes	no	G5T1	S1.3	3300	3550	Inyo	None
Galium munzii	4.3	May-Jul	yes	no	G4G5	S3.3	1100	3330	Inyo (INY), San Bernardino (SBD)	Arizona (AZ), Nevada (NV)+
Galium wrightii	2.3	Jun-Oct	yes	**Yes**	G3G4	S1.2	1600	2000	San Bernardino	Arizona, Baja California, New Mexico, Sonora-Mexico, Texas+
Goodmania luteola	4.2	Apr-Aug	yes	no	G3	S3.2	20	2200	Fresno (FRE), Inyo (INY), Kern (KRN), Los Angeles (LAX), Madera (MAD), Mono (MNO), Tulare (TUL)	Nevada (NV)
Grindelia fraxinipratensis	1B.2	Jun-Oct	yes	**Yes**	G2	S1.2	635	700	Inyo	Nevada
Grusonia parishii	2.2	May-Jun(Jul)	yes	no	G3G4	S2	300	1524	Imperial?, Riverside, San Bernardino	Arizona, Nevada, Texas?
Hedeoma drummondii	2.2	May-Jul	yes	no	G5	S1.2	1400	1700	San Bernardino	Arizona, Colorado, New Mexico, Nevada, Texas, Utah, Wyoming, ++
Helianthus niveus ssp. tephrodes	1B.2	Sep-May	yes	no	G4T2	S1.2	50	100	Imperial	Arizona, Sonora-Mexico
Horsfordia alata	4.3	Feb-Dec	yes	no	G4	S3.3	100	500	Imperial (IMP), Riverside (RIV)	Arizona (AZ), Baja California (BA), Sonora - Mexico (SO)
Horsfordia newberryi	4.3	Feb-Dec	yes	no	G4	S3.3	3	800	Imperial (IMP), Riverside (RIV), San Diego (SDG)	Arizona (AZ), Baja California (BA), Sonora - Mexico (SO)
Hulsea vestita ssp. parryi	4.3	Apr-Aug	yes	no	G5T3	S3.3	1370	2895	Kern (KRN), Los Angeles (LAX), Mono (MNO), San Bernardino (SBD), Ventura (VEN)	None
Hymenopappus filifolius var. eriopodus	2.3	May-Jul	yes	no	G5T3	S1.3	1600	1700	San Bernardino	Nevada, Utah

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Hymenopappus filifolius var. nanus	2.3	May-Sep	yes	no	G5T4	S2.3	1500	3050	Inyo, Mono	Arizona, Nevada, Oregon, Utah
Hymenoxys odorata	2	Feb-Nov	yes	no	G5	S2	45	150	Imperial, Riverside, San Bernardino	Arizona, Baja California, Colorado, New Mexico, Texas
Imperata brevifolia	2.1	Sep-May	yes	no	G2	S2.1	0	500	Many Counties	Arizona, Colorado, New Mexico, Nevada
Iva acerosa	4.2	May-Dec	yes	no	G5	S3.2	60	900	Inyo (INY)	Arizona (AZ), New Mexico (NM), Nevada (NV), Utah (UT)+
Iva nevadensis	4.3	May-Oct	yes	no	G3?	S3.3	1000	2055	Inyo (INY), Mono (MNO)	Nevada (NV)
Ivesia arizonica var. arizonica	2.3	May-Aug	yes	no	G3G4T3T4	S2	1200	3100	Inyo	Arizona, Nevada, Utah
Ivesia jaegeri	1B.3	Jun-Jul	yes	no	G2G3	S1.3	1830	3600	San Bernardino	Nevada
Ivesia patellifera	1B.3	Jun-Oct	yes	**Yes**	G1	S1.3	1400	2100	San Bernardino	None
Jamesia americana var. rosea	4.3	May-Sep	yes	no	G5T3	S3.3	1980	3700	Fresno (FRE), Inyo (INY), Mono (MNO), Tulare (TUL)	Nevada (NV)
Juncus nodosus	2.3	Jul-Sep	yes	**Yes**	G5	S2.3	30	1980	Inyo, San Bernardino, Stanislaus, Tulare	Many states
Koeberlinia spinosa ssp. tenuispina	2.2	May-Jul	yes	no	G4T4	S2.2	150	510	Imperial	Arizona, Sonora-Mexico+
Layia heterotricha	1B.1	Mar-Jun	yes	no	G2G3	S2S3.1	300	1705	FRE, KNG*, Kern*, Los Angeles, MNT, Santa Barbara, San Benito(*?), San Luis Obispo*, Ventura	None
Leptosiphon floribundus ssp. hallii	1B.3	May-Jul	yes	no	G4T1	S1.3	1000	2000	Riverside, San Diego	None
Leymus salinus ssp. mojavensis	2.3	May-Jun	yes	no	G5T3?	S1.3	1350	2135	Inyo, San Bernardino	Arizona, Idaho, Wyoming+

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Linum puberulum	2.3	May-Jul	yes	no	G5	S1S2.3	1000	2500	San Bernardino	Arizona, New Mexico, Nevada, Texas, Utah, Wyoming, ++
Lomatium foeniculaceum ssp. inyoense	4.3	Jun-Jul	yes	no	G5T3	S3.3	2195	3200	Inyo (INY)	Idaho (ID), Nevada (NV)
Lotus argyraeus var. notitius	1B.3	May-Aug	yes	no	G4?T1	S1.3	1200	2000	San Bernardino	None
Lupinus lepidus var. utahensis	4.3	Jun-Jul	yes	**Yes**	G5T5?	S3.3	1370	3810	Inyo (INY), Lassen (LAS), Mono (MNO)	Idaho (ID), Nevada (NV), Oregon (OR), Utah (UT), Wyoming (WY)+
Mentzelia inyoensis	1B.3	Apr-Oct	yes	no	G2	S2.3	1158	1980	Inyo, Mono	Nevada
Mimulus aridus	4.3	Apr-Jul	yes	no	G3G4	S3.3	750	1100	Imperial (IMP), San Diego (SDG)	Baja California (BA)
Mirabilis coccinea	2.3	May-Jul	yes	no	G5	S2.3	1070	1800	San Bernardino	Arizona, New Mexico, Nevada, Sonora-Mexico
Monarda pectinata	2.3	Jul-Sep	yes	**Yes**	G5	S1.3	1150	1525	San Bernardino	Arizona, New Mexico, Texas, Utah, Wyoming, ++
Monardella robisonii	1B.3	(Feb)Apr-Sep(Oct)	yes	no	G2	S2.3	610	1500	Riverside, San Bernardino	None
Muhlenbergia alopecuroides	2.2	Aug-Sep	yes	**Yes**	G5	S1?	500	500	San Bernardino	Arizona, ++
Muhlenbergia arsenei	2.3	Aug-Oct	yes	**Yes**	G5	S1S2	1400	1860	San Bernardino	Arizona, Baja California, New Mexico, Nevada, Utah
Muhlenbergia fragilis	2.3	Oct	yes	**Yes**	G5?	S1.3?	1600	1600	San Bernardino	Arizona, Baja California, New Mexico, Sonora-Mexico, Texas+
Muhlenbergia pauciflora	2.3	Sep-Oct	yes	**Yes**	G5	S1.3?	1755	1860	San Bernardino	Arizona, ++
Munroa squarrosa	2.2	Oct	yes	**Yes**	G5	S1S2	1500	1800	San Bernardino	Arizona, Nevada, ++
Nama dichotomum var. dichotomum	2.3	Sep-Oct	yes	**Yes**	G4T4?	S1.3?	1900	2200	San Bernardino	Arizona, New Mexico, Texas+

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Nama stenocarpum	2.2	Jan-Jul	yes	no	G4G5	S1S2	5	500	Imperial*, Los Angeles*, Orange, Riverside, San Clemente Island, San Diego	Arizona, Baja California+
Nitrophila mohavensis	1B.1	May-Oct	yes	no	G1	S1.1	425	750	Inyo	Nevada
Oenothera caespitosa ssp. crinita	4.2	Jun-Sep	yes	**Yes**	G5T4T5	S3.3	1150	3370	Inyo (INY), San Bernardino (SBD)	Nevada (NV)+
Oenothera cavernae	2.1	Mar-May(Sep-Nov)	yes	no	G2G3	S1	760	1280	San Bernardino	Arizona, Nevada, Utah
Oenothera longissima	2.2	Jul-Sep	yes	**Yes**	G4	S1.2	1000	1700	Inyo, San Bernardino	Arizona, Colorado, New Mexico, Nevada, Utah
Oxytheca watsonii	2.2	May-Jul	yes	no	G3?	S1.2	1200	2000	Inyo	Nevada
Penstemon scapoides	4.3	Jun-Jul	yes	no	G3	S3.3	2000	3200	Inyo (INY)	None
Penstemon thurberi	4.2	May-Jul	yes	no	G5	S3.2?	500	1220	Imperial (IMP), Riverside (RIV), San Bernardino (SBD), San Diego (SDG)	Arizona (AZ), Baja California (BA), New Mexico (NM), Nevada (NV)+
Perityle inyoensis	1B.2	Jun-Aug	yes	**Yes**	G2	S2.2	1800	2710	Inyo	None
Petalonyx thurberi ssp. gilmanii	1B.3	May-Sep	yes	no	G5T2	S2.3	260	1445	Inyo, San Bernardino	None
Petradoria pumila ssp. pumila	4.3	Jul-Oct	yes	**Yes**	G5T4	S3.3	1070	3400	San Bernardino (SBD), Tulare (TUL)	Arizona (AZ), Idaho (ID), New Mexico (NM), Nevada (NV), Oregon (OR), Texas (TX), Utah (UT), Wyoming (WY)+
Phacelia barnebyana	2.3	May-Jul	yes	no	G3?	S2.3	1600	2700	Inyo, San Bernardino	Nevada
Phacelia monoensis	1B.1	May-Jul	yes	no	G3	S2.1	1900	2900	Inyo, Mono	Nevada
Phacelia mustelina	1B.3	May-Jul	yes	no	G2	S1.3	730	2620	Inyo, San Bernardino	Nevada
Phacelia parishii	1B.1	Apr-May(Jun-Jul)	yes	no	G2G3	S1.1	540	1200	San Bernardino	Arizona, Nevada
Phacelia peirsoniana	4.3	May-Aug	yes	no	G3G4	S3.3	1370	2700	Inyo (INY), Mono (MNO)	Nevada (NV)
Phacelia perityloides var. jaegeri	1B.3	May-Jul	yes	no	G4T2	S1.3	1830	2345	San Bernardino	Nevada

This list contains summer and/or fall flowering rare plants of California's deserts as reported in the CNPS Inventory. This is by no means an exhaustive list, and full spring and summer/fall botanical surveys performed after suitable local rainfall may be necessary to assess a project's potential impacts to botanical resources. Desert rare plants that are reported to flower between July and November are included on this list. Plants that are known to flower only between late June/July and November receive a "yes" in the "Only flowers in summer/fall column?". Many of these plants are likely to go undetected in spring (March to mid-June) botanical surveys. All information in this table is publically available via the Online CNPS Inventory of Rare and Endangered Plants (7th edition) (http://www.cnps.org/cnps/rareplants/inventory/).

	CNPS LIST	**Phenology**	**Fall / Summer Flowering?**	**Only Flowers in Summer / Fall?**	**Global Heritage Rank**	**State Heritage Rank**	**Low Elevation (meters)**	**High Elevation (meters)**	**Distribution in CA**	**Distribution outside CA**
Physalis lobata	2.3	(May)Sep-Jan	yes	**no**	G5	S1.3?	500	800	San Bernardino	Arizona, Nevada, ++
Physocarpus alternans	2.3	Jun-Jul	yes	**Yes**	G4	S2.3	1800	3100	Inyo, Mono	Nevada, Utah
Piptatherum micranthum	2.3	Jun-Sep	yes	**Yes**	G5	S2S3	700	2950	Inyo, Mono, San Bernardino	Idaho, ++
Plagiobothrys parishii	1B.1	Mar-Jun(Nov)	yes	no	G1	S1.1	750	1400	Inyo, Los Angeles*, Mono, San Bernardino	None
Plagiobothrys salsus	2.2	May-Aug	yes	no	G2G3	S1.2?	700	700	Inyo, Modoc	Nevada, Oregon
Polygala acanthoclada	2.3	May-Aug	yes	no	G4	S2.3	760	2285	Riverside, San Bernardino	Arizona, Nevada, Utah+
Portulaca halimoides	4.2	Sep	yes	**Yes**	G5	S3	1000	1200	Riverside (RIV), San Bernardino (SBD)	Arizona (AZ), Baja California (BA)+
Proboscidea althaeifolia	4.3	May-Aug	yes	no	G5	S3.3	150	1000	Imperial (IMP), Riverside (RIV), San Bernardino (SBD), San Diego (SDG)	Arizona (AZ), Baja California (BA), New Mexico (NM), Sonora - Mexico (SO)
Robinia neomexicana	2.3	May-Jul	yes	no	G4	S1.3	1500	1770	San Bernardino	Arizona, New Mexico, Nevada, Sonora-Mexico, Texas, Utah+
Romneya coulteri	4.2	Mar-Jul	yes	no	G3	S3.2	20	1200	Los Angeles (LAX), Orange (ORA), Riverside (RIV), San Diego (SDG)	None
Rupertia rigida	4.3	Jun-Aug	yes	**Yes**	G3	S3.3	700	2500	Los Angeles (LAX), Riverside (RIV), San Bernardino (SBD), San Diego (SDG)	Baja California (BA)
Saltugilia caruifolia	4.3	May-Aug	yes	no	G4?	S3.3	1400	2300	Riverside (RIV), San Diego (SDG)	Baja California (BA)
Sanvitalia abertii	2.2	Aug-Sep	yes	**Yes**	G5	S1S2	1570	1800	San Bernardino	Arizona, Sonora-Mexico, Texas
Sarcocornia utahensis	2.2	Aug-Sep	yes	**Yes**	G4?	S1.2	320	320	Inyo, San Bernardino	Utah, ++

