El Dorado County
Integrated Natural Resources Management Plan

Working Draft
Indicator Species in the INRMP Report

March 24, 2010

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The following report introduces the concept of indicator species and how they tell us something about ecosystem condition and impacts to ecosystems (pages 1-5). It then describes several recommended indicator species from different taxonomic groups (e.g., reptiles).

Under Task 1 of the Scope of Work for Phase 1 of the INRMP, Sierra Ecosystem Associates (SEA) is developing a list of indicator species. The goal of Subtask 1.c was to develop a list of recommended indicator species, drawn from a list of best and available indicator species based on how well these species met the needs of the INRMP. Studies and summary descriptions from the technical and scientific literature, in combination with input received from the PAWTAC and ISAC (Committees), were used to develop these species lists and descriptions. The species selection criteria and species themselves were chosen for the INRMP within the context of the General Plan.

General Plan Objective 7.4.2 is a requirement to identify and protect resources of the county. This includes: "*Identification and protection, where feasible, of critical fish and wildlife habitat including deer winter, summer, and fawning ranges; deer migration routes; stream and river riparian habitat; lake shore habitat; fish spawning areas; wetlands; wildlife corridors; and diverse wildlife habitat.*"

General Plan Policy 7.4.2.8 (A) lists five elements that must be considered and mapped for the INRMP:

1. Habitats that support special-status species;
2. Aquatic environments including lakes, streams, and rivers;
3. Wetland and riparian habitats;
4. Important habitat for migratory deer herds;
5. Large expanses of native Vegetation

The indicator species that will be described in the final report are critical for meeting objective 7.4.2 as well as identification of potential core habitat areas, corridors and linkages and are consistent with the needs of General Plan objective 7.4.2, as well as other needs under General Plan Goal 7.4: Wildlife and Vegetation Resources. "*Identify, conserve, and manage wildlife, wildlife habitat, fisheries, and vegetation resources of significant biological, ecological, and recreational value.*" The indicator species described in the current working draft report are examples of recommended indicator species.

What are Indicator Species?

Indicator species are a subset of species of the full suite of species historically present in an area who tell something about the ecological conditions and function of that area. These species should be those that are sensitive to impairment or loss of the ecological attributes or whose loss would negatively influence many other species. These species may provide an umbrella function for other species or represent large groups of other species, they may be "ecosystem engineers" in that they are responsible for the shape, form, and function of major ecological processes, and/or they may provide an efficient way to represent a planning goal – such as biodiversity protection.

Selection of indicator species may depend on what the species are needed to indicate – habitat condition, land-use effects, and changes due to natural disturbance. The species need to be linked to particular habitats or ecosystem types and changes in those habitats and ecosystems. An ideal indicator species should inform management decision-making that affects the species, other species, and the habitats in which the species lives.

Selected indicator species will be needed to meet multiple planning, representation and sensitivity needs. Planning needs include criteria that are very specific to the objectives that are set for any given conservation plan, project, or program (such as the INRMP). Certain species may rank high for planning needs, but rank lower for biodiversity needs. Other species may rank higher for biodiversity needs, but lower for social and economic (e.g., planning) needs. Finally, certain species may be more sensitive to climate change and land uses. It is unlikely that any one, or small set of, species will rank highly for all planning needs. The goal is to come up with an efficient group of species that ranks high for all needs and therefore meets the multiple demands put on the species by the INRMP.

Limitations and Benefits of Indicator Species Approach

The primary benefits of using indicator species are that they provide an efficient way to characterize the potential and/or actual ecological values of a particular place. When used in combination with land cover information (e.g., vegetation types) and wildlife occurrence data, indicator species distributions can inform land-use, transportation, and conservation planning. Vegetation information can be used to determine the potential presence or absence of individual species or groups of species. Aquatic and terrestrial surveys can provide useful information about the actual occupancy of species in specific areas.

The limitations of using the indicator species approach are primarily 1) the use of a subset of all species for planning and 2) the tendency to use potential presence and absence of indicator species rather than actual presence or absence. (1) Selecting just a fraction of the plant and animal species present in an area (e.g., western El Dorado County) runs the risk of neglecting the needs of species that are not selected. There is a balance between choosing few species and many indicator species to ensure complete representation of the issues and other species to meet planning needs. 2) Most projects using indicator species will model the potential distribution of animal and plant species across the landscape, primarily because of the perceived expense with mapping actual distributions. This limitation is easily overcome by carrying out surveys in aquatic and terrestrial habitats, or taking advantage of existing surveys carried out by other agencies.

Needs and Goals

Indicator species are most useful when they are chosen to indicate conditions in an ecosystem, to serve particular goals for a planning process, monitoring requirement, restoration program, conservation, or to understand the impacts of various human activities. For example, for the Sierra Nevada National Forests, the US Forest Service has a list of 13 individual “management indicator species” (MIS) and a group of aquatic invertebrates that, as a group, can be used to understand the effects of legacy and future decisions and actions on National Forest ecosystems,

in similar ways that the County could use in conservation planning under the INRMP. These MIS species and groups of species were chosen from a list of 62 individual species and 8 species groups (e.g., riparian bird assemblages) that were considered important by individual National Forests and most of which occur in El Dorado County. Some of these species may be useful as indicator species in the INRMP process.

Examples of needs and goals for indicator species

- To indicate changes in condition of habitats and landscape in response to land-use and transportation
- To efficiently represent a broad selection of other species and their needs by utilizing a small suite of species with similar life-cycle requirements
- Could themselves be important to ecosystem structure and function
- Could be a species with narrow, yet crucial, habitat needs not represented by wide-ranging species

Indicator species often are needed for multiple planning goals, including biodiversity protection, meeting social goals, and responding to economic needs. Within each of these goals there may be corresponding objectives that help with selection criteria and choice of species.

For suites of indicator species to meet biodiversity, social and economic needs criteria must be established that summarize how each species can meet multiple needs. This process is a hierarchical and stepwise process that should first define the objectives and goals of the conservation/planning process, then identify the corresponding selection criteria, and finally select the suite of species that can meet these needs. This suite of species will need to meet multiple overlapping needs, as well as specific needs that will require particular species to be considered.

Selection Criteria

In order to select an appropriate group of indicator species from the full suite of species present in an area, the full array of potential impacts to biodiversity in that area should be catalogued. Once these impacts have been identified, the species present in western El Dorado County can be assessed for sensitivity to these impacts. For each potential impact, the species most sensitive should be considered an indicator species in the planning process, unless they are uncommon or otherwise challenging to use in this way.

