STATE OF CALIFORNIA
The Resources Agency
DEPARTMENT OF FISH AND GAME

Off-Stream Storage Investigations
Mammal Surveys

PROGRESS REPORT

Central Valley Bay-Delta Branch
July 2003

STATE OF CALIFORNIA
The Resources Agency
DEPARTMENT OF FISH AND GAME

Robert C. Hight, Director

This report was prepared under the supervision of

Dr. Perry Herrgesell, Chief
Central Valley Bay-Delta Branch

and

Frank Wernette, Environmental Program Manager
Water Project Planning and Ecosystem Restoration Program

by

Brad Burkholder, Environmental Scientist
Amy Brinkhaus, Wildlife Biologist
Jila Fishman, Scientific Aid
Michelle Rodebaugh, Scientific Aid
Dean Whittle, Scientific Aid
Christine Westlake, Research Assistant

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 History and Background

Water availability and use in California has been the topic of many debates throughout the State's history. The latest of these has led to the current State and Federal agency investigations of future water demands, quality, and availability for California under a 1994 "Framework Agreement". This Agreement provides for increased coordination and communication for environmental protection and water supply dependability, which in turn led to the formation of CALFED and the development of the CALFED Bay-Delta Program.

CALFED is a cooperative interagency effort involving state and federal agencies with management and regulatory responsibilities in the Bay-Delta Estuary. The CALFED program is charged with the responsibility for the development of a long-term solution to fish and wildlife needs, water supply reliability, flood control, and water quality problems in the Bay-Delta.

One of CALFED's objectives was to develop an inventory of storage and conveyance opportunities which are described in a report titled *CALFED Bay-Delta Program Storage and Conveyance Component Inventories*, dated March 7, 1997. These inventories led to a more refined list of components as reported in *CALFED Storage and Conveyance Components Refinement Process*, dated October 1997. Four of the surface storage facilities described in the report are the Sites, Colusa, Thomes-Newville, and Red Bank projects.

The California Department of Water Resource's Northern District Office (DWR) became the lead agency in investigating the potential feasibility of the four off-stream storage facilities north of the Sacramento-San Joaquin Delta. The California Department of Fish and Game's Central Valley Bay-Delta Branch (DFG) was contracted in 1997 to conduct pre-feasibility field investigations for the presence of threatened, endangered, and special status mammal species on the sites. An additional task assigned to DFG was to collect baseline information and begin planning efforts for conducting a future Habitat Evaluation Procedure (HEP) analysis. Funding for DFG field efforts was provided by Proposition 204, the State General Fund, and Proposition 50.

Preliminary field investigations resulted in the removal of two of the four alternatives. The Red Bank and Colusa projects were dropped from the investigation in 2000. The results of these field investigations are described in a report titled *North of the Delta Off-Stream Storage Investigation Progress Report, Appendix S: Mammal Surveys,* dated January 2001. Continued field surveys focused on the Sites and Newville projects.

This report focuses on the results of the DFG's mammal field surveys on the two remaining proposed off-stream storage reservoirs. It outlines survey methodologies and summarizes results of field investigations that occurred from July 1997 through October 2002. It also includes a brief overview of the HEP process and its value as a potential tool for assisting future field studies.

1.2 Project Description

DWR, the U.S. Bureau of Reclamation, and local water interests are studying off-stream storage north of the Sacramento-San Joaquin Delta. The study area was identified in the August 2000 CALFED Programmatic Environmental Impact Study/Environmental Impact Report and Record of Decision. The CALFED Preferred Programmatic Alternative identified a need for up to six million acre-feet of new storage in California, including up to three million acre-feet of storage to be located North-of-the-Delta. The North-of-the-Delta Off-Stream Storage Investigation is a continuation of studies started by CALFED agencies and will be used to support the completion of a site specific EIR/S.

As a matter of policy, CALFED surface storage programs focus on off-stream reservoir sites for new surface storage, as well as expansion of existing onstream reservoirs. Onstream reservoir sites are not being pursued due to environmental impacts and implementation difficulties. This policy decision is based on the CALFED Solution Principle that prohibits redirecting significant negative impacts. Since construction of new onstream reservoirs could significantly limit the success of the CALFED Ecosystem Restoration Program by redirecting impacts, onstream reservoirs were eliminated from further consideration.

1.2.1. Off-Stream Storage

Traditionally reservoirs are created by constructing dams on major streams. These reservoirs are considered onstream storage. In contrast, an off-stream storage reservoir is typically constructed off of a major stream, but at times may be located on a small or seasonal stream that contributes a minor share of the water supply of the reservoir. Off-stream storage involves diverting water out of a major stream and transporting the water through various conveyance systems to a reservoir. Therefore, off-stream storage investigations include extensive evaluation of diversions and conveyance facilities to carry the water to and from the reservoirs.

Storing water in off-stream reservoirs can provide opportunities to increase dry year water supply reliability and improve the timing of its availability for multiple uses in an environmentally sensitive manner. Storing water under excess flow conditions will improve water supply reliability for environmental, urban, and agricultural water uses in dry years, and may also improve water quality for all beneficial uses.

Off-stream storage will allow water to be diverted and stored outside of the irrigation season when stream flows are highest or at times that are not critical to fish migration. This stored water can be released for local agricultural and refuge water use in exchange for diversions that would have occurred from the Sacramento River, when fish migration could be impaired. Such an exchange program would reduce diversions of water from the Sacramento River during the irrigation season, therefore reducing diversion impacts to the Sacramento River fishery.

Water that would otherwise have been diverted from the Sacramento River for local irrigation in late spring and summer could either be stored in Shasta Lake or released for

downstream beneficial uses. This operational method could result in increased storage and a larger cold water pool in Shasta Lake during the spring and early summer, which may benefit winter-run salmon in the Sacramento River. Additional water supply could also provide improved flexibility for agencies that own and operate or contract for off-stream storage water supplies.

1.3 Project Areas

The two alternatives are located west of Interstate 5 in the western portion of the Northern Sacramento Valley (Figure 1).

1.3.1. Sites Reservoir

The proposed Sites Reservoir area is located primarily in northwestern Colusa and southwestern Glenn counties, approximately 10 miles west of Maxwell in Antelope Valley (Figures 2a, 2b). The reservoir would be formed by constructing dams on Stone Corral Creek and Funks Creek. Evaluation of the Sites Project has focused on a 1.8 million acre-foot (maf) reservoir, although a 1.2 maf reservoir has been considered. A 1.8 maf Sites Reservoir would require construction of nine saddle-dams along the southern edge of the Hunters Creek watershed. Non-irrigation season flows in the Colusa Basin Drain, the Sacramento River, and local tributaries are potential sources of water supply for the Sites Project.

Potential conveyance systems from these sources to the reservoir include existing and/or enlarged Tehama-Colusa (TC) and Glenn-Colusa Irrigation District (GCID) canals, or a new conveyance facility from the Sacramento River near Moulton Weir and/or from the Colusa Basin Drain to Funks Reservoir on the TC Canal. All conveyance alternatives would require enlargement of the existing Funks Reservoir. Major project facilities would be situated at the Funks Creek dam site including outlet works, power plant, intake structure, and maintenance facilities.

The Sites Project would also require relocation of two county roads (Maxwell–Lodoga and Huffmaster roads) and the community of Sites. Recreational use has not been identified as a project purpose. However, five potential recreation facility locations have been identified.

The site is predominantly non-native grassland and managed primarily for cattle grazing with some areas of dryland farming. Other habitats include northern clay hardpan vernal pools, swales, seasonal wetlands, alkaline wetlands, emergent wetlands, oak savanna, oak woodland, and riparian.

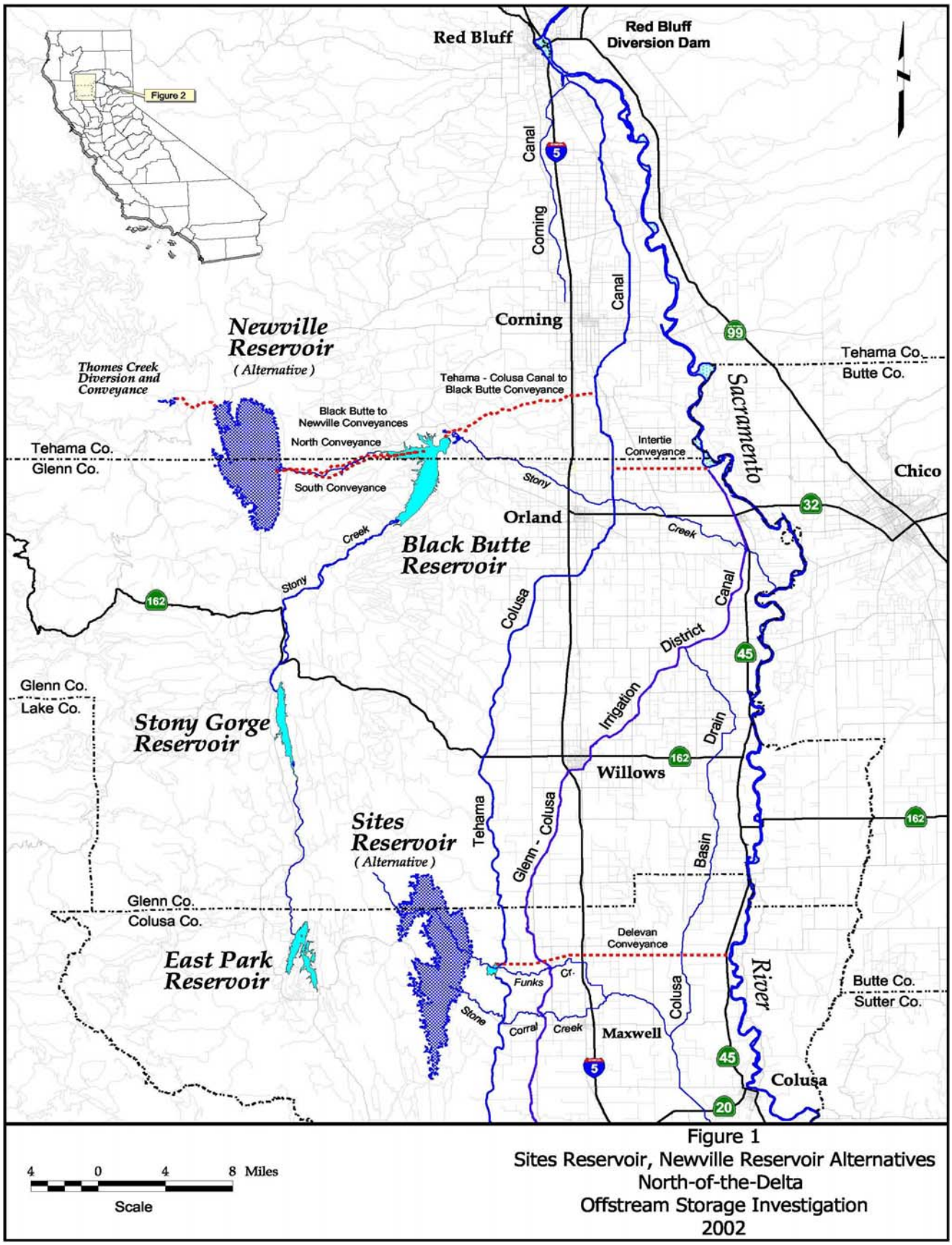


Figure 1
Sites Reservoir, Newville Reservoir Alternatives
North-of-the-Delta
Offstream Storage Investigation
2002

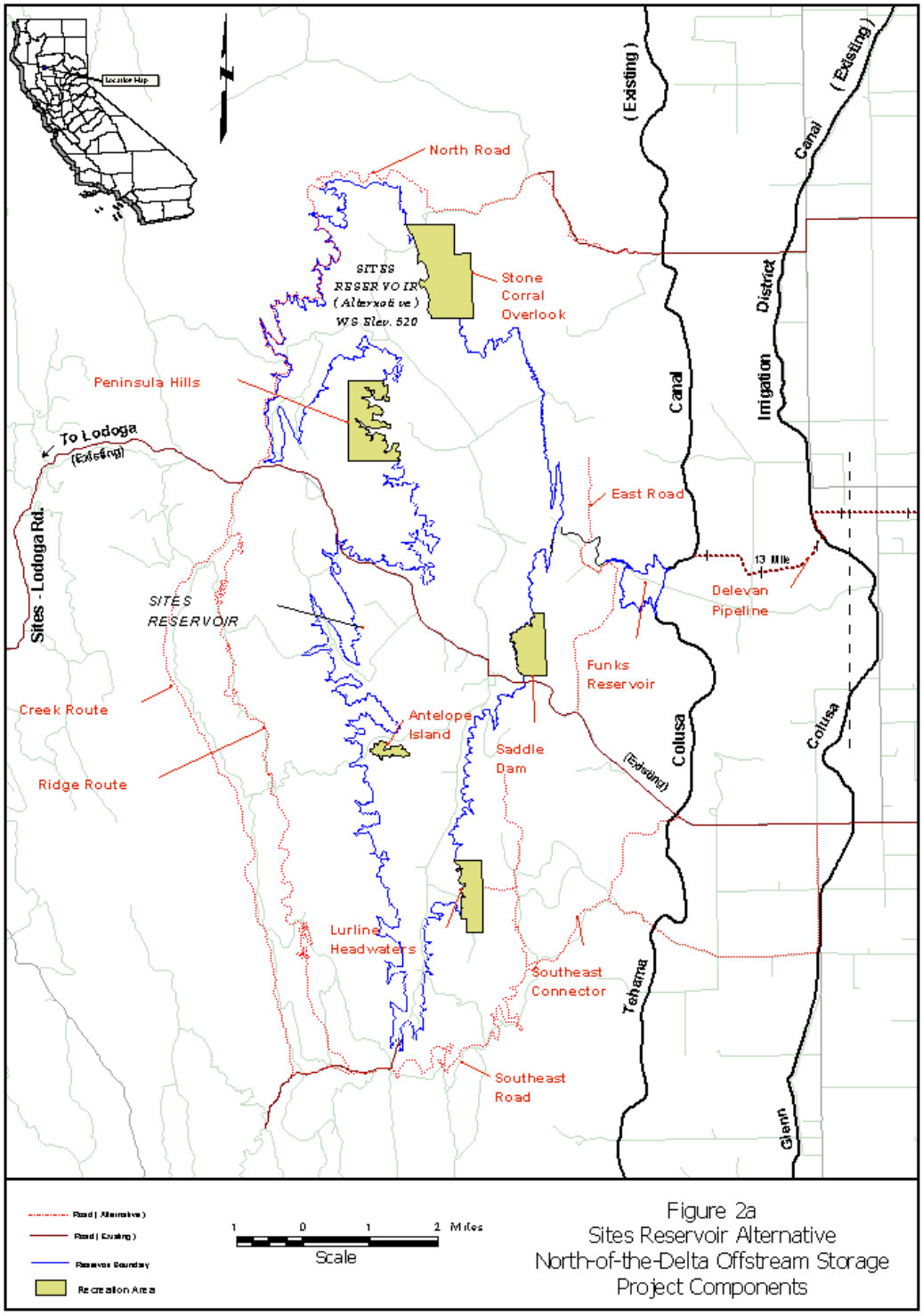


Figure 2a
Sites Reservoir Alternative
North-of-the-Delta Offstream Storage
Project Components

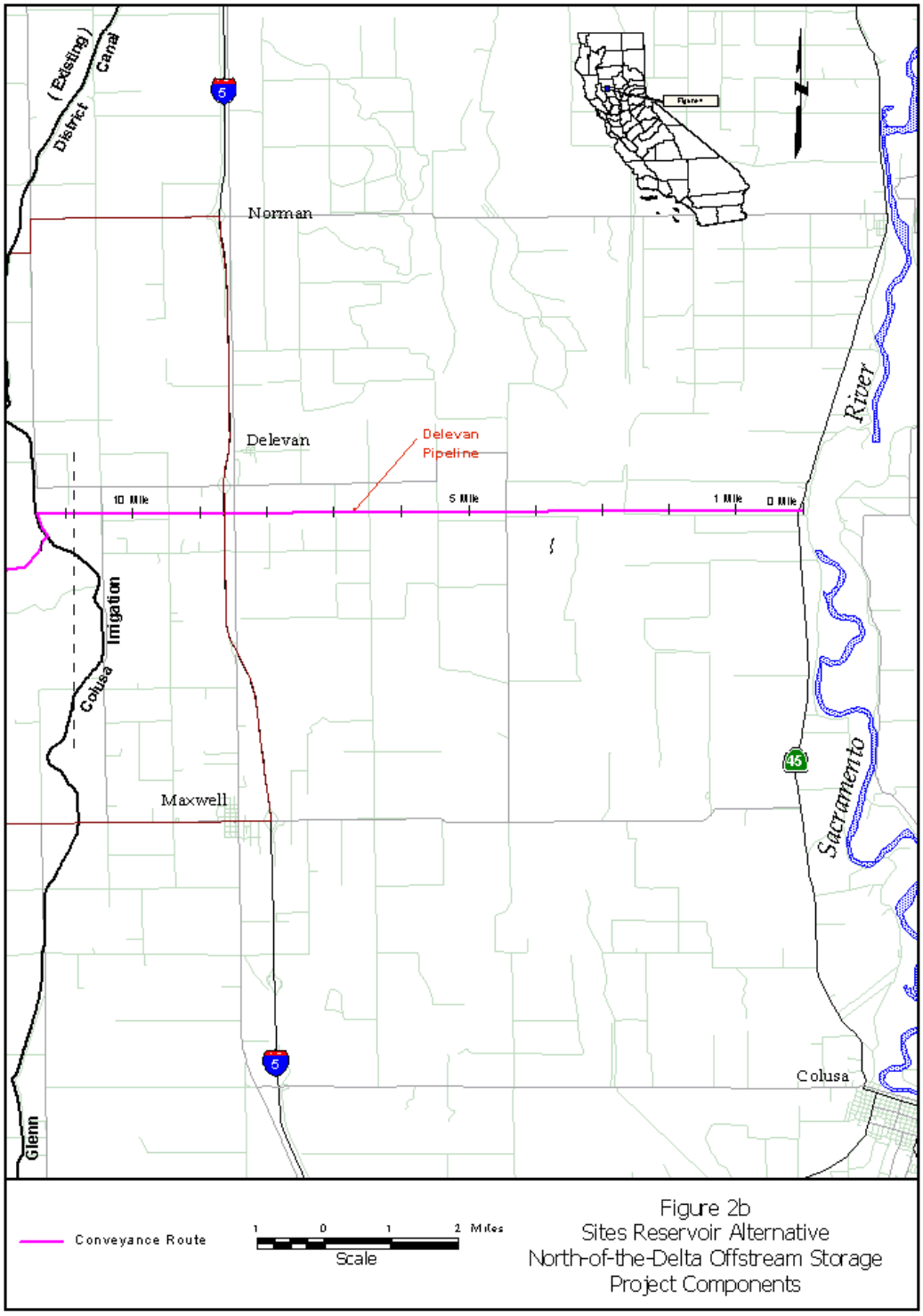


Figure 2b
Sites Reservoir Alternative
North-of-the-Delta Offstream Storage
Project Components

1.3.2. Newville Reservoir

The proposed Newville Reservoir area is located in southwestern Tehama and northwestern Glenn counties, approximately 18 miles west of the community of Orland on the North Fork of Stony Creek, upstream from the existing Black Butte Reservoir (Figures 3a, 3b, 3c, 3d). Constructing a dam on the North Fork of Stony Creek at Newville and a saddle dam at Burrows Gap would form Newville Reservoir. The alternative reservoir sizes being evaluated are 1.9 maf and 3.0 maf. Up to five additional saddle dams would be required for the 3.0 maf alternative. Potential water sources include the Sacramento River, Black Butte Reservoir, and Thomes Creek.

Potential conveyance includes the existing or enlarged TC Canal with a new conveyance between the GCID and TC canals, a new conveyance from the TC Canal to Black Butte Reservoir, and from Black Butte Reservoir to Newville Reservoir. Another potential water source would include diversion and conveyance from Thomes Creek at a location north and west of the Newville Reservoir.

Newville Reservoir would require relocation of portions of three county roads including Round Valley Road, Garland Road, and County Road 306. Recreational use has not been identified as a project purpose. However, five potential recreation areas have been identified.

The site is predominantly non-native grassland managed for cattle grazing. Other habitats include northern clay hardpan vernal pools, swales, seasonal wetlands, alkaline wetlands, emergent wetlands, oak savanna, oak woodland, and riparian.

1.4 Scope of Study

In 1997, DWR contracted with DFG to conduct field studies to inventory the special status mammal species that could occur in the project areas and to assess the potential of any red flags. A red flag could be considered any species, habitat, or situation that, in and of itself, constitutes a project stopper. A project stopper would be something that might be considered unmitigatable by the regulatory agencies or have such high mitigation costs that the project proponent could no longer afford the project.

An additional task assigned to DFG was to conduct some preliminary planning efforts for a HEP. The primary objective was to compile a list of Habitat Suitability Index (HSI) Models available for conducting a HEP (Appendix A). The focus at this stage of field surveys was to compile species lists of the project areas and HSI models currently available, which would assist with implementation of the HEP process in future survey efforts. Formal surveys for the HEP have not been conducted but will begin in August 2003.

Initially, the scope of the field investigation by DFG was limited to the mammals directly impacted by construction of the reservoirs (within the footprint or inundation zone). The level of effort varied among the alternatives due to a lack of written permission for access. Appurtenant facilities and right-of-way impacts in the immediate areas were not included in the initial

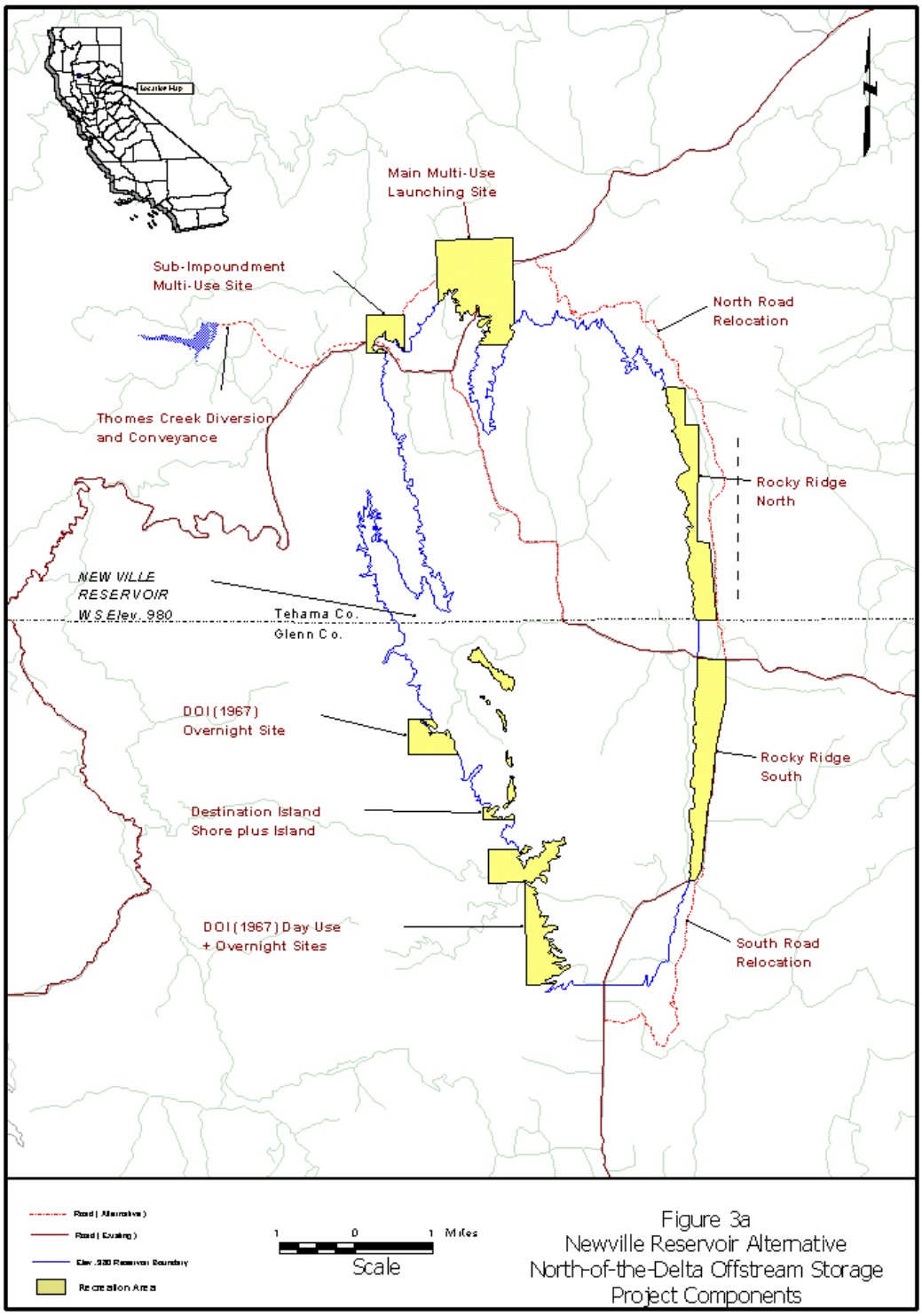


Figure 3a
Newville Reservoir Alternative
North-of-the-Delta Offstream Storage
Project Components

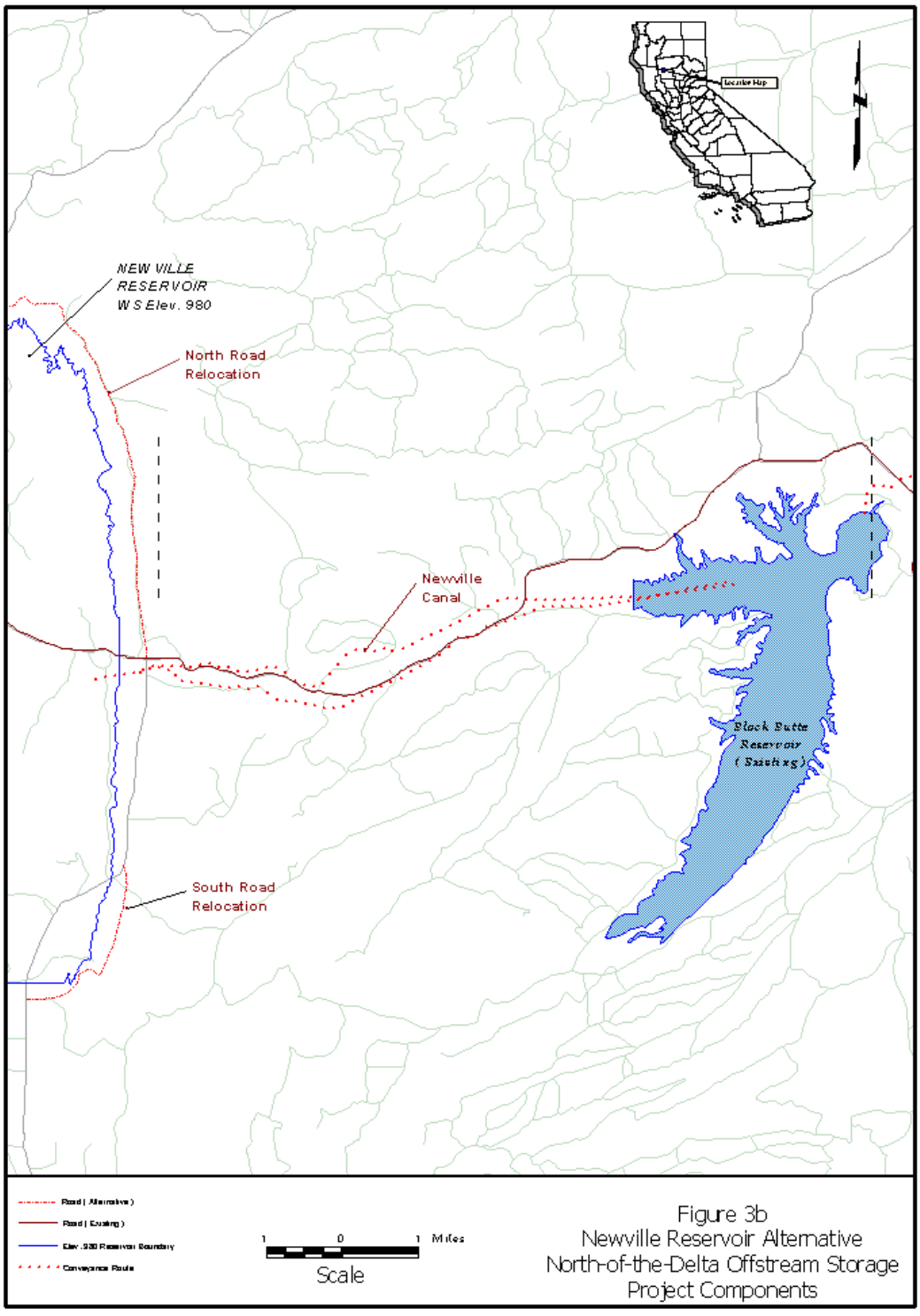


Figure 3b
Newville Reservoir Alternative
North-of-the-Delta Offstream Storage
Project Components

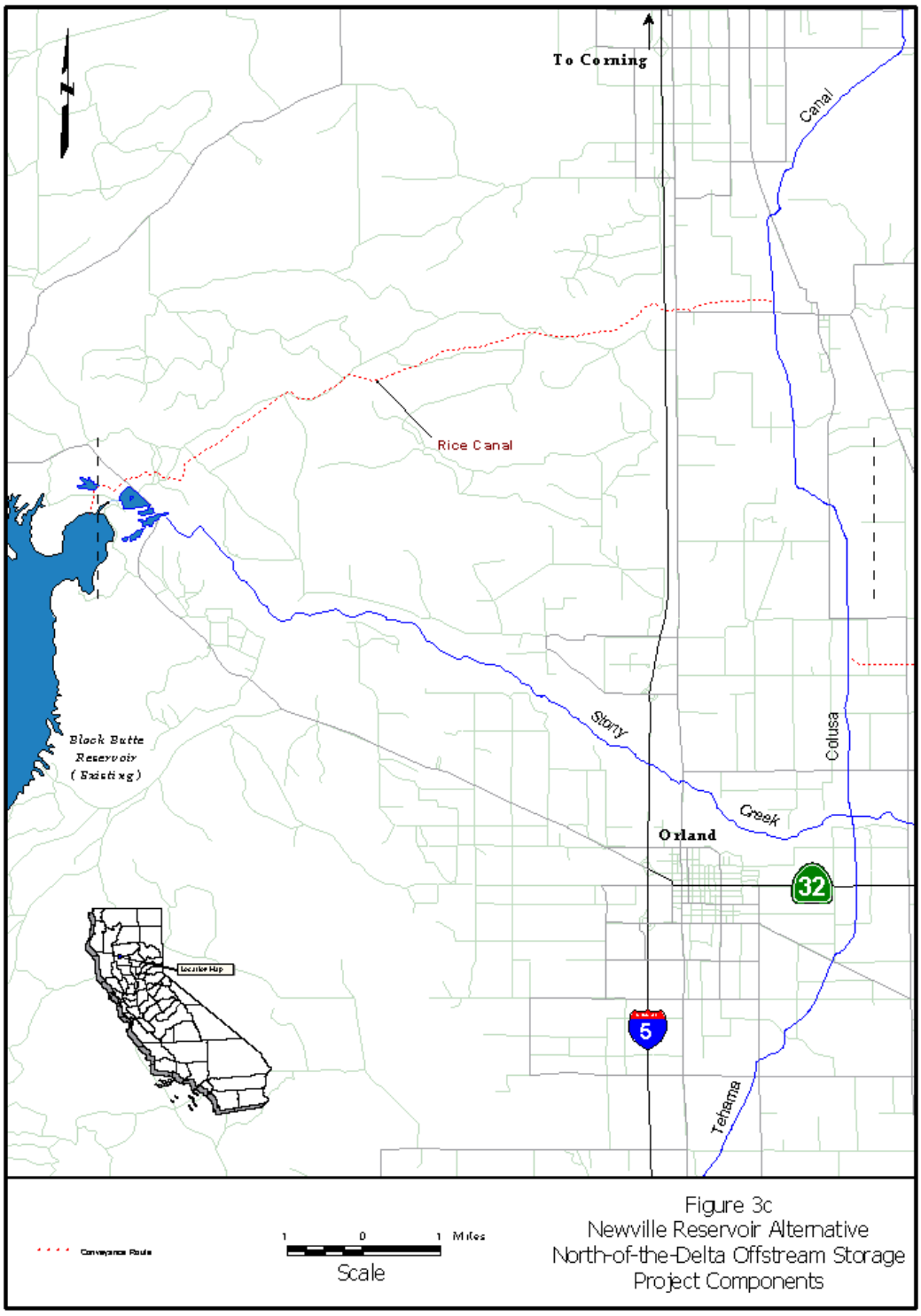


Figure 3c
Newville Reservoir Alternative
North-of-the-Delta Offstream Storage
Project Components

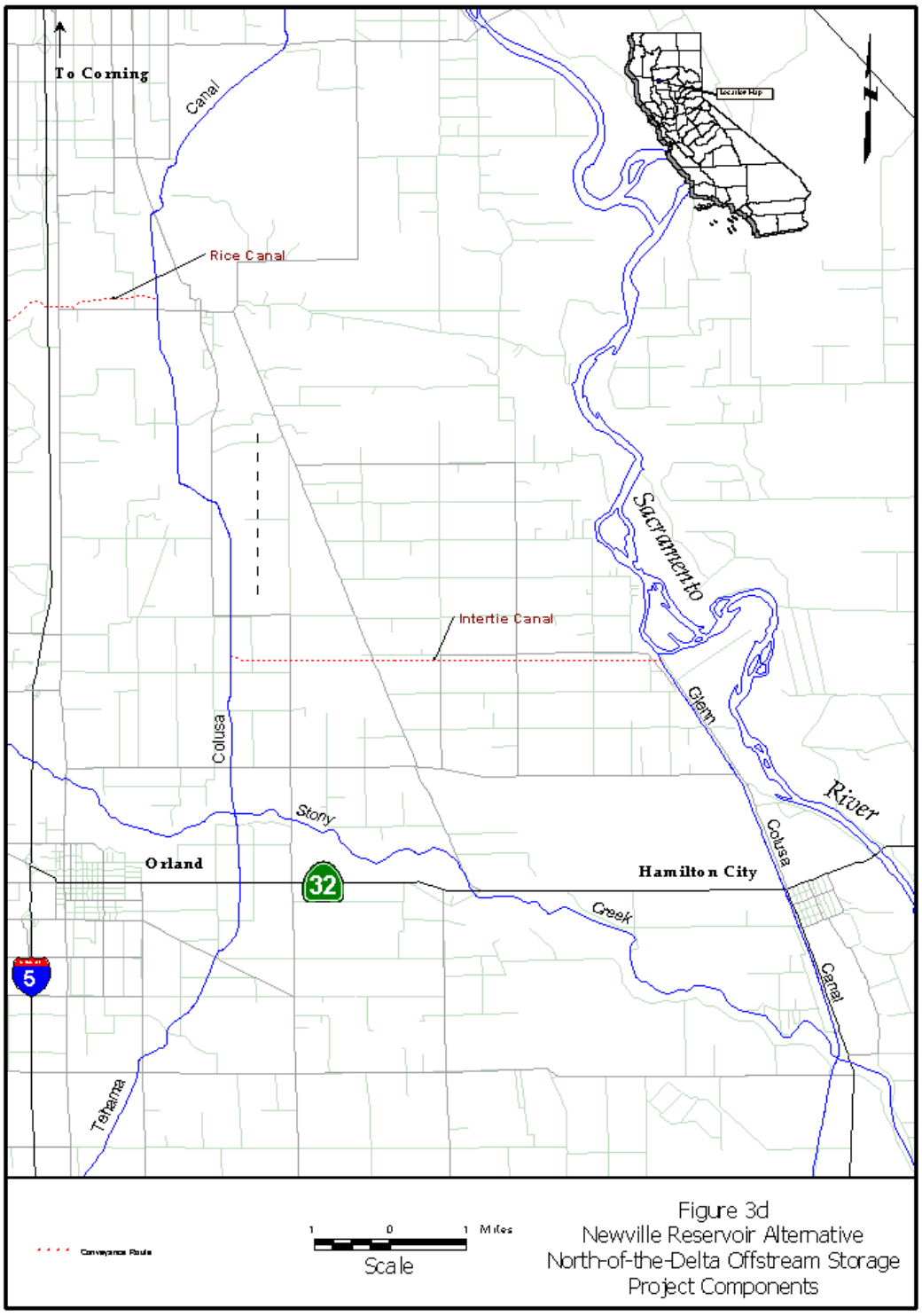


Figure 3d
Newville Reservoir Alternative
North-of-the-Delta Offstream Storage
Project Components

investigations due to lack of access and the fact that they were not yet identified. Additionally, the scope of the investigation did not address the potential impacts associated with conveyance to and from the project or use of the water stored by the project.