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	CNPS LIST	**Phenology**	**Fall / Summer Flowering?**	**Only Flowers in Summer / Fall?**	**Global Heritage Rank**	**State Heritage Rank**	**Low Elevation (meters)**	**High Elevation (meters)**	**Distribution in CA**	**Distribution outside CA**
Schkuhria multiflora var. multiflora	2.3	Sep-Oct	yes	**Yes**	G5T5	S1.3	1500	1700	San Bernardino	Arizona, Baja California, New Mexico, Texas, ++
Schoenus nigricans	2.2	Aug-Sep	yes	**Yes**	G4	S2.2	150	2000	Inyo, San Bernardino	Nevada, Texas, ++
Sclerocactus polyancistrus	4.2	Apr-Jul	yes	no	G4	S3.2	640	2320	Inyo (INY), Kern (KRN), San Bernardino (SBD)	Nevada (NV)
Scleropogon brevifolius	2.3	Oct	yes	**Yes**	G5	S1.3	1585	1600	San Bernardino	Arizona, Nevada, ++
Scutellaria bolanderi ssp. austromontana	1B.2	Jun-Aug	yes	**Yes**	G4T2	S2.2?	425	2000	Los Angeles(*?), Riverside, San Bernardino*, San Diego	None
Scutellaria lateriflora	2.2	Jul-Sep	yes	**Yes**	G5	S1.2	0	500	Inyo, Sacramento, San Joaquin	New Mexico, Oregon, ++
Sedum niveum	4.2	Jun-Aug	yes	**Yes**	G3	S3.2	2075	3000	Riverside (RIV), San Bernardino (SBD)	Baja California (BA)
Selinocarpus nevadensis	2.3	Jun-Sep	yes	**Yes**	G5	S1.3	1160	1250	Inyo	Arizona, Nevada, Utah
Streptanthus bernardinus	4.3	May-Aug	yes	no	G3	S3.3	670	2500	Riverside, San Bernardino, San Diego, Baja California?	None
Streptanthus campestris	1B.3	May-Jul	yes	no	G2	S2.3	900	2300	Riverside, Santa Barbara, San Bernardino, San Diego, Ventura	Baja California
Swertia albomarginata	4.3	May-Aug	yes	no	G5	S3.3	1370	2315	Inyo (INY), San Bernardino (SBD)	Arizona (AZ), New Mexico (NM), Nevada (NV), Utah (UT)+
Symphyotrichum defoliatum	1B.2	Jul-Nov	yes	**Yes**	G3	S3.2	2	2040	Kern, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo?	None
Tetradymia argyraea	4.3	May-Sep	yes	**no**	G4?	S3.3	1400	2230	Riverside (RIV), San Bernardino (SBD)	Arizona (AZ)

This list contains summer and/or fall flowering rare plants of California's deserts as reported in the CNPS Inventory. This is by no means an exhaustive list, and full spring and summer/fall botanical surveys performed after suitable local rainfall may be necessary to assess a project's potential impacts to botanical resources. Desert rare plants that are reported to flower between July and November are included on this list. Plants that are known to flower only between late June/July and November receive a "yes" in the "Only flowers in summer/fall column?". Many of these plants are likely to go undetected in spring (March to mid-June) botanical surveys. All information in this table is publically available via the Online CNPS Inventory of Rare and Endangered Plants (7th edition) (http://www.cnps.org/cnps/rareplants/inventory/).

	CNPS LIST	**Phenology**	**Fall / Summer Flowering?**	**Only Flowers in Summer / Fall?**	**Global Heritage Rank**	**State Heritage Rank**	**Low Elevation (meters)**	**High Elevation (meters)**	**Distribution in CA**	**Distribution outside CA**
Teucrium cubense ssp. depressum	2.2	Mar-May(Sep-Nov)	yes	no	G4G5T3T4	S2	45	400	Imperial, Riverside	Arizona, Baja California, New Mexico, Texas
Thelypodium integrifolium ssp. complanatum	2.2	Jun-Oct	yes	**Yes**	G5T5	S2.2	1100	2500	Inyo, Lassen, Mono	Nevada, Oregon, Utah
Trichostema micranthum	4.3	Jun-Sep	yes	**Yes**	G4	S3.3	1525	2300	Riverside (RIV), San Bernardino (SBD)	Baja California (BA)
Trifolium dedeckerae	1B.3	May-Jul	yes	no	G2	S2.3	2100	3500	Inyo, Kern, Mono, Tulare	None
Wislizenia refracta ssp. refracta	2.2	Apr-Nov	yes	no	G5T5?	S1.2?	600	800	Riverside, San Bernardino	Arizona, New Mexico, Texas
Woodsia plummerae	2.3	May-Sep	yes	no	G5	S1.3?	1600	2000	San Bernardino	Arizona, Baja California, New Mexico, Sonora-Mexico+
Xanthisma gracile	4.3	Apr-Jul(Sep)	yes	no	G5	S3.3	1220	1555	San Bernardino (SBD)	Arizona (AZ), Baja California (BA), New Mexico (NM), Nevada (NV), Sonora - Mexico (SO), Texas (TX), Utah (UT)+

Attachment F

Survey Protocols Required for NEPA/ESA Compliance for BLM Special Status Plant Species

Policy

It is BLM policy to conduct inventories to determine the occurrence and status of all special status plant species on lands managed by BLM or affected by BLM actions. This includes pro-active inventories directed toward developing plans or determining the status of plant species, as well as inventories conducted to determine the impacts of BLM planned or authorized actions on any special status plants that might be within the area of a proposed project. Such inventories are to be conducted at the time of year when such plant species can be found and positively identified.

Definition and Purpose

Inventory is the periodic and systematic collection of data on the distribution, condition, trend, and utilization of special status plant species (BLM Manual 6600).

Inventories are conducted for many reasons; however, for the purpose of this document only one inventory "reason" is addressed:

> To ensure compliance with the National Environmental Policy Act and the Endangered Species Act by having sufficient information available to adequately assess the effects of proposed actions on special status plants. Assessments of the effects of these actions are documented in biological assessments (if the project involves Federally listed species and qualifies as a "major construction activity" as defined by the ESA).

Special status plants include plant taxa that are Federally listed as threatened and endangered, proposed for Federal listing, candidates for Federal listing, State listed as rare, threatened, or endangered, or BLM sensitive species. All plant species that are currently on List 1B of the California Native Plant Society's Inventory of Rare and Endangered Plants of California (http://cnps.web.aplus.net/cgi-bin/inv/inventory.cgi), are BLM sensitive species, along with others that have been designated by the California State Director. BLM is party to a Memorandum of Understanding with the California Department of Fish and Game to collect information for inclusion in the California Natural Diversity Data Base. Therefore, in addition to inventorying for plants formally recognized as special status species by BLM, contractors must also inventory for all plant, lichen, and fungi species recognized as "special" by the California Natural Diversity Data Base (http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/SPPlants.pdf). Although the following discussion uses the term "special status plants," it should be interpreted to mean all of the plant taxa discussed above.

The inventory requirements below apply to energy rights-of-way applications on Federal lands managed by the BLM in California and northwestern Nevada. Projects that include State or private lands or require State approval will likely also require conformance with the rare plant survey guidelines of the California Department of Fish and Game (http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/guideplt.pdf).

Timing and Intensity of Inventory

Before conducting inventories, contractors for BLM or energy companies should research three valuable sources to see if BLM special status species are known from the project area: the California Natural Diversity Data Base (CNDDB), CALFLORA, and the Biogeographic Information & Observation System (BIOS). However, CNDDB and BIOS are positive occurrence databases only, the lack of data should not be used as verification that the species does not exist in a given location. Inventories must be timed so that contractors can both locate and positively identify target plant species in the field. Inventories must be scheduled so that they will detect all special status species present. A single inventory on a single date will seldom suffice. For example, when one special status plant species suspected to be in the inventory can only be found and identified in April and another species can only be located and identified in August, at least two inventories are necessary. The first inventory can facilitate the second and/or third inventory, however, if potential sites for the late-flowering species are flagged during the first inventory. If sufficient information is available on the habitat requirements of potentially occurring species (substrate, plant community, etc.), and the site in question is believed to be unsuitable for those species, a field visit should still be conducted to document and validate the assumptions for believing that the species to be absent. In advance of the project site inventory, contractors should visit known populations of the target species in similar habitat conditions to determine current-year growth conditions and phenology. If, based on these visits to known populations, it appears likely that the project site inventory will fail to detect occurrences because of drought conditions (as may be the case for annual plant species or geophytic plants), BLM may require contractors to perform additional inventories in the following year.

Field Survey - Methodology

Field surveys will be floristic in nature, i.e., the contractor identifies every plant taxon observed in the project area to the taxonomic level necessary to determine rarity and listing status. Surveys will be conducted so that they will ensure a high likelihood of locating all the plant taxa in the project area. Depending on the size of the project area and the heterogeneity of the habitats within the project area, surveys will involve one or a combination of the following survey methods.

Complete Survey

A complete survey is a 100 percent visual examination of the project area (Figure 1) using transects. The length of the transect and distance between transects might change as the topography changes throughout the project area. Transects should be spaced so that all of the area between transects is visible and so that the smallest rare plant expected to occur is visible. The surveyor (1) compiles a species list while traversing the project area and keeps track of the plant community or habitat type where each taxon occurs; (2) maps the locations of all rare taxa encountered using a GPS unit, and (3) fills out a CNDDB Native Species Field Survey Form for each location of each rare taxon encountered.

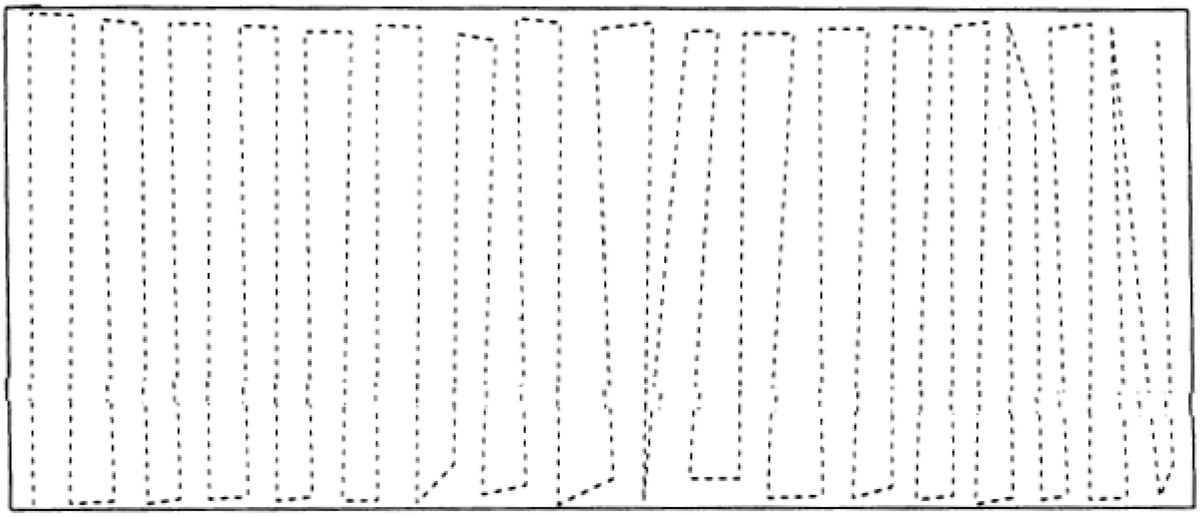

Figure 1. **Complete survey.**

Intuitive Controlled Survey

An intuitive controlled survey is a complete survey of habitats with the highest potential for supporting rare plant populations and a less intense survey of all other habitats present (Figure 2). This type of survey can only be accomplished by botanists familiar with the habitats of all the plant species that may reasonably be expected to occur in the project area. The botanist traverses through the project area enough to see a representative cross section of all the major plant habitats and topographic features. During the survey, the botanist compiles a species list of all plant taxa seen en route and keeps track of the plant community or habitat type where each taxon occurs. The surveyor maps the locations of all rare taxa encountered using a GPS unit and fills out a CNDDB Native Species Field Survey Form for each location of each rare taxon encountered. When the surveyor arrives at an area of “high potential” habitat, s/he surveys that area completely as described above and shown in Figure 1. High potential habitat areas include areas defined in a pre-field review of potential rare plants and habitat and other habitats where a rare species appears during the course of initial field work traversing the project area. Areas within the project area that are not the focus of a complete survey must be surveyed sufficiently so that is the botanist and BLM reasonably believe that few if any additional species would be added to the complete species list for the project area. The report must justify why the botanist did not consider these areas to have a high potential for supporting rare plant species and thus did not subject the area to a complete survey.

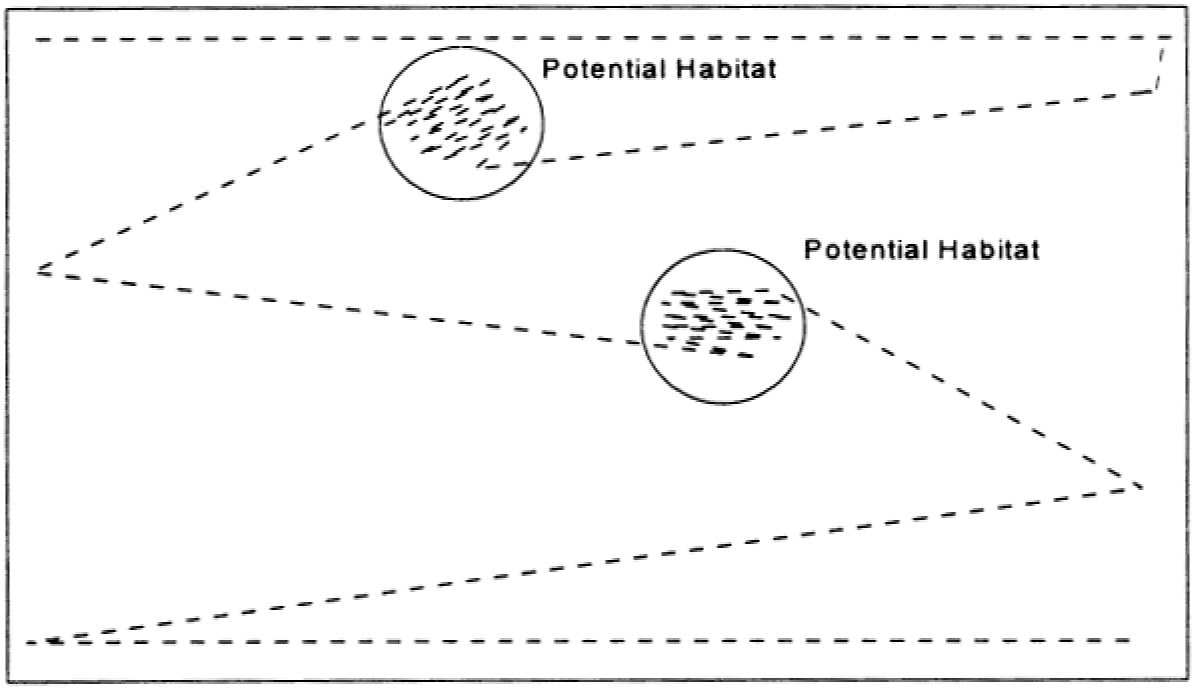

Figure 2. Intuitive Controlled Survey.