Phase I of the INRMP includes selection of indicator species likely to be useful in Phase II planning and implementation, which includes consideration of the kinds of impacts and conservation opportunities that should be considered. Ecosystem and species-level impacts can be broken into two classes, those to be addressed through management guidelines and those most effectively addressed through conservation and restoration actions. There are fiscal and political limitations on buying land for biodiversity protection in the Sierra Nevada foothills (Shilling and Girvetz, 2007). For certain critical needs, such as isolated and declining populations or habitats and choke-points for animal movement, fee title protection of lands may be the best option. Most impacts should be dealt with through management guidelines. Species that can be protected through this approach include process-limited species, sensitive to the departure of natural

ecological processes from the historical norm or newly introduced processes for which they are not adapted. Examples could be changes in fire regime or presence of invasive species. Other species that are area-limited, dispersal-limited, and resource limited may also be protected through land management guidelines. Area-limited species are those most at risk from direct habitat loss in the study area. This loss can be overall loss of natural vegetation or reduction in total area of specific types of vegetation required by that species. Generally speaking, these are wide-ranging species that require large, intact areas to meet their resource needs. Dispersal-limited species require the ability to move across the landscape either seasonally (for resource exploitation) or across generations (for genetic exchange and metapopulation dynamics). These species are sensitive to habitat fragmentation rather than habitat loss per se. Finally resource-limited species are at risk from loss of specific resource types, such as food or shelter.

One way to inform selection criteria is by defining important potential impacts to species. Indicator species may be selected based on a number of criteria, which are in turn based upon the needs and goals that the species are intended to serve and the threats that face them, such as habitat loss and fragmentation. These criteria include the list below, as well as criteria such as avoiding redundancy with other indicator species and responsiveness to threats and change. For the INRMP Phase I in western El Dorado County, the criteria are:

- Data on distribution are available for the species
- Wide ranging
- Representative of other species
- Regulatory concern
- Strongly-interactive with other species
- Have large effects on community structure and function (ecosystem engineer)
- Perform a unique role
- Sensitive to habitat fragmentation
- Sensitive to changes in hydrology and/or water quality
- Natural process limited
- Habitat area limited
- Dispersal limited
- Resource limited

(Kotliar, 2000; Lambeck, 1997; Noss et al., 1997; Power et al., 1996)

Examples of Indicator Species' Use in Decision-Making

The idea of indicator species is used in various management and planning contexts in the US and in our region. The Placer County Planning Department has chosen this definition for focal species, a related concept to indicator species: "…*species that provide insights to the larger ecological systems with which they are associated*". The following is a list of other examples where indicator species are being used:

- USFS Management Indicator Species (aquatic and terrestrial)
- USEPA Indicator Species (primarily aquatic)
- USFWS Migratory Bird Program
- Colorado Division of Wildlife (aquatic and terrestrial)

- Point Reyes Bird Observatory (Placer County & oak woodlands generally)
- Tahoe Regional Planning Agency (Environmental Improvement Program)

The following is a summary list of vertebrate species (or groups of species) that may meet criteria based upon potential impacts (species in parentheses):

- Overall loss of native vegetation (mule deer), including:
    - Loss of oak woodland (acorn woodpecker)
    - Loss of grassland (badger)
    - Loss of riparian forest (riparian bird assemblages)
    - Loss of wetlands (Western spadefoot toad)
    - Loss of chaparral (mountain lion)
    - Loss of conifer forest (northern goshawk)
    - Loss of serpentine outcrop habitat (serpentine plant communities)
    - Loss of vernal pools (vernal pool community)
- Fragmentation of native vegetation (mule deer, bobcat)
- Reduction in aquatic connectivity (salmonids)
- Impaired water quality (foothill yellow-legged frog)
- Alteration of hydrologic regimes (foothill yellow-legged frog)
- Impairments related to grazing (mule deer)
- Alteration of fire regime (northern goshawk)
- Invasive species (foothill yellow-legged frog)

INRMP Best Available and Recommended Indicator Species

The species listed here are examples of recommended indicator species to meet the needs of the INRMP. They are drawn from the list of best indicators, which is a subset of available indicators – the Sierra Nevada foothill animals for which sufficient distribution information is available to inform planning.

A. Mammals

Mule Deer/Black-Tailed Columbia Deer

1. Species description

Family Cervidae, Sub-Family: Capreolinae (New World Deer), *Odocoileus hemionus*

Herbaceous and shrub layer browsers; dwell in oak woodland and other forested areas near open meadows, shrublands, and recently-burned areas. Nearer to the valley, they will occur in riparian zones because of the natural cover there. They tend to stay near (<2 miles) water sources (lakes, ponds, streams).

Mountain populations will usually summer at higher elevations and winter at lower elevations, with migratory pathways between. In milder climates, like the Central Valley and foothills, populations may not migrate. Both populations can co-exist. Female deer do not disperse, but males do. Large groupings can occur in the winter, but during summer, small groups predominate, as opposed to herds.

Natural Predators (in order of importance): mountain lions, coyotes, eagles, bobcats

Other causes of mortality: loss and fragmentation of habitat, wildlife-vehicle collisions, feral/domestic dogs, disease, winter starvation

2. Why are deer important to this ecosystem and the INRMP?

Deer are ecosystem engineers – They can occur in large numbers and browse herbaceous plants and shrubs. Deer over-browsing can cause changes in under-story and shrub diversity and cover (Stockton et al., 2005), resulting in declines in habitat quality for other animals (Allombert et al., 2005a,b). Over-browsing can be controlled through the maintenance or re-establishment of predator-prey relationships. Deer browsing is also responsible for the positive benefit of opening forest floors to light through shrub removal.

Deer in wildlife-vehicle collisions – When vehicles collide with deer there are a variety of possible public safety, vehicle damage, and animal population effects. Collisions occur with

fairly consistent timing, with the greatest number occurring in the evening and during fall and early winter.

Deer migration – Many deer populations rely on the ability to move between winter foraging habitat at lower elevations and summer fawning areas at higher elevations. This movement often follows a combination of familiar pathways and least-disturbed areas. Deer can also occupy habitat without migration, as may be the case in the Sierra Nevada foothills. For these deer, movement will still be required among foraging areas, potentially bringing them into conflict with land-use and transportation infrastructure.

3. What do we know?

a. Meeting Selection Criteria

The following criteria for indicator species are met by this species.

- Data on distribution are available for the species
- Wide ranging
- Representative of other species (Because of their reliance and use of many habitat types, deer can carry out an umbrella function, meaning that they cover the needs of other species using similar areas.)
- Strongly-interactive with other species
- Have large effects on community structure and function (ecosystem engineer)
- Perform a unique role
- Sensitive to habitat fragmentation (Deer are sensitive to fragmentation from roads and intensive land-uses, but are less sensitive to low levels of development.)

b. Knowledge

Deer behavior, life-cycle, and habitat needs are fairly well understood in a general way. Important questions that remain include: differences between migratory and non-migratory deer in the foothills, impacts to foothill deer populations in the absence of significant predator pressure, and actual occupancy and use of specific areas for wintering, fawning, foraging, and migration.

c. Data Sources

One important source of data about deer distributions is the California Wildlife Habitat Relationship (CWHR) model developed by the California Department of Fish and Game (CDFG). This model can be used to show the distribution of habitat quality (from low to high) throughout the county. Another important source of data is mapped occurrences of deer while fawning and in winter ranges.

B. Riparian birds

Riparian bird assemblages are a class of birds under threat wherever development and land-use activities result in degraded or reduced extent of riparian under-story or canopy conditions. They are commonly counted in bird counts and used to indicate threats to and conditions of riparian zones. Because riparian areas vary in extent (e.g., width), structure (e.g., canopy and under-story), and composition (e.g., conifer species vs. cottonwood/willow mix), the individual bird species found will vary. However, as a group, they are an appropriate and commonly used index of condition. Bullock's oriole is an example of a riparian bird that is common in the Sierra Nevada foothills and in western El Dorado county.