The scope of the field investigation by DFG was expanded as road realignments, conveyance routes, and locations of potential recreation areas were delineated by DWR.

1.4.1. Initial Study (1997-1998)

The initial purpose of this study was to document special status species presence and distribution. Special status species are those species designated as threatened, endangered, sensitive, or fully protected by State and/or Federal agencies. The direction was given by DWR to focus on special status species for each alternative. It was agreed that this would provide some comparable base line information which could assist in determining the potential feasibility of each alternative. The results of the special status species surveys would also provide a better understanding of some of the potential mitigation needs. Field survey methods were the same for each alternative because the list of potential species was the same or similar for each. The level of effort, however, varied among the alternatives because access varied within the project alternatives.

1.4.2. Current Effort (1998-2002)

During the second year of studies, field investigations were modified to address the presence, distribution, and, where possible, relative abundance of all mammal species in the project areas. These studies were designed to address the future compliance needs of CEQA and NEPA, as well as address the State and Federal Endangered Species Acts. These efforts were the first of multiple years of field investigations needed to evaluate the potential impacts associated with project construction. Field efforts varied between the alternatives due to changes in available personnel and limited property access.

In addition, staff researched the applicability and potential need to conduct a HEP. HEP is a valuable tool that will help with future investigations of the alternatives. It is a computerized method for use in habitat inventory, impact assessment, and mitigation studies. The method consists of a basic accounting procedure that combines habitat quality (defined as HSI) with habitat area to calculate Habitat Units (HU). HUs are sensitive to changes in both the amount and quality of available habitat. The basic accounting procedure enables comparisons of habitat availability at several sites (baseline studies) or of changes in habitat over time (impact assessment) for various sites or project alternatives. HEP output consists of quantitative information for each species or suite of species evaluated.

During the most recent year of studies, DWR announced that field efforts on the Newville project area would cease as of June 30, 2002. In response to the changed timeline, DFG biologists modified field investigations to focus on the presence and distribution of special status species. This focus allowed biologists to gather data in areas where access had previously been denied, return to areas where previous surveys had been unsuccessful despite suitable habitat for the target species, and to return to areas where inclement weather had interrupted

prior survey attempts. Filling in these data gaps would provide comparable base line information and a better understanding of some of the potential mitigation needs.

Although the focus was on special status species, all mammal species were noted when detected. Field efforts varied between the alternatives due to limited property access, but an attempt was made to survey each alternative equally. Surveys continued on the Sites project area after the June 30, 2002 deadline for Newville field work.

2.0 METHODOLOGY

A variety of field survey methods were used to sample the mammal populations at the alternative sites. Preliminary research included general literature searches, consultation with agency and species experts, aerial photo habitat interpretations, and landowner interviews. In addition, DFG biologists reviewed the Natural Diversity Data Base (NDDB), Wildlife Habitat Relationships System, the Federal Register of Threatened, Endangered, and Special Status Species, and the 1983 *Thomes-Newville Status Report* to gather additional species information for each project area. A list was then compiled which included the following potentially occurring special status species of mammals. The listed status of each species is based on the July 2002 NDDB publication. Detailed life histories for each of these species are included in Appendix B.

- Yuma myotis (*Myotis yumanensis*) a U.S. Fish and Wildlife Service (USFWS) "Federal Species of Concern" and a Bureau of Land Management (BLM) "Sensitive Species";

- Long-eared myotis (*Myotis evotis*) a USFWS "Federal Species of Concern" and a BLM "Sensitive Species";

- Fringed myotis (*Myotis thysanodes*) a USFWS "Federal Species of Concern", a BLM "Sensitive Species", and a Western Bat Working Group (WBWG) "High Priority";

- Long-legged myotis (*Myotis volans*) a USFWS "Federal Species of Concern", a BLM "Sensitive Species", and a WBWG "High Priority"

- Western small-footed myotis (*Myotis ciliolabrum*) a USFWS "Federal Species of Concern" and a BLM "Sensitive Species";

- Western red bat (*Lasiurus blossevillii*) a U.S. Forest Service (USFS) "Sensitive Species" and a WBWG "High Priority";

- Spotted bat (*Euderma maculatum*) a USFWS "Federal Species of Concern", a DFG "California Species of Special Concern", a BLM "Sensitive Species", and a WBWG "High Priority";

- Pale big-eared bat (*Corynorhinus townsendii pallescens*) a USFWS "Federal Species of Concern", a DFG "California Species of Special Concern", a U.S. Forest Service (USFS) "Sensitive Species", a BLM "Sensitive Species, and a WBWG "High Priority";

- Townsend's western big-eared bat (*Corynorhinus townsendii townsendii*) a USFWS "Federal Species of Concern", a DFG "California Species of Special Concern", a USFS "Sensitive Species" , a BLM "Sensitive Species", and a WBWG "High Priority";

- Pallid bat (*Antrozous pallidus*) a DFG "California Species of Special Concern", a USFS "Sensitive Species", a BLM "Sensitive Species", and a WBWG "High Priority";

- Western mastiff bat (*Eumops perotis*) a USFWS "Federal Species of Concern", a DFG "California Species of Special Concern", a BLM "Sensitive Species", and a WBWG "High Priority";

- San Joaquin pocket mouse (*Perognathus inornatus inornatus*) a USFWS "Federal Species of Concern" and a BLM "Sensitive Species";

- Ringtail (*Bassariscus astutus*) a DFG "California Fully Protected Species";

- Pine marten (*Martes americana*) a USFWS "Federal Species of Concern" and a USFS "Sensitive Species";

- Pacific fisher (*Martes pennanti pacificus*) a USFWS "Federal Species of Concern", a DFG "California Species of Special Concern", a USFS "Sensitive Species"; and a BLM "Sensitive Species"; and

- American badger (*Taxidea taxus*) a DFG "California Species of Special Concern".

After the development of the species list, field surveys were designed to assess the presence, distribution, and where possible, the relative abundance of the mammal species within the two alternatives. While the species listed above were the focus of survey efforts, sampling was designed to include the detection and assessment of all mammal species. Field investigation methods included small mammal live trapping, mist netting, acoustical surveys, roost searches, track plates, camera stations, spotlighting, general habitat measurements, walking transects, road transects, pond surveys, incidental observations, and deer herd surveys. More detailed descriptions of each of the field methods can be found in the North-of-Delta Off-stream Storage Evaluations: Environmental Monitoring Plan (CDFG Components).

2.1 Small Mammal Trapping

H.B. Sherman ® live traps were used to inventory the small mammal (rodent) populations (Davis, 1982; Teitje et al., 1997). The trap size used was 3 by 3.5 by 9 inches, the standard for conducting small mammal inventories. Traps were set for three to four consecutive nights (Cutler and Morrison, 1998; Slade and Blair, 2000) and checked and closed every morning at sunrise. All captures were immediately placed in a handling bag, identified, measured, marked, recorded on data sheets, and released back in the field. Marks consisted of

clipping fur on the hind quarters or chest of captured individuals (Nietfeld et al., 1996). This provided an easy and effective marking technique for recapture studies necessary to determine the relative abundance of small mammals. Traps were baited with a mixture of bird seed and either crushed walnuts or peanut butter each afternoon approximately one half hour before sunset. When possible, traps were pre-baited by placing a small amount of bait in front of the closed door for one night. Bedding material (i.e. quilt batting) was added to each trap during inclement weather.

To reduce the risk of contracting Hantavirus Pulmonary Syndrome or other zoonotic diseases, field personnel were provided full face respirators and disposable medical examination gloves to wear while checking traps and handling captures. In addition, the traps were sterilized at the end of each week with a dilute solution of bleach, a common technique that does not affect trapping success (Yunger and Randa, 1999).

The 1997 and 1998 field surveys specifically targeted habitat areas identified from aerial photo interpretations that appeared to have the greatest suitability for the target species. Those areas were ground checked and surveyed with high densities of traps in spot trapping arrangements to maximize capture success of the potentially occurring special status San Joaquin pocket mouse.

During the 1998 and 1999 field efforts, large trapping grids were implemented. Trapping locations, or grids, were placed in specifically targeted habitat areas to maximize capture success of the target species, as well as to determine the diversity and relative abundance of all small mammal species. The trapping grids consisted of 200 traps within a 100 by 100 meter square. The grids were established by field crews using a compass and 100-meter tape. Various colors of pin flags were used to mark the grids. One pin flag was placed every ten meters on the grid, and two traps were set within two meters of each flag on the grid.

During the 2000 and 2001 field efforts, trapping grid locations were randomly selected from each of the habitat types and designed so that the number of samples represented the amount and coverage area for each of the habitat types on the alternatives, a technique known as stratified sampling (Jones et al., 1996; Thompson and White, 1998). During the 2002 field season, field personnel returned to the original 1997/1998 field methods and utilized targeted spot trapping to maximize capture success of the San Joaquin pocket mouse.

An index of abundance (also referred to as capture success rate) of small mammals was calculated by dividing the total number of individuals captured by the total number of trap nights of effort (Cutler and Morrison, 1998). An index of abundance was calculated for each project site on a project-wide basis, as well as for each habitat type. A 2 x 2 contingency table with the Yates correction for continuity (Zar, 1984) was used to determine if the relative abundance of small mammals on the Sites Project area differed from that on the Newville project area.

2.2 Mist Netting

Mist nets were the primary method of inventorying bat species (Jones et al., 1996). Mist nets are panels of various thread weights, mesh sizes, lengths, and heights that are deployed

above the ground between two poles. Nets were set over water sources (i.e. stock ponds, permanent or intermittent streams and creeks, or water troughs), across steep draws or narrow canyons, in front of entrances of old buildings, along woodland or forest edges, and in small clearings within a woodland or forest. Nets were also set in areas identified through acoustical surveys as having high bat activity (see section 2.3 Acoustical Surveys).

Various net sizes and configurations were used. The primary configuration used was a single net or several single nets spaced throughout an area. Other net configurations included "joining" several nets together and arranging them to form V, L, and T shapes. These configurations were used primarily in areas where there was a lot of known bat activity but where previous capture efforts failed.

Field personnel were required to receive pre-exposure rabies vaccinations and to attend specialized training for proper handling technique and species identification before participating in any mist netting efforts. Personnel were also provided leather handling gloves to reduce the risk of bite wounds.

All bats were removed from the nets immediately upon capture and placed in a handling bag for processing. Processing was conducted at the conclusion of netting efforts or when bat activity became slow. This reduced the potential for multiple captures of individuals of any particular species. All captures were identified, measured, recorded on data sheets, recorded on the Anabat Detector, and released back into the field. Nets were typically monitored from sunset to approximately midnight.

2.3 Acoustical Surveys

The Anabat Detector, Zero Crossing Analysis Interface Module, and software connected to a lap top computer (collectively referred to as Anabat) were used to conduct acoustical surveys of bat species in flight. The Anabat is a device that detects the ultrasound produced by flying bats (Oliveira, 1998; Corben et al., 1999) using a technique called Zero Crossing Analysis, which provides frequency-time graphs. Bats are difficult to survey and capture; acoustical surveys can greatly increase the detection of bat species in a survey area (O'Farrell and Gannon, 1999). The Anabat was primarily used to record bats flying overhead at the net sites during the initial efforts.

As the studies progressed, other survey techniques were implemented. These techniques included acoustic recording while night driving and/or walking and at stationary points. Walking and driving surveys helped field crews identify potential trapping sites. When bats were detected with Anabat, crews stopped for one minute and continued recording. If bat activity continued, an additional five minutes of recording was conducted. The recordings were saved with pertinent information (i.e. location, date, species if known, and habitat) to the computer for later review and processing.

2.4 Roost Searches

Areas identified as having high bat activity through the use of Anabat (see section 2.3 Acoustical Surveys) were recorded, mapped, and visited during the day time to see what, if any, features were present, since long periods of activity probably indicate some significance to the area, either as a foraging area or a roost location. Roost searches were also conducted in conjunction with other survey methods in areas of suitable habitat. Visual surveys were conducted during the daytime hours in rock outcrops, bridges, out buildings, tree cavities, woodlands, and snags for evidence of bat presence (Davis, 1982; Kunz et al., 1996). Visual inspections in a rock crevice or tree cavity, with the aid of a flashlight if needed, enabled field personnel to locate potential and existing roosts. The location of the roosting site was recorded, and if the bat could be identified with minimal disturbance and without handling, the species was recorded. No bats were removed from the roost because of the potential for disturbing them to the point of roost abandonment, which has been a major factor in the decline of many bat species in California.

2.5 Track Plates

Track plates were used to identify the presence of carnivores such as the pine marten and Pacific fisher (Zielinski and Kucera, 1995; Wemmer et al., 1996). Four types of track plate set-ups were used. All four set-ups used aluminum plates but involved different configurations. One type consisted of open stop sign blanks laid on a relatively flat surface. Similarly, the second type consisted of a one meter by one meter open square laid on a relatively flat surface. The third type consisted of a 25.4 centimeter by 76.2 centimeter plate placed inside a wooden shelter with open ends. This box type was set against an object (a tree, log, or rock) and camouflaged with sticks and logs. The fourth type was a modified box type which had one closed end and one end with a ten-centimeter diameter opening, designed to exclude common species while enhancing the detection of the special status ringtail. All four types were coated with a mixture of blue carpenters chalk and 90 percent or greater ethanol (two parts alcohol to one part chalk).

The open squares and stop sign blanks were thinly coated in the ethanol-chalk mixture with a garden sprayer, and bait was placed in the center of the plate. Track impressions were created when an animal walked across the plate to the bait, picking up the chalk with the pads of its feet. The box types were coated over approximately two thirds of their length. On the other one third of the plate, a piece of white contact paper was placed sticky-side up between the chalk and the bait at the end of the plate. The plate was placed in the wooden shelter with the bait at the obstructed or closed end. Track impressions were created when an animal walked across the plate and then again by walking across the sticky contact paper with powdered feet to get to the bait. The baits used included chicken parts or pieces, canned jack mackerel, canned cat food, commercial baits or scents, and strawberry jam. Fish emulsion diluted with vegetable oil was poured near the plates to attract animals to the area. Canned cat food and strawberry jam were used as the bait for the modified box type.

Track plates were placed at a minimum of 0.32- km intervals (Nottingham et al., 1989; Diefenbach et al., 1994). During the 1999 and 2000 field seasons, the plates were set for at least ten consecutive days. They were checked approximately every two days by field staff. During the 2001 field season, track plates were set for one to seven days and checked every one to two days to minimize loss of data due to rain or damage from wild pigs or cattle. Track plates were pulled when a track was recorded or at the end of the week. During the 2002 field season, when the target species became the ringtail, modified box plates were set for seven-day periods.

Checking of track plates included recording tracks and re-chalking or re-baiting as needed. All tracks were measured, identified, and recorded on data sheets. Tracks left on the plates were transferred to data sheets by lifting them with the sticky side of clear tape and taping them to data sheets. When tracks were left on the contact paper, the paper was removed, labeled, and placed in a document protector.

2.6 Camera Stations

Two types of camera surveys were conducted. Both were used to survey for carnivores in a method similar to the track plates (Zielinski and Kucera, 1995; Wemmer et al., 1996). One type of camera survey utilized the Trailmaster ® Camera system, which took 35 mm still photos. Two types of Trailmaster sensors were used. One type was the infrared sensor, which was triggered when the infrared beam was broken. The other was a motion sensor, which was triggered by any movement within an emitted infrared cone. When triggered the sensors sent a signal to the camera to take a photograph. The other type of camera survey utilized a video surveillance camera, which took 8mm video for predetermined lengths of time. The video was triggered by two motion sensors. Both camera types were baited with canned jack mackerel, commercial baits or scents, raw chicken legs, canned cat food, road kill deer, salmon carcasses, or strawberry jam.

Each event (detection by the sensor) was recorded in the sensors memory, which also differentiated which events were photographed. The camera setups were checked at various intervals, depending upon the amount of activity at each site by field personnel. All data was recorded on data sheets. Personnel noted whether the bait had been eaten or if there was new animal sign in the area, such as tracks or scat. Once a roll of film or video cassette was used, the film was removed, replaced, and taken for development or reviewed on a VCR. The photos were labeled, identified, and filed at the DFG office.

2.7 Spotlighting

The initial focus of this survey method was to identify suitable routes for implementing standardized spotlighting efforts. Biologists mapped potential routes and classified them based upon the type of road (county, private, gravel, paved, dirt, etc.). While there are fairly extensive road systems throughout the project area, major portions of each route were only accessible seasonally due to muddy or fire hazard conditions.

Spotlight surveys were conducted by two or three person crews using hand-held Q-beam

spotlights (250,000 to 1,000,000 candle power) from a vehicle traveling between five and 15 miles per hour. When eye shine was detected, the vehicle was stopped and personnel identified the species with the aid of binoculars or a spotting scope. Eye shine characteristics such as color, body size, and general behavior of the animal were useful in identifying species (Cypher, 1991; Ralls and Eberhardt, 1997). Information such as location, habitat, species, time, distance traveled on the route, and weather was recorded on data sheets each night. All accessible roads in the study areas were included in spotlight surveys. Surveys began approximately one half hour after sunset and concluded at approximately midnight.

2.8 General Habitat Measurements and Assessment

General habitat measurements were conducted primarily to assist with future efforts of a HEP analysis. Detailed vegetative inventories were conducted by DWR staff. Therefore, DFG studies focused primarily on identifying the presence of habitat features such as snags, logs, burrows, and basic vegetation measurements, such as heights and canopy cover, while conducting other surveys such as trapping or track plating. This information was recorded and will be used in the future when the HEP Team is developed and begins the HSI Model selection process.

During the track plate and camera station surveys, biologists assessed areas that were identified from aerial photos as potential pine marten and Pacific fisher habitat. This ground-truthing consisted of conducting basic forest measurements, such as species composition and percent canopy cover. The measurements and assessments were recorded in field note books.

2.9 Walking Transects

Field personnel conducted walking transects throughout the different habitat types on the project areas. This effort was designed and implemented specifically to detect American badger denning sites and rodent burrow areas (Wemmer et al., 1996). Field personnel performed walking transects between ten and 50 meters (33 and 164 feet) apart depending on terrain and ground cover. All potential denning sites and burrow areas were measured, mapped, counted, and recorded. Walking transects were conducted in conjunction with other survey methods.

2.10 Pond Surveys

Pond surveys were conducted by field crews to detect the presence of mammals using the ponds as a water source. The muddy edges of each pond were inspected for mammal tracks and scat. Vegetated pond edges were inspected for dens, lodges, and scat. Crews walked the entire perimeter of the pond when property lines and conditions allowed. Various field guides for animal track and scat identification were used.

2.11 Incidental Observations

Incidental observations were mammal sightings recorded by field personnel while driving to specific sites within the project area or while conducting formal surveys. Observations from field personnel conducting surveys for other disciplines such as plants, birds, fish, reptiles, and amphibians were also reported to DFG and recorded. Reports and sightings from other field personnel were verified when possible.

2.12 Deer Herd Surveys

In 1979, DFG conducted an intensive investigation of the Thomes Creek deer herd to determine the potential impacts of the proposed Newville reservoir project on the herd's winter range. Methods of investigation during the 1979 study included population censusing, vegetation mapping within the winter range, habitat use, and radio telemetry surveillance of deer movement and activity.

During current efforts, deer herd surveys were conducted on the Sites and Newville project areas to identify any areas of seasonal use, such as summer or winter ranges. During late fall, winter, and early spring, driving surveys were conducted from dawn to mid-morning on the Newville project area to observe and document the distribution of the Thomes Creek deer herd. Two to three field personnel mapped deer locations and recorded deer numbers with the aid of binoculars while driving all accessible roads within the winter range. Spotlighting surveys (see Section 2.7 Spotlighting) were also conducted during the same time of season, beginning at dusk and continuing until approximately midnight.

A map of the winter range of the herd, as determined in the original 1979 study, was overlaid onto the current map of the proposed Newville Alternative using ArcView 3.2a (ESRI, Redlands, CA). The total acreage of the winter range was calculated, as well as the total acreage of the inundation areas, the conveyance structure, and the two recreation areas that fall within the winter range. These calculations were used to determine the percentage of the winter range that would be impacted by the proposed project area.

Driving surveys were also conducted during the summer and winter within the remainder of the Newville project area and within the Sites project area to observe the presence and distribution of resident deer. During the remainder of the year, field crews noted incidental observations of deer while conducting other more formal surveys on both project sites.

3.0 RESULTS: Sites Project Area

This section includes all data recorded from the field investigations on the Sites project area through October 2002. The results are discussed below by project area, methodology, and effort in Section 3.1. DFG surveyed the proposed Sites reservoir on a project-wide basis for NEPA and CEQA compliance, but was asked by DWR to also report results on a project component basis.

In compliance with this request, the total number of species detected in each component is reported for the components that received extensive field efforts. Section 3.2 provides a breakdown of all data recorded and is presented by component and methodology. In areas where field efforts focused strictly on the detection of special status species, such as the recreation areas, only the number of special status species detected is reported. The special status species that were focused on are listed in Section 2.0. The level of effort varied in each component due to personnel, time, and access constraints. These issues will be discussed in detail in Section 6.0 Discussion.

3.1 Project Area

Biologists recorded a total of 41 mammal species within the Sites Project Area during the course of study (Appendix C). Research prior to our initial field efforts included literature and database searches, which found evidence of historical occurrences in or near the project area of three special status species: the Townsend's western big-eared bat, San Joaquin pocket mouse, and Pacific fisher. In addition, field investigations identified habitat which could potentially support 13 other special status species. See section 2.0 for a complete list of those potentially occurring species.

Field surveys resulted in the documentation of seven special status species: the pallid bat, western red bat, Yuma myotis, western small-footed myotis, ringtail, American badger, and San Joaquin pocket mouse.

3.1.1. Small Mammal Trapping

A total of 550 trap nights of effort was expended from April to July 1998 to detect the presence of the San Joaquin pocket mouse. Limited field personnel implemented targeted spot trapping for three consecutive nights per week, one week per month. This effort had a 4.7 percent capture success rate, but did not result in the detection of the target species. An additional 6,800 trap nights of effort was expended from April to October 1999. Targeted trapping grids were implemented by a larger field crew for two to three consecutive nights per week, two to three weeks per month. This increased effort had 2.7 percent capture success rate, but did not result in the detection of the target species.

During the month of June 2000, a limited field crew expended 170 trap nights of effort, implementing random stratified sampling through spot trapping, which resulted in a zero capture success rate. This type of sampling was continued from April to October 2001, using a

combination of spot trapping and trapping grids, for three to four consecutive nights per week, two to three weeks per month. During this period an additional 2,075 trap nights were expended to assess the distribution and relative abundance of all small mammals. This effort resulted in a 2.3 percent capture success rate and successfully documented the San Joaquin pocket mouse.

An additional 3,112 trap nights of effort was expended from March to September 2002 to detect the presence of the San Joaquin pocket mouse. Targeted spot trapping performed by limited personnel three to four nights per week, every other week, resulted in a 2.0 percent capture success rate and extended the range of documentation of the San Joaquin pocket mouse.

The 12,707 total trap nights of effort resulted in the capture of 320 individuals (431 captures when recaptures are included). This represents a 2.5 percent overall capture success rate. Trapping success was highest in rock outcrop associated with grassland (Table 1). The most commonly trapped species was the deer mouse (*Peromyscus maniculatus*) (Table 2).

A comparison of the calculated index of abundance on the Sites Project area to the Newville Project area is presented in section 4.1.1 Small Mammal Trapping. Comparisons are made on a project-wide basis, as well as within habitat types.

Table 1. Small mammal trapping success by habitat type for the Sites Project Area.

Habitat Type	Total Trap Nights of Effort	Number of Captures (Individuals)	Percent Success
grassland	7,890	221	2.8
oak savanna	282	0	0
rock outcrop associated with oak savanna	783	6	0.7
riparian	314	0	0
oak woodland	1,862	25	1.3
rock outcrop associated with grassland	1,576	68	4.3
TOTAL	**12,707**	**320**	**2.5**

3.1.2. Mist Netting

A total of 108 hours of mist netting was conducted to detect the bat species present on the Sites project area. Mist netting efforts occurred one night per week, three weeks per month, in July and August of 1998. Due to limited availability of trained personnel, mist netting was conducted one night in April and two nights in July during the 1999 field season. One night of effort was expended in May of 2000, and one night each in July and August of the 2001 field season. During the 2002 field season, a greater effort was made. Mist netting was conducted three nights in April, one night in May, and six nights in August of 2002.

All together, seven bat species were captured (Table 3). Four of the captured species are special concern species. The most commonly caught species was the pallid bat. In addition,

field crews documented that there are breeding populations of pallid and western red bats within the project area by the presence of pregnant and lactating females, adult males, and juveniles.

Table 2. Small mammal trapping results for the Sites Project Area.

Species	Number of Individuals Captured	Percent of Capture
brush mouse (*Peromyscus boylii*)	15	4.7
California kangaroo rat (*Dipodomys californicus*)	32	10.0
California vole (*Microtus californicus*)	4	1.3
deer mouse	191	59.7
house mouse (*Mus musculus*)	16	5.0
ornate shrew (*Sorex ornatus*)	1	0.3
pinon mouse (*Peromyscus truei*)	3	0.9
San Joaquin pocket mouse	23	7.2
vagrant shrew (*Sorex vagrans*)	1	0.3
western harvest mouse (*Reithrodontomys megalotis*)	34	10.6
TOTAL	**320**	**100**

Table 3. Mist netting results for the Sites Project Area.

Species	Number Captured	Percent of Capture
California myotis (*Myotis californicus*)	7	13.7
little brown bat (*Myotis lucifugus*)	3	5.9
Myotis sp.	2	3.9
pallid bat	25	49.1
western pipistrelle (*Pipistrellus hesperus*)	4	7.8
western red bat	2	3.9
western small-footed myotis	4	7.8
Yuma myotis	4	7.8
TOTAL	**51**	**100**

3.1.3. Acoustical Surveys

A total of 138 hours of acoustical surveys were conducted in order to survey free-flying bat species on the Sites Project Area. The Anabat Detector equipment and software were

obtained in 2000 and were used during the course of study in May 2000, July and August 2001, and April, May and August 2002. These surveys detected two additional species that were not documented with the mist netting efforts: the Mexican free-tailed bat (*Tadarida brasiliensis*) and the big brown bat (*Eptesicus fuscus*). A complete list of species detected with the Anabat is not available at this time because the calls are still being analyzed. Any new findings will be released as an addendum to this report.

3.1.4. Roost Searches

Roost searches were conducted throughout all field efforts in appropriate areas. A total of 35 hours was spent searching for the location of active and/or potential bat roost sites on the Sites Project Area. Five active day roosts and one active night roost were identified. At least three different species were identified using the roosts: the pallid bat, western pipistrelle (*Pipistrellus hesperus*), and myotis species (*Myotis sp.*).

3.1.5. Track Plates

A total of 635 nights of effort was expended to detect the presence of medium sized mammals. During November and December of the 1999 field season, 18 track plates were utilized. In May of 2000, 16 track plates were set. In April and June through December of the 2001 field season, an increased effort resulted in the utilization of 83 track plates. During May through July and September 2002, 27 modified track plates were set to target the special status ringtail. Overall, 23 nights of track plate effort were expended in chaparral, 178 in riparian, 74 in grassland, 160 in oak savanna, 168 in oak woodland, and 32 in foothill pine areas.

Surveys resulted in a total of 95 detections and documented nine species (Table 4). The most commonly detected species was the California ground squirrel (*Spermophilus beecheyi*). Appendix D contains representative tracks from the track plates.

3.1.6. Camera Stations

A total of 260 camera station nights of effort was expended to detect the presence of medium sized mammals. This technique was conducted in conjunction with the track plate efforts. During November and December of 1999, seven camera station surveys were implemented. During May and June of 2000, eight camera station surveys were implemented. During the 2001 field season, one camera station survey was conducted each month in April, June through August, and October through December. During the 2002 field season, 13 camera surveys were conducted during January, March, and April. Overall, camera station survey efforts were expended for 76 nights in oak savanna, 151 nights in oak woodland, and 33 nights in riparian areas.

Surveys resulted in a total of 19 detections and documented seven species (Table 5). The most commonly detected species was the wild pig. Appendix E contains representative photographs from the camera stations.

Table 4. Track plate results for the Sites Project Area.

Species	Number Detected
bobcat (*Lynx rufus*)	1
California ground squirrel	25
gray fox (*Urocyon cinereoargenteus*)	10
mouse sp. (*Peromyscus sp.*)	19
raccoon (*Procyon lotor*)	22
ringtail	2
western striped skunk (*Mephitis mephitis*)	5
wild pig (*Sus scrofa*)	9
woodrat sp. (*Neotoma sp.*)	2
TOTAL	**95**

Table 5. Camera station results for the Sites Project Area.

Species	Number Detected
black-tailed deer (*Odocoileus hemionus columbianus*)	1
black-tailed jackrabbit (*Lepus californicus*)	2
coyote (*Canis latrans*)	2
gray fox	1
raccoon	4
western striped skunk	3
wild pig	6
TOTAL	**19**

3.1.7. Spotlighting

A total of 44 hours of effort was expended to detect the presence of all nocturnal mammal species within the project area. Spotlight surveys were implemented one night in June 1998, one night in May 2000, and one night each in July, October, and November 2001. Spotlighting efforts were increased during the 2002 field season. Surveys were implemented three to four nights per month in February, April, May, and June. Surveys were conducted 17 nights during the month of July and one night in August in an effort to maximize detection of the American badger.

Surveys resulted in a total of 354 detections and documented sixteen species (Table 6). The most commonly detected species were the black-tailed deer and the black-tailed jackrabbit.

Table 6. Spotlighting results for the Sites Project Area.

