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Interim Guidance for Sampling Agricultural Properties (Third Revision)

California Department of Toxic Substances Control
California Environmental Protection Agency

August 7, 2008

Preface

In June 2000, DTSC issued “Interim Guidance for Sampling Agricultural Soils” to provide a uniform approach for evaluating former agricultural properties where pesticides have been applied, and DTSC issued the revised Version 2 in August 2002. Over the last seven years, DTSC has reviewed several hundred former agricultural properties across California. DTSC has been committed to revising and updating the approach to these properties as new information and issues emerge. This revised guidance, Version 3, incorporates and refines the sampling and risk assessment approach to former agricultural properties.

This guidance is intended to supplement the DTSC Preliminary Endangerment Assessment (PEA) Guidance Manual, CalEPA 1994 (Second Printing, June 1999). Data obtained from the investigations should be evaluated for potential health risks according the PEA Manual. This guidance is not intended to diminish the need to take focused, authoritative samples at site locations commonly associated with hazardous substances releases nor replace guidance provided by the PEA Guidance Manual. This guidance is not applicable to areas where pesticides were mixed, stored, disposed, or areas where pesticides may have accumulated, such as ponds and drainage ditches.

The scope of this document is limited to evaluating only agricultural properties during a PEA or other initial sampling investigation. This applies to proposed new and/or expanded school sites or other project where new land use could result in increased human exposure, especially residential use. Agricultural properties are lands where pesticides were uniformly applied for agricultural purposes consistent with normal application practices, and where other non-agriculturally related activities have been absent. Data obtained from the sampling analyses will be incorporated into the PEA Report, including performing a risk analysis in accordance with the guidance in the PEA Manual.

This guidance <u>does not apply</u> to disturbed land, such as, land that has been graded in preparation for construction, areas where imported soil has been brought in, or any other activity that would redistribute or impact the soil, other than normal agricultural practices, such as disking and plowing.

This guidance is an on-going effort to streamline the characterization of agricultural properties. As additional knowledge and experience is obtained, DTSC may modify this guidance, as appropriate.

1.0 PURPOSE

This guidance was initially prepared for use in evaluating soil at proposed new school sites and existing schools undergoing expansion projects where the property was currently or previously used for agricultural activities. This guidance is now expanded to include any project with DTSC oversight and is intended to supplement the DTSC PEA, and provide a uniform and streamlined approach for evaluating agricultural properties. This guidance can be used to assist environmental assessors in designing initial investigations or developing PEA Workplans for properties with agricultural uses. The analytical data obtained are to be incorporated into a risk analysis and PEA Report performed in accordance with the guidance in the PEA Manual.

2.0 AGRICULTURAL PROPERTIES

2.1 Eligible Agricultural Properties

This guidance is specific to agricultural properties where pesticides and/or fertilizers were presumably applied uniformly, for agricultural purposes consistent with normal application practices. It is applicable to agricultural properties that are currently under cultivation with row, fiber or food crops, orchards, or pasture. It is also applicable to fallow and former agricultural properties that are no longer in production and have not been disturbed beyond normal disking and plowing practices. Each field of the same crop is assumed to have been watered, fertilized and treated with agricultural chemicals to the same degree across the field. Because of this homogeneous application, contaminant levels are expected to be similar at any given location within the field. This is the underlying premise of the guidance, and one that must be verified at the scoping stage of the PEA process.

2.2 Properties not covered by this Guidance

This guidance does not apply to former agricultural property that has been graded for construction or other purposes, that has received fill, or has had parking lots or structures placed on it following active use as an agricultural field. An urban residential area that was agricultural property in the past does not qualify for this guidance since the construction of the residences would have resulted in the disturbance and redistribution of potential agricultural contaminants in the soil. These areas may require biased, discrete sampling as opposed to the sampling for agricultural properties discussed in this document.

2.3 Grazing Land and Dry-Land Farmed Agricultural Properties

2.3.1 Grazing Land and Pasture

Agricultural sampling is not required for property used exclusively as grazing lands or pasture, where the topography is not conducive to pesticide application, or the application of pesticides is not economically feasible. Aerial photographs, topographic maps, and a site visit should be used to evaluate the topography of the proposed school site and past land use. Sites that are suitable for animal grazing will often have irregular topography and often a cover of native trees, brush and range grasses. In keeping with the definition of agricultural soils, the site must not have contained any structures, or been used for any commercial or manufacturing activities.

2.3.2 Dry-Land Farmed Agricultural Soils

Dry-land farming is the practice of growing a crop without irrigation. Many dry-land farming fields are not treated with pesticides or infrequently treated, since the lack of water does not provide a desirable habitat for most agricultural pests. Properties that clearly qualify as dry-land farming do not need further investigation for pesticides or metals. For properties where there is uncertainty regarding dry-land farming, limited sampling may be conducted at a rate of four discrete samples per site, with one sample collected in each quadrant.

Some production crops such as winter wheat and barley can be grown under dry-land farming conditions. If the site has been planted in a dry-land farming production crop, every assurance should be made to determine that the crop was not irrigated and pesticides were not applied. This information may be obtained from interviews with farmers in the area, records that the County Agricultural Commissioner may have, and information the Commissioner may have about the irrigation practices for that crop in the specific county. If it cannot be clearly shown that irrigation did not take place and pesticides were not applied, limited sampling for organochlorine pesticides (OCPs) and arsenic may be necessary. At a minimum, this should include four samples per site, one sample per quadrant.

2.4 Agricultural Properties Prior to 1950

A review of 35 proposed school sites along with the historical background of OCP use in California indicates that sites with agricultural usage ending prior to 1950 do not need to be evaluated for OCPs. Organochlorine pesticides were first introduced into California agriculture in 1944 and reached peak usage in the 1960’s. In 1974 the use of the DDT was banned for agricultural purposes, and the elimination of remaining OCPs in California agriculture quickly followed. Data from 35 proposed school sites where agricultural use ended prior to 1950 indicates that OCPs were not identified as chemicals of potential concern. In those cases where OCPs were identified, the source appears to have been the application to structures on the property, and not the agricultural crops grown prior to 1950. It is recommended that former agricultural properties that terminated operation prior to 1950 not be evaluated for agriculturally related OCPs. Arsenic should still be evaluated as a chemical of potential concern (COPC) since its use as arsenical pesticides and herbicides predates 1950.

2.5 Continued Agricultural Use After PEA Sampling

Chemicals associated with agricultural activities may result in potential risks to human health or the environment. If agricultural activities continue on the subject site after DTSC issues a no further action determination on the PEA, DTSC cannot ensure the no further action determination will remain in effect.

This may have impacts for school projects where the school districts elect to postpone school construction and allow continued agricultural use of the property. The most recent chemical use documentation (e.g., local Agricultural Commissioner Pesticide Application Permits) regarding the quantity and types of agricultural chemicals used on the property should be provided in the PEA report. If the type of agricultural chemicals applied to the site change after DTSC’s no further action determination, DTSC recommends submittal of the chemical use documentation to DTSC at least three months prior to commencement of grading or other construction activities at the school site. DTSC will review the information, and if necessary, may recommend additional sample collection and analyses to assess potential impacts and ensure school site safety.

2.6 Other Areas of Concern on Agricultural Properties

In many cases, agricultural properties may include other areas of concern such as operations yards, storage areas, fuel tanks, residences, irrigation systems, and animal facilities. Examples of areas of concern may include:

- Structures such as homes, garages, equipment sheds, barns, and other out-buildings
- Pesticide storage, mixing/loading, and wash-down areas
- Ecological habitats, or rare, threatened, or endangered species
- Irrigation ditches/canals, containment berms, and low-lying swales or drainage areas
- Irrigation water containment ponds and collection/recirculation sumps
- Production wells and pumps
- Pole- or pad-mounted transformers
- Waste oil areas
- Animal pens, barns, and manure and disposal piles
- Burn piles
- Underground and above ground storage tanks
- Properties in dibromochloropropane (DBCP) study areas

Although agricultural-related, these targeted areas should be considered during the PEA scoping meeting and investigated using standard PEA protocols. The following DTSC guidance documents may be considered in these investigations:

- Interim Guidance: Evaluating Total Petroleum Hydrocarbons (TPH) (DTSC 2008) (The draft TPH guidance document is being revised at this time and will not be available to the public until DTSC finalizes the document.)
- Interim Guidance: Evaluation of School Sites with Potential Contamination from Lead Based Paint, Termiticides, and Electrical Transformers (DTSC, June 9, 2006)
- Arsenic Strategies for Determination of Arsenic Remediation: Development of Arsenic Cleanup Goals for Proposed and Existing School Sites (DTSC 2007)
- Advisory: Methane Assessment and Common Remedies at School Sites (DTSC, June 2005)
- Advisory: Active Soil Gas Investigations (DTSC, January 2003)
- Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion into Indoor Air (DTSC 2004)
- Fact Sheet: Information Advisory, Clean Imported Fill Material (DTSC, October 2001)
- Guidance Manual: Preliminary Endangerment Assessment (DTSC, January 1999)
- Data Validation Memorandum , Summary of Level II Data Validation (DTSC, May 2006)
- Guidance: Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities (DTSC, July 4, 1996)

3.0 SAMPLING STRATEGIES

3.1 Chemicals of Concern

3.1.1 Pesticides

When the property is under active agricultural production, the operator should be interviewed to determine the types and amounts of pesticides historically used on the property. The County Agricultural Commissioner should also be consulted to verify pesticide usage on the property. The Agricultural Commissioner is required to maintain this information for three years, but often will have extensive knowledge of the farming practices over many years. A local or specialized farm advisor such as the University of California Cooperative Extension Agent is another source of information for farming practices in the area. These consultations should occur during the scoping phase of the investigation. For those properties that have not been actively farmed in the past three years, obtaining accurate information is more difficult. Information from surrounding or neighboring agricultural operations on the types of crops grown in the area during the time of active farming can provide clues on what chemicals may have been applied.

Based on data from former agricultural properties over the past seven years, the only pesticide class requiring analyses at agricultural properties are OCPs, such as DDT, toxaphene, dieldrin, etc. OCPs are biopersistent and bioaccumulate in the environment. Most other classes of pesticides have relatively short half-lives and have not been found in the agricultural fields. While paraquat does have a longer half-life in soil, it has either not been detected or detected rarely at trace levels at sites which DTSC has had oversight, therefore routine analyses for paraquat is not required for field areas. Analyses for paraquat may be required in storage and mixing/loading areas.

3.1.2 Metals

Based on data from former agricultural properties, the only heavy metal required for routine analyses for these properties is arsenic. Arsenic in the form of arsenical herbicides has been applied to many agricultural properties and elevated levels of arsenic have been reported in the evaluation of these properties.

Other heavy metals may be required on a case by case basis depending on history of the property and the surrounding environment. Certain counties, such as Kern and Merced in the Central Valley, allow the application of municipal sludge on agricultural properties with or without a permit. Municipal sludge has been often shown to have elevated levels of heavy metals. These metals concentrations can impact vadose soils and often may migrate to groundwater. If there is a history of sludge application, or if sludge application is suspected on an agricultural property, Title 22 metals (former CAM 17 metals) should be evaluated.

Copper compounds were generally applied directly to select crops (e.g. vineyards) to prevent or reduce mildew. Vineyards and grain storage areas may have elevated copper due to the use of copper compounds as fungicides. To date, DTSC has not found elevated copper in any agricultural property. However, analyzing soil or sediment samples for copper may be appropriate at agricultural properties with the potential to impact aquatic ecological habitats (e.g. a creek or stream which runs through site).

3.1.3 Additional Chemicals of Concern

3.1.3.1 Mixing/Loading/Storage Areas

Focused sampling in mixing/loading/storage areas, drainage ditches, farm houses, or outbuilding areas may require analyses for a number of other constituents besides OCPs and arsenic, including other classes of pesticides/herbicides, paraquat, metals, and petroleum related compounds (see Section 2.6).

3.1.3.2 Smudge Pots

If smudge pots have been routinely used on agricultural properties, for example in citrus groves, additional sampling for PAHs and TPH may be required.

3.2 Sampling Frequency

Sampling frequency may vary depending on the size of the site and conditions found. When the site has been used for agricultural crop, the presumption is that agricultural chemicals were applied uniformly across the site in any given year and that the variation across the site will be relatively small. An analysis of several hundred former agricultural properties by DTSC has supported the general use of the assumption of uniform application.

The assumption of uniform application may not apply to areas cultivated in different crops, adjoining or adjacent properties with different owners or operators. The uniform application assumption does not apply for non-cultivated areas (e.g. drainage ditches, farm houses and other structures, mixing/loading areas, storage sheds, etc.)

In general, the sampling pattern should be sufficient to characterize the site. Recommended numbers of borings or sampling locations and composite analyses are provided in Table 1 for both OCPs and arsenic analyses for sites up to 50 acres. DTSC should be consulted for sites greater than 50 acres. For these sites, the sampling frequency may be reduced based on documentation that verifies consistent owner, operator, and use. If different parcels of the property have different owners, operators or crops, the number of samples shown in Table 1 should be applied for each different parcel.

Table 1: Recommended Number of Sampling Locations

Site Acres	Number of Borings	OCP Analyses (Composites)	Arsenic Analyses (Discrete only)
1	4	4 (Discrete analyses)	4
2	4	4 (Discrete analyses)	4
3	4	4 (Discrete analyses)	4
4	8	4	4
5	10	4	4
6	12	4	4
7	14	4	4
8	16	4	4
9	18	5	5
10	20	5	5
11	21	6	6
12	22	6	6
13	23	6	6
14	24	6	6
15	25	7	7
16	26	7	7
17	27	7	7
18	28	7	7
19	29	8	8
20	30	8	8
21	31	8	8
22	32	8	8
23	33	9	9
24	34	9	9
25	35	9	9
26	36	9	9
27	37	10	10

Site Acres	Number of Borings	OCP Analyses (Composites)	Arsenic Analyses (Discrete only)
28	38	10	10
29	39	10	10
30	40	10	10
31	41	11	11
32	42	11	11
33	43	11	11
34	44	11	11
35	45	12	12
36	46	12	12
37	47	12	12
38	48	12	12
39	49	13	13
40	50	13	13
41	51	13	13
42	52	13	13
43	53	14	14
44	54	14	14
45	55	14	14
46	56	14	14
47	57	15	15
48	58	15	15
49	59	15	15
50	60	15	15
>50	Consult with DTSC		

3.3 Composite Samples

Since this guidance assumes a relatively even distribution of chemicals across the agricultural field portion of a site, compositing of discrete samples allows for increased sampling coverage for a site, while not significantly increasing the number of analytical samples. Composite surface samples may be made up of a maximum of four discrete surface samples from adjacent sampling locations. Compositing may occur in the field or at the laboratory. In cases where two crops were grown on the site, only discrete samples from within the same crop area may be composited.

Specify the method of selecting the discrete samples to be composited and the compositing factor (e.g. 3 to 1: three discrete samples composited to one) in the workplan. Compositing requires that each discrete sample be the same in terms of volume or weight, and that the discrete sample be thoroughly homogenized prior to compositing. The detection level does not need to be reduced since the composite sampling area is assumed to be homogeneous in concentration.

If compositing is not chosen, analyses will be performed on all the discrete samples and the number of analyses will correspond to the number of borings.

For more information on composite samples, see the references provided in Section 6.0.

3.4 Discrete Sampling for Arsenic

A minimum of four discrete on-site surface samples must be analyzed for arsenic. When samples are composited for OCP analysis, one discrete sample from each composite must be analyzed for arsenic. When more than four composite samples are analyzed for OCPs, the total number of discrete samples analyzed for arsenic does not need to be greater than the number of total composite samples used for OCP analysis (see Table 1).

3.5 Sampling Depth

Based on the extensive data DTSC has reviewed for agricultural properties, only surface samples will be required for the screening assessment. Each location should be sampled to include one surface sample (0 to 6 inches). [Note: 0 inches means first encountered soil. Thick mats of vegetable material, roots, and other extraneous material should not be sampled. The locations can be staked and surveyed using a sub-meter global positioning system. This will facilitate collection of supplemental site investigation samples, such as subsurface or step out sampling, if necessary.

3.6 Sample Collection

Sampling both the furrows and beds of existing rows will detect the greatest variability in the residuals. Some methods of pesticide application will favor residuals in the beds while others favor the furrows. In fields where rows remain, roughly half of the samples should be gathered from the furrows and half from the beds in an alternating pattern. Orchards should have the sampling locations placed at the current drip line for the trees, under the canopy, between the tree rows, and between the trees within a row. For sites with slopes, swales, or other uneven topography, sampling from centers should be modified to include samples from those areas where surface water would be expected to flow and accumulate.

3.7 Field Duplicates

Field duplicates should be collected at a rate of 10 percent (or a minimum of one). For arsenic, a discrete co-located sample should be collected and analyzed for every 10 arsenic samples collected. For OCPs where composite samples will be prepared and analyzed, every 10^{th}

composite sample should be prepared (independently) in duplicate and analyzed. See Section 4.1 for a description on preparation of composite samples.

3.8 Requirements for Collection of Background Metal Samples

Consult with the DTSC project manager regarding the need for collecting background arsenic samples. In general, with the exception of arsenic, background samples for metals will not be necessary if all metals are below their respective California Human Health Screening Levels (CHHSLs). If all the arsenic results for the site are at or below 12 mg/kg, then collection of background samples will not be required. For sites where either arsenic or other metals are above their respective screening values, either collection of a background data set or use of an appropriate background data set may be required.

3.8.1 Sampling for Background Metals

If samples are needed to determine background levels of arsenic and/or other heavy metals (if additional metals are required for the PEA), a minimum of four onsite locations should be sampled at non-impacted areas, or samples may be collected at a depth of 5 to 5.5 feet bgs. In order to use background samples from 5 to 5.5 feet bgs, a licensed professional must make the determination that the background soils are similar enough geologically to the surface soils as to be representative.

Other background data sets may be substituted for on site sampling on a case by case basis in consultation with DTSC.

4.0 LABORATORY ANALYSES

4.1 Preparation of Composite Samples

Each discrete sample should be homogenized and uniformly split by trained field staff prior to compositing. A portion of each discrete sample should be frozen and archived in case additional analysis is warranted based on the composite results. Compositing requires that each discrete sample be the same in terms of volume or weight, and that the discrete sample be thoroughly homogenized prior to compositing. Excess sample from the homogenized composite sample shall be archived by the lab and/or used as a duplicate, as appropriate, for that composite set. The samples may be discarded when the PEA process has been completed and approved by the DTSC.

4.2 Methods

The analytes of primary concern are OCPs, arsenic, and, in some cases, Title 22 metals. Depending on the site history, analysis of other types of pesticides may be required. OCPs should be analyzed using U.S. EPA 8081A or equivalent. Metals must be analyzed using the U.S. EPA 6000/7000 series. If the site history indicates other classes of persistent pesticides should be evaluated, DTSC should be consulted for the acceptable method of analysis and appropriate detection limits. Highly organic topsoil may interfere with proper extraction of pesticides.

Sample holding times should be consistent with U.S. EPA SW-846. Variances to holding times and affects on data results must be discussed in the data validation section of the report.

Please note, for comparison of chlordane concentrations against the CHHSL, chlordane must be quantified against a ***technical chlordane*** standard. For purposes of the PEA, DTSC will not allow quantitation of the individual alpha and gamma isomers, with a total concentration determined by addition of those concentrations.

4.3. Detection Limits

The actual detection limits obtained will vary depending on the particular analyte. For OCPs, the analytes typically causing detection limit concerns in agricultural fields are aldrin, dieldrin, and toxaphene. The detection limits should be 0.005 mg/kg for aldrin, dieldrin, and 0.05 mg/kg for toxaphene. Table 2 lists the detection limits for several OCPs.

In samples with elevated DDT, the detected concentration may be above the range of calibration. This can result in the analytical laboratory diluting the sample for reanalysis, and then reporting only the final result. In these cases, the reported detection limits for aldrin, dieldrin, and toxaphene may exceed the detection limits needed for determining potential health effects. Ideally the laboratory should be asked to report if those three analytes were detected in the first analysis prior to dilution. Multiple analyses of the same samples may be required to obtain the data necessary for risk assessment purposes.

Table 2. Analytical Methods and Detection Limits for Selected OCPs

Pesticide	Methods[2]	CAS No.[3]	DL[4] mg/kg
Aldrin	8081A	309-00-2	0.005
a-BHC	8081A	319-84-6	0.005
b-BHC	8081A	319-85-7	0.005
g-BHC (Lindane)	8081A	58-89-9	0.005
d-BHC	8081A	319-86-8	0.005
Total Chlordane[1]	8081A	57-74-9	0.05
DBCP[5]	8081A	96-12-8	0.01
DDD	8081A	72-54-8	0.05
DDE	8081A	72-55-9	0.05
DDT	8081A	50-29-3	0.05
Dieldrin	8081A	60-57-1	0.005
Endosulfan I	8081A	959-98-8	0.005
Endosulfan II	8081A	33213-65-9	0.005
Endosulfan sulfate	8081A	1031-07-8	0.005
Endrin	8081A	72-20-8	0.05
Endrin aldehyde	8081A	7421-93-4	0.05
Endrin ketone	8081A	53494-70-5	0.05
Heptachlor	8081A	76-44-8	0.05
Heptachlor epoxide	8081A	1024-57-3	0.005
Hexachlorobenzene (HCB)	8081A	118-74-1	0.3
Hexachlorocyclopentadiene	8081A	77-47-4	0.5
Methoxychlor	8081A	72-43-5	0.005
Toxaphene	8081A	8001-35-2	0.05

Notes:

1 = Report total Chlordane (based on a Technical Chlordane standard)
2 = Although other methods may be used to quantify OPCs, DTSC recommends the use of 8081A as the primary method of quantitation
3 = Chemical Abstract Service registry number
4 = Detection Limit recommended for risk assessment purposes
5 = If sampling for this compound is indicated, inclusion in the method must be requested in the workplan and/or QAPP

4.4 Pesticide Analyses
Surface samples, discrete or composite, must be analyzed for OCPs. Analysis for other classes of persistent pesticides may be required as indicated by the agricultural history of the site. If the composite sample result exceeds the health risk screening criteria (see Section 5.3), analyze each discrete sample that made up the composite sample.

4.5 Sub-surface sample analysis
In consultation with DTSC, analyses of sub-surface samples may be required if surface samples results exceed specified screening levels. This sampling may be a part of the PEA or included in a Supplemental Site Investigation. If subsurface samples were collected during the PEA sampling event, those samples may be taken off “hold” and analyzed by the laboratory. If subsurface samples were not collected during the PEA, a Supplemental Site Investigation Workplan or Technical Memorandum should be prepared identifying appropriate step-out (vertical and horizontal) sampling locations.

4.6 Quality Control
Quality control (QC) procedures specified in SW-846 must be followed. A matrix spike/matrix spike duplicate on one soil sample per batch of 20 samples must be performed to demonstrate that the targeted pesticide(s) can be recovered from the soil investigated. The laboratory data package must include a summary of the quality control sample results: blanks, matrix spike/ matrix spike duplicate, surrogate recoveries, laboratory control samples, etc., as specified by the method. The laboratory should provide a signed narrative stating whether the QC was met and listing any discrepancies. The consultant should perform a supplementary evaluation of the data, also referred to as data validation, and present the results of that evaluation in the PEA report. For an example of what to included in the data validation section, see the example data validation memorandum at the DTSC website:
http://www.dtsc.ca.gov/Schools/upload/Data_Validation.pdf

5.0 REPORTING

5.1 Format
The results of the sampling effort are to be reported in a PEA report as described in the DTSC PEA Guidance Manual.

5.1.1 Summary Tables
Include data tables in the PEA report to summarize the results of the investigation. Summary tables should include the analytes of interest, the reported concentrations or the reporting limit for non-detect results, and indicate whether a reported concentration exceeds its respective CHHSL screening level (if a CHHSL comparison is being conducted). In addition, for samples analyzed at multiple dilutions for purposes of reporting concentrations within calibration ranges (as described in Section 4.3), summary tables should either present the results for all of the dilution analyses indicating the appropriate result for each analyte, or a combined analysis indicating which results are being reported after a dilution. Sample results should also be flagged with appropriate qualifiers, where necessary, after data validation.

5.2 Evaluating Metals (Inorganic Elements) Data
Using a robust statistical procedure to determine if on-site metal concentrations are indicative of background conditions or the result of site-related activities can be problematic because of the limited number of background samples collected at any one site. Local site background may be used if the data is approved for use by the DTSC project manager and toxicologist. If DTSC

background levels are not available, then a defensible procedure for comparing on-site with background metals should be used. The DTSC project manager and DTSC toxicologist assigned to the project should be consulted on the most appropriate method of comparison.

5.2.1 Arsenic Evaluations

The DTSC Schools Program evaluated data from a large number of school sites across California. The data evaluation indicates that 12 mg/kg maybe a useful screening number for the Schools Program when evaluating arsenic as a COPC. If the proposed school property has been adequately characterized for arsenic and all the arsenic data are equal to or less than 12 mg/kg, then arsenic will be not be considered a COPC. This decision does not require collection and comparison to a background data set. If arsenic concentrations are greater than 12 mg/kg, then comparisons to background data will be required. In some cases additional sampling may also be required.

5.2.2 Strategy for Comparison of Background Metals

If background samples are necessary, follow the procedures provided in Section 3.8. The following strategy may be used for comparing site data to background data:

1. Compare the highest site concentration with the highest background concentration. If the site concentration is equal to or less than the background, the metal may be eliminated as a COPC. If the onsite maximum is greater than the background maximum, go to 2).

2. Compare the site and background arithmetic mean concentrations. If the means are comparable, and if the highest site concentration is below the concentration associated with unacceptable risk or hazard, the metal may be eliminated as a COPC. If the site mean is greater than the maximum background, go to 3).

3. Two approaches may be used, depending on the size of the background data set.
   - If the background data set is of sufficient size, statistically evaluate the overlap of the background and onsite distributions to determine if they come from the same population. If they do, and if the highest site concentration is below the concentration associated with unacceptable risk or hazard, the metal may be eliminated as a COPC. If not, include the metal as a COPC in the risk evaluation.

   - If the background data set is limited (n=4), the onsite data can be evaluated statistically using probability plots to determine if one or more populations are present. If only one population is present, and if the highest site concentration is below the concentration associated with unacceptable risk or hazard, the metal may be eliminated as a COPC. If there are two or more populations present, then include the metal as a COPC.

4. Additional information on eliminating metals as COPCs can be found in "*Selecting Inorganic Constituents as Chemicals of Potential Concern at Risk Assessments at Hazardous Waste Sites and Permitted Facilities – Final Policy* (DTSC/HERD 1997),

5.3 Human Health Risk Assessment

All detected pesticides and any onsite metals above background should be evaluated as COPCs in a human health risk assessment as described in the DTSC PEA Guidance Manual or in comparison to CHHSLs. In the initial screening analysis, the highest concentration of each detected pesticide and metal above background must be used as the exposure point concentration in the risk assessment.

Since agricultural properties are assumed to have uniform application of pesticides, DTSC has allowed compositing of samples for OCP analyses (Sections 3.3 and 4.1). The concentration from the composited sample can be used directly in the risk assessment without adjusting the toxicity screening numbers, such as the CHHSLs. The review of the former agricultural properties over the past seven years has supported the assumption of uniform application. This is in contrast to other DTSC guidance, such as the *Lead-Based Paint, Termiticide and PCB Guidance*, (DTSC, June, 2006), where adjustments to the CHHSLs are required for composite samples because applications were not necessarily uniform.

5.3.1 Application of PEA Risk Assessment Equations and CHHSLs

Chemicals of potential concern are evaluated either by comparison to the CHHSL, or by calculating the excess cancer risk and hazard index based on equations in the PEA Guidance.

Note: CHHSLs may not be used to "screen out" COPCs.

5.3.1.1 CHHSLs

CHHSLs are soil and/or soil gas concentrations for selected chemicals developed by Cal-EPA with a target threshold of a 1E-06 risk for carcinogens, and a hazard quotient of one for non-carcinogens. CHHSLs were developed using models and exposure assumptions similar to those used in the PEA Guidance Manual, with the exception of the concentrations for volatile organic compounds (VOCs), which were developed using the vapor intrusion model for addressing the inhalation of contaminated indoor air. CHHSLs may be used as a soil screening value at school sites if all of the chemicals detected at the site have a listed CHHSL, if it is agreed upon by all parties concerned, and if it is agreed that the screening document will be reviewed by a toxicologist from the Human and Ecological Risk Division. For school sites, only the residential-based CHHSLs may be used. The exposure pathways used in calculating the CHHSLs are incidental soil ingestion, dermal absorption, and inhalation of dusts in indoor air for non-volatile soil-bound chemicals, and the inhalation of indoor air pathway for VOCs. Direct exposures to VOCs are not included in the calculation of the CHHSLs and CHHSLs do not take into consideration the leaching of contaminants from soil to groundwater. CHHSLs are not appropriate if ecological receptors are the most sensitive species on the site. Lead should be evaluated using the most current DTSC LeadSpread Model or the school site lead screening level of 255 mg/kg.

5.3.1.2 Human Health Risk Assessment with CHHSLs

Independent of whether sites were analyzed with discrete samples or with composite samples, the evaluation is similar. Note that the CHHSL values are not adjusted for the number of discrete samples that comprise a composite. The rationale behind this comparison to un-adjusted CHHSL is that application of pesticides is assumed to be uniform throughout the field, and large variations in the pesticide concentrations are not expected. This rationale applies only to the agricultural portion, not to mixing areas, storage sites, structures, etc.

5.3.2 Procedure for Human Health Risk Assessment with CHHSL or PEA Guidance

- Determine that all of the chemicals detected at the site have the appropriate CHHSLs for soil and/or soil vapor. If they do not, then a PEA risk assessment must be conducted. A DTSC toxicologist will evaluate if the CHHSL screening is appropriate for the site

- The screening document, PEA or equivalent, will be reviewed by a toxicologist from the Human and Ecological Risk Division.

- The most recently published CHHSLs should be used. This may be found at: http://www.calepa.ca.gov/Brownfields/documents/2005/CHHSLsGuide.pdf.
- The exposure pathways at the site must match the exposure pathways used to develop the CHHSLs.
  Use the maximum concentration of each contaminant detected at the site and compare to unrestricted (residential) CHHSL or PEA risk calculations.
- Background metal concentrations can be used to screen metals as COPC. Construct a table listing the COPC (see Section 5.2.2 for discussion on background metals).
- The risk and hazard for each COPC should be calculated using the following equations:

$$\text{RISK} = \frac{[\text{maximum detected concentration}]}{\text{CHHSL}} \times 10^{-6}$$

$$\text{HQ} = \frac{[\text{maximum detected concentration}]}{\text{CHHSL}}$$

- If there are multiple COPCs, calculate the cumulative risk and/or hazard. An Excel calculator is provided on the Cal/EPA website for CHHSLs: (http://www.calepa.ca.gov/Brownfields/documents/2005/Calculator.xls).
- Complete a Risk Characterization Section where the total risk and hazard are presented and discussed along with the need for any further action.
- If the maximum concentrations detected on site pose an unacceptable risk or hazard, a spatial analysis should be conducted to determine if the elevated levels represent a “hot spot”, or are representative of concentrations across the site. In those cases where the elevated concentrations are determined to be one or more “hot spots”, risk or concentration isopleths should be constructed to differentiate between those areas of the site in need of further action, and those where no further action is required. Any deviations from these analyses must be approved by the DTSC toxicologist assigned to the project.

Note: For evaluation of composite samples, the CHHSL values are not adjusted for the number of discrete samples that comprise a composite. The rationale behind this comparison to un-adjusted CHHSL is that application of pesticides is assumed to be uniform throughout the field, and large variations in the pesticide concentrations are not expected. Note that this rationale applies only to the agricultural portion, not to mixing areas, storage sites, structures, etc.

6.0 ADDITIONAL SOURCES OF INFORMATION

Pesticide Physical Properties and Half-Lives

http://ace.orst.edu/info/extoxnet/pips/ghindex.html
http://www.arsusda.gov/rsml/ppdb1.html

Active Pesticide Ingredient by Brand Name

http://www.cdpr.ca.gov/docs/label/prodnam.htm
http://www.cdpr.ca.gov/ - see databases
Farm Chemicals Handbook, current edition, Meister Publishing Company,

Willoughby, Ohio.

Maximum Application Rates

http://ace.orst.edu/info/extoxnet/
Agricultural Chemicals – Thomas Publications, Fresno, CA

Pesticide Usage by Year, County, and Crop

http://www.ipm.ucdavis.edu/PUSE/puse1.html
http://www.cdpr.ca.gov/ - see databases

Composite Sampling

http://www.clu-in.org/download/char/SF_Rep_Samp_Guid_soil.pdf
U.S.EPA. 1995a*. Superfund Program Representative Sampling Guidance, Volume 1: Soil, Interim Final,* OSWER Directive 9360.4-10, EPA 540/R-95/141, PB96-963207. Environmental Response Team, Office of Emergency and Remedial Response, Office of Solid Waste and Emergency Response. December 1995, Page 28.

http://clu-in.org/download/stats/composite.pdf
U.S.EPA. 1995b. *EPA Observational Economy Series, Volume 1: Composite Sampling*, EPA-230-R-95-005. Policy, Planning, and Evaluation (2163). August 1995.

Test Methods

http://www.epa.gov/epaoswer/hazwaste/test/
SW-846: U.S. EPA, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition, Current Revision*

Pesticide Toxicology Information

http://ace.orst.edu/info/extoxnet/ghindex.html
http://www.state.nj.us/health/eoh/rtkweb/rtkhsfs.htm

CHHSLs

http://www.calepa.ca.gov/Brownfields/documents/2005/CHHSLsGuide.pdf
http://www.calepa.ca.gov/Brownfields/documents/2005/Calculator.xls

Acronym List

bgs	Below Ground Surface
CalEPA	California Environmental Protection Agency
CHHSL	California Human Health Screening Levels
COPC(s)	Chemicals of Potential Concern
DBCP	Dibromochloropropane
DTSC	Department of Toxic Substances Control
NFA	No Further Action
OCP(s)	Organochlorine Pesticides
PAH	Polyaromatic Hydrocarbon
PEA	Preliminary Endangerment Assessment
QC	Quality Control
TPH	Total Petroleum Hydrocarbon
U.S. EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

US Fish and Wildlife Service – Pacific Southwest Region

REGION 8 INTERIM GUIDELINES FOR THE DEVELOPMENT OF A PROJECT-SPECIFIC AVIAN AND BAT PROTECTION PLAN FOR SOLAR ENERGY PLANTS AND RELATED TRANSMISSION FACILITIES

I. Introduction and Purpose

Increased energy demands and the national goal to increase energy production from renewable sources have intensified the development of energy facilities, including solar energy. The U.S. Fish and Wildlife Service (Service) supports renewable energy development. However, the Service strongly encourages energy development that is wildlife and habitat-friendly. Of concern are the cumulative effects of renewable energy projects in initiating or contributing to the decline of some bird and bat populations, as well as other affected species. In order to ensure that renewable energy projects avoid and minimize impacts to bird and bat populations, the Service's Pacific Southwest Region developed these *Interim Guidelines for the Development of a Project-Specific Bird and Bat Protection Plan for Solar Energy Plant and Related Transmission Facilities* as a means to provide energy project developers a tool for assessing the risk of potential impacts, and designing and operating a bird- and bat-friendly solar facility. Similar to the Service's wind energy guidelines, the recommendations set forth in this document were based upon the Avian Powerline Interaction Committee's (APLIC) Avian Protection Plan template (2005; see Appendix) developed for electric utilities and have been modified accordingly to address the unique concerns with solar energy facilities.

An Avian and Bat Protection Plan (ABPP) is a project-specific document that delineates a program designed to reduce the operational risks that result from bird and bat interactions with a specific solar energy facility. Although each project's ABPP will be different, the overall goal of any ABPP should be to reduce, and ultimately eliminate bird and bat mortality to the extent practicable. The statutory authority for addressing effects to birds stems primarily from the Migratory Bird Treaty Act (MBTA), the Bald and Golden Eagle Protection Act, as well as the Endangered Species Act (ESA); for bats the Service's statutory authority arises primarily from the ESA.

The development and implementation of an ABPP are voluntary actions. They do not limit or preclude the Service from exercising its authority under any law, statute, or regulation, nor do they release any individual, company or agency of its obligation to comply with Federal, State, or local laws, statutes, or regulations. A soundly developed and properly implemented ABPP may ultimately represent a "good faith" effort by companies and other project proponents to conserve migratory birds and bats and to use the most environmentally friendly ways possible to develop energy projects and produce renewable energy.

Our Office of Law Enforcement carries out its mission to protect migratory birds through investigations and enforcement, as well as by fostering relationships with individuals, companies, and industries that have taken effective steps to avoid take of migratory birds and by encouraging others to implement measures to avoid take. It is not possible to absolve individuals, companies, or agencies from liability even if they implement bird mortality avoidance or other similar protective measures.

However, the Office of Law Enforcement focuses its resources on investigating and prosecuting individuals and companies that take migratory birds without identifying and implementing all reasonable, prudent and effective measures to avoid that take. Companies are encouraged to work closely with the Service to identify available protective measures when developing project plans and/or avian protection plans or avian and bat protection plans, and to implement those measures prior to/during construction or other similar activities.

Due to the rapid advances and proliferation of solar energy technology beyond small scale photovoltaic panels, little is known about how large-scale, solar energy facilities impact birds and bats (Leitner 2009). The Service does anticipate that, due to the nature of these commercial-sized facilities, extensive terrestrial habitat loss could occur. In addition, bird and bat mortality from collisions with transmission lines, power towers, meteorological towers, or even solar reflectors could occur at these sites. In one of the few studies of avian mortality at solar energy plants, McCrary (1986) documented bird mortality from a variety of causes, including burning. Therefore, the Service recommends that commercial-scale solar energy facilities create an ABPP with an emphasis on post-construction monitoring. A well-designed monitoring scheme, with an adaptive management framework, will allow a facility to evaluate potential take and implement appropriate corrective actions .

II. Guidance on Specific Elements of a ABPP for solar energy projects

The following summary is meant to provide project planners useful information for designing each development phase of the facility. For each phase outlined below, conservation measures and guidance are recommended for inclusion in the development of any solar energy power plant.

Coordination

An essential element to developing a successful project is the coordination between the project proponent and the appropriate agencies (e.g., federal, state, county agencies). The Service highly recommends early coordination on essential elements, such as wildlife surveys, project siting criteria, operational limitations, etc. to ensure that all parties and agencies understand the scope of the project and can identify potential issues early in the planning process.

Adaptive Management and Habitat Compensation

The Service recommends that proponents take an Adaptive Management (AM) approach to project development and operation. The AM process should establish clear, biologically appropriate goals and triggers tied to mitigation measures. For a complete discussion of AM, see Williams et al. (2009).

In order to compensate for the loss of high quality wildlife habitat, the Service strongly encourages project proponents to conduct a Habitat Equivalency Analysis (HEA) to quantify interim and permanent habitat injuries (i.e, temporary disturbance vs. permanent loss) at the start of the project and to guide upfront habitat compensation. This approach is described further below.

Template for Developing ABPP

Pre-siting Data Collection

Due to local differences in wildlife concentrations and movement patterns, habitats, topography, facility design, and weather; each proposed development site is unique and requires detailed and individual evaluation. In addition, renewable energy projects are rapidly expanding into habitats and regions that have not been well studied and where animal population data are scarce. Thus, in an effort to place projects in locations that will yield the least risk of population impacts, a rigorous siting evaluation process should be completed. Data collection methods will vary among projects due to differences in topography, habitat, and animal abundance, however the Service recommends the following considerations when conducting pre-siting assessments.

A. Coarse Site Assessment – Each pre-siting assessment should start with a coarse site assessment of the potential environmental issues that might preclude the site from development based on its perceived or validated level of risk. At a minimum, every solar project should conduct a Potential Impact Index (PII) (USFWS 2003 – Appendix). A PII represents a "first cut" analysis of the suitability of a site proposed for development by estimating use of the site by selected wildlife species as an indicator of potential impact.

Factors that should be considered during any coarse assessment include:

1. Is the site designated as Critical Habitat for any federally listed species?
2. Is the site designated as an Important Bird Area (see http://www.audubon.org/bird/IBA/), or a Western Hemisphere Shorebird Reserve Network or Ramsar site?
3. Does the site provide suitable habitat for any federal or state listed species, or sensitive species?
4. What is the type and quality of bird/bat habitat within and surrounding the footprint?

B. Habitat Equivalency Analysis (HEA) – The Service encourages the solar industry to look for opportunities to promote bird, bat, and other wildlife conservation when planning renewable energy facilities. These opportunities may come in the form of voluntary habitat acquisition or conservation easements. In order to quantify the appropriate compensation acreage, the use of an HEA can be used to identify high quality habitat and calculate compensation for the development of high quality habitats for both permanent and temporary losses. The objective of an HEA is to replace lost habitat services with like services, providing a replacement ratio for interim and permanent injury. Habitat services are generally defined by a metric (e.g., species density, that represents the functionality of that habitat (e.g., the ability of that habitat to provide nest sites, prey populations, cover from predators, etc.). See HEA resources in the Appendix of this document.

C. Site Specific Wildlife Surveys

1. Development of appropriate survey question – It is important to develop the appropriate survey questions as they dictate the sampling design and protocols to be used. An inappropriate study design and/or insufficient duration of data collection may result in unreliable data inferences with resultant biases and skewed results (Kunz et al. 2007). Pre-siting survey data will become the baseline for project impacts to bird and bat populations. Thus, most survey designs should be established as before-after control impacts studies, when possible. Examples of possible survey questions include (but are not limited to):
    a. Which species of birds and bats use the project area and how do their numbers vary temporally (i.e., daily, monthly, annually)?
    b. How much time do birds/bats spend in the risk zone (within the solar array) and does this behavior vary by season?
    c. What is the estimated range of bird/bat mortalities from the project?
    d. Are there nesting raptors on site or within 3 miles of project footprint. For eagles, are there eagles nesting within 10 miles of project footprint?