Bullock's Oriole (*Icterus bullockii*)

1. *Species description:*

This bird prefers riparian forest and open woodlands for its habitat and eats insects, fruit, and nectar occurring in the trees. It tends to nest in the mid-story or canopy of trees near water, in natural and sometimes developed riparian forests. It prefers cottonwood, sycamore and willow forests, all of which are found in the lower elevations of the foothills. Its greatest densities in the US are in the Ashland OR area, Sacramento, western Placer and El Dorado counties, and southern San Joaquin valley.

This species is on the Audubon Society's list of common species in decline, based on Breeding Bird Surveys over the last 40 years. The California Partners in Flight Species Assessment for the Bullock's Oriole indicates that the species is in decline and is of regional concern in the Sierra Nevada. CPIF suggests that management actions be taken by agencies with jurisdiction to improve or protect habitat conditions through restoration, land allocation for development, or acquisition.

Common_Name	PS-g	BD-g	TB-r	PT-r	RD-b	Pct_POP	RCS-b	CC	RC	CS	RS	Act
Bullock's Oriole	3	1	3	4	3	2	14	-	Y	-	-	MA

PS-g	moderate population
BD-g	wide distribution
TB-r	slight to moderate decline projected for breeding conditions
PT-r	Moderate to high population decrease over 30 years expected
RD-b	Breeds at average abundance for the species
Pct-POP	Percent of breeding population in region
RCS-b	Score >13 = species of regional concern
RC	Species of concern in Sierra Nevada as a whole
Act	Management action needed

2. *Why are Bullock's Oriole important to this ecosystem and the INRMP?*

This common riparian forest inhabitant can indicate changing conditions in lower elevation riparian forests in western El Dorado County. It relies on productive and relatively intact riparian forest. However, if these conditions are retained in a more developed setting, it may still persist. It is a good representative of riparian birds less sensitive to development.

3. *What do we know?*

   a. Meeting Selection Criteria

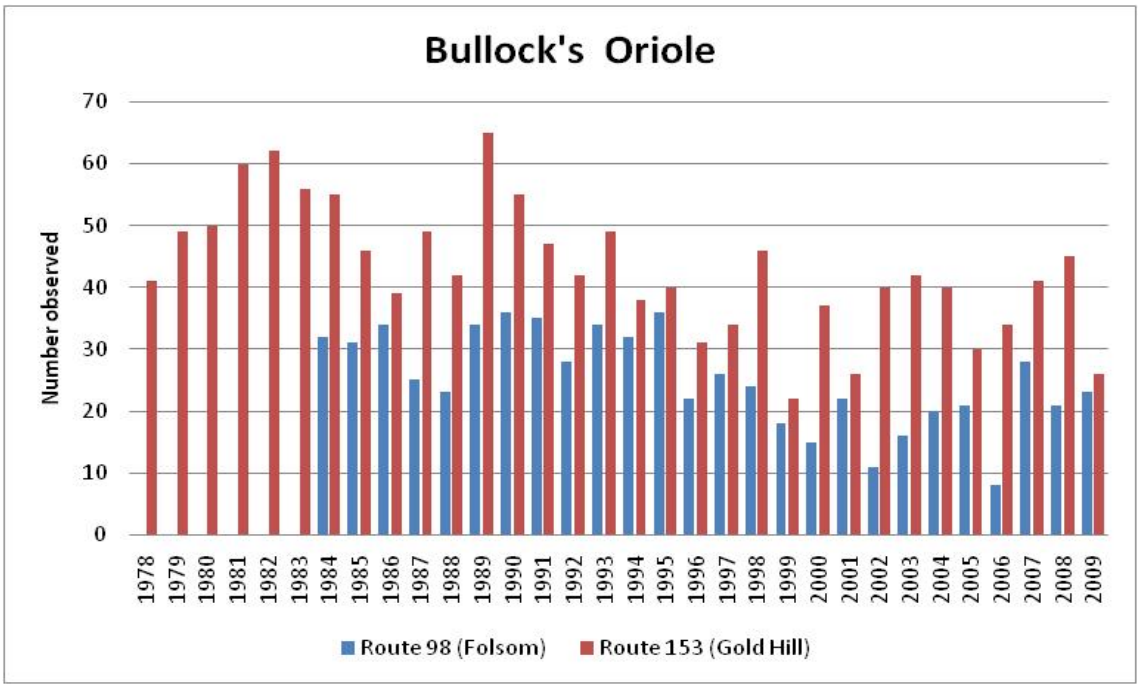
The following criteria for indicator species are met by this species:

- Data on distribution are available for the species
- Wide ranging
- Representative of other species
- Sensitive to habitat fragmentation
- Habitat area limited
- Resource limited

   b. Knowledge

The Breeding Bird Survey (BBS) includes 4 sites in Western El Dorado County, 2 of which have records of the species during the last 30 years. The BBS transects are fairly evenly distributed over the state. For the Bullock's Oriole, 10% of individuals of the species observed in the state live in El Dorado County.

Statewide, observed individual numbers have dropped ~40% over the last 30 years. In El Dorado County, numbers have dropped by closer to 50% over the same time period.



c. Data Sources?

The most consistent source of occurrence data for birds is the Breeding Bird Survey, conducted every year by a consortium of organizations and agencies called Partners in Flight. The data are collected using a formal method and made available online as direct counts and as estimates of distribution throughout the current range of the species. Another source of information is the California Wildlife Habitat Relationship system, which was originally developed over 20 years ago to model and map the habitat of all California vertebrates.

C. Wetland birds

Wetlands are one of the most threatened types of ecosystem in the US. They have been greatly reduced due to development and agricultural activities, and only recently received protection. There are many kinds of wetland, coming in all shapes and sizes. In hilly areas like western El Dorado County, wetlands may occur in pockets as vernal pools, adjacent to riparian areas, or as remnants of artificial impoundments. Obligate wetland species may have few alternatives from a habitat or dispersal point of view. Vernal pool organisms receive legal protection because of the amount of loss of this habitat type and the reliance of certain species exclusively on the intact pools. Because of their high productivity, wetlands can support a high diversity of species. Insectivorous birds like the red-winged blackbird can thrive in healthy wetlands and wet meadows/fields because of the abundance of insects. Wetland bird assemblages can indicate condition and structure of wetlands of various kinds. The common red-winged blackbird is one example from this assemblage.

Red-winged blackbird (*Agelaius phoeniceus*)

1. *Species description*

This passerine species can be seen in both natural and artificial wet areas, along creeks, and in meadows and agricultural fields where they are often foraging for insects and seeds. They nest in reeds, shrubs, or wooded areas near these wet areas where males establish territories and attract females to build nests. The birds breed in small flocks in the summer adjacent to wetlands, or sometimes drier fields. They are common in the Central Valley, Central Coast, and lower Sierra Nevada foothills.

Globally and regionally red-winged blackbirds are under no threat and are not declining. The Partners in Flight program assesses bird species for their population and conservation status. The table below shows the information available from the PIF program for the species.