Species	Number Detected
American badger	3
bat sp.	15
black-tailed deer	85
black-tailed jackrabbit	77
bobcat	3
California kangaroo rat	33
coyote	30
deer mouse	2
gray fox	5
mountain lion (*Felis concolor*)	1
mouse sp.	1
raccoon	30
ringtail	3
Virginia opossum (*Didelphis virginiana*)	2
western striped skunk	15
wild pig	49
TOTAL	**354**

3.1.8. Habitat Assessment

While conducting the track plate and camera station surveys, it was determined that no suitable habitat for the pine marten and Pacific fisher occurs within the Sites Reservoir footprint (see Appendix B for the complete life history of both species). The site is dominated by grasslands, forested only on the west and southeast margins, and interspersed with oak woodlands and savannas. Coniferous and hardwood forests occur only sporadically in this alternative.

3.1.9. Pond Surveys

A total of 25 ponds were surveyed to detect the presence of any mammals utilizing the ponds as a water source. One pond survey was conducted per month in June, August, September, October and December of 2001. Efforts were increased during the 2002 field season, resulting in the surveys of three ponds in January, one in April, 10 in June, four in August, and two in September. Surveys resulted in the detection of 10 species (Table 7). The most commonly detected species was the coyote.

Table 7. Pond Survey Results for the Sites Project Area.

Species	
black-tailed deer	coyote
bobcat	gray fox
black-tailed jackrabbit	mouse sp.
California ground squirrel	raccoon
California kangaroo rat	wild pig

3.1.10. Incidental Observations

Incidental observations throughout the course of study resulted in the detection of 28 species (Table 8).

Table 8. Incidental Observations for the Sites Project Area.

Species	
American badger	gray fox
American pronghorn antelope (*Antilocapra americana*)	Mexican free-tailed bat
beaver (*Castor canadensis*)	mountain lion
black bear (*Ursus americanus*)	mouse sp.
black-tailed jackrabbit	muskrat (*Ondatra zibethicus*)
black-tailed deer	raccoon
bobcat	rat sp.
Botta's pocket gopher (*Thomomys bottae*)	ringtail
brush rabbit (*Sylvilagus bachmani*)	river otter (*Lutra canadensis*)
California ground squirrel	western gray squirrel (*Sciurus griseus*)
California kangaroo rat	western harvest mouse
California vole	western striped skunk
coyote	wild pig
deer mouse	woodrat sp.

3.1.11. Deer Herd Surveys

Deer (mostly does with fawns) were documented to use portions of the Sites project area

each year from late April to late September, with fewer deer remaining in the area through the winter months. Surveys were limited to the boundaries of the proposed project area; it is possible that the deer remain for the duration of the year just along the outer edge of the project or on the properties that biologists could not access. The observed reduced numbers during the winter months may also be attributable to the number of deer-vehicle collisions during the summer. The year-round use of the area indicates that the Sites project area serves as range for a resident deer herd.

3.2 Project Components

As studies were conducted on the Sites project area, the areas surveyed were categorized by project component. Those components were mapped and named by DWR and broken down into the reservoir footprint, Funks Reservoir enlargement, road relocations (North Road, Southeast Road, Southeast Connector, Ridge Route, Creek Route, East Road), conveyance structures (Delevan Pipeline), and recreation areas (Lurline Headwaters, Peninsula Hills, Stone Corral Overlook, Antelope Island, Saddle Dam). Powerplants, pump stations, bridges, utility relocations, transmission line corridors, and the enlargement of the existing GCID and TC canals were not studied because location information and purpose of operation were not available. As this information becomes available, appropriate surveys will be conducted and the results will be released as an addendum to this report.

3.2.1. Sites Footprint

Biologists conducted acoustical surveys, mist net surveys, pond surveys, small mammal trapping, spotlighting surveys, track plate surveys, and walking surveys within the Sites footprint (Figure 2a). Field efforts resulted in the documentation of 26 species (Table 9). Three of those species are listed as special status species: the pallid bat, San Joaquin pocket mouse, and American badger. Anabat calls are still being analyzed; it is possible that more special status bats occur within the footprint. A small resident deer herd uses this component as part of its range.

Table 9. Survey results for the Sites footprint component.

Species	
American badger	house mouse
black bear	little brown bat
black-tail jackrabbit	mountain lion
black-tailed deer	ornate shrew
bobcat	pallid bat
Botta's pocket gopher	pinon mouse
brush mouse	raccoon
California ground squirrel	rat sp.
California kangaroo rat	San Joaquin pocket mouse
California vole	western harvest mouse
coyote	western pipistrelle
deer mouse	western striped skunk
gray fox	wild pig

3.2.2. Funks Reservoir Enlargement

Biologists conducted track plate and walking surveys around Funks Reservoir (Figure 2a) with a focus on special status species. The limited field effort resulted in the documentation of one special status species: the American badger. The surrounding rock outcrops in grassland areas provide suitable San Joaquin pocket mouse habitat. Although bat surveys were not conducted, the large existing body of water with adjacent riparian corridors and open grassland provide suitable foraging and roosting sites for bats.

3.2.3. Sites North Road

Biologists conducted camera station surveys, mist net surveys, pond surveys, small mammal trapping, spotlighting surveys, track plate surveys, and walking surveys along the North Road realignment (Figure 2a). Field efforts resulted in the documentation of 17 species (Table 10). Three of those species are listed as special status species: the pallid bat, San Joaquin pocket mouse, and American badger.

Table 10. Survey results for the Sites North Road component.

Species	
American badger	house mouse
black-tail jackrabbit	pallid bat
black-tailed deer	raccoon
bobcat	San Joaquin pocket mouse
California ground squirrel	vagrant shrew
California kangaroo rat	western harvest mouse
coyote	western striped skunk
deer mouse	wild pig
gray fox	

3.2.4. Sites Southeast Road and Southeast Connector

Biologists conducted camera station surveys, mist net surveys, pond surveys, small mammal trapping, spotlighting surveys, track plate surveys, and walking surveys along the Southeast Road alignment (Figure 2a). Field efforts resulted in the documentation of 20 species (Table 11). Two of those species are special status species: the western red bat and American badger. Suitable habitat for the San Joaquin pocket mouse exists throughout the area. Large rock outcrops, a pond, and open grassland areas provide suitable roosting sites and foraging habitat for bats. A small resident deer herd uses this area as part of its range.

Table 11. Survey results for the Sites Southeast Road and Southeast Connector component.

Species	
American badger	gray fox
black bear	house mouse
black-tailed deer	Mexican free-tailed bat
bobcat	raccoon
brush mouse	vagrant shrew
California ground squirrel	western harvest mouse
California kangaroo rat	western pipistrelle
coyote	western red bat
deer mouse	western striped skunk
dusky-footed woodrat	wild pig

3.2.5. Sites Ridge Route

Biologists conducted camera station surveys, a pond survey, small mammal trapping, and spotlighting surveys along the Ridge Route. Limited field efforts resulted in the failure to document any special status species, but suitable San Joaquin pocket mouse and American badger habitat does exist along the route. A large pond, open grassland, and a wooded area provide suitable foraging habitat and roosting sites for many species of bats. A small resident deer herd uses this component as part of its range.

3.2.6. Sites Creek Route

Biologists conducted acoustical surveys, camera station surveys, mist net surveys, pond surveys, small mammal trapping, spotlighting surveys, track plate surveys, and walking surveys along the Creek Route (Figure 2a). Field efforts resulted in the detection of 22 species (Table 12). Three of those species are listed as special status species: the pallid bat, western small-footed bat, and Yuma bat. Anabat recordings are still being analyzed; it is possible that more special status bats occur within the Creek Route. Suitable habitat exists for the American badger and the San Joaquin pocket mouse. Landowners report past sightings of ringtail along the route; biologists have been unable to document ringtail presence through field efforts, despite many areas of suitable habitat. A small resident deer herd uses this component as part of its range.

3.2.7. Sites East Road

Biologists conducted pond surveys, small mammal trapping, track plate surveys, and walking surveys along the East Road alignment (Figure 2a). Field efforts resulted in the documentation of two special status species: the San Joaquin pocket mouse and the American

badger. Abandoned buildings, open grassland areas, and Funks Creek provide suitable foraging and roosting sites for several bat species.

Table 12. Survey results for the Sites Creek Route component.

Species	
big brown bat	gray fox
black bear	little brown bat
black-tail jackrabbit	Mexican free-tailed bat
black-tailed deer	mountain lion
bobcat	pallid bat
brush rabbit	raccoon
California bat	western gray squirrel
California ground squirrel	western small-footed bat
California kangaroo rat	western striped skunk
coyote	wild pig
dusky-footed woodrat	Yuma bat

3.2.8. Delevan Pipeline

Biologists conducted spotlighting surveys, track plate surveys, and walking surveys along the Delevan Pipeline (Figure 2b). Limited field efforts resulted in the detection of one special status species along the river levee: the ringtail. Suitable habitat exists for the American badger, and the riparian corridor along the river provides suitable habitat for many bat species. An American pronghorn antelope herd was documented in locations both north and south of the proposed conveyance. Groups of deer were observed within the Delevan Wildlife Area along the proposed conveyance location.

3.2.9. Lurline Headwaters

Biologists conducted acoustical surveys, mist net surveys, pond surveys, spotlighting surveys, track plate surveys, and walking surveys within Lurline Headwaters recreation area (Figure 2a). Limited field efforts resulted in the documentation of one special status species: the American badger. Suitable habitat exists for the San Joaquin pocket mouse. Large rock outcrops, hollowed trees and snags, and a pond and creek provide suitable foraging and roosting sites for bats. Anabat recordings are being analyzed; it is possible that special status bats occur within the component.

3.2.10. Peninsula Hills

Biologists conducted walking surveys within the Peninsula Hills recreation area (Figure 2a). Limited field efforts resulted in the documentation of one special status species: the American badger. No suitable San Joaquin pocket mouse habitat was documented within the component. The area is mostly oak savanna with several open grassland areas interspersed. These habitat features, combined with the creek that passes through the component and the many snags and hollowed trees, provide suitable roosting and foraging habitat for several bat species.

3.2.11. Stone Corral Overlook

Biologists conducted walking surveys within the Stone Corral recreation area (Figure 2a). Limited field efforts resulted in the documentation of one special status species: the American badger. Surveys in immediately adjacent areas documented the pallid bat and San Joaquin pocket mouse. Numerous rock outcrops, open grassland, and nearby abandoned buildings provide suitable habitat for both species.

3.2.12. Antelope Island

Biologists conducted small mammal trapping, track plate surveys, and walking surveys within the Antelope Island recreation area (Figure 2a). Field efforts resulted in the documentation of one special status species: the American badger. No suitable San Joaquin pocket mouse habitat was documented within the area. The nearby open grasslands, abandoned buildings, and creek provide suitable roosting and foraging habitat for several bat species.

3.2.13. Saddle Dam

Biologists conducted walking surveys within the Saddle Dam recreation area (Figure 2a). Limited field efforts failed to document any special status species. No sign of the American badger was found, but suitable badger and San Joaquin pocket mouse habitat exists throughout the area. Many large snags, hollowed trees, fallen logs, and large rock outcrops surrounded by open grassland provide suitable roosting sites and foraging habitat for bats.

4.0 RESULTS: Newville Project Area

This section includes all data recorded from the field investigations on the Newville project area through June 30, 2002. The results are discussed below by project area, methodology, and effort in Section 4.1. DFG surveyed the proposed Newville reservoir on a project-wide basis for NEPA and CEQA compliance, but was asked by DWR to also report results on a project component basis.

In compliance with the request, the total number of species detected in each component is reported for the components that received extensive field efforts. Section 4.2 provides a breakdown of all data recorded and is presented by component and methodology. In areas where field efforts focused strictly on the detection of special status species, such as the recreation areas, only the number of special status species detected is reported. The special status species that were focused on are listed in Section 2.0. The level of effort varied in each component due to budgetary, time, and access constraints. These issues will be discussed in detail in Section 6.0 Discussion.

4.1 Project Area

Biologists recorded a total of 35 different mammal species using the Newville Project Area (Appendix C). It should be noted that some of these sightings were documented during the early 1980s when extensive surveys were conducted. Those studies, however, focused primarily on deer herds, so limited field surveys were conducted for other mammals. Preliminary research prior to our initial efforts, which included literature and data base searches, found evidence of past occurrences in or near the project area of one special status species: the Pacific fisher. In addition, field investigations identified habitat which could potentially support 15 other special status species. See section 2.0 for a complete list of those species.

Surveys resulted in the documentation of five special status species: the San Joaquin pocket mouse, Yuma myotis, western mastiff bat, pallid bat, and American badger.

4.1.1. Small Mammal Trapping

A total of 160 trap nights of effort was expended in June 1998 to detect the presence of the San Joaquin pocket mouse. Limited field personnel, working with limited property access, implemented targeted spot trapping for two consecutive nights in one week. This effort had a 3.75 percent capture success rate, but did not result in the detection of the target species. An additional 3,090 trap nights of effort was expended from April to October 1999. Targeted trapping grids were implemented by a larger field crew for two to three consecutive nights per week, one week per month. This increased effort had a 4.0 percent success rate and resulted in the documentation of the San Joaquin pocket mouse.

During the month of August 2000, a limited field crew expended 343 trap nights of effort in one week, implementing random stratified sampling through spot trapping, which resulted in a 1.2 percent capture success rate. This type of sampling was continued from March to October

2001, using a combination of spot trapping and trapping grids, for three to four consecutive nights per week, two to three weeks per month. During this period, an additional 2,091 trap nights were expended to assess the distribution and relative abundance of all small mammals. This effort resulted in a 1.9 percent capture success rate, but did not result in the detection of the target species.

Another 1,193 trap nights of effort was expended from May to June 2002 to detect the presence of the San Joaquin pocket mouse. Targeted spot trapping performed by limited field personnel three to four nights per week, every other week, resulted in a 1.8 percent capture success rate and successfully documented the San Joaquin pocket mouse.

The 6,877 total trap nights of effort resulted in the capture of 195 individuals (258 captures when recaptures are included). This represents a 2.8 percent overall trapping success rate. Trapping success was highest in Eucalyptus stands (Table 13). The most commonly trapped species was the deer mouse (Table 14).

A comparison of the index of abundance on Sites and Newville showed no significant difference on a project-wide basis ($0.10<P<0.25$). Similarly, there was no significant difference in the index of abundance in grassland between each project area ($0.25<P<0.50$), in oak savanna between each project area ($0.90<P< 0.95$), in rock outcrop associated with oak savanna in each project area ($0.95<P<0.975$), or in oak woodland between each project area ($0.10<P< 0.25$). However, a comparison of the index of abundance within rock outcrop associated with grassland between project areas showed that Sites had a significantly higher index ($0.025<P<0.05$). A comparison of the index of abundance within riparian habitat between project areas showed that Newville had a significantly higher index ($P<0.001$). The Eucalyptus habitat type could not be used for comparison as it only exists on the Newville project area.

Table 13. Small mammal trapping success by habitat type for the Newville Project Area.

Habitat Type	Total Trap Nights of Effort	Number of Captures (Individuals)	Percent Success
grassland	5,303	161	3.0
oak savanna	247	1	0.4
rock outcrop associated with oak savanna	59	0	0
riparian	241	10	4.1
oak woodland	210	0	0
rock outcrop associated with grassland	782	19	2.4
Eucalyptus	35	4	11.4
TOTAL	**6,877**	**195**	**2.8**

Table 14. Small mammal trapping results for the Newville Project Area.

Species	Number of Individuals Captured	Percent of Capture
brush mouse	1	0.5
California kangaroo rat	17	8.7
California vole	10	5.1
deer mouse	125	64.1
house mouse	5	2.6
San Joaquin pocket mouse	11	5.7
western harvest mouse	26	13.3
TOTAL	**195**	**100**

4.1.2. Mist Netting

A total of 81 hours of mist netting was conducted to detect the bat species present on the Newville Project Area. Mist netting efforts occurred two nights in November 1998. Due to lack of access and limited personnel, mist netting was not conducted during the 1999 field season. Mist netting efforts occurred one night in May and two nights in August of 2000. During the 2001 field season, mist netting was conducted two nights in May. Field efforts were increased in 2002, and mist netting was conducted four nights in May and one night in June.

All together, seven bat species were captured and identified (Table 15). Two of the captured species are special concern species. The most commonly caught species was the Yuma myotis.

Table 15. Mist netting results for the Newville Project Area.

Species	Number Captured	Percent of capture
big brown bat	2	4.9
California bat	1	2.4
hoary bat (*Lasiurus cinereus*)	1	2.4
Myotis sp.	9	22.0
pallid bat	2	4.9
silver-haired bat (*Lasionycteris noctivagens*)	1	2.4
western pipistrelle	3	7.3
Yuma myotis	22	53.6
TOTAL	**41**	**100**

4.1.3. Acoustical Surveys

A total of 92 hours of acoustical surveys were conducted in order to survey free-flying bat species on the Newville Project Area. The Anabat Detector equipment and software were obtained in 2000 and were used during the course of study in May and August 2000, May 2001, and May and June 2002. Among the species recorded were the Mexican free-tailed bat and western pipistrelle. An additional recorded species not previously documented with mist netting efforts was the western mastiff bat. A complete list of species detected with the Anabat is not available at this time because calls are still being analyzed. Any new findings will be released as an addendum to this report.

4.1.4. Roost Searches

Roost searches were conducted throughout all field efforts in appropriate areas. A total of 27 hours were spent searching for the location of active and/or potential roost sites on the Newville Project Area. Biologists were unsuccessful in identifying active roost sites.

4.1.5. Track Plates

A total of 446 nights of effort was expended to detect the presence of medium sized mammals. During November and December of the 1999 field season, 14 track plates were utilized. Due to limited field personnel and lack of access, no track plate effort was expended during the 2000 field season. In March through July and September through November of 2001, an increased effort resulted in the utilization of 93 track plates. During May and June 2002, five modified track plates were set to target the ringtail. Overall, 172 nights of track plate effort were expended in grassland, 82 in riparian, 15 in oak woodland, six in wet meadow, 45 in Eucalyptus stands, and 126 in oak savanna.

Surveys resulted in a total of 52 detections and documented eight species (Table 16). The most commonly detected mammals were mice (species unknown). Appendix D contains representative tracks from the track plates.

4.1.6. Camera Stations

A total of 382 camera station nights of effort was expended to detect the presence of medium sized mammals. This technique was conducted in conjunction with the track plate efforts. During November and December of 1999, eight camera station surveys were implemented. During July and August of 2000, 11 camera station surveys were implemented. During the 2001 field season, one camera station survey was conducted each month in June, July, September, and October. Three camera station surveys were implemented during August and November 2001, and six were implemented during the month of December. During the 2002 field season, 14 camera station surveys were conducted during January through March, May, and June. Overall, camera station survey efforts were expended for 27 nights in foothill pine, 76 in oak savanna, 162 in oak woodland, 36 in Eucalyptus stands, 75 in riparian, and six in chaparral.

Camera station surveys resulted in a total of 38 detections and documented nine species (Table 17). The most commonly detected species was the black-tailed deer. Appendix E contains representative photographs from the camera stations.

Table 16. Track plate results for the Newville Project Area.

Species	Number Detected
bobcat	3
California ground squirrel	14
California kangaroo rat	1
coyote	2
mouse sp.	16
raccoon	9
western striped skunk	2
woodrat sp.	5
TOTAL	**52**

Table 17. Camera station results for the Newville Project Area.

Species	Number Detected
black bear	4
black-tailed deer	15
black-tailed jackrabbit	1
coyote	2
gray fox	7
porcupine (*Erethizon dorsatum*)	2
raccoon	4
western gray squirrel	1
western striped skunk	2
TOTAL	**38**

4.1.7. Spotlighting

A total of 22 hours of effort was expended to detect the presence of all nocturnal mammal species within the Newville project area. Spotlight surveys were implemented two to three nights per month in August, October, and December of 2001. During the 2002 field season, spotlighting surveys were conducted two nights in February, one night in April, four nights in May, and one night in June.

Surveys resulted in a total of 426 detections and documented 12 species (Table 18). The

most commonly detected species was the black-tailed deer, which is a reflection of the fact that a portion of the project area is used as winter range by the Thomes Creek deer herd (see section 4.1.11 Deer Herd Surveys).

4.1.8. Habitat Assessment

While conducting track plate and camera station surveys, it was determined that no suitable habitat for the pine marten or Pacific fisher occurs within the Newville Reservoir footprint (see Appendix B for the complete life history of both species). The site is dominated by grasslands, forested only on the margins by relatively open oak woodlands with patches of foothill pine and *Ceanothus*. Late-successional coniferous forests with thick understories are not present in this alternative. Coniferous and hardwood forests occur only in open stands with less than 50 percent canopy cover.

Table 18. Spotlighting results for the Newville Project Area.

Species	Number Detected
American badger	1
bat sp.	8
black-tailed deer	350
black-tailed jackrabbit	10
bobcat	1
California kangaroo rat	17
coyote	5
deer mouse	2
gray fox	3
mountain lion	1
raccoon	22
western striped skunk	6
TOTAL	**426**

4.1.9. Pond Surveys

A total of 18 ponds were surveyed to detect the presence of any mammals utilizing the ponds as a water source. Five pond surveys were conducted in June, one per month in July, August, and September, and three per month in October and November of 2001. During the 2002 field season, three pond surveys were conducted in March and one in May.

Surveys resulted in the detection of nine species (Table 19). The most commonly detected species was the raccoon.

Table 19. Pond Survey results for the Newville Project Area.

Species	
American badger	coyote
black bear	gray fox
black-tailed deer	raccoon
black-tailed jackrabbit	wild pig
bobcat	

4.1.10. Incidental Observations

Incidental observations throughout the course of study resulted in the detection of 23 species (Table 20).

Table 20. Incidental Observations for the Newville Project Area.

Species	
American badger	Mexican free-tailed bat
bat sp.	mountain lion
beaver	mouse sp.
black bear	muskrat
black-tailed deer	porcupine
black-tail jackrabbit	raccoon
bobcat	Virginia opossum
Botta's pocket gopher	western gray squirrel
California ground squirrel	western striped skunk
California kangaroo rat	wild pig
coyote	woodrat sp.
gray fox	

4.1.11. Deer Herd Surveys

The Thomes Creek deer herd has been traditionally managed and identified by DFG as

the Lake Hollow deer herd (Siperek and Loft, 1987) and the Thomes Creek Subunit of the Yolla Bolly deer herd (Ramsey et al., 1982). Analysis of the 1979 radio telemetry data gathered for 53 collared animals resulted in a map of the estimated winter home range of the herd. The Thomes Creek deer herd was found to utilize a portion of the proposed Newville project area as winter range (Siperek and Smith, 1980). Biologists determined that the proposed project area of the 1979 reservoir would impact approximately 19% of the winter range and result in significant habitat loss (Siperek and Loft, 1987).

The wintering Thomes Creek deer herd entered the north to northeastern portion of the project area in late October and left the area in early April. A map of the Thomes Creek deer herd winter range overlaid on the current Newville project area shows that the Thomes Creek Diversion and Conveyance, portions of the North Road, the northern portion of the footprint, and two of the proposed recreation areas within the Newville Project area (see section 4.2 Project Components) will impact approximately 19% of the winter range of the Thomes Creek deer herd (Table 21) (Figure 4).

Table 21. Percent of impact to the Thomes Creek Deer Herd Winter Range by the proposed Newville project area.

Project Component	Area of Impact (in acres)	Percent of Winter Range
Newville Footprint	2,898	13.90
Thomes Creek Diversion	73	0.35
Thomes Creek Conveyance	79	0.38
North Road Relocation	88	0.42
Recreation Areas	798	3.80
TOTAL	**3,936**	**18.85**

Other portions of the Newville project area were used year-round by deer. A small deer herd was observed in the western to southwestern portion of the project area from mid-May to early September, with fewer deer remaining in the project area through the winter months. Surveys were limited to the boundaries of the proposed project area; it is possible that the deer remain for the duration of the year along the outer edge of the project or on properties that biologists could not access. This year-round use of the area indicates that the Newville project area serves as range for a resident deer herd.

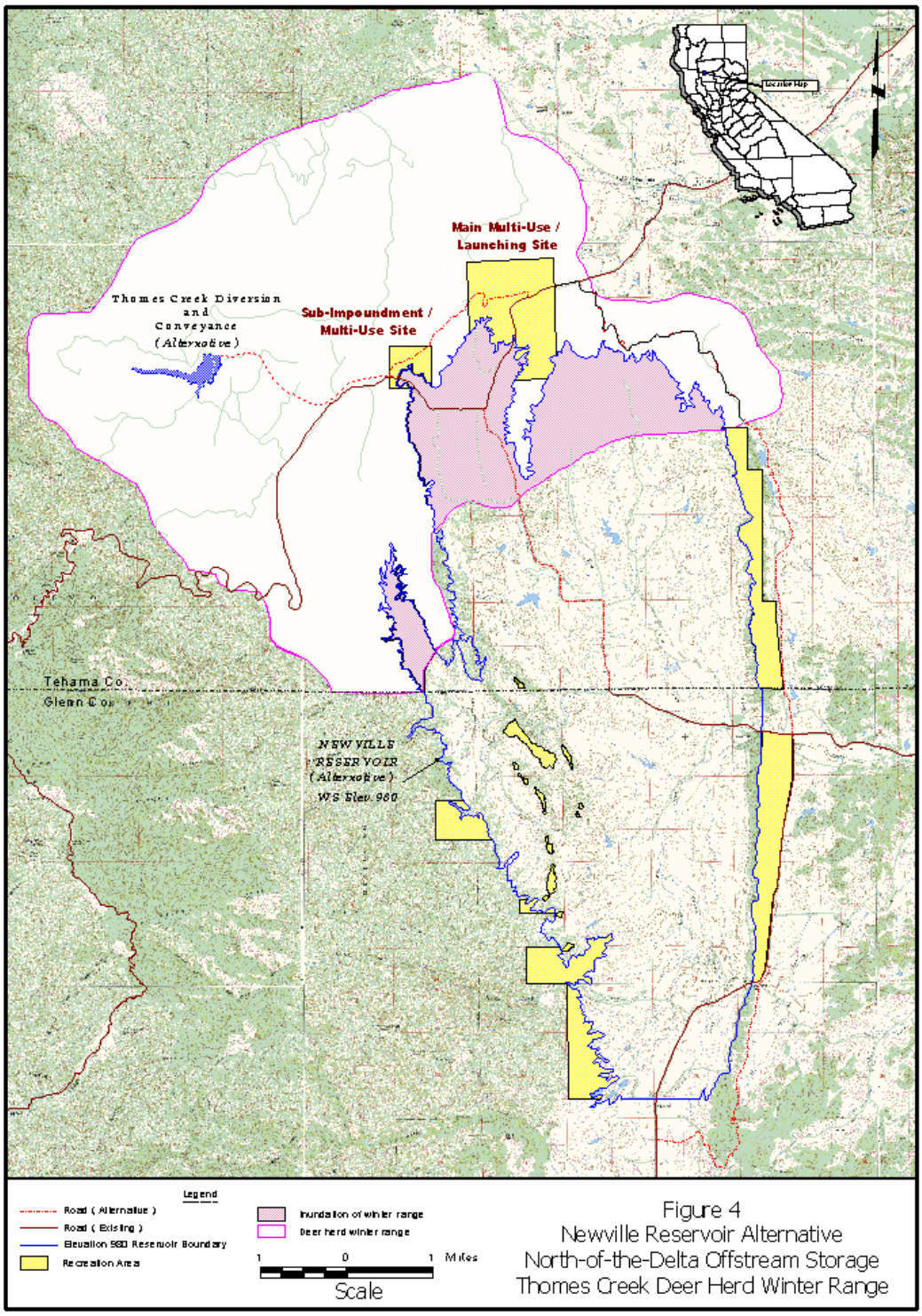


Figure 4
Newville Reservoir Alternative
North-of-the-Delta Offstream Storage
Thomes Creek Deer Herd Winter Range

4.2 Project Components

As studies were conducted on the Newville project area, the areas surveyed were categorized by project component. Those components were mapped and named by DWR and broken down into the reservoir footprint, road relocations (North Road, South Road), conveyance structures (Intertie Canal, Rice Canal, Newville Canal), Thomes Creek diversion and conveyance, and recreation areas. Results for the Thomes-Newville recreation areas are reported in summary rather than separately due to lack of property access and the shortened 2002 field season, as recreation area locations were not made available to biologists until the end of 2001 and field work ended in June 2002. Powerplants, pump stations, bridges, utility relocations, transmission line corridors, and the enlargement of the existing GCID and TC canals were not studied because location information and purpose of operation were not available. As this information becomes available, appropriate surveys will be conducted and the results will be released as an addendum to this report.

4.2.1. Newville Footprint

Biologists conducted acoustical surveys, camera station surveys, mist net surveys, pond surveys, small mammal trapping, spotlighting surveys, track plate surveys, and walking surveys within the Newville footprint (Figure 3a). Field efforts resulted in the documentation of 24 species (Table 22). Three of those species are listed as special status species: the Yuma bat, San Joaquin pocket mouse, and American badger. Anabat calls are still being analyzed; it is possible that more special status bats occur within the footprint. Open grassland areas, creeks, and abandoned buildings provide suitable habitat for the pallid bat. The northern portion of the inundation zone falls within the winter range of the Thomes Creek deer herd.

Table 22. Survey results for the Newville footprint component.

Species	
American badger	dusky-footed woodrat
black bear	gray fox
black-tail jackrabbit	house mouse
black-tailed deer	Mexican free-tailed bat
bobcat	mountain lion
Botta's pocket gopher	porcupine
brush mouse	raccoon
California ground squirrel	San Joaquin pocket mouse
California kangaroo rat	western harvest mouse
California vole	western striped skunk
coyote	wild pig
deer mouse	Yuma bat

4.2.2. Newville North Road

Biologists conducted acoustical surveys, camera station surveys, mist net surveys, pond surveys, small mammal trapping, spotlighting surveys, track plate surveys, and walking surveys along the North Road realignment (Figure 3a). Field efforts resulted in the documentation of 20 species (Table 23). Four of those species are listed as special status species: the pallid bat, Yuma bat, San Joaquin pocket mouse, and American badger. Anabat calls are still being analyzed; it is possible that more special status bats occur within the component. The area of Williams Butte contains large rock-faced cliffs, which should provide roosting habitat for western mastiff bats. The large rock crevices are located near Thomes Creek; these two features combined potentially provide suitable habitat for the spotted bat. Portions of the North Road fall within the winter range of the Thomes Creek deer herd. Deer were observed during all seasons in this component.

Table 23. Survey results for the Newville North Road component.

Species	
American badger	dusky-footed woodrat
bobcat	gray fox
Botta's pocket gopher	pallid bat
black-tail jackrabbit	porcupine
black-tailed deer	raccoon
California ground squirrel	San Joaquin pocket mouse
California kangaroo rat	western gray squirrel
California vole	western striped skunk
coyote	wild pig
deer mouse	Yuma bat

4.2.3. Newville South Road

Biologists conducted acoustical surveys, camera station surveys, mist net surveys, pond surveys, small mammal trapping, spotlight surveys, track plate surveys, and walking surveys along the Newville South Road component (Figure 3a). Field efforts resulted in the documentation of 16 species (Table 24). One of those species is listed as a special status species: the San Joaquin pocket mouse. Large rock outcrops and wooded areas provide suitable roosting sites for many species of bats. Anabat calls are still being analyzed; it is possible that special status bats occur within the component. Suitable habitat exists for the American badger. Deer were observed during all seasons in this component.

Table 24. Survey results for the Newville South Road component.

Species	
bobcat	hoary bat
black-tail jackrabbit	Mexican free-tailed bat
black-tailed deer	porcupine
California ground squirrel	raccoon
California kangaroo rat	San Joaquin pocket mouse
coyote	western pipistrelle
deer mouse	western striped skunk
gray fox	wild pig

4.2.4. Intertie Canal

No surveys were conducted along the Intertie Canal (Figure 3d) due to a lack of property access.

4.2.5. Rice Canal

Biologists conducted acoustical surveys, camera station surveys, mist net surveys, small mammal trapping, track plate surveys, and walking surveys along the Rice Canal component (Figure 3c). Field efforts resulted in the documentation of 14 species (Table 25). One of those species is listed as a special status species: the American badger. No suitable habitat was found for the San Joaquin pocket mouse. Anabat calls are still being analyzed; it is possible that special status bats occur within the component.

Table 25. Survey results for the Rice Canal component.

Species	
American badger	coyote
brush mouse	deer mouse
bobcat	dusky-footed woodrat
black-tail jackrabbit	Mexican free-tailed bat
black-tailed deer	muskrat
California ground squirrel	raccoon
California kangaroo rat	western harvest mouse

4.2.6. Newville Canal

Biologists conducted acoustical surveys, mist netting, pond surveys, small mammal trapping, spotlighting, track plating, and walking surveys along the Newville Canal component (Figure 3b). Field efforts resulted in the documentation of 16 species (Table 26). Four of those species are listed as special status species: the pallid bat, Yuma bat, western mastiff bat, and American badger. Anabat calls are still being analyzed; it is possible that special status bats occur within the component. Suitable habitat exists for the San Joaquin pocket mouse.

Table 26. Survey results for the Newville Canal component.

Species	
American badger	muskrat
bobcat	pallid bat
black-tailed deer	porcupine
California ground squirrel	raccoon
California kangaroo rat	western mastiff bat
coyote	western striped skunk
deer mouse	wild pig
hoary bat	Yuma bat

4.2.7. Thomes Creek Diversion and Conveyance

Biologists conducted acoustical surveys, camera station surveys, mist net surveys, pond surveys, small mammal trapping, spotlighting surveys, track plate surveys, and walking surveys within the Thomes Creek Diversion and Conveyance component (Figure 3a). Field efforts resulted in the documentation of 21 species (Table 27). Two of those species are listed as special status species: the Yuma bat and American badger. Large wooded areas, open grassland areas, and Thomes Creek provide suitable foraging habitat and roosting sites for many species of bats. Anabat calls are still being analyzed; it is possible that other special status bats occur within the component. Marginal habitat exists for the San Joaquin pocket mouse. This entire component falls within the winter range of the Thomes Creek deer herd.