2. Selection of appropriate survey methodology – Based on the project and questions being asked, there are many suitable methods to survey birds and bats and establish baseline data. Generally, it is recommended to employ multiple survey techniques to ensure adequate data collection. Though written for the wind energy industry, a good summary of survey methods can be found in Kunz et al (2007) for night-migrating birds and bats and Ontario Ministry of Natural Resources (2006) for bats. Specific survey methods should include:
    a. Diurnal bird use counts
    b. Nocturnal bird use counts
    c. Raptor nest searches (see Pagel et al. 2010 for golden eagle protocols)
    d. Small bird counts (Canadian Wildlife Service 2006a and 2006b)
    e. Migration counts
    f. Acoustic bat monitoring
    g. Bat roost exit counts – if applicable
3. Duration and timing of surveys – To collect data under variable climatic conditions and accumulate sufficient samples for data analysis, pre-construction surveys should be conducted to assess the potential risk of the proposed project to wildlife. Multi-year surveys, up to three years pre-construction, may be warranted. This can vary depending on the project specifics, known or perceived level of risk, the variability in use of habitat by avian species, environmental stochasticity, and species present. Surveys should be designed to ensure adequate data are collected on breeding, staging, migration, and winter bird/bat use of the project site, taking into account peak use of the site temporally and spatially. Bird surveys should include diurnal and nocturnal use studies for the project footprint. Bat surveys should also include year-round acoustic monitoring to detect presence and activity (e.g., mean number of passes/detector/night), as little information is typically known about the ecology of resident, wintering, and migrating bats. Coordinate with wildlife agencies when selecting locations for bird and bat data collection.

4. Use of additional data – Other sources of abundance or habitat data may be available for specific project sites. When available and appropriate, these data should also be included in the site evaluation. Other good sources of bird data include (but are not limited to) Audubon Christmas Bird Count data, USGS Breeding Bird Survey data, Cornell Lab of Ornithology eBird data, California Natural Diversity Database, and Audubon Important Bird Area data.

D. Risk Assessment - A risk assessment should identify potential short and long-term impacts of the project development on bird and bat populations, including lethal "take" (as defined by all applicable regulations).
   1. Site specific threats – Based on the results of the wildlife surveys, the site specific risk assessment should address the potential for take based on:
      a. Burning from concentrated light at solar arrays
      b. Transmission line, power tower, meterological tower, or guy line collision
      c. Electrocution potential
      d. Territory abandonment
      e. Nest and roost site disturbances
      f. Habitat loss and fragmentation
      g. Disturbance due to ongoing human presence at the facility
   2. Cumulative Impacts – Effects that are likely to result from the projects, which have been or will be carried out throughout the anticipated life of the project, should be analyzed. We recommend that the cumulative effects assessment, where practicable and reasonable, should include the impacts from all threats for which the proponent or landowner has some form of control. The geographic area and time frame of the analysis will depend upon the species affected and the type of impact, such as behavioral modification or direct mortality. Discussions with Federal and State resource agencies will assist the applicant in identifying focal species and issues that will ultimately define the limits of the cumulative impacts analysis.

E. Reporting – After all appropriate pre-siting survey work is completed; the resulting information and risk assessment should be provided to all appropriate agencies for review and discussion.

Project Design Conservation Measures

Based on available data, the project design should be tailored, so that avian mortality risks are avoided and minimized. The primary questions to be asked are what design features and/or considerations can potentially reduce the hazard of solar facilities to wildlife populations? Consideration for the following aspects is strongly recommended:

A. Project siting – After all pre-siting survey data have been collected and analyzed, it is important to select the site that will have the least impacts to bird and bat populations. The ultimate goal is to avoid, where possible, any take of migratory birds and bats and/or minimize the loss, destruction, or degradation of migratory bird or bat habitat by placing projects in disturbed and degraded areas to the maximum extent practicable. Siting conservation measures should include both the macro- and micro-site scales.

1. Macro-siting – Consideration should be made to avoid:
   a. Locations with federally or state listed, or otherwise designated sensitive species, and areas managed for the conservation of listed species (such as designated critical habitat)
   b. Areas frequently used for daily bird and bat movements (i.e., areas between roosting and feeding sites)
   c. Breeding and wintering eagle use areas
   d. Known migration flyways for birds and bats
   e. Areas near known bat hibernacula, breeding, and maternity/nursery colonies
   f. Fragmentation of large, contiguous tracts of wildlife habitat (see Canadian Wildlife Service 2006a and 2006b)
2. Micro-siting – Once a footprint has been selected, there may be opportunities for finer scale micro-siting of the project components. Component siting considerations include:
   a. Avoid features that attract raptors (areas supporting tall perching structures including trees, utility poles, etc.)
   b. Avoid features that attract migrant birds (e.g., water sources, riparian vegetation)
      Minimize the potential for enhancing habitats suitable for raptor prey species such as rodents that would likely attract raptors to the project site.

B. Buffer zones – It might be appropriate and necessary to establish biologically meaningful buffer zones to protect raptor and other bird nests, areas of high bird and bat use, and known bat roosts from disturbance related to operation of solar energy plants. Pre-project surveys to determine sensitive wildlife areas are highly recommended. Consideration of these buffers should be part of the project siting process. The Service recommends that the following avoidance buffers be considered:
   1. Passerines – Avoid disturbance activities (e.g., construction actions, noise) within established buffers for active nests of any protected bird species or any high quality nesting habitat (e.g., riparian areas). Buffer distances should consider species, terrain, habitat type, and activity level as these features relate to the bird alert distance and bird flight initiation distance (Whitfield et al. 2008). Buffer size should be coordinated with the Service biologists prior to activities.
   2. Raptors (including eagles) – Minimize human access, and avoid disturbance activities (e.g., construction actions, noise from operations) within 8 km (5 miles) of an active raptor/eagle nest, unless specific landscape features (e.g., terrain, barriers) dictate reduced buffers (Richardson and Miller 1997). Reduced buffers should be coordinated with the Service.
   3. Grouse – Avoid construction of solar facilities within 8 km (5 miles) of all grouse lekking sites (Manville 2004).
   4. Bats – Avoid placement of facilities in close proximity to know bat roost sites, maternity colonies, or hibernacula. Appropriate buffer distances should be established in consideration of the disturbance type (type of energy plant to be operated), distance to roost or hibernacula, time of year of disturbance (if the facility operation has seasonal activities), and the duration of the disturbance that may occur from the facility's operation.

C. Appropriate facility design – There are many conservation measures that can be incorporated into the facility design that might reduce the potential effects of a project on bird populations. Some include:
   1. Avoid using lattice-type structures, placing external ladders and platforms on towers to minimize perching and nesting.
   2. Implement measures to reduce or buffer adverse noise effects associated with operation of the facility on surrounding wildlife habitat. Noise impacts to birds (Rheindt 2003, Brumm 2004, Parris and Schneider 2009) and bats (Schaub et al. 2008) have generally been found to be negative; therefore facility design should take this fact into consideration when selecting the type of solar technology (such as photovoltaic panels vs. parabolic dish engines) to be used and the placement of the solar power plant within bird and bat habitats.
   3. Avoid the use of guy wires for all meteorological towers and do not light them unless the Federal Aviation Administration (FAA) requires them to be lit, which is generally >60 meters (>199 ft) AGL in height. Any necessary guy wires should be marked with recommended bird deterrent devices (APLIC 1994, USFWS 2000).
   4. If structures (>60 meters [>199 ft] AGL) require lights for aviation safety, the minimum amount of pilot warning and obstruction avoidance lighting specified by the FAA should be used (FAA 2007). All lights within the facility should illuminate synchronously. Lighting of the boundary of the facility is most important as an aviation safety warning. Unless otherwise requested by the FAA, use only the minimum number of strobed, strobe-like or blinking red incandescent lights of minimum intensity. No steady burning lights should be used on facility infrastructures (Gehring et al. 2009).
   5. Facility lights should be focused downward to reduce skyward illumination. Lights should be equipped with motion detectors to reduce continuous illumination.
   6. Where feasible, place electric power lines underground or on the surface as insulated, shielded wire to avoid electrocution of birds. Use recommendations of the Avian Power Line Interaction Committee (APLIC 1994, 2006) for any required above-ground lines, transformers, or conductors. When transmission lines must be above-ground, avoid placing lines within wetlands and over canyons.
   7. The creation of roads leads to further loss and fragmentation of migratory bird habitat. The Service recommends that the number of roads be minimized for all phases of a project.
   8. If evaporation ponds are required for the operation of the facility, placement of netting over the surface of the ponds is encouraged to prevent birds and bats from contacting the water's surface.
   9. Reducing the attractiveness of solar reflectors to polarotactic water insects (those attracted to polarized light) (Horvath et al. 2010) will help reduce the attractiveness of these facilities to birds and bats.

Construction Phase Conservation Measures

During the construction of energy power plants and transmission facilities, standard construction conservation measures should be established. Conservation measures (CMs) that specifically relate to bird conservation include (but are not limited to):

A. Minimize area disturbed to extent practicable, including access road construction. To minimize the amount of habitat disturbance and fragmentation, construction plans should emphasize the minimization and placement of habitat disturbance. Construction roads not required for long-term operation and maintenance of the facility should be closed and restored to the pre-construction habitat type.

B. Vegetation clearing – Over 1,000 bird species and their eggs and nests are protected from take by MBTA. Thus, the Service recommends that all vegetation within the project footprint that will be disturbed be cleared outside of the bird breeding season to the maximum extent practicable (Note: the bird breeding season will vary from location to location, by habitat type, and by species, please consult the Service for breeding seasons in the specific project area). If the proposed project includes potential for take of migratory birds and/or the loss or degradation of migratory bird habitat and vegetation removal cannot occur outside the bird breeding season, project proponents should provide the Service an explanation for why work must occur during the bird breeding season. Further, in these cases, project proponents should demonstrate that all reasonable and practicable efforts to complete work outside the bird breeding season were attempted, and that reason for work to be completed during the breeding season were beyond the proponent's control. When vegetation removal cannot take place outside of the breeding season and a reasonable explanation was provided to the Service, the Service recommends having a qualified, on-site biologist during construction activities to locate active nests, establish avoidance buffers around active nests, watch for new nesting activity, and if necessary stop construction when noise and general activity threaten to disturb an active nest. All active nests of protected birds (e.g., MBTA, Endanger Species Act, state regulations) should not be disturbed until after nest outcome is complete (i.e., the young have fledged or the nesting attempt failed).

C. Minimize wildfire potential.

D. Minimize activities that attract prey and predators – During construction, garbage should be removed promptly and properly to avoid creating attractive nuisances for birds and bats.

E. Control of non-native plants – The introduction of non-native, invasive plant species can impact bird habitat quality. The Service recommends that all appropriate control measures be implemented to prevent the introduction and spread of invasive plant species within and surrounding the project area including roads associated with operation of the power plant and associated transmission lines. Use only plants that are native to the area for seeding or planting during habitat revegetation or restoration efforts.

Operational Phase Conservation Measures

Once a facility is built, appropriate CMs should be in place to reduce the attractiveness of the facility to breeding, migrating, and wintering birds and bats to ensure mortality is minimized. The following Operational CMs should be considered:

A. Do not create or maintain attraction features for birds and bats. Avoid introducing water and food resources in the area surrounding the power plant. Through appropriate habitat maintenance, facilities should seek to reduce features that attract birds and bats to the facility.

B. Follow APLIC guidelines for overhead utilities (APLIC 1994).

C. Minimize anthropogenic noise

D. Follow APLIC guidelines for overhead utilities (APLIC 1994).

E. Minimize Anthrogenic Noise –Noise has generally been found to be negative for birds (e.g., Rheindt 2003, Brumm 2004, Parris and Schneider 2009) and bats (Schaub et al. 2008), though not all species are affected to the same degree (Brumm 2004). Therefore facility design should take this into consideration when selecting the type of solar technology (such as photovoltaic panels vs. parabolic dish engines) to be used and the placement of the solar power plant within bird and bat habitats. During the operation of these energy facilities, means to buffer, muffle, or otherwise dampen any anthropogenic noise pollution that exceeds ambient noise should be fully explored.

F. Minimize use of outdoor lighting at the power plant– Research indicates that lights can both attract and confuse migrating birds (Gehring et al. 2009, Manville 2005, 2009) and bats are known to feed on concentrations of insects at lights (Fenton 1997). The goal of every facility should be to minimize the use of lights needed to operate the facility to the maximum extent practicable.

Post-construction Monitoring

Because solar energy technology is developing rapidly, the potential impacts of solar energy facilities are not well understood. To accurately evaluate the potential impacts of a solar facility, post-construction monitoring is a critical element to any ABPP. The goal of the post-construction monitoring program is to validate the pre-construction risk assessment and allow the facility to implement adjustments based on identified problems and triggers (see Adaptive management section above).

A. Monitoring Objectives should include but are not limited to:
    1. Estimate bird and bat fatality due to all aspects of facility operation.
    2. Assess bird use of evaporation ponds, if applicable.
    3. Assess changes in bird and bat behavior due to all aspects of facility operation (noise, lighting, etc.).
    4. Assess territorial abandonment, nest avoidance, and changes in population status within and adjacent to the project footprint.
    5. When operations have been adapted to reduce bird and/or bat mortality, assess whether mortality avoidance and minimization measures implemented for the project were adequate.

B. Monitoring Design - The degree and intensity of a monitoring program is determined by a combination of factors including size of the facility, presence of special status species as determined by pre-construction data, and perceived/known risks at the site. Important aspects of a post-construction monitoring plan include:

1. Duration and Timing - Post-construction monitoring programs should be done for a minimum of three years after operation of the facility begins (see Pagel et al. 2010 for duration of eagle monitoring). For projects that will be built in phases over the course of several years, each complete phase should include a minimum of three years of monitoring. Where risk is determined to be high or where regular mortality is observed, at least five years of assessment and monitoring is recommended (Stewart et al. 2007). This time period ensures data capture differences in parameters due to seasonal and annual variability. Monitoring programs should be extended, as appropriate, if mortality level triggers are reached or the project results in the mortality of a listed species or eagle. It is important to ensure that monitoring includes data collection during breeding, wintering, and migration periods as bird and bat use of areas will vary seasonally.
2. Study Components – All injury and fatality studies should be based on the objectives of the monitoring program and should follow accepted scavenger and search efficiency studies (e.g., Erickson et al. 2004 for wind energy projects).
    a. Mortality Studies should cover solar panel/dish/tower collisions and mortalities associated with other aspects of the facility (e.g., electrocutions, transmission line collisions, displacement). The Service recommends that mortality surveys be completed on a weekly basis for at least one year post-construction. The survey frequency could be adjusted, if appropriate, depending on the results of the detectability and scavenger studies
    b. Assessment of search efficiency (observer bias studies)
    c. Assessment of carcass scavenger rates
    d. Ensure monitoring plan is representative of the entire footprint
3. Eagle Monitoring – In addition to project-specific mortality monitoring studies, the Service recommends monitoring eagles separately to ensure that Bald and Golden eagle mortality is adequately assessed (see 2007 National Bald Eagle Management Guidelines for Bald Eagle protocols). If eagles do occur on or near the project site, project proponents should consult the Service's 2010 eagle permitting implementation guidance (USFWS 2010) if they intend to seek permits under 50 CFR 22.26 or 22.27.

C. Nest Management – Each facility should have protocols in place on how to manage nests established on any part of the facility (see APLIC 2006). Eagle nests should be addressed per the Service's 2007 National Bald Eagle Management Guidelines.

D. Risk Assessment Validation – Using pre-and post-construction data, the proponent should validate the identified risks of the project. The validation process should consider:

1. Whether the documented mortality rate is higher, lower, or as expected, compared to the pre-construction risk assessment
2. Are CMs adequate to minimize bird and/or bat mortality to the maximum extent practicable?

3. Would additional CMs reduce mortality rates?
4. Do documented mortality rates trigger additional management or mitigation actions?

E. Reporting – All post-construction monitoring results and risk assessment validation should be reviewed annually. An annual meeting should be held between the Service, Facility Manager, and other applicable state or federal agencies to review the annual monitoring report and discuss monitoring results and CMs.

III. Literature Cited

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- Review the Service's 2009 *Final Environmental Assessment, Proposal to Permit Take as Provided Under the Bald and Golden Eagle Protection Act*; located at http://www.fws.gov/migratorybirds/CurrentBirdIssues/BaldEagle/FEA_EagleTakePermit_Final.pdf
- Review the Service's 2009 *Eagle Permits; Take Necessary to Protect Interests in Particular Localities; Final Rules*; located at http://www.fws.gov/migratorybirds/CurrentBirdIssues/BaldEagle/Final%20Disturbance%20Rule%209%20Sept%202009.pdf
- Minimize impacts to bald eagles by implementing recommendations provided in the Service's 2007 *National Bald Eagle Management Guidelines*; located at http://www.fws.gov/migratorybirds/CurrentBirdIssues/Management/BaldEagle/NationalBaldEagleManagementGuidelines.pdf
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Environmental Assessment to Implement a Desert Tortoise Recovery Plan Task: Reduce Common Raven Predation on the Desert Tortoise

FINAL

Lead Agency:	**U.S. Department of the Interior** **Fish and Wildlife Service** **Ventura, California**
Cooperating Agencies:	**U.S. Department of Agriculture** **Animal and Plant Health Inspection Service,** **Wildlife Services Program**
	U.S. Department of Defense **Air Force Flight Test Center** **Edwards Air Force Base** **Army National Training Center and Ft. Irwin** **Marine Air Ground Task Force Training Command,** **Twentynine Palms** **Marine Corps Logistics Base, Barstow** **Naval Air Weapons Station, China Lake**
	U.S. Department of the Interior **Bureau of Land Management, California Desert District** **National Park Service, Mojave National Preserve** **National Park Service, Joshua Tree National Park**

March 2008

EXECUTIVE SUMMARY

The United Sates Fish and Wildlife Service (USFWS) and several cooperating agencies are proposing to implement a plan to reduce predation by the common raven (*Corvus corax*) on the federally threatened desert tortoise (*Gopherus agassizii*) in the California desert. During the past few decades, the population of the common raven has increased substantially in the California desert, primarily in response to human-provided subsidies of food, water, and nest sites. The common raven is a known predator of the desert tortoise. There is documentation of numerous carcasses of hatchling and juvenile desert tortoises under the nests of common ravens and a reduction in the proportion of hatchling and juvenile desert tortoises in the population at several locations in the California desert. The Desert Tortoise (Mojave population) Recovery Plan identifies reducing predation on the desert tortoise as a recovery task.

The agencies have developed six alternatives:

1. Alternative A or Current Program;

2. Alternative B–Integrated Predator Management Emphasizing Cultural and Physical Methods;

3. Alternative C–Integrated Predator Management and Removal of Ravens from Desert Tortoise Management Areas;

4. Alternative D–Integrated Predator Management and Removal of Ravens from Desert Tortoise Management Areas and Raven Concentration Areas;

5. Alternative E–Integrated Predator Management using only Nonlethal Cultural and Physical Methods; and

6. Alternative F-Integrated Predator Management using a Phased Approach of Alternatives B, C, and D.

These alternatives were developed to provide the full range of possible levels to reduce predation, from no new programs beyond existing management, to new programs using nonlethal methods, to new programs using nonlethal and lethal methods in various locations in the California desert.

The Alternative A describes the current level of management–limited nonlethal management actions being implemented at a few locations and no lethal control of common ravens. Alternative B focuses on reducing human subsidies of food, water, and nest sites to the common raven in the California desert. It provides immediate protection to hatchling and juvenile desert tortoises by identifying and removing ravens that have preyed or attempted to prey on the desert tortoise. Alternative C includes reduction of human subsidies to common ravens and removal of all ravens in specific areas (e.g., Desert Wildlife Management Areas, critical habitat, and specially designated management areas). No evidence of predation on the desert tortoise would be needed to remove ravens. Alternative D would incorporate raven removal in the areas identified in Alternative C and raven concentration areas, such as landfills. Alternative E would use nonlethal methods to reduce human subsidies of food, water, nest sites, and roost sites for the common raven thereby eventually reducing the size of the common raven population. Alternative F would implement Alternative B followed by Alternatives C and D if each of the previous alternatives were unsuccessful. Removal methods for Alternatives B, C, D, and F include trapping, use of toxicants, and shooting. Depending on the location of the lethal removal, the most appropriate and humane method would be used.

In addition, several alternatives were identified, but eliminated because they are not feasible or would not achieve the purpose of reducing predation by the common raven on the desert tortoise.

The issues identified for analysis included impacts on: target species (common raven), nontarget species (desert tortoise and other wildlife species), socioeconomics, recreation, and human health and safety. The issues that were not analyzed were identified and included in a discussion on why their analysis was not appropriate.

These issues were evaluated for each of the six alternatives. Impacts on the common raven were analyzed so that a potential worst-case scenario is presented for the number of ravens that may be removed annually. For the foreseeable future, the actual impact would probably be much lower than what is estimated in this Environmental Assessment (EA). In addition, with a substantial reduction in human-provided subsidies, the common raven population should start to decline after a few years. The alternatives range from reducing the raven population in the California desert by 2.4 percent (Alternative B) to 18.7 percent (Alternatives D and F). Alternatives B, C, D, E, and F should benefit the desert tortoise and other species of wildlife upon which the common raven preys, but the extent and immediacy of this benefit would vary for these alternatives. With respect to the impacts on the issues, none of the alternatives evaluated rise to the level of significance.

Regarding cumulative impacts, we are unaware of any past, current, or planned future actions that would directly or indirectly impact the common raven with the exception of those proposed in this environmental assessment and a past effort by the Bureau of Land Management (BLM). Past actions to reduce predation by the common raven in the California desert are provided; however, BLM terminated this effort around 1994. Currently there is no organized program being implemented to reduce the number of common ravens in the California desert. Raven removal is occurring in other locations in the state and in adjacent states, primarily associated with loss of agriculture and livestock. Since many of the common ravens in the California desert are resident birds, these removal efforts elsewhere should have little effect on the raven population in the California desert. Future actions that may indirectly impact the common raven would be continued human development throughout various locations in the California desert. These actions would benefit the common raven and would likely contribute to increased population numbers. However, these actions are detrimental to the desert tortoise and other species of wildlife in the California desert.

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1.0 INTRODUCTION

The United States Fish and Wildlife Service's (USFWS's) major responsibilities are to manage the Nation's public resources, which include endangered and threatened species, migratory birds, and anadramous fishes (fish that breed in freshwater but spend their adult life in saltwater). Through the Endangered Species Act of 1973 (ESA), as amended, Congress directed the USFWS as the lead federal agency that works with other federal, state and local agencies, and private citizens to recover and conserve species listed under the ESA so they may be removed from the list. The purpose of the ESA is to provide a means whereby, the ecosystems upon which endangered and threatened species depend may be conserved. The USFWS's goal is to ensure that listed species, and the ecosystems upon which they depend, are properly managed and conserved so the species no longer require protections of the ESA.

The USFWS is the lead agency that administers the Migratory Bird Treaty Act of 1918 (MBTA), as amended. The MBTA provides the USFWS with regulatory authority to protect bird species that migrate to or from the United States. This law prohibits the "take" of these species by any entity, unless permitted by the USFWS; USFWS can issue permits to take migratory birds that are causing damage to resources.

In the California desert, the USFWS works with federal, state, and local agencies to plan and implement activities that would contribute to the recovery and conservation of several listed species including the federally threatened desert tortoise (*Gopherus agassizii*). The desert tortoise occurs on federal, state, and privately-owned land in various locations in the California desert; it continues to decline in numbers from various factors which include predation by the common raven (*Corvus corax*).

The USFWS is also the lead agency and decision maker for this Environmental Assessment (EA), and is responsible for its scope, content, and outcome. Successful implementation of the recovery program for the desert tortoise in the California desert requires cooperation among numerous federal, state, and local agencies and the public. Any program to reduce raven predation on the desert tortoise requires the cooperation of the agencies with management authority for those lands. As part of this partnership recovery effort, this EA has been prepared with the cooperation of the U.S. Department of the Interior (DOI) USFWS, Bureau of Land Management (BLM), and National Park Service (NPS); U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service, Wildlife Services (APHIS-WS); Department of Defense (DOD), Department of the Army, Department of the Navy, the U.S. Marine Corps, and Department of the Air Force. This EA identifies and analyzes the potential environmental impacts related to the proposed action to reduce raven predation on hatchling and juvenile desert tortoises, with the goal of increasing hatchling and juvenile desert tortoise survivorship and recruitment into the adult population. Achieving this goal would bring us closer to recovering the desert tortoise. Many of the activities described in the alternatives to reduce human-provided subsidies of food, water, nest sites, and communal roost sites for the common raven have been initiated on lands administered by these agencies in the California desert. Other efforts to improve desert tortoise survival and recruitment are outside of the scope of this analysis.

This EA considers 16 alternatives in addition to the Current Action Alternative. It also describes alternatives that were considered but dismissed. The USFWS and its cooperating agencies are considering various management actions to increase desert tortoise survivorship by removing human-provided subsidies of food, water, and nest sites that attract and support elevated population numbers of ravens in the California desert. We are also considering removing individual ravens known to prey on desert tortoises, removing ravens from Desert Tortoise Management Areas (DTMAS) (e.g., desert tortoise critical habitat, Desert Wildlife Management Areas (DWMAs), research and other special management areas), and raven concentration areas (e.g., landfills).

Reducing common raven predation on the desert tortoise is one component of a multifaceted effort to aid in the recovery of this species. Other recovery tasks include acquiring, protecting, and restoring habitat; reducing mortality from other human activities; disease management; head starting; translocation; research; monitoring; and education and outreach (USFWS 1994, Tracy et al. 2004). Inherent in all of these activities is human education and outreach. Reducing common raven predation on the desert tortoise may require obtaining a permit to remove common ravens under the Migratory Bird Treaty Act.

1.1 Background

For more than two decades, researchers have documented population declines throughout much of the range of the desert tortoise in California, with some populations showing dramatic declines (Berry 1990, Corn 1994, USFWS 1994, Tracy et al. 2004). Because of these drops, in 1989, the USFWS listed the Mojave population of the desert tortoise as endangered under emergency provisions of the ESA. In 1990, the USFWS published a final rule listing the desert tortoise as threatened, because of sharp population declines that were documented throughout its range (55 Federal Register 12178–12191). The decline of the Mojave population of the desert tortoise is attributed to direct and indirect human-caused mortality including destruction, degradation, fragmentation of habitat, and loss of individual desert tortoises from human contact, predation, and disease. The desert tortoise is also listed as threatened under the California ESA.

The USFWS published a Recovery Plan for the Mojave population of the desert tortoise in 1994. The Recovery Plan identified six recovery units and one or more Desert Wildlife Management Areas (DWMAs) within each recovery unit. The DWMAs are the primary focus areas to promote the recovery and long-term persistence of viable desert tortoise populations (Figure 1-1). The Recovery Plan includes predation as one of the important factors in the decline of the Mojave population of the desert tortoise that must be reduced. This includes predation of adult and subadult desert tortoises by free-roaming and feral dogs and intense predation of hatchling and juvenile desert tortoises by an escalating population of common ravens (Figure 1-2).

Since listed as threatened in 1990, desert tortoise populations in the west Mojave, northeast and east Mojave, and north and east Colorado-desert areas have shown downward trends. These population declines are of particular concern in the west Mojave Desert. The desert tortoise in the west Mojave recovery unit has experienced substantial population decline which are due, to loss of habitat and other threats (Tracy et al. 2004).

Figure 1-1. Hatchling desert tortoise at Edwards Air Force Base. (Photo by Mark Bratton)

Figure 1-2. Juvenile desert tortoise shell with classic puncture marks from a common raven's beak.

Populations of the desert tortoise cannot increase and recover unless the number of young desert tortoises that are recruited into the breeding population (e.g., allowed to survive, reach adulthood, and reproduce) is greater than the number of adults that die (Congdon et al. 1993, USFWS 1994). Several researchers and field biologists have reported occurrences of numerous carcasses of hatchling and juvenile desert tortoises beneath raven nests and perch sites (Berry 1985, BLM 1990a, Campbell 1983, Farrell 1991). Campbell (1983) found 136 dead bodies or carcasses of juvenile desert tortoises with evidence of raven predation at the base of fenceposts on the perimeter of the Desert Tortoise Natural Area. Within a 4-year period, 250 juvenile desert tortoise carcasses were located beneath one raven nest in the west Mojave Desert (Woodman and Juarez 1988). Berry et al. (1986) reported that 29 and 44 percent, respectively, of the desert tortoise deaths or mortality at two study plots during a 6-year period, were probably caused by raven predation. At another location, 70 percent of the mortality to juvenile desert tortoises was attributed to raven predation (Berry et al. 1986). Ravens have also been observed attacking and eating juvenile desert tortoises (Berry 1985, Boarman 1993). Ravens eat hatchling and juvenile desert tortoises by pulling off the head and limbs (40 percent) or pecking holes through the soft carapace (upper half of the shell) (46 percent) or plastron (lower half of the shell) (13 percent; n = 341) (Boarman and Heinrich 1999). Boarman and Hamilton (personal communication) obtained 266 desert tortoise shells collected beneath common raven nests. These carcasses showed patterns of shell damage that were consistent with raven predation. Ravens are able to catch, carry while flying, and eat juvenile and hatchling desert tortoises because of their small size and weight, the lack of ossification or hard bone material in their shells, and the corresponding high-activity periods of both desert tortoises and nesting ravens in the spring. In the open desert in California, 89 percent of ravens observed foraging were eating wild animals in the spring versus 5 percent in fall (McKernan 1992a, McKernan 1992b). This level of predation may prevent recruitment in declining populations (Congdon et al. 1993) such as the desert tortoise.

Populations of the common raven have increased in the California desert in the last several decades. Johnson et al. (1948) reported common ravens as not common in the east Mojave Desert of San Bernardino County in the 1930s. They were not seen in the winter and spring. They were observed in the summer at lower elevations and flying along a railroad track, and near Kelso and Purdy, locations of human development. This information suggests that in the 1930s, common ravens were migratory, not common, and did not overwinter or breed in the desert.

From 1969 to 2004 the numbers of common ravens in the west Mojave Desert increased approximately 700 percent (Boarman and Kristan 2006). Population increases have also been noted at other locations in the California desert. This many-fold increase above historic levels and a shift from a migratory species to a resident species is due in a large part to recent human subsidies of food, water, and nest sites (Knight et al. 1993, Boarman 1993, Boarman and Berry 1995). Table 1-1 presents the rate of increase in survey results for common ravens, golden eagles (*Aquila chrysaetos*), greater roadrunners (*Geococcyx californianus*), and red-tailed hawks (*Buteo jamaecensiis*) in the California desert. From 1966 to 2006, the number of common ravens observed during surveys increased 1,685-fold while golden eagles, greater roadrunners, and red-tailed hawks increased 5-, 13-, and 57-fold, respectively. Raven population numbers have increased at a rate that is disproportionately greater than other predatory birds in the California desert.

Table 1-1. Summary of Results from Christmas Bird Count Surveys in the California Desert for Four Potential Avian Predators of the Desert Tortoise

Years	Number of Observations			
	Common Raven	Golden Eagle	Greater Roadrunner	Red-Tailed Hawk
1961-1965	1	0	5	1
1966-1970	3	3	4	6
1971-1975	174	4	7	21
1976-1980	619	15	24	68
1981-1985	749	39	56	180
1986-1990	1,018	31	52	179
1991-1995	2,591	19	64	210
1996-2000	3,930	25	37	329
2001-2006	5,056	15	65	344

At these elevated population levels, common raven predation on desert tortoise hatchlings and juveniles has shifted the composition of the desert tortoise population to predominantly adult desert tortoises by removing a substantial proportion of hatchling and juvenile desert tortoises in some areas, and has adversely affected recruitment (Berry et al. 1986). Without recruitment of hatchling and juvenile desert tortoises to the next generation of adult desert tortoises in the population, the old adults will eventually die and the population will become extinct. For example, at one location, the percentage of adults in the desert tortoise population increased from

54 to 82 percent from 1979 to 1988, while the percentage of juvenile desert tortoises in the population declined from 27 to 12 percent.

The declines in juvenile desert tortoises were attributed to raven predation (Berry, Woodman, and Knowles 1989). This trend in increased proportion of adults and decreased proportion of juvenile desert tortoises also occurred at other sites (Berry et al. 1990). Ray et al. (1992) developed a simple model of population growth for the desert tortoise. While it contained several assumptions, it demonstrated that the population growth rate of a healthy desert tortoise population could be changed to a declining rate by decreasing the survival rate of hatchling and juvenile desert tortoises by about 25 percent. The decline in juvenile desert tortoises from 27 to 12 percent is a decrease in the survival rate of more than 50 percent. If this declining trend is not reversed soon, these populations of the desert tortoise would eventually be exterminated.

Some of the California desert does not provide suitable habitat for common ravens to survive and reproduce. For example, ravens need a high location to construct a nest (e.g., tree, utility pole, abandoned vehicle, freeway sign, or cliff), and adequate food and water within their nesting territory (Appendix A). Common ravens actively defend their nest territory during the breeding season. In 2004 and 2005, McIntyre (2006) conducted surveys of common raven nests in part of the California desert. The purpose of the surveys was to determine locations of raven nests and collect data on the number of nests with desert tortoise remains under them. In 2004 and 2005, 28 and 27 nests, respectively, were located with desert tortoise remains beneath them.

1.2 Purpose and Need

The purpose and need of this EA is to present and analyze a proposed action to reduce common raven predation on hatchling and juvenile desert tortoises in the California desert by modifying land management practices and selective removal (see Figure 1). The USFWS believes that reducing this predation is needed to increase desert tortoise survivorship. This position is based on the best information currently available (Boarman 2002, Congdon et al. 1993, USFWS 1994). Increased survivorship of juvenile and hatchling desert tortoises into the reproductively active adult population is expected to contribute to the recovery of the species.

1.2.1 Level of Reduction Needed

Common raven pairs establish a home range in which they forage and nest. The entire home range is not defended from other common ravens. However, within this home range, they establish a breeding territory which they actively defend from other ravens, especially during the breeding season (Boarman and Heinrich 1999). The common raven breeds in spring in the California desert. A pair of common ravens constructs a nest and actively defends a territory around this nest. During this breeding period, most of their hunting activity is confined to this territory. Thus, this area is intensively hunted in the spring, which also corresponds to the time when desert tortoise activity is greatest, and the need for food for breeding ravens and their offspring is greatest. In a successfully defended breeding territory, only the common raven breeding adults pose a risk of predation to the desert tortoise with the risk increasing closer to the nest (Kristan and Boarman 2003). Common ravens are accomplished hunters, but not all common ravens hunt and eat desert tortoises (Boarman and Hamilton in prep).

The feeding behavior of nonbreeding common ravens is different from that for breeding adults. Large numbers or crowds of nonbreeding common ravens are attracted to concentrated human-subsidized sources of food, water, and roost sites. In general, these nonbreeding ravens are spatially restricted in the California desert, whereas, breeding common ravens are more evenly distributed throughout the California desert area (Kristan and Boarman 2003). These common raven crowds feed at concentrated food sources (e.g., landfills and illegal dumps) (Chamblin and Boarman 2004) and are frequently reported in the California desert (Boarman and Heinrich 1999). They have also been observed moving between concentrated food source sites. Nonbreeding ravens are gregarious and use other nonbreeding raven as cues of food availability (Kristan and Boarman 2003). Fledgling chicks move to human-subsidized resources that have crowds of common ravens.

Kristan and Boarman (2003) investigated the spatial pattern of risk of common raven predation on the desert tortoise in the Mojave Desert of California. They learned that the risk of raven predation to hatchling and juvenile desert tortoises was high near places attracting large numbers of nonbreeding ravens such as landfills. Where the common raven's human-subsidized habitat is intermixed with the desert tortoise's habitat, the risk of predation by the common raven on the desert tortoise increases and can exterminate the desert tortoise (Kristan and Boarman 2003). Many sources of human-subsidized habitat that support crowds of common ravens are located within or adjacent to human development. Desert tortoise predation from these raven crowds is termed "spillover" predation. For example, the predation by a crowd of common ravens at a landfill spills over from the landfill to any nearby desert tortoise habitat, thus increasing the risk of predation on the desert tortoise occupying this nearby habitat. In certain locations, these crowds of common ravens may represent a threat to the hatchling and juvenile desert tortoise populations at localized sites in the California desert, where these sites are adjacent to desert tortoise habitat.

From the available information, the greatest risk of predation to hatchling and juvenile desert tortoises from the common raven appears to be from breeding common ravens within their territories and from spillover predation from crowds of nonbreeding common ravens. The spillover predation risk appears to be localized and can likely be effectively managed by reducing human subsidies of food, water, and roost sites. The predation risk from breeding common ravens occurs throughout the California desert and does not appear to be substantially limited by food availability.

To determine the number of common ravens that would need to be reduced to effectively manage the predation risk from breeding common ravens, we used the data from McIntyre (2006) on the number of nests or raven pairs preying on desert tortoises from part of the California desert. We also used the information on the reproductive needs and behavior of the common raven (Appendix A). McIntyre's data showed that about 28 common raven nests in 2004, and again in 2005, had desert tortoise remains beneath these nests. We applied or extrapolated McIntyre's information to the range of the desert tortoise throughout the California desert. The result was that approximately 100 nests or pairs of common ravens would have desert tortoise remains under their nests in a given year. Therefore, if 100 pairs of common ravens that prey annually on hatchling and juvenile desert tortoises were removed, this action would eliminate most of the predation on juvenile and hatchling desert tortoises by breeding common ravens in the California desert. Common raven predation on the desert tortoise is primarily a learned behavior. Ravens can learn to hunt for and kill desert tortoises from other ravens or, through trial and error, learn themselves. Because predation on the desert tortoise is a learned behavior, not all common ravens prey on desert tortoises. If other common ravens replace those removed, they may never learn to prey on the desert tortoise. If they do learn, there would likely be a period of time when they do not prey on desert tortoises. This predation reduction should provide immediate relief to the adult-dominated and senescent desert tortoise populations in the California desert by increasing the number of hatchling and juvenile desert tortoises in the populations and increasing the total number of desert tortoises in the populations.

1.2.2 Decisions to Be Made

The USFWS is the lead agency for the proposed action. The USFWS and the cooperating agencies will address the following questions using an interdisciplinary analysis in this EA.

a. What is the method of selected common raven management that will most effectively contribute to desert tortoise recovery in the California desert?

b. What are the environmental effects of implementing the various alternatives?

1.3 Issues and Concerns

The following listed issues were identified using federal laws, regulations, executive orders, agency management policies, and our knowledge of limited or easily impacted resources. The USFWS and the cooperating agencies determined, through interagency consultation, past planning efforts, coordination with environmental groups, input from state agencies, and initial public involvement, that the following issues should be considered in the decision making process for this EA to help compare the impacts of the alternative management strategies. Following is a brief discussion of why certain issues were selected for further analysis and why others were dismissed from further consideration:

a. Impact on the Common Raven–The National Environmental Policy Act (NEPA) calls for an examination of the impacts on all components of the human environment. The BLM, NPS, and DOD policy is to protect the natural abundance and diversity of natural communities. Since all alternatives would involve manipulation of wildlife resources, specifically the common raven, and there are concerns for impacts to nontarget species, impacts on target species are addressed as an impact topic in this document. What effect would the alternatives have on the common raven? How would management strategies affect local or regional populations of the common raven?

b. Impact on Nontarget Species–The ESA requires an examination of effects to all federally listed threatened or endangered species. This section will address all federal and state threatened and/or endangered species. The desert tortoise is a federal and California state-listed species. Therefore, federal and state listed species are addressed as an impact topic in this document.

Since the alternatives would involve manipulation of wildlife resources, and there are concerns for impacts on nontarget species, the impacts on nontarget species will be addressed in this document.

c. Socioeconomic Issues–What effect might the alternatives have on increasing or decreasing the amount of money that would be spent in the area thereby, adding to or subtracting from the economy in the California desert? What effect might the alternatives have on the lifestyle of the residents and businesses in the California desert?

d. Recreation–How might the alternatives affect recreation opportunities and experiences in the California desert?

e. Human Health and Safety–During the scoping period, the public identified concerns for human health and safety regarding some of the raven management actions that are considered in this document. Therefore, human health and safety are addressed in this document. What effect might the alternatives have on human health and safety if the public is at or near locations where lethal methods would be used to remove common ravens?

1.4 Issues Not Discussed with Rationale

a. Impacts on Biodiversity and Ecosystems–If the USDA's APHIS-WS uses lethal methods to remove the common raven, their activities would be confined to removing specific offending individuals or a species at specific locations. They would not remove common ravens to significantly reduce or eradicate the population as a whole. The APHIS-WS operates according to international, federal, and state laws and regulations, which were enacted to ensure species diversity and viability. The APHIS-WS has determined that the impacts of their program on biodiversity from predator management would not have a significant effect nationwide, statewide, or in the analysis area (USDA 1997, revised). The number of ravens that may be removed ranges from a very small to moderate percentage of the total population as analyzed in Section 4.0 of this report.

b. Impact on Minority or Low-Income Persons or Populations (Environmental Justice [EJ] and Executive Order 12898)–All of the activities implemented by the USFWS and federal cooperating agencies are evaluated for their impacts on the human environment and compliance with EO 12898 to ensure EJ. There are no minority or low income populations within the proposed action area on federal land. On nonfederal land, the proposed action is expected to be implemented throughout the California desert or substantial areas of the California desert. Since the proposed management methods would not pose a disproportional risk to low income persons or their environment and does not locate any facilities or contain any ground disturbing activities, we do not anticipate that any of the alternatives would result in any adverse or disproportionate environmental impacts to persons of any race, income, or culture.

c. Protection of Children from Environmental Health and Safety Risks (EO 13045)– Because the USFWS has determined that identifying and assessing environmental health and safety risks is a high priority, the USFWS has considered impacts that the alternatives analyzed in this EA might have on children. Reducing predation by common ravens on the desert tortoise, as proposed in this EA, would only involve legally available and approved management methods in situations or under circumstances where it is highly unlikely that children would have the potential for exposure. Some actions, such as properly containing and disposing of trash and reducing water sources for disease-bearing mosquitoes, would improve human health and safety for children and adults. Therefore, implementation of any of the alternatives is highly unlikely, and not reasonably foreseeable, to pose an environmental health or safety risks to children.

d. Impact on Cultural Resources–The Mojave and Colorado deserts have been occupied by humans for at least 11,000 years. The historical record shows that the region of the Mojave Desert of interest to this project was inhabited and/or used by the Owens Valley Paiute, Timbisha Shoshone, Chemehuevi, Serrano, Mojave, and Cahuilla.