Documenting the Results of Inventory

The results of special status plant inventories should be well documented. This documentation must include as a minimum the completion and submission of Field Survey Forms and shapefiles/geodatabases of all special status plants found by BLM personnel or consultants. CNDDB defines occurrences as being separated from other plant locations by 0.25 mile. These forms are submitted to the BLM State Botanist and to the California Natural Diversity Data Base (CNDDB) at the following address:

CNDDB - Dept. of Fish and Game
1807 13th Street, Suite 202
Sacramento, CA 95811

Forms can be submitted electronically at: CNDDB@dfg.ca.gov
Copies of the Field Survey Form are available from the CNDDB at the same address. They will also provide photocopied parts of topo maps if needed.

If the inventory discovers any rare or unusual plant communities,[1] a Natural Community Field Survey Form must be completed for each such community and sent to the CNDDB at the address above.

[1] Rare or unusual plant communities includes those communities marked with asterisks in the most current list of California plant communities recognized by the California Natural Diversity Data Base, available at: http://www.dfg.ca.gov/biogeodata/vegcamp/pdfs/natcomlist.pdf, and Unusual Plant Assemblages as defined in

Most special status plant inventories of public lands conducted to assess the impacts of a project are performed by consultants hired by project proponents. These inventories must meet or exceed the intensity level required for the project by BLM. Personnel conducting the inventory must meet the qualifications outlined in this document. For BLM to adequately determine the quality of third party inventories, the following information must appear in a detailed report to BLM from the consultant or project proponent:

a. Project description, including a detailed map of the project location and study area.

b. A written description of the biological setting, including descriptions of the plant communities found in the project area and a vegetation map. Plant communities should be described and mapped to at least the alliance level using the vegetation classification system of the California Department of Fish and Game (CDFG). A list of the alliances currently recognized by CDFG can be found at: http://www.dfg.ca.gov/biogeodata/vegcamp/pdfs/NaturalCommunitiesList_Oct07.pdf. When the Manual of California Vegetation is published in 2009, the alliances recognized in that document should be used.

c. A detailed description of the inventory methodology, including techniques and intensity of the inventory and maps showing areas actually searched. This will also include areas searched but no special status plants found.

d. The results of the inventory.

e. The dates of the inventory.

f. An assessment of potential impacts and recommended mitigation measures to reduce impacts.

g. Recommended management actions to conserve any special status plants encountered should include both actions the BLM might take, as well as actions that might be taken by the FWS (listing or delisting of T/E plants, changes in candidate status, etc.).

h. A discussion of the significance of any special status plant occurrences found, with consideration for other nearby occurrences, and the distribution of the species as a whole.

i. Assessments of the health, population size, and protective status of any special status plants found.

j. A complete list of *all* plant species (not just special status species) identified within the project area, and a discussion of any range extensions discovered as a result of the inventory

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the California Desert Conservation Area Plan (http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/cdd/cdcaplan.Par.15259.File.dat/CA_Desert_.pdf) or shown on Map 6 of the California Desert Conservation Area Plan, as amended (copies on file at the BLM California State Office, the California Desert District, and each of the field offices in the California Desert District).

k. Copies of all Field Survey Forms, for all special status plant occurrences found, or Natural Community Field Survey Forms, for any unusual communities found.

l. The name(s) and qualifications of the persons conducting the inventory.

m. A list of references cited, persons contacted and herbaria visited.

n. Additional data needs.

o. Other information as appropriate such as vegetation maps and photographs (see below).

Voucher specimens of special status plants should be collected if necessary to conclusively document the occurrence of the species and if the collection will not adversely affect the health of the population at the site. Collection of Federally listed plants on Federal lands requires a permit from the FWS. If voucher specimens are collected, they should be deposited in major recognized herbaria for future reference, preferably The University of California, Berkeley (UC), The Jepson Herbarium (JEPS), The California Academy of Sciences (CAS), or Rancho Santa Ana Botanic Garden (RSA).

Photographs should be taken of the areas inventoried, of all special status plants found, and of the habitat associated with each special status plant occurrence.

Data Collection – Data Submission

Data should be collected using a Mapping Grade GPS Receiver with an accuracy of < 3 meters Horizontal Root Mean Squared (HRMS).

All positions should be logged according to the following specifications:

- Maximum PDOP of 6
- Minimum of 5 Satellites
- Minimum elevation mask of 15 degrees
- Datum: NAD83
- Coordinate System: UTM Zone 10 or Zone 11, depending on where in California or northwestern Nevada the data is collected.
- ESRI compliant formats (Geodatabase, Coverage or Shapefile)

Metadata must be included with the data. The following must be included in the metadata:

- Project Name
- Purpose – Summary of the intentions with which the data set was developed
- Abstract Information – Brief narrative summary of the data set
- Location – What area(s) does your data cover? ie., list statewide, regions, city, county?
- Developer – Who collected the data?

Data Dictionary – A data dictionary must be used for all projects. The dictionary should include the data that is requested on the CNDDB forms. This ensures that the botanist is collecting (electronically) the same data as is requested by DFG. This also ensures that all inventories are collecting the same level/standard of data.

GIS Support Data: BLM California State Office Downloadable Data Sources

Index Page with BLM Data Naming Rules
http://www.blm.gov/ca/pa/gis/Data_Page/Data%20Page.html

Geospatial Data Downloads
http://www.blm.gov/ca/gis/index.html

All data collected in and referenced to the public land survey are required to conform to this version of PLSS published on the California BLM data download page.

In addition to the local Field Office; a copy of the Data (DVD or CDROM) must be submitted directly to:

BLM California State Office
Geographic Services, W1939
Attention: Chief Mapping Sciences
2800 Cottage Way
Sacramento, CA 95825

GIS Questions: Please Call
(916) 978-4343

Qualifications of Personnel Conducting Inventories

All personnel conducting special status plant inventories must have the following:

- strong backgrounds in plant taxonomy and plant ecology
- strong background in field sampling design and methods
- knowledge of the floras of the inventory area including the special status plant species
- familiarity with natural communities of the area

These qualifications help ensure that all special status plants in the inventory area will be located, including taxa that BLM or project proponents did not predict at the start of the inventory. All survey efforts must be coordinated with the responsible BLM Field Office botanist or biologist

Attachment G

Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities

State of California
CALIFORNIA NATURAL RESOURCES AGENCY
Department of Fish and Game
November 24, 2009[1]

INTRODUCTION AND PURPOSE

The conservation of special status native plants and their habitats, as well as natural communities, is integral to maintaining biological diversity. The purpose of these protocols is to facilitate a consistent and systematic approach to the survey and assessment of special status native plants and natural communities so that reliable information is produced and the potential of locating a special status plant species or natural community is maximized. They may also help those who prepare and review environmental documents determine when a botanical survey is needed, how field surveys may be conducted, what information to include in a survey report, and what qualifications to consider for surveyors. The protocols may help avoid delays caused when inadequate biological information is provided during the environmental review process; assist lead, trustee and responsible reviewing agencies to make an informed decision regarding the direct, indirect, and cumulative effects of a proposed development, activity, or action on special status native plants and natural communities; meet California Environmental Quality Act (CEQA)[2] requirements for adequate disclosure of potential impacts; and conserve public trust resources.

DEPARTMENT OF FISH AND GAME TRUSTEE AND RESPONSIBLE AGENCY MISSION

The mission of the Department of Fish and Game (DFG) is to manage California's diverse wildlife and native plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. DFG has jurisdiction over the conservation, protection, and management of wildlife, native plants, and habitat necessary to maintain biologically sustainable populations (Fish and Game Code §1802). DFG, as trustee agency under CEQA §15386, provides expertise in reviewing and commenting on environmental documents and makes protocols regarding potential negative impacts to those resources held in trust for the people of California.

Certain species are in danger of extinction because their habitats have been severely reduced in acreage, are threatened with destruction or adverse modification, or because of a combination of these and other factors. The California Endangered Species Act (CESA) provides additional protections for such species, including take prohibitions (Fish and Game Code §2050 *et seq.*). As a responsible agency, DFG has the authority to issue permits for the take of species listed under CESA if the take is incidental to an otherwise lawful activity; DFG has determined that the impacts of the take have been minimized and fully mitigated; and, the take would not jeopardize the continued existence of the species (Fish and Game Code §2081). Surveys are one of the preliminary steps to detect a listed or special status plant species or natural community that may be impacted significantly by a project.

DEFINITIONS

Botanical surveys provide information used to determine the potential environmental effects of proposed projects on all special status plants and natural communities as required by law (i.e., CEQA, CESA, and Federal Endangered Species Act (ESA)). Some key terms in this document appear in **bold font** for assistance in use of the document.

For the purposes of this document, **special status plants** include all plant species that meet one or more of the following criteria[3]:

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1 This document replaces the DFG document entitled “Guidelines for Assessing the Effects of Proposed Projects on Rare, Threatened and Endangered Plants and Natural Communities.”

2 http://ceres.ca.gov/ceqa/

3 Adapted from the East Alameda County Conservation Strategy available at http://www.fws.gov/sacramento/EACCS/Documents/080228_Species_Evaluation_EACCS.pdf

- Listed or proposed for listing as threatened or endangered under ESA or candidates for possible future listing as threatened or endangered under the ESA (50 CFR §17.12).

- Listed[4] or candidates for listing by the State of California as threatened or endangered under CESA (Fish and Game Code §2050 *et seq.*). A species, subspecies, or variety of plant is **endangered** when the prospects of its survival and reproduction in the wild are in immediate jeopardy from one or more causes, including loss of habitat, change in habitat, over-exploitation, predation, competition, disease, or other factors (Fish and Game Code §2062). A plant is **threatened** when it is likely to become endangered in the foreseeable future in the absence of special protection and management measures (Fish and Game Code §2067).

- Listed as rare under the California Native Plant Protection Act (Fish and Game Code §1900 *et seq*.). A plant is **rare** when, although not presently threatened with extinction, the species, subspecies, or variety is found in such small numbers throughout its range that it may be endangered if its environment worsens (Fish and Game Code §1901).

- Meet the definition of rare or endangered under CEQA §15380(b) and (d). Species that may meet the definition of rare or endangered include the following:

    - Species considered by the California Native Plant Society (CNPS) to be "rare, threatened or endangered in California" (Lists 1A, 1B and 2);

    - Species that may warrant consideration on the basis of local significance or recent biological information[5];

    - Some species included on the California Natural Diversity Database's (CNDDB) *Special Plants, Bryophytes, and Lichens List* (California Department of Fish and Game 2008)[6].

- Considered a **locally significant species,** that is, a species that is not rare from a statewide perspective but is rare or uncommon in a local context such as within a county or region (CEQA §15125 (c)) or is so designated in local or regional plans, policies, or ordinances (CEQA Guidelines, Appendix G). Examples include a species at the outer limits of its known range or a species occurring on an uncommon soil type.

Special status natural communities are communities that are of limited distribution statewide or within a county or region and are often vulnerable to environmental effects of projects. These communities may or may not contain special status species or their habitat. The most current version of the Department's *List of California Terrestrial Natural Communities*[7] indicates which natural communities are of special status given the current state of the California classification.

Most types of wetlands and riparian communities are considered special status natural communities due to their limited distribution in California. These natural communities often contain special status plants such as those described above. These protocols may be used in conjunction with protocols formulated by other agencies, for example, those developed by the U.S. Army Corps of Engineers to delineate jurisdictional wetlands[8] or by the U.S. Fish and Wildlife Service to survey for the presence of special status plants[9].

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4 Refer to current online published lists available at: http://www.dfg.ca.gov/biogeodata.

5 In general, CNPS List 3 plants (plants about which more information is needed) and List 4 plants (plants of limited distribution) may not warrant consideration under CEQA §15380. These plants may be included on special status plant lists such as those developed by counties where they would be addressed under CEQA §15380. List 3 plants may be analyzed under CEQA §15380 if sufficient information is available to assess potential impacts to such plants. Factors such as regional rarity vs. statewide rarity should be considered in determining whether cumulative impacts to a List 4 plant are significant even if individual project impacts are not. List 3 and 4 plants are also included in the California Natural Diversity Database's (CNDDB) *Special Plants, Bryophytes, and Lichens List.* [Refer to the current online published list available at: http://www.dfg.ca.gov/biogeodata.] Data on Lists 3 and 4 plants should be submitted to CNDDB. Such data aids in determining or revising priority ranking.

6 Refer to current online published lists available at: http://www.dfg.ca.gov/biogeodata.

7 http://www.dfg.ca.gov/biogeodata/vegcamp/pdfs/natcomlist.pdf. The rare natural communities are asterisked on this list.

8 http://www.wetlands.com/regs/tlpge02e.htm

9 U.S. Fish and Wildlife Service Survey Guidelines available at http://www.fws.gov/sacramento/es/protocol.htm

BOTANICAL SURVEYS

Conduct botanical surveys prior to the commencement of any activities that may modify vegetation, such as clearing, mowing, or ground-breaking activities. It is appropriate to conduct a botanical field survey when:

- Natural (or naturalized) vegetation occurs on the site, and it is unknown if special status plant species or natural communities occur on the site, and the project has the potential for direct or indirect effects on vegetation; or
- Special status plants or natural communities have historically been identified on the project site; or
- Special status plants or natural communities occur on sites with similar physical and biological properties as the project site.

SURVEY OBJECTIVES

Conduct field surveys in a manner which maximizes the likelihood of locating special status plant species or special status natural communities that may be present. Surveys should be **floristic in nature**, meaning that every plant taxon that occurs on site is identified to the taxonomic level necessary to determine rarity and listing status. "Focused surveys" that are limited to habitats known to support special status species or are restricted to lists of likely potential species are not considered floristic in nature and are not adequate to identify all plant taxa on site to the level necessary to determine rarity and listing status. Include a list of plants and natural communities detected on the site for each botanical survey conducted. More than one field visit may be necessary to adequately capture the floristic diversity of a site. An indication of the prevalence (estimated total numbers, percent cover, density, etc.) of the species and communities on the site is also useful to assess the significance of a particular population.

SURVEY PREPARATION

Before field surveys are conducted, compile relevant botanical information in the general project area to provide a regional context for the investigators. Consult the CNDDB[10] and BIOS[11] for known occurrences of special status plants and natural communities in the project area prior to field surveys. Generally, identify vegetation and habitat types potentially occurring in the project area based on biological and physical properties of the site and surrounding ecoregion[12], unless a larger assessment area is appropriate. Then, develop a list of special status plants with the potential to occur within these vegetation types. This list can serve as a tool for the investigators and facilitate the use of reference sites; however, special status plants on site might not be limited to those on the list. Field surveys and subsequent reporting should be comprehensive and floristic in nature and not restricted to or focused only on this list. Include in the survey report the list of potential special status species and natural communities, and the list of references used to compile the background botanical information for the site.

SURVEY EXTENT

Surveys should be comprehensive over the entire site, including areas that will be directly or indirectly impacted by the project. Adjoining properties should also be surveyed where direct or indirect project effects, such as those from fuel modification or herbicide application, could potentially extend offsite. Pre-project surveys restricted to known CNDDB rare plant locations may not identify all special status plants and communities present and do not provide a sufficient level of information to determine potential impacts.