Common_Name	PS-g	BD-g	TB-r	PT-r	RD-b	Pct_POP	RCS-b	CC	RC	CS	RS	Act
Red-winged Blackbird	1	1	2	3	2	0	9	-	-	-	-	-

PS-g	Large global breeding population
BD-g	Large global breeding habitat
TB-r	Future breeding expected to remain stable
PT-r	Variable change, uncertain population trend
Pct-Pop	<0.5% of global population in region
RCS-b	Species is not of concern in Sierra Nevada as a whole

2. *Why are red-winged blackbirds important to this ecosystem and the INRMP?*

Red-winged blackbirds are one of the most and possibly the most abundant native bird in North America and is not faced with any known risks. They are aggressive toward invaders and are sometimes found foraging with invasive birds (e.g., starlings) that probably cannot displace them from breeding habitat. Because of its strong association with wetlands, wet agricultural areas, and dry fields, this species may function best as a common species which should not decline in the El Dorado County area. As wetlands are developed or impacted by development, fewer blackbirds may use them, instead using agricultural landscapes. Regional or local loss of both of these landscape types is likely to result in declines in the species.

3. *What do we know?*

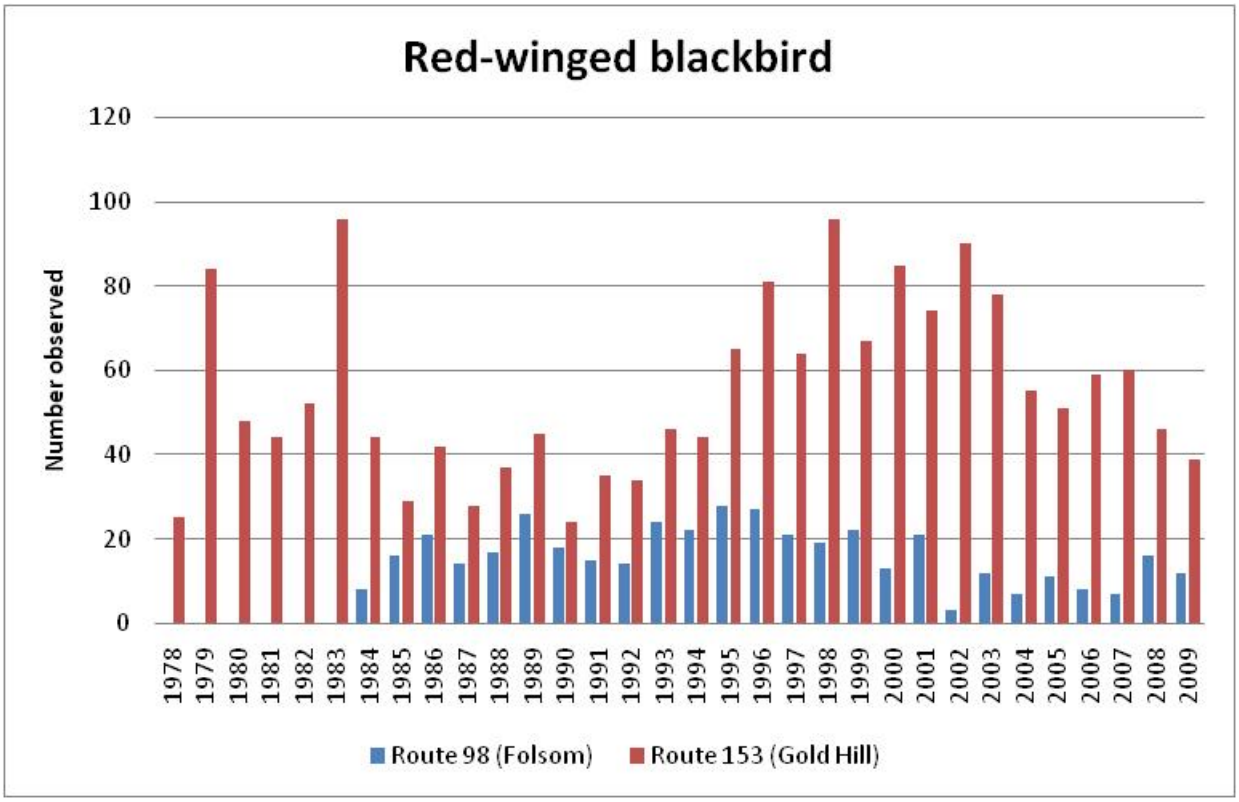
    a. Meeting Selection Criteria

The following criteria for indicator species are met by this species.

- Data on distribution are available for the species
- Wide ranging
- Representative of other species
- Sensitive to habitat fragmentation
- Sensitive to changes in hydrology and/or water quality
- Natural process limited
- Habitat area limited
- Dispersal limited
- Resource limited

    b. Knowledge

The Breeding Bird Survey (BBS) includes 4 sites in Western El Dorado County, 2 of which have records of the species during the last 30 years. For red-winged blackbirds, El Dorado County had 0.5% of the California population in 2009 and 2% in 2002. Statewide, the population may be declining, and is variable and recently declining in western El Dorado County.



c. Data Sources

The most consistent source of occurrence data for birds is the Breeding Bird Survey, conducted every year by a consortium of organizations and agencies called Partners in Flight. The data are collected using a formal method and made available online as direct counts and as estimates of distribution throughout the current range of the species. Another source of information is the California Wildlife Habitat Relationship system, which was originally developed over 20 years ago to model and map the habitat of all California vertebrates.

D. Grasslands birds

The grasslands of the Central Valley and lower elevation Sierra Nevada foothills have been heavily impacted by agricultural and suburban development, road and highway construction, and grazing. In contrast to the remaining wetlands and riparian areas in central California, grasslands are naturally extensive and the species using them may move around extensively. Birds of the grasslands may forage and nest on the ground, or forage in grassy open areas, while nesting in nearby shrubs and trees. Many mammals, birds, reptiles, and amphibians naturally occurring in grasslands have some kind of management or regulatory concern. Even common grassland fauna may be in decline in the Central Valley and foothills due to continuing loss, fragmentation, and degradation of their habitat. The Lark Sparrow is an example of the grassland bird assemblage.

Lark Sparrow (*Chondestes grammacus*)

1. *Species description*

This bird forages for seeds and insects along the ground in grassland areas. For breeding habitat, it prefers savannah settings, where open grasslands adjoin trees and shrubs. It may nest on the ground among grasses, in shrubs, or in small trees. Occasionally it will adopt an old thrasher or mockingbird nest, or even share the nest with one of these species.

2. *Why are Lark Sparrows important to this ecosystem and the INRMP?*

This species is a good indicator for the health of natural or pasture grasslands and savannahs. As a common species, it can be more easily tracked. In the lower Sierra Nevada foothills, it is affected by several main disturbances: agricultural land management that leads to conversion of pasture lands, loss of grassland and savannah habitat to suburban development, fire suppression, and weed invasion. Because it is a common species, its decline indicates poor land management affecting biodiversity and habitat condition in general.

3. *What do we know?*

The California Wildlife Habitat Relationship map for this species indicates that it inhabits the grassland and oak savannah areas of the lower elevations of the western county. The Lark Sparrow is regularly observed and counted over the last 30 years in 2 of the 4 Breeding Bird Survey transects in western El Dorado County: transect route 98 near Folsom reservoir and transect route 153 near Gold Hill.

a. Meeting Selection Criteria

The following criteria for indicator species are met by this species.