During federal interagency consultations, agencies noted that some tribes may have concerns about the lethal or nonlethal removal of common ravens. Ravens may be important to their cultural and religious heritage.

We contacted tribal offices and cultural committees in the action area in 2004 and invited their comments and concerns about this issue. The Bureau of Indian Affairs initiated outreach to tribal offices and cultural committees in August 2005. One tribe indicated that they would like to receive future documents associated with this project (Appendix B).

Removal of common ravens on tribal lands is not proposed and no ground disturbing activities are planned in any of the alternatives in this EA. The actions that are proposed to reduce human subsidies to the raven do not have the potential to affect objects, sites, or properties that are listed on or eligible for listing on the National Register of Historic Places (NRHP). Therefore, impacts to cultural resources are dismissed from further consideration.

e. Impact on Wilderness–The actions proposed in the alternatives could be implemented within designated, proposed, or potential wilderness areas, but this is not proposed or expected to occur. If any of the actions are implemented in wilderness areas, the land management agency for that area would first prepare a Minimum Tool Analysis, as required by the *Wilderness Act of 1964*. Wilderness should not contain human-subsidized sources of food, water, and nest/ roost sites for common ravens. Because federal action to reduce raven predation on the desert tortoise is unlikely in wilderness areas and because any action proposed for implementation in a wilderness area would require additional evaluation through the Minimum Tool Analysis, wilderness impacts are dismissed from further consideration.

f. Impact on Noise–Hunting and shooting are allowed on BLM land and hunting is allowed on the Mojave National Preserve. Discharge of firearms also occurs on military lands. The increase in the level of use of firearms from shooting the common raven would result in a negligible increase in the hunting and shooting that is already allowed in these areas. Noise suppressors in key areas are included in the alternatives and could be used to minimize noise impacts.

g. Other Resources–The actions discussed in this EA involve minimal ground disturbance, no new construction, minimal use of vehicles and equipment, and use of existing roads. Therefore, the following resource values should not be affected by any of the alternatives analyzed: air quality, soils, geology, minerals, water quality, water quantity, floodplains, wetlands, aquatic resources, prime and unique farmlands, park lands, vegetation, ecologically critical areas, traffic, visual quality, energy requirements and conservation, natural or depletable resources, urban quality, unique ecosystems, geological resources (rocks and streambeds), stream-flow characteristics, seismicity, and sacred sites and Indian Trust resources at our proposed sites. There are no wild and scenic rivers in or adjacent to the project area. Each of these topics was analyzed as it relates to the potential alternatives. Each was dismissed because of lack of relevance and/or lack of impact from the proposed alternatives.

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2.0 AFFECTED ENVIRONMENT

2.1 Background–California Desert

The California desert includes the Mojave and Colorado deserts within California. It extends north to the Nevada State Line and Highway 168 junction and continues south to the United States-Mexican border. The California-Nevada and California-Arizona State Lines define its eastern boundary. The following mountain ranges primarily define its western boundary: eastern and southern Sierra Nevada, eastern end of the Tehachapi Mountains, San Bernardino and San Gabriel Mountains, and Mount San Jacinto to the Peninsular Ranges. The California desert occupies more than 30 million acres and covers portions of Imperial, Inyo, Kern, Los Angeles, Riverside, San Bernardino, and San Diego counties.

2.2 Climate

Hot summer temperatures (average daily highs above 100 degrees Fahrenheit) and low annual precipitation (approximately 5 inches or less) characterize the California desert. Precipitation in the form of snow can occur during the winter at higher elevations. Probably more important than the averages is the extreme variability in the weather. Daily temperature variations of 40 degrees can occur. Precipitation extremes are also common; variations of 80 percent in annual precipitation can occur. Summer thunderstorms can drop more precipitation on a site in one event than the mean precipitation for that location for the year. High winds can occur; peak-wind velocities above 50 mph are not uncommon.

During the summer, the west side of the Mojave Desert is heavily influenced by the dry southwest airflows resulting in typically very dry weather. The influence of southwest winds diminishes toward the eastern Mojave Desert. This results in a more continental influence and its resulting monsoonal weather patterns. Thus the western section of the California deserts predominately have winter rains and the eastern sections, which receive winter rainfall, receive more of their annual rainfall with the summer thunderstorms. Both east and west sections of the California deserts can receive rain in both periods.

Extreme variability is another characteristic of the precipitation. Some locations such as the town of Mojave have a mean precipitation of 6.06 inches and a standard deviation of 4.04 inches. This means that the normal precipitation ranges from a low of 2.02 inches to 10.10 inches. This is an 80 percent variation in precipitation.

2.3 Biological Environment

The California desert has a distinct flora and fauna that have adapted to the local conditions and formed distinct natural communities, including species found nowhere else (e.g., endemics). It also incorporates the ecotones or transitional communities from the Sierra Nevada, Tehachapi, San Gabriel, and San Bernardino Mountains. The predominant aspect of the California desert is a flat, sparsely vegetated region interspersed with mountain ranges and dry lakes. Elevational changes range from more than 10,000 feet to below sea level. The Mojave Desert is a part of the high desert, large portions of which lie at elevations between 2,500 and 4,000 feet. The low desert or Colorado Desert occurs at elevations from below sea level to 2,500 feet. Wildflowers cover the characteristic creosote bush and saltbush plant communities of these two deserts in years of above-normal winter rainfall, and up to 90 percent of the floral diversity is composed of annual plants.

The BLM Desert Plan staff inventoried the California Desert Conservation Area (CDCA) for its flora and fauna in the late 1970s (BLM 2005). They recorded 1,836 vascular plant species in 116 families and 635 species of vertebrate animals. This diversity reflects the varied topography, soils, and landforms within the planning area. For example, the western Mojave Desert contains thirty-two distinct plant communities. The most common communities are creosote bush and saltbush scrubs, which occupy 75 percent of the natural lands. Mojave mixed woody scrub accounts for 13 percent of the native vegetation. The remaining 29 plant communities are found in isolated areas with unique conditions, such as freshwater or alkali wetlands, or occur along the south and west edges of the desert-mountain transition.

Inventories of invertebrates, such as insects, mollusks, and fairy shrimp have been completed for only a few groups, but show a high level of endemism and specialization to unique substrates, host plants, and water sources. Thousands of additional invertebrate species are present (BLM 2005).

The region contains at least four endemic vertebrate animals and thirteen endemic plants. A number of disjunct localities exist where plants and animals range into the planning area far from their primary distribution. Many of the rare species are concentrated at special sites, where unique substrates, water sources, or topography is present. Several areas have high biodiversity because of location at the desert-mountain transition zone or ecotone.

A large number of introduced plant species and a small number of introduced animal species (excluding insects) are found in the California desert. A few of these animal species have substantial effects locally on the native environment, particularly feral burros and bullfrogs. They provide a new level of pressure or threat to the native species. In addition, feral and free roaming dogs are a problem in several areas because of added predation on native species. The common raven is a natural predator of the desert tortoise. However, its population numbers have increased markedly in the last few decades, which have increased the level of predation on the desert tortoise (Boarman and Berry 1995, Boarman 2006).

The number of introduced invasive plant species is higher and in some respects more of a threat to the natural ecosystem. Riparian invasive plants include tamarisk (*Tamarix parviflora)*, Russian olive (*Elaeagnus angustifolia*), and common reed (*Phragmites australis*), which crowd out native willows and cottonwoods in riparian habitats. Weedy annuals such as storkbill, several species of brome grass, split grass (*Schismus barbatus)*, Sahara mustard (*Brassica tournefortii* Gouan) and other annual plant species compete with native wildflowers, provide a nutritionally deficient food plant for the desert tortoise (Oftedal et al. 2002), and have altered the fire regimen in the desert. They provide fuel to support and sustain large fires in the desert, which is not adapted to them (Brooks 1998).

3.0 PROPOSED ACTION AND ALTERNATIVES

3.1 Proposed Action

The proposed action is to reduce raven populations by integrating federal, state, and local management plans and developing a major public outreach and education program. The management techniques include cultural and mechanical methods (e.g., reduce human subsidies of food, water, nest sites, roosting sites for the common raven, and aggressive nest removal) with the potential of limited raven removal in designated areas. The alternatives analyzed in Section 4.0 use various combinations of methods to implement the proposed action. We expect this level of effort to include one USFWS administrator (part-time), a part-time identification field team, and potentially a small part-time removal team per year for the life of the project.

The proposed action would occur at various locations within desert tortoise habitat in the California desert and at areas with human development that are in and near desert tortoise habitat (e.g., communities, waste disposal sites, and agricultural areas). Three of the alternatives discussed include the removal of common ravens.

The Proposed Action also contains many safeguards to avoid and/or minimize the potential impacts of this action. These measures include:

a. Measures to Avoid or Minimize Impacts on Target Species Populations

1) California Department of Fish and Game (CDFG) has been consulted on state regulations and policies affecting the management of the common raven and the status of the common raven population in the California desert. Implementation of effectiveness monitoring will ensure that common ravens will be removed only when necessary to meet stated objectives.

2) Wildlife specialists would be used to capture and release or dispatch the common raven.

3) The impacts of the program on the common raven would be monitored annually.

4) The impacts of the program on the common raven would be monitored by considering the "cumulative take" which involves assessing the impacts of all known forms of take against the common raven population estimates and trend indicators.

5) Common ravens that are trapped would not be relocated. They would be euthanized using the most humane methods practicable and offered to museums or laboratories for research purposes.

b. Measures to Avoid or Minimize Impacts on Nontarget Species Including Federal and State Listed Threatened and Endangered Species

1) The CDFG has been consulted on state wildlife regulations and policies concerning the state-listed desert tortoise and Mohave ground squirrel. The CDFG concurred with our determination that take was unlikely to occur (see Section 3.1.a.1).

2) The CDFG has been consulted regarding potential risks to state listed threatened and endangered species.

3) The USFWS would be consulted regarding potential risks to federally listed-threatened and endangered species and species proposed for listing. All applicable measures

identified through the consultation/conference process to protect listed and proposed species would be implemented.

4) The impacts of the removal program on nontarget species would be monitored annually.

5) Bait used for the common raven would be as selective as possible for this species, while still maintaining effectiveness.

6) Personnel working to remove the common raven would be trained to identify federal and state endangered and threatened species that may be present and avoid them.

7) Carrion and meat baits would not be used at baiting platforms.

8) Vehicle speeds on nonpaved roads in desert tortoise habitat would be limited to 25 miles per hour (mph) for personnel accessing sites to remove common ravens.

c. Measures to Avoid or Minimize Impacts on Recreation

1) Suppressed firearms would be used in situations where noise from gunshot would have a negative impact on recreational use of the site.

2) Activities to remove common ravens would only be conducted after agreements, work plans, or other comparable documents are developed with the landowner/managing agency.

3) Work plans would consider activities in closely adjacent settlements and communities to minimize impacts on lifestyle or human communities on adjacent lands.

4) Activities to remove common ravens in areas known to receive extensive human use or close to human communities or settlements would be conducted at times and with methods which would minimize impacts on recreational activities.

d. Measures to Avoid or Minimize Impacts on Human Health and Safety

1) Activities to remove common ravens would only be conducted on private/public lands with the permission of the landowner/managing agency. Agreements, work plans, or other comparable documents would be prepared with the landowner/managing agency designating the times and methods.

2) Activities to remove the common raven would only be conducted after agreements, work plans, or other comparable documents are developed with the landowners, or adjacent communities are informed of the removal activities prior to implementation. No lethal methods would be used in areas with legal or policy restrictions that preclude the proposed activities.

3.2 Effectiveness Monitoring and Adaptive Management

A key component of integrated predator management is to monitor the effectiveness of the management action in meeting the stated objective. This is called effectiveness monitoring. If the action was effective, then it would continue. If it was not effective, then the action would be modified or adapted. This implementation of adaptive management includes monitoring to determine if the adaptive management is effective. Management actions might change or adapt, depending on the results of the monitoring to determine the effectiveness of these actions.

The existing Raven Management Interagency Task Group, established in late 2002, would coordinate implementation of the Proposed Action, evaluate monitoring reports, assess progress of the actions, and recommend changes in the program. This adaptive management/effectiveness monitoring program would include elements to determine if there is a change in predation by the common raven on the desert tortoise and a change in the raven population or distribution at a regional level within the California desert.

To determine change in raven predation on the desert tortoise at a local or site specific level, we propose to measure changes in the occurrence of desert tortoise remains found at raven nests, after removing specific pairs of nesting ravens (Boarman and Kristan 2006). Using data from the previous or current year on nest locations for common ravens, surveys would be conducted at nest sites for evidence of predation on the desert tortoise. The Proposed Action would be effective if the number or percent of nests surveyed, with evidence of predation and the number of desert tortoise carcasses found during surveys, are lower than the baseline or first year's data collected. Another possible approach to measure changes in predation pressure on desert tortoise populations at any location, would be to use an approach similar to Kristan and Boarman (2003), where models of juvenile desert tortoises are placed in the California desert and monitored to determine changes in the frequency of raven attacks (Boarman and Kristan 2006).

Common raven population trends would be monitored using road surveys both inside and outside the Desert Tortoise Management Areas (DTMAs). Trend analysis would also include the Christmas Bird Count (CBC) survey data and the Breeding Bird Survey (BBS) data. The road surveys would provide information on whether ravens use the DTMAs at the same level as unmanaged areas and could yield data for testing the effectiveness of specific actions or projects. The CBC and BBS data sets would provide the overall long-term trend of the raven population in the California desert.

The USFWS, in coordination with the cooperating agencies, would monitor the selected action through periodic reviews of the monitoring data as compared to the goal in the final NEPA document and decision. Data from the USFWS's range-wide monitoring program for the desert tortoise would be used to determine changes in the desert tortoise population regionally or range wide. The APHIS-WS would assist in the production of an annual report discussing the locations where work was conducted, the number of target and nontarget animals, if any, removed, and recommendations for subsequent season's work. The USFWS and cooperating agencies would review the results of the effectiveness monitoring including any recommendations for modifications, and use this information and information from APHIS-WS to determine if the impacts of the program are within the parameters analyzed in the EA, and if a new evaluation pursuant to the NEPA or Section 7 of the ESA is necessary.

3.3 Objectives of the Proposed Action

3.3.1 Objective 1

Reduce human-provided subsidies of food and water; and nest and communal roost sites for the common raven.

Many of the following activities listed would be implemented by state and local agencies and the public. Many would be implemented by the USFWS or any of the agencies previously listed. Since implementation of any of these activities may or may not be a federal action, we are listing all of the activities. From this set of activities, those that require analysis under NEPA are analyzed in Section 4.0, Environmental Consequences.

To implement the first objective, the following activities are proposed:

a. Develop and implement an outreach program–The USFWS and the agencies would develop and implement an outreach program. The outreach program would inform the public about the status of the desert tortoise, build support among the public to help the desert tortoise reverse its declining population numbers, and inform the public that they, as individuals, can help reduce mortality of the desert tortoise by making simple changes in their home, work, or recreational environment. The USFWS recognizes that the public plays a key role in reducing many of the unintentional human-provided subsidies, which have contributed to the raven's population explosion in the California desert in the last few decades and hopes that the public would implement the recommendations provided to them through the outreach program.

Before developing the outreach program, the USFWS and cooperating agencies would conduct a study that would gather baseline data on public attitudes, perceptions, and values about the desert tortoise and the raven, desert tortoise recovery efforts, and conservation of the California desert. The survey results would be used to help design effective public outreach messages and strategies. This outreach program would include developing and distributing written, audio, and video materials directly to residents of the California desert, visitors to the California desert, school children, decision makers, and stakeholders. A follow-up survey would be conducted to evaluate the effectiveness of the outreach program a few years after its full implementation.

b. Reduce or eliminate human-subsidized food and water for the common raven–We would coordinate with local waste management companies, and local, state, and federal agencies to reduce raven access to organic wastes and standing water at locations such as landfills and transfer stations. We would work with local, state, and federal agencies to clean up unauthorized dumps and develop incentives for the public to report unauthorized dumping, trash containment, or watering.

Working with local, state, and federal agencies, we would encourage an enhanced level of enforcement of existing regulations on trash management and water use. If needed, we would work with local agencies to develop and implement additional regulations to reduce human-provided subsidies of food and water to the common raven.

To better manage solid waste at its point of origin (e.g., businesses and homes), we would work closely with federal agencies to contain solid waste on federal lands and at federal facilities, and strongly encourage nonfederal agencies to do the same. Such efforts would include: using raven-proof trash bins at public (e.g., roadside rest stops, campsites), business (e.g., construction sites, restaurants and food manufacturers, gas stations, and grocery stores), and residential (e.g., apartments and houses) facilities; and reduce availability of livestock feed, carcasses, afterbirths, and insects at feedlots and dairy and poultry farms.

To better manage surface water use, we would implement the same approach with federal, state, and local agencies as for solid waste to minimize the availability of surface water, which can be used by ravens. We would coordinate with agencies and appropriate businesses (e.g., water companies, well drilling companies) to promptly repair leaks in landscaping and irrigation systems, reduce over-watering and standing water as products of their operation, and encourage municipalities to reduce water features in their landscapes.

c. Reduce the availability of animal carcasses along roadways–We would continue to work with federal, state, and local road departments to install desert tortoise exclusion fencing and culverts along highways in desert tortoise habitat. These features would direct desert tortoises, and possibly other wildlife, to culverts to safely pass under roadways rather than attempting to cross the roadway where they might be struck by vehicles. We would also work with federal, state, and local highway departments to quickly remove animal carcasses from roadways to reduce food subsidies for common ravens.

d. Remove common raven nests not occupied with eggs or nestling–On federal lands and facilities, we would work with federal agencies to remove raven nests from human-created structures within the DTMAs and along a 2-mile perimeter around the DTMAs. For those ravens whose nests were removed during courtship but prior to egg-laying, we would attempt to trap, tag, and transmitter the ravens to determine whether they attempted to renest, and if so, where.

e. Remove or modify manmade communal roosting sites for ravens–For abandoned or nonfunctioning structures that are used as communal roost sites by common ravens, we would encourage federal and nonfederal entities to remove these unnecessary structures. For human-built structures that are not removed, we would encourage federal and nonfederal entities to modify the existing structures to reduce or eliminate roosting by common ravens. In addition, we would work with federal, state, and local agencies to minimize construction of new structures that are used by ravens for communal roosting (e.g., communication towers, billboards, and shade structures). As structures are designed and built, we would work with project proponents to design structures to minimize or prevent ravens from using them as communal roost sites.

f. Remove or modify human-provided nest sites for ravens–We would encourage federal and nonfederal entities to remove unnecessary structures inside and within 2 miles of any DTMA that are used as nest sites by the common raven. For structures that cannot be removed, we would encourage federal and nonfederal entities to modify existing structures to reduce or eliminate the likelihood of these structures being used as nest sites by ravens. In addition, we would work with federal, state, and local agencies to minimize construction of new structures (e.g., electrical towers, billboards, communication towers, open warehouses, or shade towers). As structures are designed and built, we would work with project proponents to design structures to minimize or prevent ravens from using them as nest sites.

3.3.2 Objective 2

Remove ravens that prey on the desert tortoise. This objective includes:

a. Identify ravens that have preyed on the desert tortoise–Evidence of predation would be locating a minimum of one desert tortoise shell showing the classic peck marks of raven predation within 1 mile of a nest (Boarman 2002b). Direct observation of a common raven preying or attempting to prey on a desert tortoise would also be evidence of predation. All raven pairs documented as desert tortoise predators would be removed.

b. Remove predatory ravens–Common ravens would be removed using the most appropriate humane and safe method. Removal methods could include shooting, using an avicide (DRC-1339), or live trapping and euthanasia. The ravens would be preserved and offered to researchers to collect data on diseases (e.g., West Nile Virus [WNV] and avian influenza), genetics, or for museum collections. Young ravens and eggs found in nests of removed adults would be euthanized after being removed from the nest.

Due to the legal authorities and recognized expertise of APHIS-WS in wildlife damage management, the lead and cooperating agencies implementing lethal removal of ravens would contract this work to WS to be performed by their trained professional staff. The USFWS proposes to use the decision model described in Section 3.3.3 as the primary tool for the selection of common ravens to be removed.

3.3.3 Use of a Decision Model for Implementing Removal of the Common Raven

The *Wildlife Services Decision Model* (Slate et al. 1992) is adopted from the APHIS-WS decision-making process, which is a standardized procedure for evaluating and responding to wildlife damage complaints. The Decision Model is a description of the thought process used by wildlife management specialists, USFWS, and cooperating agencies to develop and implement the most appropriate method to reduce predation by the common raven on the desert tortoise through removal methods (Appendix C).

3.4 Description of Alternatives

This section describes 16 management alternatives. These alternatives were developed and analyzed to provide the full range of reasonable alternatives that provide levels of raven management, ranging from no programs beyond existing management, to a full-scale control program throughout much of the California desert. The current program provides a basis for comparing the management direction and environmental consequences of the other alternative actions. Of these16 alternatives, 10 were dismissed for various technical reasons (see Section 3.5) and 6 alternatives were carried forward.

3.4.1 Alternative A

The Current Program Alternative (Alternative A) describes the current level of management. This alternative would maintain the status quo and would not involve additional actions. This can be thought of as the current “program” alternative. Development in the California desert would continue with increased human subsidies for the common raven of food, water, nest sites, and roost sites. Activities currently being implemented by various federal, state, and local agencies to reduce the population of the common raven in the California desert are limited to a few efforts at selected locations. These current efforts include: reducing trash availability at landfills that have consulted with the USFWS, removing illegal dumps, fencing along highways to reduce road-kills, and installing perch guards on fences at the Desert Tortoise Natural Area. Many of these actions are nonfederal actions and do not require analysis under NEPA. Those actions that are federal actions have been analyzed by the federal action agency through the NEPA process.

3.4.2 Alternative B

Integrated Predator Management Emphasizing Cultural and Physical Methods (removing ravens only after evidence of predation or attempted predation on young desert tortoises has been collected).

Alternative B would reduce human subsidies of food, water, nest, and roosting sites for the common raven, and includes aggressive nest removal. The survival of hatchling and juvenile desert tortoises would be expected to increase from the removal of ravens known to prey or attempting to prey on the desert tortoise.

This alternative applies the principles of integrated pest management (IPM); the biology of the animal dictates the appropriate method(s) and timing of management measures to implement. The primary focus of IPM is to reduce or eliminate the source, cause, or reason the pest species is attracted to a location and causes a problem, thus becoming a pest. The IPM uses nonlethal actions to reduce the number of animals causing problems. Sometimes this is sufficient to reduce the conflict. At other times, removal actions are also needed to achieve the goals and objectives of a pest management situation.

We anticipate that the number of common ravens that would be removed annually would be approximately 100 pairs of ravens and their associated offspring each year. This is 0.5 percent of the adult population and 2.4 percent of the total population (adults plus newly hatched birds). We also anticipate that the need to remove ravens would decline over time with the reduction in human-provided subsidies of food, water, and nest and communal roost sites for the common raven in the California desert. We propose to work with local, state, and federal agencies, and the public to implement management actions to effectively reduce human-provided subsidies to the common raven.

3.4.3 Alternative C

The Integrated Predator Management and Removal of Ravens from Desert Tortoise Management Areas.

Alternative C would implement the portion of the proposed action (Alternative B) on reducing human subsidies for food, water, nest sites, and roost sites, but expand the portion on removal of the common raven to include any raven found within a DTMA. The DTMAs include the desert wildlife management and critical habitat areas in Table 3-1. No evidence of predation on the desert tortoise would be needed to remove common ravens.

We estimate that approximately 2,000 ravens occur in the DTMAs and would be removed each year, or approximately 5.3 percent of the population in the California desert. We used the best available information on common raven population size, geographic area, and other factors to determine the number of ravens to be removed. The lethal removal methods described in Alternative B would be used for raven removal from DTMAs. This removal would occur during any time of the year. Only authorized wildlife specialists would conduct the lethal removals.

Table 3-1. Areas in the California Desert Designated for Management of the Desert Tortoise for Survival and Recovery

Desert Wildlife Management Area	Critical Habitat Unit	Recovery Unit	State	Critical Habitat Unit (acres)
Chemehuevi	Chemehuevi	Northern Colorado	California	937,400
Chuckwalla	Chuckwalla	Eastern Colorado	California	1,020,600
Fenner	Piute-Eldorado	Eastern Mojave	California	453,800
Fremont-Kramer	Fremont-Kramer	Western Mojave	California	518,000
Ivanpah	Ivanpah	Eastern Mojave	California	632,400
Joshua Tree	Pinto Mountain	Western Mojave	California	171,700
Ord-Rodman	Ord-Rodman	Western Mojave	California	253,200
Superior-Cronese	Superior-Cronese	Western Mojave	California	766,900

Under Alternative C, we propose to remove up to 2,000 common ravens per year from the DTMAs in the California desert. This is based on spending twice the effort as Alternative B, but because Alternative C allows for raven removal efforts in defined areas or DTMAs, the ability to remove more ravens in the same period of time would be much greater. Thus, if twice the effort is expended with a reduced need to spend time and money on logistics, we could remove up to 2,000 ravens.

Desert tortoises spend most of their time underground in their burrows where the temperature and humidity remain within a more moderate range than aboveground. The desert tortoise is an ectotherm or cold-blooded animal; its body temperature and metabolic rate are determined by the surrounding temperature. Like most animals, the desert tortoise does not tolerate high temperatures or low temperatures so it modifies its behavior and habitat to occupy space with moderate temperatures. This is accomplished by excavating and using burrows for the cold and hot periods of the year as well as the dry periods. Desert tortoises also use their burrows for protection from predators. Thus, desert tortoises are usually not aboveground at night, in the winter, summer, or hot or cold periods of spring and fall.

Desert tortoise usually emerges from their burrows in the daylight hours of spring to forage on the native annual and perennial herbaceous vegetation produced from the winter rains. They are aboveground for a short period to several hours a day replenishing their bodies with food to last them until the next spring.

For the common raven, the greatest demand for food is in the spring during the breeding season. Common ravens must increase their food intake (protein and calories) to produce eggs and feed nestlings. Breeding ravens actively defend their breeding territories and spend much of their time intensively hunting in these territories. This intensive hunting effort coincides with the active season for desert tortoises.

In 2004 and 2005, McIntyre (2006) observed that 5 percent of the common raven nests surveyed showed evidence of desert tortoise predation. Since two birds establish and use a nest for breeding, this means that about 10 percent of the breeding common ravens in the areas observed had evidence of preying on desert tortoises. If 2,000 common ravens are removed, approximately 10 percent or 200 birds were likely preying on desert tortoises. Thus, in

Alternative C, more common ravens are removed, but the number of ravens that were likely preying on the desert tortoise that would be removed is similar to Alternative B.

3.4.4 Alternative D

Alternative D provides for integrated predator management and removal of ravens from desert tortoise management areas and raven concentration areas.

This alternative would implement the actions proposed in Alternative C and would also incorporate raven removal in DTMAs and raven concentration areas, such as landfills. Under this alternative, about 3,000 to 7,000 ravens, or 8 percent to 18.7 percent of the population, would be removed each year from the California desert including urban and suburban areas. We used the best available information on common raven population size, geographic area, and other factors to determine the number of ravens to be removed. Ravens located at these concentration centers would be removed using any or all of the methods listed under the proposed action. This removal would occur during any time of the year. As described in Alternative B, only authorized wildlife specialists would conduct the removals.

In Alternative D, the level of effort to remove common ravens is three times that of Alternative B. However, the areas identified for raven removal include raven concentration areas. Thus a moderate increase in effort may produce a disproportionate increase in the number of birds removed. Although we estimate that 3,000 to 7,000 common ravens may be removed by this action under Alternative D, many of the ravens removed would be from sites where large groups of ravens feed. These feeding sites are the result of human activity that unintentionally provides a reliable food source for the common raven. Of the 3,000 to 7,000 common ravens that may be removed, we estimate that approximately 1,000 to 5,000 of them may likely be dependent on these human-provided food sources (e.g., landfills and agricultural sites) rather than nonhuman food sources (e.g., desert tortoise and other wildlife species). Therefore, removing 3,000 to 7,000 common ravens may provide us with similar results as Alternatives B and C, that is, the number of common ravens removed that are preying on hatchling and juvenile desert tortoise would be about 200 birds.

3.4.5 Alternative E

Alternative E provides for integrated predator management using only nonlethal cultural and physical methods.

This alternative would not remove common ravens from the California desert. It would reduce human subsidies of food, water, roost, and nest sites, includes aggressive nest removal of raven nests without eggs or nestlings. The primary focus of this alternative is to reduce or eliminate the source, cause, or reason that ravens are attracted to a location and cause a problem, thus becoming a pest. This alternative uses cultural and mechanical methods to reduce the number of ravens preying on hatchling and juvenile desert tortoises. This alternative would implement all of the nonlethal methods listed in Alternative B. Table 3-2 presents the anticipated environmental effects.

Table 3-2. Anticipated Environmental Effects

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Air Quality	None	None	None	None	None	None
Children and Low Income populations	None	None	None	None	None	None
Noise	None	None	None	None	None	None
Water Resources	None	None	None	None	None	None
Floodplains/wetlands	None	None	None	None	None	None
Cultural Resources	None	None	None	None	None	None
Geology and Soils	None	None	None	None	None	None
Hazardous Material/Waste[1]	None	None	None	None	None	None
Socioeconomics(project costs)	None	$200K	$400K	$550K	None	$200 – 550K
Recreation Impact[2]	None	5–10 days	10–20 days	10–20 days	None	5 – 20 days
Desert Tortoise[3]	Hundreds per year	Up to 75%	Up to 75%	Up to 75%	< 1–5%	Up to 75%
Ravens Removed[4]	None	215/yr	2000/yr	3000-7000/yr	None	215 – 7000/yr
Nontarget Species[5](200g/day/raven)	None	43kg	400kg	600-1400kg	13kg	43 – 1400 kg
Biodiversity/Ecosystem	None	None	None	None	None	None
Wilderness	None	None	None	None	None	None
Traffic	None	None	None	None	None	None
Sensitive Areas	None	None	None	None	None	None
Visual Resources	None	None	None	None	None	None

[1]All wastes and residues would be disposed of in compliance with all exist rules and regulations. The preferred avicide is nontoxic to mammals and most other vertebrates and is metabolized rapidly by ravens to nontoxic metabolites.
[2]Expressed as days not available for recreation purposes at a specific site
[3] This number would be expected to increase over time. The percentages are desert tortoises that would be expected to survive annually, that would otherwise be expected to be consumed by the raven.
[4]If nesting pairs are removed the nest and any nestlings would also be removed.
[5]The diet of ravens is known to vary greatly from juvenile to adult, from season to season, and from location to location. The impact on other wildlife is expressed here as a weight because of the known variation in diet composition.

3.4.6 Alternative F

Alternative F provides for the phased implementation of Alternatives B, C, and D, as needed.

We would remove common ravens by implementing up to three phases, as needed. The first phase, Alternative B, would remove up to 0.5 percent of the adult common ravens in the California desert, for which we have evidence that they are preying or attempting to prey on desert tortoises. This action would be implemented in combination with reducing human subsidies to ravens. If successful, we would only implement Alternative B. If effectiveness monitoring indicates that our actions are not successful, we would implement the second phase. The second phase, Alternative C, would be to remove up to 5.3 percent of the adult common ravens in the California desert and including removal of ravens in the DTMAs in combination with reducing human subsidies to common ravens. If effectiveness monitoring indicates that our actions are not successful, we would implement the third phase. The third phase would be to remove up to 18.7 percent of the common ravens in the California desert and would include removal of ravens in the DTMAs and raven concentration areas in combination with reducing human subsidies to ravens. We would remove only the minimum number of common ravens; ravens would be removed until there is no evidence of predation on the desert tortoise based on effectiveness monitoring results. Phased implementation with monitoring and adaptive management is necessary to determine the lowest level of removal that is effective in reducing raven predation on the desert tortoise to meet our goals in combination with implementing cultural and mechanical methods to reduce human subsidies to common ravens.

The methodology for determining whether to move to a greater or lesser removal of the common raven (e.g., from Alternative B to C or from Alternative C to B) would be through analysis of 3 years of effectiveness monitoring data. If the data indicate less than a 75 percent reduction in predation by the common raven on the desert tortoise for each year, the next phase or alternative would be implemented. If the data indicate a 90 percent or more reduction in predation by the common raven on the desert tortoise for each year, the previous phase or alternative would be implemented. If the results are between these thresholds, we would continue implementing the current alternative.

3.5 Alternatives Considered and Dismissed

Alternatives identified in the following paragraphs were offered by the public during the public scoping session or were developed by the lead/cooperating agencies. They were researched and/or analyzed, but dismissed from further consideration in this document for the reasons provided as follows:

a. Establish a hunting season and/or bounty for permitted hunters–Common ravens are protected under the MBTA. The MBTA has two designations for listed birds, nongame (which includes the common raven) and game (hunted). The common raven is listed as a nongame migratory bird under the MBTA and California Fish and Game Code; there is no provision under MBTA for the general public to hunt nongame birds. To establish a hunting season for common ravens in California, ravens would need to be moved from the nonhunted list to the hunted list. To do this, the USFWS would propose new regulations to hunt common ravens. The process includes developing the proposed regulations, publishing them in the *Federal Register* and soliciting public comment, complying with NEPA, and then finalizing the regulations depending on information received during the comment period (Mike Green, USFWS, personal communication). Because of the time involved, the workload of the agency, the importance of this action when weighed with other actions, the likelihood of this alternative occurring is unlikely in the near future.

If the change in designation occurred at the federal level, ravens could not be hunted in California until the California Fish and Game Commission approved changes to the state regulations to allow hunting for sport (Mike McBride, CDFG, personal communication).

If the federal and state regulations were changed, establishing a hunting season for ravens would not necessarily achieve the goal of reducing predation of the common raven on the desert tortoise. Not all ravens prey on desert tortoises. A hunting season for ravens would not target the offending birds. Hunting would not occur throughout the desert. Hunting ravens or any other animal is generally not allowed within city limits or near a dwelling in unincorporated areas. This restriction and the ever-changing urban-wildland interface would make it difficult to hunt ravens in many locations in the California desert. Ravens that are actively hunted become more wary of humans and more difficult to hunt or manage. For these reasons, this alternative is not considered realistic or effective and is eliminated from further consideration.

b. Establish an Adopt-a-Raven Program. This alternative would require live-trapping common ravens, locating willing individuals or organizations to adopt and care for the birds and establishing a licensing program to track the placement and care of these birds. The MBTA and California Fish and Game regulations (California Fish and Game Code 3800 and Title 14, Section 671) prohibit the capture and possession of native nongame birds, including common ravens, except under special circumstances of research or education (Michael Green, personal communication; Hank Hodel, CDFG, personal communication). Under the MBTA, wild birds may be held for scientific and educational purposes. An adoption program for the common raven, a nongame bird, would not meet either of these two requirements. Generally, education permits are granted to persons who will use the birds for educational purposes. In these situations, birds are not removed from the wild. Rather, birds that cannot be rehabilitated to the wild are used for educational purposes. Permits under the MBTA are not granted for adoption purposes; there is no provision in the MBTA for that type of permit. For these reasons, this alternative is not considered realistic and will not be evaluated further.

c. Trap and Relocate Ravens–This alternative would require live-trapping common ravens, moving them to another location, and releasing them. Stiehl (1978) recommends that ravens be moved a minimum of 125 miles (200 km) to increase the success of the relocation. Both the USFWS's Office of Migratory Birds and CDFG would need to issue permits prior to trapping and relocating ravens. Concerns about transmitting diseases (e.g., WNV), moving the rising numbers of ravens throughout California, and transferring a predation problem from one location to another were concerns expressed by CDFG. For these reasons, they would not permit this alternative (e-mail dated August 15, 2006). Also, there is little information available that demonstrates that relocation would be successful, that is, that the relocated ravens would remain at their new location. Without approval from the regulatory agencies, this alternative is not possible. This alternative will no longer be considered.

d. Provide Another Food Source for Ravens–The current condition is that new food sources were provided for ravens by humans in the California desert. Common ravens freely eat from waste and garbage associated with human development, animals killed on roads, and water associated with human development. These human subsidies have contributed to increased survival of raven offspring and reduced mortality of adults, leading to the population increase. Continuing to sustain or increase the availability of food and water for ravens would only exacerbate the current predation problem on the desert tortoise, not reduce it. Because this alternative would likely result in increased numbers of ravens and increased predation on the desert tortoise, it would not help achieve the goal and is eliminated from consideration.

e. Implement Visual or Auditory Aversion for Ravens–Visual and auditory aversion usually consists of bright flashes of light, effigies, and loud noises. While visual and auditory aversion training has been used on ravens, its utility was limited to a few territorial birds preying upon a concentrated food source (i.e. least tern eggs in a tern nesting colony, Boarman and Heinrich 1999). Ravens frequently learn to disregard aversion methods such as "hazing" in a short period of time. Shooting to supplement harassment typically enhances the effectiveness of harassment techniques and can help prevent bird habituation to hazing methods (Kadlec 1968).

f. Conditioned Taste Aversion (CTA)–This aversion involves training animals to form an association between particular foods or prey item and a negative consequence. For CTA, this negative consequence is illness. Theoretically, after "teaching" the animal to avoid the food item using CTA, even food items that have not been treated with the aversion agent should be avoided.

This is a form of behavioral modification. The target prey or a close mimic of the target prey is laced with a substance that causes illness when consumed by a common raven. The raven learns that eating the prey or mimic will make it sick. This method has limited application and is unlikely to work given the scale of this project. Aversion training is recommended for use when only a few individuals are the target, a large amount of time can be invested, and the problem area is limited in geographic area. The California desert covers more than 25 million acres. Implementing an aversion program for ravens on this scale of landscape would be extremely expensive, time consuming, labor intensive, and annoying to people. Currently, there are no suitable products registered for CTA use. Using CTA with a carcass or likeness of a prey species may result in adverse effects to nontarget species. Nontarget species may be attracted to the carcass or likeness and consume the illness-causing substance. Problems associated with this method include: locating a suitable mimic for hatchling and juvenile desert tortoises; shielding nontarget individuals and other species from adverse effects; monitoring during the conditioning period; implementing the method on a region-wide or desert-wide area, and implementing a method that has little data to demonstrate its effectiveness and longevity. For these reasons, this method is eliminated from consideration.

g. Introduce a Predator for Ravens–Past wildlife management activities have shown that introducing nonnative predators to an ecosystem greatly upsets the balance of the system and usually leads to undesirable consequences, (i.e., mongoose in Hawaii). Executive Order 13112 directs federal agencies to prevent the introduction of invasive species. For those already present, it provides for their control to minimize the economic, ecological, and human-health impacts that invasive species cause, subject to availability of appropriations. Currently, there are few native predators of the common raven in the California desert. Eggs and nestlings are potential prey for other ravens and a few birds of prey. Adult ravens have no known predators. Because of the large-scale consequences of such actions; the time, expense, and permits required to test this nonnative predator alternative; the requirement to comply with Executive Order 13112 on invasive species; the NEPA compliance requirements; and monitoring requirement following implementation; this alternative was not considered reasonable and was eliminated from further consideration.

h. Implement a Birth Control or Chemical Sterilization Program–Birth control or chemical sterilization programs have shown some promise in some animal pest situations (i.e., Canada geese in urban area). Implementation of an effective birth control method for the common raven could reduce the raven population over time. However, its implementation is not possible at this time. There is no approved contraceptive for the common raven. Administering the proper dose of an approved contraceptive to a wild noncaptive animal would be difficult to do in a safe and effective manner. Underdosing would be ineffective. Overdosing may cause serious health issues for the individual animal. To ensure the contraceptive is administered properly, each adult raven would be trapped, the contraceptive administered seasonally or annually, and the bird marked to ensure that it does not receive multiple doses. If administered on a large scale, this method would eventually reduce the raven population over time. However, it would not remove any of the individual ravens who would continue to prey on juvenile desert tortoise. Since ravens can live 10 to 14 years, the ravens known to prey on juvenile desert tortoises would continue to adversely affect the survival of hatchling and young desert tortoises. We encourage the continued study and development of a contraceptive program, but at this time, it is not a viable option and will not be considered.

i. Allow Diseases (e.g., WNV and Newcastle's Disease) to Reduce the Raven Population–While WNV can have a 95-percent mortality on some corvid species, this level of mortality has not occurred in raven populations in the California desert. This absence of documented mortality in the raven populations in the California desert indicates that WNV will not likely have a large effect on these populations. West Nile Virus also adversely affects horses and humans. The equine community would likely be opposed to this approach as WNV can cause death (Trock et al. 2001). The Centers for Disease Control, State and County Vector Control, and health departments will not allow this disease to "run its course" in the wildlife population because the risk to human health is too great.

Newcastle's disease is cause by a paramyxovirus. An outbreak of the disease rarely occurs in the United States because of strict quarantine requirements for importing birds. Migratory and free-ranging wild birds appear to have little impact on spreading the disease. It is frequently fatal to poultry and is highly regulated by the USDA and other agencies (Wissman and Parsons 2004). Once detected, the USDA and California Department of Food and Agriculture impose strict quarantines on transporting poultry and other birds to and from the quarantine area. Thus, outbreaks of Newcastle's disease are rare and quickly eradicated.

Given the detrimental effects these diseases have on other species, this option is not considered a reliable or reasonable way to achieve the objectives.

j. Control/Reduce Human Population Control–Several citizens stated that the real problem for desert tortoise recruitment is not ravens, but rather humans and human activities and development. The proposed action contains elements to educate the public on the benefits of changing some of its activities that subsidize the common raven, but the lead and cooperating agencies for this document does not have regulatory authority over the expanding human population in the desert and the associated increased human development. It was agreed that reducing or slowing development in and adjacent to the desert would reduce adverse effects to the desert tortoise for several reasons. However, this is only one of a myriad of threats to the desert tortoise (Tracy et al. 2004). All of the alternatives carried forward have incorporated, in part, certain aspects of this alternative.

k. Modify all utility poles and towers to preclude raven perching or nesting–With respect to precluding perching on human-built poles and towers, this alternative was considered, but dismissed for the following reasons:

1) Perch availability does not likely limit raven population size; ravens do not rely on perch sites for hunting like some raptors;

(a) Eliminating human-made perch sites would adversely affect other avian species that use these perches for resting and hunting; and

(b) There are thousands of utility poles and towers in the California desert so modifying these structures would be expensive and take several years to complete.