4.2.8. Newville Recreation Areas

Biologists conducted a combination of acoustical surveys, camera station surveys, mist net surveys, pond surveys, small mammal trapping, spotlighting surveys, track plate surveys, and walking surveys on several of the proposed Newville recreation areas (Figure 3a). Field efforts resulted in the documentation of four special status species: the Yuma bat, pallid bat, San Joaquin pocket mouse, and American badger. Anabat calls are still being analyzed; it is possible that other special status bats occur within the component. Two of the proposed recreation areas in the northwest portion of the project area overlap with the winter range of the Thomes Creek deer herd.

Table 27. Survey results for the Thomes Creek Diversion and Conveyance component.

Species	
American badger	gray fox
big brown bat	Mexican free-tailed bat
black bear	mountain lion
black-tail jackrabbit	raccoon
black-tailed deer	silver-haired bat
bobcat	western gray squirrel
Botta's pocket gopher	western pipistrelle
California bat	western striped skunk
California ground squirrel	wild pig
California kangaroo rat	Yuma bat
coyote	

5.0 SUMMARY

Field investigations were designed to detect the presence and distribution of special status species within the project areas of the two alternatives in order to provide decision makers with some baseline information that might assist with assessing potential mitigation requirements. As the studies progressed, modifications were made to address the presence and distribution of all mammal species in the alternatives in an attempt to assess the cumulative potential impacts that would result from project construction.

Literature searches, species habitat requirement reviews, range maps, and consultation with State and Federal species experts revealed that sixteen special status mammal species potentially occurred in the alternatives (Section 2.0). Database searches revealed that three of those species historically occurred in or near the two project areas (Table 28).

Table 28. Historical sightings of special status mammal species by project area.

Species	Sites	Thomes-Newville
Pacific fisher	X	X
San Joaquin pocket mouse	X	
Townsend's western big-eared bat	X	

In 1911 and 1929, the San Joaquin pocket mouse was documented to occur within the proposed footprint of the Sites project area. The historical records of the fisher in 1987 and the Townsend's western big-eared bat in 1988 were of occurrences outside of the footprint of the project areas. However, these species were included because potential habitat exists within the alternatives to support them, and construction of the reservoir and/or appurtenant facilities could impact them. In addition to the historical records listed above, field investigations documented the occurrence of eight special status mammal species in the two project areas (Table 29).

Table 29. Special status species documented during field efforts by project area.

Species	Sites	Newville
American badger	X	X
pallid bat	X	X
Ringtail	X	
San Joaquin pocket mouse	X	X
western mastiff bat		X
western red bat	X	
western small-footed myotis	X	
Yuma myotis	X	X

Results from field efforts were broken down into project components and reported as the

total number of mammal species documented, as well as the number of special status species documented. Overall, 41 mammal species were documented on the Sites project area (Table 30), while 35 species were documented on the Newville project area (Table 31).

Table 30. Total number of species and special status species documented during field efforts on the Sites project area by project component.

Project Component	Total # Species Documented	# Special Status Species Documented
Sites Project Area	41	7
- Sites Footprint	26	3
- Funks Reservoir Enlargement	*	2
- North Road	17	3
- Southeast Road and Southeast Connector	20	3
- Ridge Route	*	2
- Creek Route	22	5
- East Road	*	2
- Delevan Pipeline	*	2
- Recreation Areas	*	3

**Limited survey efforts occurred in these areas. Surveys focused on special status species only.*

Table 31. Total number of species and special status species documented during field efforts on the Newville project area by project component.

Project Component	Total # Species Documented	# Special Status Species Documented
Newville Project Area	35	5
- Newville Footprint	24	3
- Newville North Road	20	4
- Newville South Road	16	2
- Intertie Canal	*	*
- Rice Canal	14	1
- Newville Canal	16	4
- Thomes Creek Diversion and Conveyance	21	3
- Newville Recreation Area	**	4

** Area was not surveyed due to lack of property access.*
*** Limited survey efforts occurred in these areas. Surveys focused on special status species only.*

During the small mammal trapping efforts, a combination of both trapping grids and spot

trapping arrangements were used to maximize the detection of the San Joaquin pocket mouse, document species diversity and distribution, and determine relative abundance in all habitat types at both project sites. A combination of random stratified sampling and targeted trapping was used. Continued low trapping success resulted in the decision to stop using the labor-intensive trapping grid arrangements and to rely on transect lines or spot arrangements of traps. Stratified sampling was later discontinued because of the need to continue targeting potential San Joaquin pocket mouse habitat. Although the focus of study was on the special status species, information on all species captured was documented. Biologists documented the presence of ten small mammal species on the Sites project area and seven species on the Newville project area. The special status San Joaquin pocket mouse was documented on both project areas.

An index of abundance of small mammals was calculated for each alternative for comparison. The index of abundance on each alternative was calculated as the total number of individuals captured per total trap nights of effort, on a project-wide basis and within each habitat type. The index of abundance of small mammals on the Sites project area was compared to that of the Newville project area. No significant difference in small mammal abundance was found between the two alternatives on a project-wide basis, within grassland between sites, within oak savanna between sites, within oak woodland between sites, or within rock outcrop associated with oak savanna between sites. Significant differences were detected within rock outcrop associated with grassland between sites, and within riparian between sites.

During mist netting efforts and roost searches, field personnel documented the presence of eight bat species on each project site. Acoustical surveys resulted in the documentation of an additional two bat species on each project site. Four of the bat species documented on the Sites project area are special concern species, while three of the bat species documented on the Newville project area are special concern species. It is possible that more special status bat species exist at each of the project areas because calls recorded with the Anabat Detector equipment are still being analyzed. If any undocumented bat species are detected during analysis of the recorded bat calls, the findings will be released as an addendum to this report.

During track plate efforts, biologists documented the presence of nine mammal species on the Sites project area and eight species on the Newville project area. During camera station efforts, field personnel documented the presence of seven mammal species on the Sites project area and nine species on the Newville project area. During pond survey efforts, biologists documented a total of 10 mammal species on the Sites project area, while nine species were documented on the Newville project area. In general, the same species were detected by each survey method.

As a result of habitat assessment surveys, field personnel concluded that suitable habitat for the pine marten and Pacific fisher did not occur on either project area. The pine marten prefers dense, late-successional coniferous forests with thick understories, and the Pacific fisher prefers large stands of mature trees with at least 50 percent canopy cover, typically in coniferous and hardwood forests. These habitat types and features are absent or occur only sporadically on each of the alternatives.

During spotlighting efforts, field personnel documented a total of 16 mammal species on

the Sites project area, while 12 species were documented on the Newville area. The special status American badger was documented on both project areas during these surveys.

Through incidental observation, field personnel documented 28 mammal species on the Sites project area and 23 species on the Newville project area. Within the surrounding area of the Sites Project, an American pronghorn antelope herd was noted through incidental observation. The herd has north to south movement patterns that may be affected by the proposed Delevan Pipeline.

A small resident deer herd utilizes the Sites Project area footprint, Ridge Route, Creek Route, Southeast Road, and surrounding recreation areas as part of its range. Similarly, a resident deer herd utilizes the Newville Project area footprint, North and South roads, Newville Canal, and the surrounding recreation areas as part of its range. Unique to the Newville Project area is the Thomes Creek deer herd, which has critical winter range that would be directly impacted by the footprint, North Road, Thomes Creek Diversion and Conveyance, and two recreation areas.

6.0 DISCUSSION

An attempt was made to sample each of the alternatives with equal effort to allow for meaningful comparisons of species numbers. Continued problems with property access, incomplete information about project components, and the inability to hire personnel due to a state hiring freeze prohibited field crews from sampling the project areas equally. In addition, DWR ordered that all surveys on the Newville project area cease as of June 30, 2002, while surveys continued on the Sites project area through October 2002.

The results section of this report was originally presented for each alternative on a project wide basis only. In compliance with a request made by DWR, the results are also broken down into distinct project components. However, due to the mobile nature of mammals, it is reasonable to assume that mammals found within the footprint are also found in the adjacent road alignments and recreation areas, provided that suitable habitat exists. In other words, it is inappropriate to assume that the lack of detection of a species during field efforts on any one project component equates to the absence of that species from that component. The majority of field efforts occurred within the reservoir footprints because other project component locations, such as road relocations and recreation areas, were not made available until 2000 or later. It is therefore misleading to report total number of mammal species detected in any one component, as the number detected may reflect the level of field effort and not the actual number of species present in the area.

Small mammal trapping efforts resulted in a low capture success rate, regardless of the trapping style used, habitat sampled, or time of year. Despite the attempt to sample both project areas equally, the total trap nights of effort on Sites is almost twice that of the effort on Newville. Surveys of all small mammals were implemented in an attempt to calculate relative abundance of the prey base, as well as assess species diversity. These results were intended for use in comparisons of the two alternatives. Overall, the two project areas have very similar small mammal abundance and species diversity. Differences in relative abundance between the two sites were detected in both rock outcrop associated with grassland and in riparian areas. It should be noted, however, that the trap nights of effort on Newville within rock outcrop associated with grassland were half the effort of that on Sites and could contribute to the result. Within the riparian areas, a small effort was made on both alternatives, and there were no captures on Sites. This zero value weakens the strength of the statistical test. Zero values were also used in the comparisons of abundance within the rock outcrop associated with oak savanna, and within oak woodland habitat types.

Small mammal trapping efforts did provide biologists with information on species diversity, as well as the presence, distribution, and habitat association of the special status San Joaquin pocket mouse. Populations of the San Joaquin pocket mouse will be directly impacted by the inundation of the proposed footprint of both project areas. On the Sites project area, all proposed roads, with the associated increase in traffic, and recreation areas, with the associated increase in human activity, will directly impact known populations of the special status species. Exceptions are the Delevan Pipeline, the Peninsula Hills recreation area, and the Antelope Island recreation area, where no suitable habitat was documented. On the Newville project area, all

proposed roads and conveyances, as well as several recreation areas, will also directly impact known populations of the special status species. An exception is the Rice Canal, where no suitable habitat was documented.

Special status bat species were documented on both project areas. Inundation of trees or the removal of buildings and structures will result in the loss of roosting sites for the western small-footed myotis on the Sites project area, and the Yuma bat and the pallid bat throughout both project areas. The inundation of open grassland areas, as well as the disturbance from human activity associated with grassland recreation areas, will result in a loss of foraging habitat for the western red bat on the Sites project area and the pallid bat on both project areas. A proposed Newville recreation area that includes large rock outcrops could disturb roosting and foraging habitat for the greater western mastiff bat. A major reason for the decline of each of these species of special concern is the loss of habitat, which includes the loss of suitable roosting sites due to destruction and disturbance.

The American badger was documented in almost every component of both project areas. Suitable habitat exists within the few components where the species was not documented. The badger has a large home range (up to 4,200 acres), so areas in which no sign was detected could still be part of that range. The inundation of the project footprints, the human activity associated with recreation areas, and the potential increase in road kill associated with new or expanded roadways will directly impact this special status species.

The fully protected ringtail was documented within the Delevan Pipeline component of the Sites project area. Documented populations were limited to a riparian strip along the Sacramento River. The details of the operation and purpose of the project are not yet available. Potential destruction of the riparian habitat for associated facilities, such as pump stations, will directly impact this special status species.

Deer herd surveys resulted in the documentation of small resident deer herds on both alternatives, as well as a winter range for the Thomes Creek deer herd on the Newville project area. Although deer are not listed as a special status species, the proposed project areas will directly impact this game species.

Other studies of black-tailed deer home ranges have shown that deer have very high fidelity to their seasonal home ranges (Leopold et al., 1951; Kufeld et al., 1989). Summer ranges are important as fawning habitat (Kie et al., 1982). A variety of habitat types are required within the summer range, as fawns have different requirements of habitat than does. A loss of habitat diversity can therefore result in lower fawn recruitment (Loft et al., 1987). A loss or reduction of winter range can result in the loss of adult deer, especially during severe winters (Kie et al., 1982).

Migration routes in the spring and fall tend to be the same, and deer tend to use the same corridor each year (Bertram and Rempel, 1977). Although our studies did not identify migration routes, it is possible that portions of them exist within the project areas. In other studies of the impacts of a reservoir project to a deer herd, the displacement of migration routes resulted in the deer swimming across the reservoir at the narrowest sections (Boroski et al., 1999). Studies also

show that areas near human development are used less frequently by deer than similar but undisturbed areas (Rost and Bailey, 1979). Therefore, as the level of human disturbance increases, the value of habitat for deer decreases (Nicholson et al., 1997).

Currently, the structure of the Thomes Creek Conveyance is undecided. It could be constructed as an open canal or an underground pipeline. An underground pipeline would cause an initial habitat disturbance during construction, but would not result in direct loss of habitat. An open canal, however, would result in the permanent loss of habitat and pose threats to the deer herd. Studies of deer drownings in canals suggest that a combination of methods is needed to protect deer. The placement of bridges at all areas where the canal disrupts an existing game trail, the installation of escape structures such as ramps and steps with cable-and-float directors, and the maintenance of a consistently high water level will potentially reduce the number of deer drownings associated with a canal (Rautenstrauch and Krausman, 1989), but will not completely eliminate the risk of drowning.

Overall, the special concern species on the two project alternatives will experience direct habitat loss as a result of the inundation of the footprint and the construction of roads and canals, while the construction of underground pipelines will result in a temporary habitat disturbance. These species will also experience habitat disturbance and degradation as a result of the construction and associated use of recreation areas.

REFERENCES

Barbour, R., and W. Davis. 1969. Bats of America. Lexington: University of Kentucky Press.

Bertram, R., and R. Rempel. 1977. Migration of the North Kings Deer Herd. California Fish and Game, 63(3): 157-179.

Best, T., M. Harvey, and J. Altenback. 1999. *Lasiurus blossevillii* (Western Red Bat). University of New Mexico. Available at: http://www.biology001.unm.edu/~batcall/accounts/accountsbase/labl.html.

Black, H. 1974. A north temperate bat community: structure and prey populations. Journal of Mammalogy. 55:138-157.

Boitani, L., S. Bartoli, and S. Anderson. 1990. Simon and Schuster's guide to mammals. New York: Simon and Schuster.

Boroski, B., R. Barrett, and J. Kie. 1999. Movement patterns and survivorship of black-tailed deer migrating across Trinity Reservoir, California. California Fish and Game, 85(2): 63-69.

Brown, P., and E. Pierson. 1996. Natural history and management of bats in California and Nevada. Materials prepared for conference sponsored by the Western Section of the Wildlife Society, November 13-15, 1996.

Buskirk, S., and R. Powell. 1994. Habitat ecology of fishers and American martens. *In* Buskirk, S., A. Harestad, M. Raphael, comps. eds. Biology and conservation of martens, sables, and fishers. Ithaca, NY. Cornell University Press. 283-296.

California Department of Fish and Game (DFG). 1983. Thomes Newville Unit Fish and Wildlife Evaluation. A Status Report.

California Department of Fish and Game (DFG). 2000. North-of-Delta Off-Stream Storage Evaluations: Environmental Monitoring Plan (CDFG Components). Draft.

California Department of Fish and Game (DFG). 2001. North of Delta Off-Stream Storage Investigation. Progress Report. Appendix S: Mammal Surveys.

Cockrum, E., and S. Cross. 1964. Time of bat activity over water holes. Journal of Mammalogy. 45:635-636.

_____. 1973. Additional longevity records for American bats. Journal of Arizona Academy of Science. 8:108-110.

Constantine, D. 1959. Ecological observations on lasiurine bats in the North Bay Area of California. Journal of Mammalogy. 40: 13-15.

_____. 1998. An overlooked external character to differentiate *Myotis californicus* and *Myotis ciliolabrum* (Vespertilionidae). Journal of Mammalogy. 79(2): 624-630.

Corben, C., W. Gannon, and M. O'Farrell. 1999. Techniques for the effective use of Anabat: identifying free-flying bat species. Anabat Workshop Manual.

Cutler, T., and M. Morrison. 1998. Habitat use by small vertebrates at two water developments in southwestern Arizona. The Southwestern Naturalist. 43(2): 155-162.

Cypher, B. 1991. A technique to improve spotlight observations of deer. Wildlife Society Bulletin, 19:391-393.

Dalquest, W. 1946. The daytime retreat of a California mastiff bat. Journal of Mammalogy. 27:87-88.

_____. 1947. Notes on the natural history of the bat *Corynorhinus rafinesquii* in California. Journal of Mammalogy. 28:17-30.

Davis, D. 1982. Handbook of census methods for terrestrial vertebrates. CRC Press, Inc., Boca Raton, Florida.

Davis, W., and D. Schmidley. 1947. The mammals of Texas. Online Version. Texas Parks and Wildlife, Nongame and Urban Division. 1994. Available at www.nsrl.ttu.edu/tmot/

Diefenbach, D., M.. Conroy, R. Warren, W. James, L. Baker, and T. Hon. 1994. A test of the scent-station survey technique for bobcats. Journal of Wildlife. Management. 58(1): 10-17. WR 241.

Douglas, C., and M. Strickland. 1987. Fisher. *In* : Novak, M.., J. Baler, J. Obbard, comps., eds. Wild furbearer management and conservation in North America. Toronto, Ontario. Ontario Ministry of Natural Resources. 511-529.

Grinnell, J. 1933. Review of the recent mammal fauna of California. University of California Publications in Zoology. 40: 71-234.

Hall, E. 1981. The mammals of North America. 2nd edition. New York: Wiley, 2 volumes.

Handley, C., Jr. 1959. A revision of American bats of the genera *Euderma* and *Plecotus* : Smithsonian Institution, United States National Museum. Washington, D.C.

Harris, A. 1974. *Myotis yumanensis* in interior southwestern North America, with comments on *Myotis lucifugus*. Journal of Mammalogy. 55:589-607.

Hawbecker, A. 1951. Small mammal relationships in an *Ephedra* Community. Journal of

Mammalogy 32: 50-60.

Hawley, V., and F. Newby. 1957. Marten home ranges and population fluctuations. Journal of Mammalogy. 38:74-184.

Hermanson, J., and T. O'Shea. 1983. *Antrozous pallidus*. Mammalian Species series. No. 213. American Society of Mammalogists.

Herrera, M., G. Luis, T. Fleming, and J. Findley. 1993. Geographic variation in carbon composition of the pallid bat, *Antrozous pallidus*, and its dietary implications. Journal of Mammalogy. 74 (3): 601-606.

Hooven, E. 1971. The porcupine in Oregon: its life history and control. Oregon State University, School of Forestry, Corvallis. Research Paper No. 10. 22pp.

Howell, A., and L. Little. 1920. Additional notes on California bats, with observations upon the young of *Eumops*. Journal of Mammalogy. 5:261-263.

Husar, S. 1976. Behavioral character displacement: evidence of food partitioning in insectivorous bats. Journal of Mammalogy. 57:331-339.

Ingles, L. 1965. Mammals of California and its coastal waters. (Revised edition), Stanford University Press. Stanford, California. 506 p.

Jameson, E. 1988. California mammals. Berkeley: University of California Press.

Jones, C. 1965. Ecological distribution and activity records of bats of the Mogollon Mountains area of New Mexico and adjacent Arizona. Tulane Studies Zoology. 12: 93-100.

_____. W. McShea, M. Conroy, and T. Kunz. 1996. Capturing mammals. *In* Measuring and monitoring biological diversity. Standard methods for mammals. D. Wilson, F. Cole, J. Nichols, R. Rudran, and M. Foster, eds. Smithsonian Institution Press, Washington and London. pp.115-155.

Kaufmann, J. 1982. Raccoon and allies. *In* Wild mammals of North America: Biology, Management, Economics. J. Chapman and G. Feldhamer, eds. The Johns Hopkins University Press. Baltimore, Maryland.

Kie, J., T. Burton, and J. Menke. 1982. Deer populations and reservoir construction in Trinity County, California. California Fish and Game, 68(2): 109-117.

Kufeld, R., D. Bowden, and D. Schrupp. 1989. Distribution and movements of female mule deer in the Rocky Mountain foothills. The Journal of Wildlife Management, 53:871-877.

Kunz, T., D. Thomas, G. Richards, C. Tidemann, E. Pierson, and P. Racey. 1996. Observational techniques for bats. *In* Measuring and monitoring biological diversity. Standard methods

for mammals. D. Wilson, F. Cole, J. Nichols, R. Rudran, and M. Foster, eds. Smithsonian Institution Press, Washington and London pp.105-114.

Leopold, A., T. Riney, R. McCain, and L. Tevis, Jr. 1951. The jawbone deer herd. California Department Fish and Game, Game Bulletin (4): 1-139 p.

Lindzey, F. 1982. Badger (*Taxidea taxus*). Wild Mammals of North America. Chapman, J., and G. Feldhamer, eds. John Hopkins University Press. Baltimore, Maryland.

Loft, E., J. Menke, J. Kie, and R. Bertram. 1987. Influence of cattle stocking rate on the structural profile of deer hiding cover. The Journal of Wildlife Management, 51: 655-664.

Long, C. 1973. *Taxidea taxus*. Mammalian Species series. No. 26. American Society of Mammalogists.

Martin, S. 1994. Feeding ecology of American martens and fishers. *In*: Buskirk, S., A. Harestad, M. Raphael, and R. Powell, eds. Martens, sables, and fishers: biology and conservation. Ithaca, NY. Cornell University Press. 297-315

Maser, C., B. Mate, J. Franklin, and C. Dyrness. 1981. Natural history of Oregon coast mammals. Pacific Northwest Forestry and Range Experiment Station, USDA, Forest Service, General Technical Report, PNW-133. 496pp.

Messick, J., and M. Hornocker. 1981. Ecology of the badger in southwestern Idaho. Wildlife Monographs. No. 76. 53pp.

Nicholson, M., R. Bowyer, and J. Kie. 1997. Habitat selection and survival of mule deer: tradeoffs associated with migration. Journal of Mammalogy, 78(2): 483-504.

Nietfeld, M., M. Barrett, and N. Silvy. 1996. Wildlife Marking Techniques. *In* Research and Management Techniques for Wildlife and Habitats. Fifth ed., rev. The Wildlife Society, Bethesda, MD. pp. 140-168.

Nottingham, B., Jr.; K. Johnson and M. Pelton. 1989. Evaluation of scent-station surveys to monitor raccoon density. Wildlife Society Bulletin. 17(1): 29-35. WR 214.

O'Farrell, M., and W. Gannon. 1999. A comparison of acoustic versus capture techniques for the inventory of bats. Journal of Mammalogy. 80(1):24-30.

Oliveira, M. 1998. Anabat system Practical Guide. The State of Queensland, Department of Natural Resources.

Pierson, E., and W. Rainey. 1998. Distribution, status, and management of Townsend's Big-eared bat (*Corynorhinus townsendii*) in California. BMCP Technical Report Number 96-

7. Sacramento: The Resources Agency. California Department of Fish and Game.

Powell, R. 1981a. Hunting behavior and food requirements of the fisher (*Martes pennanti*). Pages 883-917 *in* J. Chapman and D. Pursley, eds. Worldwide furbearer conference proceedings. 3 vols. 2056pp.

_____. 1981b. *Martes pennanti*. Mammalian Species series. No.156. American Society of Mammalogists.

_____. 1982. The fisher. University of Minnesota Press, Minneapolis. 219pp.

_____. and W. Zielinski. 1994. Fisher. *In*: Ruggiero, L., K. Aubry, S. Buskirk, L. Lyon, W. Zielinski, eds. The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. General Technical Report. RM-254. Fort Collins, CO. Rocky Mountain Forest and Range Experiment Station, USDA, Forest Service, U.S. Department of Agriculture; 38-73.

Ralls, K., and L. Eberhardt. 1997. Assessment of abundance of San Joaquin kit foxes by spotlight surveys. Journal of Mammalogy, 78(1): 65-73.

Ramsey, T., D. Smith, T. Brumley, L. Murray, and B. Lawhorn. 1982. Yolla Bolly deer herd management plan. California Department of Fish and Game.

Rautenstrauch, K., and P. Krausman. 1989. Preventing mule deer drownings in the Mohawk Canal, Arizona. Wildlife Society Bulletin, 17: 280-286.

Rost, G., and J. Bailey. 1979. Distribution of mule deer and elk in relation to roads. The Journal of Wildlife Management, 43: 634-641.

Ruggiero, L., D. Pearson, and S. Henry. 1998. Characteristics of American marten den sites in Wyoming. Journal of Wildlife Management. 62(2): 663-673.

Siders, M. 1996. Melissa Siders' Bats of Arizona. Created from information obtained while working with Arizona Game and Fish Department. Available at www.xpressweb.com/~talon/smallbats.html

Siperek, J., and D. Smith. 1980. Lake Hollow deer herd investigation. California Department of Fish and Game Progress Report.

_____. and E. Loft. 1987. The Thomes Creek deer herd. California Department of Fish and Game unpublished report.

Slade, N., and S. Blair. 2000. An empirical test of using counts of individuals captured as indices of population size. Journal of Mammalogy. 81(4): 1035-1045.

Snow, T. 2000. Arizona Department of Game and Fish Nongame Field Notes - Western Red Bat. Arizona Department of Game and Fish Nongame Department. Available at: http://www.gf.state.az.us/frames/fishwild/ngame_m.htm. Accessed Sept, 2002.

Taylor, W. 1954. Food habits and notes on life history of the ring-tailed cat in Texas. Journal of Mammalogy 35: 55-63.

Teitje, W., J. Vreeland, N. Siepel, and J. Dockter. 1997. Relative abundance and habitat associations of vertebrates in oak woodlands in coastal-central California. General Technical Report PSW-GTR-160 United States Department of Agriculture Forest Service.

Thompson, W., and G. White. 1998. Monitoring vertebrate populations. Academic Press. San Diego, California.

Trapp, G. 1972. Some anatomical and behavioral ecology of the ringtail and gray fox in southwestern Utah. Journal of Mammalogy, 53:549-557.

_____. 1978. Comparative behavior ecology of the ringtail and gray fox in southwestern Utah. Carnivore. 1: 3-32.

Tuttle, M., and L. Heaney. 1974. Maternity habits of *Myotis leibii* in South Dakota. Southern California Academy of Science Bulletin. 73: 80-83.

United States Geological Survey. 1998. House Bat Management. http://www.npwrc.usgs.gov/resource/1998/housebat/appendb.html.

Wai-Ping, V., and M. Fenton. 1989. Ecology of spotted bat (*Euderma maculatum*): roosting and foraging behavior. Journal of Mammalogy 70: 617-622.

Walker, E., F. Warnick, and S. Hamlet. 1968. Mammals of the World. Second edition, 2 volumes, John Hopkins Press, Baltimore, MD. 1500pp.

Watkins, L. 1977. *Euderma maculatum*. Mammalian Species series. No. 77. American Society of Mammalogists.

Wemmer, C., H. Kunz, G. Lundie-Jenkins, and W. McShea. 1996. Mammalian sign. *In* Measuring and monitoring biological diversity. Standard methods for mammals. D. Wilson, F. Cole, J. Nichols, R. Rudran, and M. Foster, eds. Smithsonian Institution Press, Washington and London. pp. 157-176.

Whitaker, J., Jr., C. Maser, and L. Keller. 1977. Food habits of bats of western Oregon. Northwest Science. 51:46-55.

_____. C. Maser, and S. Cross. 1981. Food habits of eastern Oregon bats, based on stomach

and scat analyses. Northwest Science. 55:281-292.

Yunger, J., and L. Randa. 1999. Trap decontamination using hypochlorite: effects on trappability of small mammals. Journal of Mammalogy. 80(4):1336-1340.

Zeiner, D., W. Laudenslayer, Jr., K. Mayer. 1990. California's wildlife. Sacramento: Resources Agency, Department of Fish and Game.

Zar, J. 1984. Biostatistical analysis. Prentice Hall, New Jersey. 718 pp.

Zielinski, W., and E. Kucera. 1995. American marten, fisher, lynx, and wolverine: survey methods for their detection. General Technical Report PSW-GTR-157. U.S. Department of Agriculture Forest Service.

Additional References Not Cited

Armstrong, D., R. Adams, and J. Freeman.1994. Distribution and ecology of bats of Colorado. Boulder, CO: University of Colorado Museum.

Kunz, T., and R. Martin. 1982. Townsend's big-eared bat (*Plecotus townsendii)*. Mammalian Species series. No. 175. American Society of Mammalogists.

Nowak, R. 1991. Walker's mammals of the world. Fifth Edition. Johns Hopkins University Press. Baltimore, Maryland. 1629pp.

Shump, K., Jr., and A. Shump. 1982. Red Bat (*Lasiurus borealis*). Mammalian Species series. No. 183. American Society of Mammalogists.

Zielinski, W., R. Truex, C. Ogan, and K. Busse. 1997. Detection surveys for fishers and American martens in California, 1989-1994: Summary and Interpretations. *Martes*: taxonomy, ecology, techniques, and management. Alberta, Canada: Provincial Museum of Alberta. pp 372-392.

APPENDIX A. List of Habitat Suitability Models Available from the U.S. Fish and Wildlife Service for Conducting Habitat Evaluation Procedures

MODEL NAME **VERIFICATION LEVEL** **DATE**

ARIZONA HABITAT LAYERS Expert Review 1-3-1989
Short, H. L. 1984. Habitat Suitability Index Models: The Arizona guild and layers of habitat models. U. S. Fish and Wildlife Service Biological Report 82/10.70. 37 pp. Uses layers of habitat alternative. Range: ecoregion 3222 of Bailey (southwest Arizona, southeast California), and perhaps nationwide.

SHELTERBELT SPECIES RICHNESS Expert Review 4-20-1987
Schroeder, R. L. 1986. Habitat Suitability Index Models: Wildlife Species Richness in Shelterbelts. U. S. Fish and Wildlife Service Biological Report 82/10.128. 17 pp.. Applies to rows of shrubs and trees planted on the windward side of farmstead buildings and similar plantings designed to reduce wind erosion of agricultural lands. Range: northern Great Plains states of North Dakota, South Dakota, and Minnesota.

RED-SPOTTED NEWT (aquatic) Expert Review 11-19-1985
Sousa, P. J. 1985. Habitat Suitability Index Models: Red-Spotted Newt. U. S. Fish and Wildlife Service Biological Report Biological Report 82/10.111. 18 pp.. Note: see model for specific guidance in application and potential modifications of the model. Applies to aquatic cover and reproduction. Range: throughout the species= range.

RED-SPOTTED NEWT (terrestrial) Expert Review 9-11-1985
Sousa, P. J. 1985. Habitat Suitability Index Models: Red-Spotted Newt. U. S. Fish and Wildlife Service Biological Report Biological Report 82/10.111. 18 pp.. Note: see model for specific guidance in application and potential modifications of the model. Applies to terrestrial cover. Range: throughout the species= range.

BULLFROG Expert Review 12-13-1988
Graves, B. M., and S. H. Anderson. 1987. Habitat Suitability Index Models: Bullfrog. U. S. Fish and Wildlife Service Biological Report 82/10.138. 22 pp.. Range: midwestern United States

AMERICAN ALLIGATOR (non-tidal) Expert Review 12-13-1988
Newson, J. D., T. Joanen, and R. J. Howard. 1987. Habitat Suitability Index Models: American Alligator. U. S. Fish and Wildlife Service Biological Report 82/10.136. 14 pp.. Applies to the alligator nesting season (May through September) in areas not affected by tidal influences. Range: northern Gulf of Mexico coastal marshes.

AMERICAN ALLIGATOR (tidal) Expert Review 12-13-1988
Newson, J. D., T. Joanen, and R. J. Howard. 1987. Habitat Suitability Index Models: American Alligator. U. S. Fish and Wildlife Service Biological Report 82/10.136. 14 pp.. Applies to the alligator nesting season (May through September) in areas affected by tidal influences. Range: northern Gulf of Mexico coastal marshes.

SNAPPING TURTLE Expert Review 12-14-1988
Graves, B. M., and S. H. Anderson. 1987. Habitat Suitability Index Models: Snapping Turtle. U. S. Fish and Wildlife Service Biological Report 82/10.141. 18 pp.. Range: throughout the North American range of the snapping turtle.

DIAMONDBACK TERRAPIN (nesting) Expert Review 12-14-1988
Palmer, W. M., and C. L. Cordes. 1988. Habitat Suitability Index Models: Diamondback Terrapin (nesting) - Atlantic Coast. U. S. Fish and Wildlife Service Biological Report 82/10.151. 18 pp.. Applies to year-round habitat. Range: Atlantic coast from New Jersey to Florida.

SLIDER TURTLE Expert Review 4-7-1987
Morreale, S. J., and J. W. Gibbons. 1986. Habitat Suitability Index Models: Slider Turtle. U. S. Fish and Wildlife Service Biological Report 82/10.125. 14 pp.. Applies to all areas, including with thermal effluents. Range: throughout the species= range in the U.S. (see map in publication)

WESTERN GREBE Expert Review 12-27-1985
Short, H. L. 1984. Habitat Suitability Index Models: Western Grebe. U. S. Fish and Wildlife Service Biological Report 82/10.69. 20 pp.. Applies to nesting season, April through July. Range: breeding

range see map in publication).

BROWN PELICAN (eastern, mangrove) Expert Review 2-27-1987

Hingten, T. M., R. Mulholland, and A. V. Zale. 1985. Habitat Suitability Index Models: Eastern Brown Pelican. U. S. Fish and Wildlife Service Biological Report 82/10.90. 20 pp.. Applies to breeding habitat. Range: within the range of the mangrove (Florida, Alabama, Louisiana).