- Data on distribution are available for the species
- Wide ranging
- Representative of other species
- Sensitive to habitat fragmentation
- Natural process limited
- Habitat area limited
- Resource limited

b. Knowledge

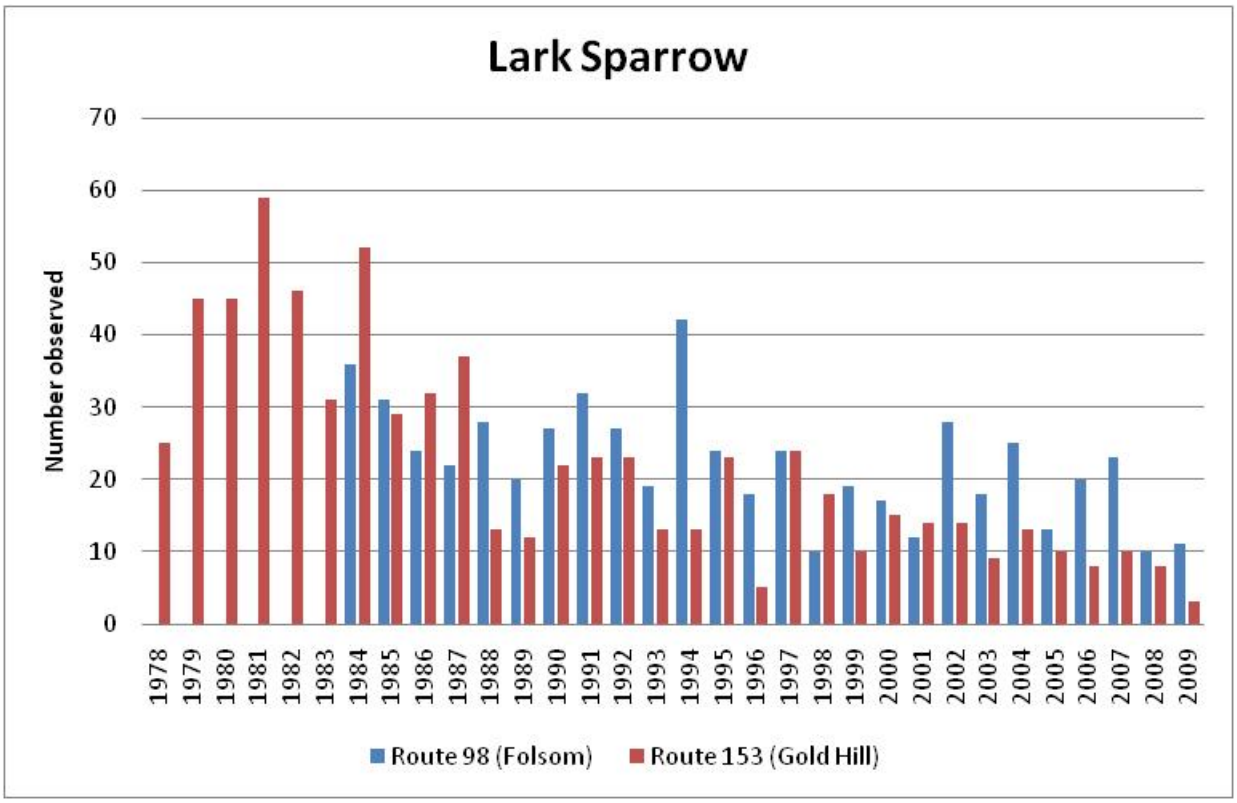
There has been a nationwide decrease in the abundance of this species, though its current population is large enough that it is not under threat of endangerment at the nation scale. According to the Audubon Society, the species has declined by 63% in 40 years and is #13 on their list of 20 common birds in decline in the US, #9 in California. The organization also notes that agricultural intensification (e.g., conversion from pasture to plowed ground) and suburbanization of grasslands pose threats to habitats, as do inappropriate fire management and

weed invasion. The Partners in Flight assessment for this species indicates that it is not currently of conservation concern for the Sierra Nevada region, but that declines are expected.

Common_Name	PS-g	BD-g	TB-r	PT-r	RD-b	Pct_POP	RCS-b	CC	RC	CS	RS	Act
Lark Sparrow	2	1	3	3	2	0	11	-	-	-	-	-

PS-g	Moderate to large global breeding population
BD-g	Large global breeding habitat
TB-r	Slight to moderate decline in breeding conditions expected
PT-r	Variable change, uncertain population trend
Pct-Pop	<0.5% of global population in region
RCS-b	Species is not of concern in Sierra Nevada as a whole

Statewide, the population of this species has declined by 50%; in El Dorado County, the decline has been by 75%. Between 5% (2009) and 20% (1987) of California Lark Sparrow observed statewide have been in El Dorado County.



c. Data Sources

The most consistent source of occurrence data for birds is the Breeding Bird Survey, conducted every year by a consortium of organizations and agencies called Partners in Flight. The data are collected using a formal method and made available online as direct counts and as estimates of distribution throughout the current range of the species. Another source of information is the

California Wildlife Habitat Relationship system, which was originally developed over 20 years ago to model and map the habitat of all California vertebrates.

E. Oak woodlands birds

In El Dorado County, oak woodlands extend from their intermixed savannah zone with grasslands to the lower-elevation west to the mixed hardwood-conifer habitat types at higher elevations to the east. This productive forest type naturally includes a wide variety of oak species, under-story and intermixed shrubs, and herbaceous ground-cover. Acorn mast provides food for many species, while the trees themselves provide canopy cover and alternating closed and open areas. Birds of the Sierra Nevada foothill oak woodlands are under threat in many of the same ways that oak woodlands themselves are. Habitat loss and fragmentation, habitat degradation, and invasion of non-native species (e.g., household pets and starlings) pose threats to even common oak woodland bird species. The Acorn Woodpecker is thought to be a good, but not very sensitive indicator of overall oak woodland condition. If this species declines, it is likely that others will have already done so.

Acorn Woodpecker (*Melanerpes formicivorus*)

1. *Species description*

This species collects acorns from a variety of oak species and stores them in holes drilled into the stems of snags and dead tree limbs, and even old buildings. Like all woodpeckers, their primary food is insects, but they are dependent on acorn stores to make it through the winter when fewer insects are available. They stay within a ¼ mile of water and prefer undisturbed patches of habitat >15 acres. They are an obligate to oak woodland habitat, meaning that they cannot survive in other habitat types. They rely on total acorn production for maintaining population abundance and a variety of oak species to ensure acorn availability every year. This species lives in colonies around granary trees, which they aggressively defend. Colonies and family groups may remain in a single small area for generations with very little dispersal.

2. *Why are Acorn Woodpecker important to this ecosystem and the INRMP?*

Their fate is tied to the condition and extent of oak woodlands. They seem to benefit from oak species diversity, as opposed to the presence of just one kind of oak. Poor grazing practices that lead to low recruitment of oak seedlings threaten future generations of the species as well as current populations in certain areas. They are sensitive to loss of oak species diversity, absence of multiple age classes of oak trees, loss of snags and dead limbs, and natural stands of oak trees. They are an excellent and sensitive indicator of oak woodland structure, composition, and health.