2) With respect to precluding nesting, this alternative was considered and dismissed for the following reasons:

(a) Eliminating human-built nest sites would adversely affect other avian species that use these sites for nesting;

(b) There are thousands of utility poles and towers in the California desert so the modification would be expensive and take several years to complete;

(c) We would need the cooperation of the utility companies complete this task; and

(d) A study would need to be conducted to determine an effective design prior to successfully modifying the towers and poles.

4.0 ENVIRONMENTAL CONSEQUENCES INTRODUCTION

This section forms the scientific and analytic basis for the comparison of alternatives. It consolidates the discussions of the following elements:

a. The environmental impacts of the alternatives for the proposed action,

b. Any adverse environmental effects which cannot be avoided should the proposal be implemented,

c. The relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

d. Any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented.

Cumulative impacts are discussed for each alternative.

4.1 Significance Criteria (by Resource Area)

In the Council on Environmental Quality's regulations for implementing NEPA (Section 1508.27), "significantly," as used in NEPA, requires considerations of both context and intensity:

a. Context–This means that the significance of an action must be analyzed in several contexts such as society as a whole (human/national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant.

b. Intensity–This refers to the severity of impact.

Table 4-1 presents the significant criteria that were developed and used to evaluate the various potential impacts to each resource area for each alternative considered.

The impacts of the various alternatives are summarized in Table 4-2.

4.2 Alternative A–(Status Quo Alternative)

4.2.1 Impact on the Target Species (Common Raven) Population

The current program alternative should have negligible to minimal beneficial impacts to the common raven population in the short- and long-term. Although several agencies have implemented efforts to reduce human subsidies of food, water, and nest and roost sites for the common raven, these efforts are localized, small, and are unable to keep up with the increases in these subsidies from the growing human development in the California desert. Ongoing efforts to reduce human subsidies to the common raven have shown little change in raven population levels from the early 1990s to 2004 (Boarman and Kristan 2006). Currently there is no known effort to remove common ravens from the California desert (Craig Coolihan, USDA APHIS, personal communication).

Table 4-1. List of Significance Criteria to Determine the Threshold for Significance Regarding Various Potential Impacts for each Resource Area

Biological Resources and Ecosystems Vegetation and Wildlife	**Significance Criteria of the Proposed Action**
Listed, proposed plants and animals	Causes mortality, permanent habitat loss, or lowered reproductive success for individuals of state or federally listed threatened or endangered plant or animal species or plants or animals proposed for state or federal listing as threatened or endangered
Candidate species	Causes mortality, permanent habitat loss, or lowered reproductive success for major portions of candidate plant or animal species for state or federal listing or identified by California Native Plant Society (CNPS) as rare, threatened, or endangered in California
Fully protected species	Causes mortality, permanent habitat loss, or lowered reproductive success for wildlife species designated by the state of California as fully protected species
Plant and animal species	Reduces a plant or wildlife species to a level that meets the definition of threatened or endangered
Habitat loss, degradation, biodiversity	Diminishes habitat for fish, wildlife, or plants by the loss of a greater than 10 percent of the available habitat or number of individuals of any plant or animal species (sensitive or nonsensitive species) that could affect the abundance of a species or the biological diversity of an ecosystem beyond normal variability
Activity patterns for listed and candidate species and species of special concern	Causes long-term or permanent disturbance or displacement by human activities of substantial portions of local populations of state or federally listed, proposed, or candidate plant or animal species, or species of special concern including areas used as movement corridors or areas that provide connectivity among populations
Sensitive, unique habitats	Causes the measurable degradation or loss of sensitive or unique habitats
Socioeconomics	**Significance Criteria**
	Places a change of greater than 10 percent of current demand on the services in local communities in the project area
	Causes the population to exceed historic growth rates or substantially affects the local housing market and vacancy rates.
	Causes a substantial increase in out-of-pocket expenses by local communities or individuals
	Decreases or increases the baseline of local employment levels by more than 10 percent or alters substantially the location and distribution of the population within the geographic region of influence
	Prevents continuation of existing authorized off-highway vehicle recreation use
	Prevents continuation of the existing hunting and fishing programs
	Increases or decreases by more than 10 percent the availability of any other recreation resource which results in demand for the remaining facilities to exceed their capacity
Human Health and Safety	**Significance Criteria**
	Exposes people to potential health hazards
	Is inconsistent with existing health and safety regulations

Table 4-2. Comparison of the Environmental Impacts of Each Alternative with Resource Issues

Description	Alternative A (Status Quo)	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Raven Populations	**Minimal Beneficial**, Raven populations would be expected to expand and follow human development in the California desert	**Negligible Adverse**, Raven populations would be decreased by less than 0.5 percent of the existing raven population in the California desert	**Minimal Adverse**, Raven populations would be decreased by about 5 percent in selected areas of the California desert, however, raven populations would still be well above the historic levels for these areas, and be considered viable and self sustaining	**Minor Adverse**, Raven populations would be decreased by about 19 percent across the California desert; however, raven populations would still be well above the historic levels for these areas, and be considered viable and self sustaining	**Negligible Adverse**, Raven populations would be expected to grow or remain steady initially, then decrease slowly in the California desert because only cultural and physical means to manage ravens would be used	**Negligible Adverse to Minor Adverse,** Raven populations would decrease between 0.5 and 19 percent across the California desert; however, increases from ongoing population growth would reduce this rate of decrease; raven population would remain well above historic levels and be considered viable
Desert Tortoise Populations	**Moderate Adverse**, Hundreds of juvenile desert tortoises would continue to be killed by ravens each year and this number would be expected to increase	**Moderate Beneficial**, Numerous Additional hatchling and juvenile desert tortoises would have the opportunity to reach adulthood, increase the size of the population and reproduce	**Moderate Beneficial**, Numerous additional juvenile desert tortoises would have the opportunity to reach adulthood, increase the size of the population, and reproduce	**Moderate Beneficial**, Numerous additional juvenile desert tortoises would have the opportunity to reach adulthood, increase the size of the population, and reproduce	**Minimal Beneficial**, Slowly more juvenile desert tortoises would have the opportunity to reach adulthood, increase the size of the population, and reproduce	**Moderate Beneficial**, Numerous additional juvenile desert tortoises would have the opportunity to reach adulthood, increase the size of the population, and reproduce
Other Wildlife	**Moderate Adverse**, Slow continued predation pressure from a growing raven population, competition for other resources (space and water)	**Minor to Moderate Beneficial**, Populations of prey species for ravens would likely increase with the reduction of predation by the common raven	**Minor to Moderate Beneficial**, Populations of prey species for ravens would likely increase with the reduction in the numbers of predatory ravens	**Minor to Moderate Beneficial**, Population of prey species used by ravens would likely increase with the reduction in the numbers of predatory ravens	**Minimal Beneficial**, Slowly Populations of prey species used by ravens would likely increase with the reduction of predation by the common raven	**Minor to Moderate Beneficial**, Population of prey species used by ravens would likely increase with the reduction in the numbers of predatory ravens
Socioeconomics	**No Change or Non**e, No additional funds would be brought to the area, no change in life style lifestyle in the area	**Negligible Beneficial,** $200K effort, limited to 4 months per year	**Negligible Beneficial,** $400K effort, ravens could be killed anytime	**Negligible Beneficial,** $550K effort, ravens could be killed anytime	**No Change to Negligible Beneficial**, Reduction in food and water subsidies results in reduced water costs	**Negligible Beneficial,** $550K effort, ravens could be killed anytime
Human Health and Safety	**Negligible Beneficial**, Reduction in some unauthorized dumps would reduce possible spread of disease, etc.	**Negligible Adverse and Beneficial**, limited use of fire arms and avicide bait, however, these methods would be conducted by trained professionals and follow all safety regulations; better trash containment and reduction of unauthorized dumps would reduce the possible spread of disease, etc.	**Negligible Adverse and Beneficial**, limited use of fire arms and avicide bait, however, these methods would be conducted by trained professionals and follow all safety regulations; better trash containment and reduction of unauthorized dumps would reduce the possible spread of disease, etc.	**Negligible Adverse and Beneficial**, limited use of fire arms and avicide bait; however, these methods would be conducted by trained professionals and follow all safety regulations; better trash containment and reduction of unauthorized dumps would reduce the possible spread of disease	**None to Negligible Beneficial**, Better trash containment and reduction of unauthorized dumps would reduce the possible spread of disease	**Negligible Adverse and Beneficial**, limited use of fire arms and avicide bait; however, these methods would be conducted by trained professionals and follow all safety regulations; better trash containment and reduction of unauthorized dumps would reduce the possible spread of disease

Table 4-2. Comparison of the Environmental Impacts of Each Alternative with Resource Issues (Concluded)

	Alternative A (Status Quo)	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Recreation	**Negligible Adverse and Beneficial,** Some recreational opportunities may be restricted during illegal dumpsite cleanup; opportunities to view a variety of wildlife species would increase	**Negligible Adverse and Beneficial**, Some recreational opportunities may be restricted on a site specific basis for a short period of time; opportunities to view a variety of wildlife species would increase	**Negligible Adverse and Beneficial**, Some recreational opportunities may be restricted on a site specific basis for a short period of time; opportunities to view a variety of wildlife species would increase	**Negligible Adverse and Beneficial**, Some recreational opportunities may be restricted on a site specific basis for a short period of time; opportunities to view a variety of wildlife species would increase	**Negligible Adverse and Beneficial,** Some recreational opportunities may be restricted during illegal dumpsite cleanup; opportunities to view a variety of wildlife species would increase	**Negligible Adverse and Beneficial**, Some recreational opportunities may be restricted on a site specific basis for a short period of time; opportunities to view a variety of wildlife species would increase

Notes:
1. No Change or None–There are no impacts expected.
2. Negligible–The impacts are very small and possible, but not probable or likely to occur.
3. Minimal–The impacts are not expected to be measurable and are within the capacity of the impacted system to absorb the change, or the impacts can be compensated for with little effort and resources so the impact is not substantial.
4. Minor–The impacts are measurable, but are within the capacity of the impacted system to absorb the change, or the impacts can be compensated with limited effort and resources so the impact is not substantial.
5. Moderate–Potentially adverse impacts that are measurable but do not violate any laws or regulations and are within the capacity of the impacted system to absorb or can be mitigated with effort and/or resources so that they are not significant.
6. Major–Potentially adverse impacts that individually or cumulatively could be significant.

4.2.2 Impact on Nontarget Species

4.2.2.1 Desert Tortoise

The current program alternative would not achieve the purpose of and need for the action. Under this alternative, the impact to desert tortoises would be moderate and adverse for the short- and long-term. Current efforts to reduce human subsidies to the common raven have been localized and scattered. They have shown little change in raven population levels and no increase in the percent of juvenile and hatchling desert tortoises in the California desert. Under this alternative, we expect raven predation to continue to remove hatchling and juvenile desert tortoises at the same or increasing levels because of the current and projected increased human development in the California desert. Recruitment of hatchling and juvenile desert tortoises to the adult population would be minimal to nonexistent in some populations.

4.2.2.2 Other Nontarget Species

The impacts to the Mohave ground squirrel and other native wildlife species (excluding the desert tortoise) that are prey for the common raven would be moderately negative for the short- and long-term. Recent limited efforts to reduce human subsidies of food, water, and nesting/perching sites have shown little change in the population level of the common raven. Common ravens are efficient hunters and scavengers. They prey on birds (eggs, nestlings, and adults), snakes, lizards, rodents, and lagomorphs (rabbits and hares). Under this alternative, we expect raven predation to continue at a similar or increased level on these species.

Under the current program alternative, there are no methods used that directly affect common ravens (e.g., trapping and shooting). The only methods currently implemented are limited actions in the local areas to reduce human subsidies, primarily food and water. Wildlife species that use these human-subsidized food and water sources would be adversely affected by this alternative. The primary species that would be adversely affected would be the coyote (*Canis latrans*). As a scavenger of road kill and garbage, the human-subsidized food source for the coyote would be reduced.

4.2.3 Impact on Socioeconomic Issues

Current efforts to reduce human subsidies, such as food and water, to the common raven have resulted in no changes to human lifestyle or addition of funding or cost to the area. The cleanup of illegal dumps, which has been limited in number and location, would result in no effect on the lifestyle of the human population in the California desert. Efforts to reduce standing water on some federal lands should result in no effect to human lifestyle.

4.2.4 Impact on Recreation

Under the current program, no activities would be conducted in desert tortoise habitat with the exception of cleanup of illegal dumps. These sites are usually small and located near communities. The cleanup activities may deter from the recreation experience in the immediate area for a short time, but the long-term benefits of making the area safe, free of garbage and debris, and restoring the area would greatly outweigh the short-term localized adverse effects of cleanup activities on the recreation experience. This alternative would have negligible adverse impacts to recreation during cleanup and negligible beneficial impacts afterward.

4.2.5 Impact on Human Health and Safety

Measures that would be implemented include removal of illegal dumps and eliminating standing water on some federal lands. Illegal dumps may contain hazardous substances or harbor diseases. Since they are usually easily accessible, the public is at risk of exposure to these hazards. They also contain debris, which can cause injury or death to anyone inspecting or playing at a dumpsite. Some of the measures would provide limited improvement to human health and safety, as their locations are limited in number and size.

Standing water in a warm environment is a breeding habitat for mosquitoes that carry diseases. Encouraging agencies to manage their outside watering to eliminate standing water, which subsidizes the common raven, would also reduce the likelihood of mosquitoes breeding and carrying diseases (WNV). Implementation of this alternative would have a negligible beneficial impact on human health and safety.

4.2.6 Effectiveness/Conclusion

Based on the description of the Need for Action, the current program is not providing an acceptable level of reduced mortality and increased recruitment for the desert tortoise. This alternative would not meet the purpose and objectives of the proposed action. The current program alternative is not expected to be as effective as the other alternatives. It would not allow for the lethal removal of common ravens known to prey on hatchling and juvenile desert tortoises, and it would not implement a large-scale "cultural and physical" program by federal, state, and local agencies and the public. Elevated levels of predation by the common raven on the desert tortoise would continue. There would be no immediate relief to allow desert tortoise populations to begin the 15- to 20-year process of recruiting hatchling and juvenile desert tortoises into the adult population. Without implementation of a large-scale outreach program and "cultural and physical" program by agencies and the public to reduce human subsidies to the common raven, raven predation would continue to remove hatchling and juvenile desert tortoises at a rate similar to or greater than the current rate. The desert tortoise population in the California desert, especially in the Western Mojave Recovery Unit, would continue to decline. If this rate of decline continues, it could result in a decline in status of the desert tortoise in California to that of endangered and a decline toward extinction for the west Mojave population.

4.3 Alternative B–Integrated Predator Management with Limited Removal of Ravens

4.3.1 Impact on the Target Species (Common Raven) Population

In analyzing the impact of this removal action on the common raven population, we used the following process. Under this alternative, we would expect to remove approximately 100 pairs of ravens and their nests and approximately 4 ravens from each of the desert tortoise head starting facilities per year. The population estimate for the common raven in the California desert is about 37,500 birds. Removing about 200 common ravens per year would mean removing about 0.5 percent of the raven population. Because predation on the desert tortoise by common ravens is a learned behavior, not all common ravens prey on desert tortoises.

Removing 100 pairs of ravens and 7 eggs (maximum clutch size) per year, per nest, would mean removing 2.4 percent of the raven population in the California desert. This is a worst-case scenario, as not all nests would have seven eggs, not all eggs would be viable, not all viable eggs would hatch, and not all nestlings would survive to fledge and eventually reproduce. A demographic model of the Mojave raven populations indicated that this level of removal would have no impact on raven population viability because more than 99 percent of the population would remain after implementation (Boarman and Kristan 2005).

Direct impacts to the selective removal of only those ravens with evidence of predation or attempted predation on hatchling and juvenile desert tortoises using trapping, shooting, or the use of toxicants would have negligible adverse impacts to the raven population in the California desert. Raven population numbers would be at historically high levels after selective removal and well above that of the population in the early and mid-twentieth century (Appendix A, Section 2.0). The number of birds removed would depend on several variables: effectiveness of cultural and physical methods to reduce raven predation on the desert tortoise, number of ravens identified as preying on desert tortoises that would be removed, availability of staff, and funding. Trapping, shooting, and use of an avicide would be limited to those locations where nesting ravens were documented as preying on hatchling and juvenile desert tortoises. Given the large numbers of common ravens in the California desert, a new breeding pair would likely take the place of the removed pair. Not all ravens prey on desert tortoises (See Section 1.1.2, and Appendix A, Section 2.7 of the EA).

We anticipate that the removal of 100 pairs of common ravens annually would result in an increase in the raven population in the California desert. Between 1966 and 1999, ravens in the Mojave Desert had an annual population increase of 5.4 percent and 7.1 percent in the Colorado Desert (Liebezeit et al. 2002).

There is the possibility that ravens that do not prey on desert tortoises may be removed. This possibility should be minimal. We would use information on the behavior and biology of the common raven, including the following, to tailor a method to identify and remove common ravens preying or attempting to prey on desert tortoises. Implementing this process should ensure that the appropriate ravens are targeted for removal. Nesting common ravens actively defend their nest territory from other large birds including other ravens, usually to a distance of 2 miles from the nest. The time when tortoise-preying ravens would be identified is during or immediately following the breeding season when they are actively defending their territories. This means that other ravens would not likely enter and remain in these territories. In addition, this process would include identifying desert tortoise remains with evidence of raven predation within ¼ mile of a raven nest. If desert tortoise remains with characteristic signs of raven predation are found within a territory, the conclusion would be that the ravens defending that territory were the ravens responsible for the desert tortoise mortality.

At the desert tortoise head start facilities, only those common ravens that attempt to enter the facilities that hold hatchling and juvenile desert tortoises, and thereby prey on desert tortoises, would be removed.

Indirect impacts would include the implementation of cultural and physical methods. These methods include reducing human subsidies of food, water, and nest and roost sites for the common raven, and removing unoccupied raven nests. The number of unoccupied raven nests that would remove annually is unpredictable at this time. However, we would limit our actions to removing 1,500 unoccupied nests or less per year. This estimate is considered high and is derived from the sampling effort of McIntyre et al. (2006). Its implementation is contingent upon funding and/or availability of staff. The impacts of removing nests on the common raven would not result in the death of ravens or their eggs or nestlings; however, it may increase the expenditure of energy by a raven pair to construct a new nest.

Indirect impacts would include the removal of common raven nests and the reduction in the availability of food, water, and nest and roost sites for the common raven throughout the California desert. As mentioned above, removal of up to 1,500 unoccupied nests would likely increase the amount of energy that a pair of common ravens would use to construct a new nest. It may also result in fewer successful nests and reduced recruitment. Reduction of human-subsidized food, water, and nest and roost sites would likely result in the California desert not being able to support the same high number of common ravens that currently occur in the area.

The level of potential impact from this alternative to common ravens does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.3.2 Impact on Nontarget Species

4.3.2.1 Desert Tortoise

Actions to remove common ravens that prey on desert tortoises should have a moderate beneficial impact on desert tortoise populations in those areas. For declining populations of long-lived animal species, such as the desert tortoise in much of California, annual mortality of juvenile tortoises should not exceed 5 percent to ensure recruitment of new individuals into the breeding population and to help return the population to stable numbers (Congdon et al. 1993). Since nesting common ravens have a greater need for calories and protein in the spring and their hunting territory is limited in size during the nesting season and intensively searched, one pair of common ravens can prey on numerous hatchling and juvenile desert tortoises in a year. McIntyre et al. (2006) determined through recent surveys that 27 and 28 nests, in 2 survey years, had evidence of desert tortoise predation beneath them. While the surveys did not cover the entire California desert, they did represent a sample of the California desert. When applying this rate to the California desert, we estimate that approximately 100 pairs of breeding common ravens annually are responsible for most of the predation on hatchling and juvenile desert tortoises during the breeding season. The removal of these ravens annually should result in an immediate response of hundreds of hatchling and juvenile desert tortoises now having a higher probability of survival, reaching adult size, and reproducing. They would be able to help slow and reverse the dramatic population declines in the west Mojave Desert and contribute to the long-term survival and recovery of the desert tortoise. Implementing actions that would have an immediate and beneficial impact is essential as the population of the desert tortoise has continued to decline.

The increased efforts to reduce human subsidies of food, water, and nest and roost sites for the common raven would eventually indirectly benefit desert tortoise populations, as these methods would require time to implement and to affect the common raven population. Over time, the number of common ravens that prey on hatchling and juvenile desert tortoises would be reduced. The population size for the common raven would decline over time in the California desert. Once the reduction of human subsidies is fully implemented throughout the California desert, the number of hatchling and juvenile desert tortoises that survive to reproductive adult size should increase. We estimate that achieving full implementation would take a minimum of 10 years.

Reducing the availability of human-subsidized food, water, and nest and roost sites for the common raven, would not likely place more predation pressure on the desert tortoise. Historically, common ravens were neither abundant nor resident birds in the California desert as they are today. For ravens to continue as abundant resident birds, all of their life needs (e.g., food, water, shelter, and reproduction needs) must be available and not be difficult to obtain. Reducing one of these life needs means that the common raven must expend additional energy to find new supplies of this life need. Reducing more than one life need compounds the energy expended. The more energy expended, the less likely common ravens would remain at their current location. Moving to a new location may expend less energy than searching for a new food source at the current location, thus common ravens would leave those areas of the California desert that did not provide them with their life needs, based on energy expenditure. For example, reducing or eliminating human-subsidized food sources (e.g., landfills, illegal dumps, open trash cans and dumpsters, and road kill) would force ravens to expend additional energy to hunt for food.

The removal of unoccupied common raven nests would indirectly benefit the desert tortoise. During the breeding season, the number of successful raven nests would be reduced. Some of these ravens would be those that prey on hatchling and juvenile desert tortoises. With no offspring, the adult ravens would not be able to teach their young how to prey on desert tortoises. The increased demand for food to support adult female ravens with developing eggs and hatchling ravens in the spring would be eliminated, but the demand for food to maintain the existing raven population would continue. This reduced demand for food in the spring for common ravens coupled with normal population mortality, would likely mean decreased predation pressure by ravens on desert tortoises during the tortoise's primary activity period. The benefits of decreased predation by the common raven on the desert tortoise population from nest removal, would likely take time before producing measurable results. Reduced predation pressure would eventually result in a greater percentage of hatchling and juvenile desert tortoises recruited to the adult population, thus contributing to recovery.

There is one indirect impact of this alternative that is a potential negative impact to the desert tortoise; it is negligible but possible. Desert tortoises may be injured or killed by vehicles carrying project employees. This possibility would be mitigated by following posted speed limits, driving less than 25 mph on dirt roads, and educating field staff on desert tortoise awareness.

4.3.2.2 Other Wildlife Species

This alternative would have several indirect impacts to other wildlife species and would be similar to impacts to the desert tortoise. Most impacts would be minor to moderate and beneficial. Removing approximately 100 pairs of common ravens annually that prey on other species of wildlife such as small birds, bird eggs, nestlings, lizards, snakes, small mammals and invertebrates would mean that these animals would have a greater likelihood of surviving, reproducing, and contributing to the long-term survival of their respective species.

Methods to reduce human subsidies of food, water, and nest and roost sites are expected to reduce common raven numbers in the long-term; thereby, reducing predation by the raven on other wildlife species in the California desert. Because this alternative focuses on removing common ravens that prey on desert tortoises, it would likely have a beneficial effect on other prey species of the common raven including lizards, snakes, diurnal rodents (including the state threatened Mohave ground squirrel), birds, eggs, and nestlings. The benefits previously described for the desert tortoise should also apply for wildlife species that are prey for the common raven. Removing common raven nests may benefit raptor species, as more undefended locations with nest sites would become available in the California desert.

Reduction of human-subsidized water sources may also reduce water subsidies for other wildlife species such as coyotes, native and nonnative rodents, and some species of native and nonnative birds. The majority of nontarget desert wildlife species are not dependent on human-subsidized sources of water. The locations of most native wildlife are not near human-subsidized water sources. This distance precludes use by native wildlife. This impact would be minimal and adverse.

The removal of unoccupied common raven nests would indirectly benefit other species of wildlife. During the breeding season, the number of successful raven nests would be reduced. All of these ravens would at some time prey on other species of small wildlife. The increased demand for food to support adult female ravens with developing eggs and hatchling ravens in the spring would be eliminated, but the demand for food to maintain the existing raven population would continue. This reduced demand for food in the spring for common ravens coupled with normal population mortality over time would likely mean decreased predation pressure by common ravens on other wildlife species. For many desert wildlife species, spring is their primary activity period. The benefits of decreased predation by the common raven on other wildlife species from nest removal would likely take time before producing measurable results. Reduced predation pressure would eventually result in a greater percentage of young individuals recruited to the adult population, thus contributing to long-term viability.

One potential indirect and adverse impact to other wildlife species is implementation of the removal methods for the common raven (shoot, trap and euthanize, and use of an avian toxicant). However, their implementation should have little probability of removing species other than common ravens as their design and implementation would minimize this possibility. Shooting requires seeing the target animal before discharging the firearm. Common ravens are large birds and easily distinguished from other desert avian species. The location of the avian toxicant would be aboveground where ground or climbing animals would not have access. The selection of eggs as bait would minimize herbivorous and carnivorous species of birds from being attracted to and consuming the bait. The eggs would be “tied down” so common ravens could not cache the bait where it might be found and consumed by other animal species. The avian toxicant (DRC-1339) is not lethal to most birds that might be attracted to the hard-boiled eggs. Most species of birds are nonsensitive to DRC-1339. However, the use of the avian toxicant could accidentally cause illness in other avian egg-eating species such as golden eagles and roadrunners. The possibility of trapping or poisoning nontarget species would be unlikely.

Traps and bait sites would be monitored and modified, if necessary, to ensure that nontarget species do not take the bait. The toxicant is metabolized quickly and would not be lethal to other species that might scavenge raven carcasses (Cunningham et al. 1979).

Another indirect negative impact that is possible, but not likely to occur is injury or death from vehicles carrying project employees. This possibility would be mitigated by following posted speed limits, driving less than 25 mph on dirt roads, and educating field staff on awareness of wildlife species.

The level of potential impact from this alternative to the nontarget species does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.3.3 Impact on Socioeconomic Issues

The indirect impacts to socioeconomics include funding for raven removal, implementation of raven removal, and cooperative efforts among local agencies and others to provide better management of human-subsidized resources. The expenditure of funds to implement removal of common ravens (shooting, trapping and euthanasia, and use of an avian toxicant) that prey or attempt to prey on desert tortoises would provide beneficial impacts to socioeconomic issues. We estimate that implementation of these removal actions would cost about $200,000 per year and would occur during a 4-month period per year. The impact of spending this amount to the economy of the California desert would be beneficial and negligible.

Additional indirect impacts include implementation of the three methods to remove common ravens on nearby human populations. These impacts would be localized. Often these activities would not occur near communities. If they do, their effects would be limited in duration and isolated, and should have minimal impacts on human lifestyle. Shooting would occur during daylight hours, and its occurrence would be minimal with respect to frequency and duration. All laws and regulations regarding discharge of firearms would be strictly followed. Trapping and use of an avian toxicant are not likely to affect the residents of local desert communities directly; these activities would occur in the desert, not within communities or settlements. Trained professionals from APHIS-WS would implement these removal methods.

Part of the proposed action is to work with cities, and encourage counties and the public to implement existing ordinances or develop processes that manage the disposal and storage of solid waste, conserve water, and minimize opportunities for human-created nesting and roost sites (e.g., communication towers, power-line towers, and shade structures) to reduce human subsidies of the common raven. Implementation of these programs would likely indirectly impact human values and lifestyles. The public would be informed about what they can do to help recover the desert tortoise, conserve limited resources such as water, and enjoy and appreciate the associated social and economic benefits of these conservation and management actions (e.g., water conservation, reduced water bills, and reduction in occurrence and cleanup of illegal dumps). They would be encouraged to implement these actions. We anticipate that, over the long-term, there would be changes in human behavior and consequently their actions would result in effective management of solid waste, hazardous materials, water, and vertical structures that would reduce the raven population and benefit the human population. The impacts to socioeconomics of the area, from implementation of Alternative B, would be negligible and beneficial.

The level of potential impact from this alternative to socioeconomics does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.3.4 Impact on Recreation

As stated under the current program alternative, much of the California desert is open to the public for various forms of recreational use. This includes hunting and off-highway vehicle use. Closed areas include private lands and military bases. There are restrictions on methods of access to some of the public use areas (e.g., wilderness). Numerous opportunities exist for various forms of recreation on lands managed by the BLM and NPS.

The implementation of common raven removal would indirectly impact recreation. At removal locations for the common raven, small, localized areas may be unavailable for humans to enter. For example, if APHIS-WS determines that shooting is the best means to remove a predatory raven at a particular location, the area may be closed to human access for part of the day to ensure that no one is accidentally injured of killed. The APHIS-WS would consider any public activity patterns at those areas as part of the decision process to select the method and time to remove identified common ravens. This temporary closure of a localized area would not allow the public to recreate in that area at that time. Most public use for recreation occurs on weekends and holidays. This time period would be avoided. However, the frequency and duration of a closure at a particular location, given the total area available in the California desert for recreation, would be negligible. The USFWS and APHIS-WS would consult with the BLM, NPS, California Department of Parks and Recreation, and the CDFG to minimize adverse impacts on scheduled activities, where appropriate. Effective implementation of this alternative over time would result in greater opportunities for the recreating public to view a desert tortoise and other wildlife species in their natural habitat. The impacts would be negligible and adverse initially and negligible and beneficial over time.

The level of potential impact from this alternative to recreation does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.3.5 Impact on Human Health and Safety

The implementation of this alternative would result in indirect impacts to human health and safety. Measures to avoid adverse impacts to human health and safety are included in the proposed action through use of the *Wildlife Services Decision Model* (Slate et al. 1992). Standard operating procedures used to reduce the risk to human health and safety is listed in Section 3.2.3 of the Wildlife Services Environmental Impact Statement (EIS). Many of the procedures intended to minimize impacts on recreation would also minimize or eliminate risks to human health and safety. For example, if shooting is selected as the method to remove identified ravens, the area would be closed to human access to prevent accidental injury or mortality. If use of an avicide is selected, methods would be implemented that would avoid or minimize risk to humans. For example, the bait station may be designed so it is not readily accessible by people, the area may be posted with warning signs, and the bait station may be monitored when in use.

A formal human risk assessment of currently available APHIS-WS methods, including those proposed for use in the EA, concluded low risks to humans (USDA 1997, revised, Appendix P).

The human risk assessment evaluated potential impacts on APHIS-WS employees and the public. Although some of the materials and methods available for reducing predation by the common raven on the desert tortoise have the potential to present a threat to human health and safety if used improperly, problems associated with their misuse have rarely occurred, and the greatest risk is to the user. Professionals trained in the safe and effective use of each method would conduct the damage management practices. Although this could reduce effectiveness, human safety is the highest priority for all of the agencies concerned. This adverse impact to human health and safety from raven removal is expected to be negligible to none.

There should be indirect beneficial impacts to human health and safety from the reduction in human subsidies of food and water. The cleanup of illegal dumps and better management of permitted landfills and transfer stations would remove garbage and hazardous waste from unsecured locations and ensure that it is properly contained and managed. These actions would reduce the spread of disease and groundwater contamination. Reduction in standing water would reduce the number of breeding sites for mosquitoes, which may carry disease that could infect humans. This beneficial impact to human health and safety would be negligible.

The level of potential impact from this alternative to human health and safety does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.3.6 Effectiveness/Conclusion

The effectiveness of the program can be defined in terms of the increase in the number of hatchling and juvenile desert tortoises in the population and the numbers recruited into the adult population over time. Effectiveness can also be determined by the reduction in the number of common raven nest sites, with evidence of desert tortoise shell remains near them. With respect to removal of common ravens, the wildlife specialist must be able to complete wildlife damage management expeditiously, while minimizing harm to nontarget species and the environment and risks to human health and safety. The wildlife specialist must comply with all regulations on the use of each method, and use methods as humane as possible within the limits of current technology. The U.S. Government Accounting Office (1990) concluded that APHIS-WS was effective overall in preventing and reducing wildlife damage while not significantly impacting nontarget predator populations, the environment, or the public. Many of the details on effectiveness were discussed in the Final EIS on the national APHIS-WS program (USDA 1997, revised) where integrated wildlife damage management was concluded to be the most effective.

Based on the description of the "Purpose and Need," the combined efforts to remove common ravens and implement a "cultural and physical" based program would meet the purpose and objectives of the proposed action. Data were used from McIntyre et al. (2006) on the number of nests or raven pairs preying on desert tortoises annually, for those portions of the California desert that were surveyed. In addition, information was applied on the reproductive needs and behavior of the common raven. The result was that approximately 27 nests or pairs of common ravens would have desert tortoise remains under their nests in a year. From these data, the number of nests or pairs of ravens throughout the California desert that likely prey on juvenile and hatchling desert tortoises, or 100 nests or pairs of common ravens were extrapolated. Therefore, if 100 pairs of common ravens that prey on the desert tortoise were removed, this action would eliminate most of the predation on juvenile and hatchling desert tortoises by breeding common ravens in the California desert. The removal of common ravens should yield both immediate relief to hatchling and juvenile desert tortoises from common raven predation and allow desert tortoise populations to begin the 15- to 20-year process of recruiting hatchling and juvenile desert tortoises into the population. This immediate relief is especially critical for the west Mojave population of the desert tortoise, where populations continue to decline with little to no evidence of juvenile of hatchling animals in the population. This alternative would remove only those common ravens with evidence of predation or attempted predation on desert tortoises; the other ravens in the population would not be removed.

The implementation of the "cultural and physical" based program would provide for long-term reduction of common ravens in the California desert. This reduction would help bring the population numbers of this top predator in balance with the populations of other desert animals. As the common raven population and associated predation pressure on the desert tortoise declines, the level of common raven removal would also decline. Even with the proposed reductions, the population numbers for the common raven would remain above historic levels in the California desert and would not affect the sustainability of the population in the California desert.

4.4 Alternative C–Integrated Predator Management and Removal of Ravens within Desert Tortoise Management Areas

4.4.1 Impact on the Target Species (Common Raven) Population

The direct impacts of this alternative would be greater than that of Alternative B, but still have only minimal adverse impacts to the common raven population in the short- and long-term. The impacts would be greater as approximately 2,000 common ravens or 5.3 percent of the California desert population of ravens would be removed annually at the DTMAs. The number of common ravens removed would depend on several variables: effectiveness of methods to reduce human subsidies of food, water, and nest and roost sites to the common raven, availability of staff, and funding. The wildlife specialist would determine which removal strategy or strategies would be most effective for the removal of the common raven from these areas.

While the number of common ravens removed from trapping, shooting and using an avian toxicant would likely result initially in decreased raven densities within each of the DTMAs, it would not remove ravens from other areas of the California desert such as private lands, state lands outside of DTMAs, many wilderness areas, and some BLM and NPS lands. Common raven population numbers would remain well above the historic levels of ravens for the California desert. We do not anticipate this removal to adversely affect the short- or long-term survivability and sustainability of the common raven or to reduce raven population numbers significantly throughout the desert region of California. Movement of common ravens from adjacent populations into the California desert would still occur.

This alternative would remove up to 2,000 common ravens annually from the DTMAs. Recent data (McIntyre 2006) show that about 5 percent of the common raven nests surveyed in portions of the California desert had evidence of desert tortoise predation under the nests. We anticipate that the removal of 2,000 common ravens annually would result in an increase in the raven population in the California desert. Between 1966 and 1999, ravens in the Mohave Desert had an annual population increase of 5.4 percent and 7.1 percent in the Colorado Desert (Liebezeit et al. 2002).

The indirect impacts from implementation of the actions to reduce human subsidies of food, water, nest sites, and roost sites and remove unoccupied raven nests would be similar to those of Alternative B.

The level of potential impact from this alternative to common ravens does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.4.2 Impact on Nontarget Species

4.4.2.1 Desert Tortoise

The indirect impacts from implementing Alternative C to the desert tortoise would be similar to that of Alternative B, moderate and beneficial. The increased number of common ravens removed from DTMAs would likely lead to an immediate beneficial effect in these locations by reducing all ravens that prey in these essential DTMAs. The reduction of ravens preying on desert tortoises in the DTMAs would allow hatchling and juvenile desert tortoises in these areas to survive, thus increasing the desert tortoise population. It would also allow more desert tortoises to reach adulthood and reproduce, thus contributing to the recovery of the species.

The other part of the alternative, to reduce human subsidies of food, water, nest and roosting sites for the common raven, and to remove unoccupied nests of common ravens would have the same indirect impacts as that in Alternative B. The reduction in human subsidies would eventually reduce common raven population numbers and raven predation on desert tortoises throughout the California desert, thereby increasing desert tortoise population numbers.

Another indirect impact is that desert tortoises may be injured or killed by vehicles carrying project employees. This impact would be similar to that described in Alternative B although the number of employees and vehicle trips would likely be greater. Although we estimate up to a 50 percent increase in number of miles traveled, we consider this risk negligible because of the mitigation measures. The likelihood of this adverse impact occurring is negligible; therefore, the impact is negligible.

4.4.2.2 Other Wildlife Species

This alternative would have similar indirect impacts to other wildlife species as Alternative B. Wildlife species that are prey for the common raven and located within the DTMAs. would experience minor to moderate beneficial impacts with the reduction in numbers of common ravens that prey on these wildlife species. The impacts from implementation of Alternative C for raven removal, reduction of human subsidies, and removal of unoccupied common raven nests would be similar to that of Alternative B although the geographic extent of this impact would be greater.

The level of potential impact from this alternative to nontarget species does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.4.3 Impact on Socioeconomic Issues

The indirect impacts to socioeconomic issues from raven removal and reduction in human subsidies would be similar to those of Alternative B. The efforts to remove (shoot, trap and euthanize, and use an avian toxicant) ravens would cover the DTMAs ,which are large blocks of area located throughout much of the California desert, rather than being scattered throughout. Occasionally these activities would occur near communities. If they do, their effects would be limited in duration. For example, shooting would occur during daylight hours, and its occurrence would be minimal with respect to frequency and duration. All laws and regulations regarding discharge of firearms would be strictly followed including discharge of firearms near dwellings. Trapping and use of an avian toxicant are not likely to affect the residents of local desert communities; these activities would occur in the desert, not within communities or settlements. Implementation of these actions would result in negligible adverse impacts to socioeconomic issues.

Implementation of actions to remove common ravens would likely cost $400,000 per year and could occur at any time during the year. Qualified professionals from APHIS-WS would implement these removal methods. The impact of spending this amount in the economy of the California desert would be negligible and beneficial.

Part of Alternative C is to encourage and work with local cities, counties, and the public to implement existing ordinances and/or develop basic processes that manage the disposal and storage of solid waste, conserve water, and modify structures to reduce human subsidies of food, water, nest and roost sites for the common raven. Implementation of these programs would likely result in minimal changes in human lifestyles, and costs. The public would be informed about what they can do to help recover the desert tortoise, conserve limited resources such as water, and enjoy and appreciate the associated social and economic benefits of these conservation and management actions. They would be encouraged to implement these actions. We anticipate that, over the long-term, there would be changes in human behavior and consequently their actions and would result in effective management of solid waste, water, and nest and roost sites that would reduce the common raven population. This portion of Alternative C should have negligible beneficial impacts on socioeconomic issues.

The level of potential impact from this alternative to socioeconomics does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.4.4 Impact on Recreation

As stated under the current program alternative, much of the California desert is open to the public for various forms of recreational use. Closed areas include private lands and military bases. There are restrictions on methods of access to some of the public use areas (e.g., wilderness). Numerous opportunities are available for various forms of recreation on lands managed by the BLM, NPS, and California Department of Parks and Recreation. Implementation of Alternative C would not affect the continuation of these recreation opportunities.

Implementation of common raven removal and reduction in human subsidies to ravens would indirectly impact recreation in the California desert and would have similar impacts to

Alternative B. At removal locations for the common raven, consideration would be given to public activity patterns in the DTMAs. Most public recreation occurs on weekends and holidays. The USFWS and APHIS-WS would consult with the BLM, NPS, California Department of Parks and Recreation, and CDFG to minimize impacts of raven removal on scheduled recreational activities. At sites where people are likely to be exposed to raven removal activities, emphasis would be placed on education and using tools that would not potentially harm the public. These impacts would be adverse and negligible.

The cleanup of illegal dumpsites and similar activities may detract from the recreation experience for a short time, but the long-term benefits of making the area safe, free of garbage and debris, and restoring the area would greatly outweigh the adverse effects of cleanup activities on the recreation experience. This alternative would have negligible adverse impacts to recreation during cleanup.

Effective implementation of this alternative would over time result in greater opportunities for the recreating public to view a desert tortoise and other wildlife species in their natural habitat. The long-term impacts from implementation of this alternative would be negligible and beneficial.

The level of potential impact from this alternative to recreation does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.4.5 Impact on Human Health and Safety

The implementation of this alternative would have similar indirect impacts as Alternative B. If removal efforts are conducted in the DTMAs, the effects to human health and safety would be unlikely, as DTMAs contain few communities or settlements. Measures to avoid adverse impacts to human health and safety are included in the proposed action through use of the Wildlife Services Decision Model (Slate et al. 1992). Standard operating procedures used to reduce the risk to human health and safety are listed in Section 3.2.2 of the Wildlife Services EIS. Many of the procedures intended to minimize impacts on recreation would also minimize risks to human health and safety.

A formal human risk assessment of currently available APHIS-WS methods, including those proposed for use in this EA concluded low risks to humans (USDA 1997, revised, Appendix P). The risk assessment evaluated potential impacts on APHIS-WS employees and the public. Although some of the materials and methods available for reducing predation by the common raven on the desert tortoise have the potential to present a threat to human health and safety if used improperly, problems associated with their misuse have rarely occurred, and the greatest risk is to the user. Professionals trained in the safe and effective use of each method would conduct the damage management practices. Although this could reduce effectiveness, human safety is the highest priority for all of the agencies concerned. Therefore, the impact to human health and safety from common raven removal is expected to be negligible and adverse.

The reduction in human subsidies to the common raven would have indirect impacts on human health and safety. The cleanup of illegal dumps and better management of permitted landfills and transfer stations would remove garbage and hazardous waste from unsecured locations and ensure that it is properly contained and managed. These actions would reduce the spread of disease and groundwater contamination. Reduction in standing water would reduce the number of breeding sites for mosquitoes, which may carry disease that could infect humans. There should be negligible beneficial impacts to human health and safety from the reduction in human subsidies of food, water, nest sites, and roost sites for the common raven.