BROWN PELICAN (eastern, non-mangrove) Expert Review 7-11-1988

Hingten, T. M., R. Mulholland, and A. V. Zale. 1985. Habitat Suitability Index Models: Eastern Brown Pelican. U. S. Fish and Wildlife Service Biological Report 82/10.90. 20 pp.. Applies to breeding habitat. Range: outside the range of the mangrove (North Carolina, South Carolina, Texas).

GREAT BLUE HERON Expert Review 5-11-1987

Short, H. L., and R. J. Cooper. 1985. Habitat Suitability Index Models: Great Blue Heron. U. S. Fish and Wildlife Service Biological Report 82/10.99. 23 pp.. Applies to treeland habitats near water as potential heronry sites, and aquatic habitats near potential heronry sites as foraging habitats. Range: throughout the species= range in the United States.

GREAT EGRET (feeding) Expert Review 9-17-1985

Chapman, B. R., and R. J. Howard. 1984. Habitat Suitability Index Models: Great Egret. U. S. Fish and Wildlife Service Biological Report 82/10.78. 23 pp. Applies to coastal wetlands in defined range. May also apply along the Atlantic coast, remainder of the Gulf of Mexico coast, and inland in the Southeast. Applies to breeding habitat and season (February - August), and may also apply year-round. Range: coast of Texas and Louisiana.

GREAT EGRET (nesting, islands) Expert Review 11-21-1985

Chapman, B. R., and R. J. Howard. 1984. Habitat Suitability Index Models: Great Egret. U. S. Fish and Wildlife Service Biological Report 82/10.78. 23 pp.. Applies to coastal wetlands in defined range. May also apply along the Atlantic coast, remainder of the Gulf of Mexico coast, and inland in the Southeast. Applies to breeding habitat and season (February - August), and may also apply year-round. Applies to populations nesting on islands. Range: coast of Texas and Louisiana.

GREAT EGRET (nesting, non-islands) Expert Review 11-21-1985

Chapman, B. R., and R. J. Howard. 1984. Habitat Suitability Index Models: Great Egret. U. S. Fish and Wildlife Service Biological Report 82/10.78. 23 pp.. Applies to coastal wetlands in defined range. May also apply along the Atlantic coast, remainder of the Gulf of Mexico coast, and inland in the Southeast. Applies to breeding habitat and season (February - August), and may also apply year-round. Applies to populations nesting on the mainland. Range: coast of Texas and Louisiana.

WHITE IBIS (islands, uplands) Expert Review 12-16-1985

Hingtgen, T. M., R. Mulholland, and R. W. Repenning. 1985. Habitat Suitability Index Models: White Ibis. U. S. Fish and Wildlife Service Biological Report 82/10.93. 18 pp.. Applies to breeding habitat. Range: coast of Gulf of Mexico and Atlantic from North Carolina south, and from the coast to 257 km inland.

WHITE IBIS (wetlands) Expert Review 4-16-1987

Hingtgen, T. M., R. Mulholland, and R. W. Repenning. 1985. Habitat Suitability Index Models: White Ibis. U. S. Fish and Wildlife Service Biological Report 82/10.93. 18 pp.. Applies to breeding habitat. Range: coast of Gulf of Mexico and Atlantic from North Carolina south, and from the coast to 257 km inland.

ROSEATE SPOONBILL (island, future) Expert Review 12-10-1985

Lewis, J. C. 1983. Habitat Suitability Index Models: Roseate Spoonbill. U. S. Fish and Wildlife Service Biological Report 82/10.50. 16 pp.. Applies to nesting and roosting habitat. Range: Atlantic and Gulf of Mexico coast of United States south of 31 degrees North.

ROSEATE SPOONBILL (island, present) Expert Review 12-30-1985

Lewis, J. C. 1983. Habitat Suitability Index Models: Roseate Spoonbill. U. S. Fish and Wildlife Service Biological Report 82/10.50. 16 pp.. Applies to nesting and roosting habitat. Range: Atlantic and Gulf of Mexico coast of United States south of 31 degrees North.

ROSEATE SPOONBILL (mainland, future) Expert Review 12-10-1985

Lewis, J. C. 1983. Habitat Suitability Index Models: Roseate Spoonbill. U. S. Fish and Wildlife Service Biological Report 82/10.50. 16 pp.. Applies to nesting and roosting habitat. Range: Atlantic and Gulf of Mexico coast of United States south of 31 degrees North.

ROSEATE SPOONBILL (mainland, present) Expert Review 12-10-1985

Lewis, J. C. 1983. Habitat Suitability Index Models: Roseate Spoonbill. U. S. Fish and Wildlife Service Biological Report 82/10.50. 16 pp.. Applies to nesting and roosting habitat. Range: Atlantic and Gulf of Mexico coast of United States south of 31 degrees North.

BLACK-BELLIED WHISTLING-DUCK Expert Review 12-13-1988

McKenzie, P. M., and P. J. Zwank. 1988. Habitat Suitability Index Models: Black-bellied Whistling-Duck (breeding). U. S. Fish and Wildlife Service Biological Report 82/10.150. 22 pp.. Range: throughout the breeding range of the black-bellied whistling-duck in Texas.

LESSER SNOW GOOSE (wintering) Expert Review 4-24-1987

Leslie, J. C., and P. J. Zwank. 1985. Habitat Suitability Index Models: Lesser Snow Goose (wintering). U. S. Fish and Wildlife Service Biological Report 82/10.97. 16 pp.. Applies to wintering habitat from October - March. Not applicable to agricultural lands. Range: Gulf of Mexico coasts of Texas and Louisiana. May also apply to other inland marshes.

BLACK BRANT Expert Review 8-16-1985

Schroeder, R. L. 1984. Habitat Suitability Index Models: Black Brant. U. S. Fish and Wildlife Service Biological Report 82/10.63. 11 pp.. Applies to wintering habitat. Range: throughout the wintering range on the Pacific Coast.

WOOD DUCK (breeding) Expert Review 4-8-1987

Sousa, P. J., and A. H. Farmer. 1983. Habitat Suitability Index Models: Wood Duck. U. S. Fish and Wildlife Service Biological Report 82/10.43. 27 pp.. Applies to breeding habitat (spring - summer). Range: throughout the breeding range of the species.

WOOD DUCK (wintering) Expert Review 4-8-1987

Sousa, P. J., and A. H. Farmer. 1983. Habitat Suitability Index Models: Wood Duck. U. S. Fish and Wildlife Service Biological Report 82/10.43. 27 pp.. Applies to wintering habitat. Range: throughout the wintering range.

WOOD DUCK (year-round) Expert Review 4-8-1987

Sousa, P. J., and A. H. Farmer. 1983. Habitat Suitability Index Models: Wood Duck. U. S. Fish and Wildlife Service Biological Report 82/10.43. 27 pp.. Applies to areas where populations are resident throughout the year. Range: throughout those areas where the breeding and wintering ranges overlap.

AMERICAN BLACK DUCK (winter, estuary) Expert Review 2-26-1987

Lewis, J. C., and R. L. Garrison. 1984. Habitat Suitability Index Models: American Black Duck (wintering). U. S. Fish and Wildlife Service Biological Report 82/10.68. 16 pp.. Applies to winter habitat that is vegetated estuarine wetland. Range: Atlantic coast.

AMERICAN BLACK DUCK (winter, northern) Expert Review 2-26-1987

Lewis, J. C., and R. L. Garrison. 1984. Habitat Suitability Index Models: American Black Duck (wintering). U. S. Fish and Wildlife Service Biological Report 82/10.68. 16 pp.. Applies to winter habitat that is subtidal open water marine and estuarine systems. Range: Atlantic coast north of Cape Cod.

AMERICAN BLACK DUCK (winter, southern) Expert Review 2-26-1987

Lewis, J. C., and R. L. Garrison. 1984. Habitat Suitability Index Models: American Black Duck (wintering). U. S. Fish and Wildlife Service Biological Report 82/10.68. 16 pp. Applies to winter habitat that is subtidal open water marine and estuarine systems. Range: Atlantic coast south of Cape Cod.

MALLARD (winter, low Mississippi valley) Expert Review 5-5-1987

Allen, A. W. 1986. Habitat Suitability Index Models: Mallard (winter habitat, lower Mississippi valley). U. S. Fish and Wildlife Service Biological Report 82/10.132. 37 pp. Applies to winter habitat in the lower Mississippi valley but is not intended for evaluation of winter habitat in the coastal marshes of the Gulf of Mexico. Range: Missouri, Kentucky, Arkansas, Tennessee, Mississippi, Louisiana bottomland habitat.

NORTHERN PINTAIL (Gulf coast, breeding) Expert Review 12-15-1988

Suchy, W. J., and S. H. Anderson. 1987. Habitat Suitability Index Models: Northern Pintail. U. S. Fish and Wildlife Service Biological Report 82/10.145. 23 pp. Range: Prairie Pothole region of central and eastern North Dakota and eastern South Dakota.

NORTHERN PINTAIL (Gulf coast, resting) Expert Review 4-30-1987

Howard, R. J., and H. A. Kantrud. 1986. Habitat Suitability Index Models: Northern Pintail (Gulf coast wintering). U. S. Fish and Wildlife Service Biological Report 82/10.121. 16 pp. Applies to wintering habitat. Range: wetlands along the Gulf of Mexico coast in Texas and Louisiana and to major inland wintering areas of Texas and Louisiana described in the model.

NORTHERN PINTAIL (Gulf coast, resting/feeding) Expert Review 4-30-1987

Howard, R. J., and H. A. Kantrud. 1986. Habitat Suitability Index Models: Northern Pintail (Gulf coast wintering). U. S. Fish and Wildlife Service Biological Report 82/10.121. 16 pp. Applies to wintering habitat. Range: wetlands along the Gulf of Mexico coast in Texas and Louisiana and to major inland wintering areas of Texas and Louisiana described in the model.

BLUE-WINGED TEAL (breeding) Expert Review 12-16-1988

Sousa, P. J. 1985. Habitat Suitability Index Models: Blue-winged Teal (breeding). U. S. Fish and Wildlife Service Biological Report 82/10.114. 36 pp. Curves are in the publication for South Dakota. Applies to breeding habitat. Range: prairie pothole region of North Dakota (see map in publication).

MOTTLED DUCK Expert Review 11-25-1985

Rorabaugh, J. C., and P. J. Zwank. 1983. Habitat Suitability Index Models: Mottled Duck. U. S. Fish and Wildlife Service Biological Report 82/10.52. 26 pp. Applies to breeding habitat, spring and summer. Range: throughout the species= breeding range.

GADWALL (breeding) Expert Review 12-16-1988

Sousa, P. J. 1985. Habitat Suitability Index Models: Gadwall (breeding). U. S. Fish and Wildlife Service Biological Report 82/10.100. 35 pp. Applies to breeding habitat. Range: the prairie pothole region of North Dakota. (The publication contains curves for South Dakota as well.)

CANVASBACK (breeding) Expert Review 3-31-1987

Schroeder, R. L. 1984. Habitat Suitability Index Models: Canvasback (breeding habitat). U. S. Fish and Wildlife Service Biological Report 82/10.82. 16 pp. Applies to breeding habitat. Range: throughout the breeding range of the species (see map in publication).

REDHEAD (wintering) Expert Review 12-2-1985

Howard, R. J., and H. A. Kantrud. 1983. Habitat Suitability Index Models: Redhead (wintering). U. S. Fish and Wildlife Service Biological Report 82/10.53. 14 pp. Applies to period on wintering habitat, October - February. Range: bays and lagoons of Gulf of Mexico.

LESSER SCAUP (breeding) Expert Review 4-28-1987

Allen, A. W. 1986. Habitat Suitability Index Models: Lesser Scaup (breeding). U. S. Fish and Wildlife Service Biological Report 82/10.117. 16 pp. Applies to breeding habitat. Range: throughout the breeding range in the conterminous 48 States (see map in publication).

LESSER SCAUP (wintering) Expert Review 9-26-1985

Mulholland, R. 1985. Habitat Suitability Index Models: Lesser Scaup (wintering). U. S. Fish and Wildlife Service Biological Report 82/10.91. 15 pp. Applies to food and cover, November to April. Range: Gulf of Mexico and southern Atlantic coast.

AMERICAN EIDER Expert Review 12-13-1988

Blumton, A. K., R. B. Owen, Jr., and W. B. Krohn. 1988. Habitat Suitability Index Models: American Eider (breeding). U. S. Fish and Wildlife Service Biological Report 82/10.149. 24 pp. Applies to breeding season (late April to mid-July). Range: entire breeding range where habitat requirements are similar to the Maine coastal islands.

OSPREY (lacustrine) Expert Review 12-13-1988

Vana-Miller, S. L. 1987. Habitat Suitability Index Models: Osprey. U. S. Fish and Wildlife Service Biological Report 82/10.154. 46 pp. Applies to breeding habitat of migratory ospreys during April to August. Includes lands within 5 km of the water body being evaluated. Range: breeding range of migratory ospreys that forage in freshwater habitats, excluding resident ospreys in southern portions of North America.

OSPREY (riverine) Expert Review 12-13-1988

Vana-Miller, S. L. 1987. Habitat Suitability Index Models: Osprey. U. S. Fish and Wildlife Service Biological Report 82/10.154. 46 pp. Applies to breeding habitat of migratory ospreys during April to August. Includes lands within 5 km of the riverine system being evaluated. Range: breeding range of migratory ospreys that forage in freshwater habitats, excluding resident ospreys in southern portions of N. America.

BALD EAGLE (breeding) Expert Review 4-21-1987

Peterson, A. 1986. Habitat Suitability Index Models: Bald Eagle (breeding season). U. S. Fish and Wildlife Service Biological Report 82/10.126. 25 pp. Applies to breeding habitats. Range: north of the 37th parallel in North America.

FERRUGINOUS HAWK Expert Review 4-7-1987

Jasikoff, T. M. 1982. Habitat Suitability Index Models: Ferruginous Hawk. U. S. Fish and Wildlife Service Biological Report 82/10.10. 18 pp. Applies to breeding habitat. Range: throughout the breeding range of the species.

GREATER PRAIRIE-CHICKEN Expert Review 6-22-1988

Prose, B. L. 1985. Habitat Suitability Index Models: Great Prairie-Chicken (multiple levels of resolution). U. S. Fish and Wildlife Service Biological Report 82/10.102. 33 pp. Applies to year-round habitat. Range: throughout the historic range of the species.

BLUE GROUSE Expert Review 4-28-1987

Schroeder, R. L. 1984. Habitat Suitability Index Models: Blue Grouse. U. S. Fish and Wildlife Service Biological Report 82/10.81. 19 pp. Range: throughout the species= range.

PLAINS SHARP-TAILED GROUSE Expert Review 6-8-1988

Prose, B. L. 1987. Habitat Suitability Index Models: Plains Sharp-Tailed Grouse. U. S. Fish and Wildlife Service Biological Report 82/10.142. 31 pp.

RUFFED GROUSE Expert Review 12-13-1988

Cade, B. S., and P. J. Sousa. 1985. Habitat Suitability Index Models: Ruffed Grouse. U. S. Fish and Wildlife Service Biological Report 82/10.86. 31 pp. Applies where aspen is a predominate component of the vegetation. Range: throughout the range of the species.

NORTHERN BOBWHITE Expert Review 10-2-1987

Schroeder, R. L. 1985. Habitat Suitability Index Models: Northern Bobwhite. U. S. Fish and Wildlife Service Biological Report 82/10.104. 32 pp. Range: throughout the range of the species.

GRAY PARTRIDGE Expert Review 4-29-1987

Allen, A. W. 1984. Habitat Suitability Index Models: Gary Partridge. U. S. Fish and Wildlife Service Biological Report 82/10.73. 23 pp. Range: throughout the range of the species in North America (see map in publication). Note: See publication for a definition of Aidle@ land (p. 8).

EASTERN WILD TURKEY Expert Review 3-9-1987

Schroeder, R. L. 1985. Habitat Suitability Index Models: Eastern Wild Turkey. U. S. Fish and Wildlife Service Biological Report 82/10.106. 33 pp. Range: throughout the species= range.

CLAPPER RAIL Expert Review 3-3-1987

Lewis, J. C., and R. L. Garrison. 1983. Habitat Suitability Index Models: Clapper Rail. U. S. Fish and Wildlife Service Biological Report Biological Report 82/10.51. 15 pp. Range: Atlantic, Gulf of Mexico, and Pacific coasts of United States.

AMERICAN COOT Expert Review 12-22-1987

Allen, A. W. 1985. Habitat Suitability Index Models: American Coot. U. S. Fish and Wildlife Service Biological Report 82/10.115. 19 pp. Applies to breeding. Range: throughout the species= breeding range.

GREATER SANDHILL CRANE Expert Review 12-13-1988

Armbruster, M. J. 1987. Habitat Suitability Index Models: Greater Sandhill Crane. U. S. Fish and Wildlife Service Biological Report 82/10.140. 26 pp. Range: within the breeding range of five extant breeding populations of greater sandhill cranes in the United States.

AMERICAN WOODCOCK (winter, forest) Expert Review 2-27-1987

Cade, B. S. 1985. Habitat Suitability Index Models: American Woodcock (wintering). U. S. Fish and Wildlife Service Biological Report 82/10.105. 23 pp. Applies to winter habitat. Range: southern winter range, including VA, NC, SC, GA, FL, AL, MS, LA, AR, TN, eastern TX, and eastern OK.

AMERICAN WOODCOCK (winter, shrub land) Expert Review 2-27-1987

Cade, B. S. 1985. Habitat Suitability Index Models: American Woodcock (wintering). U. S. Fish and Wildlife Service Biological Report 82/10.105. 23 pp. Applies to winter habitat. Range: southern winter range, including VA, NC, SC, GA, FL, AL, MS, LA, AR, TN, eastern TX, and eastern OK.

LAUGHING GULL Expert Review 9-26-1985

Zale, A. V., and R. Mulholland. 1985. Habitat Suitability Index Models: Laughing Gull. U. S. Fish and Wildlife Service Biological Report 82/10.94. 23 pp. Applies to nesting habitats, February to September. Range: Gulf of Mexico salt marsh, barrier islands, and spoil islands.

LEAST TERN Expert Review 12-29-1985

Carreker, R. G. 1985. Habitat Suitability Index Models: Least Tern. U. S. Fish and Wildlife Service Biological Report Biological Report 82/10.103. 29 pp. The model makes numerous assumptions and

includes special notes on application. Thoroughly understand the publication before you try to use this model. Applies to breeding habitat (May - August). Range: throughout the breeding range of the species in the United States (see map in publication).

SPOTTED OWL (2) Expert Review 11-19-1985

Layman, S. A., J. Salwasser, and R. H. Barrett. 1985. Habitat Suitability Index Models: Spotted Owl. U. S. Fish and Wildlife Service Biological Report 82/10.113. 14 pp. Uses second equation to calculate HSI (not geometric mean). Applies to reproduction (spring - autumn), and may apply to winter. Range: restricted to the Sierran Forest Province (M261) of Bailey.

BARRED OWL Expert Review 12-13-1988

Allen, A. W. 1987. Habitat Suitability Index Models: Barred Owl. U. S. Fish and Wildlife Service Biological Report 82/10.143. 17 pp. Applies to reproductive habitat of the Barred Owl. Range: throughout the range of the barred owl in North America.

BELTED KINGFISHER (lacustrine) Expert Review 2-27-1987

Prose, B. L. 1985. Habitat Suitability Index Models: Belted Kingfisher. U. S. Fish and Wildlife Service Biological Report 82/10.87. 22 pp. Applies to breeding habitat. Range: throughout the breeding range of the species.

BELTED KINGFISHER (riverine) Expert Review 12-5-1985

Prose, B. L. 1985. Habitat Suitability Index Models: Belted Kingfisher. U. S. Fish and Wildlife Service Biological Report 82/10.87. 22 pp. Applies to breeding habitat. Range: throughout the breeding range of the species.

LEWIS= WOODPECKER (cropland) Expert Review 12-16-1985

Sousa, P. J. 1982. Habitat Suitability Index Models: Lewis= Woodpecker. U. S. Fish and Wildlife Service Biological Report 82/10.32. 14 pp. Applies to corn crops only. Range: throughout the species= breeding and wintering ranges.

LEWIS= WOODPECKER (dec. forest/desertic woodland) Expert Review 11-19-1985

Sousa, P. J. 1982. Habitat Suitability Index Models: Lewis= Woodpecker. U. S. Fish and Wildlife Service Biological Report 82/10.32. 14 pp. Applies to deciduous wetlands, but not evergreen ones. Range: throughout the species= breeding and wintering ranges.

LEWIS= WOODPECKER (evergreen forest) Expert Review 11-19-1985

Sousa, P. J. 1982. Habitat Suitability Index Models: Lewis= Woodpecker. U. S. Fish and Wildlife Service Biological Report 82/10.32. 14 pp. Applies to summer food and reproduction. Range: throughout the species= breeding range.

LEWIS= WOODPECKER (evergreen tree savanna) Expert Review 11-19-1985

Sousa, P. J. 1982. Habitat Suitability Index Models: Lewis= Woodpecker. U. S. Fish and Wildlife Service Biological Report 82/10.32. 14 pp. Range: throughout the summer and winter ranges.

WILLIAMSON=S SAPSUCKER Expert Review 11-7-1985

Sousa, P. J. 1983. Habitat Suitability Index Models: Williamson=s Sapsucker. U. S. Fish and Wildlife Service Biological Report 82/10.47. 13 pp. Applies to reproduction in spring and summer. Range: breeding range of inland subspecies (*S. t. nataliae*).

DOWNY WOODPECKER Expert Review 11-6-1985

Schroeder, R. L. 1982. Habitat Suitability Index Models: Downy Woodpecker. U. S. Fish and Wildlife Service Biological Report 82/10.38. 10 pp. Range: throughout the species= range.

HAIRY WOODPECKER Tested 12-13-1988

Sousa, P. J. 1987. Habitat Suitability Index Models: Hairy Woodpecker. U. S. Fish and Wildlife Service Biological Report 82/10.146. 19 pp. Applies to year-round habitat. Range: within forested habitat throughout entire range.

PILEATED WOODPECKER (eastern) Expert Review 12-13-1988

Schroeder, R. L. 1982. Habitat Suitability Index Models: Pileated Woodpecker. U. S. Fish and Wildlife Service Biological Report 82/10.39. 15 pp. Range: throughout the eastern portion of the species= range.

PILEATED WOODPECKER (western) Expert Review 12-13-1988

Schroeder, R. L. 1982. Habitat Suitability Index Models: Pileated Woodpecker. U. S. Fish and Wildlife Service Biological Report 82/10.39. 15 pp. Range: throughout the western portion of the species= range.

BLACK-CAPPED CHICKADEE (1) Expert Review 2-27-1987

Schroeder, R. L. 1982. Habitat Suitability Index Models: Black-capped Chickadee. U. S. Fish and

Wildlife Service Biological Report 82/10.37. 12 pp. Uses tree height and canopy cover option. Applies to breeding habitats. Range: throughout the breeding range of the species.

BLACK-CAPPED CHICKADEE (2) Expert Review 11-7-1985

Schroeder, R. L. 1982. Habitat Suitability Index Models: Black-capped Chickadee. U. S. Fish and Wildlife Service Biological Report 82/10.37. 12 pp. Uses foliage volume option. Applies to breeding habitats. Range: throughout the breeding range of the species.

CACTUS WREN Expert Review 11-12-1985

Short, H. L. 1985. Habitat Suitability Index Models: Cactus Wren. U. S. Fish and Wildlife Service Biological Report 82/10.96. 15 pp. Applies to deciduous shrub land containing arborescent cacti. Range: Sonoran and Chihuahuan deserts.

MARSH WREN Expert Review 12-13-1988

Gutzwiller, K. J., and S. H. Anderson. 1987. Habitat Suitability Index Models: Marsh Wren. U. S. Fish and Wildlife Service Biological Report 82/10.139. 13 pp. Range: throughout the breeding range of the marsh wren.

VEERY (non-wetlands) Expert Review 11-6-1985

Sousa, P. J. 1982. Habitat Suitability Index Models: Veery. U. S. Fish and Wildlife Service Biological Report 82/10.22. 12 pp. Applies to breeding habitats cover and reproduction (spring to summer). Range: throughout the breeding range of the species.

VEERY (wetlands) Expert Review 11-7-1985

Sousa, P. J. 1982. Habitat Suitability Index Models: Veery. U. S. Fish and Wildlife Service Biological Report 82/10.22. 12 pp. Applies to breeding habitats cover and reproduction (spring to summer). Range: throughout the breeding range of the species.

BROWN THRASHER Expert Review 4-24-1987

Cade, B. S. 1986. Habitat Suitability Index Models: Brown Thrasher. U. S. Fish and Wildlife Service Biological Report 82/10.118. 14 pp. Applies to breeding season habitat. Range: throughout the breeding range of the species (see map in publication).

YELLOW WARBLER Expert Review 11-6-1985

Schroeder, R. L. 1982. Habitat Suitability Index Models: Yellow Warbler. U. S. Fish and Wildlife Service Biological Report 82/10.27. 7 pp. Applies to breeding. Range: throughout the breeding range of the species.

PINE WARBLER Expert Review 11-6-1985

Schroeder, R. L. 1985. Habitat Suitability Index Models: Pine Warbler. U. S. Fish and Wildlife Service Biological Report 82/10.28 (revised). 9 pp. First published September 1982. Applies to breeding season. Range: entire breeding range of the species.

BREWER=S SPARROW Expert Review 2-27-1987

Short, H. L. 1984. Habitat Suitability Index Models: Brewer=s Sparrow. U. S. Fish and Wildlife Service Biological Report 82/10.83. 16 pp. Users of this model should refer to the published version of the model since compatibility for model entry into the software required minor modifications in variable definitions and categories. Applies to breeding habitat. Range: throughout the breeding range (see map in publication).

FIELD SPARROW Tested 12-11-1985

Sousa, P. J. 1983. Habitat Suitability Index Models: Field Sparrow. U. S. Fish and Wildlife Service Biological Report 82/10.62. 14 pp. Applies to breeding habitat. Range: throughout the breeding range (see map in publication).

LARK BUNTING Expert Review 12-13-1988

Finch, D. M., S. H. Anderson, and W. A. Hubert. 1987. Habitat Suitability Index Models: Lark Bunting. U. S. Fish and Wildlife Service Biological Report 82/10.137. 16 pp. Range: the breeding range of the lark bunting (May through July).

BAIRDS SPARROW Expert Review 11-14-1985

Sousa, P. J., and W. N. McDonal. 1983. Habitat Suitability Index Models: Bairds Sparrow. U. S. Fish and Wildlife Service Biological Report 82/10.44. 12 pp. Applies of breeding habitat (late May - mid-August). Range: throughout the breeding range in U.S. (see map in publication).

RED-WINGED BLACKBIRD (upland) Expert Review 12-12-1985

Short, H. L. 1985. Habitat Suitability Index Models: Red-winged Blackbird. U. S. Fish and Wildlife Service Biological Report 82/10.95. 20 pp. Applies to nesting habitat, March -July. Range: throughout

the species= range in the 48 conterminous States.

RED-WINGED BLACKBIRD (wetlands, condition A) Expert Review 12-16-1985

Short, H. L. 1985. Habitat Suitability Index Models: Red-winged Blackbird. U. S. Fish and Wildlife Service Biological Report 82/10.95. 20 pp. Note: Condition A wetlands contains >= .1 HA of emergent herbaceous vegetation. Applies to nesting habitat, March -July. Range: throughout the species= range in the 48 conterminous states.

EASTERN MEADOWLARK Expert Review 11-12-1985

Schroeder, R. L., and P. J. Sousa. 1982. Habitat Suitability Index Models: Eastern Meadowlark. U. S. Fish and Wildlife Service Biological Report 82/10.29. 9 pp. Applies to breeding habitat. Range: throughout the breeding range of the species.

YELLOW-HEADED BLACKBIRD Expert Review 4-16-1987

Schroeder, R. L. 1982. Habitat Suitability Index Models: Yellow-headed Blackbird. U. S. Fish and Wildlife Service Biological Report 82/10.26. 12 pp. Applies to breeding season. Range: throughout the breeding range of the species.

EASTERN COTTONTAIL Expert Review 4-29-1987

Allen, A. W. 1984. Habitat Suitability Index Models: Eastern Cottontail. U. S. Fish and Wildlife Service Biological Report 82/10.66. 23 pp. Applies to winter habitat evaluation in the eastern cottontail=s range. Range: throughout the species= range in the contiguous United States.

SNOWSHOE HARE Expert Review 9-13-1985

Carreker, R. G. 1985. Habitat Suitability Index Models: Snowshoe Hare. U. S. Fish and Wildlife Service Biological Report 82/10.101. 21 pp. The food component of this model is based on % visual obstruction of living vegetation < 3 m tall. The published model provides guidance to incorporate a measure of available browse biomass if sampling and time permits a more detailed analysis of snowshoe hare habitat quality. Applies to winter habitat. Range: throughout the species= range.

GRAY SQUIRREL Expert Review 11-22-1985

Allen, A. W. 1982. Habitat Suitability Index Models: Gray Squirrel. U. S. Fish and Wildlife Service Biological Report 82/10.19. 11 pp. Range: throughout the species= range.

GRAY SQUIRREL (revised) Expert Review 12-13-1988

Allen, A. W. 1987. Habitat Suitability Index Models: Gray Squirrel (Revised). U. S. Fish and Wildlife Service Biological Report 82/10.135. 16 pp. Range: throughout the range of the gray squirrel in North America.

FOX SQUIRREL Expert Review 11-26-1985

Allen, A. W. 1982. Habitat Suitability Index Models: Fox Squirrel. U. S. Fish and Wildlife Service Biological Report 82/10.18. 11 pp. Applies to subspecies noted below. Does not apply to subspecies inhabiting Bailey=s AOuter Coastal Plain Forest@ and ASoutheastern Mixed Forest@ provinces. Within PFO, applies only to deciduous stands. Range: throughout the ranges of the following subspecies: *S. n. rufiuenter, S. n. vulpinus, S. n. ludovicianus,* and *S. n. limitis.*

BEAVER Expert Review 11-30-1988

Allen, A. W. 1983. Habitat Suitability Index Models: Beaver. U. S. Fish and Wildlife Service Biological Report 82/10.30 (revised). 20 pp. Note: The software requires that an area be entered for the cover type Alarge lakes@ in order to enter values for variables associated with the large lake habitat. This area should not be considered, however, in the final Habitat Unit computations, because (as noted in the published model in Figure 1 on page 6) the area of large lakes is not considered to be useable habitat for beavers.

SOUTHERN RED-BACKED VOLE (western subspecies) Expert Review 11-7-1985

Allen, A. W. 1983. Habitat Suitability Index Models: Southern Red-backed Vole (Western United States). U. S. Fish and Wildlife Service Biological Report 82/10.42. 14 pp. Applies to food and cover. Range: throughout the range of the western subspecies (see map in the publication).

MUSKRAT (estuarine) Expert Review 4-28-1987

Allen, A. W., and R. D. Hoffman. 1984. Habitat Suitability Index Models: Muskrat. U. S. Fish and Wildlife Service Biological Report 82/10.46. 27 pp. Applies to year-round habitat of estuarine-associated populations. Range: Atlantic and Gulf of Mexico coastal marshes.

MUSKRAT (herbaceous wetlands) Expert Review 4-29-1987

Allen, A. W., and R. D. Hoffman. 1984. Habitat Suitability Index Models: Muskrat. U. S. Fish and Wildlife Service Biological Report 82/10.46. 27 pp. Applies to year-round habitat of populations using

herbaceous wetlands. Range: throughout species= range of inland freshwater habitats only.

MUSKRAT (riverine) Expert Review 4-29-1987

Allen, A. W., and R. D. Hoffman. 1984. Habitat Suitability Index Models: Muskrat. U. S. Fish and Wildlife Service Biological Report 82/10.46. 27 pp. Applies to year-round habitat of riverine-associated populations. Range: throughout species= range of inland freshwater habitats only.

BLACK BEAR (upper Great Lakes) Expert Review 12-16-1988

Rogers, L. L., and A. W. Allen. 1987. Habitat Suitability Index Models: Black Bear, Upper Great Lakes Region. U. S. Fish and Wildlife Service Biological Report 82/10.144. 54 pp. Applies to year-round black bear habitat. Range: upper Great Lakes region, including northeast Minnesota, northern Wisconsin, Michigan=s upper peninsula and the upper half of the lower peninsula of Michigan.

MARTEN Expert Review 11-12-1985

Allen, A. W. 1982. Habitat Suitability Index Models: Marten. U. S. Fish and Wildlife Service Biological Report 82/10.11. 9 pp. Applies to boreal coniferous forest as winter habitat. Range: western United States

MINK (forest and shrub wetlands > 405 ha in size) Expert Review 4-29-1987

Allen, A. W. 1984. Habitat Suitability Index Models: Mink (Revised). U. S. Fish and Wildlife Service Biological Report 82/10.127. 23 pp. Applies to year-round habitat of forested and shrub wetland populations in wetlands larger than 405 ha (1000 acres). Range: throughout the historic range of the species in North America. First printed as: U. S. Fish and Wildlife Biological Report 82/10.61, October 1983.