FIELD SURVEY METHOD

Conduct surveys using **systematic field techniques** in all habitats of the site to ensure thorough coverage of potential impact areas. The level of effort required per given area and habitat is dependent upon the vegetation and its overall diversity and structural complexity, which determines the distance at which plants can be identified. Conduct surveys by walking over the entire site to ensure thorough coverage, noting all plant taxa

10 Available at http://www.dfg.ca.gov/biogeodata/cnddb

11 http://www.bios.dfg.ca.gov/

12 Ecological Subregions of California, available at http://www.fs.fed.us/r5/projects/ecoregions/toc.htm

observed. The level of effort should be sufficient to provide comprehensive reporting. For example, one person-hour per eight acres per survey date is needed for a comprehensive field survey in grassland with medium diversity and moderate terrain[13], with additional time allocated for species identification.

TIMING AND NUMBER OF VISITS

Conduct surveys in the field at the time of year when species are both evident and identifiable. Usually this is during flowering or fruiting. Space visits throughout the growing season to accurately determine what plants exist on site. Many times this may involve multiple visits to the same site (e.g. in early, mid, and late-season for flowering plants) to capture the floristic diversity at a level necessary to determine if special status plants are present[14]. The timing and number of visits are determined by geographic location, the natural communities present, and the weather patterns of the year(s) in which the surveys are conducted.

REFERENCE SITES

When special status plants are known to occur in the type(s) of habitat present in the project area, observe reference sites (nearby accessible occurrences of the plants) to determine whether those species are identifiable at the time of the survey and to obtain a visual image of the target species, associated habitat, and associated natural community.

USE OF EXISTING SURVEYS

For some sites, floristic inventories or special status plant surveys may already exist. Additional surveys may be necessary for the following reasons:

- Surveys are not current[15]; or
- Surveys were conducted in natural systems that commonly experience year to year fluctuations such as periods of drought or flooding (e.g. vernal pool habitats or riverine systems); or
- Surveys are not comprehensive in nature; or fire history, land use, physical conditions of the site, or climatic conditions have changed since the last survey was conducted[16]; or
- Surveys were conducted in natural systems where special status plants may not be observed if an annual above ground phase is not visible (e.g. flowers from a bulb); or
- Changes in vegetation or species distribution may have occurred since the last survey was conducted, due to habitat alteration, fluctuations in species abundance and/or seed bank dynamics.

NEGATIVE SURVEYS

Adverse conditions may prevent investigators from determining the presence of, or accurately identifying, some species in potential habitat of target species. Disease, drought, predation, or herbivory may preclude the presence or identification of target species in any given year. Discuss such conditions in the report.

The failure to locate a known special status plant occurrence during one field season does not constitute evidence that this plant occurrence no longer exists at this location, particularly if adverse conditions are present. For example, surveys over a number of years may be necessary if the species is an annual plant having a persistent, long-lived seed bank and is known not to germinate every year. Visits to the site in more

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13 Adapted from U.S. Fish and Wildlife Service kit fox survey guidelines available at www.fws.gov/sacramento/es/documents/kitfox_no_protocol.pdf

14 U.S. Fish and Wildlife Service Survey Guidelines available at http://www.fws.gov/sacramento/es/protocol.htm

15 Habitats, such as grasslands or desert plant communities that have annual and short-lived perennial plants as major floristic components may require yearly surveys to accurately document baseline conditions for purposes of impact assessment. In forested areas, however, surveys at intervals of five years may adequately represent current conditions. For forested areas, refer to "Guidelines for Conservation of Sensitive Plant Resources Within the Timber Harvest Review Process and During Timber Harvesting Operations", available at https://r1.dfg.ca.gov/portal/Portals/12/THPBotanicalGuidelinesJuly2005.pdf

16 U.S. Fish and Wildlife Service Survey Guidelines available at http://www.fws.gov/ventura/speciesinfo/protocols_guidelines/docs/botanicalinventories.pdf

than one year increase the likelihood of detection of a special status plant especially if conditions change. To further substantiate negative findings for a known occurrence, a visit to a nearby reference site may ensure that the timing of the survey was appropriate.

REPORTING AND DATA COLLECTION

Adequate information about special status plants and natural communities present in a project area will enable reviewing agencies and the public to effectively assess potential impacts to special status plants or natural communities[17] and will guide the development of minimization and mitigation measures. The next section describes necessary information to assess impacts. For comprehensive, systematic surveys where no special status species or natural communities were found, reporting and data collection responsibilities for investigators remain as described below, excluding specific occurrence information.

SPECIAL STATUS PLANT OR NATURAL COMMUNITY OBSERVATIONS

Record the following information for locations of each special status plant or natural community detected during a field survey of a project site.

- A detailed map (1:24,000 or larger) showing locations and boundaries of each special status species occurrence or natural community found as related to the proposed project. Mark occurrences and boundaries as accurately as possible. Locations documented by use of global positioning system (GPS) coordinates must include the datum[18] in which they were collected;
- The site-specific characteristics of occurrences, such as associated species, habitat and microhabitat, structure of vegetation, topographic features, soil type, texture, and soil parent material. If the species is associated with a wetland, provide a description of the direction of flow and integrity of surface or subsurface hydrology and adjacent off-site hydrological influences as appropriate;
- The number of individuals in each special status plant population as counted (if population is small) or estimated (if population is large);
- If applicable, information about the percentage of individuals in each life stage such as seedlings vs. reproductive individuals;
- The number of individuals of the species per unit area, identifying areas of relatively high, medium and low density of the species over the project site; and
- Digital images of the target species and representative habitats to support information and descriptions.

FIELD SURVEY FORMS

When a special status plant or natural community is located, complete and submit to the CNDDB a California Native Species (or Community) Field Survey Form[19] or equivalent written report, accompanied by a copy of the relevant portion of a 7.5 minute topographic map with the occurrence mapped. Present locations documented by use of GPS coordinates in map and digital form. Data submitted in digital form must include the datum[20] in which it was collected. If a potentially undescribed special status natural community is found on the site, document it with a Rapid Assessment or Relevé form[21] and submit it with the CNDDB form.

VOUCHER COLLECTION

Voucher specimens provide verifiable documentation of species presence and identification as well as a public record of conditions. This information is vital to all conservation efforts. Collection of voucher specimens should

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[17] Refer to current online published lists available at: http://www.dfg.ca.gov/biogeodata. For Timber Harvest Plans (THPs) please refer to the "Guidelines for Conservation of Sensitive Plant Resources Within the Timber Harvest Review Process and During Timber Harvesting Operations", available at https://r1.dfg.ca.gov/portal/Portals/12/THPBotanicalGuidelinesJuly2005.pdf

[18] NAD83, NAD27 or WGS84

[19] http://www.dfg.ca.gov/biogeodata

[20] NAD83, NAD27 or WGS84

[21] http://www.dfg.ca.gov/biogeodata/vegcamp/veg_publications_protocols.asp

be conducted in a manner that is consistent with conservation ethics, and is in accordance with applicable state and federal permit requirements (e.g. incidental take permit, scientific collection permit). Voucher collections of special status species (or suspected special status species) should be made only when such actions would not jeopardize the continued existence of the population or species.

Deposit voucher specimens with an indexed regional herbarium[22] no later than 60 days after the collections have been made. Digital imagery can be used to supplement plant identification and document habitat. Record all relevant permittee names and permit numbers on specimen labels. A collecting permit is required prior to the collection of State-listed plant species[23].

BOTANICAL SURVEY REPORTS

Include reports of botanical field surveys containing the following information with project environmental documents:

- **Project and site description**
    - A description of the proposed project;
    - A detailed map of the project location and study area that identifies topographic and landscape features and includes a north arrow and bar scale; and,
    - A written description of the biological setting, including vegetation[24] and structure of the vegetation; geological and hydrological characteristics; and land use or management history.
- **Detailed description of survey methodology and results**
    - Dates of field surveys (indicating which areas were surveyed on which dates), name of field investigator(s), and total person-hours spent on field surveys;
    - A discussion of how the timing of the surveys affects the comprehensiveness of the survey;
    - A list of potential special status species or natural communities;
    - A description of the area surveyed relative to the project area;
    - References cited, persons contacted, and herbaria visited;
    - Description of reference site(s), if visited, and phenological development of special status plant(s);
    - A list of all taxa occurring on the project site. Identify plants to the taxonomic level necessary to determine whether or not they are a special status species;
    - Any use of existing surveys and a discussion of applicability to this project;
    - A discussion of the potential for a false negative survey;
    - Provide detailed data and maps for all special plants detected. Information specified above under the headings "Special Status Plant or Natural Community Observations," and "Field Survey Forms," should be provided for locations of each special status plant detected;
    - Copies of all California Native Species Field Survey Forms or Natural Community Field Survey Forms should be sent to the CNDDB and included in the environmental document as an Appendix. It is not necessary to submit entire environmental documents to the CNDDB; and,
    - The location of voucher specimens, if collected.

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22 For a complete list of indexed herbaria, see: Holmgren, P., N. Holmgren and L. Barnett. 1990. Index Herbariorum, Part 1: Herbaria of the World. New York Botanic Garden, Bronx, New York. 693 pp. Or: http://www.nybg.org/bsci/ih/ih.html

23 Refer to current online published lists available at: http://www.dfg.ca.gov/biogeodata.

24 A vegetation map that uses the National Vegetation Classification System (http://biology.usgs.gov/npsveg/nvcs.html), for example *A Manual of California Vegetation*, and highlights any special status natural communities. If another vegetation classification system is used, the report should reference the system, provide the reason for its use, and provide a crosswalk to the National Vegetation Classification System.

- **Assessment of potential impacts**
  - A discussion of the significance of special status plant populations in the project area considering nearby populations and total species distribution;
  - A discussion of the significance of special status natural communities in the project area considering nearby occurrences and natural community distribution;
  - A discussion of direct, indirect, and cumulative impacts to the plants and natural communities;
  - A discussion of threats, including those from invasive species, to the plants and natural communities;
  - A discussion of the degree of impact, if any, of the proposed project on unoccupied, potential habitat of the species;
  - A discussion of the immediacy of potential impacts; and,
  - Recommended measures to avoid, minimize, or mitigate impacts.

QUALIFICATIONS

Botanical consultants should possess the following qualifications:

- Knowledge of plant taxonomy and natural community ecology;
- Familiarity with the plants of the area, including special status species;
- Familiarity with natural communities of the area, including special status natural communities;
- Experience conducting floristic field surveys or experience with floristic surveys conducted under the direction of an experienced surveyor;
- Familiarity with the appropriate state and federal statutes related to plants and plant collecting; and,
- Experience with analyzing impacts of development on native plant species and natural communities.

SUGGESTED REFERENCES

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U.S. Fish and Wildlife Service. 1996. Guidelines for conducting and reporting botanical inventories for federally listed, proposed and candidate plants. Sacramento, CA.

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Attachment H

Staff Report on Burrowing Owl Mitigation

State of California

Natural Resources Agency

Department of Fish and Game

March 7, 2012[1]

[1] This document replaces the Department of Fish and Game 1995 Staff Report On Burrowing Owl Mitigation.

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INTRODUCTION AND PURPOSE

Maintaining California's rich biological diversity is dependent on the conservation of species and their habitats. The California Department of Fish and Game (Department) has designated certain species as "species of special concern" when their population viability and survival is adversely affected by risk factors such as precipitous declines or other vulnerability factors (Shuford and Gardali 2008). Preliminary analyses of regional patterns for breeding populations of burrowing owls (*Athene cunicularia*) have detected declines both locally in their central and southern coastal breeding areas, and statewide where the species has experienced modest breeding range retraction (Gervais et al. 2008). In California, threat factors affecting burrowing owl populations include habitat loss, degradation and modification, and eradication of ground squirrels resulting in a loss of suitable burrows required by burrowing owls for nesting, protection from predators, and shelter (See Appendix A).

The Department recognized the need for a comprehensive conservation and mitigation strategy for burrowing owls, and in 1995 directed staff to prepare a report describing mitigation and survey recommendations. This report, "1995 Staff Report on Burrowing Owl Mitigation," (Staff Report) (CDFG 1995), contained Department-recommended burrowing owl and burrow survey techniques and mitigation measures intended to offset the loss of habitat and slow or reverse further decline of this species. Notwithstanding these measures, over the past 15+ years, burrowing owls have continued to decline in portions of their range (DeSante et al. 2007, Wilkerson and Siegel, 2010). The Department has determined that reversing declining population and range trends for burrowing owls will require implementation of more effective conservation actions, and evaluating the efficacy of the Department's existing recommended avoidance, minimization and mitigation approaches for burrowing owls.

The Department has identified three main actions that together will facilitate a more viable, coordinated, and concerted approach to conservation and mitigation for burrowing owls in California. These include:

1. Incorporating burrowing owl comprehensive conservation strategies into landscape-based planning efforts such as Natural Community Conservation Plans (NCCPs) and multi-species Habitat Conservation Plans (HCPs) that specifically address burrowing owls.
2. Developing and implementing a statewide conservation strategy (Burkett and Johnson, 2007) and local or regional conservation strategies for burrowing owls, including the development and implementation of a statewide burrowing owl survey and monitoring plan.
3. Developing more rigorous burrowing owl survey methods, working to improve the adequacy of impacts assessments; developing clear and effective avoidance and minimization measures; and developing mitigation measures to ensure impacts to the species are effectively addressed at the project, local, and/or regional level (the focus of this document).

This Report sets forth the Department's recommendations for implementing the third approach identified above by revising the 1995 Staff Report, drawing from the most relevant and current knowledge and expertise, and incorporating the best scientific information available pertaining to the species. It is designed to provide a compilation of the best available science for Department staff, biologists, planners, land managers, California Environmental Quality Act (CEQA) lead agencies, and the public to consider when assessing impacts of projects or other activities on burrowing owls.

This revised Staff Report takes into account the California Burrowing Owl Consortium's Survey Protocol and Mitigation Guidelines (CBOC 1993, 1997) and supersedes the survey, avoidance, minimization and mitigation recommendations in the 1995 Staff Report. Based on experiences gained from implementing the 1995 Staff Report, the Department believes revising that report is warranted. This document also includes general conservation goals and principles for developing mitigation measures for burrowing owls.

DEPARTMENT ROLE AND LEGAL AUTHORITIES

The mission of the Department is 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 has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and habitats necessary to maintain biologically sustainable populations of those species (Fish and Game Code (FGC) §1802). The Department, as trustee agency pursuant to CEQA (See CEQA Guidelines, §15386), has jurisdiction by law over natural resources, including fish and wildlife, affected by a project, as that term is defined in Section 21065 of the Public Resources Code. The Department exercises this authority by reviewing and commenting on environmental documents and making recommendations to avoid, minimize, and mitigate potential negative impacts to those resources held in trust for the people of California.