The level of potential impact from this alternative to human health and safety does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.4.6 Effectiveness/Conclusion

The effectiveness of the program in relation to accomplishing the purpose and objectives of the proposed action can be defined as the increase in number of hatchling and juvenile desert tortoises that comprise the population in the DTMAs, and the numbers over time that are recruited into the adult population in these areas. Effectiveness can also be determined by the reduction in the number of common raven nest sites with evidence of desert tortoise shell remains near them in the DTMAs. Since this alternative would result in the removal of all ravens in the DTMAs in the California desert, raven removal coupled with reduction in human subsidies would provide a greater level of effectiveness in accomplishing the purpose and objectives of the proposed action in these areas. It would also remove ravens that may not be preying on desert tortoises.

Based on the description of the "Purpose and Need," the combined efforts to remove common ravens and implement a "cultural and physical" based program would meet the purpose and objectives of the proposed action. The removal of common ravens that may, or may not prey on desert tortoises, should yield both immediate relief from raven predation on hatchling and juvenile desert tortoises in the DTMAs and allow desert tortoise populations to begin the 15- to 20-year process of recruiting hatchling and juvenile desert tortoises into the population in these areas. It would provide little relief to those areas outside the DTMAs. The implementation of the "cultural and physical" based program would provide for long-term reduction of common ravens in the California desert. This reduction would help bring the population numbers of this top predator in balance with the populations of other desert animals. Population numbers for the common raven would remain above historic levels in the California desert.

With respect to removal of common ravens in the DTMAs, the wildlife specialist must be able to complete wildlife damage management expeditiously and thoroughly, while minimizing harm to nontarget species and the environment and risks to human health and safety. The wildlife specialist must comply with all regulations on the use of each method, and use methods as humane as possible within the limits of current technology. The U.S. Government Accounting Office (1990) concluded that APHIS-WS was effective overall in preventing and reducing wildlife damage while not significantly impacting target predator populations, the environment, or the public. Many of the details on effectiveness were discussed in the Final EIS on the national APHIS-WS program (USDA 1997, revised) where integrated wildlife damage management was concluded to be the most effective. The effectiveness of methods used, given they are used by trained professionals, would influence the overall effectiveness of this alternative.

4.5 Alternative D–Integrated Predator Management and Removal of Ravens within Desert Tortoise Management Areas and Raven Concentration Areas

4.5.1 Impact on the Target Species (Common Raven) Population

The direct impacts of this alternative would be similar to, but greater than, that of Alternatives B or C, but would still have minor adverse impacts to the common raven population in the California desert in the short- and long-term. The impacts would be greater as approximately 3,000 to 7,000 common ravens or 8 to 18.7 percent of the California desert population of ravens would be removed annually at the DTMAs and concentration areas. The number of common ravens removed would depend on several variables: effectiveness of implementing methods to reduce human subsidies of food, water, and nest and roost sites to the common raven; availability of staff; and funding. The wildlife specialist would determine which removal strategy or strategies would be most effective for removal of the common raven for these areas.

The number of common ravens removed using trapping, shooting, and avian toxicant methods would result in decreased raven densities within the DTMAs and concentration sites. We would not remove ravens from other areas in the California desert such as most private lands, many military installations, state lands outside DTMAs, and some BLM and NPS lands including many wilderness areas. There would be removal of unoccupied raven nests. We anticipate that the removal of 3,000 to 7,000 common ravens annually would result in a slight decrease in the raven population in the California desert. Between 1966 and 1999, ravens in the Mohave Desert had an annual population increase of 5.4 percent and 7.1 percent in the Colorado Desert (Liebezeit et al. 2002). Raven population numbers would remain well above historic levels in the California desert. We do not anticipate that implementation of this alternative would reach the threshold of reducing the common raven in the California desert to a level below self-sustaining (see Table 4-1). Movement of common ravens from adjacent populations into the California desert would still occur.

The indirect impacts from implementation of the actions to reduce human subsidies of food, water, and nest and roost sites and remove unoccupied raven nests would be similar to those of Alternative B.

The level of potential impact from this alternative to common ravens does not reach a level of significance as defined in the Significance Criteria in Table 4-1. However, a minor portion of the population in the California desert would be removed annually.

4.5.2 Impact on Nontarget Species

4.5.2.1 Desert Tortoise

The indirect impacts from implementing Alternative D to the desert tortoise would be similar to Alternative C. The increased number of common ravens removed from the DTMAs and raven concentration sites would lead to a greater immediate beneficial effect than Alternative C. This would occur by removing both ravens that prey and do not prey on desert tortoises in these DTMAs, which are essential for desert tortoise survival and recovery, and reducing the concentrated numbers of potential predatory ravens in desert tortoise habitat near these concentration sites. Raven removal would allow hatchling and juvenile desert tortoises in these and nearby areas to survive and contribute to increased desert tortoise populations. Implementation of this alternative would also allow more desert tortoises to reach adulthood and reproduce, contributing to the recovery of the species.

The other part of Alternative D, reduce human subsidies of food, water, and nest and roost site for the common raven, would have the same impact at Alternative B. The reduction in human subsidies would eventually reduce raven population numbers and raven predation on desert tortoises, thereby increasing desert tortoise population numbers. These impacts would be moderate and beneficial.

A potential negative impact of this alternative is minimal but possible. Desert tortoises may be injured or killed by vehicles carrying project employees. This possibility would be minimized or eliminated by following posted speed limits, driving less than 25 mph on dirt roads, and educating field staff on desert tortoise awareness. Although we estimate up to a 100 percent increase in number of miles traveled above the Alternative B miles, we consider the risk negligible because of the mitigation measures.

4.5.2.2 Other Wildlife Species

The indirect impacts of implementing this alternative would be similar to those of Alternative C. This alternative would have minor to moderate beneficial impacts to wildlife species that are prey for the common raven in the DTMAs and concentration sites. The impacts from implementing Alternative D for raven removal, reduction of human subsidies, and removal of unoccupied raven nests would be similar to that of Alternative C although the geographic area of this impact would be greater as it includes raven concentration areas.

The potential removal methods (trapping and relocation, shooting, trapping and euthanasia, and poisoning) are not likely to affect nontarget species. The actual raven removal effort is not expected to affect other wildlife species.

The level of potential impact from this alternative to nontarget species does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.5.3 Impact on Socioeconomics Issues

The indirect impacts to socioeconomic issues from implementing Alternative D would be similar to Alternative C. The efforts to remove (shoot, trap and euthanize, and use an avian toxicant) ravens would cover a larger area than Alternative C and occur in defined blocks or polygons located throughout the California desert. Occasionally these activities may occur near communities. If they do, their effects would be limited, and should have negligible adverse impacts on socioeconomics. Shooting would occur during daylight hours, and its occurrence would be minimal with respect to frequency and duration. All laws and regulations regarding discharge of firearms would be strictly followed including discharge of firearms near dwellings. Trapping and use of an avian toxicant are not likely to affect the residents of local desert communities; these activities would occur in the desert, not within communities or settlements. We estimate that implementation of these removal actions would cost $550,000 per year and could occur at any time during the year. Qualified professionals from APHIS-WS would implement these removal methods. Implementation of these actions would result in negligible adverse impacts to socioeconomic issues.

Part of Alternative D is to work with federal, state, and local agencies, and the public to develop and/or implement existing authorities and develop basic processes that manage the disposal and storage of solid waste; conserve water; and modify structures to reduce human subsidies of food, water, and nest and roost sites for the common raven in the California desert. Implementation of these programs would likely result in minimal changes in human lifestyles and costs. We would inform the public about what they can do to help recover the desert tortoise, conserve limited resources such as water, and enjoy and appreciate the associated social and economic benefits of these conservation and management actions. They would be encouraged to implement these actions. We anticipate that, over the long-term, there would be changes in human behavior and consequently their actions and would result in effective management of solid waste, water, and nest and roost sites that would reduce the common raven population. This portion of Alternative D should have negligible beneficial impacts on socioeconomic issues.

The level of potential impact from this alternative to socioeconomics does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.5.4 Impact on Recreation

As stated under the current program alternative, much of the California desert is open to the public for various forms of recreational use. Closed areas include private lands and military bases. There are restrictions on methods of access to some of the public use areas (e.g., wilderness). Numerous opportunities are available for various forms of recreation on lands managed by the BLM, NPS, and California Department of Parks and Recreation. Implementation of Alternative D would not affect the continuation of these recreation opportunities.

The indirect impacts to recreation from implementation of Alternative D would be similar to Alternative C. At common raven removal locations (DTMAs and concentration sites), consideration would be given to public recreation activity patterns in these areas. Most public recreation occurs on weekends and holidays. The USFWS and APHIS-WS would consult with the BLM, NPS, California Department of Parks and Recreation, and CDFG to minimize impacts of raven removal on scheduled recreational activities. At sites where people are likely to be exposed to raven removal activities, emphasis would be placed on education and using tools that would not potentially harm the public. This impact would be negligible and adverse.

The cleanup of illegal dumpsites and similar activities may detract from the recreation experience for a short time, but the long-term benefits of making the area safe, free of garbage and debris, and restoring the area would greatly outweigh the adverse effects of cleanup activities on the recreation experience. This alternative would have negligible adverse impacts to recreation during cleanup.

Effective implementation of this alternative would result in greater opportunities over time for the recreating public to view a desert tortoise and other wildlife species in their natural habitat. The long-term impacts from implementation of this alternative would be negligible and beneficial.

The level of potential impact from this alternative to recreation does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.5.5 Impact on Human Health and Safety

The indirect impact to human health and safety from implementation of Alternative D would be similar to Alternative C. Measures to avoid adverse impacts on human health and safety are built into this alternative through use of the Wildlife Services Decision Model (Slate et al. 1992). Standard operating procedures used to reduce the risk to human health and safety is listed in Section 3.1.2 of the Wildlife Services EIS. Many of the procedures intended to minimize impacts on recreation would also minimize or avoid risks to human health and safety.

A formal human risk assessment of currently available APHIS-WS methods, including those proposed for use in this EA concluded low risks to humans (USDA 1997, revised, Appendix P). The risk assessment evaluated potential impacts on APHIS-WS employees and the public. Although some of the materials and methods available for reducing predation by the common raven on the desert tortoise have the potential to represent a threat to human health and safety if used improperly, problems associated with their misuse have rarely occurred, and the greatest risk is to the user. Professionals trained in the safe and effective use of each method would conduct the damage management practices. Although this could reduce effectiveness, human safety is the highest priority for all of the agencies concerned. Therefore, the impact to human health and safety from common raven removal is expected to be negligible and adverse.

The reduction in human subsidies to the common raven would have indirect impacts on human health and safety. The cleanup of illegal dumps and better management of permitted landfills and transfer stations would remove garbage and hazardous waste from unsecured locations and ensure that it is properly contained and managed. These actions would reduce the spread of disease and groundwater contamination. Reduction in standing water would reduce the number of breeding sites for mosquitoes, which may carry disease that could infect humans. There should be negligible beneficial impacts to human health and safety from the reduction in human subsidies of food, water, nest sites, and roost sites for the common raven.

The level of potential impact from this alternative to human health and safety does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.5.6 Effectiveness/Conclusion

The effectiveness of the program in relation to accomplishing the purpose and objectives of the proposed action can be defined as the increase in number of hatchling and juvenile desert tortoises that comprise the population in the DTMAs and areas adjacent to raven concentration areas, and the numbers recruited into the adult population over time in these areas. Effectiveness can also be determined by the reduction in the number of common raven nest sites with evidence of desert tortoise shell remains near them in the DTMAs. Because this alternative would result in the greatest number of common ravens removed in the California desert, many of which may not prey on the desert tortoise, raven removal coupled with reduction in human subsidies and nest removal would provide a similar level of effectiveness in accomplishing the purpose and objectives of the proposed action.

With respect to removal of common ravens in the DTMAs and concentration areas, the wildlife specialist must be able to complete wildlife damage management expeditiously and thoroughly, while minimizing harm to nontarget species and the environment and risks to human health and safety. The wildlife specialist must comply with all regulations on the use of each method, and use methods as humane as possible within the limits of current technology. The U.S. Government Accounting Office (1990) concluded that the APHIS-WS was effective overall in preventing and reducing wildlife damage while not significantly impacting target predator populations, the environment, or the public. Many of the details on effectiveness were discussed in the Final EIS on the national APHIS-WS program (USDA 1997, revised) where integrated wildlife damage management was concluded to be the most effective. The effectiveness of methods used, given they are used by trained professionals, would influence the overall effectiveness of this alternative.

Based on the description of the "Purpose and Need," the combined efforts to remove common ravens and implement a "cultural and physical" based program would meet the purposes and objectives of the proposed action. The removal of common ravens should yield both immediate relief from raven predation on hatchling and juvenile desert tortoises in the DTMAs and areas adjacent to raven concentration sites. It would allow desert tortoise populations to begin the 15- to 20-year process of recruiting hatchling and juvenile desert tortoises into the population. The implementation of the "cultural and physical" based program would provide for long-term reduction of common ravens in the California desert. This reduction would help bring the population numbers of this top predator in balance with the populations of other desert animals. Population numbers for the common raven would remain above historic levels in the California desert.

4.6 Alternative E–Integrated Predator Management Using only Cultural and Physical Methods

4.6.1 Impact on the Target Species (Common Raven) Population

Alternative E would have indirect impacts to the common raven that are similar to those of Alternative B for implementation of cultural and physical methods. Alternative E should have negligible impacts to the common raven population in the short-term. Currently several federal agencies have implemented limited efforts to reduce human subsidies of food, water, and nest and roost sites on federal lands. These efforts would be expanded and integrated across the California desert to gradually reduce the population of common ravens in the California desert.

The long-term "cultural and physical" efforts of reducing human subsidies would result in a gradual reduction of the common raven population in the California desert. The impact of this reduction would be minimal and adverse. The effectiveness of this alternative would depend on the cooperation of federal, state, and local agencies and the public in implementing measures to reduce human subsidies of food, water, and nest and roosts sites for the common raven in the California desert. If this alternative is not implemented completely, the common raven population would continue to increase in the California desert.

The level of potential impact from this alternative to common ravens does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.6.2 Impact on Nontarget Species

4.6.2.1 Desert Tortoise

Because this alternative does not remove any ravens, we anticipate a slowly developing, long-term beneficial impact to desert tortoises that are hunted by the common raven. Until the cultural and physical efforts are fully implemented, we anticipate the population of the desert tortoise to continue to decline. Eventually, the removal of raven nests and increased actions to reduce anthropogenic subsidies (including food, water, and nest and roost sites) would benefit the desert tortoise, but these benefits to the desert tortoise population would not likely occur for several years. Sustained levels of predation by the common raven would likely continue for several years until the cultural and physical efforts were fully implemented by the agencies and the public. For the desert tortoise in the California desert, particularly in the west Mojave Desert, this gradual implementation of cultural and physical efforts and delayed reduction in predation may not be in time to prevent the status of the desert tortoise in California from declining to that of endangered.

4.6.2.2 Other Wildlife Species

Because this alternative does not remove any ravens, we would anticipate a slowly developing, long-term beneficial impact to other wildlife species that are hunted by the common raven. Beneficial impacts would likely occur to birds, reptiles, and small mammals. As ravens are known to be omnivorous, a reduction in their numbers in certain areas would reduce predation on species including, but not limited to: small birds (eggs, nestlings, and adults), eggs, and nestlings of most birds nesting in the desert, snakes, lizards, rodents, and lagomorphs (rabbits and hares). In some specific portions of the project area, minimal benefits to animals would also affect declining, sensitive populations and in a few specific instances (Mohave ground squirrel, and Coachella Valley fringe-toed lizard), listed and/or candidate species would be positively impacted by actions proposed under this plan. Concentrations of common ravens occur near the Edom Hill landfill, an area adjacent to Coachella Valley fringe-toed lizard habitat.

The level of potential impact from this alternative to nontarget species does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.6.3 Impact on Socioeconomics Issues

An integrated effort (using cultural and physical methods) to reduce human subsidies, such as food and water, to the common raven would be expected to result in negligible changes to human lifestyle. The current cleanup of illegal dumps has had no impact on the lifestyle of the human population in the California desert. Efforts to reduce standing water on some lands would likely result in no effect to human lifestyle and a negligible beneficial effect from reduction in water costs.

The level of potential impact from this alternative to socioeconomics does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.6.4 Impact on Recreation

Under Alternative E, activities would be conducted in desert tortoise habitat with the exception of cleanup of illegal dumps. These sites are usually small and located near communities. The cleanup activities may deter from the recreation experience for a short time, but the long-term benefits of making the area safe, free of garbage and debris, and restoring the area would greatly outweigh the adverse effects of cleanup activities on the recreation experience. This alternative would have negligible adverse impacts to recreation during cleanup and negligible beneficial effects afterward.

Effective implementation of this alternative would over time result in greater opportunities for the recreating public to view a desert tortoise and other wildlife species in their natural habitat. The long-term impacts from implementation of this alternative would be negligible and beneficial.

The level of potential impact from this alternative to recreation does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.6.5 Impact on Human Health and Safety

Some of the "cultural and physical" measures would provide limited improvement to human health and safety. These include removal of illegal dumps, better management of transfer stations, and eliminating standing water. Illegal dumps may contain hazardous materials. Since they are usually easily accessible, the public is at risk of exposure to these hazards. They also contain debris, which can cause injury or death to anyone inspecting or playing at a dumpsite.

Standing water in a warm environment is a breeding habitat for mosquitoes that carry diseases. Encouraging agencies and the public to manage their outside watering to eliminate standing water which subsidizes the common raven would also reduce the likelihood of mosquitoes breeding and carrying diseases to humans. Implementation of this alternative would have a negligible beneficial impact on human health and safety.

The level of potential impact from this alternative to human health and safety does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.6.6 Effectiveness/Conclusion

Based on the description of the Need for Action, a "cultural and physical" based program would be expected to slowly reduce mortality and increased recruitment for the desert tortoise after a period of implementation of the program to manage the common raven populations. Alternative E would not be as effective initially or in the long-term as Alternatives B, C, or D. It would not allow for the immediate removal of common ravens known to prey or that may prey on hatchling and juvenile desert tortoises. It would not provide an environment for the survival of hatchling and juvenile desert tortoises in a timely manner. It would not contribute to the recruitment of young animals into the adult population or the survival of the next generation. Elevated levels of predation by the common raven on the desert tortoise would continue for at least the current life span of an adult raven (13 years in the wild) or longer. Ravens that prey on the desert tortoise would remain in the population; other ravens would learn from them how to prey on desert tortoises. This behavioral cycle would continue for the current number of ravens although over time it would eventually be less. There would be no immediate relief to allow desert tortoise populations to begin the 15- to 20-year process of recruiting hatchling and juvenile desert tortoises into the population. This time lag in providing relief from juvenile and hatchling mortality would continue the current one to two decade long period with little or no survival and recruitment of these hatchling and juvenile desert tortoises, especially in the west Mojave Desert, and could eventually result in local or regional extinction. Even with a large-scale outreach program to the federal, state, local agencies, and the public to reduce human subsidies to the common raven, ravens would continue to prey on hatchling and juvenile desert tortoises at a rate greater than historic levels and at a rate greater than the current population can endure. It would likely take several decades after full implementation of the "cultural and physical" based program to meet the purpose and objectives of the proposed action. Given the continued long-term decline of the population of the desert tortoise, such a delay in achieving any measure of success substantially diminishes the potential benefits to the desert tortoise populations.

With respect to determining whether the impacts to the resource areas rise to the level of significance for the alternatives, see Table 4-1. None of the alternatives considered would cause mortality or permanent habitat loss for listed or candidate species or other protected species. Alternative D does remove the largest percentage of the common raven population; however, the remaining population would remain at historically high levels in the California desert.

The socioeconomic impacts of the alternatives analyzed would be well below the 10 percent criteria for significance. None of the alternatives would likely stimulate local area growth rates or change employment levels.

The impacts to recreation from implementation of the alternatives would not prevent the continuation of existing authorized off-highway vehicle recreation use or continuation of existing hunting programs. The availability of any recreation resource would not be increased or decrease by 10 percent or more.

None of the alternatives would expose people to potential health hazards. All are consistent with existing health and safety regulations.

4.7 Alternative F–Phased Implementation of Integrated Predator Management and Removal of Ravens Using a Phased Implementation, as Needed (Alternatives B, C, and D)

4.7.1 Impact on the Target Species (Common Raven) Population

The direct impacts of this alternative would be similar to that of Alternatives B, C, and D, with the greatest degree of impact occurring if Alternative D is implemented. The short- and long-term impacts to the common raven population in the California desert would range from negligible adverse from implementation of Alternative B to minor adverse impacts from implementation of Alternative D. The estimated percent of the population of common ravens that would be removed would range from 0.5 percent from implementation of Alternative B to about 19 percent from implementation of Alternative D. The number of common ravens removed would depend on several variables: effectiveness of implementing methods to reduce human subsidies of food, water, and nest and roost sites to the common raven; availability of staff; and funding. The wildlife specialist would determine which removal strategy or strategies would be most effective for removal of the common raven for these areas. See sections 4.3.1, 4.4.1, and 4.5.1 above for a description of impacts from implementation of this phased approach.

The level of potential impact from this alternative to common ravens does not reach a level of significance as defined in the Significance Criteria in Table 4-1. However, a minor portion of the population in the California desert would be removed annually.

4.7.2 Impact on Nontarget Species

4.7.2.1 Desert Tortoise

The indirect impacts from implementing Alternative F to the desert tortoise would be similar to Alternatives B, C, and D. The increased number of common ravens removed from the DTMAs and raven concentration sites would lead to a greater immediate beneficial effect than Alternative C. This would occur by removing both ravens that prey and do not prey on desert tortoises in these DTMAs, which are essential for desert tortoise survival and recovery, and reducing the concentrated numbers of potential predatory ravens in desert tortoise habitat near these concentration sites. Raven removal would allow hatchling and juvenile desert tortoises in these and nearby areas to survive and contribute to increased desert tortoise populations. Implementation of this alternative would also allow more desert tortoises to reach adulthood and reproduce, contributing to the recovery of the species.

The other part of Alternative F, reduce human subsidies of food, water, and nest and roost site for the common raven, would have the same impact as Alternatives B, C, and D. The reduction in human subsidies would eventually reduce raven population numbers and raven predation on desert tortoises, thereby increasing desert tortoise population numbers. These impacts would be moderate and beneficial.

A potential negative impact of this alternative is minimal but possible. Desert tortoises may be injured or killed by vehicles carrying project employees. This possibility would be minimized or eliminated by following posted speed limits, driving less than 25 mph on dirt roads, and educating field staff on desert tortoise awareness. We consider the risk negligible because of the mitigation measures.

4.7.2.2 Other Wildlife Species

The greatest indirect impacts of implementing this alternative would be similar to those of Alternative D. This alternative would have minor to moderate beneficial impacts to wildlife species that are prey for the common raven in the DTMAs and concentration sites. The impacts from implementing Alternative F for raven removal, reduction of human subsidies, and removal of unoccupied raven nests would be similar to that of Alternative D although the geographic area of this impact would be greater as it includes raven concentration areas.

The potential removal methods (trapping and relocation, shooting, trapping and euthanasia, and poisoning) are not likely to affect nontarget species. The actual raven removal effort is not expected to affect other wildlife species.

The level of potential impact from this alternative to nontarget species does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.7.3 Impact on Socioeconomics Issues

The greatest indirect impacts to socioeconomic issues from implementing Alternative F would be similar to Alternatives D. The efforts to remove (shoot, trap and euthanize, and use an avian toxicant) ravens would cover a larger area than Alternative C and occur in defined blocks or polygons located throughout the California desert. Occasionally these activities may occur near communities. If they do, their effects would be limited, and should have negligible adverse impacts on socioeconomics. Shooting would occur during daylight hours, and its occurrence would be minimal with respect to frequency and duration. All laws and regulations regarding discharge of firearms would be strictly followed including discharge of firearms near dwellings. Trapping and use of an avian toxicant are not likely to affect the residents of local desert communities; these activities would occur in the desert, not within communities or settlements. We estimate that implementation of these removal actions would cost $550,000 per year and could occur at any time during the year. Qualified professionals from APHIS-WS would implement these removal methods. Implementation of these actions would result in negligible adverse impacts to socioeconomic issues.

Part of Alternative F is to work with federal, state, and local agencies, and the public to develop and/or implement existing authorities and develop basic processes that manage the disposal and storage of solid waste; conserve water; and modify structures to reduce human subsidies of food, water, and nest and roost sites for the common raven in the California desert. Implementation of these programs would likely result in minimal changes in human lifestyles and costs. We would inform the public about what they can do to help recover the desert tortoise, conserve limited resources such as water, and enjoy and appreciate the associated social and economic benefits of these conservation and management actions. They would be encouraged to implement these actions. We anticipate that, over the long-term, there would be changes in human behavior and consequently their actions and would result in effective management of solid waste, water, and nest and roost sites that would reduce the common raven population. This portion of Alternative F should have negligible beneficial impacts on socioeconomic issues.

The level of potential impact from this alternative to socioeconomics does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.7.4 Impact on Recreation

As stated under the current program alternative, much of the California desert is open to the public for various forms of recreational use. Closed areas include private lands and military bases. There are restrictions on methods of access to some of the public use areas (e.g., wilderness). Numerous opportunities are available for various forms of recreation on lands managed by the BLM, NPS, and California Department of Parks and Recreation. Implementation of Alternative F would not affect the continuation of these recreation opportunities.

The greatest indirect impacts to recreation from implementation of Alternative F would be similar to Alternative D. At common raven removal locations (DTMAs and concentration sites), consideration would be given to public recreation activity patterns in these areas. Most public recreation occurs on weekends and holidays. The USFWS and APHIS-WS would consult with the BLM, NPS, California Department of Parks and Recreation, and CDFG to minimize impacts of raven removal on scheduled recreational activities. At sites where people are likely to be exposed to raven removal activities, emphasis would be placed on education and using tools that would not potentially harm the public. This impact would be negligible and adverse.

The cleanup of illegal dumpsites and similar activities may detract from the recreation experience for a short time, but the long-term benefits of making the area safe, free of garbage and debris, and restoring the area would greatly outweigh the adverse effects of cleanup activities on the recreation experience. This alternative would have negligible adverse impacts to recreation during cleanup.

Effective implementation of this alternative would result in greater opportunities over time for the recreating public to view a desert tortoise and other wildlife species in their natural habitat. The long-term impacts from implementation of this alternative would be negligible and beneficial.

The level of potential impact from this alternative to recreation does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.7.5 Impact on Human Health and Safety

The indirect impact to human health and safety from implementation of Alternative F would be similar to Alternative D. Measures to avoid adverse impacts on human health and safety are built into this alternative through use of the Wildlife Services Decision Model (Slate et al. 1992). Standard operating procedures used to reduce the risk to human health and safety is listed in Section 3.1.2 of the Wildlife Services EIS. Many of the procedures intended to minimize impacts on recreation would also minimize or avoid risks to human health and safety.

A formal human risk assessment of currently available APHIS-WS methods, including those proposed for use in this EA concluded low risks to humans (USDA 1997, revised, Appendix P). The risk assessment evaluated potential impacts on APHIS-WS employees and the public. Although some of the materials and methods available for reducing predation by the common raven on the desert tortoise have the potential to represent a threat to human health and safety if used improperly, problems associated with their misuse have rarely occurred, and the greatest risk is to the user. Professionals trained in the safe and effective use of each method would conduct the damage management practices. Although this could reduce effectiveness, human safety is the highest priority for all of the agencies concerned. Therefore, the impact to human health and safety from common raven removal is expected to be negligible and adverse.

The reduction in human subsidies to the common raven would have indirect impacts on human health and safety. The cleanup of illegal dumps and better management of permitted landfills and transfer stations would remove garbage and hazardous waste from unsecured locations and ensure that it is properly contained and managed. These actions would reduce the spread of disease and groundwater contamination. Reduction in standing water would reduce the number of breeding sites for mosquitoes, which may carry disease that could infect humans. There should be negligible beneficial impacts to human health and safety from the reduction in human subsidies of food, water, nest sites, and roost sites for the common raven.

The level of potential impact from this alternative to human health and safety does not reach a level of significance as defined in the Significance Criteria in Table 4-1.

4.7.6 Effectiveness/Conclusion

The effectiveness of the program in relation to accomplishing the purpose and objectives of the proposed action can be defined as the increase in number of hatchling and juvenile desert tortoises that comprise the population in the DTMAs and areas adjacent to common raven concentration areas, and the numbers recruited into the adult population over time in these areas. Effectiveness can also be determined by the reduction in the number of common raven nest sites with evidence of desert tortoise shell remains near them in the DTMAs. Since this alternative would result in the greatest number of common ravens removed in the California desert, many of which may not prey on the desert tortoise, raven removal coupled with reduction in human subsidies and nest removal would provide a similar level of effectiveness in accomplishing the purpose and objectives of the proposed action.

With respect to removal of common ravens in the DTMAs and concentration areas, the wildlife specialist must be able to complete wildlife damage management expeditiously and thoroughly, while minimizing harm to nontarget species and the environment and risks to human health and safety. The wildlife specialist must comply with all regulations on the use of each method, and use methods as humane as possible within the limits of current technology. The U.S. Government Accounting Office (1990) concluded that the APHIS-WS was effective overall in preventing and reducing wildlife damage while not significantly impacting target predator populations, the environment, or the public. Many of the details on effectiveness were discussed in the Final EIS on the national APHIS-WS program (USDA 1997, revised) where integrated wildlife damage management was concluded to be the most effective. The effectiveness of methods used, given they are used by trained professionals, would influence the overall effectiveness of this alternative.

Based on the description of the "Purpose and Need," the combined efforts to remove common ravens and implement a "cultural and physical" based program would meet the purposes and objectives of the proposed action. The removal of common ravens should yield both immediate relief from common raven predation on hatchling and juvenile desert tortoises in the DTMAs and areas adjacent to raven concentration sites. It would allow desert tortoise populations to begin the 15- to 20-year process of recruiting hatchling and juvenile desert tortoises into the population. The implementation of the "cultural and physical" based program would provide for long-term reduction of common ravens in the California desert. This reduction would help bring the population numbers of this top predator more in balance with the populations of other desert animals. Population numbers for the common raven would remain above historic levels in the California desert. The implementation of a phased approach would provide the optimum ability to reduce common raven predation on the desert tortoise as needed while minimizing the number of ravens that need to be removed.

4.8 Selection of the Preferred Alternative

Based on the analysis of impacts for the six alternatives, we have selected Alternative F, implementation of a phased approach of Alternatives B, C, and D. Of the alternatives presented, this alternative would implement the proposed action to reduce predation to the desert tortoise immediately (common raven removal) and for the long-term (implementation of the "cultural and physical based program"). It would provide the flexibility needed to adjust management actions to minimize the removal of the common raven and effectively reduce predation on the desert tortoise by the common raven.

4.9 Irreversible and Irretrievable Commitment of Resources

The resources involved with the proposed action include socioeconomics, recreation, common ravens, and nontargeted wildlife species. The maximum commitment of resources and manpower would be: for socioeconomics, the expenditure of up to $550,000 per year and employment of the equivalent of 1.25 full-time positions per year; for recreation, the loss of up to a total of 20 days per year at limited local sites; and for common ravens, the removal of up to 7,000 birds per year. Nontargeted species would experience a positive impact from reduced raven predation.

By implementing the proposed action, the only irreversible and irretrievable commitment of resources would be the removal of up to 7,000 common ravens annually. This would still leave the population at an historic high level.

4.10 Cumulative Impacts

This section of this EA analyzes cumulative impacts associated with the proposed action in the context of other "past, present, and reasonably foreseeable" action in the California desert. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. In analyzing the specific impacts of the alternatives considered to implement the proposed action, the following cumulative analyses were identified. The identified impacts were analyzed in accordance with NEPA (42 USC 4321–4347), Council on Environmental Quality (CEQ) regulation (40 CFR Parts 1500–1508) and CEQ guidelines for conducting cumulative impact analysis (*Considering Cumulative Effects under the National Environmental Policy Act, Executive Office of the President*, January 1997).

4.10.1 Council on Environmental Quality Guidelines

The 1997 CEQ guidelines clarify NEPA requirements for cumulative impact analysis, focusing on issues affected by the proposed action and using resource-based analyses as opposed to activity-based analyses. The recommended CEQ methodology identifies and analyzes other past and present projects and forecasts for future actions that have affected (or will affect) resource or issues in the region. In addition, the 1999 EPA guidance on cumulative impact analysis, as well as the FWS guidance on analyzing threats to endangered species, were utilized in the analysis of the cumulative impacts.

Table 4-3 presents the resources analyzed based on CEQ guidelines and the three levels of analysis performed. Level 1 reflects resources (or issues) that did not have any potential cumulative effects concerns, thus no further analyses were needed. Level 2 analyses were conducted for those resources (or issues) that might be subject to potential cumulative effects. Level 3 analyses were conducted for those resources (or issues) that were identified as having cumulative effects resulting from direct and indirect effects of the potential actions and other past, present, or future actions. Level 3 analyses included a more in-depth review of the combined effects on specific relevant topics within the given resource (or issue).

The impacts to socioeconomics, human health and safety, and recreation from implementation of each of the six alternatives would be negligible to none (Table 4-4). We considered/analyzed this level of impact for these resource issues and did not carry them forward for further discussion/analysis in the Cumulative Impacts section.

Table 4-5 presents the Level 3 analysis as it relates to the common ravens and other wildlife species.

Other than the alternatives proposed in this document, we are unaware of any past, current, or planned future actions that would directly or indirectly impact the common raven with one exception, the BLM's effort about 15 to 20 years ago to remove common ravens. Future actions that may impact the common raven would be continued human development throughout various locations in the California desert. These future actions are beneficial to the common raven and would likely contribute to higher common raven population numbers and increased predation pressure on the desert tortoise and other wildlife species.

Cumulative impacts for the common raven were discussed under Environmental Consequences Section. The worst-case scenarios discussed previously indicate that all alternatives would have minimal or minor cumulative impacts on the common raven population. Since the common raven is a resident bird in the California desert, removal efforts outside the California desert should have little effect on the common raven population in the California desert.

Cumulative impacts on nontarget species are also expected to range from moderate adverse to moderate beneficial. Implementation of the four action alternatives presented in this EA would likely have no to minimal adverse effects on the federal and state threatened desert tortoise and moderate beneficial effects. Actions that are effective in reducing raven predation on the desert tortoise would benefit this species. For other wildlife species, the implementation of the four action alternatives would likely have no to minimal adverse effects and moderate beneficial effects. Actions that are effective in reducing the number of ravens in the California desert would likely benefit these species of small mammals, birds, and reptiles from reduced rates of predation.

4.10.1.1 Comparison of Alternatives under CEQ Guidelines

4.10.1.1.1 Alternative A

Under Alternative A, the current program alternative, the common raven populations would be expected to continue to increase. With larger raven populations, we would expect increased predation of juvenile desert tortoises causing a lesser likelihood of desert tortoise recovery. Without substantially reducing hatchling and juvenile desert tortoise mortality and increasing desert tortoise recruitment, it would be impossible for desert tortoise populations to recover. The current program alternative would continue the status quo in the California desert, which is a continued decline of desert tortoise densities and reduction of its geographic range especially in the Western Mojave Recovery Unit. Without an integrated approach to desert tortoise recovery, including a reduction in predation, the long-term cumulative impact is anticipated to be a continued decline of the desert tortoise populations and other wildlife species in the California deserts and extirpation of the desert tortoise in some locations.

The cumulative impact of implementation of the current outreach program by the Defenders of Wildlife would be limited. We are unaware of any other outreach efforts in the California desert regarding educating the public and local and state agencies about what they can do to reduce human subsidies of food, water, and nest and roost sites for the common raven thereby increasing hatchling and juvenile desert tortoise survival and recruitment. Because of the current limited size of this program, we anticipate minimal adverse impacts to ravens as they would continue to expand in numbers and geographic area following human development in the California desert.

Table 4-3. Level of Analysis for Each Resource Area

Level 1 No Impacts Identified	Level 2 Analysis and Discussion	Level 3 Detailed Analysis
Air Quality Geology Soils Floodplains Wetlands Vegetation Aquatic Resources Unique Ecosystems Park Lands Natural or Depletable Resources Traffic Noise Cultural Resources Indian Trust Resources Urban Quality Seismicity Environmental Justice Protection of Children from Environmental Health and Safety Risks Prime and Unique Resources (farmlands) Geological Resources (rocks and streambeds) Biodiversity and Ecosystems Stream Flow Characteristics Energy Requirements and Conservation Water Quantity Minerals Ecologically Critical Areas Visual Quality Sacred Sites Wilderness	Socioeconomics Recreation Human Health and Safety	Target Species (common raven) Nontarget Species (desert tortoise and other wildlife species)

Table 4-4. Analysis of Socioeconomics, Recreation, and Human Health and Safety

Socioeconomic Resources
Quick Look Questions

No **Has** the project area undergone any major changes in economic activity or population in the last 10 years as a result of actions similar to the proposed action?

While the California desert has experienced major growth in economic activity and population size, this growth is not the substantial result of similar types of projects. More than 15 years ago, the BLM proposed and implemented for several days a raven management plan. This action would have contributed a negligible amount of socioeconomic activity in the project area.

No **Will the** proposed action contribute to this major growth in economic activity and population size?

The California desert has a million plus population size and economic activity and value in the hundreds of millions of dollars. The proposed action would contribute a few seasonal positions annually to the economy and no contribution to the population.

No Is **additional** cumulative effects analysis needed?

Human Health and Safety
Quick Look Questions

Yes Are **there** any known or suspected contaminated sites that would be affected by the proposed action?

Part of the proposed action is to clean up illegal dumps.

Yes **Would** the proposed action increase the use of existing hazardous materials or involve the use of new hazardous materials?

We will use an avicide that will be administered by certified professionals in handling, use, and disposal of the avicide. Localized in application and used in small amounts

Yes **Are** there any potential health or safety risks to the public from the proposed action?

There are potential risks because of the use of firearms and an avicide. However, these methods would be implemented by qualified professionals who would select the most appropriate method including consideration of human activity in the use area

No Do **any** risks remain that cannot be mitigated?

No Is **additional** cumulative effects analysis needed?

Table 4-4. Analysis of Socioeconomics, Recreation, and Human Health and Safety

Recreation **Quick Look Questions**	
Yes	Are there areas within the project area that are used for access and recreation? *Much of the California desert is used for a variety of types of recreation.*
No	**Does** the proposed action increase the potential for additional recreational activities?
Slight	Does the proposed action have the potential to limit recreational activities? *Proposed action would be limited to small areas for short period of time.*
Yes	Are **there** any limitations to recreation that cannot be mitigated? *There is the possibility that after implementing mitigation for recreation (e.g., considering scheduled recreation events and periods of higher use - weekends and holidays), some activities would occur that would limit recreation in a small area and for a short time. The rest of the California desert would be available for various types of recreation.*
No	Is a detailed cumulative effects analysis needed?

Table 4-5. Level 3 Analysis–Common ravens and Other Wildlife Species (Refer to Table 4-3)

No **Would** any of the alternatives result in significant changes (as defined under NEPA)?

No **Would** the proposed action result in the removal of listed species from the wild?

The proposed action would only result in the removal of the common raven which is not a federal or state-listed species.

Yes Has the project area been surveyed for listed species?

Yes Does **the** proposed action result in the removal from the wild of nonlisted species?

Yes **Will the proposed action take place on sensitive habitats?**

Locations may include desert tortoise critical habitat, BLM lands with special designation such as Areas of Critical Environmental Concern, and NPS lands.

Yes **Will** the proposed action take place near or in designated wilderness?

The proposed action may occur near wilderness but would not likely occur in designated wilderness. Most wilderness areas are mountainous areas and are not considered high quality habitat for the desert tortoise in California. However, if we implement the proposed action in wilderness areas, we would follow all applicable rules for wilderness areas.

Yes Does **the** proposed action involve the use of hazardous or toxic material in association with wildlife species?

An avian toxicant may be used to remove common ravens.

Yes **Are** any state or federal permits or authorization required for the proposed action?

Both state permits and federal authorization are required.

Yes Is **additional** cumulative impact analysis required?

We anticipate the cumulative impacts to socioeconomics, human health and safety, and recreation in the California desert to be negligible. The USFWS and other agencies would not be implementing actions that would create or remove jobs from the area and would not be implementing actions that would likely affect human health and safety or recreation.

4.10.1.1.2 Alternative B

The removal of 100 pairs of common ravens each year is not considered large enough to have a cumulative impact on ravens in the California desert or in the state as a whole. There are other raven depredation activities being conducted within the state and in adjacent states, primarily associated with damage to agricultural and livestock resources, and threats to human health and safety. However, none of these activities are in the California desert. Since the common raven in the California desert is a resident or nonmigratory animal, these depredation activities should not affect the ravens in the California desert. Population levels of the common raven from removal actions would decline but would be greater than they were in the 1960s, 1970s, 1980s, and 1990s.

This alternative would allow for a decrease in hatchling and juvenile desert tortoise mortality, which would provide a positive impact to the desert tortoise population, and would ultimately increase desert tortoise recruitment in the California desert. It would not eliminate predation by the common raven on the desert tortoise and would not eliminate ravens in any part of the California desert. This alternative would allow for enough of a decrease in hatchling and juvenile desert tortoise mortality to provide a positive impact for the desert tortoise. It would also provide a benefit to other wildlife species in the desert upon which the common raven preys by reducing the level of mortality from common raven predation.

The cumulative impact of implementation of a cultural and physical based program, which includes a public education and outreach program by the USFWS and cooperating agencies, would be coordinated with the outreach program recently initiated by the Defenders of Wildlife. We are unaware of any other outreach efforts in the California desert regarding educating the public and local and state agencies about what they can do to reduce human subsidies of food, water, nest sites, and roosts sites for the common raven. Over time, if these actions are fully implemented, they should reduce the size of the common raven population in the California desert thereby reducing the occurrence of common ravens preying on juvenile and hatchling desert tortoises.

We anticipate the cumulative impacts to socioeconomics in the California desert to be minimal. Only a handful of jobs would be created from implementation of this action, and those jobs would be seasonal. Compared to the tens of thousands of people and jobs that are in the California desert, this impact would be negligible.