MINK (herbaceous wetlands) Expert Review 4-29-1987

Allen, A. W. 1984. Habitat Suitability Index Models: Mink (Revised). U. S. Fish and Wildlife Service Biological Report 82/10.127. 23 pp. Applies to year-round habitat of herbaceous wetland populations. Range: throughout the historic range of the species in North America. First printed as: U. S. Fish and Wildlife Biological Report 82/10.61, October 1983.

MINK (forest and shrub wetlands < 405 ha in size) Expert Review 4-29-1987

Allen, A. W. 1984. Habitat Suitability Index Models: Mink (Revised). U. S. Fish and Wildlife Service Biological Report 82/10.127. 23 pp. Applies to year-round habitat of forested and shrub wetland populations in wetlands less than 405 ha (1000 acres). Range: throughout the historic range of the species in North America. First printed as: U. S. Fish and Wildlife Biological Report 82/10.61, October 1983.

MINK (lacustrine) Expert Review 11-30-1988

Allen, A. W. 1984. Habitat Suitability Index Models: Mink (Revised). U. S. Fish and Wildlife Service Biological Report 82/10.127. 23 pp. Applies to year-round habitat of lacustrine-associated populations. Range: throughout the historic range of the species in North America. First printed as: U. S. Fish and Wildlife Biological Report 82/10.61, October 1983. Note: The software requires that an area be entered for the lacustrine cover types. As shown in the published model (page 14), however, the area of concern is actually a 100 meter band around the lake. Be certain to use the area of this 100 meter band in the final Habitat Unit computations, because the lake itself does not provide useable habitat for mink.

MINK (riverine) Expert Review 8-8-1988

Allen, A. W. 1984. Habitat Suitability Index Models: Mink (Revised). U. S. Fish and Wildlife Service Biological Report 82/10.127. 23 pp. Applies to year-round habitat of riverine-associated populations. Range: throughout the historic range of the species in North America. First printed as: U. S. Fish and Wildlife Biological Report 82/10.61, October 1983.

BOBCAT (evaluation area >=4 ha) Expert Review 12-13-1988

Boyle, K. A., and T. T. Fendley. 1987. Habitat Suitability Index Models: Bobcat. U. S. Fish and Wildlife Service Biological Report 82/10.147. 16 pp. Range: Piedmont and Coastal Plains regions of the southeastern United States.

BOBCAT (evaluation area < 4 ha) Expert Review 12-13-1988

Boyle, K. A., and T. T. Fendley. 1987. Habitat Suitability Index Models: Bobcat. U. S. Fish and Wildlife Service Biological Report 82/10.147. 16 pp. Range: Piedmont and Coastal Plains regions of the southeastern United States.

WHITE-TAILED DEER (southern coast) Expert Review 4-24-1987

Short, H. L. 1986. Habitat Suitability Index Models: White-tailed Deer in the Gulf of Mexico and South Atlantic Coastal Plains. U. S. Fish and Wildlife Service Biological Report 82/10.123. 36 pp. Uses model

III. Applies to autumn and winter habitats as food sources. Range: coastal plains of South Atlantic and Gulf of Mexico (see map in publication).

MOOSE (dormant season) Expert Review 12-13-1988

Allen, A. W., P. A. Jordan, and J. W. Terrell. 1987. Habitat Suitability Index Models: Moose, Lake Superior Region. U. S. Fish and Wildlife Service Biological Report 82/10.155. 47 pp. Applies during mid-September to mid-May (dormant season). Range: Lake Superior region, including portions of Ontario, Minnesota, Wisconsin, and the upper peninsula of Michigan.

MOOSE (growing season) Expert Review 12-13-1988

Allen, A. W., P. A. Jordan, and J. W. Terrell. 1987. Habitat Suitability Index Models: Moose, Lake Superior Region. U. S. Fish and Wildlife Service Biological Report 82/10.155. 47 pp. Applies during mid-September to mid-May (growing season). Range: Lake Superior region, including portions of Ontario, Minnesota, Wisconsin, and the upper peninsula of Michigan.

MOOSE (large areas) Expert Review 12-13-1988

Allen, A. W., P. A. Jordan, and J. W. Terrell. 1987. Habitat Suitability Index Models: Moose, Lake Superior Region. U. S. Fish and Wildlife Service Biological Report 82/10.155. 47 pp. This is Model II of the Lake Superior region Moose model that is intended for evaluation of large areas (e.g., larger than a township, 36 square miles). Range: Lake Superior region, including portions of Ontario, Minnesota, Wisconsin, and the upper peninsula of Michigan.

PRONGHORN Tested 11-19-1985

Allen, A. W., J. G. Cook, and M. J. Armbruster. 1984. Habitat Suitability Index Models: Pronghorn. U. S. Fish and Wildlife Service Biological Report 82/10.65. 22 pp. Applies of winter habitat. Range: Great Basin and Great Plains, may apply throughout the range of *A. americana* (see map in publication).

AMERICAN OYSTER (Gulf of Mexico) Expert Review 12-12-1985

Cake, E. W., Jr. 1983. Habitat Suitability Index Models: Gulf of Mexico American Oyster. U. S. Fish and Wildlife Service Biological Report 82/10.57. 37 pp. This model is designed to evaluate oyster habitat. For other uses, such as oyster management, the model may be modified and the user is to refer to the published model. Range: Louisianian estuarine province of Cowardin et al. (1979).

HARD CLAM Expert Review 6-10-1988

Mulholland, R. 1984. Habitat Suitability Index Models: Hard Clam. U. S. Fish and Wildlife Service Biological Report 82/10.77. 21 pp. Applies to areas without heavy pollution. Range: Atlantic and Gulf of Mexico coasts.

LITTLENECK CLAM Expert Review 4-11-1987

Rodnick, K., and H. W. Li. 1983. Habitat Suitability Index Models: Littleneck Clam. U. S. Fish and Wildlife Service Biological Report 82/10.59. 15 pp. Specific cover types: Marine, intertidal, rocky shore, rubble. Marine, intertidal, unconsolidated shore, cobble-gravel. Marine, intertidal, unconsolidated shore, sand. Estuarine, intertidal, rocky shore, rubble. Estuarine, intertidal, unconsolidated shore, cobble-gravel. Estuarine, intertidal, unconsolidated shore, sand. Range: throughout the species= range on the Pacific coast.

BROWN SHRIMP Expert Review 9-12-1985

Turner, R. E., and M. S. Brody. 1983. Habitat Suitability Index Models: Northern Gulf of Mexico Brown Shrimp and White Shrimp. U. S. Fish and Wildlife Service Biological Report 82/10.54. 24 pp. Range: northern Gulf of Mexico from Tampa Bay (Florida) to Corpus Christi Bay (Texas).

PINK SHRIMP Expert Review 4-12-1987

Mulholland, R. 1984. Habitat Suitability Index Models: Pink Shrimp. U. S. Fish and Wildlife Service Biological Report 82/10.76. 17 pp. Applies to postlarval and juvenile life stages in estuarine habitats. Range: Gulf of Mexico coast, including southern Florida.

WHITE SHRIMP Expert Review 9-12-1985

Turner, R. E., and M. S. Brody. Habitat Suitability Index Models: Northern Gulf of Mexico Brown Shrimp and White Shrimp. U. S. Fish and Wildlife Service Biological Report 82/10.54. 24 pp. Applies to post-larvae and juveniles. Range: estuaries and bays of northern Gulf of Mexico, from Tampa Bay (Florida) to Corpus Cristi (Texas).

RED KING CRAB (larval) Expert Review 12-14-1988

Jewett, S. C. and C. P. Onuf. 1988. Habitat Suitability Index Models: Red King Crab. U. S. Fish and Wildlife Service Biological Report 82/10.153. 34 pp. Range: continental shelf of the north Pacific ocean, primarily the coastal waters of the Gulf of Alaska and southeastern Bering Sea.

RED KING CRAB (young of year) Expert Review 12-14-1988

Jewett, S. C. and C. P. Onuf. 1988. Habitat Suitability Index Models: Red King Crab. U. S. Fish and Wildlife Service Biological Report 82/10.153. 34 pp. Range: continental shelf of the north Pacific ocean, primarily the coastal waters of the Gulf of Alaska and southeastern Bering Sea.

RED KING CRAB (juvenile < 4 yr) Expert Review 12-14-1988

Jewett, S. C. and C. P. Onuf. 1988. Habitat Suitability Index Models: Red King Crab. U. S. Fish and Wildlife Service Biological Report 82/10.153. 34 pp. Range: continental shelf of the north Pacific ocean, primarily the coastal waters of the Gulf of Alaska and southeastern Bering Sea.

RED KING CRAB (adult) Expert Review 12-14-1988

Jewett, S. C. and C. P. Onuf. 1988. Habitat Suitability Index Models: Red King Crab. U. S. Fish and Wildlife Service Biological Report 82/10.153. 34 pp. Applies to ages, 4 years and older; juvenile, sub-adult, and adult. Range: continental shelf of the north Pacific ocean, primarily the coastal waters of the Gulf of Alaska and southeastern Bering Sea.

SHORTNOSE STURGEON (estuarine) Expert Review 4-20-1987

Crance, J. H. 1986. Habitat Suitability Index Models: Shortnose Sturgeon. U. S. Fish and Wildlife Service Biological Report 82/10.129. 31 pp. Applies to summer foraging habitat. Range: along the Atlantic coast of the United States. May also apply to the St. John River, Canada.

SHORTNOSE STURGEON (riverine) Expert Review 4-20-1987

Crance, J. H. 1986. Habitat Suitability Index Models: Shortnose Sturgeon. U. S. Fish and Wildlife Service Biological Report 82/10.129. 31 pp. Applies to spawning, incubation, and summer foraging habitat. Range: throughout the Atlantic coast of the United States. May also apply to the St. John River, Canada.

PADDLEFISH (adult) Expert Review 4-12-1987

Hubert, W. A., S. H. Anderson, P. D. Southall, and J. H. Crance. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: Paddlefish. U. S. Fish and Wildlife Service Biological Report 82/10.80. 32 pp. Applies to large rivers and connected lakes. Range: throughout the natural range of the species in North America (Mississippi River and other rivers flowing into the Gulf of Mexico).

PADDLEFISH (spawning) Expert Review 4-12-1987

Hubert, W. A., S. H. Anderson, P. D. Southall, and J. H. Crance. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: Paddlefish. U. S. Fish and Wildlife Service Biological Report 82/10.80. 32 pp. Applies to rivers and connected lakes. Range: throughout the natural range of the species in North America.

BLUEBACK HERRING Expert Review 4-2-1987

Pardue, G. B. 1983. Habitat Suitability Index Models: Alewife and Bluebacked Herring. U. S. Fish and Wildlife Service Biological Report 82/10.58. 22 pp. Range: Atlantic coast of North America from Newfoundland to Florida.

ALEWIFE Expert Review 12-11-1985

Pardue, G. B. 1983. Habitat Suitability Index Models: Alewife and Blueback Herring. U. S. Fish and Wildlife Service Biological Report 82/10.58. 22 pp. Range: Atlantic coast, from Newfoundland to South Carolina.

AMERICAN SHAD (estuarine) Expert Review 9-26-1985

Stier, D. J., and J. H. Crance. 1985. Habitat Suitability Index Models and Instream Flow Suitability Curves: American Shad. U. S. Fish and Wildlife Service Biological Report 82/10.88. 34 pp. Range: Atlantic coast of United States

AMERICAN SHAD (riverine) Expert Review 9-26-1985

Stier, D. J., and J. H. Crance. 1985. Habitat Suitability Index Models and Instream Flow Suitability Curves: American Shad. U. S. Fish and Wildlife Service Biological Report 82/10.88. 34 pp. Range: Atlantic coast of United States

GULF MENHADEN (estuarine) Expert Review 4-6-1987

Christmas, J. Y., J. T. McBee, R. S. Waller, and F. C. Sutter III. 1982. Habitat Suitability Index Models: Gulf Menhaden. U. S. Fish and Wildlife Service Biological Report 82/10.23. 23 pp. Applies where fresh water inflow dilutes seawater most of the year. Range: Northern Gulf of Mexico from Florida to Texas.

GULF MENHADEN (marine) Expert Review 4-6-1987

Christmas, J. Y., J. T. McBee, R. S. Waller, and F. C. Sutter III. 1982. Habitat Suitability Index Models: Gulf Menhaden. U. S. Fish and Wildlife Service Biological Report 82/10.23. 23 pp. Applies to open

waters of the continental shelf out to the 70 m depth contour. Range: Northern Gulf of Mexico, from Florida to Texas.

GIZZARD SHAD (lacustrine) Expert Review 11-18-1988

Williamson, K. L., and P. C. Nelson. 1985. Habitat Suitability Index Models and Instream Flow Suitability Curves: Gizzard Shad. U. S. Fish and Wildlife Service Biological Report 82/10.112. 33 pp. Range: lakes and reservoirs throughout the United States.

COMMON CARP (reservoir, low effort, bld??) Quantitative Analysis 4-24-1987

McConnell, W. J., E. P. Bergerson, and K. L. Williamson. 1984. Habitat Suitability Index Models: A Low Effort System for Planned Coolwater and Coldwater Reservoirs (Revised). U. S. Fish and Wildlife Service Biological Report 82/10.3A. 62 pp. Applies where nonliving cover comes only from boulders, standing timber or talus fields. Applies to planned reservoirs that: 1. have an inflow total dissolved solids < 3000 mg/l (weighted mean). 2. have inflow with an ion mixture dominated by K+, Na+, Ca++, Mg++, HCO3-, CO3B, Cl-, and SO4B, in which HCO3- plus CO3B is no more than 300 mg/l and pH is less than 8.5. 3. have a surface area greater than 3 km^2. 4. do not have a grossly polluted river being impounded (as indicated by fish kills, low species diversity, and official quality or use classification). 5. are seldom to be drawn down to a volume of < 1/4 of maximum. 6. are true reservoirs, not merely a natural lake with a raised level. Range: north of 37 degrees, north latitude.

COMMON CARP (riverine) Expert Review 10-29-1987

Edwards, E. A., and K. A. Twomey. 1982. Habitat Suitability Index Models: Common Carp. U. S. Fish and Wildlife Service Biological Report 82/10.12. 27 pp. Applies where salinity is not a problem. Salinity can be added to the model if desired. See publication. Range: throughout the species= range in the conterminous 48 States.

COMMON SHINER (lacustrine) Expert Review 4-6-1987

Trial, J. G., C. S. Wade, J. G. Stanley, and P. C. Nelson. 1983. Habitat Suitability Information: Common Shiner. U. S. Fish and Wildlife Service Biological Report 82/10.40. 22 pp. Range: throughout the northeastern range of the species in North America as described by Lee et al. (1980, Atlas of North American freshwater fishes).

COMMON SHINER (riverine) Expert Review 4-6-1987

Trial, J. G., C. S. Wade, J. G. Stanley, and P. C. Nelson. 1983. Habitat Suitability Information: Common Shiner. U. S. Fish and Wildlife Service Biological Report 82/10.40. 22 pp. Range: throughout the northeastern range of the species in North America as described by Lee et al. (1980, Atlas of North American freshwater fishes).

BLACKNOSE DACE (lacustrine) Expert Review 9-17-1985

Trial, J. G., J. G. Stanley, M. Batcheller, G. Gebhart, O. E. Maughan, and P. C. Nelson. 1983. Habitat Suitability Information: Blacknose Dace. U. S. Fish and Wildlife Service Biological Report 82/10.41. 28 pp. Range: throughout the species range in North America.

BLACKNOSE DACE (riverine) Expert Review 4-2-1987

Trial, J. G., J. G. Stanley, M. Batcheller, G. Gebhart, O. E. Maughan, and P. C. Nelson. 1983. Habitat Suitability Information: Blacknose Dace. U. S. Fish and Wildlife Service Biological Report 82/10.41. 28 pp. Range: throughout the species range in North America.

LONGNOSE DACE (lacustrine) Expert Review 4-11-1987

Edwards, E. A., H. Li, and C. B. Schreck. 1983. Habitat Suitability Index Models: Longnose Dace. U. S. Fish and Wildlife Service Biological Report 82/10.33. 13 pp. Range: throughout North America.

LONGNOSE DACE (riverine) Expert Review 4-11-1987

Edwards, E. A., H. Li, and C. B. Schreck. 1983. Habitat Suitability Index Models: Longnose Dace. U. S. Fish and Wildlife Service Biological Report 82/10.33. 13 pp. Range: throughout North America.

CREEK CHUB Expert Review 4-6-1987

McMahon, T. E. 1982. Habitat Suitability Index Models: Creek Chub. U. S. Fish and Wildlife Service Biological Report 82/10.4. 23 pp. Range: throughout the range of the species.

FALLFISH (lacustrine) Expert Review 4-6-1987

Trial, J. G., C. S. Wade, J. G. Stanley, and P. C. Nelson. 1983. Habitat Suitability Information: Fallfish. U. S. Fish and Wildlife Service Biological Report 82/10.48. 15 pp. Range: throughout the species= range in North America.

FALLFISH (riverine) Expert Review 4-6-1987

Trial, J. G., C. S. Wade, J. G. Stanley, and P. C. Nelson. 1983. Habitat Suitability Information: Fallfish. U. S. Fish and Wildlife Service Biological Report 82/10.48. 15 pp. Range: throughout the species= range in North America.

LONGNOSE SUCKER (lacustrine) Expert Review 4-11-1987

Edwards, E. A. 1983. Habitat Suitability Index Models: Longnose Sucker. U. S. Fish and Wildlife Service Biological Report 82/10.35. 21 pp. Range: throughout the native range of the species in North America.

LONGNOSE SUCKER (riverine) Expert Review 4-11-1987

Edwards, E. A. 1983. Habitat Suitability Index Models: Longnose Sucker. U. S. Fish and Wildlife Service Biological Report 82/10.35. 21 pp. Range: throughout the native range of the species in North America.

WHITE SUCKER (lacustrine, lacustrine spawning) Expert Review 4-17-1987

Twomey, K. A., K. L. Williamson, and P. C. Nelson. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: White Sucker. U. S. Fish and Wildlife Service Biological Report 82/10.64. 56 pp. Applies to populations residing and reproducing in lakes. Range: throughout the species= range in the conterminous 48 States.

WHITE SUCKER (lacustrine, riverine spawning) Expert Review 4-27-1987

Twomey, K. A., K. L. Williamson, and P. C. Nelson. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: White Sucker. U. S. Fish and Wildlife Service Biological Report 82/10.64. 56 pp. Note: This model is for lacustrine with riverine spawning. Applies to populations residing and reproducing in lakes. Range: throughout the species= range in the conterminous 48 States.

WHITE SUCKER (riverine) Expert Review 4-17-1987

Twomey, K. A., K. L. Williamson, and P. C. Nelson. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: White Sucker. U. S. Fish and Wildlife Service Biological Report 82/10.64. 56 pp. Note: This is Amodel 5" of the publication. Applies to populations residing and reproducing in rivers and streams. Range: throughout the species= range in the conterminous 48 States.

SMALLMOUTH BUFFALO (riverine) Expert Review 4-27-1987

Edwards, E. A., and K. Twomey. 1982. Habitat Suitability Index Models: Smallmouth Buffalo. U. S. Fish and Wildlife Service Biological Report 82/10.13. 30 pp. Applies where salinity is not a problem. Salinity can be included, see the model publication. Range: throughout the native and introduced range in North America.

BIGMOUTH BUFFALO (lacustrine) Expert Review 4-2-1987

Edwards, E. A. 1983. Habitat Suitability Index Models: Bigmouth Buffalo. U. S. Fish and Wildlife Service Biological Report 82/10.34. 23 pp. Range: throughout the native and introduced range in North America.

BIGMOUTH BUFFALO (riverine) Expert Review 5-27-1987

Edwards, E. A. 1983. Habitat Suitability Index Models: Bigmouth Buffalo. U. S. Fish and Wildlife Service Biological Report 82/10.34. 23 pp. Range: throughout the native and introduced range in North America

BLACK BULLHEAD (lacustrine) Expert Review 4-2-1987

Stuber, R. J. 1982. Habitat Suitability Index Models: Black Bullhead. U. S. Fish and Wildlife Service Biological Report 82/10.14. 25 pp. Range: throughout the conterminous 48 States.

BLACK BULLHEAD (riverine) Expert Review 4-2-1987

Stuber, R. J. 1982. Habitat Suitability Index Models: Black Bullhead. U. S. Fish and Wildlife Service Biological Report 82/10.14. 25 pp. Range: throughout the conterminous 48 States.

CHANNEL CATFISH (lacustrine) Expert Review 4-22-1988

McMahon, T. E., and J. W. Terrell. 1982. Habitat Suitability Index Models: Channel Catfish. U. S. Fish and Wildlife Service Biological Report 82/10.2. 29 pp. Range: conterminous 48 States.

CHANNEL CATFISH (riverine) Expert Review 4-3-1987

McMahon, T. E., and J. W. Terrell. 1982. Habitat Suitability Index Models: Channel Catfish. U. S. Fish and Wildlife Service Biological Report 82/10.2. 29 pp. Range: conterminous 48 States.

FLATHEAD CATFISH (macrohabitat) Expert Review 12-13-1988

Lee, L. A., and J. W. Terrell. 1987. Habitat Suitability Index Models: Flathead Catfish. U. S. Fish and Wildlife Service Biological Report 82/10.152. 39 pp. Range: throughout the flathead catfish range.

FLATHEAD CATFISH (riverine, cover) Expert Review 12-13-1988

Lee, L. A., and J. W. Terrell. 1987. Habitat Suitability Index Models: Flathead Catfish. U. S. Fish and Wildlife Service Biological Report 82/10.152. 39 pp. Riverine adult cover model. Applies to riverine habitat where food is not limiting, stream width is greater than or equal to 9.3 m stream gradient is low, and the temperature fluctuations do not reduce embryo survival. Range: throughout the flathead catfish range.

ESOX SPECIES (regression) Expert Review 4-6-1987

Aggus, L. R., and W. M. Biven. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Range: coolwater reservoirs throughout the conterminous 48 States.

NORTHERN PIKE (regression) Expert Review 10-01-1985

Aggus, L. R., and W. M. Biven. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Applies to coolwater reservoirs. Range: throughout the United States.

NORTHERN PIKE (riverine) Expert Review 4-12-1987

Inskip, P. D. 1982. Habitat Suitability Index Models: Northern Pike. U. S. Fish and Wildlife Service Biological Report 82/10.17. 40 pp. Applies to permanent streams and rivers with base flows > 50 % of average annual daily flow, and having pools and backwaters with mean depth of at least 0.5 m. Sewage is assumed to not be Aoverabundant@, and there is assumed to be no significant heating (e.g., thermal effluent) or concentrations of toxic materials. At least one species of prey fish is assumed to be present. Range: throughout North America.

MUSKELLUNGE Expert Review 12-13-1988

Cook, M. F., and R. C. Solomon. 1987. Habitat Suitability Index Models: Muskellunge. U. S. Fish and Wildlife Service Biological Report 82/10.148. 33 pp. Range: the 48 contiguous United States and Canada.

MUSKELLUNGE (regression) Expert Review 12-30-1985

Aggus, L. R., and W. M. Biven. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Applies to coolwater reservoirs. Range: throughout the United States.

TROUT, ALL (coldwater, regression) Expert Review 4-7-1987

Aggus, L. R., and W. M. Biven. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Applies to coldwater reservoirs. Range: throughout the United States.

TROUT, ALL (2-story, regression) Expert Review 10-1-1985

Aggus, L. R., and W. M. Biven. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Applies to coldwater reservoirs that are two-storied. Range: throughout the United States.

CUTTHROAT TROUT (regression) Expert Review 4-6-1987

Aggus, L. R., and W. M. Bivin. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Range: coldwater reservoirs throughout the conterminous 48 States.

CUTTHROAT TROUT (river, cold, expt. Lahontan Basin) Expert Review 4-6-1987

Hickman, T., and R. F. Raleigh. 1982. Habitat Suitability Index Models: Cutthroat Trout. U. S. Fish and Wildlife Service Biological Report 82/10.5. 38 pp. Applies to cold and unproductive streams < 50 m wide. Range: throughout the range of the species except the Lahontan Basin.

PINK SALMON Expert Review 4-12-1987

Raleigh, R. F., and P. C. Nelson. 1985. Habitat Suitability Index Models and Instream Flow Suitability Curves: Pink Salmon. U. S. Fish and Wildlife Service Biological Report 82/10.109. 36 pp. Model uses simple limiting factor assumption. Applies to fresh and brackish waters. Range: entire freshwater range of the species (but application says it also applies to brackish water - no resolution available).

CHUM SALMON Expert Review 4-3-1987

Hale, S. S., T. E. McMahon, and P. C. Nelson. 1985. Habitat Suitability Index Models and Instream Suitability Curves: Chum Salmon. U. S. Fish and Wildlife Service Biological Report 82/10.108. 48 pp. Range: throughout the species= range.

COHO SALMON Expert Review 10-5-1987

McMahon, T. E. 1983. Habitat Suitability Index Models: Coho Salmon. U. S. Fish and Wildlife Service Biological Report 82/10.49. 29 pp. Range: throughout the species= native and introduced range.

COHO SALMON (regression) Expert Review 4-3-1987

Aggus, L. R., and W. M. Biven. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Range: coldwater reservoirs throughout the United States.

RAINBOW TROUT (coldwater, regression) Expert Review 4-7-1987

Aggus, L. R., and W. M. Biven. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Applies to coldwater reservoirs. Range: throughout the United States.

RAINBOW TROUT (lacustrine) Expert Review 4-24-1987

Raleigh, R. F., T. Hickman, R. C. Solomon, and P. C. Nelson. 1984. Habitat Suitability Information: Rainbow Trout. U. S. Fish and Wildlife Service Biological Report 82/10.60. 64 pp. Applies to lakes with suitable tributaries for spawning. Assumes only one area for embryos (see publication for how to deal with more). Range: throughout the species= range in North America.

RAINBOW TROUT (reservoir, low effort, bld??) Quantitative Analysis 4-24-1987

McConnell, W. J., E. P. Bergerson, and K. L. Williamson. 1984. Habitat Suitability Index Models: A Low Effort System for Planned Coolwater and Coldwater Reservoirs (Revised). U. S. Fish and Wildlife Service Biological Report 82/10.3A. 62 pp. Applies where nonliving cover comes only from boulders, standing timber, or talus fields. Applies to planned reservoirs that: 1. have an inflow total dissolved solids < 3000 mg/l (weighted mean). 2. have inflow with an ion mixture dominated by K+, Na+, Ca++, Mg++, HCO3-, CO3B, Cl-, and SO4B, in which HCO3- plus CO3B is no more that 300 mg/l and pH is less than 8.5. 3. have a surface area greater than 3 km^2. 4. do not have a grossly polluted river being impounded (as indicated by fish kills, low species diversity, and official quality or use classification). 5. are seldom to be drawn down to a volume of < 1/4 of maximum. 6. are true reservoirs, mot merely a natural lake with a raised level. Range: north of 37 degrees, north latitude.

RAINBOW TROUT (riverine) Expert Review 4-28-1987

Raleigh, R. F., T. Hickman, R. C. Solomon, and P. C. Nelson. 1984. Habitat Suitability Information: Rainbow Trout. U. S. Fish and Wildlife Service Biological Report 82/10.60. 64 pp. Single cover type model entered as muti-cover type to facilitate entry. Uses the equal component value method of calculating HSI. Includes the optional variables, V12 (stable streambank) and V17 (midday shade). Applies to streams <= 50 m mean width for resident populations (not steelhead). Range: throughout the species= range in North America.

RAINBOW TROUT (2-story, regression) Expert Review 10-1-1985

Aggus, L. R., and W. M. Biven. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Applies to coldwater reservoirs. Range: throughout the United States.

KOKANEE SALMON (regression) Expert Review 10-01-1985

Aggus, L. R., and W. M. Bivin. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Applies to coldwater reservoirs. Range: throughout the United States.

CHINOOK SALMON (2, spring) Expert Review 4-27-1987

Raleigh, R. F., W. J. Miller, and P. C. Nelson. 1986. Habitat Suitability Index Models and Instream Flow Suitability Curves: Chinook Salmon. U. S. Fish and Wildlife Service Biological Report 82/10.122. 64 pp. Single cover type model entered as multi-cover type to facilitate entry. This model uses the limiting factor option for calculating HSI. Applies to spring spawning populations with overwintering juveniles. Range: throughout the fresh water range of the species in North America.

BROWN TROUT (riverine) Expert Review 9-1-1988

Raleigh, R. F., L. D. Zuckerman, and P. C. Nelson. 1986. Habitat Suitability Index Models and Instream Flow Curves: Brown Trout, Revised. U. S. Fish and Wildlife Service Biological Report 82/10.124. 65 pp. First printed as U. S. Fish and Wildlife Service Biological Report 82/10.71, 9/84. Single cover type species encoded as multi-cover type to facilitate entry. Range: throughout the species= range in North America.

BROOK TROUT (regression) Expert Review 4-6-1987

Aggus, L. R., and W. M. Biven. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Range: coldwater reservoirs throughout the United States.

BROOK TROUT (river, cold, < 50 m) Expert Review 2-2-1988

Raleigh, R. F. 1982. Habitat Suitability Index Models: Brook Trout. U. S. Fish and Wildlife Service Biological Report 82/10.24. 42 pp. For cold, unproductive streams < 50 m wide. Range: throughout the species= range.

LAKE TROUT (regression) Expert Review 10-01-1985

Aggus, L. R., and W. M. Bivin. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Applies to coldwater reservoirs. Range: throughout the United States.

LAKE TROUT (reproducing, reservoirs) Expert Review 4-6-1987

Marcus, M. D., W. A. Hubert, and S. H. Anderson. 1984. Habitat Suitability Index Models: Lake Trout (Exclusive of the Great Lakes). U. S. Fish and Wildlife Service Biological Report 82/10.84. 12 pp. Applies to oligotrophic reservoirs (mean metric MEI <= 6) with mean depth greater than 6 m and having naturally reproducing populations of lake trout. Range: throughout North America except for the Great Lakes.

LAKE TROUT (reproducing, lakes) Expert Review 9-20-1985

Marcus, M. D., W. A. Hubert, and S. H. Anderson. 1984. Habitat Suitability Index Models: Lake Trout (Exclusive of the Great Lakes). U. S. Fish and Wildlife Service Biological Report 82/10.84. 12 pp. Applies to oligotrophic lakes (mean metric MEI <= 6) with mean depth greater than 6 m and having naturally reproducing populations of lake trout. Range: throughout North America except for the Great Lakes.

LAKE TROUT (stocked lakes) Expert Review 9-20-1985

Marcus, M. D., W. A. Hubert, and S. H. Anderson. 1984. Habitat Suitability Index Models: Lake Trout (Exclusive of the Great Lakes). U. S. Fish and Wildlife Service Biological Report 82/10.84. 12 pp. Applies to oligotrophic lakes and reservoirs (mean metric MEI <= 6) with mean depth greater than 6 m and having stocked populations of lake trout. Range: throughout North America except for the Great Lakes.

ARCTIC GRAYLING (riverine) Expert Review 12-16-1985

Hubert, W. A., R. S. Helzner, L. A. Lee, and P. A. Nelson. 1985. Habitat Suitability Index Models and Instream Flow Suitability Curves: Arctic Grayling Riverine Populations. U. S. Fish and Wildlife Service Biological Report 82/10.110. 34 pp. Range: throughout the species= range: Alaska and northern Canada, Michigan, Montana, Vermont, Colorado, Wyoming. Idaho, Utah, and California.

INLAND SILVERSIDE Expert Review 4-19-1987

Weinstien, M. P. 1986. Habitat Suitability Index Models: Inland Silverside. U. S. Fish and Wildlife Service Biological Report 82/10.120. 25 pp. Applies to all life stages found in tidal creeks and flats, marsh pools, and all shallow subtidal (to 3 m deep at low tide) estuarine habitats, including tidal freshwaters. May not apply where habitats have been severely altered by impounding, toxic materials, cultural eutrophication or thermal discharges. Range: Massachusetts to New Jersey (and may apply throughout the range).

WHITE BASS (lacustrine) Expert Review 4-17-1987

Hamilton, K., and P. C. Nelson. 1984. Habitat Suitability Index Models and Instream Flow Suitability Index Curves: White Bass. U. S. Fish and Wildlife Service Biological Report 82/10.89. 35 pp. Range: throughout the native and introduced range in the conterminous 48 States.

WHITE BASS (riverine) Expert Review 4-17-1987

Hamilton, K., and P. C. Nelson. 1984. Habitat Suitability Index Models and Instream Flow Suitability Index Curves: White Bass. U. S. Fish and Wildlife Service Biological Report 82/10.89. 35 pp. Range: throughout the native and introduced range in the conterminous 48 States.

STRIPED BASS (coastal, estuary-river) Expert Review 4-24-1987

Bain, M. B., and J. L. Bain. 1982. Habitat Suitability Index Models: Coastal Stocks of Striped Bass. U. S. Fish and Wildlife Service Biological Report 82/10.01. 29 pp. Applies to estuarine-associated populations only. Range: Atlantic, Pacific, and Gulf coasts of United States.

STRIPED BASS (lacustrine, adult) Expert Review 12-12-1985

Crance, J. H. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: Inland Stocks

of Striped Bass. U. S. Fish and Wildlife Service Biological Report 82/10.85. 63 pp. Note: Publication revised 1986,, but models unchanged. Applies to habitats no Aoverburdened@ with toxic chemicals, or heated effluents, or rapidly fluctuating conditions of temperature during spawning season. Range: throughout the conterminous 48 States.