Field surveys designed to detect the presence of a particular species, habitat element, or natural community are one of the tools that can assist biologists in determining whether a species or habitat may be significantly impacted by land use changes or disturbance. The Department reviews field survey data as well as site-specific and regional information to evaluate whether a project's impacts may be significant. This document compiles the best available science for conducting habitat assessments and surveys, and includes considerations for developing measures to avoid impacts or mitigate unavoidable impacts.

CEQA

CEQA requires public agencies in California to analyze and disclose potential environmental impacts associated with a project that the agency will carry out, fund, or approve. Any potentially significant impact must be mitigated to the extent feasible. Project-specific CEQA mitigation is important for burrowing owls because most populations exist on privately owned parcels that, when proposed for development or other types of modification, may be subject to the environmental review requirements of CEQA.

Take

Take of individual burrowing owls and their nests is defined by FGC section 86, and prohibited by sections 3503, 3503.5 and 3513. Take is defined in FGC Section 86 as "hunt, pursue, catch, capture or kill, or attempt to hunt, pursue, catch, capture or kill."

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) implements various treaties and conventions between the United States and Canada, Japan, Mexico, and Russia for the protection of migratory birds, including the burrowing owl (50 C.F.R. § 10). The MBTA protects migratory bird nests from possession, sale, purchase, barter, transport, import and export, and collection. The other prohibitions of the MBTA - capture, pursue, hunt, and kill - are inapplicable to nests. The regulatory definition of take, as defined in Title 50 C.F.R. part 10.12, means to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to hunt, shoot, wound, kill, trap, capture, or collect. Only the verb "collect" applies to nests. It is illegal to collect, possess, and by any means transfer possession of any migratory bird nest. The MBTA prohibits the destruction of a nest when it contains birds or eggs, and no possession shall occur during the destruction (see Fish and Wildlife Service, Migratory Bird Permit Memorandum, April 15, 2003). Certain exceptions to this prohibition are included in 50 C.F.R. section 21. Pursuant to Fish & Game Code section 3513, the Department enforces the Migratory Bird Treaty Act consistent with rules and regulations adopted by the Secretary of the Interior under provisions of the Migratory Treaty Act.

Regional Conservation Plans

Regional multiple species conservation plans offer long-term assurances for conservation of covered species at a landscape scale, in exchange for biologically appropriate levels of incidental take and/or habitat loss as defined in the approved plan. California's NCCP Act (FGC §2800 et seq.) governs such plans at the state level, and was designed to conserve species, natural communities, ecosystems, and ecological processes across a jurisdiction or a collection of jurisdictions. Complementary federal HCPs are governed by the Endangered Species Act (7 U.S.C. § 136, 16 U.S.C.§ 1531 et seq.) (ESA). Regional conservation plans (and certain other landscape-level conservation and management plans), may provide conservation for unlisted as well as listed species. Because the geographic scope of NCCPs and HCPs may span many hundreds of thousands of acres, these planning tools have the potential to play a significant role in conservation of burrowing owls, and grasslands and other habitats.

Fish and Game Commission Policies

There are a number of Fish and Game Commission policies (see FGC §2008) that can be applied to burrowing owl conservation. These include policies on: Raptors, Cooperation, Endangered and Threatened Species, Land Use Planning, Management and Utilization of Fish and Wildlife on Federal Lands, Management and Utilization of Fish and Wildlife on Private Lands, and Research.

GUIDING PRINCIPLES FOR CONSERVATION

Unless otherwise provided in a statewide, local, or regional conservation strategy, surveying and evaluating impacts to burrowing owls, as well as developing and implementing avoidance, minimization, and mitigation and conservation measures incorporate the following principles. These principles are a summary of Department staff expert opinion and were used to guide the preparation of this document.

1. Use the Precautionary Principle (Noss et al.1997), by which the alternative of increased conservation is deliberately chosen in order to buffer against incomplete knowledge of burrowing owl ecology and uncertainty about the consequences to burrowing owls of potential impacts, including those that are cumulative.
2. Employ basic conservation biology tenets and population-level approaches when determining what constitutes appropriate avoidance, minimization, and mitigation for impacts. Include mitigation effectiveness monitoring and reporting, and use an adaptive management loop to modify measures based on results.
3. Protect and conserve owls in wild, semi-natural, and agricultural habitats (conserve is defined at FGC §1802).
4. Protect and conserve natural nest burrows (or burrow surrogates) previously used by burrowing owls and sufficient foraging habitat and protect auxiliary "satellite" burrows that contribute to burrowing owl survivorship and natural behavior of owls.

CONSERVATION GOALS FOR THE BURROWING OWL IN CALIFORNIA

It is Department staff expert opinion that the following goals guide and contribute to the short and long-term conservation of burrowing owls in California:

1. Maintain size and distribution of extant burrowing owl populations (allowing for natural population fluctuations).
2. Increase geographic distribution of burrowing owls into formerly occupied historical range where burrowing owl habitat still exists, or where it can be created or enhanced, and where the reason for its local disappearance is no longer of concern.
3. Increase size of existing populations where possible and appropriate (for example, considering basic ecological principles such as carrying capacity, predator-prey relationships, and inter-specific relationships with other species at risk).
4. Protect and restore self-sustaining ecosystems or natural communities which can support burrowing owls at a landscape scale, and which will require minimal long-term management.
5. Minimize or prevent unnatural causes of burrowing owl population declines (e.g., nest burrow destruction, chemical control of rodent hosts and prey).
6. Augment/restore natural dynamics of burrowing owl populations including movement and genetic exchange among populations, such that the species does not require future listing and protection under the California Endangered Species Act (CESA) and/or the federal Endangered Species Act (ESA).
7. Engage stakeholders, including ranchers; farmers; military; tribes; local, state, and federal agencies; non-governmental organizations; and scientific research and education communities involved in burrowing owl protection and habitat management.

ACTIVITIES WITH THE POTENTIAL TO TAKE OR IMPACT BURROWING OWLS

The following activities are examples of activities that have the potential to take burrowing owls, their nests or eggs, or destroy or degrade burrowing owl habitat: grading, disking, cultivation, earthmoving, burrow blockage, heavy equipment compacting and crushing burrow tunnels, levee maintenance, flooding, burning and mowing (if burrows are impacted), and operating wind turbine collisions (collectively hereafter referred to as "projects" or "activities" whether carried out pursuant to CEQA or not). In addition, the following activities may have impacts to burrowing owl populations: eradication of host burrowers; changes in vegetation management (i.e. grazing); use of pesticides and rodenticides; destruction, conversion or degradation of nesting, foraging, over-wintering or other habitats; destruction of natural burrows and burrow surrogates; and disturbance which may result in harassment of owls at occupied burrows.

PROJECT IMPACT EVALUATIONS

The following three progressive steps are effective in evaluating whether projects will result in impacts to burrowing owls. The information gained from these steps will inform any subsequent avoidance, minimization and mitigation measures. The steps for project impact evaluations are: 1) habitat assessment, 2) surveys, and 3) impact assessment. Habitat assessments are conducted to evaluate the likelihood that a site supports burrowing owl. Burrowing owl surveys provide information needed to determine the potential effects of proposed projects and activities on burrowing owls, and to avoid take in accordance with FGC sections 86, 3503, and 3503.5. Impact assessments evaluate the extent to which burrowing owls and their habitat may be impacted, directly or indirectly, on and within a reasonable distance of a proposed CEQA project activity or non-CEQA project. These three site evaluation steps are discussed in detail below.

Biologist Qualifications

The current scientific literature indicates that only individuals meeting the following minimum qualifications should perform burrowing owl habitat assessments, surveys, and impact assessments:

1. Familiarity with the species and its local ecology;
2. Experience conducting habitat assessments and non-breeding and breeding season surveys, or experience with these surveys conducted under the direction of an experienced surveyor;
3. Familiarity with the appropriate state and federal statutes related to burrowing owls, scientific research, and conservation;
4. Experience with analyzing impacts of development on burrowing owls and their habitat.

Habitat Assessment Data Collection and Reporting

A habitat assessment is the first step in the evaluation process and will assist investigators in determining whether or not occupancy surveys are needed. Refer to Appendix B for a definition of burrowing owl habitat. Compile the detailed information described in Appendix C when conducting project scoping, conducting a habitat assessment site visit and preparing a habitat assessment report.

Surveys

Burrowing owl surveys are the second step of the evaluation process and the best available scientific literature recommends that they be conducted whenever burrowing owl habitat or sign (see Appendix B) is encountered on or adjacent to (within 150 meters) a project site

(Thomsen 1971, Martin 1973). Occupancy of burrowing owl habitat is confirmed at a site when at least one burrowing owl, or its sign at or near a burrow entrance, is observed within the last three years (Rich 1984). Burrowing owls are more detectable during the breeding season with detection probabilities being highest during the nestling stage (Conway et al. 2008). In California, the burrowing owl breeding season extends from 1 February to 31 August (Haug et al. 1993, Thompsen 1971) with some variances by geographic location and climatic conditions. Several researchers suggest three or more survey visits during daylight hours (Haug and Diduik 1993, CBOC 1997, Conway and Simon 2003) and recommend each visit occur at least three weeks apart during the peak of the breeding season, commonly accepted in California as between 15 April and 15 July (CBOC 1997). Conway and Simon (2003) and Conway et al. (2008) recommended conducting surveys during the day when most burrowing owls in a local area are in the laying and incubation period (so as not to miss early breeding attempts), during the nesting period, and in the late nestling period when most owls are spending time above ground.

Non-breeding season (1 September to 31 January) surveys may provide information on burrowing owl occupancy, but do not substitute for breeding season surveys because results are typically inconclusive. Burrowing owls are more difficult to detect during the non-breeding season and their seasonal residency status is difficult to ascertain. Burrowing owls detected during non-breeding season surveys may be year-round residents, young from the previous breeding season, pre-breeding territorial adults, winter residents, dispersing juveniles, migrants, transients or new colonizers. In addition, the numbers of owls and their pattern of distribution may differ during winter and breeding seasons. However, on rare occasions, non-breeding season surveys may be warranted (i.e., if the site is believed to be a wintering site only based on negative breeding season results). Refer to Appendix D for information on breeding season and non-breeding season survey methodologies.

Survey Reports

Adequate information about burrowing owls present in and adjacent to an area that will be disturbed by a project or activity will enable the Department, reviewing agencies and the public to effectively assess potential impacts and will guide the development of avoidance, minimization, and mitigation measures. The survey report includes but is not limited to a description of the proposed project or proposed activity, including the proposed project start and end dates, as well as a description of disturbances or other activities occurring on-site or nearby. Refer to Appendix D for details included in a survey report.

Impact Assessment

The third step in the evaluation process is the impact assessment. When surveys confirm occupied burrowing owl habitat in or adjoining the project area, there are a number of ways to assess a project's potential significant impacts to burrowing owls and their habitat. Richardson and Miller (1997) recommended monitoring raptor behavior prior to developing management recommendations and buffers to determine the extent to which individuals have been sensitized to human disturbance. Monitoring results will also provide detail necessary for developing site-specific measures. Postovit and Postovit (1987) recommended an analytical approach to mitigation planning: define the problem (impact), set goals (to guide mitigation development), evaluate and select mitigation methods, and monitor the results.

Define the problem. The impact assessment evaluates all factors that could affect burrowing owls. Postovit and Postovit (1987) recommend evaluating the following in assessing impacts to raptors and planning mitigation: type and extent of disturbance, duration and timing of disturbance, visibility of disturbance, sensitivity and ability to habituate, and influence of environmental factors. They suggest identifying and addressing all potential direct and indirect impacts to burrowing owls, regardless of whether or not the impacts will occur during the breeding season. Several examples are given for each impact category below; however, examples are not intended to be used exclusively.

Type and extent of the disturbance. The impact assessment describes the nature (source) and extent (scale) of potential project impacts on occupied, satellite and unoccupied burrows including acreage to be lost (temporary or permanent), fragmentation/edge being created, increased distance to other nesting and foraging habitat, and habitat degradation. Discuss any project activities that impact either breeding and/or non-breeding habitat which could affect owl home range size and spatial configuration, negatively affect onsite and offsite burrowing owl presence, increase energetic costs, lower reproductive success, increase vulnerability to predation, and/or decrease the chance of procuring a mate.

Duration and timing of the impact. The impact assessment describes the amount of time the burrowing owl habitat will be unavailable to burrowing owls (temporary or permanent) on the site and the effect of that loss on essential behaviors or life history requirements of burrowing owls, the overlap of project activities with breeding and/or non-breeding seasons (timing of nesting and/or non-breeding activities may vary with latitude and climatic conditions, which should be considered with the timeline of the project or activity), and any variance of the project activities in intensity, scale and proximity relative to burrowing owl occurrences.

Visibility and sensitivity. Some individual burrowing owls or pairs are more sensitive than others to specific stimuli and may habituate to ongoing visual or audible disturbance. Site-specific monitoring may provide clues to the burrowing owl's sensitivities. This type of assessment addresses the sensitivity of burrowing owls within their nesting area to humans on foot, and vehicular traffic. Other variables are whether the site is primarily in a rural versus urban setting, and whether any prior disturbance (e.g., human development or recreation) is known at the site.

Environmental factors. The impact assessment discusses any environmental factors that could be influenced or changed by the proposed activities including nest site availability, predators, prey availability, burrowing mammal presence and abundance, and threats from other extrinsic factors such as human disturbance, urban interface, feral animals, invasive species, disease or pesticides.

Significance of impacts. The impact assessment evaluates the potential loss of nesting burrows, satellite burrows, foraging habitat, dispersal and migration habitat, wintering habitat, and habitat linkages, including habitat supporting prey and host burrowers and other essential habitat attributes. This assessment determines if impacts to the species will result in significant impacts to the species locally, regionally and range-wide per CEQA Guidelines §15382 and Appendix G. The significance of the impact to habitat depends on the extent of habitat disturbed and length of time the habitat is unavailable (for example: minor – several days, medium – several weeks to months, high - breeding season affecting juvenile survival, or over winter affecting adult survival).

Cumulative effects. The cumulative effects assessment evaluates two consequences: 1) the project's proportional share of reasonably foreseeable impacts on burrowing owls and habitat caused by the project or in combination with other projects and local influences having impacts on burrowing owls and habitat, and 2) the effects on the regional owl population resulting from the project's impacts to burrowing owls and habitat.