The cumulative impact from implementation of this alternative to human health and safety would be none to negligible. Implementation would not expose people to potential health hazards. Use of firearms and avicide bait would be by trained professionals and limited to local sites away from communities. The egg bait would be on platforms high above the ground to keep small children from accessing the eggs. The platform would be signed with warnings in English and Spanish. Personnel would be nearby to monitor the avicide sites for human behavior. This alternative is consistent with existing health and safety regulations. Its implementation would have limited beneficial impacts through improved trash containment and reduction of unauthorized dumps which would reduce the possible spread of disease.

The cumulative impacts to recreation would also be minimal. There are numerous types of recreational opportunities available throughout the millions of acres of public land (e.g. BLM, NPS, and California State Parks) in the California desert. Implementation of this action may seasonally restrict the public from fully using a small number of sites. This action would also provide a benefit by increase wildlife viewing opportunities in the future. We are unaware of any other actions that would adversely or beneficially impact recreation opportunities other than those currently implemented by federal, state, and local agencies in their land management plans.

4.10.1.1.3 Alternative C

The removal of 2,000 adult ravens from the California desert annually is not considered large enough to lead to a cumulative negative impact on the common raven population in the California desert or throughout the state. We are unaware of any other raven removal or depredation activities currently planned or conducted in the California desert. There are other raven depredation activities being conducted within the state and in adjacent states, primarily associated with damage to agricultural and livestock resources, and threats to human health and safety. However, none of these activities are in the California desert. Since the common raven in the California desert is a resident or nonmigratory animal, these depredation activities would not affect the ravens in the California desert. Population levels of the common raven from removal actions would still be greater than they were in the 1960s, 1970s, 1980s, and 1990s.

This alternative would immediately decrease hatchling and juvenile desert tortoise mortality from common ravens to provide a positive impact for the desert tortoise and would ultimately improve desert tortoise recruitment. Additionally, because common raven removal would not be limited to only those ravens known to prey upon desert tortoise, we would anticipate a positive cumulative impact for other wildlife species upon which the common raven preys with this reduced level of raven predation.

The cumulative impact of implementation of a cultural and physical based program, which includes a public education and outreach program by the USFWS and cooperating agencies, would be coordinated with the outreach program recently initiated by the Defenders of Wildlife. We are unaware of any other outreach efforts in the California desert regarding educating the public and local and state agencies can do to reduce human subsidies of food, water, nest sites, and roosts sites for the common raven. Over time, if these actions are implemented, they should reduce the size of the common raven population in the California desert thereby reducing the occurrence of common ravens preying on juvenile and hatchling desert tortoises.

We anticipate the cumulative impacts to socioeconomics in the California desert to be minimal. Less than a dozen jobs would be created from implementation of this action. Compared to the tens of thousands of people and jobs that are in the California desert, this impact would be negligible.

The cumulative impact from implementation of this alternative to human health and safety would be minimal. Implementation would not expose people to potential health hazards. Use of firearms and avicide bait would be by trained professionals and within defined geographic areas that are generally away from human populations. It is consistent with existing health and safety regulations. It would have limited beneficial impacts through improved trash containment and reduction of unauthorized dumps which would reduce the possible spread of disease.

The cumulative impacts to recreation would also be minimal. There are numerous types of recreational opportunities available throughout the millions of acres of public land (e.g. BLM, NPS, and California State Parks) in the California desert. Implementation of this action may restrict the public from fully using a small number of sites. This action would also provide a benefit by increase wildlife viewing opportunities in the future. We are unaware of any other actions that would adversely or beneficially impact recreation opportunities other than those currently implemented by federal and state agencies in their land management plans.

4.10.1.1.4 Alternative D

The removal of 3,000 to 7,000 ravens (8 to 18.7 percent) annually is potentially large enough to lead to a minimal negative cumulative impact on raven populations within the California desert region. The annual population growth rate for the common raven from 1966 to 1999 was 5.4 percent in the Mojave Desert and 7.1 percent in the Colorado Desert. We are unaware of any other raven removal or depredation activities currently planned or conducted in the California desert. There are raven depredation activities being conducted within the state and in adjacent states, primarily associated with loss of agriculture and livestock. Since the common raven in the California desert is a resident or nonmigratory animal, these depredation activities should not affect the common ravens in the California desert. Over the long-term, this level of removal would reduce the overall common raven population in the California desert. However, population levels of the common raven after the removal actions would still be greater than they were in the 1960s, 1970s, 1980s, and 1990s. We would not expect the additional raven removal actions proposed in this alternative to have a long-term significant impact on the survival or continuation of the species.

This alternative would decrease hatchling and juvenile desert tortoise mortality to provide a positive cumulative impact for desert tortoise and would ultimately improve desert tortoise recruitment. Additionally, because raven removal would not be limited to only ravens known to prey upon desert tortoise, we would anticipate a positive impact for other wildlife species that are prey for the common raven with this reduced level of predation.

The cumulative impact of a public education and outreach program by the USFWS and cooperating agencies would be coordinated with the outreach program recently initiated by the Defenders of Wildlife. We are unaware of any other outreach efforts in the California desert regarding educating the public and local and state agencies can do to reduce human subsidies of food, water, nest sites, and roost sites for the common raven. Over time, if these actions are fully implemented, they should reduce the size of the common raven population in the California desert thereby reducing the occurrence of common ravens preying on juvenile and hatchling desert tortoises.

We anticipate the cumulative impacts to socioeconomics in the California desert to be negligible. Less than a handful of jobs would be created from implementation of this action.

Compared to the tens of thousands of people and jobs that are in the California desert, this change in socioeconomic benefits impact would be negligible.

The cumulative impact from implementation of this alternative to human health and safety would be minimal. Implementation would not expose people to potential health hazards. Use of firearms and avicide bait would be by trained professionals and within defined geographic areas that are generally away from human populations. It is consistent with existing health and safety regulations. It would have limited beneficial impacts through improved trash containment and reduction of unauthorized dumps which would reduce the possible spread of disease.

The cumulative impacts to recreation would also be minimal. There are numerous types of recreational opportunities available throughout the millions of acres of public land (e.g. BLM, NPS, and California State Parks) in the California desert. Implementation of this action may restrict the public from fully using a small number of sites. This action would also provide a benefit by increasing wildlife viewing opportunities in the future. We are unaware of any other actions that would adversely or beneficially impact recreation opportunities other than those currently implemented by federal and state agencies in their land management plans.

4.10.1.1.5 Alternative E

Under Alternative E, many of the current cultural and physical methods would be used but in an integrated program with a larger scope. The common raven populations would be expected to continue to increase for a few generations, because this is the expected time it would take for the public and agencies to fully implement these methods and produce results. Raven populations would be expected to continue preying on hatchling and juvenile desert tortoises at the current or increased rate. This would contribute to declining desert tortoise populations and cause a lag in desert tortoise recovery. Without substantially reducing hatchling and juvenile desert tortoise mortality and increasing desert tortoise recruitment, it would remain impossible for desert tortoise populations to recover. The need to accomplish this as soon as possible is especially important in the Western Mojave Recovery Unit. The long-term use of cultural and physical methods is anticipated to stabilize and eventually result in reduction of the raven populations, but not below historic levels.

We anticipate the cumulative impacts to socioeconomics, human health and safety, and recreation in the California desert to be none. The USFWS and other agencies would not be implementing actions that would create or remove jobs from the area and would not be implementing actions that would affect human health and safety or recreation.

4.10.1.1.6 Alternative F

The removal of 200 to 7,000 common ravens (0.5 to 18.7 percent) annually is potentially large enough to lead to a minimal negative cumulative impact on raven populations within the California desert region. The annual population growth rate for the common raven from 1966 to 1999 was 5.4 percent in the Mojave Desert and 7.1 percent in the Colorado Desert. We are unaware of any other raven removal or depredation activities currently planned or conducted in the California desert. There are common raven depredation activities being conducted within the state and in adjacent states, primarily associated with loss of agriculture and livestock. Since the common raven in the California desert is a resident or nonmigratory animal, these depredation activities should not affect the common ravens in the California desert. Over the long-term, this level of removal would reduce the overall common raven population in the California desert. However, population levels of the common raven after the removal actions would still be greater than they were in the 1960s, 1970s, 1980s, and 1990s. We would not expect the additional raven removal actions proposed in this alternative to have a long-term significant impact on the survival or continuation of the species. In addition, this alternative provides the flexibility to remove the minimum number of common ravens needed to meet the proposed action.

This alternative would decrease hatchling and juvenile desert tortoise mortality to provide a positive cumulative impact for desert tortoise and would ultimately improve desert tortoise recruitment. Additionally, because raven removal would not be limited to only ravens known to prey upon desert tortoise, we would anticipate a positive impact for other wildlife species that are prey for the common raven with this reduced level of predation.

The cumulative impact of a public education and outreach program by the USFWS and cooperating agencies would be coordinated with the outreach program recently initiated by the Defenders of Wildlife. We are unaware of any other outreach efforts in the California desert regarding educating the public and local and state agencies can do to reduce human subsidies of food, water, nest sites, and roost sites for the common raven. Over time, if these actions are fully implemented, they should reduce the size of the common raven population in the California desert thereby reducing the occurrence of common ravens preying on juvenile and hatchling desert tortoises.

We anticipate the cumulative impacts to socioeconomics in the California desert to be negligible. Less than a handful of jobs would be created from implementation of this action. Compared to the tens of thousands of people and jobs that are in the California desert, this change in socioeconomic impact would be negligible.

The cumulative impact from implementation of this alternative to human health and safety would be minimal. Implementation would not expose people to potential health hazards. Use of firearms and avicide bait would be by trained professionals and within defined geographic areas that are generally away from human populations. It is consistent with existing health and safety regulations. It would have limited beneficial impacts through improved trash containment and reduction of unauthorized dumps which would reduce the possible spread of disease.

The cumulative impacts to recreation would also be minimal. There are numerous types of recreational opportunities available throughout the millions of acres of public land (e.g. BLM, NPS, and California State Parks) in the California desert. Implementation of this action may restrict the public from fully using a small number of sites. This action would also provide a benefit by increasing wildlife viewing opportunities in the future. We are unaware of any other actions that would adversely or beneficially impact recreation opportunities other than those currently implemented by federal and state agencies in their land management plans.

4.10.2 U.S. Environmental Protection Agency (U.S. EPA) Guidance on Cumulative Impacts

The U.S. EPA has identified criteria they use to analyze all aspects of the natural environment when reviewing NEPA documentation. These criteria focus on ecological and evolutionary processes, such as natural disturbance regimes, hydrological processes, nutrient cycles, and biotic interactions. These processes summarize and capture the cumulative effects at the landscape scale. As a practical matter, the guidance suggests that environmental assessments should focus on ecological processes and how they can be affected by various stressors (U.S. EPA 1999).

The 10 ecological processes identified by the U.S. EPA that we evaluated to determine potential cumulative effects on the habitat and ecological resources are discussed as follows:

a. Habitats Critical to Ecological Processes–Loss of keystone habitats, such as desert springs, California native grasslands, Southern California coastal sage scrub, and California riparian forests and wetlands are not expected to be impacted because no construction or ground-disturbing activities are planned as part of this proposed action.

b. Patterns and Connectivity of Habitat Patches–Since no new construction, ground-disturbing activities, or changes in land use are planned, there would be no expected loss of rare habitats or connectivity among habitat patches, or change in homogeneity across the landscape.

c. Natural Disturbance Regimes–No natural disturbance regimes such as fire, flood, or insect infestations, or ground-disturbing activities would be expected to result from the proposed action. Increases to water sources, streams that would increase the vegetation in the desert climate, are not planned; as such additional fire sources or food sources for insects would not be expected.

d. Structural Complexity–Loss or reduction of components that create structural diversity, such as coarse woody debris, Joshua trees, and downed trees; reduced structural complexity in riparian areas; and reduced complexity of micro-site structures are not be anticipated because no new ground-disturbing activities are planned in these areas.

e. Hydrologic Patterns–Changes in water chemistry, including temperature changes, reduced infiltration, increased surface flow, or greater variation in flow frequencies and volumes, would not be expected. Construction activities that might alter the hydrologic patterns are not planned as part of the proposed action.

f. Nutrient Cycling–Because of the limited scope of the proposed action, contact with the habitat would be limited; a disruption of feedback loops that conserve and recycle nutrients, increase leaching of nutrients from the system, or alter levels and normal patterns of variation of nutrients would not be expected.

g. Purification Services–The method by which the ecosystem breaks down waste and detoxifies contaminants and the ability of the system to process waste materials, toxics, or other contaminants would not be affected. Any waste materials generated as part of the proposed action would be managed and disposed following specific federal and state guidelines.

h. Biotic Interactions–Some changes to nontarget species are expected. The current common raven population in the California desert is at a historically high level with an increasing trend for the last few decades. Increasing the survivorship of the desert tortoise is a goal of this proposed action, and the reduced predation pressure is expected to increase the survivorship of hatchling and juvenile desert tortoises. Other wildlife species that are prey for the common raven would also be expected to benefit with increased survivorship.

i. Population Dynamics–Mechanisms that tend to lessen fluctuations in populations, greatly increase populations (equals overpopulation), irruptions, and cause population crashes would not be affected because of the extremely limited contact by professionally training biologists as noted previously.

j. Genetic Diversity–Loss of genotypes, a reduction in generic variation, and genetically based deformities and reproduction dysfunction would not be expected because activities would be very limited, thus minimizing any potential for affecting genetic diversity.

We looked at these cumulative effects of the six alternatives to these ecological processes and determined that they do not apply.

4.10.3 USFWS Guidance on Analysis of Threats to Listed Species

For the cumulative impacts under the USFWS guidelines, we will focus discussion on the resource issues for target species (the common raven) and nontarget species (the desert tortoise and other wildlife). For these issues we have identified potential cumulative impacts to habitat degradation, habitat loss, exotic species, disease/contaminants, and mortality/reduced reproduction. Tables 4-6a and 4-6b summarize the USFWS guidance on analysis of threats to listed species associated with common raven management projects.

4.10.3.1 Common Raven

4.10.3.1.1 Past Actions

Habitat Degradation/Habitat Loss

In this document, we are defining habitat degradation and habitat loss as the alteration and/or removal of native habitat in the California desert. For the common raven, past federal land management actions that have impacted the common raven through habitat degradation and loss include inadvertently providing increased food, water, and nest and roost sites in the California desert to support the needs of a growing human population in the desert or to support agency missions. While these land management actions have degraded or destroyed native habitat in the California desert, this habitat modification has impacted the common ravens by providing this species with these life requisites previously not present on a sustainable basis in the California desert.

Exotic Species

In the past, there was little knowledge of, recognition of, or concern for the impacts that might result from the introduction of exotic species to the California desert by land management agencies. Regulated management activities provided opportunities for unintentional importation of exotic plant and animal species from outside the California desert as regional and interstate commerce from activities such as grazing and mining promoted the transport of goods into and out of the desert. During the last few decades, federal land management agencies have become aware of this impact and have implemented actions in their management plans to reduce the likelihood of new species being introduced in the future. These unintentional introductions of exotic plant and animal species to the California desert do not appear to have impacted the common raven.

Disease/Contaminants

We are unaware of any disease or contaminant issues associated with common raven management projects in the past. Past actions by the BLM to reduce predation by the common raven in the California desert are discussed in Section 3 of Appendix D. As part of this effort, the avicide DRC-1339 was used for 6 days in 1989 at the Desert Tortoise Natural Area in Kern County and the Marine Corps Air Ground Combat Center near Twenty Nine Palms. Because of

Table 4-6a. Summary of Fish and Wildlife Guidance on Analysis of Threats to Listed Species Associated with Common Raven Management Projects: Common Ravens (Target Species)

Fish and Wildlife Service Concerns	Past	Present	Alternatives Plus Reasonably Foreseeable Action					
			Alternative A (Status Quo)	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Habitat degradation	Increased food, water, and nest resource from human development	Increased food, water, and nest resource from human development	**Minor Beneficial**, Increased food, water, and nest resource from human development	**No Effect**, no ground disturbing activities are proposed	**No Effect**, no ground disturbing activities are proposed	**No Effect**, no ground disturbing activities are proposed	**No Effect**, no proposed ground disturbing activities are	**No Effect**, no ground disturbing activities are proposed
Habitat loss	Increased food, water, and nest resource from human development	Increased food, water, and nest resource from human development	**Minor Beneficial**, Increased food, water, and nest resource from human development	**No Effect**, no ground disturbing activities are proposed	**No Effect**, no ground disturbing activities are proposed	**No Effect**, no ground disturbing activities are proposed	**No Effect**, no ground disturbing activities are proposed	**No Effect**, no ground disturbing activities are proposed
Exotic species	Management activities inadvertently introduced exotic species to California desert (e.g., grazing)	Relative number of new introduced species is low	**No Effect**, Relative number of new introduced species is low; no documentation of impacts to ravens from their occurrence	**No Effect**, No known or anticipated exotic species that would be introduced and impact the raven	**No Effect**, No known or anticipated exotic species that would be introduced and impact the raven	**No Effect**, No known or anticipated exotic species that would be introduced and impact the raven	**No Effect**, No known or anticipated exotic species that would be introduced and impact the raven	**No Effect**, No known or anticipated exotic species that would be introduced and impact the raven
Disease and/or Contaminants	No known disease or contamination issues	Potential for West Nile virus near standing water sources	**Negligible Adverse**, Potential for West Nile virus near standing water sources	**Negligible Adverse**, Less than Alternative A because of better water management practices	**Negligible Adverse**, Less than Alternative A because of better water management practices	**Negligible Adverse**, Less than Alternative A because of better water management practices	**Negligible Adverse**, Less than Alternative A because of better water management practices	**Negligible Adverse**, Less than Alternative A because of better water management practices
Mortality/Reduced Reproduction	No known authorized take in project area except BLM program in 1989	No known authorized take in project area	**No Effect**, no known authorized take in project area	**Minimal Adverse**, Take of approximately 0.5 percent of total population; habitat for food, water, nesting, and roosting would be reduced	**Minimal Adverse**, Take of approximately 5 percent of total population; habitat for food, water, nesting, and roosting would be reduced	**Minor Adverse**, Take of approximately 8 to 19 percent of total population; habitat for food, water, nesting, and roosting would be reduced	**Minimal Adverse**, Habitat for food, water, nesting, and roosting would be reduced	**Minor Adverse**, Take of approximately 8 to 19 percent of total population; habitat for food, water, nesting,

Table 4-6b. Summary of Fish and Wildlife Guidance on Analysis of Threats to Listed Species Associated with Common Raven Management Projects: Desert Tortoise and Other Nontarget Species

Fish and Wildlife Service Concerns	Past	Present	Alternatives Plus Reasonably Foreseeable Action					
			Alternative A (Status Quo)	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Habitat degradation	Historic land management plans have authorized activities that have degraded habitat	Better management plans with limited ability to implement	**Minor Adverse**, Better management plans with limited ability to implement	**No Effect**, no ground disturbing activities are proposed	**No Effect,** no ground disturbing activities are proposed	**No Effect,** no ground disturbing activities are proposed	**No Effect,** no ground disturbing activities are proposed	**No Effect,** no ground disturbing activities are proposed
Habitat loss	Historically a small percentage lost because of implementation of land management plans	Existing management plans developed under stricter regulatory requirements	**Minor Adverse**, Existing management plans developed under greater regulatory requirements	**No Effect,** no ground disturbing activities are proposed	**No Effect,** no ground disturbing activities are proposed	**No Effect,** no ground disturbing activities are proposed	**No Effect,** no ground disturbing activities are proposed	**No Effect,** no ground disturbing activities are proposed
Exotic species	Management activities inadvertently introduced exotic species to California desert (e.g., grazing)	Relative number of new introduced species is low	**Minimal Adverse**, Relative number of new introduced species is low	**Minimal Adverse**, Potential inadvertent vehicle transport of nonnative species to the California desert	**Minimal Adverse**, Same as Alternative B but with greater number of vehicle trips	**Minimal Adverse**, Same as Alternative C but with greater number of vehicle trips	**Minimal Adverse**, Same as Alternative B but less vehicle trips Relative number	**Minimal Adverse**, Same as Alternative C but with greater number of vehicle trips
Disease and/or Contaminants	Pre-1990, no standard protocols in management plans to minimize disease transmission; effects of contaminants limited to widely scattered industrial sites	Disease transmission minimized through implementation of protocols; effects of contaminants limited to widely scattered industrial sites with improved industrial practices	**Negligible Adverse,** Disease transmission minimized through implementation of protocols; effects of contaminants limited to widely scattered industrial sites with improved industrial practices	**Negligible Adverse,** Disease transmission is minimized or eliminated through implementation of protocols; implementation of standard operating procedures would minimize potential for dispersal of contaminants; secondary poisoning from eating carcasses unlikely	**Negligible Adverse,** Disease transmission is minimized or eliminated through implementation of protocols; implementation of standard operating procedures would minimize potential for dispersal of contaminants; secondary poisoning from eating carcasses unlikely	**Negligible Adverse,** Disease transmission is minimized or eliminated through implementation of protocols; implementation of standard operating procedures would minimize potential for dispersal of contaminants; secondary poisoning from eating carcasses unlikely	**Negligible Adverse,** Disease transmission is minimized or eliminated through implementation of protocols	**Negligible Adverse,** Disease transmission is minimized or eliminated through implementation of protocols; implementation of standard operating procedures would minimize potential for dispersal of contaminants; secondary poisoning from eating carcasses unlikely

Table 4-6b. Summary of Fish and Wildlife Guidance on Analysis of Threats to Listed Species Associated with Common Raven Management Projects: Desert Tortoise and Other Nontarget Species (Concluded)

Fish and Wildlife Service Concerns	Past	Present	Alternatives Plus Reasonably Foreseeable Action					
			Alternative A (Status Quo)	**Alternative B**	**Alternative C**	**Alternative D**	**Alternative E**	**Alternative F**
Mortality/Reduced Reproduction	Historically management plans allowed some activities that resulted in mortality of wildlife	Existing management plans developed under stricter regulatory requirements	**Minimal Adverse,** Existing management plans developed under stricter regulatory requirements	**Minimal to Minor Beneficial and Negligible Adverse**, reduced raven predation on desert tortoises and other wildlife species; nesting and roosting habitat for large birds reduced	**Minimal to Minor Beneficial and Negligible Adverse**, more ravens removed, therefore less predation that in Alternative B; roosting and nesting habitat for large birds reduced	**Minimal to Minor Beneficial and Negligible Adverse**, more ravens removed, therefore less predation than in Alternatives B and C; nesting and roosting habitat for large birds reduced	**Minimal Beneficial and Negligible Adverse**, reduced raven predation on desert tortoises and other wildlife species but at much slower rate than Alternatives B, C, and D; nesting and roosting habitat for large birds reduced	**Minimal to Minor Beneficial and Negligible Adverse**, range of number of ravens removed as needed (same as Alternatives B, C, and D); reduced raven predation on desert tortoises and other wildlife species; nesting and roosting habitat for large birds reduced

Notes: 1. No Change or None–There are no impacts expected.
2. Negligible–The impacts are very small and possible, but not probable or likely to occur.
3. Minimal–The impacts are not expected to be measurable and are within the capacity of the impacted system to absorb the change, or the impacts can be compensated for with little effort and resources so the impact is not substantial.
4. Minor–The impacts are measurable, but are within the capacity of the impacted system to absorb the change, or the impacts can be compensated with limited effort and resources so the impact is not substantial.
5. Moderate–Potentially adverse impacts that are measurable but do not violate any laws or regulations and are within the capacity of the impacted system to absorb or can be mitigated with effort and/or resources so that they are not significant.
6. Major–Potentially adverse impacts that individually or cumulatively could be significant.

the careful and selective use of this avicide, short time period of use, limited location, and short persistence of this avicide in the environment, we would consider this avicide to be a contaminant with an impact limited to the time period of its application.

Mortality/Reduced Reproduction

Within the California desert, we are not aware of any land management plan or permitted action that authorized the mortality of the common raven in the California desert other than those discussed in Section 3 of Appendix D. Such authorization would have been required under the Migratory Bird Treaty Act and, more recently, the National Environmental Policy Act. The 1989 BLM plan was implemented for 6 days and removed approximately 120 birds.

4.10.3.1.2 Present Actions

Habitat Degradation/Habitat Loss

Present federal land management actions that impact the common raven regarding habitat degradation and loss are similar to those of the past. Development of desert habitat to support the needs of a growing human population in the desert or accomplish agency missions continues to occur. These actions result in a greater increase in food, water, nest sites, and roost sites in the California desert for the common raven. While these human activities continue to degrade or destroy native habitat in the California desert, this habitat modification has impacted the common raven by providing it with life requisites previously not present on a sustainable basis in the California desert. Exotic Species

The current federal land management plans for the California desert include provisions for the implementation of these provisions continues to improve although there are still opportunities for unintentional importation of exotic plant and animal species from outside the California desert through visitors from outside the area and federal agencies conducting business activities. For example, we have the opportunity to introduce and spread exotic species in the California desert through transport of vehicles with seeds or plant parts imbedded in the tread of vehicle tires, trapped in the grills or other crevices of vehicles, or imbedded in mud or dirt on vehicles. These unintentional introductions of exotic plant and animal species to the California desert do not appear to have adversely impacted the common raven or its habitat requirements.

Disease/Contaminants

For disease, there is potential for WNV to adversely impact common ravens. West Nile virus was introduced in North America in 1999. As of 2005, WNV has been documented in desert communities in San Bernardino, Los Angeles, Kern, and Riverside counties. Since the potential exists for common ravens to contact mosquitoes that carry the virus when near standing water sources and the disease is potentially fatal to common ravens, the disease could impact the raven population in the desert by killing a proportion of the population. However, there has been little documentation that the disease has impacted the population through a reduction in population size.

We are not aware of any current contaminants issues in the California desert that would contribute to cumulative impacts to the common raven.

Mortality/Reduced Reproduction

Within the California desert, we are not aware of any land management plan or permitted action authorizing the mortality of the common raven in the California desert. Such action would require authorization under the Migratory Bird Treaty Act and National Environmental Policy Act. We contacted the Office of Migratory Birds and APHIS-WS to determine if a permit has been issued to remove common ravens or if there are current or recent activities to remove common ravens in the California desert. Neither agency has information on the implementation of programs to reduce the number of ravens in the California desert. Raven removal is occurring at other locations in the state and in adjacent states, primarily associated with loss of agriculture and livestock.

4.10.3.2 Comparison of Alternatives under USFWS Guidelines

4.10.3.2.1 Alternative A, Status Quo (Common Raven)

The cumulative impacts to the common raven associated with common raven management projects are expected to be the same as those described above in Present Actions (Common raven), for habitat degradation, habitat loss, exotic species, disease, contaminants, and mortality. We have analyzed these impacts and determined that Alternative A (status quo) results in minor beneficial impacts for habitat degradation and loss, no effect for exotic species, negligible adverse impacts for disease/contaminants, and no effect for mortality/reduced reproduction.

4.10.3.2.2 Alternative B (Common Raven)

We have identified and reviewed federal planning documents for the California desert (Appendix E) and are aware of the general management plans for the counties of Imperial, Inyo, Kern, Los Angeles, Riverside, and San Bernardino. We have identified large-scale land use action that would alter the current land use. The large-scale proposed actions include the expansion of the National Training Center at Ft. Irwin, the residential development of the Sunland area southwest of Barstow, and the agricultural/industrial development in the Harper Lake area (e.g., Harper Lake Dairy Park). Numerous small residential, commercial, industrial, and agricultural developments are proposed throughout the counties listed above and within the city limits of many desert municipalities. For the California desert, however, we were unable to identify any current or proposed plans that are similar to the proposed action in this EA.

Habitat Degradation/Habitat Loss

There would be no alteration or removal of native desert habitat; therefore, there would be no habitat degradation from implementation of raven management activities on federal lands. No new ground disturbance activities are proposed that would contribute to native habitat loss, therefore, there would be no impact from habitat loss.

Exotic Species

The implementation of common raven management projects described under this alternative could result in potential inadvertent transport in vehicles of nonnative species to the California desert. However, current federal land management plans for the California desert include provisions for the consideration of and management to reduce or avoid introduction and establishment of exotic species. Because of the continued opportunity to introduce exotic species to the area, we consider this impact to be minimal and adverse.

Disease/Contaminants

For disease, the impact from this alternative when considered with other raven management projects would be negligible and adverse. There is potential for WNV to adversely impact common ravens. West Nile Virus was introduced in North America in 1999. As of 2005, WNV has been documented in desert communities in San Bernardino, Los Angeles, Kern, and Riverside counties. While the disease is potentially fatal to common ravens, there has been little documentation that the disease has had an adverse impact on the population. This potential would be less than for Alternative A because federal agencies would implement better water management practices to reduce or eliminate standing water from human sources.

The use of an avicide to remove common ravens could be considered a contaminant. However, its placement, monitoring, and limited toxicity over time should minimize its impacts to target individual ravens. We are not aware of any other contaminants issues in the California desert that would contribute to cumulative impacts to the common raven. This impact would be negligible and adverse.

Mortality/Reduced Reproduction

Within the California desert, we would propose to remove a maximum of approximately 0.5 percent of the adult population of common ravens/2.4 percent of the adult and nestling population. We are not aware of any other proposed or existing land management plan or permitted action that authorizes the mortality of the common raven in the California desert. Such action would require authorization under the Migratory Bird Treaty Act and National Environmental Policy Act. We contacted the Office of Migratory Birds and USDA Wildlife Services to confirm this information. Neither agency has information on the implementation of programs to reduce the number of ravens in the California desert. Raven removal is occurring in other locations in the state and in adjacent states, primarily associated with loss of agriculture and livestock. Additional impacts to the common raven would occur from implementation of actions to reduce human subsidies of food, water, nest sites, and roost sites for the raven on federal lands in the California desert and from removing unoccupied raven nests. This should impact the common raven by reducing reproductive success.

4.10.3.2.3 Alternative C (Common Raven)

The cumulative impacts to the common raven associated with common raven management projects are expected to be the similar as those described above in Alternative B (Common Raven), for habitat degradation, habitat loss, exotic species, and disease/contaminants. The impacts would be greater for mortality/reduced reproduction.

Mortality/Reduced Reproduction

Within the California desert, we would propose to remove a maximum of approximately 5.3 percent of the total population of common ravens. We are not aware of any other proposed or existing land management plan or permitted action that authorizes the mortality of the common raven in the California desert. Such action would require authorization under the Migratory Bird Treaty Act and National Environmental Policy Act. We contacted the Office of Migratory Birds and Wildlife Services to confirm this information. Neither agency has information on the implementation of programs to reduce the number of ravens in the California desert. Raven removal is occurring in other locations in the state and in adjacent states, primarily associated with loss of agriculture and livestock. Additional impacts to the common raven would occur from implementation of actions to reduce human subsidies of food, water, nest sites, and roost sites for the raven on federal lands in the California desert and from removing unoccupied raven nests.

4.10.3.2.4 Alternative D (Common Raven)

The cumulative impacts to the common raven associated with common raven management projects are expected to be the similar as those described above in Alternative C (Common raven), for habitat degradation, habitat loss, exotic species and disease/contaminants. The impacts would be greater for mortality/reduced reproduction.

Mortality/Reduced Reproduction

Within the California desert, we would propose to remove a maximum of approximately 8 to 18.7 percent of the total population of common ravens. We are not aware of any other proposed or existing land management plan or permitted action that authorizes the mortality of the common raven in the California desert. Such action would require authorization under the Migratory Bird Treaty Act and National Environmental Policy Act. We contacted the Office of Migratory Birds and Wildlife Services to confirm this information. Neither agency has information on the implementation of programs to reduce the number of ravens in the California desert. Raven removal is occurring in other locations in the state and in adjacent states, primarily associated with loss of agriculture and livestock. Additional impacts to the common raven would occur from implementation of actions to reduce human subsidies of food, water, nest sites, and roost sites for the raven on federal lands in the California desert and from removing unoccupied raven nests. This should impact the common raven by reducing reproductive success.

4.10.3.2.5 Alternative E (Common Raven)

The cumulative impacts to the common raven associated with common raven management projects are expected to be the similar as those described above in Alternative B (Common Raven), for habitat degradation, habitat loss, exotic species, and disease/contaminants. The impacts would initially be less for mortality/reduced reproduction but similar after several years.

4.10.3.2.5.1 Mortality/Reduced Reproduction

Within the California desert, there would be no authorized mortality from federal management actions. We are not aware of any other proposed or existing land management plan or permitted action that authorizes the mortality of the common raven in the California desert. Such action would require authorization under the Migratory Bird Treaty Act and National Environmental Policy Act. We contacted the Office of Migratory Birds and USDA Wildlife Services to confirm this information. Neither agency has information on the implementation of programs to reduce the number of ravens in the California desert. Raven removal is occurring in other locations in the state and in adjacent states, primarily associated with loss of agriculture and livestock. Additional impacts to the common raven would occur from implementation of actions to reduce human subsidies of food, water, nest sites, and roost sites for the raven on federal lands in the California desert and from removing unoccupied raven nests. This should impact the common raven by reducing reproductive success.

4.10.3.2.6 Alternative F (Common Raven)

The cumulative impacts to the common raven associated with common raven management projects are expected to be the similar as those described above in Alternatives B, C, and D (Common Raven)**,** for habitat degradation, habitat loss, exotic species, disease/contaminants, and mortality/reduced reproduction.

4.10.3.3 Desert Tortoise and Other Nontarget Species

4.10.3.1.1 Past Actions

4.10.3.3.1.1 Habitat Degradation/Habitat Loss

Federal historic land management plans have authorized activities that have degraded desert habitat or did not address activities that degraded or destroyed habitat. Habitat management and conservation on federal lands became a regulatory requirement in the 1970s with the passage of several environmental laws. A smaller percentage of the existing habitat was lost because of implementation of land management plans. Lands were needed to implement agency missions and provide for the needs of a small but growing population in the area.

4.10.3.3.1.2 Exotic Species

In the past, there was little knowledge of, recognition of, or concern for the impacts that might result from the introduction of exotic species to the California desert by land management agencies. Regulated management activities provided opportunities for unintentional importation of exotic plant and animal species from outside the California desert as regional and interstate commerce from activities such as grazing and mining promoted the transport of goods into and out of the desert. During the last few decades, federal land management agencies have become aware of this impact and have implemented actions in their management plans to reduce the likelihood of new species being introduced in the future.

4.10.3.3.1.3 Disease/Contaminants

In the past, many wildlife diseases that are known to occur in species in the California desert were not known or had not been transmitted to species in the desert. Prior to the early 1990s, there were no standard protocols in management plans to minimize the transmission of known or unknown diseases from handling desert species. This practice recently changed with the identification of wildlife diseases (e.g., Upper Respiratory Tract Disease, Newcastle’s disease, WNV) and development of protocols to minimize the probability of transmission.

The effects of contaminants on the desert tortoise and other wildlife species are limited to industrial sites scattered throughout the California desert. Some of these sites are past mining operations that used contaminants to process materials (e.g., cyanide or other hazardous chemicals) or were found in conjunction with or are byproducts of processing the ore (e.g., arsenic). These contaminants would impact the desert tortoise and other wildlife species in the form of injury, disease, or mortality. These contaminants and their impacts would have occurred on an infrequent basis and scattered throughout the desert.

4.10.3.3.1.4 Mortality/Reduced Reproduction

In the past, activities regulated under land management plans allowed activities that incidentally killed wildlife species. This mortality was not regulated or disclosed until passage of several environmental laws in the 1970s and the listing of the desert tortoise under the Endangered Species Act in 1989. The impacts to wildlife species from this mortality would have been a reduced population size at and near the locations of these activities.

4.10.3.3.2 Present Actions

4.10.3.3.2.1 Habitat Degradation/Habitat Loss

Current federal land management plans have included recent scientific knowledge plus stricter regulatory requirements to manage and monitor for the desert tortoise and other nontarget species. The full implementation of many of these plans has been hampered by reduced funding. The increased demand for land use to support the needs of a growing human population in and adjacent to the desert and accomplish agency missions continues to occur. Thus, habitat degradation and loss continues from both authorized and unauthorized activities with limited ability to monitor and enforce. A smaller percentage of the existing habitat is lost because of implementation of land management plans under stricter regulatory requirements. However, there is no overall coordination in the development of these management plans which results in a patchwork of development actions scattered throughout much of the desert. For the desert tortoise and other wildlife species, this impact from present action continues to result in degradation and loss of native desert habitat.

4.10.3.3.2.2 Exotic Species

The current federal land management plans for the California desert include provisions for the consideration of and management to reduce or avoid introduction and establishment of exotic species. The implementation of these provisions continue to improve although there are still opportunities for unintentional importation of exotic plant and animal species from outside the California desert from visitors from outside the area and federal agencies conducting business activities. Because of the continued opportunity to introduce exotic species to the California desert and the difficulty in managing established exotic species, the impacts to wildlife species including changes in forage species abundance and composition, availability of less nutritious species for food, reduction or loss of shade and cover provided by plants, increased frequency of fire, and type conversion of dominant woody species to other habitat types.

4.10.3.3.2.3 Disease/Contaminants

Currently disease transmission has been minimized or eliminated from the development and implementation of standard protocols. Federal agencies usually require the use of standard protocol in permits and other authorizing documents they issue. The present impact from disease transmission and spread has been greatly reduced or eliminated from implementation of these protocols.

The impacts of contaminants to the desert tortoise and other wildlife species are limited to industrial sites scattered throughout the California desert. Some of these sites are existing mining operations that use contaminants to process materials (e.g., cyanide or other hazardous chemicals) or are found in conjunction with or are byproducts of processing the ore (e.g., arsenic). These contaminants would impact the desert tortoise and other wildlife species in the form of injury, disease, or mortality. These contaminants and their impacts have occurred on an infrequent basis and scattered throughout the desert.

4.10.3.3.2.4 Mortality/Reduced Reproduction

Current land management plans have been developed and are being implemented under environmental legislation that places stricter requirements on minimizing or avoiding mortality to wildlife species. The impacts to wildlife species in the form of mortality should be less on a per project basis than in the past. However, the number of projects currently in place and in process is greater than that in the past. Impacts to the desert tortoise and other wildlife species continue to occur in the form of mortality.

4.10.3.4 Comparison of Alternatives under USFWS Guidelines

4.10.3.4.1 Alternative A (Status Quo)

The cumulative impacts to the desert tortoise and other nontarget species associated with common raven management projects are expected to be the same as those described above in Present Actions (Desert Tortoise and Other Nontarget Species), for habitat degradation, habitat loss, exotic species, disease/contaminants, and mortality/reduced reproduction. We have analyzed these impacts and determined that Alternative A (status quo) results in minor adverse impacts for habitat degradation and loss, minimal adverse impact for exotic species, negligible adverse impacts for disease/contaminants, and minimal adverse impacts to mortality/reduced reproduction.

4.10.3.4.2 Alternative B (Desert Tortoise and Other Nontarget Species)

4.10.3.4.2.1 Habitat Degradation/Habitat Loss

There would be no impact to habitat degradation from implementation of raven management activities on federal lands. No new ground disturbance activities are proposed that would contribute to habitat degradation. No desert habitat loss would occur from implementation of raven management activities. The impacts to habitat loss would be none for the desert tortoise and negligible adverse for other target species. The implementation of actions to reduce human-subsidized food, water, nest sites, and roost sites on federal lands in the California desert would be negligible and beneficial for the desert tortoise and other nontarget species.

4.10.3.4.2.2 Exotic Species

The implementation of common raven management projects described under this alternative could result in potential inadvertent transport in vehicles of nonnative species to the California desert. However, current federal land management plans for the California desert include provisions for the consideration of and management to reduce or avoid introduction and establishment of exotic species. Because of the continued opportunity to introduce exotic species to the area, we consider this impact to be minimal and adverse.

4.10.3.4.2.3 Disease/Contaminants

For disease, the impact from this alternative when considered with other raven management projects would be negligible and adverse. Disease transmission would be minimized or eliminated by implementing standard protocols. Federal agencies would require the use of standard protocol in permits and other authorizing documents they issue. The present impact from disease to desert tortoise and other nontarget species is negligible and adverse.

The use of the avicide to remove common ravens could be considered a contaminant. However, its placement, monitoring, and limited toxicity over time and to most other species would minimize its impact to nontarget species. This impact would be considered negligible and adverse.

4.10.3.4.2.4 Mortality/Reduced Reproduction

Within the California desert, the implementation of management actions would result in the reduction of ravens that prey on the desert tortoises. These ravens would also likely prey on other species of small wildlife so the rate of predation on these species would also be reduced. Reduced predation or reduced mortality would result in a minimal to minor beneficial impact for the desert tortoise and other nontarget species. However, the number of man-made sites available for use by large birds for nesting and roosting would be reduced. This would result in a negligible adverse impact for these species.

4.10.3.4.3 Alternative C (Desert Tortoise and Other Nontarget Species)

The cumulative impacts to the desert tortoise and other nontarget species associated with common raven management projects are expected to be the similar as those described in Section 4.9.3.4.2, *Alternative B (Desert Tortoise and Other Nontarget Species)*, for habitat degradation, habitat loss, and disease/contaminants.

4.10.3.4.3.1 Exotic Species

The implementation of common raven management projects described under this alternative could result in potential inadvertent transport in vehicles of nonnative species to the California desert. This opportunity would be greater than for Alternative B because of the greater number of vehicle trips to the desert to remove a larger number of common ravens. However, current federal land management plans for the California desert include provisions for the consideration of and management to reduce or avoid introduction and establishment of exotic species. Because of the continued opportunity to introduce exotic species to the area, we consider this impact to be minimal and adverse.

4.10.3.4.3.2 Mortality/Reduced Reproduction

Within the California desert, the implementation of management actions would result in the removal of more common ravens than in Alternative B. This action would occur in the Desert Tortoise Management Areas. These ravens would likely prey on the desert tortoise and other species of small wildlife. Removal of these ravens would mean reduced predation or reduced mortality in the DTMAs for all prey species for the common raven. Thus, the impact greater than for Alternative B as more common ravens would be removed; it would be minimal to minor and beneficial for the desert tortoise and other nontarget species.

4.10.3.4.4 Alternative D (Desert Tortoise and Other Nontarget Species)

The cumulative impacts to the desert tortoise and other nontarget species associated with common raven management projects are expected to be the similar as those described in Section 4.10.5.2.3, *Alternative C (Desert Tortoise and Other Nontarget Species)*, for habitat degradation, habitat loss, and disease/contaminants.