STRIPED BASS (lacustrine, juvenile) Expert Review 7-11-1988

Crance, J. H. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: Inland Stocks of Striped Bass. U. S. Fish and Wildlife Service Biological Report 82/10.85. 63 pp. Note: Publication revised 1986,, but models unchanged. Applies to habitats no Aoverburdened@ with toxic chemicals, or heated effluents, or rapidly fluctuating conditions of temperature during spawning season. Range: throughout the conterminous 48 States.

STRIPED BASS (lacustrine, larval) Expert Review 9-18-1985

Crance, J. H. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: Inland Stocks of Striped Bass. U. S. Fish and Wildlife Service Biological Report 82/10.85. 63 pp. Note: Publication revised 1986,, but models unchanged. Applies to habitats no Aoverburdened@ with toxic chemicals, or heated effluents, or rapidly fluctuating conditions of temperature during spawning season. Range: throughout the conterminous 48 States.

REDBREAST SUNFISH (palustrine) Expert Review 7-11-1988

Aho, J. M., C. S. Anderson, and J. W. Terrell. 1986. Habitat Suitability Index Models and Instream Flow Suitability Curves: Redbreast Sunfish. U. S. Fish and Wildlife Service Biological Report 82/10.119. 23 pp. Applies to palustrine habitat throughout the North American range of the redbreast sunfish.

GREEN SUNFISH (lacustrine) Expert Review 3-20-1987

Stuber, R. J., G. Gebhart, and O. E. Maughan. 1982. Habitat Suitability Index Models: Green Sunfish. U. S. Fish and Wildlife Service Biological Report 82/10.15. 28 pp. For artificial bodies of water (e.g., ponds, reservoirs) without salinity problems.

GREEN SUNFISH (riverine) Expert Review 4-6-1987

Stuber, R. J., G. Gebhart, and O. E. Maughan. 1982. Habitat Suitability Index Models: Green Sunfish. U. S. Fish and Wildlife Service Biological Report 82/10.15. 28 pp. Applies where salinity is not a problem. Salinity can be added, see the model publication. Range: throughout the native and introduced range in North America.

WARMOUTH (lacustrine) Expert Review 1-13-1986

McMahon, T. E., G. Gebhart, O. E. Maughan, and P. C. Nelson. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: Warmouth. U. S. Fish and Wildlife Service Biological Report 82/10.67. 21 pp. Range: throughout the native and introduced range.

WARMOUTH (riverine) Expert Review 1-13-1986

McMahon, T. E., G. Gebhart, O. E. Maughan, and P. C. Nelson. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: Warmouth. U. S. Fish and Wildlife Service Biological Report 82/10.67. 21 pp. Range: throughout the native and introduced range.

BLUEGILL (lacustrine) Expert Review 4-3-1987

Stuber, R. J., G. Gebhart, and O. E. Maughan. 1982. Habitat Suitability Index Models: Bluegill. U. S. Fish and Wildlife Service Biological Report 82/10.8. 26 pp. Range: throughout the range in North America.

BLUEGILL (riverine) Expert Review 12-5-1985

Stuber, R. J., G. Gebhart, and O. E. Maughan. 1982. Habitat Suitability Index Models: Bluegill. U. S. Fish and Wildlife Service Biological Report 82/10.8. 26 pp. If salinity is considered to be a problem in the study area, the user is to refer to the published model. Applies where salinity is not a problem. Model can be modified to include salinity as a factor. Range: throughout the species= range in North America.

REDEAR SUNFISH (lacustrine) Expert Review 4-16-1987

Twomey, K. A., G. Gebhart, O. E. Maughan, and P. C. Nelson. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: Redear Sunfish. U. S. Fish and Wildlife Service Biological Report 82/10.79. 29 pp. Range: throughout the native and introduced range in North America.

REDEAR SUNFISH (riverine) Expert Review 4-16-1987

Twomey, K. A., G. Gebhart, O. E. Maughan, and P. C. Nelson. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: Redear Sunfish. U. S. Fish and Wildlife Service Biological Report 82/10.79. 29 pp. Range: throughout the native and introduced range in North America.

SMALLMOUTH BASS (lacustrine) Expert Review 12-4-1985

Edwards, E. A., G. Gebhart, and O. E. Maughan. 1983. Habitat Suitability Information: Smallmouth Bass. U. S. Fish and Wildlife Service Biological Report 82/10.36. 47 pp. Range: throughout the native and introduced range in North America.

SMALLMOUTH BASS (reservoir, low effort, bld??) Quantitative Analysis 4-24-1987

McConnell, W. J., E. P. Bergerson, and K. L. Williamson. 1984. Habitat Suitability Index Models: A Low Effort System for Planned Coolwater and Coldwater Reservoirs (Revised). U. S. Fish and Wildlife Service Biological Report 82/10.3A. 62 pp. Applies where nonliving cover comes only from boulders, standing timber or talus fields. Applies to planned reservoirs that: 1. have an inflow total dissolved solids < 3000 mg/l (weighted mean). 2. have inflow with an ion mixture dominated by K+, Na+, Ca++, Mg++, HCO3-, CO3B, Cl-, and SO4B, in which HCO3- plus CO3B is no more that 300 mg/l and pH is less than 8.5. 3. have a surface area greater than 3 km^2. 4. do not have a grossly polluted river being impounded (as indicated by fish kills, low species diversity, and official quality or use classification). 5. are seldom to be drawn down to a volume of < 1/4 of maximum. 6. are true reservoirs, mot merely a natural lake with a raised level. Range: north of 37 degrees, north latitude.

SMALLMOUTH BASS (riverine) Expert Review 12-4-1985

Edwards, E. A., G. Gebhart, and O. E. Maughan. 1983. Habitat Suitability Information: Smallmouth Bass. U. S. Fish and Wildlife Service Biological Report 82/10.36. 47 pp. Range: throughout the native and introduced range in North America.

SPOTTED BASS (lacustrine) Expert Review 1-12-1986

McMahon, T. E., G. Gebhart, O. E. Maughan, and P. C. Nelson. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: Spotted Bass. U. S. Fish and Wildlife Service Biological Report 82/10.72. 41 pp. Range: throughout the native and introduced range.

SPOTTED BASS (riverine) Expert Review 1-14-1986

McMahon, T. E., G. Gebhart, O. E. Maughan, and P. C. Nelson. 1984. Habitat Suitability Index Models and Instream Flow Suitability Curves: Spotted Bass. U. S. Fish and Wildlife Service Biological Report 82/10.72. 41 pp. Range: throughout the native and introduced range.

LARGEMOUTH BASS (lacustrine, southern) Expert Review 2-23-1988

Stuber, R. J., G. Gebhart, and O. E. Maughan. 1982. Habitat Suitability Index Models: Largemouth Bass. U. S. Fish and Wildlife Service Biological Report 82/10.16. 33 pp. Range: southern latitudes throughout the conterminous 48 States.

WHITE CRAPPIE (riverine) Expert Review 12-6-1985

Edwards, E. A., D. A. Krieger, G. Gebhart, and O. E. Maughan. 1982. Habitat Suitability Index Models: White Crappie. U. S. Fish and Wildlife Service Biological Report 82/10.7. 22 pp. Applies where salinity is not a problem. Salinity can be added as a factor, see publication. Range: throughout the native and introduced range in North America.

BLACK CRAPPIE (lacustrine) Expert Review 4-2-1987

Edwards, E. A., D. A. Krieger, M. Bacteller, and O. E. Maughan. 1982. Habitat Suitability Index Models: Black Crappie. U. S. Fish and Wildlife Service Biological Report 82/10.6. 25 pp. Range: throughout the native and introduced range in North America.

BLACK CRAPPIE (reservoir, low effort, bld?) Quantitative Analysis 4-24-1987

McConnell, W. J., E. P. Bergerson, and K. L. Williamson. 1984. Habitat Suitability Index Models: A Low Effort System for Planned Coolwater and Coldwater Reservoirs (Revised). U. S. Fish and Wildlife Service Biological Report 82/10.3A. 62 pp. Applies where nonliving cover comes only from boulders, standing timber or talus fields. Applies to planned reservoirs that: 1. have an inflow total dissolved solids less than 3000 mg/l (weighted mean). 2. have inflow with an ion mixture dominated by K+, Na+, Ca++, Mg++, HCO3-, CO3B, Cl-, and SO4B, in which HCO3- plus CO3B is no more than 300 mg/l and pH is less than 8.5. 3. have a surface area greater that 3 km^2. 4. do not have a grossly polluted river being impounded (as indicated by fish kills, low species diversity, and official quality or use classification). 5. are seldom to be drawn down to a volume of less than 1/4 of maximum. 6. are true reservoirs, not merely a natural lake with a raised level. Range: North of 37 degrees, north latitude.

SLOUGH DARTER (lacustrine) Expert Review 4-16-1987

Edwards, E. A., M. Bacteller, and O. E. Maughan. 1982. Habitat Suitability Index Models: Slough Darter. U. S. Fish and Wildlife Service Biological Report 82/10.9. 13 pp. Range: throughout the native range in North America.

SLOUGH DARTER (riverine) Expert Review 4-16-1987

Edwards, E. A., M. Bacteller, and O. E. Maughan. 1982. Habitat Suitability Index Models: Slough Darter. U. S. Fish and Wildlife Service Biological Report 82/10.9. 13 pp. Range: throughout the native range in North America.

YELLOW PERCH (lacustrine) Expert Review 4-17-1987

Krieger, D. A., J. W. Terrell, and P. C. Nelson. 1983. Habitat Suitability Index Models: Yellow Perch. U. S. Fish and Wildlife Service Biological Report 82/10.55. 37 pp. Range: throughout the conterminous 48 States.

YELLOW PERCH (regression) Expert Review 10-1-1985

Aggus, L. R., and W. M. Biven. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Applies to cool and coldwater reservoirs. Range: throughout the United States.

YELLOW PERCH (riverine) Expert Review 12-10-1985

Krieger, D. A., J. W. Terrell, and P. C. Nelson. 1983. Habitat Suitability Index Models: Yellow Perch. U. S. Fish and Wildlife Service Biological Report 82/10.55. 37 pp. Range: throughout the conterminous 48 States.

WALLEYE (lacustrine) Expert Review 1-12-1986

McMahon, T. E., J. W. Terrell, and P. C. Nelson. 1984. Habitat Suitability Information: Walleye. U. S. Fish and Wildlife Service Biological Report 82/10.56. 43 pp. Range: throughout the native and introduced range in North America.

WALLEYE (regression) Expert Review 4-27-1987

Aggus, L. R., and W. M. Biven. 1982. Habitat Suitability Index Models: Regression Models Based on Harvest of Coolwater and Coldwater Fishes in Reservoirs. U. S. Fish and Wildlife Service Biological Report 82/10.25. 38 pp. Applies to coolwater reservoirs. Range: throughout the United States.

WALLEYE (riverine) Expert Review 11-18-1988

McMahon, T. E., J. W. Terrell, and P. C. Nelson. 1984. Habitat Suitability Information: Walleye. U. S. Fish and Wildlife Service Biological Report 82/10.56. 43 pp. Range: throughout the native and introduced range in North America.

SPOTTED SEATROUT Expert Review 9-24-1985

Kostecki, P. T. 1984. Habitat Suitability Index Models: Spotted Seatrout. U. S. Fish and Wildlife Service Biological Report 82/10.75. 22 pp. Range: estuaries along the Atlantic and Gulf of Mexico coasts of the United States.

SPOT (juvenile) Expert Review 4-6-1987

Stickney, R. R., and M. L. Cuenco. 1982. Habitat Suitability Index Models: Juvenile Spot. U. S. Fish and Wildlife Service Biological Report 82/10.20. 12 pp. Applies to winter to fall. Range: estuaries throughout Amost@ of its range: coastal waters from Galveston Bay (Texas) to Long Island Sound (New York).

SOUTHERN KINGFISH (estuarine) Expert Review 9-23-1985

Sikora, W. B., and J. P. Sikora. 1982. Habitat Suitability Index Models: Southern Kingfish. U. S. Fish and Wildlife Service Biological Report 82/10.31. 22 pp. Applies to areas without kepone and toxaphene contamination. Range: throughout the species= range along the continental United States.

SOUTHERN KINGFISH (marine) Expert Review 9-23-1985

Sikora, W. B., and J. P. Sikora. 1982. Habitat Suitability Index Models: Southern Kingfish. U. S. Fish and Wildlife Service Biological Report 82/10.31. 22 pp. Applies to areas not contaminated by kepone or toxaphene. Range: throughout the species= range along the continental United States.

ATLANTIC CROAKER (juv., brackish, Louisiana) Expert Review 4-7-1987

Diaz, R. J., and C. P. Onuf. 1985. Habitat Suitability Index Models: Juvenile Atlantic Croaker (Revised). U. S. Fish and Wildlife Service Biological Report 82/10.98. 23 pp. Applies during spring and summer in areas not seriously contaminated and without Abroad brackish and fresh wetland zone.@ Applies to habitat for juveniles. Range: Southeast Atlantic and Gulf of Mexico coasts, not including coastal Louisiana. First printed July 1982 as U. S. Fish and Wildlife Service Biological Report 82/10.21; revised June 1985.

RED DRUM (non-vegetated substrate) Expert Review 12-12-1985

Buckley, J. 1984. Habitat Suitability Index Models: Larval and Juvenile Red Drum. U. S. Fish and

Wildlife Service Biological Report 82/10.74. 15 pp. Applies to estuaries that cannot support bottom vegetation because of natural factors, for larva and juvenile life stages. Range: throughout the species= range, but apply with caution to Atlantic Coast.

RED DRUM (vegetated substrate) Expert Review 12-12-1985

Buckley, J. 1984. Habitat Suitability Index Models: Larval and Juvenile Red Drum. U. S. Fish and Wildlife Service Biological Report 82/10.74. 15 pp. Applies to vegetated substrates for larva and juvenile life stages. Range: throughout the species= range, but apply with caution to Atlantic Coast.

GULF FLOUNDER Expert Review 4-6-1987

Enge, K. M., and R. Mulholland. 1985. Habitat Suitability Index Models: Southern and Gulf Flounders. U. S. Fish and Wildlife Service Biological Report 82/10.92. 25 pp. Applies to juveniles year-round, and adults from May to August. Range: Gulf of Mexico, from Florida to Texas.

SOUTHERN FLOUNDER Expert Review 9-26-1985

Enge, K. M., and R. Mulholland. 1985. Habitat Suitability Index Models: Southern and Gulf Flounders. U. S. Fish and Wildlife Service Biological Report 82/10.92. 25 pp. Applies to juveniles year-round, and adults from May to August. Range: Gulf of Mexico, from Florida to Texas.

JUVENILE ENGLISH SOLE (impacted) Expert Review 12-13-1988

Toole, C. L., R. A. Barnhart, and C. P. Onuf. 1987. Habitat Suitability Index Models: Juvenile English Sole. U. S. Fish and Wildlife Service Biological Report 82/10.133. 27 pp. This model includes an alternative suitability function for the hydrodynamic regime - with impacted tidal exchange. Range: Estuaries and coastal lagoons year-round, primarily the Pacific coast from central California to northern Washington.

JUVENILE ENGLISH SOLE (non-impacted) Expert Review 12-13-1988

Toole, C. L., R. A. Barnhart, and C. P. Onuf. 1987. Habitat Suitability Index Models: Juvenile English Sole. U. S. Fish and Wildlife Service Biological Report 82/10.133. 27 pp. In this model, the hydrodynamic regime (V1) suitability function is defined by energy class. Range: Estuaries and coastal lagoons year-round, primarily the Pacific coast from central California to northern Washington.

APPENDIX B. SPECIES ACCOUNTS:
LIFE HISTORIES OF SPECIAL STATUS SPECIES

B.1 Yuma myotis (*Myotis yumanensis*)

Listed by the USFWS as a "Federal Species of Concern" and a BLM "Sensitive Species".

The Yuma myotis is described as having short rounded ears with a pointed tragus, and lacking a keeled calcar. The body is light buff to dark brown with lighter underparts. The fur is darker at the base and dull-looking. The braincase rises sharply from the rostrum, giving it a steep sloped appearance. Typical body measurements are a total length of 73-91 mm, a foot length of 9-11 mm (Ingles, 1965), a forearm length of 32-38 mm, an ear length of 11-14.5 mm, and greatest length of skull of 13-14.2 mm.

The Yuma myotis is very similar in appearance to, and can be very difficult to distinguish from, the little brown bat. The two species may hybridize where their ranges overlap in the mid- to northwestern, northeastern, and eastern parts of California (Cockrum, 1973; Harris, 1974). The Yuma myotis usually has dull-tipped fur and a sharp slope to the forehead, compared to the shiny-tipped fur and more gradually sloping forehead of the little brown bat. However, some subspecies of *M. yumanensis* may have shiny fur. The Yuma myotis is generally larger in size than the little brown bat, but overlap does occur in measurements and slope of forehead.

The Yuma myotis occurs along the western quarter of North America, from Canada south to Mexico, eastward to Idaho and Texas, including parts of Montana, Utah, and Colorado, and excluding most of Nevada and areas northeastward. The species is comprised of six subspecies, with four of those subspecies (*M.y. saturatus, M.y. oxalis, M.y. sociabilis, M.y. yumanensis*) occurring in California (Hall, 1981).

This bat is common in California and found throughout the state except in the Mojave and Colorado deserts of southeastern California. It occupies a variety of habitats below 11,000 ft (3,300 m), but is rare above 8,000 ft (2,560 m). The Yuma myotis is found in open forests and woodlands and is almost always associated with water.

It emerges one to two and one half hours after sunset to forage on a variety of flying and aquatic insects. Throughout the night this species will use night roosts located in buildings, mines, caves, or crevices. Such roosts may also be used as day, hibernation, and maternity roosts (Zeiner et al., 1990). Elevational migrations may occur in some parts of its range to preferred hibernacula during the winter months. The Yuma myotis has been known to roost with other species such as the pallid and Mexican free-tailed bats.

Like other myotis species, the Yuma myotis breeds in the fall and the females store the sperm until ovulation and fertilization occurs. At this time, the females typically form large maternity colonies in dark, warm, and poorly ventilated roosts such as old buildings, caves, and bridge structures. Between May and July, females give birth to one young per year (Dalquest, 1947). These colonies may contain several thousand females and young.

Reasons for decline of this species include loss of habitat (including suitable roosting sites) and the use of pesticides.

B.2 Long-eared myotis (*Myotis evotis*)

Listed by the USFWS as a "Federal Species of Concern" and a BLM "Sensitive Species".

The long-eared myotis can be distinguished by its large ears, extending approximately seven millimeters beyond the muzzle when laid forward. Other characteristics include a long, pointed tragus, gradually sloping forehead, black wing membranes and ears, and light to dark brown fur. Typical body measurements are a total length of 75-97 mm, a foot length of 7-10 mm (Ingles, 1965), an ear length of 18-22.4 mm, a forearm length of 35.5-41 mm, and a greatest length of skull of 15-16.4 mm (Hall, 1981).

This myotis is distributed from British Columbia, south to Baja California, east to North Dakota, then southward through South Dakota, Nebraska, and New Mexico, excluding the southern deserts of Arizona and California. Two subspecies exist in North America (*M. e. evotis, M. e. pacificus*), and both are found in California (Hall, 1981).

In California, this species can be found throughout the state, with the exception of the hot Central Valley and deserts of southern and southeastern California. This bat can be found in brush, woodland, and forest habitats up to 9,000 ft (2,700 m), possibly preferring coniferous woodlands and forests (Zeiner et al., 1990).

The diet consists of many different arthropods, with a preference for beetles, unlike other myotis species (Husar, 1976). The long-eared myotis tends to feed over water, among trees and shrubs within 40 ft (12 m) of the ground, and catches its prey in flight, on the ground, or gleaning from foliage. This bat is capable of hovering, allowing it to feed on the edges of habitat or over water. Compared to other species, it tends to emerge later in the evenings to forage.

The long-eared myotis can be found using rock outcrops, crevices, mines, caves, loose bark on trees and snags, and buildings as diurnal roosts. Night roosts can be found in caves, mines, and structures such as bridges (Brown and Pierson, 1996). This myotis typically roosts as solitary individuals or small clusters. Maternity colonies may include 12 to 30 individuals. Mating likely occurs in the fall with one young born, typically, in May to June. The young are able to fly by early August. The winter habits of the long-eared myotis are poorly known, but they may make short movements to hibernating sites.

The destruction of suitable roosting sites and maternity colonies is probably the main reason for decline. Pesticide use, eradication from buildings, and destruction of foraging habitat could also play a critical role.

B.3 Fringed myotis (*Myotis thysanodes*)

Listed by the USFWS as a "Federal Species of Concern", a BLM "Sensitive Species", and a WBWG "High Priority".

The fringed myotis is characterized by light to dark brown fur, a well-developed sagittal crest, large ears that extend 3-5 mm beyond the muzzle when laid forward, and a conspicuous fringe of hair along the border of the interfemoral membrane. Typical body measurements are a total length of 80-95 mm, a foot length of 8-11 mm (Ingles, 1965), an ear length of 16-19 mm, a forearm length of 39.8-46.0 mm, and greatest length of skull of 16.2-17.2 mm (Hall, 1981).

The fringed myotis is distributed from British Columbia south to southern Mexico and in the United States from the west coast to southwest Montana, down through Idaho, Utah, the southwest quarter of Colorado, New Mexico, and western Texas. Three subspecies are recognized, with only one *(M. t. thysanodes)* found in California (Hall, 1981).

This bat is found throughout California below 9,350 ft (2,850 m), excluding the Central Valley and southern deserts. It appears to be common locally in many habitats including pinyon-juniper, valley foothill hardwood and hardwood conifer forest from 4,000 to 7,000 ft (1,300 to 2,200 m) (Zeiner et al., 1990). In other parts of its range, it has been documented in desert scrub and grasslands at intermediate elevations (Davis and Schmidley, 1947).

The diet consists of a variety of insects, primarily beetles (Black, 1974). Prey may be captured on the ground or gleaned from the foliage. This bat is also capable of hovering and forages in open areas around streams, lakes, and ponds. Activity begins soon after sunset with peaks usually one to two hours and sometimes four to five hours afterward. This species is fairly tolerant of cold, but hibernation may occur from October to March. Short migratory movements to hibernating sites may occur.

The fringed myotis may roost in caves, buildings, and crevices with adults and sub-adults forming segregated groups. Breeding occurs in the fall and the female stores the sperm through the winter months until ovulation. Fertilization and implantation occur in the spring. Large maternity colonies of up to 200 individuals form from late April to September. During this time a single pup is born from May to July, typically in late June after a 50-to-60-day gestation period. Young are capable of flight at 16 to 17 days, but remain dependent upon their mothers, who will continue to nurse young through August.

This bat is easily disturbed at roost sites, which may be a cause of decline in the species. The destruction of suitable roosting sites, pesticide use, eradication from buildings, and destruction of foraging habitat could also be critical factors.

B.4 Long-legged myotis (*Myotis volans*)

Listed by the USFWS as a "Federal Species of Concern", a BLM "Sensitive Species", and a WBWG "High Priority".

The long-legged myotis is described as having cinnamon red to dark brown fur above and lighter brown to buff fur below. Hair extends from the body outward to the elbow on the wing membrane and down to the knee on the interfemoral membrane. The forehead is abruptly sloped with a low sagittal crest, and the ears are rounded and small, not reaching the muzzle. This bat also has small feet and a keeled calcar. Typical body measurements are a total length of 87-103 mm, a tail length of 37- 49 mm, a tibia length of 16.5-19 mm (Ingles, 1965), an ear length of 11- mm, a forearm length of 35.2-41.2 mm, and a greatest length of skull of 12.2-15 mm (Hall, 1981).

Distribution of this species is from North Dakota, south through Texas, and west to the Pacific Coast of the United States, central Mexico, Baja California, and central to northwestern Canada. There are four subspecies described by Hall (1981), with two (*M. v. interior* and *M. v. longicrus*) occurring in California.

This is a common bat found in all the mountain ranges above 4,000 ft (1,200 m) and is excluded only from California's Central Valley, the Colorado and Mojave deserts, and eastern Lassen and Modoc counties. The long-legged bat can be found in woodland, forest, chaparral, shrub, and coastal scrub habitats, and is uncommon in arid grassland and desert habitats.

Feeding typically occurs during the first three to four hours after sunset, when it forages near trees and cliffs, over water, and in wooded openings, 10 to 15 ft (3 to 5 m) above the ground. The diet consists primarily of moths and other flying insects (Black, 1974; Whitaker et al., 1977, 1981). Emergence for the evening forage is typically later than other myotis species but still occurs near dusk. Information on winter habits is lacking, but this bat probably makes short migrations to hibernating sites.

Suitable day roosts include tree hollows, cavities, and loose bark on large snags and trees. Suitable evening roosts and hibernacula include caves and mines. Nursery colonies may consist of several hundreds of bats under the bark of trees or in hollow cavities, and occasionally in crevices of rocks or buildings.

Breeding occurs in the fall, but the sperm is stored in the reproductive tract of the females until March through May. At that time, ovulation and then fertilization occur. Females give birth to young from late June to July (Siders, 1996). Lactating females can be found from July to August, and young may reach flight capabilities in July.

This bat is easily disturbed at roost sites, which may be a cause of decline in the species. The destruction of suitable roosting sites, pesticide use, eradication and exclusion from buildings, and destruction of foraging habitat could also play a critical role.

B.5 Western small-footed myotis (*Myotis ciliolabrum*)

Listed by the USFWS as a "Federal Species of Concern" and a BLM "Sensitive Species".

The western small-footed myotis is described as having buff to golden brown fur above, usually with glossy tips and buff to white below. The face and ears are black, giving the appearance of a mask. When the ear is laid forward, it barely extends beyond the muzzle. The calcar is long and keeled and the forehead is gradually sloped between the rostrum and braincase. The small-footed myotis closely resembles the California myotis, which has a steep slope to the forehead, and ears that extend beyond the muzzle when laid forward (Hall, 1981). In addition, the tail of the small-footed myotis extends approximately four millimeters beyond the edge of the uropatagium, whereas the tail of the California myotis does not (Constantine, 1998). Typical body measurements are a total length of 75-88 mm, a foot length of 7- 9 mm (Ingles, 1965), an ear length of 12.2-15 mm, a forearm length of 29.6-36 mm, and a greatest length of skull of 13.1-14.7 mm (Hall, 1981).

The western small-footed myotis is found from southwestern Canada, south to Mexico, and distributed all over the United States except along the north Pacific Coast, the southeastern states, and the central portion of the United States. Four subspecies of *M. ciliolabrum* occur in the United States, with only one species (*M. c. melanorhinus*) occurring in California (Hall, 1981).

This species is a common bat of arid uplands in the Upper Sonoran and Transition life zones of California. It occurs along the southern half of the California coast and the west and east slopes of the Sierra Nevada below 8,900 ft (2,700 m). It seems to prefer open stands in forests, woodlands and brushy habitats.

The western small-footed myotis feeds on a variety of small flying insects including moths, flies, and beetles, while flying over water and among trees. It requires more water than most other bats and can be found drinking shortly after emergence from the roost.

The western small-footed bat can be found roosting in caves, buildings, crevices, and sometimes under tree bark or bridges, preferring more humid areas. It emerges shortly after sunset with activity peaks approximately 30 minutes and two to three hours after sunset. This bat may make small movements to hibernacula to hibernate from November to March, but has a very high tolerance of cold temperatures (Cockrum and Cross, 1964; Jones, 1965).

Like other myotis species, this bat mates in the fall and the female stores the sperm until spring when she ovulates (Siders, 1996). In the spring, females may form small maternity colonies with up to 20 individuals and bear either a single young or twins from May through June. Young are usually able to fly by mid August (Tuttle and Heaney, 1974).

Reasons for decline of this species include loss of habitat, loss of suitable roosting sites (including destruction and disturbance), and pesticide use.

B.6 Western red bat (*Lasiurus blossevillii*)

Listed by the USFS as a "Sensitive Species" and a WBWG "High Priority".

The western red bat is a medium sized bat with short, rounded ears, and a densely furred body. The western red bat's coloration ranges from bright orange to yellow-brown fur and black wing membranes. Unlike the eastern red bat (*L. borealis*), the western red bat does not have white tips on its dorsal fur (Davis and Schmidley, 1947). The western red bat is slightly smaller than the eastern red bat, with a forearm length of 35-45 mm. Both the western and eastern red bat have a densely furred posterior uropatagium, while the anterior side of the membrane is only sparsely furred.

The western red bat can be found throughout lower elevations in western Canada, the western United States, western Mexico, and in Central America (Best et al., 1999). In California, the western red bat can be found throughout the state in lower elevations, with the exception of desert regions. Although the western red bat migrates, in California it travels only short distances, making it a year-round resident.

As the western red bat roosts in trees, it can mostly be found in wooded and riparian areas. These wooded areas can be made up of almost any type of California lowland forest or woodland, including orchards (Constantine, 1959), up to low elevation coniferous forests in the Sierra Nevada. Foraging habitat of the western red bat includes grasslands, shrub lands, open wooded areas, agricultural lands, and even street lamps usually within about 3,020 ft (920 m) of their roost (Snow, 2000). Foraging red bats target moths, crickets, beetles, and cicadas, although size appears to be the most discriminating factor in prey selection. Most foraging occurs high over the tree canopy one to two hours after sunset.

As mentioned previously, the red bat roosts primarily in trees and sometimes in shrubs 2 to 43 ft (0.6 to 13 m) above ground. These types of vegetation provide not only cover, but also camouflage. Snow (2000) writes of an account where a red bat looked so much like a dead leaf that a person actually picked the bat off of a peach tree. Trees are used for both summer roosts and hibernacula. Red bats have also been documented hibernating in duff.

Mating occurs from August to October. Like other bat species, the sperm is stored until early spring when ovulation and fertilization occur. Following fertilization, the gestation period lasts approximately 65 days, after which the female red bat gives birth to one to five young. Usually a female will give birth to only two or three young. The young begin to fly at four to six weeks and nurse until three to six weeks (Zeiner et al., 1990). The red bat does not form maternal colonies but instead will form family groups made up of a female and her offspring.

The western red bat is rare throughout the state. The most common cause of the species' rarity is conversion of riparian roosting communities into agricultural fields. Other causes of decline include agricultural spraying, fire, and predation. Predators of the red bat include owls, hawks, opossums, cats and jays.

B.7 Spotted bat (*Euderma maculatum*)

Listed by the USFWS as a "Federal Species of Concern", a DFG "California Species of Special Concern", a BLM "Sensitive Species", and a WBWG "High Priority".

The spotted bat is described as having extremely large ears, a dark body, and three white patches, or spots, (one on the rump and one on each shoulder) on its back. The abdominal hairs are black with white ends. A bare patch of skin is found on its throat. The ears, wing and tail membranes are pinkish-red. The total length of the spotted bat is 107-115 mm, the ear measures 37-47 mm, and the length of the forearm is approximately 48-51 mm (Hall, 1981). This species has the largest ears of all North American bat species.

The spotted bat is considered to be one of North America's rarest mammals (Zeiner et al., 1990). It has been recorded from British Columbia to Mexico, including the western United States. In California it was traditionally thought to be found primarily in the southeastern Sierra foothills, mountains, and desert regions, with only occasional occurrences outside this range. Recent studies over the past ten years have documented significant occurrences of this species well outside of its historical range. These range expansions have documented the distribution of this species to include Ventura, Riverside, Mariposa, Kern, San Bernardino, San Diego, Fresno, Inyo, Shasta, Tehama, Tuolumne, Mono, and Tulare counties (Pierson and Rainey, 1998). This bat may also be a year-long resident with recorded occurrences in Mecca, Red Rock Canyon, Nevada; Yosemite Valley, California; and Reno, Nevada (Hall, 1981).

Horizontal rock crevices provide optimal roost sites (Watkins, 1977), although the spotted bat may occasionally use caves and buildings as well. The spotted bat may migrate from high elevations to lowlands in fall. In many accounts, sightings are associated in or around water. This finding has led some to believe that the spotted bat may inhabit riparian areas (Siders, 1996).

This bat is a late flyer compared to most other bats and is not frequently caught until after midnight (Watkins, 1977). The spotted bat flies 15 to 45 ft (4.5 to 14 m) above the ground in large elliptical paths [600 to 900 ft (183 to 274 m) long] while foraging (Wai-Ping and Fenton, 1989). It feeds primarily on moths, although there is some evidence that beetles are also part of their diet. Spotted bats have been observed to land on the ground and capture food items (Watkins, 1977).

The spotted bat is apparently a solitary animal. It mates in the fall, with a single pup born before mid-June. Lactating females have been found from June to August.

Due to the rare nature of this animal and minimal information about its range, it has been included as a potentially occurring species. Factors for its decline are unknown.

B.8 Pale big-eared bat (*Corynorhinus townsendii pallescens*)

Listed by the USFWS as a "Federal Species of Concern", a DFG "California Species of Special Concern", a USFS "Sensitive Species", a BLM "Sensitive Species", and a WBWG "High Priority".

Like other big-eared bats, the pale big-eared bat can be identified by its very large, forward facing ears, pointed tragus, horseshoe shaped nose, and the lack of a keel on its calcar. The pale big-eared bat has a brown to cinnamon back, with the hair bases being light cinnamon to brown. The belly fur hair bases are fawn to brown with tips that are "light pinkish cinnamon" to "pinkish buff". Immature individuals tend to have a grayish tinge to their coats. *C. t. pallescens* is the palest and most yellow of the *C. townsendii* subspecies (Handley, 1959).