3. *What do we know?*

    a. Meeting Selection Criteria

The following criteria for indicator species are met by this species.

- Data on distribution are available for the species
- Wide ranging
- Representative of other species
- Perform a unique role
- Natural process limited
- Dispersal limited
- Resource limited (highly dependent on acorn crop)

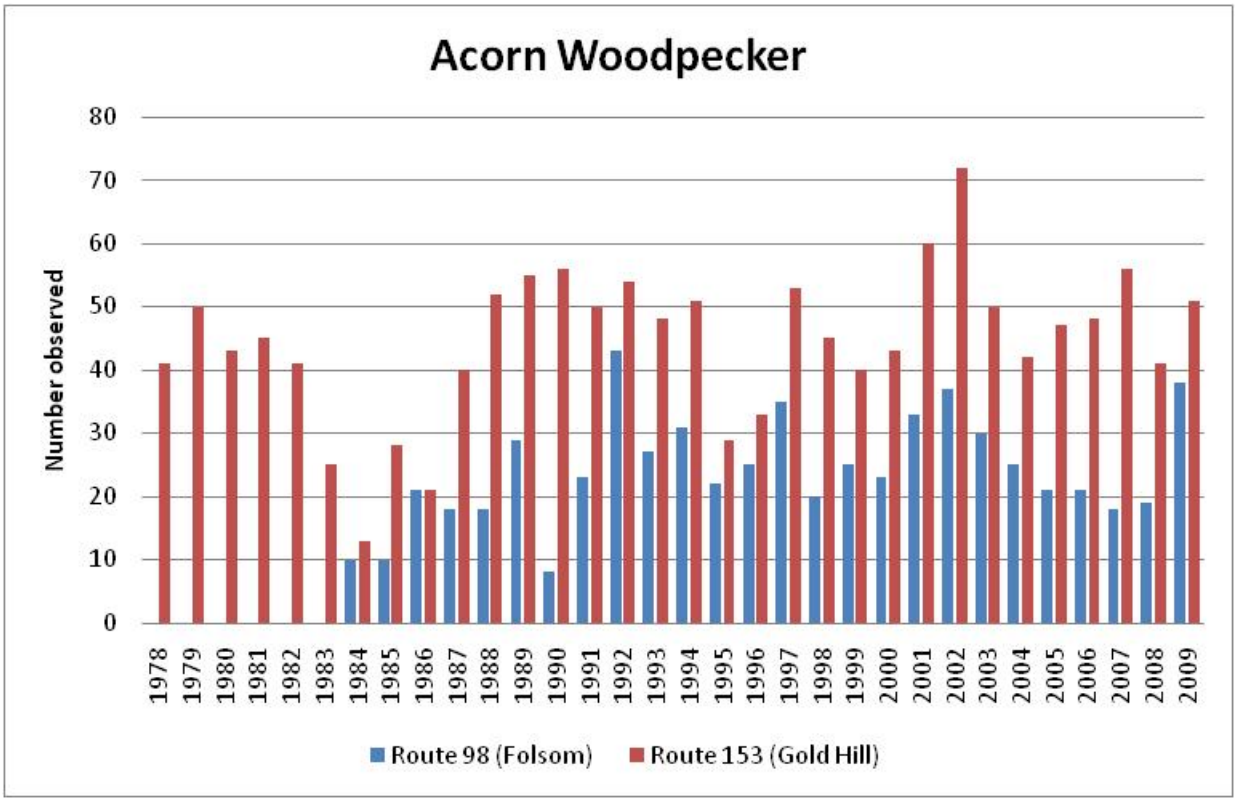
    b. Knowledge

The California Partners in Flight (CPIF) program species assessment indicates that the species is relatively stable and is not yet of conservation concern, but its score for concern is just below the cutoff. The CPIF considers the species to not yet be in decline, but a combination of habitat loss and fragmentation, European starling invasion, and decline in oak seedling recruitment could threaten individual populations and the species as a whole.

Common_Name	PS-g	BD-g	TB-r	PT-r	RD-b	Pct_POP	RCS-b	CC	RC	CS	RS	Act
Acorn Woodpecker	3	2	2	2	3	6	12	-	-	-	-	-

PS-g	Moderate global breeding population
BD-g	Moderate to large global breeding habitat
TB-r	Breeding conditions expected to remain stable
PT-r	Population trend expected to increase slightly or remain stable
Pct-Pop	6% of global population in region
RCS-b	Species is not of concern in Sierra Nevada as a whole (but cutoff for concern is 13)

Four to six percent of the statewide observations of the species have been in western El Dorado County. Observations for the state and the western county have held steady over the last 30 years.



c. Data Sources

The most consistent source of occurrence data for birds is the Breeding Bird Survey, conducted every year by a consortium of organizations and agencies called Partners in Flight. The data are collected using a formal method and made available online as direct counts and as estimates of distribution throughout the current range of the species. Another source of information is the California Wildlife Habitat Relationship system, which was originally developed over 20 years ago to model and map the habitat of all California vertebrates.

F. Herpetofauna

Reptiles and amphibians are sensitive to habitat disturbance, climatic conditions, and air/water quality. They are often used as sensitive indicators of impacts to various aquatic, riparian, and wetland habitat types. The foothill yellow-legged frog does well in intact and functioning foothill streams, free of hydro-modification and invading bullfrogs and trout. Western Spadefoot Toad rely on seasonal wetlands embedded in grassland areas and are sensitive to loss and fragmentation of this habitat type and to invasive species. Western pond turtles are sensitive to riparian modification insofar as it affects aquatic habitat and flows.

Foothill yellow-legged frog (*Rana boylii*)

1. *Species description*

The foothill yellow-legged frog is medium-sized with variable coloration. It historically was found in most Pacific drainages in California, from sea level to approximately 2000m (Jennings and Hayes 1994). A stream-dwelling species, it is rarely found far from permanent water. It prefers rocky pools and riffles of small to moderate sized streams, where refuge habitat is available, especially for tadpoles. Stream-side habitat is varied, and includes grassland and forest. Tadpoles feed on algae, while adults eat aquatic and terrestrial invertebrates. A major predator of the foothill yellow-legged frog is the garter snake; however invasive bullfrogs also prey on the species (Moyle 1973). Breeding takes place in relatively stable stream reaches (Kupferberg 1996). This species is sensitive to changes in flow regime in stream habitats as well as temperature shifts, both of which are expected to accelerate due to projected shifting climate patterns in the future (Jennings and Hayes 1994).

2. *Why are foothill yellow-legged frogs important to this ecosystem and the INRMP?*

As a species sensitive to changes in water regime (both flow and temperatures), the foothill yellow-legged frog is an important indicator of stream health where it occurs. Because they rely on aquatic habitat to a greater degree than most other frogs, their population trends will provide insight into the status of a number of other stream-dwelling organisms. This species is also susceptible to predation by invasive fish and bullfrogs (Jennings and Hayes 1994). More recent work has found that foothill yellow-legged frog population declines are sometimes associated with pesticide use (Davidson 2004). Sensitivity to pesticides makes this species a potential indicator of effects to other species as well. This species is listed as a California Species of Special Concern as well as a BLM and USFS Sensitive Species.