4.10.3.4.4.1 Exotic Species

The implementation of common raven management projects described under this alternative could result in potential inadvertent transport in vehicles of nonnative species to the California desert. This opportunity would be greater than for Alternative C because of the greater number of vehicle trip into the desert to remove a larger number of common ravens. However, current federal land management plans for the California desert include provisions for the consideration of and management to reduce or avoid introduction and establishment of exotic species. Because of the continued opportunity to introduce exotic species to the area, we consider this impact to be minimal and adverse.

4.10.3.4.4.2 Mortality/Reduced Reproduction

Within the California desert, the implementation of management actions would result in the removal of ravens at Desert Tortoise Management Areas and raven concentration areas. These ravens would also likely prey on other species of small wildlife. Removal of these ravens would mean reduced predation or reduced mortality in the DTMAs and near concentration areas for desert tortoises and other nontarget wildlife species. Thus, the impact would be minimal to minor and beneficial for the desert tortoise and other nontarget species.

4.10.3.4.5 Alternative E (Desert Tortoise and Other Nontarget Species)

The cumulative impacts to the desert tortoise and other nontarget species associated with common raven management projects are expected to be the similar as those described above in Alternative B (Desert Tortoise and Other Nontarget Species), for habitat degradation and habitat loss.

4.10.3.4.5.1 Exotic Species

The current federal land management plans for the California desert include provisions for the consideration of and management to reduce or avoid introduction and establishment of exotic species. The implementation of these provisions continue to improve although there are still opportunities for unintentional importation of exotic plant and animal species from outside the California desert from visitors from outside the area and federal agencies conducting business activities. We would continue to monitor desert tortoise mortality near common raven nests but there would be no vehicle trips to remove ravens. The number of vehicle trips would be less than for Alternative B. However, there is the continued opportunity to introduce exotic species to the California desert and difficulty in managing established exotic species. The impact would be minimal and adverse.

4.10.3.4.5.2 Disease/Contaminants

For disease, the impact from this alternative when considered with other raven management projects would be negligible and adverse. Disease transmission would be minimized or eliminated by implementing standard protocols. Federal agencies would require the use of standard protocol in permits and other authorizing documents they issue. The present impact from disease to desert tortoise and other nontarget species is negligible and adverse.

No avicide or other potential contaminant would be used therefore there would be no impact from contaminants on nontarget species.

4.10.3.4.5.3 Mortality/Reduced Reproduction

Within the California desert, the implementation of management actions would result in the gradual reduction of ravens in the California desert over time. Some of these ravens would likely prey on desert tortoises. All would likely prey on other species of small wildlife. A reduction in predation would mean a reduction in mortality but this reduction would be slower and smaller than in alternatives B, C, or D. Thus, the impact would be minimal and beneficial for the desert tortoise and other nontarget species.

4.10.3.4.6 Alternative F- (Desert Tortoise and Other Nontarget Species)

The cumulative impacts to the desert tortoise and other nontarget species associated with common raven management projects are expected to be the similar as those described above in Alternatives B, C, and D (Desert Tortoise and Other Nontarget Species), for habitat degradation, habitat loss, exotic species, disease/contaminants, and mortality/reduced reproduction.

4.11 Related Environmental Documents

The following plans that contain similar or related actions concerning raven control and desert tortoise management were identified. Many of the activities recommended in the proposed action can be found in these documents. While all of these plans have addressed desert tortoise declines, the combined effect has not stopped the decline in desert tortoise populations and additional actions are considered necessary.

a. BLM Land Management Plans for the California Desert Conservation Area–The BLM uses the California Desert Conservation Area (CDCA) Plan and Amendments to guide management on the lands it administers. Any decisions made as a result of this EA process would be consistent with the guidance in the CDCA Plan and Amendments and the Federal Land Policy and Management Act of 1976.

b. Death Valley National Park General Management Plan–The subject plan was completed in 2002. This document guides the management of lands administered by the NPS within Death Valley National Park.

c. Joshua Tree National Park General Management Plan–The subject plan was completed in 1994 and amended in 2000. The amended document, Record of Decision Final General Management Plan Amendment EIS/Backcountry and Wilderness Management Plan, guides the management of lands administered by the NPS within Joshua Tree National Park.

d. Mojave National Preserve General Management Plan–The subject plan was completed in 2002. This document guides the management of lands administered by the NPS within the Mojave National Preserve.

e. Programmatic Environmental Impact Statement–The APHIS-WS, formerly called Animal Damage Control (ADC), issued a Final EIS on the national APHIS-WS program (USDA 1997, revised). This EIS addressed an ongoing program of wildlife damage management. Information in the Final EIS that is pertinent to the alternatives in this EA has been incorporated by reference.

f. Master Memorandum of Understanding (MOU) between APHIS and BLM–This MOU specifies that all programs for animal damage management on lands administered by BLM would be coordinated with appropriate state and federal agencies prior to implementation. APHIS-WS would develop and update work plans for animal damage management annually in cooperation with the BLM and other appropriate agencies. APHIS-WS and BLM would identify restrictions for human safety or other mitigation that should be implemented to comply with the BLM's existing Land Management Plans.

g. Integrated Natural Resources Management Plans–Each of the six military installations within the California desert (Naval Air Weapons Station China Lake [NAWS], Edwards Air Force Base, National Training Center [NTC] at Fort Irwin, Marine Corps Logistics Base [MCLB] Barstow, Marine Corps Air Ground Combat Center Twentynine Palms [MCAGCC], and Chocolate Mountains Aerial Gunnery Range) is required to maintain and implement an Integrated Natural Resources Management Plan (INRMP).

The purpose of each INRMP is to develop and follow a prescribed planning process for the management of natural resources on the individual installation. Development and implementation of the INRMP must support military mission readiness by ensuring that lands and airspace are available for sustained use. This process meets statutory requirements under the Sikes Act Improvement Act (SAIA), Public Law 105-85, Div. B Title XXIX, Nov. 18, 1997, 111 Statutes 2017–2019, 2020–2033. This Act requires the Secretaries of the Army, Air Force, and Navy to prepare and implement INRMPs for each military installation, unless exempted due to the absence of significant natural resources.

Each installation coordinates with the USFWS and the CDFG to ensure that each INRMP reflects the mutual agreement of these parties on conserving, protecting, and managing natural resources on each installation. As required by the SAIA, the INRMPs are provided for public comment.

h. County General Plans–California state law requires each county to prepare and adopt a comprehensive and long-range general plan for its physical development (Government Code Section 65300). A comprehensive general plan provides the County with a consistent framework for land use decision-making. Traditionally, the general plan has been organized as a collection of "elements" or subject categories such as land use, housing, conservation, noise, circulation, open space, and safety. The conservation element addresses the conservation, development, and use of natural resources including water, forests, soils, rivers, and mineral deposits. The open-space element details plans and measures for preserving open space for natural resources, the managed production of resources, outdoor recreation, public health and safety, and the identification of intensive agriculture and irrigated pasturelands. For the California desert there are five counties each with a county general plan for these elements. These plans are: Imperial County General Plan, Inyo County General Plan, Kern County General Plan, Los Angeles County General Plan (Antelope Valley), Riverside County General Plan, and San Bernardino County General Plan.

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APPENDIX A
BIOLOGICAL INFORMATION ON THE DESERT TORTOISE *(GOPHERUS AGASSIZII)* AND COMMON RAVEN (*CORVUS CORAX*)

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1.0 DESERT TORTOISE

1.1 Morphology and Genetics

The adult desert tortoise (Figure A-1) is a medium-sized, herbivorous land turtle in the family Testudinidae. The shell is high-domed, light brown to very dark brown in color with brown to orange or yellow in the centers of the scutes, particularly in young animals. The skin is dry and scaly with thick, stumpy, elephantine hind legs. The gular horn is a projection located at the anterior end of the plastron (that portion of the shell on the underside of the desert tortoise) and is more pronounced in adult males than females. Desert tortoises exhibit secondary sexual characteristics only after reaching adult size. These characteristics include a concave plastron, chin glands, a longer gular horn, and a longer tail. Males are usually larger than females. Adult desert tortoises weigh 10+ pounds and maximum length is from 11 to 16 inches (maximum carapace length [MCL]) for females and males (Boarman 2002). The carapace is the top portion of the shell.

Figure A-1. Adult Desert Tortoise (*Gopherus agassizii*)

The desert tortoise exhibits significant morphological and genetic variation throughout its range. Based on genetic and morphological criteria, *G. agassizii* is divided into at least two well-differentiated entities, one south and east of the Colorado River or the Sonoran population, and one north and west of the Colorado River or the Mojave population. The U.S. Fish and Wildlife Service listed the Mojave population of the desert tortoise as threatened (*Federal Register* April 2, 1990). The USFWS also identified six population segments or recovery units in the *Recovery Plan for the Desert Tortoise Mojave Population* (USFWS 1994). Each recovery unit represents significant adaptive variation within the species based on ecology, behavior, morphology, and genetics (Figure A-2).

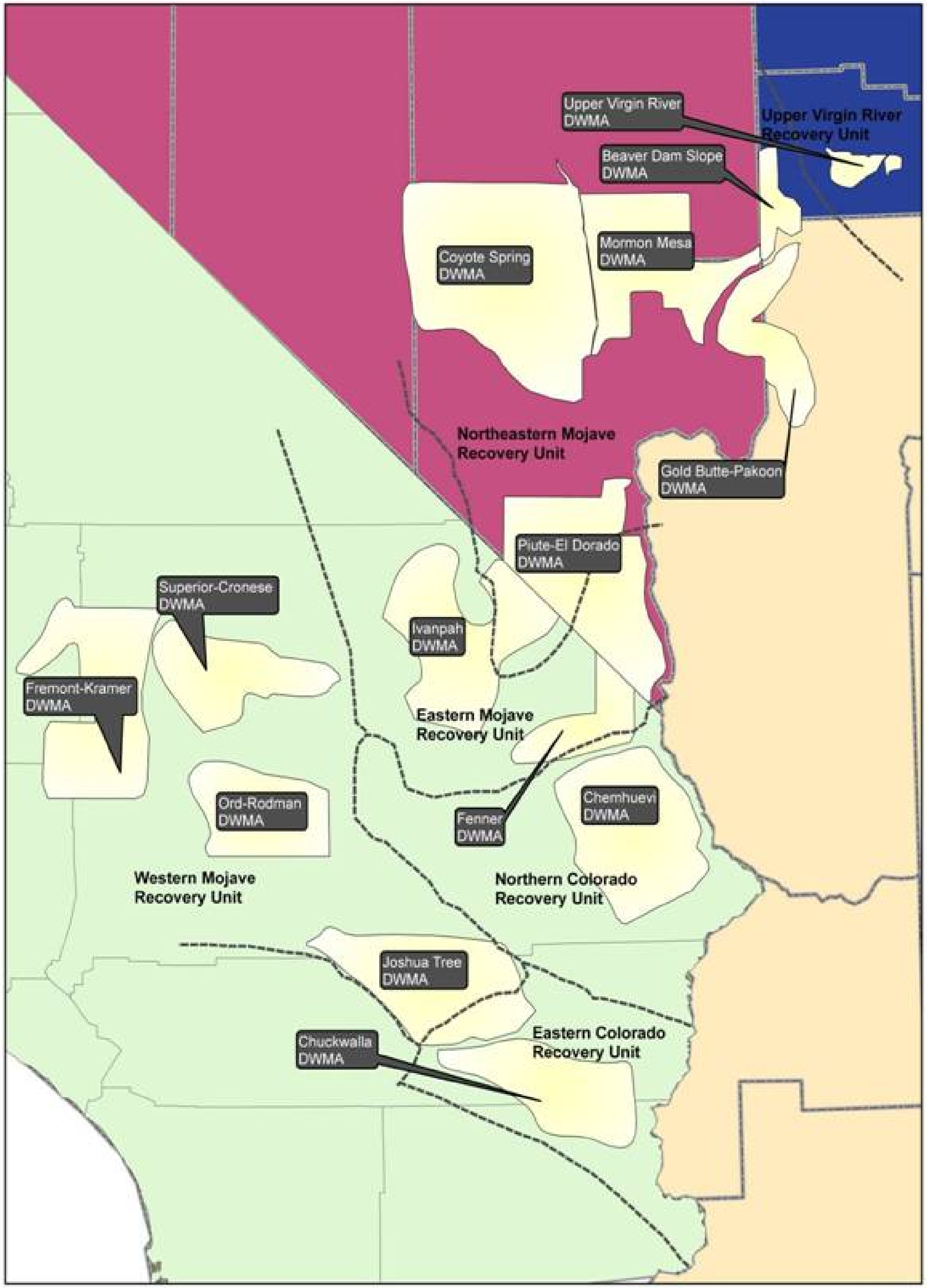

Figure A-2. Map of Recovery Units and Desert Wildlife Management Areas (DWMAs) in the *Recovery Plan for the Desert Tortoise Mojave Population*.

1.2 Range

Desert tortoises occur in suitable habitat in the Mojave and Sonoran deserts from southeastern California, southern Nevada, and extreme southwestern Utah, through western and southern Arizona, western Sonora and Sinaloa, Mexico. In California, desert tortoises occur in the desert from below sea level to an elevation of 7,300 feet, but the most favorable habitat occurs at elevations of approximately 1,000 to 4,000 feet (Luckenbach 1982, Schamberger and Turner 1986). No other land turtle occurs within the range of the desert tortoise.

1.3 Habitat

Habitat for the desert tortoise includes well-drained sandy loam soils of flats, valleys, alluvial fans, rolling hills, and occasionally rocky outcrops and mountain slopes in the California desert. They may also occur along the edges of basaltic flow, other rock outcrops, and lower elevation slopes of mountains. Desert tortoises typically avoid plateaus, playas, sand dunes, and steep slopes. They prefer areas with soils composed of sand and fine gravel versus coarse gravel, pebbles, and desert pavement (Weinstein 1989).

In California, the desert tortoise occurs primarily within the creosote, shadscale, and Joshua tree series of the Mojave desert scrub, and the lower Colorado River Valley subdivision of Sonoran desert scrub. Optimal habitat has been characterized as creosote bush scrub in which precipitation ranges from 2 to 8 inches, diversity of perennial plants is relatively high, and production of native annual plants is high (Luckenbach 1982, Turner and Brown 1982, Schamberger and Turner 1986). In one study in the western Mojave Desert, the greatest population densities of desert tortoises were in creosote bush scrub with lower densities occurring in Joshua tree woodland and Mojave-saltbush-allscale scrub. In the eastern Mojave Desert, desert tortoises showed a preference for woody bottle washer (*Camissonia boothii)*, popcorn flower (*Cryptantha angustifolia)*, desert dandelion (*Malacothrix glabrata)*, beavertail (*Opuntia basilaris)*, desert chicory (*Rafinesquia neomexicana)* and other species (Avery 1998). The native perennial bunchgrass, big galleta (*Hilaria [Pleuraphis] rigida*), is often present where the desert tortoise is most abundant.

Plant density and diversity play important roles in stabilizing soil, providing cover for protection from predators and temperature extremes, and providing adequate nutritional forage and water.

1.4 Reproduction

Desert tortoises are long-lived with delayed sexual maturity. Some individuals begin reproducing at 7.4 inches (180 mm) MCL, which they attain when about 12 to 15 years old. The majority of desert tortoises do not begin reproducing until they reach 8.2 inches MCL (208 mm), at approximately 12 to 20 years old (Turner and Berry 1984, Turner et al. 1986). Maximum longevity in the wild is likely to be about 50 to 70 years, the norm being 25 to 35 years (Germano 1992 and 1994). The average clutch size is 4.5 eggs (range 1 to 8), with 0 to 3 clutches laid per year (Turner et al. 1986). Clutch size and number probably depend on female size, water availability, and annual productivity of high quality forage plants in the current and previous year (Turner et al. 1984 and 1986, Henen 1997).

The life history strategy of the desert tortoise is longevity and ability to reproduce several times during its life. Under natural conditions, this strategy allows the species to persist despite the stresses of an extremely harsh and variable environment in the desert. The interaction of longevity, slow growth and late maturation, and relatively low annual reproductive output means that under the best circumstances desert tortoise populations recover slowly from natural- or human-caused losses in population density (USFWS 1994).

The desert tortoise mating system is probably polygynous (one male mating with many females), and it is polyandrous (one female mating with more than one male) (Murphy 2005). Choice of mate is mediated by aggressive male-male interactions and possibly by female choice (Niblick et al. 1994). Mating usually occurs in April and May when desert tortoises are active, and again in August through October if the right environmental conditions (i.e., temperature and food supply) are present. Most eggs are laid in spring (April through June) and occasionally in fall (September and October). Eggs are laid in sandy or friable soil, often at the mouth of the female's burrow or under a bush. Egg size is 37 to 47 mm by 36 to 46 mm (Berry 1975). The female excavates the nest (a hole in the ground), deposits the eggs, covers them, and urinates on the nest. There is no parental care. Most clutches contain 3 to 7 eggs. Hatching occurs 90 to120 days later, mostly in late summer and fall (mid-August to October). Sex determination of desert tortoises is environmentally controlled; hatchlings develop into females when the incubation temperature is greater than 89.3 degrees Fahrenheit (° F) (31.8 degrees Celsius [° C]) and males when the temperature is below that (Spotila et al. 1994). Mortality increases when incubation temperatures are greater than 95.5° F (35.3° C) or less than 78.8° F (26.0° C). The sensitivity of embryonic desert tortoises to incubation temperature may make populations vulnerable to changes in soil temperature (e.g., changes in vegetation cover or rising temperatures) (Boarman 2002).

Egg size is approximately 1.3 by 1.6 inches (35 mm by 45 mm) (Burge 1977) while hatchling size is slightly larger. Upon hatching underground in the summer or fall, the desert tortoise unfolds and absorbs its external yolk sac through the plastron. The newly hatched desert tortoise digs to the surface to escape the nest. The yolk sac is an initial reserve of nutrients upon which the desert tortoise depends until it is able to find forage; sometimes as long as the following spring. Hatchling desert tortoises resemble tiny versions of adults except they are usually lighter in color and do not have a bony or ossified shell to protect them from predators. They require shelter (e.g., burrows) to survive the desert extremes of temperature and humidity and for protection from predators. Eighty-three percent of hatchling desert tortoises excavated new burrows or enlarged preexisting rodent burrows in their first weeks (Niblick et al. 1994, Turner et al. 1984 and 1986, USFWS 1994).

1.5 Activity Period

Desert tortoises spend most of their time belowground in burrows they excavate, or they modify burrows of other animals. They emerge from their burrows during the day to look for food, regulate their body temperature, and to mate. Desert tortoises, including hatchling and juvenile desert tortoises, are most active in California during the spring and early summer when native annual plants, their food supply, are most common. Although they spend most of their lives underground to escape the extreme temperature and humidity conditions of the desert and for protection from predators, they become active in suitable weather at any time of the year; rainfall, particularly during the summer and early fall, often initiates activity. Desert tortoise activity patterns are primarily controlled by ambient temperature and precipitation (Nagy and Medica 1986, Zimmerman et al. 1994). Adult desert tortoises were aboveground with body temperatures ranging from 77 to 95° F 25 to 35° C. Desert tortoises may also be active during periods of mild or rainy weather in summer and winter. During the spring season in the Mojave Desert, desert tortoises were observed aboveground for 3 hours every fourth day and some tortoises did not feed for several weeks following spring emergence from cover sites (Behler and King 1979). During inactive periods, desert tortoises retreat to their burrows, and spend approximately 98 percent of the time in these cover sites (Marlow 1979, Nagy and Medica 1986). During active periods, they usually spend nights and the hotter or cooler part of the day in their burrows; they may also rest under shrubs or in shallow burrows.

Hatchling desert tortoises emerge from their winter burrows as early as late January to take advantage of freshly germinating annual plants. As plants grow taller during the spring, some species become inaccessible to small desert tortoises. Their greatest period of activity is late winter to spring. Hatchling desert tortoises have been observed aboveground in January with air temperatures below 55° F (13° C). Hatchling and juvenile desert tortoises are more likely to be active in less optimal weather than adults (Wilson et al. 1999).

1.6 Cover Sites

Desert tortoises depend on their burrows to escape the extreme effects of temperature, humidity, and to avoid predators (Brattstrom 1965, McGinnis and Voigt 1971). The desert tortoise usually excavates and uses several burrows per season. Juvenile desert tortoises are particularly prone to excavate multiple burrows (mostly under large shrubs), and use abandoned rodent burrows (Woodbury and Hardy 1948, Luckenbach 1982). Soils must be friable enough for digging of burrows, but firm enough so that burrows do not collapse. In California, desert tortoises are typically associated with gravelly flats or sandy soils with some clay, but are occasionally found in windblown sand or in rocky terrain (Luckenbach 1982). In the Mojave Desert, where a veneer of desert pavement may obscure the sandy loam soils, burrows are most often located in the banks of washes and arroyos under these conditions.

Burrows often extend from 1 to 8 feet in length and have a single opening. Desert tortoises use an average of 7 to 12 burrows at any given time (Barrett 1990, Bulova 1994, Burge 1977); some burrows may be used for relatively short periods and then are replaced by other burrows. Burrows may also collapse with a desert tortoise inside. In this situation, the desert tortoise then must excavate its way out of the collapsed burrow. Desert tortoises sometimes share a burrow with several other desert tortoises (Bulova 1994) or other species such as snakes, scorpions, and kit foxes. For the Mojave Desert, burrows tend to open under a creosote bush (59 to 77 percent of the time) or white bursage shrub (21 percent). Deeper burrows, more properly called dens, are extensive and up to 30 feet in length. These dens are used frequently in winter and are often subject to communal use by several individuals (Woodbury and Hardy 1948, Boarman 2002). These "caliche dens" are located in the sides of washes and below the caliche or calcium carbonate layer in the soil.

1.7 Home Range

Desert tortoise activities are concentrated in core areas, known as home ranges. Since they do not actively defend this entire area, it is considered a home range, not a territory. Annual home range sizes have been measured at 10 to 450 acres (4 to 180 ha) and vary with sex, age, season, and density or availability of resources. There is significant overlap of home ranges of different individuals (USFWS 1994). In years of higher than average precipitation, desert tortoises have larger home ranges than during dry years. During their life span, the size of a desert tortoise's lifetime home range is considerably larger than that of its annual home range. This expansion of home range may be influenced by availability and distribution of food or mates. Adult female desert tortoises also move great distances (e.g., several miles) within a short time and may return within a few months or a few years.

1.8 Food and Nutrition

In general, desert tortoises forage primarily on native winter and summer annual plants, perennial grasses, cacti, and perennial shrubs in descending order of preference. Although they will eat nonnative plants, desert tortoises generally prefer native forbs when available (Jennings 1993, Esque 1993, Avery 1998). The dietary preference may place them at a nitrogen- and water-deficit physiological state that may be exacerbated by drought (Oftadal, Hillard, and Morafka 2002). Optimal diet items include forbs, which are higher in protein, carbohydrates, lipids, calcium, crude fiber, and water and are low in potassium. Forbs known in desert tortoise diets include *Eriogonum inflatum, Astragalus nuttallianus, Plantago insularis, Erodium cicutarium, Krameria parvifolia, Amsinckia* spp., *Camissonia* spp., *Descurainea* spp., *Lotus* spp., *Lupinus* spp., *Malacothrix* spp., *Gilia* spp., *Mentzelia nitens*, and *Nama* spp. Annual grasses in desert tortoise diets are largely nonnatives and include *Bromus rubens, Schismus barbatus, Festuca octoflora*, and the native *Bouteloua barbata*. Perennial grasses provide not only food, but also provide shelter, soil retention, and a longer growing season; these species include *Hilaria (Pleuraphis) rigida, Muhlenbergia porteri*, and *Oryzopsis hymenoides*. *Sphaeralcea ambigua*, a shrub, is regularly ingested by the desert tortoise, and *Opuntia basilaris* buds, flowers, and fruits are also seasonally ingested (Berry 1978). Desert tortoises will eat many species of plants. However, at any time, most of their diet often consists of a few species (Nagy and Medica 1986, Jennings 1993). Additionally, their preferences can change during the course of a season (Avery 1998) and over several seasons (Esque 1993). Possible reasons for desert tortoises to alter their preferences may include changes in nutrient concentrations in plant species, the availability of plants, and the nutrient requirements of individual animals (Avery 1998, Oftedahl et al. 2002).

Desert tortoises may sometimes ingest high-calcium materials such as limestone pebbles, caliche from layers along embankments, soil, and bones. The ingestion of calcium is most frequently observed in adult females and possibly in growing juveniles (Esque and Peters 1994, Marlow and Tollestrup 1982).

1.9 Mortality

Sources of mortality include predation, disease, and malnutrition. Kit foxes (*Vulpes macrotus*) are predators of desert tortoise eggs (Coombs 1977). Coyotes (*Canis latrans*), kit foxes, common ravens, ground squirrels (*Spermopholus* sp.) and native fire ants are known predators of hatchling and juvenile desert tortoises (Ken Nagy, personal communication). Subadult and adult desert tortoises are prey for coyotes, kit foxes, bobcats (*Lynx rufus*), and mountain lions (*Felis concolor*), and domestic dogs (*Canis familiaris*).

Another source of mortality for the desert tortoise is disease. Disease is frequently the result of a suppressed immune system from other stresses in the environment, such as malnutrition. One disease is upper respiratory tract disease (URTD) which can be caused by mycoplasmosis or bacteria from the genus *Mycoplasma*, herpes virus, or other pathogens (Berry et al. 2006). Desert tortoises also suffer from shell disease or cutaneous dyskeratosis.

Human-caused or influenced sources of mortality include elevated levels of predation from common ravens and domestic dogs, shooting and vandalism, collecting, vehicle strikes on roads, and vehicle strikes of desert tortoises above and belowground by off-road vehicles. At certain locations, desert tortoises contain high levels of heavy metals such as mercury or arsenic, the source of which is believed to be nearby mining activities. These high levels of hazardous materials cause or contribute to poor health and mortality for the desert tortoise. Habitat degradation from soil surface disturbance (e.g., urban and agricultural development, mining, livestock grazing, or proliferation of roads) and the introduction of nonnative plant species with poor nutritional quality also cause or contribute to mortality.

A new cause of mortality to the desert tortoise is fire. A fire can kill a desert tortoise by burning the animal or from smoke inhalation. Fire will also destroy the habitat of the desert tortoise and cause the vegetation composition to change from native perennial shrubs and annual plants to nonnative annual plants. This is sometimes referred to as vegetation type conversion. Desert plant communities are not adapted to fire. With unsuitable vegetation present for cover and for forage, desert tortoises in the area die.

1.10 Desert Tortoise Population Trends

Population trend information is available from data collected at site locations and from data compiled across the range of the desert tortoise.

In 1994, the Recovery Plan presented data that showed populations of the desert tortoise in the western extent of the species' range were experiencing significant declines (USFWS 1994, Tracy et al. 2004). With the data available in the early 1990s, no trend in adult densities of desert tortoises was discernable. The population trend of the desert tortoise in the western Mojave Desert continues to decline and a downward trend has been documented for populations in the eastern Mojave Desert (Tracy et al. 2004).

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2.0 COMMON RAVEN

2.1 Morphology and genetics

Common ravens (*Corvus corax*) are the largest of all passerines or song birds (Figure A-3). They are in the same family as crows, jays, and magpies (Corvidae). The common raven is a large black conspicuous bird. It resembles the American crow in appearance, but is easily differentiated by larger body size, larger chisel-like bill, well-developed throat hackles, and a wedge-shaped tail. Sexes are similar in appearance. Life expectancy is 10 to 14 years.

Figure A-3. Adult Common Raven (*Corvus corax*).

There are four recognized subspecies in North America. The northernmost subspecies, *C. c. kamtschaticus* is a resident from northeast Siberia east to the Aleutian Islands and the Alaska Peninsula. *C. c. principalis* is a resident from north Alaska across Canada to Greenland and south to Oregon, northern Wisconsin, and the Appalachian Mountains of northern Georgia. *C. c. sinuatus* is a resident from southeast British Columbia and Montana south through the Great Plains and Great Basin and mainland Mexico to Nicaragua. *C. c. clarionensis* is a resident from northern California south through Baja California, east to southern Nevada and western Arizona. Common ravens occur throughout California, except for some areas of the Central Valley, parts of the central coast, and cultivated valleys of the south east (Small 1994). Common ravens in California are not known to migrate. Recent mitochondrial and microsatellite evidence indicates that common ravens in the southwest United States are genetically distinct from ravens in the rest of their range (Omland et al. 1999).

2.2 Range

Common ravens are found throughout major portions of North America, Europe, Asia, and North Africa (Boarman and Heinrich 1999). Common ravens are widespread throughout North America and can be found in Canada, Alaska, and the contiguous United States (west of the continental divide, and throughout the Appalachian Mountains of the eastern United States (Figure A-4).

2.3 Habitat

Common ravens are found in a wide range of natural habitat types, preferring areas with some vertical relief (e.g. cliffs, trees, or human-made structures) to provide nesting and foraging sites (Boarman and Heinrich 1999). They occur in a broad range of habitats including ice flows and high mountains, deciduous and coniferous forests, tundras, prairies, grasslands and deserts, isolated settlements and cities, and agricultural fields.

The common raven is highly adaptable to a wide range of habitats and foods. Consequently, they often respond positively to human-influenced environments. They thrive in many human-altered habitats (Kristan et al. 2004, Webb et al. 2004), including agricultural areas (Engel and Young 1989a), roadsides and linear rights-of-way (Knight and Kawashima 1993, Sherman 1993), ranches (Rothe et al. 1999), rangelands (Knight 1984), and near campgrounds and picnic areas (Wallen et al. 1998, 1999). They have recently expanded their range in California and are increasing in density in areas already occupied (Boarman and Berry 1995, Boarman 2003, Leibezeit and George 2002).

2.4 Reproduction

Adult common ravens form long-term pair bonds. Little is known about pair formation and nest-site selection for common ravens. Pairs are thought to be monogamous throughout the year, although extra-pair copulations have been observed. Common ravens do not breed until 2 to 4 years of age (Jolie 1976). Nesting substrates are highly variable, ranging from cliffs to trees to powerlines, telephone poles, buildings, and highway overpasses (Boarman and Heinrich 1999). In the California desert, common ravens have been observed nesting in tamarisk trees (*Tamarix* sp.), Joshua trees (*Yucca brevifloria*), on transmission towers, distribution poles, rock outcrops (BLM 1990b) freeway signs (Rebecca Jones, CDFG, personal communication), and abandoned vehicles (Tom Egan, AMEC Earth and Environmental, personal communication). Many common ravens return to the same nest year to year, or build multiple nests (two to four) in close proximity and rotate between them year to year.

Nest construction begins in early to late winter; sticks are the predominant nest building material. Nest construction takes from 1 to 4 weeks. Egg-laying usually occurs in March to April, with clutch size ranging from three to seven eggs. Incubation lasts 20 to 25 days. The nestling stage lasts 5 to 7 weeks, with an average of three chicks produced per nest each year. Fledglings will stay near the nest for 4 to 8 weeks following their first flight, with most nests fledged by mid-June. Females perform most of the nest construction and incubation, while both parents feed the young. If a clutch is lost early in the season, a second clutch may be laid. However, there are few reports of a pair of ravens successfully raising two sets of chicks in a single season (Boarman and Heinrich 1999).

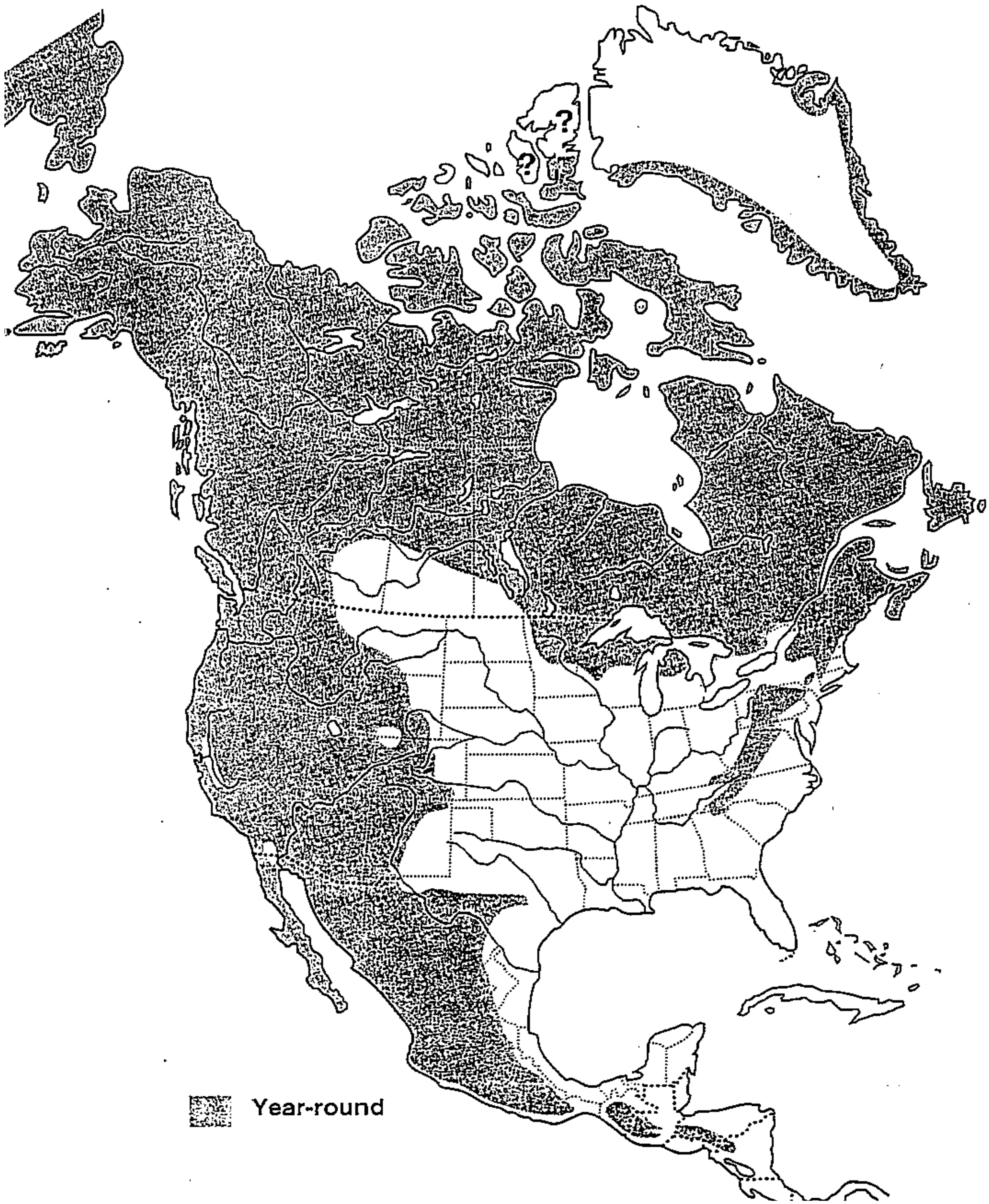

Figure A-4. Range of the Common Raven.

2.5 Activity Period

Common ravens are resident birds and active throughout the year in the California desert during the day.

2.6 Shelter

Nonbreeding ravens typically roost together at night, especially when a concentrated food source is nearby. Ravens generally roost in trees, on telephone poles, on powerlines, or communication towers. Roost size varies from a few birds to several thousand and generally peak in fall and winter (Chamblin and Boarman 2005). Roosts may serve as information centers for food by enabling new birds in a roost to find a previously located food source quickly (Heinrich 1988). Breeding adults usually do not join communal roosts and often roost at the nest site, even when not breeding (Engel et al. 1992).

2.7 Home Range and Territory

Common raven pairs typically occupy a home range in which they forage and nest. They establish territories, smaller areas within their home ranges in which the nest is built, that are nonoverlapping and defended year-round (most vigorously during the breeding season) (Boarman and Heinrich 1999). Unlike territories, home ranges of common ravens may overlap with those of neighboring raven pairs. Nonresident juvenile ravens often wander greater distances than territorial birds, and both resident and nonresident birds gather at sites of abundant food (e.g., landfills) (Heinrich et al.1994). Groups of ravens typically do not form a tight cohesive flock, but mix (Heinrich et al. 1994).

2.8 Feeding Behavior and Nutrition

Common ravens are general omnivores. The variety of food types in their diet often reflect differences within and among individuals, as well as the distribution of food in a given area (Engel and Young 1989a, Stiehl and Trautwein 1991, Kristan et al. 2004). Ravens commonly eat live meat, garbage, carrion, grains, eggs, and fruit. They are accomplished predators and use a variety of methods to attack and acquire food as a single predator or a pair. Prey species include arthropods, amphibians, reptiles, birds (adults, chicks, and eggs, e.g., mourning doves), and small mammals (Stiehl 1978, Sherman 1993, Boarman and Heinrich 1999). The following accounts demonstrate their efficiency as a predator. Ravens preyed on 3 of 15 breeding aggregations of western toads and ate more that 20 percent of the breeding toads at one aggregation (Olson 1989). More than one third of 282 pinyon jay nests were preyed upon by ravens or crows (Marzluff 1988). Ravens preyed on 95 of 647 nests of greater sandhill cranes in Oregon (Littlefield 1986). Common ravens prey on the eggs and young of several endangered species, including the western snowy plover, California least tern, California condor, marbled murrelet, and desert tortoise. While common ravens have been documented hunting and eating desert tortoises, not all ravens prey on desert tortoises.

Breeding common ravens concentrate their foraging activities during the breeding season within their territories (Sherman 1993). In the Mojave Desert, common ravens spend an equal amount of time scavenging and live hunting. Most (75 percent) hunting/food-finding activity takes place within 1,300 feet (400 meters) of the nest (Sherman 1993). Common ravens forage within 1 mile (1.6 km) of linear rights-of-way (roads, railways, transmission powerlines, and telephone lines) and spend 49 percent of the time foraging directly on the linear rights-of-way (Sherman 1993). When human-subsidized food is present, ravens often concentrate their feeding at these food sources and travel distances may be significantly shorter (Engel and Young 1992b).

Common ravens typically concentrate their feeding activity in the morning and late afternoon (Engel and Young 1992a, Sherman 1993), which coincides with the most active desert tortoise times. Nonbreeders, usually juvenile vagrants, often form "crowds" when feeding at concentrated food sources (Heinrich 1988). These crowds lack cohesiveness in membership that most flocking birds exhibit (Heinrich et al. 1994); most members of the crowd are not closely related (Parker et al. 1994). Common ravens often cache food for later use (Heinrich 1988) and are thought to rely mostly on visual cues to detect prey (Littlefield 1995).

2.9 Mortality

Causes of mortality include predation and disease. Predation on raven eggs has never been recorded. Possible predators on nestlings include hawks, owls, and other common ravens (Boarman and Heinrich 1999). Predation on adult common ravens is rarely observed. Possible predators on fledglings before they become proficient at flying include the coyote (Webb et al. 2004).

Disease causes mortality among common ravens. In California, common ravens are susceptible to Newcastle's disease which can be fatal. Newcastle's disease is usually spread by illegal transport of domestic poultry and is fatal to poultry. Hence, when an outbreak of Newcastle's disease is identified, the California department of Food and Agriculture implement stringent immediate measures to contain the disease and remove the infected birds. West Nile virus is another disease that can be lethal to common ravens. West Nile virus is carried by mosquitoes, which infect animals upon which they feed including the common raven. In the California desert there have been few reports of WNV among birds. Most of the available information is on the infection rate of WNV to humans. In August 2006, the number of confirmed cases declined from previous years. This decline has been attributed to increasing immunity in humans and animals. For example, in San Bernardino County, the number of reported cases of WNV was 197 in 2004 and 35 in 2005 (Doan 2006).

2.10 Common Raven Population Trends

Population trend information was derived from museum accounts and the Breeding Bird Surveys (BBS) during the period of 1966 and 2004 (Boarman and Berry 1995, Liebezeit and George 2002, Boarman and Kristan 2006) and the Christmas Bird Count (CBC) database during the period of 1959 to 1999 (Liebezeit and George 2002). Both BBS and CBC data provide a large-scale or regional perspective on bird population trends across North America. Because all surveys are conducted from roadsides, there is a possibility of overestimating corvid numbers. Corvids, in particular common ravens, are often found at higher densities along roadsides than other less disturbed habitats (Knight and Kawashima 1993). However, these data provide a reliable index of corvid population trends in California because most other biases associated with BBS and CBC survey techniques are minimal regarding corvids, and roadside habitat is prevalent across the state. In the Mojave Desert, more than 36,000 miles (57,600 km) of roads cross the landscape (Sherman 1993).

Common ravens were uncommon in the California desert in the first half of the 20th century. In the early 1940s, Eugene Cardiff, Curator of Natural History at the San Bernardino County Museum, searched for 2 years in the western Mojave Desert to locate a specimen for the Museum (BLM 1990a). In the eastern Mojave Desert, Johnson et al. (1948) conducted a survey in the Providence, New York, and Clark mountains and adjacent areas and reported few ravens. They noted that the raven was only present in the summer.

Since that time, common raven populations appear to have increased in the past 50 years in most parts of the west. Prior to this, common ravens were reported as becoming scarcer in settled parts of California because of human persecution (Grinnell and Miller 1944). As early as the 1950s, common ravens showed signs of increasing numbers in some areas of western North America (Houston 1977). Analysis of BBS data from 1969 to 1979 indicate an increase in common raven populations throughout the west, with major increases noted in California (Robbins et al. 1986). Using BBS data from 1966 to 1990, Marzluff et al. (1994) also documented an increase in the common raven populations. The number of common ravens estimated to occur within the 12 western states is greater than one half million. In the Mojave and Colorado deserts of California, the number of common ravens is estimated at 37,500 ± 8,500 (M. Green personal communication.). This population estimate was calculated from BBS data using methods described in Rich et al. 2004. The 30-year population trend for the common raven in California indicates the species is increasing at a rate of 5.4 and 7.1 percent per year in the Mojave and Sonoran Deserts (Sauer et al. 1999, as cited by Liebezeit and George 2002).

From the 1920s to the 1970s, common ravens changed from a summer resident to a permanent resident (BLM 1990a). Between 1966 and 2004, common raven populations increased in the southwestern deserts of California. The BBS data from 1968 to 2004 indicated increases in the raven populations of more than 700 percent in the west Mojave Desert and more than 70 percent in the East Mojave Desert. There were similar increases in the Colorado Desert (Boarman and Kristan 2006). In adjacent areas of the Great Basin Desert of California and Nevada and the southern California basin, raven populations have increased 168 percent and 328 percent, respectively, in 25 years (Boarman and Berry 1995).