In Northern California and the extreme portions of the Northwest, the pale big-eared bat shows a much darker phenotype than in other areas, which makes it virtually indistinguishable from the Townsend's western big-eared bat in this part of its range (Handley, 1959). In other areas where the two subspecies have range overlap, they can be distinguished by the color of their fur. There have been attempts to distinguish these two subspecies genetically, but efforts have been unsuccessful (Pierson and Rainey, 1998).

The size of the pale big-eared bat varies by region and sex. Based upon data collected in central and northern Arizona, general measurement ranges for females are a total length of 93-105 mm, a hind foot length of 9-11 mm, a forearm length of 40.9-43.8 mm, and a wing spread of 302-310 mm. General measurement ranges for males are a total length of 95-101 mm, a hind foot length of 9-11 mm, a forearm length of 43.5-44.6 mm, and a wing spread of 305-311 mm.

The pale big-eared bat occurs over the majority of the western half of the United States, except along the Pacific Coast north of the Channel Islands. In California, it has been documented from Siskiyou to San Diego counties in the Sonoran Transition Zone below 9,600 ft (2,930 m) (Handley, 1959). The habitats most closely associated with this species include coastal forests, oak woodland, low elevation forests of the Sierra Mountains, and semiarid scrubland of the eastern Sierra foothills and desert areas.

Roosting sites are restricted to caves and cave-like structures such as tunnels, mines, and bridges. This species is perhaps the most characteristic of bats that dwell in caves and abandoned mine tunnels (Barbour and Davis, 1969), and shows a high site fidelity if left undisturbed. From October to April it typically hibernates, roosting singly or in small clusters in cool roosts. In California, nursery colonies can be found in mines and sometimes in the attics of buildings from May to June. The males are solitary in the spring, at which time the females form maternity colonies, sometimes consisting of several hundred individuals. Females return to their natal groups every spring. This species does not migrate but may make short elevational movements.

This bat is thought to be a moth specialist, foraging by gleaning insects from shrubs and trees while feeding along habitat edges. Peak activity occurs in the late evening.

Breeding occurs from October to February (some prior to hibernation), with females giving birth from May to June after a gestation period of 56-to-100 days. One young is born per year and can fly by three weeks of age. The young are weaned at six weeks of age.

In the past 40 to 60 years there have been significant declines in the number of maternity colonies, roosts, average colony size, and the total number of big-eared bats (Pierson and Rainey, 1998). Reasons for decline include loss of suitable roosting habitat, which includes destruction and disturbance, and to some degree, pesticides. This bat is extremely sensitive to disturbance at roosting sites and all known nursery colonies in California's limestone caves have been abandoned. Few maternity colonies have been found in buildings.

B.9 Townsend's western big-eared bat (*Corynorhinus townsendii townsendii*)

Listed by the USFWS as a "Federal Species of Concern", a DFG "California Species of Special Concern", a USFS "Sensitive Species", a BLM "Sensitive Species", and a WBWG "High Priority".

Like other big-eared bats, the Townsend's has large, forward facing ears measuring 30-36 mm in length that are joined across the forehead. The tragus is pointed and no keel is present on the calcar. Body measurements vary by sex. Females have a total length of 100-112 mm, a hind foot length of 11-12 mm, and a forearm length of 43.3-44.7 mm. Males have a total length of 96-103 mm, a hind foot length of 10-11 mm, and a forearm length of 41.2-42.5 mm. There are two glandular lumps between the nose and eyes. The adult fur coloring ranges from dark to medium-light brown, with the darkest individuals having very little variation between the bases and the tips of the hairs, and light individuals having considerable variation between the bases and tips of the hairs (Handley, 1959).

This subspecies has the shortest wingspan and darkest fur of the *C. townsendii spp*. When compared to *C. t. pallescens*, the townsendii subspecies is darker, slightly larger, has a heavier rostrum, and has a more robust skull (Handley, 1959).

This bat's range and distribution covers the coastal regions from southwestern Canada along the Pacific Coast to Santa Barbara County in California. The inland boundary appears to be the eastern edge of the coast ranges. The Townsend's big-eared bat is rarely captured in mist nets, making it difficult to assess exact distribution (Barbour and Davis, 1969).

Suitable roosting sites are restricted to caves and cave-like structures such as tunnels, mines, and bridges. This species is perhaps the most characteristic of bats to dwell in caves and abandoned mine tunnels (Barbour and Davis, 1969). In California, nursery colonies can be found in mines and sometimes in the attics of buildings. Hibernation occurs from October to April, when the bat may be found solitary or in small clusters in cool roosts. This species shows a high site fidelity if left undisturbed. The males are solitary during spring, when the females form maternity colonies that may consist of several hundred individuals. Females return to their natal group every spring. This species does not migrate, but does make shorter movements.

This bat is thought to be a moth specialist, foraging by gleaning insects from shrubs and trees while feeding along habitat edges. Peak activity occurs in the late evening.

Breeding occurs from October to February (some prior to hibernation). Young are born from May to June after a gestation period of 56-to-100 days. One young is born per year and can fly by three weeks of age. Young are typically weaned at six weeks of age.

In the last 40 to 60 years there have been dramatic declines in the number of maternity colonies, number of roosts, average colony size, and total number of *C. townsendii spp.* (Pierson and Rainey, 1998). Reasons for decline of this species include loss of suitable roosting habitat, which includes destruction and disturbance, and to some degree, pesticides. This bat is extremely sensitive to disturbance at roosting sites, and all known nursery colonies in California's limestone caves have been abandoned. Few maternity colonies have been found in buildings.

B.10 Pallid bat (*Antrozous pallidus*)

Listed as a DFG "California Species of Special Concern", a USFS "Sensitive Species", a BLM "Sensitive Species", and a WBWG "High Priority".

Pallid bats are large bats with big ears that are not joined together on their head. They also have large eyes and broad wings. The fur on their dorsum is creamy to light brown at the base with brown or gray tips, while the ventral fur is pale creamy to white. The wing membranes are tan (USGS, 1998). The pallid bat has a pig-like muzzle and wart-like bumps on its face. The measurement ranges are a total length of 114-135 mm (Ingles, 1965), an ear length of 23-27 mm, and a forearm length of 48-60.2 mm (Hall, 1981). The tragus is long and lanceolate, longer than one half of the length of the pinna. The females are generally heavier than the males.

The pallid bat occurs throughout California, except in the high Sierra Nevada from Shasta to Kern counties, and the extreme northwest of the state from Del Norte and western Siskiyou counties (Hall, 1981). This bat inhabits a variety of habitats, including grasslands, shrublands, woodlands, and forests, from sea level up through mixed coniferous forests below 8,000 ft (2,440m). It is common in grasslands and desert regions in the southwestern United States, and most abundant in the Sonoran life zones. It tends to be less abundant in evergreen and mixed forests than in vegetation assemblages characteristic of lower elevations (Hermanson and O'Shea, 1983). In California, the pallid bat is associated with oak woodlands at lower elevations, and may roost in a variety of places including tree cavities, rock crevices, and man-made structures.

The diet of the pallid bat consists of a variety of insects, with a preference for Jerusalem crickets, moths, froghoppers, leafhoppers, June beetles, and grasshoppers (Davis and Schmidley, 1947). The pallid bat has also been known to feed on arachnids such as spiders and scorpions. While foraging over open ground for these insects, it generally flies slowly and close to the ground [1.6 to 8.2 ft (0.5 to 2.5 m)]. While most of its prey is captured by gleaning, it is not uncommon for a pallid bat to land on the ground to capture prey items such as the Jerusalem

cricket. Unlike other bat species, very few of the pallid bat's prey are actually taken in the air. In desert regions it has been found that the pallid bat tends to feed on insects visiting cacti and agave flowers. In the process of feeding on these insects, the bat acts as a pollinator for these plant species. There is no evidence that the pallid bat feeds on the nectar of the flowers (Herrera et al., 1993).

The pallid bat is a social animal, sharing roosts with 20-160 individuals. The pallid bat has been known to share roosts with other bat species, such as the Mexican free-tailed bat and many *Myotis* species. The same types of roosts can be used as day and night roosts. Pallid bat estimated travel distance from day to night roosts is 1.86 mi (3 km). However, it may make longer movements to hibernacula and for post-breeding dispersal. The pallid bat prefers roosts where it can be out of sight and wedged into small, tight crevices. Such sites include rock crevices, bridges, caves, mines, and hollow trees. The pallid bat uses these roosts in tight spaces to thermoregulate, especially during cooler weather. However, during warmer weather periods it will roost in open areas such as the sides of rafters and open barns. Barns seem to be preferred roost sites because the bat can choose from many micro-habitats.

Breeding occurs from October to February. The female stores the sperm until early spring with delayed fertilization. Following implantation, the gestation period is 53 to 71 days for one to four embryos. Young number from one to three but typically twins are born from May to June. The young open their eyes at eight to ten days and are capable of flight at six weeks (Davis and Schmidley, 1947). There is evidence, however, that young may continue to nurse even after six weeks. The females will breed in their first autumn while the males not until their second year.

The pallid bat is extremely sensitive to roost disturbance. Disturbance and the loss of roosting habitat are the leading causes of decline in the pallid bat. Natural predators include owls and snakes.

B.11 Greater western mastiff bat (*Eumops perotis*)

Listed as a USFWS "Federal Species of Concern" a DFG "California Species of Special Concern", a BLM "Sensitive Species", and a WBWG "High Priority".

The greater western mastiff bat is the largest bat species in North America and belongs to the Molossid family of free-tailed bats. Two of its distinguishing characteristics are long, narrow wings and large, rounded ears that are joined at the midline across the forehead and project forward, extending beyond the nose. As with all free-tailed bats, the tail extends well beyond the uropatagium, or interfemoral membrane. The typical body measurements are a total length of 157-184 mm (Ingles, 1965), and a forearm length of 73-80 mm (Hall, 1981). The color of the body fur and membranes are dark to brownish gray, but may be slightly paler on the venter.

This species is uncommon but inhabits arid and semiarid lowlands in the lower Sonoran life zone of California, generally below 4,000 ft (1,220 m). The distribution is not completely known and new sightings in northern California are expanding its previously recorded range. Currently in California, the western mastiff bat ranges from San Francisco across to the Sierra

Nevada and south, encompassing the southern half of the state (Hall, 1981).

The mastiff bat is apparently a permanent resident throughout its range in the United States (Barbour and Davis, 1969). It primarily roosts in crevices in vertical cliffs of granite or consolidated sandstone, and in broken terrain with exposed rock faces (Howell, 1920; Dalquest, 1946; Barbour and Davis, 1969). It is also occasionally found in high buildings, trees, and tunnels. Roost sites may change from season to season. Due to its large size, this bat needs vertical faces to drop from in order to take flight. This species has been documented to share roost sites with other species such as the big brown bat, pallid bat, and the Mexican free-tailed bat.

The mastiff bat is a swift flyer with very poor maneuverability. It is active year round, limited only when temperatures drop below 41 degrees Fahrenheit (5 degrees Celsius). Night roosts are uncommon for this species because of its ability to fly for long periods of time, up to six or seven hours a night and for distances of 15 mi (24 km) while foraging at higher elevations. Its preferred diet consists of moths, but includes crickets and grasshoppers (Davis and Schmidley, 1947).

The greater western mastiff bat mates in the months surrounding the early spring. After a gestation period of 80 to 90 days, one young is born between April and September. The birth of twins has been documented, but is uncommon (Davis and Schmidley, 1947). The young are born between April and September. Males and females can be found roosting together throughout the parturition period (Zeiner et al., 1990).

The reasons for the observed decline of this species are not well known, but include the destruction of roost sites in canyons from dam development. Other factors probably include urbanization and human disturbance.

B.12 San Joaquin pocket mouse (*Perognathus inornatus inornatus*)

Listed as a USFWS “Federal Species of Concern” and a BLM “Sensitive Species”.

The San Joaquin pocket mouse is a small buff-orange mouse with a sprinkling of darker guard hairs on its back. It does not contain any spiny hairs as do some of the other species of pocket mice. There is an indistinct lateral line on the sides that separates the lighter belly hairs from the darker, dorsal hairs. The ears are relatively short and may contain a patch of lighter hair at the base. The hind foot has hair on the sole. The tail is relatively long, covered with hair, uniform in color, and has a tuft of hair on the last 3 to 6 mm that may extend beyond the tip. External, fur-lined cheek pouches are used to store grass and forb seeds, which are carried back to or near their dens for eating.

The historical range was widespread throughout the Central and Salinas valleys of California. Dry, open grassland or scrub areas with fine textured soils between 1,100 and 2,000 ft (335 and 610 m) characterize the best habitat types.

The foraging habits of the pocket mouse tend to occur above ground within the cover of a

shrub. Pocket mice do not travel very far to forage and generally stay out of relatively open areas. This mouse may occur on shrubby ridge tops and hillsides (Hawbecker, 1951) but more characteristically inhabits sandy areas with grasses and forbs (Grinnell, 1933). During extreme hot or cold weather, this nocturnal animal may become torpid or inactive (Zeiner et al., 1990).

The diet of the pocket mouse consists of seeds of grasses, forbs, and shrubs (such as *Atriplex*) which are its main food source. Soft-bodied insects such as cutworms and grasshoppers are also eaten, but are not stored in their external cheek pouches. The pocket mouse lives in arid habitats, so all water needs are metabolized through seed digestion.

Breeding season is from March to July, and females have at least two litters of four to six young per litter. It is believed that young will remain in the birthing den until mature. However, the length of time to maturity is uncertain.

Predators include badgers, owls, weasels, skunks, foxes, and feral cats. Loss of native grasslands is the major cause of decline for this species.

B.13 Ringtail (*Bassariscus astutus*)

Listed by the DFG as a "Fully Protected Species".

The ringtail is a slender procyonid with a tail that is often as long as the body. Body length ranges between 12-16 in (30-40 cm) and the tail length ranges between 12-17 in (30-43 cm). The general color is tan with black-tipped guard hairs dorsally, and yellowish white below (Kaufmann, 1982). The tail is white with seven or eight black bands and a black tip. The ringtail is not much larger than a gray squirrel and weighs about 2-2.5 lbs (0.9-1.1 kg). The raccoon is distinguished from the ringtail by its shorter tail, black mask, and larger size. A track of the ringtail will show five toes but not the semi-retractable claws. The hind feet are unique in that they can rotate 180 degrees when climbing down a tree, enabling it to hold itself on the side of a tree while it is pointed toward the ground.

This nocturnal animal is primarily carnivorous, feeding mostly on rodents and rabbits, but will also take substantial amounts of birds and eggs, reptiles, invertebrates, fruits, nuts, and some carrion (Taylor, 1954; Trapp, 1978). Food items may be obtained on the ground, among rocks, or in trees, but never far from water.

The range of the ringtail is north into southwest Oregon, throughout California with the exception of the agricultural portion of the Central Valley, east to Colorado, and south into Central America. It is found in dense riparian growth, montane evergreen forests, oak woodlands, pinyon juniper, chaparral, and deserts (Kaufmann, 1982). Its territory is usually no farther than one half mile from a permanent water source. Cover for reproduction and resting includes tree hollows, logs, snags, rocks, and abandoned burrows. Densities have been reported to be one individual per 0.3-7.9 mi^2 (0.8-20.5 km^2) (Zeiner et al., 1990).

The ringtail mates in March and April and has a gestation period of 40 to 50 days. One to five young (with an average of three) are born from May to June (Walker et al, 1968). The young weigh 1 oz (28.4 g), have closed eyes, and are covered with white fuzzy hair. The adult

female keeps the male away from the young for about three to four weeks, until the eyes open. The young are weaned at three to five months at which time they then learn to hunt by watching the adults. Juveniles disperse in late fall and early winter.

Predators to the ringtail include bobcats, raccoons, foxes, and large owls, all of which are potential competitors for food (Trapp, 1972). Other competitors include coyotes, rattlesnakes, and gopher snakes.

B.14 Pine marten (*Martes americana*)

Listed as a USFWS "Federal Species of Concern" and a USFS "Sensitive Species"

The pine marten is a small mustelid weighing 1-2.9 lbs (470-1,300 g). The marten has a long, slender body measuring 360-450 mm, with a tail measuring 150-230 mm. This mustelid has sharp, curved claws, large eyes, and catlike ears for nocturnal hunting. The marten also has a gray head with dark brown to black legs and tail. The fur is long and glossy with dorsal hairs that tend to be light brown, and the chest contains a cream-colored patch.

The marten can be found from Alaska east to Newfoundland and Nova Scotia. Southward, this animal can be found through sections of the Rocky Mountains and the Sierra Nevada range of California. The marten can also be found in some sections of Maine, Michigan, Minnesota, New York, and Wisconsin.

In California, the marten is a permanent resident of the Southern Cascade range, Sierra Nevada range, and the Klamath Mountains (Zielinski and Kucera, 1995). In these areas the marten inhabits dense, old growth coniferous forests. This animal prefers areas with a thick understory, large trees, and many large snags. All of these habitat features provide suitable den sites and adequate prey populations.

The marten is mostly carnivorous, feeding mainly on mice and voles. The marten has also been known to eat tree squirrels, chipmunks, shrews, rabbits, pikas, fish, birds, nuts, and fruit (Douglas and Strickland, 1987; Martin, 1994). The marten forages in many areas including on the ground, in trees, snags, around logs, and rocky areas. The marten has also been sighted foraging along the edges of water bodies. The marten can usually be found foraging at dusk and during the night as it is a nocturnal animal, but is also known to be active during the day when prey are abundant.

The marten is mostly a solitary animal, living a partially arboreal life. Home ranges are marked in the trees as well as on the ground. Home ranges are variable, with males occupying larger areas than the females (Hawley and Newby, 1957). Adults and juveniles of either sex are tolerant of one another inside their home ranges.

Breeding occurs from late July to August (Maser et al., 1981). After breeding, the embryos do not begin active gestation until 27 days before they are born in April. A female marten gives birth to one to five kits per year in a maternal den. Maternal dens are lined with dried plant material and normally found in squirrel middens and "cone caches", large snags,

rocks, and large logs (Ruggiero et al., 1998). The kits are weaned at approximately 42 days and reach full size at three and one half months of age. Kits leave their mother and become solitary in the fall. Males will reach sexual maturity at one year and females at two years of age.

The marten is becoming increasingly rare due to loss of habitat to the timber industry. The marten requires old-growth forests for habitat (Buskirk and Powell, 1994). Road access to past lumber sites also creates a problem in that it allows human access to marten ranges. Road closures are essential in maintaining the marten's required geographical isolation. Another reason for this species decline in the past was hunting for pelts. Hunting marten has since been banned in California, but left the species severely depleted. In addition to human impacts, the marten is prey to a variety of species. These animals include bear, mountain lion, bobcat, coyote, eagles, great-horned owl, and fishers.

B.15 Pacific fisher (*Martes pennanti pacificus*)

Listed as a USFWS "Federal Species of Concern", a DFG "California Species of Special Concern", a USFS "Sensitive Species", and a BLM "Sensitive Species".

The Pacific fisher is a small, nocturnal carnivore measuring up to 25 in (63.5 cm) long and weighing from 4.4-11 lbs (2-5 kg). Males are approximately twice the size of females. The Pacific fisher is medium to dark brown in color with a gold sheen to its fur on the head and shoulders. The fisher's tail and legs are black. The color and pattern of a fisher's fur vary among individuals depending on its sex and time of year. The fisher has five toes with retractable claws.

The fisher is found only in North America. The subspecies *M. p. pacificus* can be found from Alaska to California near the Pacific Ocean. In California, the Pacific fisher can be found in the Southern Cascade range, the Sierra Nevada Range, the Klamath Mountains, and some areas in the Northern Coastal range (Zielinski and Kucera, 1995). In these areas, the fisher prefers large stands of mature trees with large snags, with at least 50 percent canopy cover. Coniferous and hardwood forests usually provide these habitat requirements. The fisher also prefers forests with hollow trees, rock crevices, slash piles, and porcupine dens. These habitat features provide suitable denning sites.

The fisher is an agile hunter, able to pursue prey anywhere from small ground burrows to the forest canopy. Primary prey items include snowshoe hares, mice, squirrels, mountain beavers, shrews, and birds (Powell, 1981a, 1981b). In addition to these species, the fisher is the only known species that predates on and actively seeks out, or hunts, porcupines. The fisher has been translocated to act as a porcupine biological control agent in parts of the United States (Hooven, 1971; Powell 1981a, 1981b, 1982).

The fisher typically gives birth to a litter of one to five young between February and May. Breeding occurs within several days of the birth of a litter. The embryo does not begin growth until the following winter. At that time, the gestation period begins and lasts approximately 30 days. The female fisher reaches sexual maturity at one year of age and usually produces its first litter during its second year (Powell, 1982). This cycle means that the female

fisher spends its entire life, after one year of age, in a state of pregnancy or lactation. During breeding, the female stays in its territory while the male covers long distances looking for females. Young leave their mother and disperse to begin a solitary life in late fall.

The main cause of decline of the Pacific fisher is loss of habitat, including old growth stands (Powell and Zielinski, 1994). In addition, the fisher is still hunted in many areas for its pelt.

B.16 American badger (*Taxidea taxus*)

Listed as a DFG "California Species of Special Concern".

The badger is a somewhat large mustelid that has evolved for a semi-fossorial life. It has powerful, short legs with partially webbed toes and claws measuring 1-1.5 in (2.5-3.8 cm) long, which aid in digging. The hind feet have shovel-like claws (Boitani et al., 1990). The body is stout and flat, wider than high. Coloration of its shaggy coat is a silver gray, with a head that is dark with a white stripe that often extends down the back. The snout of the badger is slightly upturned and the eyes are small with nictating membranes (Lindzey, 1982), an adaptation for its fossorial lifestyle. The skin of the badger is loose, particularly across the chest, shoulder, and back. The tail is relatively short, moderately furred, and somewhat yellowish. The legs are black. The weight of adults can range from 12-24 lbs (5.4-10.9 kg), with males weighing more than females, on the average.

The badger was once fairly widespread throughout the open grassland habitats of California. The badger is now an uncommon permanent resident found throughout most of the state, with the exception of the northern North Coast area. It is most abundant in the drier open stages of most shrub, forest, and herbaceous habitats with friable soils. The badger is generally associated with treeless regions, prairies, park lands and cold desert areas (Lindzey, 1982). Cultivated lands have been reported to provide little usable habitat for this species.

The badger is basically a solitary, nocturnal creature, foraging at night and then remaining underground during the daylight hours. The badger digs burrows with 8-12 in (20-30.5 cm) elliptical, wider than tall, entrances, in friable soil types for cover. The burrows generally have a single entrance. The badger frequently reuses old burrows, although it has been known to dig a new den each night, especially in summer (Messick and Hornocker, 1981). Soil excavated during formation of the den is piled at the entrance. Often when a den is occupied in cold weather, the tunnel is partially plugged.

The badger is a highly specialized fossorial carnivore. It feeds primarily on small mammals, especially ground squirrels, pocket gophers, rats, mice, and chipmunks (Messick and Hornocker, 1981). The badger captures its prey by digging out the prey's burrows. The badger captures some of its prey above ground and also forages on birds, eggs, reptiles, invertebrates, and carrion. Diet will shift seasonally and yearly depending upon prey availability, and the badger may bury surplus food.

One to four young are born in an extensive burrow system (Jameson, 1988). Mating

occurs in late summer or early autumn and is followed by delayed implantation. Implantation then occurs in December or January with the young born in March or April (Long, 1973). At birth the young are furred but blind. They become independent by August.

The American badger is somewhat tolerant of human activities. Predator control with the use of indiscriminate trapping and poisoning, along with habitat loss, has caused extensive losses. Additionally, road kills, farming operations, and indiscriminate shootings are also a cause of mortality. Being a fossorial animal, deaths caused by other factors may easily go undetected (Lindzey, 1982). Larger predators such as coyotes occasionally kill badgers.

APPENDIX C. Observed and Potentially Occurring Mammal Species of the Proposed Alternatives and Surrounding Areas

		Status	Sites	Newville
Order Marsupialia				
Family Didelphidae				
Didelphis virginiana	Virginia opossum		O	O
Order Insectivora				
Family Soricidae				
Sorex trowbridgii	Trowbridge shrew		P	P
Sorex vagrans	vagrant shrew		O	
Sorex ornatus	ornate shrew		O	P
Family Talpidae				
Neurotrichus gibbsii	shrew-mole			P
Scapanus latimanus	broad-footed mole		P	P
Order Chiroptera				
Family Vespertilionidae				
Myotis lucifugus	little brown bat		O	P
Myotis yumanensis	Yuma myotis	USFWS-SC, BLM-S	O	O
Myotis evotis	long-eared myotis	USFWS-SC, BLM-S	P	P
Myotis thysanodes	fringed myotis	USFWS-SC, BLM-S	P	P
Myotis volans	long-legged myotis	USFWS-SC, BLM-S	P	P
Myotis californicus	California bat		O	O
Myotis ciliolabrum	western small-footed myotis	USFWS-SC, BLM-S	O	P

		Status	Sites	Newville
Lasionycteris noctivagans	silver haired bat			O
Pipistrellus hesperus	western pipistrelle		O	O
Eptesicus fuscus	big brown bat		P	O
Lasiurus blossevillii	western red bat	USFWS-S	O	P
Lasiurus cinereus	hoary bat		P	O
Euderma maculatum	spotted bat	USFWS-SC, BLM-S, CDFG-SC	P	P
Corynorhinus townsendii townsendi	Townsend's western big-eared bat	USFWS-SC, BLM-S, CDFG-SC, USFS-S	P	P
Corynorhinus townsendii pallescens	pale big-eared bat	USFWS-SC, BLM-S, CDFG-SC, USFS-S	P	P
Antrozous pallidus	pallid bat	BLM-S, CDFG-SC, USFS-S	O	O
Family Molossidae				
Tadarida brasiliensis	Mexican free-tailed bat		O	O
Eumops perotis californicus	greater western mastiff bat	USFWS-SC, BLM-S, CDFG-SC	P	O
Order Lagomorpha				
Family Leporidae				
Lepus californicus	black-tailed jackrabbit	CDFG-G	O	O
Sylvilagus audubonii	desert cottontail	CDFG-G	P	P
Sylvilagus bachmani	brush rabbit	CDFG-G	O	P
Order Rodentia				
Suborder Sciuromorpha				
Family Sciuridae				
Spermophilus beecheyi	California ground squirrel		O	O

		Status	Sites	Newville
Eutamias sonomae	Sonoma chipmunk			P
Sciurus griseus	western gray squirrel	CDFG-G	O	O
Tamiasciurus douglasii	Douglas' tree squirrel	CDFG-G		P
Family Geomyidae				
Thomomys bottae	Botta's pocket gopher		O	O
Family Heteromyidae				
Perognathus inornatus inornatus	San Joaquin pocket mouse	USFWS-SC, BLM-S	O	O
Dipodomys californicus	California kangaroo rat		O	O
Family Castoridae				
Castor canadensis	beaver	CDFG-F	O	O
Suborder Mymorpha				
Family Muridae				
Subfamily Sigmodontinae				
Reithrodontomys megalotis	western harvest mouse		O	O
Peromyscus maniculatus	deer mouse		O	O
Peromyscus boylii	brush mouse		O	O
Peromyscus truei	pinon mouse		O	P
Neotoma fuscipes	dusky-footed woodrat		O	O
Subfamily Arvicolinae				
Microtis californicus	California vole		O	O
Ondatra zibethicus	muskrat	CDFG-F	O	O

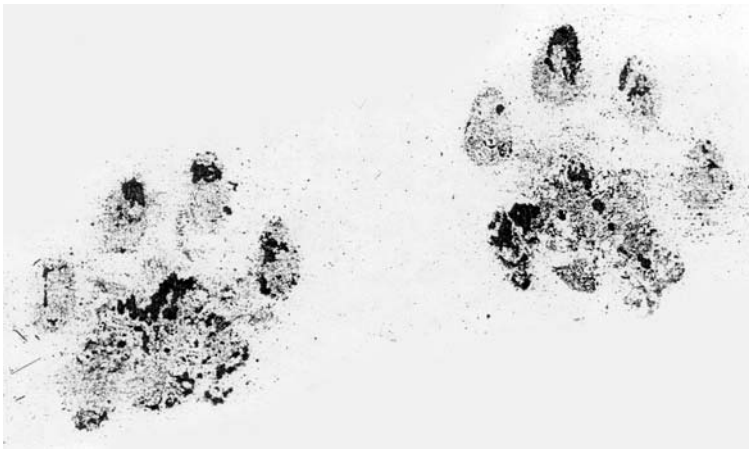
		Status	Sites	Newville
Subfamily Murinae				
Rattus norvegicus	Norway rat		P	P
Rattus rattus	black rat		O	P
Mus musculus	house mouse		O	O
Suborder Hystricomorpha				
Family Erethizontidae				
Erethizon dorsatum	porcupine			O
Order Carnivora				
Family Canidae				
Canis latrans	coyote	CDFG-N	O	O
Vulpes vulpes	red fox	CDFG-F	P	P
Urocyon cinereoargenteus	gray fox	CDFG-F	O	O
Family Ursidae				
Ursus americanus	black bear	CDFG-G	O	O
Family Procyonidae				
Bassariscus astutus	ringtail	CDFG-P	O	P
Procyon lotor	raccoon	CDFG-F	O	O
Family Mustelidae				
Martes pennanti	Pacific fisher	USFWS-SC, CDFG-SC, USFS-S, BLM-S	P	P
Martes americana	Pine marten	USFWS-SC, USFS-S	P	P

		Status	Sites	Newville
Mustela erminea	ermine			P
Mustela frenata	long-tailed weasel		P	P
Mustela vison	mink	CDFG-F		P
Taxidea taxus	American badger	CDFG-SC	O	O
Lutra canadensis	river otter	CDFG-F	O	P
Family Mephitidae				
Spilogale gracilis	western spotted skunk		P	P
Mephitis mephitis	western striped skunk		O	O
Family Felidae				
Puma concolor	mountain lion	CDFG-S	O	O
Lynx rufus	bobcat	CDFG-N	O	O
Order Artiodactyla				
Family Suidae				
Sus scrofa	wild pig	CDFG-G	O	O
Family Cervidae				
Odocoileus hemionus columbianus	black-tailed deer	CDFG-G	O	O
Family Antilocapridae				
Antilocapra americana	American pronghorn antelope	CDFG-G	O	

Legend

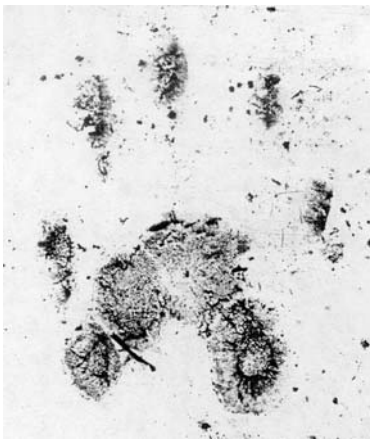
USFWS-SC	U.S. Fish and Wildlife Service “Federal Species of Concern”
USFS-S	U.S. Forest Service “Sensitive Species”
CDFG-SC	California Department of Fish and Game “California Species of Special Concern”
CDFG-S	California Department of Fish and Game “Special Protected Species”
CDFG-P	California Department of Fish and Game “Fully Protected Mammal”
CDFG-G	California Department of Fish and Game Harvested “Game Mammal”
CDFG-F	California Department of Fish and Game Harvested “Fur-bearing Mammal”
CDFG-N	California Department of Fish and Game Harvested “Non-game Mammal”
BLM-S	Bureau of Land Management “Sensitive Species”
O	Observed in the project area or surrounding areas
P	Potentially occurring species in the project area

APPENDIX D. Representative Track Samples from the Track Plate Efforts



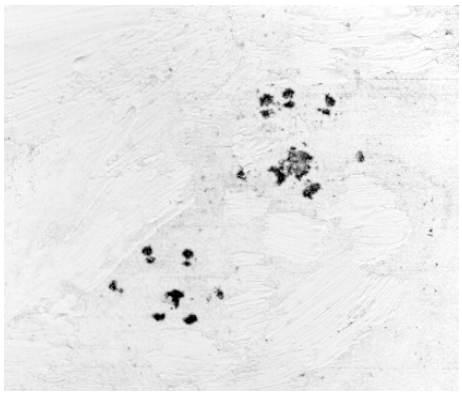
Bobcat

Striped Skunk

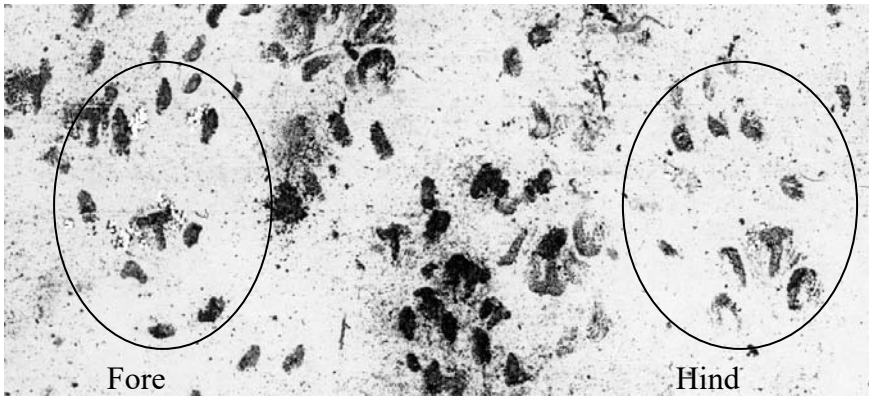


Raccoon

Mouse species



Dusky-footed woodrat



California ground squirrel

APPENDIX E. Representative Photographs from the Photo Station Efforts

Coyote

Black-tailed Deer

Gray Fox

Wild Pig