Mitigation goals. Establishing goals will assist in planning mitigation and selecting measures that function at a desired level. Goals also provide a standard by which to measure mitigation success. Unless specifically provided for through other FGC Sections or through specific regulations, take, possession or destruction of individual burrowing owls, their nests and eggs is prohibited under FGC sections 3503, 3503.5 and 3513. Therefore, a required goal for all project activities is to avoid take of burrowing owls. Under CEQA, goals would consist of measures that would avoid, minimize and mitigate impacts to a less than significant level. For individual projects, mitigation must be roughly proportional to the level of impacts, including cumulative impacts, in accordance with the provisions of CEQA (CEQA Guidelines, §§ 15126.4(a)(4)(B), 15064, 15065, and 16355). In order for mitigation measures to be effective, they must be specific, enforceable, and feasible actions that will improve environmental conditions. As set forth in more detail in Appendix A, the current scientific literature supports the conclusion that mitigation for permanent habitat loss necessitates replacement with an equivalent or greater habitat area for breeding, foraging, wintering, dispersal, presence of burrows, burrow surrogates, presence of fossorial mammal dens, well drained soils, and abundant and available prey within close proximity to the burrow.

MITIGATION METHODS

The current scientific literature indicates that any site-specific avoidance or mitigation measures developed should incorporate the best practices presented below or other practices confirmed by experts and the Department. The Department is available to assist in the development of site-specific avoidance and mitigation measures.

Avoiding. A primary goal is to design and implement projects to seasonally and spatially avoid negative impacts and disturbances that could result in take of burrowing owls, nests, or eggs. Other avoidance measures may include but not be limited to:

- Avoid disturbing occupied burrows during the nesting period, from 1 February through 31 August.
- Avoid impacting burrows occupied during the non-breeding season by migratory or non-migratory resident burrowing owls.
- Avoid direct destruction of burrows through chaining (dragging a heavy chain over an area to remove shrubs), disking, cultivation, and urban, industrial, or agricultural development.
- Develop and implement a worker awareness program to increase the on-site worker's recognition of and commitment to burrowing owl protection.
- Place visible markers near burrows to ensure that farm equipment and other machinery does not collapse burrows.
- Do not fumigate, use treated bait or other means of poisoning nuisance animals in areas where burrowing owls are known or suspected to occur (e.g., sites observed with nesting

owls, designated use areas).

- Restrict the use of treated grain to poison mammals to the months of January and February.

Take avoidance (pre-construction) surveys. Take avoidance surveys are intended to detect the presence of burrowing owls on a project site at a fixed period in time and inform necessary take avoidance actions. Take avoidance surveys may detect changes in owl presence such as colonizing owls that have recently moved onto the site, migrating owls, resident burrowing owls changing burrow use, or young of the year that are still present and have not dispersed. Refer to Appendix D for take avoidance survey methodology.

Site surveillance. Burrowing owls may attempt to colonize or re-colonize an area that will be impacted; thus, the current scientific literature indicates a need for ongoing surveillance at the project site during project activities is recommended. The surveillance frequency/effort should be sufficient to detect burrowing owls if they return. Subsequent to their new occupancy or return to the site, take avoidance measures should assure with a high degree of certainty that take of owls will not occur.

Minimizing. If burrowing owls and their habitat can be protected in place on or adjacent to a project site, the use of buffer zones, visual screens or other measures while project activities are occurring can minimize disturbance impacts. Conduct site-specific monitoring to inform development of buffers (see Visibility and sensitivity above). The following general guidelines for implementing buffers should be adjusted to address site-specific conditions using the impact assessment approach described above. The CEQA lead agency and/or project proponent is encouraged to consult with the Department and other burrowing owl experts for assistance in developing site-specific buffer zones and visual screens.

Buffers. Holroyd et al. (2001) identified a need to standardize management and disturbance mitigation guidelines. For instance, guidelines for mitigating impacts by petroleum industries on burrowing owls and other prairie species (Scobie and Faminow, 2000) may be used as a template for future mitigation guidelines (Holroyd et al. 2001). Scobie and Faminow (2000) developed guidelines for activities around occupied burrowing owl nests recommending buffers around low, medium, and high disturbance activities, respectively (see below).

Recommended restricted activity dates and setback distances by level of disturbance for burrowing owls (Scobie and Faminow 2000).

Location	Time of Year	Level of Disturbance		
		Low	Med	High
Nesting sites	April 1-Aug 15	200 m*	500 m	500 m
Nesting sites	Aug 16-Oct 15	200 m	200 m	500 m
Nesting sites	Oct 16-Mar 31	50 m	100 m	500 m

* meters (m)

Based on existing vegetation, human development, and land uses in an area, resource managers may decide to allow human development or resource extraction closer to these area/sites than recommended above. However, if it is decided to allow activities closer than the setback distances recommended, a broad-scale, long-term, scientifically-rigorous monitoring program ensures that burrowing owls are not detrimentally affected by alternative approaches.

Other minimization measures include eliminating actions that reduce burrowing owl forage and burrowing surrogates (e.g. ground squirrel), or introduce/facilitate burrowing owl predators. Actions that could influence these factors include reducing livestock grazing rates and/or changing the timing or duration of grazing or vegetation management that could result in less suitable habitat.

Burrow exclusion and closure. Burrow exclusion is a technique of installing one-way doors in burrow openings during the non-breeding season to temporarily exclude burrowing owls, or permanently exclude burrowing owls and close burrows after verifying burrows are empty by site monitoring and scoping. Exclusion in and of itself is not a take avoidance, minimization or mitigation method. Eviction of burrowing owls is a potentially significant impact under CEQA.

The long-term demographic consequences of these techniques have not been thoroughly evaluated, and the fate of evicted or excluded burrowing owls has not been systematically studied. Because burrowing owls are dependent on burrows at all times of the year for survival and/or reproduction, evicting them from nesting, roosting, and satellite burrows may lead to indirect impacts or take. Temporary or permanent closure of burrows may result in significant loss of burrows and habitat for reproduction and other life history requirements. Depending on the proximity and availability of alternate habitat, loss of access to burrows will likely result in varying levels of increased stress on burrowing owls and could depress reproduction, increase predation, increase energetic costs, and introduce risks posed by having to find and compete for available burrows. Therefore, exclusion and burrow closure are not recommended where they can be avoided. The current scientific literature indicates consideration of all possible avoidance and minimization measures before temporary or permanent exclusion and closure of burrows is implemented, in order to avoid take.

The results of a study by Trulio (1995) in California showed that burrowing owls passively displaced from their burrows were quickly attracted to adjacent artificial burrows at five of six passive relocation sites. The successful sites were all within 75 meters (m) of the destroyed burrow, a distance generally within a pair's territory. This researcher discouraged using passive relocation to artificial burrows as a mitigation measure for lost burrows without protection of adjacent foraging habitat. The study results indicated artificial burrows were used by evicted burrowing owls when they were approximately 50-100 m from the natural burrow (Thomsen 1971, Haug and Oliphant 1990). Locating artificial or natural burrows more than 100 m from the eviction burrow may greatly reduce the chances that new burrows will be used. Ideally, exclusion and burrow closure is employed only where there are adjacent natural burrows and non-impacted, sufficient habitat for burrowing owls to occupy with permanent protection mechanisms in place. Any new burrowing owl colonizing the project site after the CEQA document has been adopted may constitute changed circumstances that should be addressed in a re-circulated CEQA document.

The current scientific literature indicates that burrow exclusion should only be conducted by qualified biologists (meeting the Biologist's Qualifications above) during the non-breeding season, before breeding behavior is exhibited and after the burrow is confirmed empty by site surveillance and/or scoping. The literature also indicates that when temporary or permanent burrow exclusion and/or burrow closure is implemented, burrowing owls should not be excluded from burrows unless or until:

- A Burrowing Owl Exclusion Plan (see Appendix E) is developed and approved by the applicable local DFG office;
- Permanent loss of occupied burrow(s) and habitat is mitigated in accordance with the Mitigating Impacts sections below. Temporary exclusion is mitigated in accordance with the item #1 under Mitigating Impacts below.
- Site monitoring is conducted prior to, during, and after exclusion of burrowing owls from their burrows sufficient to ensure take is avoided. Conduct daily monitoring for one week to confirm young of the year have fledged if the exclusion will occur immediately after the end of the breeding season.
- Excluded burrowing owls are documented using artificial or natural burrows on an adjoining mitigation site (if able to confirm by band re-sight).

Translocation (Active relocation offsite >100 meters). At this time, there is little published information regarding the efficacy of translocating burrowing owls, and additional research is needed to determine subsequent survival and breeding success (Klute et al. 2003, Holroyd et al. 2001). Study results for translocation in Florida implied that hatching success may be decreased for populations of burrowing owls that undergo translocation (Nixon 2006). At this time, the Department is unable to authorize the capture and relocation of burrowing owls except within the context of scientific research (FGC §1002) or a NCCP conservation strategy.

Mitigating impacts. Habitat loss and degradation from rapid urbanization of farmland in the core areas of the Central and Imperial valleys is the greatest of many threats to burrowing owls in California (Shuford and Gardali, 2008). At a minimum, if burrowing owls have been documented to occupy burrows (see Definitions, Appendix B) at the project site in recent years, the current scientific literature supports the conclusion that the site should be considered occupied and mitigation should be required by the CEQA lead agency to address project-specific significant and cumulative impacts. Other site-specific and regionally significant and cumulative impacts may warrant mitigation. The current scientific literature indicates the following to be best practices. If these best practices cannot be implemented, the lead agency or lead investigator may consult with the Department to develop effective mitigation alternatives. The Department is also available to assist in the identification of suitable mitigation lands.

1. Where habitat will be temporarily disturbed, restore the disturbed area to pre-project condition including decompacting soil and revegetating. Permanent habitat protection may be warranted if there is the potential that the temporary impacts may render a nesting site (nesting burrow and satellite burrows) unsustainable or unavailable depending on the time frame, resulting in reduced survival or abandonment. For the latter potential impact, see the permanent impact measures below.
2. Mitigate for permanent impacts to nesting, occupied and satellite burrows and/or burrowing owl habitat such that the habitat acreage, number of burrows and burrowing owls impacted are replaced based on the information provided in Appendix A. Note: A

minimum habitat replacement recommendation is not provided here as it has been shown to serve as a default, replacing any site-specific analysis and discounting the wide variation in natal area, home range, foraging area, and other factors influencing burrowing owls and burrowing owl population persistence in a particular area.

3. Mitigate for permanent impacts to nesting, occupied and satellite burrows and burrowing owl habitat with (a) permanent conservation of similar vegetation communities (grassland, scrublands, desert, urban, and agriculture) to provide for burrowing owl nesting, foraging, wintering, and dispersal (i.e., during breeding and non-breeding seasons) comparable to or better than that of the impact area, and (b) sufficiently large acreage, and presence of fossorial mammals. The mitigation lands may require habitat enhancements including enhancement or expansion of burrows for breeding, shelter and dispersal opportunity, and removal or control of population stressors. If the mitigation lands are located adjacent to the impacted burrow site, ensure the nearest neighbor artificial or natural burrow clusters are at least within 210 meters (Fisher et al. 2007).
4. Permanently protect mitigation land through a conservation easement deeded to a non-profit conservation organization or public agency with a conservation mission, for the purpose of conserving burrowing owl habitat and prohibiting activities incompatible with burrowing owl use. If the project is located within the service area of a Department-approved burrowing owl conservation bank, the project proponent may purchase available burrowing owl conservation bank credits.
5. Develop and implement a mitigation land management plan to address long-term ecological sustainability and maintenance of the site for burrowing owls (see Management Plan and Artificial Burrow sections below, if applicable).
6. Fund the maintenance and management of mitigation land through the establishment of a long-term funding mechanism such as an endowment.
7. Habitat should not be altered or destroyed, and burrowing owls should not be excluded from burrows, until mitigation lands have been legally secured, are managed for the benefit of burrowing owls according to Department-approved management, monitoring and reporting plans, and the endowment or other long-term funding mechanism is in place or security is provided until these measures are completed.
8. Mitigation lands should be on, adjacent or proximate to the impact site where possible and where habitat is sufficient to support burrowing owls present.
9. Where there is insufficient habitat on, adjacent to, or near project sites where burrowing owls will be excluded, acquire mitigation lands with burrowing owl habitat away from the project site. The selection of mitigation lands should then focus on consolidating and enlarging conservation areas located outside of urban and planned growth areas, within foraging distance of other conserved lands. If mitigation lands are not available adjacent to other conserved lands, increase the mitigation land acreage requirement to ensure a selected site is of sufficient size. Offsite mitigation may not adequately offset the biological and habitat values impacted on a one to one basis. Consult with the Department when determining offsite mitigation acreages.
10. Evaluate and select suitable mitigation lands based on a comparison of the habitat attributes of the impacted and conserved lands, including but not limited to: type and structure of habitat being impacted or conserved; density of burrowing owls in impacted and conserved habitat; and significance of impacted or conserved habitat to the species range-wide. Mitigate for the highest quality burrowing owl habitat impacted first and foremost when identifying mitigation lands, even if a mitigation site is located outside of

a lead agency's jurisdictional boundary, particularly if the lead agency is a city or special district.

11. Select mitigation lands taking into account the potential human and wildlife conflicts or incompatibility, including but not limited to, human foot and vehicle traffic, and predation by cats, loose dogs and urban-adapted wildlife, and incompatible species management (i.e., snowy plover).
12. Where a burrowing owl population appears to be highly adapted to heavily altered habitats such as golf courses, airports, athletic fields, and business complexes, permanently protecting the land, augmenting the site with artificial burrows, and enhancing and maintaining those areas may enhance sustainability of the burrowing owl population onsite. Maintenance includes keeping lands grazed or mowed with weed-eaters or push mowers, free from trees and shrubs, and preventing excessive human and human-related disturbance (e.g., walking, jogging, off-road activity, dog-walking) and loose and feral pets (chasing and, presumably, preying upon owls) that make the environment uninhabitable for burrowing owls (Wesemann and Rowe 1985, Millsap and Bear 2000, Lincer and Bloom 2007). Items 4, 5 and 6 also still apply to this mitigation approach.
13. If there are no other feasible mitigation options available and a lead agency is willing to establish and oversee a Burrowing Owl Mitigation and Conservation Fund that funds on a competitive basis acquisition and permanent habitat conservation, the project proponent may participate in the lead agency's program.

Artificial burrows. Artificial burrows have been used to replace natural burrows either temporarily or long-term and their long-term success is unclear. Artificial burrows may be an effective addition to in-perpetuity habitat mitigation if they are augmenting natural burrows, the burrows are regularly maintained (i.e., no less than annual, with biennial maintenance recommended), and surrounding habitat patches are carefully maintained. There may be some circumstances, for example at airports, where squirrels will not be allowed to persist and create a dynamic burrow system, where artificial burrows may provide some support to an owl population.