The underlying cause of corvid increase throughout California is inextricably linked to the activities of humans. Common ravens are "human commensals" and thrive in highly disturbed habitats including agriculture, suburban, and urban areas (Marzluff et al. 1994). Common ravens are generalist foragers, and readily eat human-produced wastes. A key factor in the common raven population increases is thought to be the availability of human food sources that subsidize raven populations (Boarman 1993, Marzluff et al. 2001). Their reproductive success in the Mojave Desert is enhanced significantly by proximity to human developments (Kristan et al. 2004, Webb et al. 2004). Additionally, water subsidies are thought to be an important factor contributing to raven increase in desert areas of California (Liebezeit and George 2004). Subsidized water sources include cattle watering troughs, irrigation canals, reservoirs, sewage treatment areas, and irrigated agricultural areas. Some have questioned whether artificial wildlife watering sources (e.g., guzzlers) have assisted in providing water for common ravens. Habitat fragmentation has also contributed to an increase in habitat generalists, like common ravens (Andren 1992). Ravens thrive in fragmented landscapes and habitats. Suitable nesting and roosting structures have also allowed common raven populations to expand into areas where natural nesting substrate is limited or absent. The social nature of common ravens improves their ability to exploit human food and water resources and communal roost sites through their flocking behavior. Additionally, human persecution of common ravens has been reduced because of implementation of and education about the *Migratory Bird Treaty Act* in 1918 (Liebezeit and George 2004), which prohibits indiscriminate killing of migratory birds including the common raven.

2.11 Impacts of the Common Raven to the Desert Tortoise

Evidence of common ravens preying on hatchling and juvenile desert tortoises has been recorded numerous times during the past 25 years. Most of this information consists of observations reported by several researchers and field biologists; no standardized survey has been conducted. To develop a standardized method to collect data, a survey was initiated in 2004 and repeated in 2005 (McIntyre 2006, Boarman 2006). The objectives of this study were to ascertain the location of predatory bird nests in the Mojave Desert, determine the number and location of nests that were common raven nests, and locate evidence of hatchling and juvenile desert tortoise predation at nest sites. Using locations of historical raven nests (documented during the preceding 25 years), field workers located and recorded previously known nest locations and recorded the presence of nests at these sites or newly discovered nests along the route (Figures A-5 and A-6). Many of these nests were along transmission line routes. Under each nest area, the ground was searched for evidence of desert tortoise shells.

In summer 2004, 28 of 447 nests in the desert portions of San Bernardino, Kern, and Los Angeles counties were observed with evidence of desert tortoise predation beneath them. In 2005, 27 of approximately 600 nests in the desert portions of Kern, Los Angeles, and San Bernardino counties were observed with evidence of desert tortoise predation beneath them (McIntyre 2006).

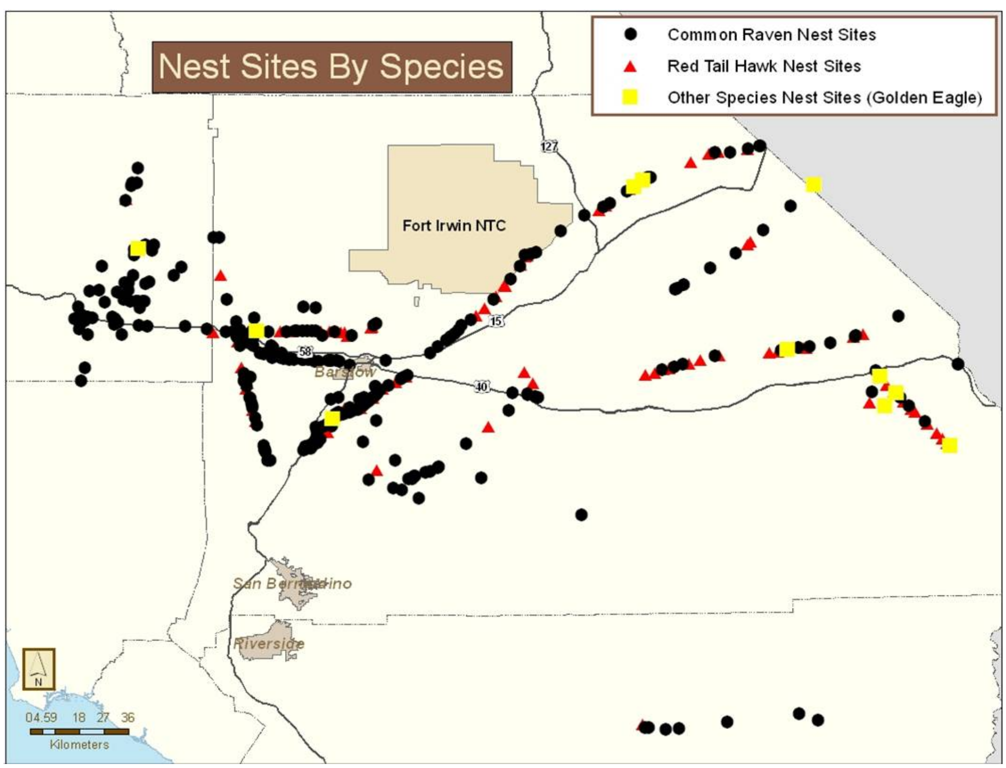

Figure A-5. Nest Sites Observed in 2004 and the Identified Species

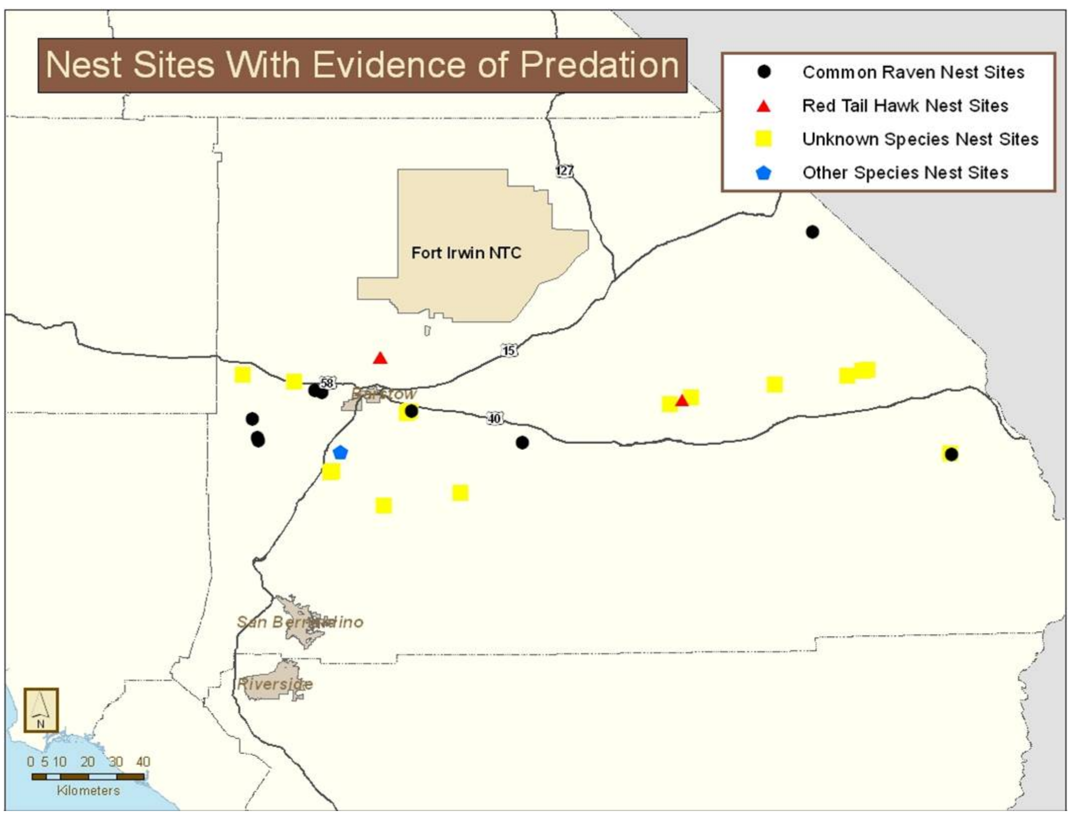

Figure A-6. Locations of Nests Observed in 2004 and Associated Species with Evidence of Desert Tortoise Predation.

APPENDIX B
SUMMARY OF PUBLIC INVOLVEMENT

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1.0 Summary of Public Involvement

The United States and Fish and Wildlife Service (USFWS) followed the *National Environmental Policy Act (NEPA)* and its implementing regulations as developed by the Council on Environmental Quality (CEQ) to encourage public participation in this process. The public involvement and notification process to date are described in the following sections.

1.1 General Process

Various federal and state agencies identified issues related to the proposed action during interagency meetings beginning in 2003.

The USFWS conducted a scoping, or information-gathering phase in which potentially interested groups, individuals, tribes, and agencies were contacted. These individuals and groups included conservation groups, government officials, tribal representatives, and land managers. These entities received letters about the objectives of the action and were asked to respond with any information on methods, concerns, or effects. The scoping effort was also announced to the public through a media release to several newspapers in southern California, including the *Los Angeles Times*, *San Diego Union-Tribune*, *San Bernardino Sun*, *North County Times*, *Desert Sun*, *Victorville Daily Press*, *Desert Dispatch, Daily Independent*, and *Antelope Valley Press*.

The USFWS received comments from 201 entities. Most respondents supported reduction efforts at some level, but some disagreed with the proposed action. The respondents identified various methods to consider in raven management/reduction efforts. These included shooting, removing nests/eggs, implementing an “adopt-a-raven” program, trapping and relocating, establishing a hunting season, implementing aversion training, introducing a predator for the raven, implementing birth control for common ravens, and controlling or reducing the human population and associated development. Some respondents suggested that efforts be directed towards helping the desert tortoise through captive breeding programs, relocation programs, and placing an impenetrable wire ceiling over desert tortoise habitat.

1.2 Tribal Contacts

The USFWS coordinated a separate scoping, or information-gathering effort with the tribes with lands of interest in southeastern California. The USFWS sent letters to 14 tribes and 2 cultural organizations. One response was received from the Agua Caliente Band of Cahuilla Indians. They responded that there was no desert tortoise habitat on their reservation and they did not support nonlethal or lethal management of the common raven.

The Bureau of Indian Affairs (BIA), as the primary trustee safeguarding tribal trust resources, sent letters to 16 tribes in southern California on 2 August 2005. Some of the tribes contacted by BIA were new contacts while many were repeat contacts from the USFWS’s earlier effort. The BIA contacted these tribes to inform them of the proposal from the Desert Managers Group to manage the common raven in the California desert to reduce predation on the desert tortoise. The proposed actions would not occur on tribal lands without the tribe’s explicit request to implement raven management measures on their reservation. The BIA requested that the tribes respond if they had opposition to the proposal. The BIA received one response from the

Big Pine Reservation. They requested that they be kept informed and sent a copy of the draft NEPA document.

In total, 22 tribes and 2 cultural organizations were contacted by letter during the scoping process.

APPENDIX C
DECISION MODEL

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1.0 DECISION MODEL

Use of a Decision Model for Implementing Removal of the Common Raven. The Decision Model (Slate et al. 1992) is adopted from the United States Department of Agriculture, Animal and Plant health Inspection Service-Wildlife Services (APHIS-WS) decision-making process which is a standardized procedure for evaluating and responding to wildlife damage complaints. The decision model is a description of the thought process used by wildlife specialists, United States Fish and Wildlife Service, and cooperating agencies at each site to develop and implement the most appropriate method to reduce predation by the common raven on the desert tortoise through removal (Figure D-1).

Receive request for assistance
↓
Assess problem
↕
Evaluate removal methods
↕
Formulate removal strategy
↕
Provide assistance
↕
Monitor and evaluate results of removal actions
↓
End of action

Figure D-1. APHIS-WS Decision Model

Agency personnel would evaluate the appropriateness of methods in context of their availability (legal and administrative) and suitability based on the biological, economic, and social considerations. Following this evaluation, the methods determined to be practical for the situation form the basis of a management strategy. After the management strategy has been implemented, monitoring is conducted and an evaluation of the strategy is conducted to assess its effectiveness.

Alternatives B through D, which include common raven removal, would implement safe and practical methods for the reduction of damage caused by common ravens on the desert tortoise based on local problem analysis, environmental and social factors, and the professional judgment of trained personnel.

In selecting a management technique, consideration would be given to the following:

a. Time of day
b. Time of year
c. Other land uses (e.g., proximity to recreational or residential areas and other structures)

d. Feasibility of implementation of various allowed techniques
e. Movement patterns and life cycle of the common raven for that year
f. Status of nontarget species in the area
g. Local environmental conditions (e.g., terrain, weather, and vegetation)
h. Presence of people
i. Potential legal restrictions
j. Humaneness of the available options, and
k. Cost.

APPENDIX D
RELEVANT LAWS AND AUTHORITIES

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1.0 RELEVANT LAWS AND AUTHORITIES

1.1 Compliance with Major Applicable Federal Laws

Several federal laws regulate wildlife damage management. The federal agencies involved in this action must comply with these laws, as well as consult and cooperate with each other and other agencies, as appropriate. The following federal laws are relevant to the actions considered in this environmental assessment (EA):

a. National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code [U.S.C.] 4321–4347, Public Law [PL] 91-190)–Environmental documents prepared pursuant to NEPA must be completed before federal actions can be implemented. The NEPA process requires careful evaluation of the need for action, and that federal actions be considered alongside all reasonable alternatives, including the “No Action Alternative.” The NEPA also requires that potential impacts on the human environment be considered for each alternative, the alternatives and impacts must be considered by the decision maker(s) prior to implementation, and that the public is to be informed.

This EA has been prepared in compliance with NEPA; the President’s Council for Environmental Quality (CEQ) Regulations, 40 Code of Federal Regulations Section 1500–1508; and Department of the Interior’s Departmental Manual (DM) for NEPA compliance (516 DM 6, 30 AM 2-3); U.S. Fish and Wildlife Service’s (USFWS) directive manual 550 FW 1-3 and 505 FW 1-5; Bureau of Land Management’s NEPA handbook H-1790-1; and National Park Service’s handbook and Director’s Order DO-12. It was also reviewed to comply with Department of Defense requirements including Title 32 Code of Federal Regulations (CFR) Part 989 (Air Force), 32 CFR 651 (Army), Marine Corps Order 5090.2a (Environmental Protection), and 32 CFR 775 (SECNAV Instruction 5090.6). The U.S. Marine Corps is regulated under 32 CFR 775.

Pursuant to NEPA and CEQ regulations, this EA documents the analysis of a proposed federal action, and all reasonable alternatives thereto, including the “No Action” or Status Quo alternative. The EA evaluates impacts anticipated from all alternatives, informs decision-makers and the public, and serves as a decision-aiding mechanism. The EA was prepared using an interdisciplinary approach to address all aspects of the natural and social sciences relevant to the potential impacts of the action. The direct, indirect, and cumulative impacts of the proposed action are analyzed.

b. Animal Damage Control Act of March 2, 1931, as amended (46 Statute [Stat.] 1486: 7 U.S.C. 426–426c); and Rural Development, Agriculture, and Related Agencies Appropriations Act of 1988 (Public Law 100-102, December 1987, Stat. 1329–1331; 7 U.S.C. 426c)–These acts authorize Animal and Plant Health Inspection Service-Wildlife Services, in cooperation with other agencies, to reduce damage caused by wildlife.

c. Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531–1544)–Under the ESA, all federal agencies shall seek to conserve endangered and threatened species and shall utilize their authorities in furtherance of the purposes of the ESA (Section 2[c]). Section 7 consultations with the USFWS are conducted to use the expertise of the USFWS to ensure that "any action authorized, funded, or carried out by such an agency...is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of habitat of such species…which is determined to be critical….” “(E)ach agency shall use the best scientific and commercial data available.” (Section 7[a][2]).

c. Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended (7 U.S.C. 136 et seq.; 86 Stat. 975)–This proposal includes the use of the avicide DRC-1339, which is only available for use by certified Animal and Plant Health Inspection Service, Wildlife Services (APHIS-WS) personnel. The FIFRA requires the registration, classification, and regulation of all pesticides used in the United States. The United States Environmental Protection Agency (U.S. EPA) is responsible for implementing and enforcing the FIFRA. All chemical methods integrated into any selected program as implemented by APHIS-WS or other cooperating agencies must be registered with and regulated by the U.S. EPA and the California Department of Pesticide Regulation and used in compliance with labeling procedures and requirements.

d. Migratory Bird Treaty Act (MBTA) of 1918 (16 U.S.C. 703–711; 40 Stat. 755), as amended–The MBTA provides USFWS regulatory authority to protect bird species that migrate outside the United States. This law prohibits the “take” or killing of these species by any entity, unless permitted by the USFWS. People can obtain permits to take migratory birds under this law that are causing damage to resources. The Migratory Bird Treaty Reform Act of 2004 was passed to clarify the original intent of the MBTA, the conservation and protection of migratory birds native to North America. It directed USFWS to establish a list of nonnative bird species found in the United States. Species on this list will not receive MBTA protection. The USFWS has prepared and published this list in the *Federal Register*.

e. National Historic Preservation Act (NHPA) of 1966, as amended (U.S.C. 470 *et seq*.)– The NHPA requires federal agencies to: 1) evaluate the effects of any federal undertaking on cultural resources; 2) consult with the State Historic Preservation Office (SHPO) regarding the value and management of specific cultural, archaeological, and historic resources; and 3) consult with appropriate American Indian tribes to determine whether they have concerns for traditional cultural resources in areas of these federal undertakings.

f. Sikes Act Improvement Act of 1997, as amended–The Sikes Act requires the Department of Defense to manage the natural resources of each of its military reservations within the United States and to provide sustained, multiple use of those resources. To meet these goals, the act requires Integrated Natural Resource Management Plans be prepared for military installations. These plans must be developed in coordination with the USFWS and appropriate state fish and wildlife agency, and reflect the mutual understanding of the parties concerning conservation, protection, and management of fish and wildlife resources.

g. Wilderness Act of 1964 (16 U.S.C. 1131–1136, 78 Stat. 890, and PL 88-577)–The Wilderness Act established a national wilderness preservation system composed of federally owned areas designated by Congress as wilderness areas. The lands in this system must be managed to leave them unimpaired for future use and enjoyment as wilderness. The purpose of the Wilderness Act is to ensure that an increasing human population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the Unites States and its possessions, leaving no lands designated for preservation and protection in their natural condition. It is the policy of Congress to secure for present and future generations the benefits of an enduring resource of wilderness.

Each federal agency with wilderness is responsible for administering the wilderness for the purposes for which it was established (e.g., a national park) and in a manner that preserves its wilderness character. With limited exceptions, no commercial enterprise or permanent road is allowed within a wilderness area. Temporary roads, motor vehicles, motorized equipment, landing of aircraft, structures and installations are only allowed for administration of the area. The use of aircraft may be permitted in wilderness areas where their use has already been established. Measures may be taken to control fire, insects, and disease.

h. California Desert Protection Act of 1994 (16 U.S.C. 410)–The California Desert Protection Act established and expanded Death Valley and Joshua Tree National parks and created Mojave National Preserve. Through this law, Congress declared that appropriate public lands in the California desert must be included within the National Park System and the National Wilderness Preservation System. The purpose of these lands is to preserve their scenic, geologic, and wildlife values; perpetuate their significant and diverse ecosystems; protect and interpret ecological and geological features, maintain wilderness resource values; and promote public understanding and appreciation.

i. Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (Executive Order [EO] 12898)–Environmental justice promotes the fair treatment of people of all races, incomes, and cultures with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no person or group of people should endure a disproportionate share of the negative environmental impacts resulting either directly or indirectly from the activities conducted to execute this country's domestic and foreign policies or programs. Environmental justice has been defined as the pursuit of equal justice and equal protection under the law for all environmental statutes and regulations without discrimination based on race, ethnicity, or socioeconomic status. All federal activities are evaluated for their impact on the human environment and compliance with EO 12898 to ensure environmental justice. Any methods selected to reduce predation by the common raven on the desert tortoise will be used as selectively and environmentally conscientiously as possible.

j. Protection of Children from Environmental Health and Safety Risks (EO 13045)– Children may suffer disproportionately from environmental health and safety risks, including their developmental physical and mental status for many reasons. Because the USFWS makes it a high priority to identify and assess environmental health and safety risks, the USFWS has considered impacts that the alternatives analyzed in this EA might have on children. Reducing predation by common ravens on the desert tortoise, as proposed in this EA, would only involve legally available and approved management methods in situations or under circumstances where it is highly unlikely that children would have the potential for exposure.

k. Migratory Birds (EO 13186)–Executive Order 13186 directs federal agencies to use their programs and authorities to develop memorandums of understanding with the USFWS outlining how each agency will promote conservation of migratory birds. The common raven is designated as a migratory bird by federal legislation and regulation.

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2.0 AUTHORITIES OF FEDERAL AND STATE AGENCIES IN WILDLIFE DAMAGE MANAGEMENT

a. Federal Management Authorities

1) Department of the Interior–The Department of the Interior (DOI) was established in 1849. Its mission is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to American Indian tribes and our commitments to island communities.

(a) USFWS–The mission of the USFWS is to work with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. The primary statutory authorities for the USFWS mission are: 16 U.S.C. 1521 et seq.; Endangered Species Act of 1973, as amended; and 16 U.S.C. 703–712, Migratory Bird Treaty Act (MBTA) of 1918, as amended.

(b) Bureau of Land Management (BLM)–The BLM manages it lands in accordance with the Federal Land Policy and Management Act of 1976 (FLPMA). The FLPMA directs BLM to follow 13 policies which include: managing lands on the basis of multiple use and sustained yield; managing lands in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; preserving and protecting certain public lands in their natural condition; providing food and habitat for fish, wildlife, and domestic animals; providing for outdoor recreation and human occupancy; and developing plans for the protection of public land areas of environmental concern.

The California Desert Conservation Area (CDCA) Plan of 1980, as amended, is BLM's planning document to manage BLM lands within the CDCA or southern California desert area. The CDCA Plan has been amended with bioregional plans, whose boundaries were generally established to correspond to the recovery units of the 1994 desert tortoise recovery plan. The bioregional plans are: 1) the Northern and Eastern Colorado Desert Coordinated Management Plan, 2) the Northern and Eastern Mojave Desert Management Plan, 3) the Coachella Valley Plan, 4) the Western Colorado Desert Management Plan, and 5) the West Mojave Plan. Most of these planning documents address the need for control of predation by common ravens on the desert tortoise. All alternatives presented in this document comply with these regulations and management plans.

(c) National Park Service (NPS)–All units managed by the NPS are managed in accordance with the Organic Act of 1916, 16 U.S.C. 1. This law states that the primary purpose of park units is: "...to conserve the scenery and the natural and historic objects and the wildlife therein, and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations." In the 1970 General Authorities Act, Congress amended the Organic Act to clarify that all units, regardless of their specific designation, are to be managed under the Organic Act mandate. In 1978, Congress amended the General Authorities Act in the Redwood National Park Act to further clarify the importance of park resources system wide: "The authorization of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided for by Congress." In addition to the purpose of national parks as outlined in the NPS's Organic Act, as amended, specific purposes may also be provided in establishing or enabling legislation for each park unit and specific legislation for each NPS unit. Death Valley National Park, Joshua Tree National Park, and Mojave National Preserve must be managed in accordance with the California Desert Protection Act, PL 103-433 (1994). Actions within Death Valley National Park, Joshua Tree National Park, and Mojave National Preserve must comply with the general management plan for each park unit. The Death Valley National Park and Mojave National Preserve General Management Plans were completed in 2002; the Joshua Tree National Park General Management Plan was completed in 1994 and amended in 2000. All alternatives presented in this document comply with these regulations and management plans.

2) Department of Defense (DOD)–The DOD has the mission of protecting the national security of the United States and providing the military forces needed to deter war. The installations cooperating in this EA each have different missions, but all work together to achieve the overall mission of the DOD. Combined, the four installations manage nearly 2 million acres in the Mojave Desert.

(a) Edwards Air Force Base (AFB)–Edwards AFB is located in the Antelope Valley in the western Mojave Desert of California. The base manages 301,000 acres in a three-county area in Los Angeles, Kern, and San Bernardino counties. Approximately 11,000 military and civilian personnel work on Edwards AFB to support the mission of the Air Force Flight Test Center (AFFTC). The AFFTC is the Air Force Materiel Command center of excellence for conducting and supporting research, development, testing, and evaluation of aerospace systems from concept to combat. Test forces at Edwards AFB have played a role in the development of virtually every aircraft to enter the Air Force inventory since World War II. With the center's capability of just-in-time testing, Edwards AFB can provide real-time solutions during combat operations. This combat support establishes the AFFTC's direct and tangible link to the warfighter.

Edwards AFB manages its land under Department of Defense Instruction (DoDI) 4715.3, Environmental Conservation Program, May 1996, and Air Force Instruction (AFI) 32-7064, Integrated Natural Resources Management, 22 July 1994. The Integrated Natural Resources Management Plan, Edwards AFB Plan 32-7064, September 2004, is the primary management tool that incorporates additional federal mandates such as the Endangered Species Act of 1973, as amended; Migratory Bird Treaty Act of 1918, as amended; Federal Noxious Weed Act of 1974; Federal Insecticide, Fungicide, and Rodenticide Act; EO 11990, Protection of Wetlands; and EO 13112, Invasive Species. All alternatives presented in this document comply with these regulations and management plans.

(b) National Training Center (NTC) and Ft. Irwin–The NTC, located at Fort Irwin, California, is the only instrumented training facility in the world that is suitable for force-on-force and live-fire training of heavy brigade-sized military forces. The realistic training provided at the NTC assures soldiers are adequately prepared to protect and preserve US interests here and abroad. Each month the NTC provides 4000-5000 soldiers from other installations the essential training opportunities necessary to maintain and improve military readiness and promote national security. The evolving sophistication of military equipment and advances in technology require a comprehensive battlefield that realistically simulates the tempo, range, and intensity of current and future conflicts. The NTC must provide all the necessary components to achieve world-class training for the U.S. Army. The U.S. Army manages 755,606 acres (1,180 square miles) in the Mojave Desert of California.

The U.S. Army manages all of its installations under the following Army Regulations (AR): AR 200-1, Environmental Protection and Enhancement (February 1997); AR 200-2, Natural Resources–Land, Forests, and Wildlife Management (February 1995); and AR 200-3, Environmental Effects of Army Actions (August 1953). In accordance with the Sikes Act Improvement Act (Fish and Wildlife Conservation and Natural Resources Management Program on Military Reservations), each installation has an Integrated Natural and/or Cultural Resource Management Plan (INRMP/ICRMP). Fort Irwin's INRMP was revised on 15 July 2005 and signed in June 2006 by the USFWS. All alternatives presented in this document comply with these regulations and management plans.

(c) United States Marine Corps (USMC)–The USMC regulations mandate that natural resources under the control of the USMC will be managed to support the military mission, while preserving, protecting, and enhancing these resources. Land use practices and decisions must coincide with the military mission, rely on scientifically sound conservation procedures and techniques, and employ scientific methods and an interdisciplinary approach. Legal requirements by which the USMC abides include: 43 U.S.C. 1701 et seq., Federal Land Policy and Management Act of 1976; 16 U.S.C. 670a–670o , Sikes Act Improvement Act (Fish and Wildlife Conservation and Natural Resources Management Program on Military Reservations); DODI 5000.13, Natural Resources; and Marine Corps Order P5090.2A, Environmental Compliance and Protection Manual. Under Marine Corps Order P5090.2A, stewardship will be recognized as a high priority requirement in retaining control and use of USMC lands for mission needs. The USMC's most relevant plan is the INRMP. All alternatives presented in this document comply with these regulations and management plans.

(d) Marine Corps Air Ground Combat Center (MCAGCC)–The MCAGCC, Twentynine Palms, California, hosts the live-fire Combined Arms training program, which promotes military readiness and allows Marines to coordinate training between forces in the air and on the ground. Artillery, aircraft, armored vehicles, and infantry work together to create a unified force and defend our nation. The MCAGCC manages 596,477 acres (932 square miles) in the Mojave Desert of California. The mission of the MCAGCC, Twentynine Palms, is to develop and conduct the Marine Corps' Combined Arms Training Program and to provide support to the Marine Corps Communication-Electronics School. The following general principles have been identified for MCAGCC:

1) Comply with Federal laws, such as the Sikes Act Improvement Act, Endangered Species Act, Clean Water Act, and Clean Air Act, in such a fashion as to not impede mission activities;

2) Maintain the capability of MCAGCC to support its military mission (Sikes Act) and ensure that lands are continuously available for military training;

3) Manage MCAGCC natural resources consistent with Department of Defense and MCAGCC policies;

4) Participate in regional ecosystem initiatives; and

5) Provide stewardship of public lands.

(e) Marine Corps Logistics Base (MCLB), Barstow–As one of only two logistics bases operated by the USMC, MCLB Barstow is the primary west coast MCLB and Maintenance Center. It is located just east of the city of Barstow and consists of 6,165 acres in the west Mojave Desert. It has two missions: to procure, maintain, store, and issue all classes of supplies and equipment; and to repair and rebuild Marine Corps-owned and other DOD equipment. The MCLB furnishes supplies for the Marine Corps facilities worldwide and is a direct support provider for all installations. The MCLB is also responsible for assuring the technical training of Marines, developing and maintaining their skills, and job efficiency.

All alternatives presented in this document comply with these regulations and management plans as directed by Marine Corps Order MCO5090.2A and the Sikes Act Improvement Act of 1977. The Base Master Plan is also under revision with an expected completion date of September 2006. In all documents, the alternatives presented will comply with the military and civilian regulations and management plans.

3) Department of Agriculture–The United States Department of Agriculture (USDA) was established in 1862. Its mission areas include farm and foreign agricultural services; food, nutrition, and consumer services; food safety; marketing and regulatory programs; natural resources and the environment; research, education, and economics; and rural development.

4) USDA, APHIS-WS–The APHIS-WS is a federal agency authorized by Congress to protect American resources and human health and safety from damage caused by wildlife. The APHIS-WS provides federal leadership and expertise to resolve wildlife conflicts effectively and humanely, using state-of-the-art science and technology. The primary statutory authorities for the APHIS-WS program are the Animal Damage Control Act, which authorized APHIS-WS to reduce damage caused by wildlife in cooperation with other agencies (Animal Damage Control Act of March 2, 1931, as amended [46 Stat. 1486; 7 U.S.C. 426–426c]); and the Rural Development, Agriculture and Related Agencies Appropriations Act of 1988 (PL 100-102, Dec. 22, 1987; Stat. 1329-1331; 7 U.S.C. 426c). The APHIS-WS is a program within the USDA's Animal and Plant Health Inspection Service. It does not manage any land resources. All alternatives presented in this document comply with these regulations and management plans.

b. State Management Authorities

1) California Department of Fish and Game (CDFG)–The CDFG is the state agency with the statutory and common law responsibilities for fish and wildlife resources and habitats. California's fish and wildlife resources, including their habitats, are held in trust for the people of California by CDFG (Fish and Game Code Section 711.7). The CDFG has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitats necessary for biologically sustainable populations of those species (Fish and Game Code Section 1802). The CDFG's fish and wildlife management functions are implemented through its administration and enforcement of the Fish and Game Code (Fish and Game Code Section 702). The CDFG is a trustee agency for fish and wildlife under the California Environmental Quality Act (see CEQA Guidelines, 14 California Code of Regulations, Section 15386[a]). The CDFG is entrusted to protect threatened and endangered species under the California Endangered Species Act (Fish and Game Code Sections 2050–2115.5).

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3.0 PROJECT BACKGROUND AND PREVIOUS PLANNING

The USFWS has worked to recover and conserve the desert tortoise since it was listed in 1989. These efforts include working cooperatively with numerous federal, state, and local agencies with management or regulatory responsibilities in the California desert. Examples of some of these efforts include population surveys, land acquisition, modification of land management plans, designation of critical habitat, development of a recovery plan, and reduction in or consolidation of activities that result in human disturbance to desert tortoise habitat.

In 1989, a multiagency pilot raven control program was initiated by the BLM, USFWS, CDFG, California Department of Parks and Recreation, USMC, and Animal Damage Control (now Wildlife Services) of the USDA (BLM 1989, Rado 1993). The purpose of the pilot program was to reduce raven predation on hatchling and juvenile desert tortoises and gain information necessary to design a long-term raven control program. The BLM prepared an EA to implement the pilot program at two regions: one in the western Mojave Desert from China Lake Naval Air Weapons Station south to Victorville, west to the El Paso Mountains, and east to Barstow; and the second in the eastern Mojave Desert from north and west of Needles south into the Chemehuevi area (BLM 1989). The EA estimated that 500 common ravens would be removed in 1 year. The pilot program consisted of shooting and selective use of the toxicant DRC-1339 in hard-boiled eggs to remove ravens (Rado 1993). An estimated 100 to 110 individual ravens were killed over a 4-day period at the MCAGCC landfill form May 19 through 25, 1989. Eighteen of these birds were shot while the remaining birds were treated with toxicants. In addition, 6 to 10 ravens were treated with toxicants in a 1-day effort on May 24, 1989, at the Desert Tortoise Natural Area (DTNA). The pilot program was halted on May 24, 1989, by a Temporary Restraining Order. The request to halt the pilot program was initiated by the Humane Society of the United States (HSUS) (*HSUS* v. *Manuel Lujan et al*. 1989).[1] The Humane Society's primary concerns were that birds not responsible for preying on desert tortoises would be killed, other species of animals could be harmed by ingesting the avicide, and insufficient data were presented to justify the control efforts. The lawsuit was subsequently settled out of court, but the pilot program was not resumed.

In 1990, as a followup to the aborted pilot program, the BLM and several partner agencies drafted and distributed for public review a Raven Management Plan (BLM 1990b) that proposed a long-term strategy for reducing common raven predation on desert tortoises throughout the CDCA. This Raven Management Plan was presented in an Environmental Impact Statement (EIS) for the Management of the Common Raven in the California Desert Conservation Area (BLM 1990a). The decision to prepare an EIS was based on the regional scope of the project, the long-term duration of the project actions, and the controversial aspect of using lethal forms of raven control. Twenty-six polygons for implementing raven management were identified throughout the CDCA. The Raven Management Plan incorporated basic principles of Integrated Pest Management (Council for Agricultural Science and Technology 1982) as they apply to vertebrate pests (Timm 1984). These include: lethal control with toxicants and shooting; nonlethal control such as nest destruction, hazing, sterilization, and removal of road kills; habitat management such as changing landfill operation methods and altering perch/nest sites; research

[1] *Humane Society of the United States* v. *Manuel Lujan, et al.*, Civil Action 89-1523 (RCL), D.D.C., Settlement Agreement filed June 29, 1989.

into pertinent aspects of common raven and desert tortoise behavior and ecology; and monitoring common raven and desert tortoise populations. Several concerns, including the need to collect additional data on common raven ecology and behavior, explore and adopt effective nonlethal means of raven control, and monitor both common raven and desert tortoise populations, were raised by various groups and individuals during the public comment period.

In response to public concerns, BLM convened a Technical Review Team (TRT) composed mainly of professional, nongovernment biologists, and conservation policy specialists. The TRT members were from the following organizations: HSUS; Natural Resources Defense Council; National Audubon Society; Defenders of Wildlife; Desert Tortoise Council; Washington State Department of Natural Resources; Desert Tortoise Preserve Committee; Southern California Edison; and Dr. Ed Hill, USDA/APHIS-WS. The TRT supported an experimental approach that focused on shooting individual ravens known to prey on desert tortoises and removing all ravens that were foraging within the DTNA. The intent of this effort was to determine the efficacy of shooting rather than using toxicants as a control measure, and to assess the likelihood that removing only known offending birds rather than all birds in a specific area would aid desert tortoise recruitment. The TRT also recommended that research be conducted to address various aspects of raven ecology and management to develop a more focused and effective raven management program.

In 1993 and 1994, the BLM followed the recommendations of the TRT and implemented an experimental common raven removal program. The two primary objectives of the program were: 1) remove ravens known to prey on desert tortoises (identified if three or more desert tortoise shells showing evidence of raven predation were found within their territories); and 2) remove all ravens that were likely foraging within the DTNA. The program was delayed by an appeal, filed on April 27, 1993, with the Interior Board of Land Appeals by the HSUS. The HSUS objected to the removal of ravens with chicks on the nest without evidence that those ravens were eating desert tortoises. The appeal was withdrawn after BLM agreed to only shoot birds if desert tortoise shells were found within their presumed territories. Shooting commenced on May 13, 1993; 49 ravens were subsequently shot and 10 nestlings euthanized during 1993 and 1994.

An additional objective of the experimental program was to determine if shooting is effective at removing all birds from foraging within a specific area. The result of the study showed that shooting can be used to remove nesting pairs, but it is often difficult to kill the second member of the pair. Difficulties were also encountered when removing common ravens from a broad targeted area (e.g., DTNA) because these birds would often forage in flocks; and after one bird was shot, the rest quickly scattered.

APPENDIX E
LAND MANAGEMENT AND PLANNING DOCUMENTS

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LAND MANAGEMENT AND PLANNING DOCUMENTS

Bureau of Land Management (BLM) Land Management Plans for the California Desert Conservation Area–The BLM uses the California Desert Conservation Area (CDCA) Plan and Amendments to guide management on the lands it administers. Any decisions made because of this Environmental Assessment (EA) process will be consistent with the guidance in the CDCA Plan and Amendments and the *Federal Land Policy and Management Act of 1976*.

Death Valley National Park General Management Plan–The subject plan was completed in 2002. This document guides the management of lands administered by the National Park Service within Death Valley National Park.

Joshua Tree National Park General Management Plan–The subject plan was completed in 1994 and amended in 2000. The amended document, Record of Decision Final General Management Plan Amendment Environmental Impact Statement (EIS)/Backcountry and Wilderness Management Plan, guides the management of lands administered by the National Park Service within Joshua Tree National Park.

Mojave National Preserve General Management Plan–The subject plan was completed in 2002. This document guides the management of lands administered by the National Park Service within the Mojave National Preserve.

Programmatic Environmental Impact Statement–Animal and Plant Health Inspection Service-Wildlife Services (APHIS-WS), formerly called Animal Damage Control (ADC), issued a Final EIS on the national APHIS-WS program (USDA 1997, revised). This EIS addressed an ongoing program of wildlife damage management. Information in the Final EIS that is pertinent to the alternatives in this EA has been incorporated by reference.

Master Memorandum of Understanding (MOU) between APHIS and BLM–This MOU specifies that all programs for animal damage management on lands administered by BLM will be coordinated with appropriate state and federal agencies prior to implementation. The APHIS-WS will develop and update work plans for animal damage management annually in cooperation with the BLM and other appropriate agencies. The APHIS-WS and BLM will identify restrictions for human safety or other mitigation that should be implemented to comply with the BLM's existing Land Management Plans.

Integrated Natural Resources Management Plans–Each of the six military installations within the California desert (Naval Air Weapons Station China Lake, Air Force Flight Test Center at Edwards Air Force Base, National Training Center at Fort Irwin, Marine Corps Logistics Base Barstow, Marine Corps Air Ground Combat Center Twentynine Palms, and Chocolate Mountains Aerial Gunnery Range) is required to maintain and implement an Integrated Natural Resources Management Plan (INRMP).

The purpose of each INRMP is to develop and follow a prescribed planning process for the management of natural resources on each installation. Development and implementation of the INRMP must support military mission readiness by ensuring lands and airspace are available for sustained use. This process meets statutory requirements under the *Sikes Act Improvement Act*

(SAIA), Public Law 105-85, Div. B Title XXIX, Nov. 18, 1997, 111 Stat 2017-2019, 2020-2033. This Act requires the Secretaries of the Army, Air Force, and Navy to prepare and implement INRMPs for each military installation, unless exempted due to the absence of significant natural resources.

Each installation coordinates with the USFWS and the California Department of Fish and Game (CDFG) to ensure that each INRMP reflects the mutual agreement of these parties on conserving, protecting, and managing natural resources on each installation. In addition, as required by the SAIA, the INRMPs are provided for public comment.

County General Plans–California state law requires each county to prepare and adopt a comprehensive and long-range general plan for its physical development (Government Code Section 65300). A comprehensive general plan provides each county with a consistent framework for land use decision-making. Traditionally, the general plan has been organized as a collection of elements or subject categories such as land use, housing, conservation, noise, circulation, open space, and safety. The conservation element addresses the conservation, development, and use of natural resources including water, forests, soils, rivers, and mineral deposits. The open-space element details plans and measures for preserving open space for natural resources, the managed production of resources, outdoor recreation, public health and safety, and the identification of intensive agriculture and irrigated pasturelands. For the California desert there, are five counties each with a county general plan for these elements. These plans are: Imperial County General Plan, Inyo County General Plan, Kern County General Plan, Los Angeles County General Plan (Antelope Valley), Riverside County General Plan, and San Bernardino County General Plan.

APPENDIX F
PUBLIC COMMENTS RECEIVED AND RESPONSES

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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

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

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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

<u>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</u>.—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. <u>Avoid constructing new nesting structures and reduce the number of existing nesting structures in areas where natural or anthropogenic substrates are lacking.</u>--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. <u>Modify agricultural practices to reduce availability of food and water to ravens.</u>—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. Determine behavior and ecology of ravens as they pertain to predation on tortoises.-- 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. <u>Determine how humans use the desert, what practices might be amenable to change, and best to effect those changes</u>.--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.

ACKNOWLEDGMENTS

Ted Rado, Kristin Berry, and Larry Foreman were particularly instrumental in developing the earlier Plan upon which several of the current recommendations are based. Valuable input during the evolutionary process was received from many individuals. Of particularly note is advice and recommendations from members of the Raven Technical Review Team, which included John Grandy, John Borneman, Faith Campbell, James A. St. Amant, David Otis, Steve Johnson, Frank Hoover, Lenny Young, Tom Dodson, Ed Hill, and Daniel C. Pearson. Valuable comments on earlier drafts of this report were received from Larry Foreman, John Grandy, Faith Campbell, John Marzluff, William Webb, William Kristan, and Al Stein.

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