3. *What do we know?*

    a. Meeting Selection Criteria

The following criteria for indicator species are met by this species.

- Data on distribution are available for the species
- Representative of other species
- Regulatory concern
- Strongly-interactive with other species
- Sensitive to habitat fragmentation
- Sensitive to changes in hydrology and/or water quality
- Natural process limited
- Habitat area limited

- Dispersal limited
- Resource limited

Sensitivity to change in water regime:
Change in either timing or volume of flow or in water temperature can have a large effect on populations of foothill yellow-legged frog. A declining population can indicate that detrimental effects to not only this species but others that use rocky stream habitat as well.

Vulnerable to invasive species:
This species is vulnerable to predation by both invasive fish and bullfrogs. Population decline not associated with water regime change can indicate the arrival of invasive species leading to potential harm not only to foothill yellow-legged frog, but other aquatic species as well.

Vulnerable to pesticide use:
Population declines in this species have been associated with pesticide use. This species can serve as an indicator of detrimental pesticide effects on a variety of species found in western El Dorado County ecosystems.

b. Knowledge

Jennings and Hayes (1994) argue for an urgent need of more natural history data on the foothill yellow-legged frog. Especially needed, they claim, are new studies on habitat requirements of larvae and early postmetamorphic stages, before adequate management recommendations can be made. However, since that date, a number of studies have been published on the species, including a Ph.D. dissertation on ecology and reintroduction of the species (Lind 2004). However, there is still likely a need for more habitat studies as well as investigations into flow change effects on the species.

c. Data sources

One important source of information on life history, habitat requirements, and conservation needs of foothill yellow-legged frog is the 1994 CDFG publication *Amphibian and reptile species of special concern in California* (Jennings and Hayes 1994). The California Wildlife Habitat Relationship model developed by the CDFG also contains a good deal of information on the species. There are only a handful of recent publications on the species however to augment these sources.

Western spadefoot (*Spea hammondii*)

1. Species description

Family Scaphiopodidae

Western spadefoots are a medium-sized brownish toad mostly endemic to California. They are residents primarily of grasslands in the Central Valley, southern California, and Sierra Nevada foothills, although are also occasionally found in oak woodlands. Western spadefoots require


Western Spadefoot *(Spea hammondii)* Photo Credit: James Bettaso U.S. Fish & Wildlife Service

temporary, seasonal ponds (e.g. vernal pools) for reproduction and larvae habitat. Presence of exotic predators, such as bullfrogs, fish, and crayfish, can render pools unusable (Jennings and Hayes 1994). Outside of the breeding season (generally spring and fall), they are terrestrial, spending much of their time in burrows in loose soil. Prey include a variety of invertebrates, such as flies, ants, butterflies, beetles, earthworms, and crickets (Morey and Guinn 1992). Important predators include raccoons, great blue herons, garter snakes, and California tiger salamanders (Jennings and Hayes 1994). Loss of seasonal wetland habitat has negatively impacted the species, both through direct habitat loss and possible disruption of metapopulation structure. In addition, introduction of mosquitofish to pools for mosquito abatement threatens the species, as does emigration of bullfrogs to breeding pools.

2. *Why are western spadefoots important to this ecosystem and the INRMP?*

Western spadefoots are one of a number of species at risk from extensive loss of seasonal wetland habitat in California grasslands. As a predator species of the many invertebrates found in seasonal wetlands, they are susceptible to impacts on these habitats. Habitat impacts have led to their listing as a California Species of Special concern and a BLM Sensitive Species.

3. *What do we know?*

    a. Meeting Selection Criteria

The following criteria for indicator species are met by this species.

- Data on distribution are available for the species
- Representative of other species
- Regulatory concern
- Strongly-interactive with other species
- Perform a unique role
- Sensitive to habitat fragmentation
- Sensitive to changes in hydrology and/or water quality
- Natural process limited
- Habitat area limited
- Dispersal limited
- Resource limited

<u>Sensitive to loss and fragmentation of vernal pool habitat:</u>
Because of their requirement of seasonal wetland presence for breeding, western spadefoots are at risk when this habitat is lost. Seasonal wetland habitat loss is the primary cause of concern for this species (Davidson et al. 2002). Metapopulation disruption is also an indicator of loss of

seasonal wetland habitat or fragmentation of that habitat (rendering movement between patches unlikely). Higher densities of seasonal wetlands are necessary to enable movement between pools by spadefoot individuals.

Vulnerable to invasive species:
Introduced mosquitofish and emigrating bullfrogs can lead to inability of seasonal wetland s to support breeding and juvenile spadefoots. A decline in spadefoot population numbers in intact seasonal wetland landscapes can point to a detrimental level of invasion by these species.

b. Knowledge

Western spadefoot general habitat needs are pretty well established. However, specific feature requirements (e.g. burrow soil patterns and characteristics) remain poorly known. Many life history traits are poorly known, including movement patterns, longevity, and survivorship. The biggest knowledge gap, however, may be the effects of habitat fragmentation on population and metapopulation structure (Jennings and Hayes 1994). Investigation of this question is necessary to understand the potential for long-term survival of the species, especially in urbanizing areas.

c. Data sources

One important source of information on life history, habitat requirements, and conservation needs of western spadefoots is the 1994 CDFG publication *Amphibian and reptile species of special concern in California* (Jennings and Hayes 1994). The California Wildlife Habitat Relationship model developed by the CDFG also contains a good deal of information on the species. There are only a handful of recent publications on the species however to augment these sources.

Western pond turtle (*Emys marmorata*)

1. Species description

Family Emydidae

The western pond turtle is the only turtle species native to central California and the Sierra Nevada foothills. It is generally drab brown/gray and medium-sized. They historically ranged along the Pacific coast, from Washington state in the north to northern Baja California in the south, and from the coast on the west to approximately 1,500 m in elevation in the Sierra Nevada on the east (Jennings and Hayes 1994). The western pond turtle is an aquatic species, but leaves the water to overwinter, aestivate, and reproduce. Aquatic habitat requirements include slack or

slow-moving water, as well as basking sites, such as partially submerged logs, rocks, and mats of vegetation (Jennings and Hayes 1994). Nesting takes place up to several hundred feet from water, with eggs shallowly buried in soil in a variety of habitats (Rathbun et al. 1992). Western pond turtles are omnivorous and opportunistic, consuming aquatic vegetation as well as invertebrates, fish, and amphibians. They, in turn, are predated by a variety of vertebrates, including bullfrogs, garter snakes, birds, fish, and some mammals. This species experienced heavy hunting pressures in the past, resulting in much-reduced populations across the range. In addition, introduced species and human impacts to nesting areas have impacted the species (Jennings and Hayes 1994). They are also potentially impacted by dams and changes in flow regime (Reese and Welsh 1998).

2. *Why are western pond turtles important to this ecosystem and the INRMP?*

Western pond turtles are an important management species in the INRMP planning area for several reasons. They are sensitive to impacts to terrestrial habitat (such as urbanization, conversion to agriculture, or over-grazing) adjacent to their aquatic habitat, and adequate stream buffers are important to ensure continued population viability (Rathbun et al. 1992). Western pond turtle populations are also vulnerable to the presence of a number of exotic species, including bullfrogs, fish, and others (Jennings and Hayes 1994). Finally, alterations in flow regime can lead to detrimental effects on the species. As a result of past and current impacts, western pond turtles are listed as a California Species of Special Concern, as well as a BLM and USFS Sensitive Species.