Many variables may contribute to the successful use of artificial burrows by burrowing owls, including pre-existence of burrowing owls in the area, availability of food, predators, surrounding vegetation and proximity, number of natural burrows in proximity, type of materials used to build the burrow, size of the burrow and entrance, direction in which the burrow entrance is facing, slope of the entrance, number of burrow entrances per burrow, depth of the burrow, type and height of perches, and annual maintenance needs (Belthoff and King 2002, Smith et al. 2005, Barclay et al. 2011). Refer to Barclay (2008) and (2011) and to Johnson et al. 2010 (unpublished report) for guidance on installing artificial burrows including recommendations for placement, installation and maintenance.

Any long-term reliance on artificial burrows as natural burrow replacements must include semi-annual to annual cleaning and maintenance and/or replacement (Barclay et al. 2011, Smith and Conway 2005, Alexander et al. 2005) as an ongoing management practice. Alexander et al. (2005), in a study of the use of artificial burrows found that all of 20 artificial burrows needed some annual cleaning and maintenance. Burrows were either excavated by predators, blocked by soil or vegetation, or experienced substrate erosion forming a space beneath the tubing that prevented nestlings from re-entering the burrow.

Mitigation lands management plan. Develop a Mitigation Lands Management Plan for projects that require off-site or on-site mitigation habitat protection to ensure compliance with and effectiveness of identified management actions for the mitigation lands. A suggested outline and related vegetation management goals and monitoring success criteria can be found in Appendix E.

Mitigation Monitoring and Reporting

Verify the compliance with required mitigation measures, the accuracy of predictions, and ensure the effectiveness of all mitigation measures for burrowing owls by conducting follow-up monitoring, and implementing midcourse corrections, if necessary, to protect burrowing owls. Refer to CEQA Guidelines Section 15097 and the CEQA Guidelines for additional guidance on mitigation, monitoring and reporting. Monitoring is qualitatively different from site surveillance; monitoring normally has a specific purpose and its outputs and outcomes will usually allow a comparison with some baseline condition of the site before the mitigation (including avoidance and minimization) was undertaken. Ideally, monitoring should be based on the Before-After Control-Impact (BACI) principle (McDonald et al. 2000) that requires knowledge of the pre-mitigation state to provide a reference point for the state and change in state after the project and mitigation have been implemented.

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Appendix A. Burrowing Owl Natural History and Threats

Diet

Burrowing owl diet includes arthropods, small rodents, birds, amphibians, reptiles, and carrion (Haug et al. 1993).

Breeding

In California, the breeding season for the burrowing owl typically occurs between 1 February and 31 August although breeding in December has been documented (Thompson 1971, Gervais et al. 2008); breeding behavior includes nest site selection by the male, pair formation, copulation, egg laying, hatching, fledging, and post-fledging care of young by the parents. The peak of the breeding season occurs between 15 April and 15 July and is the period when most burrowing owls have active nests (eggs or young). The incubation period lasts 29 days (Coulombe 1971) and young fledge after 44 days (Haug et al. 1993). Note that the timing of nesting activities may vary with latitude and climatic conditions. Burrowing owls may change burrows several times during the breeding season, starting when nestlings are about three weeks old (Haug et al. 1993).

Dispersal

The following discussion is an excerpt from Gervais et al (2008):

> “The burrowing owl is often considered a sedentary species (e.g., Thomsen 1971). A large proportion of adults show strong fidelity to their nest site from year to year, especially where resident, as in Florida (74% for females, 83% for males; Millsap and Bear 1997). In California, nest-site fidelity rates were 32%–50% in a large grassland and 57% in an agricultural environment (Ronan 2002, Catlin 2004, Catlin et al. 2005). Differences in these rates among sites may reflect differences in nest predation rates (Catlin 2004, Catlin et al. 2005). Despite the high nest fidelity rates, dispersal distances may be considerable for both juveniles (natal dispersal) and adults (postbreeding dispersal), but this also varied with location (Catlin 2004, Rosier et al. 2006). Distances of 53 km to roughly 150 km have been observed in California for adult and natal dispersal, respectively (D. K. Rosenberg and J. A. Gervais, unpublished data), despite the difficulty in detecting movements beyond the immediate study area (Koenig et al. 1996).”

Habitat

The burrowing owl is a small, long-legged, ground-dwelling bird species, well-adapted to open, relatively flat expanses. In California, preferred habitat is generally typified by short, sparse vegetation with few shrubs, level to gentle topography and well-drained soils (Haug et al. 1993). Grassland, shrub steppe, and desert are naturally occurring habitat types used by the species. In addition, burrowing owls may occur in some agricultural areas, ruderal grassy fields, vacant lots and pastures if the vegetation structure is suitable and there are useable burrows and foraging habitat in proximity (Gervais et al 2008). Unique amongst North

American raptors, the burrowing owl requires underground burrows or other cavities for nesting during the breeding season and for roosting and cover, year round. Burrows used by the owls are usually dug by other species termed host burrowers. In California, California ground squirrel (*Spermophilus beecheyi*) and round-tailed ground squirrel (*Citellus tereticaudus*) burrows are frequently used by burrowing owls but they may use dens or holes dug by other fossorial species including badger (*Taxidea taxus*), coyote (*Canis latrans*), and fox (e.g., San Joaquin kit fox, *Vulpes macrotis mutica*; Ronan 2002). In some instances, owls have been known to excavate their own burrows (Thompson 1971, Barclay 2007). Natural rock cavities, debris piles, culverts, and pipes also are used for nesting and roosting (Rosenberg et al. 1998). Burrowing owls have been documented using artificial burrows for nesting and cover (Smith and Belthoff, 2003).

Foraging habitat. Foraging habitat is essential to burrowing owls. The following discussion is an excerpt from Gervais et al. (2008):

> "Useful as a rough guide to evaluating project impacts and appropriate mitigation for burrowing owls, adult male burrowing owls home ranges have been documented (calculated by minimum convex polygon) to comprise anywhere from 280 acres in intensively irrigated agroecosystems in Imperial Valley (Rosenberg and Haley 2004) to 450 acres in mixed agricultural lands at Lemoore Naval Air Station, CA (Gervais et al. 2003), to 600 acres in pasture in Saskatchewan, Canada (Haug and Oliphant 1990). But owl home ranges may be much larger, perhaps by an order of magnitude, in non-irrigated grasslands such as at Carrizo Plain, California (Gervais et al. 2008), based on telemetry studies and distribution of nests. Foraging occurs primarily within 600 m of their nests (within approximately 300 acres, based on a circle with a 600 m radius) during the breeding season."

Importance of burrows and adjacent habitat. Burrows and the associated surrounding habitat are essential ecological requisites for burrowing owls throughout the year and especially during the breeding season. During the non-breeding season, burrowing owls remain closely associated with burrows, as they continue to use them as refuge from predators, shelter from weather and roost sites. Resident populations will remain near the previous season's nest burrow at least some of the time (Coulombe 1971, Thomsen 1971, Botelho 1996, LaFever et al. 2008).

In a study by Lutz and Plumpton (1999) adult males and females nested in formerly used sites at similar rates (75% and 63%, respectively) (Lutz and Plumpton 1999). Burrow fidelity has been reported in some areas; however, more frequently, burrowing owls reuse traditional nesting areas without necessarily using the same burrow (Haug et al. 1993, Dechant et al. 1999). Burrow and nest sites are re-used at a higher rate if the burrowing owl has reproduced successfully during the previous year (Haug et al. 1993) and if the number of burrows isn't limiting nesting opportunity.

Burrowing owls may use "satellite" or non-nesting burrows, moving young at 10-14 days, presumably to reduce risk of predation (Desmond and Savidge 1998) and possibly to avoid nest parasites (Dechant et al. 1999). Successful nests in Nebraska had more active satellite burrows within 75 m of the nest burrow than unsuccessful nests (Desmond and Savidge

1999). Several studies have documented the number of satellite burrows used by young and adult burrowing owls during the breeding season as between one and 11 burrows with an average use of approximately five burrows (Thompsen 1984, Haug 1985, Haug and Oliphant 1990). Supporting the notion of selecting for nest sites near potential satellite burrows, Ronan (2002) found burrowing owl families would move away from a nest site if their satellite burrows were experimentally removed through blocking their entrance.

Habitat adjacent to burrows has been documented to be important to burrowing owls. Gervais et al. (2003) found that home range sizes of male burrowing owls during the nesting season were highly variable within but not between years. Their results also suggested that owls concentrate foraging efforts within 600 meters of the nest burrow, as was observed in Canada (Haug and Oliphant 1990) and southern California (Rosenberg and Haley 2004). James et al. (1997), reported habitat modification factors causing local burrowing owl declines included habitat fragmentation and loss of connectivity.

In conclusion, the best available science indicates that essential habitat for the burrowing owl in California must include suitable year-round habitat, primarily for breeding, foraging, wintering and dispersal habitat consisting of short or sparse vegetation (at least at some time of year), presence of burrows, burrow surrogates or presence of fossorial mammal dens, well-drained soils, and abundant and available prey within close proximity to the burrow.

Threats to Burrowing Owls in California

Habitat loss. Habitat loss, degradation, and fragmentation are the greatest threats to burrowing owls in California. According to DeSante et al. (2007), "the vast majority of burrowing owls [now] occur in the wide, flat lowland valleys and basins of the Imperial Valley and Great Central Valley [where] for the most part,...the highest rates of residential and commercial development in California are occurring." Habitat loss from the State's long history of urbanization in coastal counties has already resulted in either extirpation or drastic reduction of burrowing owl populations there (Gervais et al. 2008). Further, loss of agricultural and other open lands (such as grazed landscapes) also negatively affect owl populations. Because of their need for open habitat with low vegetation, burrowing owls are unlikely to persist in agricultural lands dominated by vineyards and orchards (Gervais et al. 2008).

Control of burrowing rodents. According to Klute et al. (2003), the elimination of burrowing rodents through control programs is a primary factor in the recent and historical decline of burrowing owl populations nationwide. In California, ground squirrel burrows are most often used by burrowing owls for nesting and cover; thus, ground squirrel control programs may affect owl numbers in local areas by eliminating a necessary resource.

Direct mortality. Burrowing owls suffer direct losses from a number of sources. Vehicle collisions are a significant source of mortality especially in the urban interface and where owls nest alongside roads (Haug et al. 1993, Gervais et al. 2008). Road and ditch maintenance, modification of water conveyance structures (Imperial Valley) and discing to control weeds in fallow fields may destroy burrows (Rosenberg and Haley 2004, Catlin and Rosenberg 2006) which may trap or crush owls. Wind turbines at Altamont Pass Wind Resource Area are known to cause direct burrowing owl mortality (Thelander et al. 2003). Exposure to pesticides may pose a threat to the species but is poorly understood (Klute et al. 2003, Gervais et al. 2008).

Appendix B. Definitions

Some key terms that appear in this document are defined below.

Adjacent habitat means burrowing owl habitat that abuts the area where habitat and burrows will be impacted and rendered non-suitable for occupancy.

Breeding (nesting) season begins as early as 1 February and continues through 31 August (Thomsen 1971, Zarn 1974). The timing of breeding activities may vary with latitude and climatic conditions. The breeding season includes pairing, egg-laying and incubation, and nestling and fledging stages.

Burrow exclusion is a technique of installing one-way doors in burrow openings during the non-breeding season to temporarily exclude burrowing owls or permanently exclude burrowing owls and excavate and close burrows after confirming burrows are empty.

Burrowing owl habitat generally includes, but is not limited to, short or sparse vegetation (at least at some time of year), presence of burrows, burrow surrogates or presence of fossorial mammal dens, well-drained soils, and abundant and available prey.

Burrow surrogates include culverts, piles of concrete rubble, piles of soil, burrows created along soft banks of ditches and canals, pipes, and similar structures.

Civil twilight - Morning civil twilight begins when the geometric center of the sun is 6 degrees below the horizon (civil dawn) and ends at sunrise. Evening civil twilight begins at sunset and ends when the geometric center of the sun reaches 6 degrees below the horizon (civil dusk). During this period there is enough light from the sun that artificial sources of light may not be needed to carry on outdoor activities. This concept is sometimes enshrined in laws, for example, when drivers of automobiles must turn on their headlights (called lighting-up time in the UK); when pilots may exercise the rights to fly aircraft. Civil twilight can also be described as the limit at which twilight illumination is sufficient, under clear weather conditions, for terrestrial objects to be clearly distinguished; at the beginning of morning civil twilight, or end of evening civil twilight, the horizon is clearly defined and the brightest stars are visible under clear atmospheric conditions.

Conservation for burrowing owls may include but may not be limited to protecting remaining breeding pairs or providing for population expansion, protecting and enhancing breeding and essential habitat, and amending or augmenting land use plans to stabilize populations and other specific actions to avoid the need to list the species pursuant to California or federal Endangered Species Acts.

Contiguous means connected together so as to form an uninterrupted expanse in space.

Essential habitat includes nesting, foraging, wintering, and dispersal habitat.

Foraging habitat is habitat within the estimated home range of an occupied burrow, supports suitable prey base, and allows for effective hunting.

Host burrowers include ground squirrels, badgers, foxes, coyotes, gophers etc.

Locally significant species is a species that is not rare from a statewide perspective but is rare or uncommon in a local context such as within a county or region (CEQA §15125 (c)) or is so designated in local or regional plans, policies, or ordinances (CEQA Guidelines, Appendix G). Examples include a species at the outer limits of its known range or occurring in a unique habitat type.

Non-breeding season is the period of time when nesting activity is not occurring, generally September 1 through January 31, but may vary with latitude and climatic conditions.

Occupied site or occupancy means a site that is assumed occupied if at least one burrowing owl has been observed occupying a burrow within the last three years (Rich 1984). Occupancy of suitable burrowing owl habitat may also be indicated by owl sign including its molted feathers, cast pellets, prey remains, eggshell fragments, or excrement at or near a burrow entrance or perch site.

Other impacting activities may include but may not be limited to agricultural practices, vegetation management and fire control, pest management, conversion of habitat from rangeland or natural lands to more intensive agricultural uses that could result in “take”. These impacting activities may not meet the definition of a project under CEQA.

Passive relocation is a technique of installing one-way doors in burrow openings to temporarily or permanently evict burrowing owls and prevent burrow re-occupation.

Peak of the breeding season is between 15 April and 15 July.

Sign includes its tracks, molted feathers, cast pellets (defined as 1-2” long brown to black regurgitated pellets consisting of non-digestible portions of the owls’ diet, such as fur, bones, claws, beetle elytra, or feathers), prey remains, egg shell fragments, owl white wash, nest burrow decoration materials (e.g., paper, foil, plastic items, livestock or other animal manure, etc.), possible owl perches, or other items.

Appendix C. Habitat Assessment and Reporting Details

Habitat Assessment Data Collection and Reporting

Current scientific literature indicates that it would be most effective to gather the data in the manner described below when conducting project scoping, conducting a habitat assessment site visit and preparing a habitat assessment report:

1. Conduct at least one visit covering the entire potential project/activity area including areas that will be directly or indirectly impacted by the project. Survey adjoining areas within 150 m (Thomsen 1971, Martin 1973), or more where direct or indirect effects could potentially extend offsite. If lawful access cannot be achieved to adjacent areas, surveys can be performed with a spotting scope or other methods.
2. Prior to the site visit, compile relevant biological information for the site and surrounding area to provide a local and regional context.
3. Check all available sources for burrowing owl occurrence information regionally prior to a field inspection. The CNDDB and BIOS (see References cited) may be consulted for known occurrences of burrowing owls. Other sources of information include, but are not limited to, the Proceedings of the California Burrowing Owl Symposium (Barclay et al. 2007), county bird atlas projects, Breeding Bird Survey records, eBIRD (http://ebird.org), Gervais et al. (2008), local reports or experts, museum records, and other site-specific relevant information.
4. Identify vegetation and habitat types potentially supporting burrowing owls in the project area and vicinity.
5. Record and report on the following information:
    a. A full description of the proposed project, including but not limited to, expected work periods, daily work schedules, equipment used, activities performed (such as drilling, construction, excavation, etc.) and whether the expected activities will vary in location or intensity over the project's timeline;
    b. A regional setting map, showing the general project location relative to major roads and other recognizable features;
    c. A detailed map (preferably a USGS topo 7.5' quad base map) of the site and proposed project, including the footprint of proposed land and/or vegetation-altering activities, base map source, identifying topography, landscape features, a north arrow, bar scale, and legend;
    d. A written description of the biological setting, including location (Section, Township, Range, baseline and meridian), acreage, topography, soils, geographic and hydrologic characteristics, land use and management history on and adjoining the site (i.e., whether it is urban, semi-urban or rural; whether there is any evidence of past or current livestock grazing, mowing, disking, or other vegetation management activities);
    e. An analysis of any relevant, historical information concerning burrowing owl use or occupancy (breeding, foraging, over-wintering) on site or in the assessment area;
    f. Vegetation type and structure (using Sawyer et al. 2009), vegetation height, habitat types and features in the surrounding area plus a reasonably sized (as supported with logical justification) assessment area; (Note: use caution in discounting habitat based on grass height as it can be a temporary condition variable by season and conditions (such as current grazing regime) or may be distributed as a mosaic).

g. The presence of burrowing owl individuals or pairs or sign (see Appendix B);
h. The presence of suitable burrows and/or burrow surrogates (>11 cm in diameter (height and width) and >150 cm in depth) (Johnson et al. 2010), regardless of a lack of any burrowing owl sign and/or burrow surrogates; and burrowing owls and/or their sign that have recently or historically (within the last 3 years) been identified on or adjacent to the site.

Appendix D. Breeding and Non-breeding Season Surveys and Reports

Current scientific literature indicates that it is most effective to conduct breeding and non-breeding season surveys and report in the manner that follows:

Breeding Season Surveys

Number of visits and timing. Conduct 4 survey visits: 1) at least one site visit between 15 February and 15 April, and 2) a minimum of three survey visits, at least three weeks apart, between 15 April and 15 July, with at least one visit after 15 June. Note: many burrowing owl migrants are still present in southwestern California during mid-March, therefore, exercise caution in assuming breeding occupancy early in the breeding season.

Survey method. Rosenberg et al. (2007) confirmed walking line transects were most effective in smaller habitat patches. Conduct surveys in all portions of the project site that were identified in the Habitat Assessment and fit the description of habitat in Appendix A. Conduct surveys by walking straight-line transects spaced 7 m to 20 m apart, adjusting for vegetation height and density (Rosenberg et al. 2007). At the start of each transect and, at least, every 100 m, scan the entire visible project area for burrowing owls using binoculars. During walking surveys, record all potential burrows used by burrowing owls as determined by the presence of one or more burrowing owls, pellets, prey remains, whitewash, or decoration. Some burrowing owls may be detected by their calls, so observers should also listen for burrowing owls while conducting the survey.

Care should be taken to minimize disturbance near occupied burrows during all seasons and not to "flush" burrowing owls especially if predators are present to reduce any potential for needless energy expenditure or burrowing owl mortality. Burrowing owls may flush if approached by pedestrians within 50 m (Conway et al. 2003). If raptors or other predators are present that may suppress burrowing owl activity, return at another time or later date for a follow-up survey.

Check all burrowing owls detected for bands and/or color bands and report band combinations to the Bird Banding Laboratory (BBL). Some site-specific variations to survey methods discussed below may be developed in coordination with species experts and Department staff.

Weather conditions. Poor weather may affect the surveyor's ability to detect burrowing owls, therefore, avoid conducting surveys when wind speed is >20 km/hr, and there is precipitation or dense fog. Surveys have greater detection probability if conducted when ambient temperatures are >20º C, <12 km/hr winds, and cloud cover is <75% (Conway et al. 2008).

Time of day. Daily timing of surveys varies according to the literature, latitude, and survey method. However, surveys between morning civil twilight and 10:00 AM and two hours before sunset until evening civil twilight provide the highest detection probabilities (Barclay pers. comm. 2012, Conway et al. 2008).

Alternate methods. If the project site is large enough to warrant an alternate method, consult current literature for generally accepted survey methods and consult with the Department on the proposed survey approach.

Additional breeding season site visits. Additional breeding season site visits may be necessary, especially if non-breeding season exclusion methods are contemplated. Detailed information, such as approximate home ranges of each individual or of family units, as well as foraging areas as related to the proposed project, will be important to document for evaluating impacts, planning avoidance measure implementation and for mitigation measure performance monitoring.

Adverse conditions may prevent investigators from determining presence or occupancy. Disease, predation, drought, high rainfall or site disturbance may preclude presence of burrowing owls in any given year. Any such conditions should be identified and discussed in the survey report. Visits to the site in more than one year may increase the likelihood of detection. Also, visits to adjacent known occupied habitat may help determine appropriate survey timing.

Given the high site fidelity shown by burrowing owls (see Appendix A, Importance of burrows), conducting surveys over several years may be necessary when project activities are ongoing, occur annually, or start and stop seasonally. (See Negative surveys).

Non-breeding Season Surveys

If conducting non-breeding season surveys, follow the methods described above for breeding season surveys, but conduct at least four (4) visits, spread evenly, throughout the non-breeding season. Burrowing owl experts and local Department staff are available to assist with interpreting results.

Negative Surveys

Adverse conditions may prevent investigators from documenting presence or occupancy. Disease, predation, drought, high rainfall or site disturbance may preclude presence of burrowing owl in any given year. Discuss such conditions in the Survey Report. Visits to the site in more than one year increase the likelihood of detection and failure to locate burrowing owls during one field season does not constitute evidence that the site is no longer occupied, particularly if adverse conditions influenced the survey results. Visits to other nearby known occupied sites can affirm whether the survey timing is appropriate.

Take Avoidance Surveys

Field experience from 1995 to present supports the conclusion that it would be effective to complete an initial take avoidance survey no less than 14 days prior to initiating ground disturbance activities using the recommended methods described in the Detection Surveys section above. Implementation of avoidance and minimization measures would be triggered by positive owl presence on the site where project activities will occur. The development of avoidance and minimization approaches would be informed by monitoring the burrowing owls.

Burrowing owls may re-colonize a site after only a few days. Time lapses between project activities trigger subsequent take avoidance surveys including but not limited to a final survey conducted within 24 hours prior to ground disturbance.

Survey Reports

Report on the survey methods used and results including the information described in the Summary Report and include the reports within the CEQA documentation:

1. Date, start and end time of surveys including weather conditions (ambient temperature, wind speed, percent cloud cover, precipitation and visibility);
2. Name(s) of surveyor(s) and qualifications;
3. A discussion of how the timing of the survey affected the comprehensiveness and detection probability;
4. A description of survey methods used including transect spacing, point count dispersal and duration, and any calls used;
5. A description and justification of the area surveyed relative to the project area;
6. A description that includes: number of owls or nesting pairs at each location (by nestlings, juveniles, adults, and those of an unknown age), number of burrows being used by owls, and burrowing owl sign at burrows. Include a description of individual markers, such as bands (numbers and colors), transmitters, or unique natural identifying features. If any owls are banded, request documentation from the BBL and bander to report on the details regarding the known history of the banded burrowing owl(s) (age, sex, origins, whether it was previously relocated) and provide with the report if available;
7. A description of the behavior of burrowing owls during the surveys, including feeding, resting, courtship, alarm, territorial defense, and those indicative of parents or juveniles;
8. A list of possible burrowing owl predators present and documentation of any evidence of predation of owls;
9. A detailed map (1:24,000 or closer to show details) showing locations of all burrowing owls, potential burrows, occupied burrows, areas of concentrated burrows, and burrowing owl sign. Locations documented by use of global positioning system (GPS) coordinates must include the datum in which they were collected. The map should include a title, north arrow, bar scale and legend;
10. Signed field forms, photos, etc., as appendices to the field survey report;
11. Recent color photographs of the proposed project or activity site; and
12. Original CNDDB Field Survey Forms should be sent directly to the Department's CNDDB office, and copies should be included in the environmental document as an appendix. (http://www.dfg.ca.gov/bdb/html/cnddb.html).

Appendix E. Example Components for Burrowing Owl Artificial Burrow and Exclusion Plans

Whereas the Department does not recommend exclusion and burrow closure, current scientific literature and experience from 1995 to present, indicate that the following example components for burrowing owl artificial burrow and exclusion plans, combined with consultation with the Department to further develop these plans, would be effective.

Artificial Burrow Location

If a burrow is confirmed occupied on-site, artificial burrow locations should be appropriately located and their use should be documented taking into consideration:

1. A brief description of the project and project site pre-construction;
2. The mitigation measures that will be implemented;
3. Potential conflicting site uses or encumbrances;
4. A comparison of the occupied burrow site(s) and the artificial burrow site(s) (e.g., vegetation, habitat types, fossorial species use in the area, and other features);
5. Artificial burrow(s) proximity to the project activities, roads and drainages;
6. Artificial burrow(s) proximity to other burrows and entrance exposure;
7. Photographs of the site of the occupied burrow(s) and the artificial burrows;
8. Map of the project area that identifies the burrow(s) to be excluded as well as the proposed sites for the artificial burrows;
9. A brief description of the artificial burrow design;
10. Description of the monitoring that will take place during and after project implementation including information that will be provided in a monitoring report.
11. A description of the frequency and type of burrow maintenance.

Exclusion Plan

An Exclusion Plan addresses the following including but not limited to:

1. Confirm by site surveillance that the burrow(s) is empty of burrowing owls and other species preceding burrow scoping;
2. Type of scope and appropriate timing of scoping to avoid impacts;
3. Occupancy factors to look for and what will guide determination of vacancy and excavation timing (one-way doors should be left in place 48 hours to ensure burrowing owls have left the burrow before excavation, visited twice daily and monitored for evidence that owls are inside and can't escape i.e., look for sign immediately inside the door).
4. How the burrow(s) will be excavated. Excavation using hand tools with refilling to prevent reoccupation is preferable whenever possible (may include using piping to stabilize the burrow to prevent collapsing until the entire burrow has been excavated and it can be determined that no owls reside inside the burrow);
5. Removal of other potential owl burrow surrogates or refugia on site;
6. Photographing the excavation and closure of the burrow to demonstrate success and sufficiency;

7. Monitoring of the site to evaluate success and, if needed, to implement remedial measures to prevent subsequent owl use to avoid take;
8. How the impacted site will continually be made inhospitable to burrowing owls and fossorial mammals (e.g., by allowing vegetation to grow tall, heavy disking, or immediate and continuous grading) until development is complete.

Appendix F. Mitigation Management Plan and Vegetation Management Goals

Mitigation Management Plan

A mitigation site management plan will help ensure the appropriate implementation and maintenance for the mitigation site and persistence of the burrowing owls on the site. For an example to review, refer to Rosenberg et al. (2009). The current scientific literature and field experience from 1995 to present indicate that an effective management plan includes the following:

1. Mitigation objectives;
2. Site selection factors (including a comparison of the attributes of the impacted and conserved lands) and baseline assessment;
3. Enhancement of the conserved lands (enhancement of reproductive capacity, enhancement of breeding areas and dispersal opportunities, and removal or control of population stressors);
4. Site protection method and prohibited uses;
5. Site manager roles and responsibilities;
6. Habitat management goals and objectives:
    a. Vegetation management goals,
        i. Vegetation management tools:
            1. Grazing
            2. Mowing
            3. Burning
            4. Other
    b. Management of ground squirrels and other fossorial mammals,
    c. Semi-annual and annual artificial burrow cleaning and maintenance,
    d. Non-natives control – weeds and wildlife,
    e. Trash removal;
7. Financial assurances:
    a. Property analysis record or other financial analysis to determine long-term management funding,
    b. Funding schedule;
8. Performance standards and success criteria;
9. Monitoring, surveys and adaptive management;
10. Maps;
11. Annual reports.

Vegetation Management Goals

- Manage vegetation height and density (especially in immediate proximity to burrows). Suitable vegetation structure varies across sites and vegetation types, but should generally be at the average effective vegetation height of 4.7 cm (Green and Anthony 1989) and <13 cm average effective vegetation height (MacCracken et al. 1985*a)*.
- Employ experimental prescribed fires (controlled, at a small scale) to manage vegetation structure;

- Vegetation reduction or ground disturbance timing, extent, and configuration should avoid take. While local ordinances may require fire prevention through vegetation management, activities like disking, mowing, and grading during the breeding season can result in take of burrowing owls and collapse of burrows, causing nest destruction. Consult the take avoidance surveys section above for pre-management avoidance survey recommendations;
- Promote natural prey distribution and abundance, especially in proximity to occupied burrows; and
- Promote self-sustaining populations of host burrowers by limiting or prohibiting lethal rodent control measures and by ensuring food availability for host burrowers through vegetation management.

Refer to Rosenberg et al. (2009) for a good discussion of managing grasslands for burrowing owls.

Mitigation Site Success Criteria

In order to evaluate the success of mitigation and management strategies for burrowing owls, monitoring is required that is specific to the burrowing owl management plan. Given limited resources, Barclay et al. (2011) suggests managers focus on accurately estimating annual adult owl populations rather than devoting time to estimating reproduction, which shows high annual variation and is difficult to accurately estimate. Therefore, the key objective will be to determine accurately the number of adult burrowing owls and pairs, and if the numbers are maintained. A frequency of 5-10 years for surveys to estimate population size may suffice if there are no changes in the management of the nesting and foraging habitat of the owls.

Effective monitoring and evaluation of off-site and on-site mitigation management success for burrowing owls includes (Barclay, pers. comm.):

- Site tenacity;
- Number of adult owls present and reproducing;
- Colonization by burrowing owls from elsewhere (by band re-sight);
- Evidence and causes of mortality;
- Changes in distribution; and
- Trends in stressors.