3. *What do we know?*

    a. Meeting Selection Criteria

The following criteria for indicator species are met by this species.

- Data on distribution are available for the species
- Representative of other species
- Regulatory concern
- Strongly-interactive with other species
- Sensitive to habitat fragmentation
- Sensitive to changes in hydrology and/or water quality
- Natural process limited
- Habitat area limited
- Dispersal limited
- Resource limited

<u>Sensitive to loss of streamside habitat:</u>
The major current cause of population decline in western pond turtles in California is loss of nesting habitat near waterways. They serve as a valuable indicator of stream buffer habitat quality. Population decline can indicate loss of habitat to urbanization agriculture or over-grazing.

Sensitivity to change in water regime:
While western pond turtles require slow or slack water, large expanses, such as those created by damming, are generally not used (Reese and Welsh 1998). A population decline can indicate a disrupted flow regime and aquatic habitat change.

Sensitive to loss of aquatic connectivity:
Western pond turtles may be sensitive to loss of aquatic connectivity and impairment of movement. This could lead to impacts on metapopulation dynamics as well as the ability to re-colonize areas from which they have been extirpated. However, this is an area of research that needs a good deal more attention to fully understand the sensitivity of this species to this potential threat (Jennings and Hayes 1994).

Vulnerable to invasive species:
A number of exotic species can potentially negatively impact western pond turtle populations. A decline in population can indicate the arrival of a new exotic species to a region or population of a native species (e.g. raccoon) that is increasing as a result of human impacts within a region (Jennings and Hayes 1994).

b. Knowledge

There are many gaps in our knowledge about western pond turtle behavior and habitat. Overwintering and seasonal patterns apparently vary according to specifics of location, but these characteristics are poorly known (Jennings and Hayes 1994). Movement ecology and behavior (and associated potential for re-colonization of habitat) is similarly poorly understood. This is important knowledge for understanding of metapopulation dynamics and restoration potential. Finally, more information is need on habitat variation associated with nesting location (Jennings and Hayes 1994).

c. Data sources

One important source of information on life history, habitat requirements, and conservation needs of western pond turtles is the 1994 CDFG publication *Amphibian and reptile species of special concern in California* (Jennings and Hayes 1994). The California Wildlife Habitat Relationship model developed by the CDFG also contains a good deal of information on the species. Several other peer-reviewed papers also provided useful data on the species.

References

Kotliar, N.B. 2000. Application of the new keystone-species concept to prairie dogs: how well does it work? Conservation Biology 14(6):1715-1721.

Lambeck, R. J. 1997. Focal species: A multi-species umbrella for nature conservation. Conservation Biology **11**:849-856.

Margules CR, Pressey RL (2000) Systematic conservation planning. Nature 405:243–253

Noss, R.F., M.A. O'Connell, and D.D. Murphy. 1997. The science of conservation planning. Island Press, Washington, D.C.

Power, M.E., D. Tilman, J.A. Estes, B.A. Menge, W.J. Bond, L.S. Mills, G. Daily, J.C. Castilla, J. Lubchenco, and R.T. Paine. 1996. Challenges in the quest for keystones. BioScience 46:609-620.

Roberge, J. and P. Angelstam. 2004. Usefulness of the umbrella species concept as a conservation tool. Conservation Biology, 18(1): 76-85.

Shilling, F.M. and E. Girvetz (2007). Barriers to implementing a wildland network. *Landscape and Urban Planning*. Volume 80(1-2): 165-172.

INRMP Best Available and Recommended Indicator Species References

A. Mammals - Mule Deer/Black-Tailed Columbia Deer

Allombert, S., AJ. Gaston, J-L. Martin. 2005a. A natural experiment on the impact of overabundant deer on songbird populations. Biological Conservation, 126: 1-13.

Allombert, S., S. Stockton, and J-L. Martin. 2005b. A natural experiment on the impact of overabundant deer on forest invertebrates. Conservation Biology, 19(6): 1917-1929.

Loft, E. R., J. G. Kie, and J. W. Menke. 1993. Grazing in the Sierra Nevada: Home Range and Space use Patterns of Mule Deer as Influenced by Cattle. Calif. Fish and Game 79(4):145-166.

Stockton, S.A., S. Allombert, A.J. Gaston, and J-L. Martin. 2005. A natural experiment on the effects of high deer densities on the native flora of coastal temperate rain forests. Biological Conservation, 126: 118-128.

B. Riparian birds - Bullock's Oriole (*Icterus bullockii*)

Audubon: http://ca.audubon.org/birds_in_decline.html

Cornell Ornithology Lab: http://www.allaboutbirds.org/guide/Bullocks_Oriole/id

USGS: http://www.mbr-pwrc.usgs.gov/id/framlst/i5080id.html

Rising, James D. and Pamela L. Williams. 1999. Bullock's Oriole (Icterus bullockii), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/416

C. Wetland birds - Red-winged blackbird (*Agelaius phoeniceus*)

http://www.allaboutbirds.org/guide/red-winged_blackbird/id

http://www.rmbo.org/pif/pifdb.html

D. Grasslands birds - Lark Sparrow (*Chondestes grammacus*)

Cornell Ornithology Lab: http://www.allaboutbirds.org/guide/Lark_Sparrow/id

Audubon: http://www.audubon.org/bird/stateofthebirds/CBID/profile.php?id=13

Audubon, Common Birds in Decline: http://ca.audubon.org/birds/birds-in-decline.php

Martin, John W. and Jimmie R. Parrish. 2000. Lark Sparrow (Chondestes grammacus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/488

E. Oak woodlands birds - Acorn Woodpecker (*Melanerpes formicivorus*)

Bock, C.E. and J.H. Bock 1974. Geographical ecology of the acorn woodpecker: diversity versus abundance of resources. Am. Nat. 108.694-698.

CalPIF (California Partners in Flight). 2002. Version 2.0. The oak woodland bird conservation plan: a strategy for protecting and managing oak woodland habitats and associated birds in California (S. Zack, lead author). Point Reyes Bird Observatory, Stinson Beach, CA. http://www.prbo.org/calpif/pdfs/oak.v-2.0.pdf .

Hooge, P.N. 1995. Dispersal dynamics of the cooperatively breeding acorn woodpecker. Ph.D. Diss., Univ. of California, Berkeley

Koenig, W.D. and J. Haydock. 1999. Oaks, acorns, and the geographical ecology of acorn woodpeckers. J. Biogeography 26(1):159-165.

Koenig, W.D. and Mumme R.L. 1987. Population Ecology of the Cooperatively Breeding acorn woodpecker. Princeton Univ. Press: Princeton.

MacRoberts, M.H. and B.R. MacRoberts. 1976. Social organization and behavior of the Acorn woodpecker in central coastal California. Ornithol. Monogr. 21:1-115.

Trail, P. W. 1980. Ecological correlates of social organization in a communally breeding bird, the Acorn Woodpecker, *Melanerpes formicivorus.* Behav. Ecol. Sociobiol. 7:83-92.

F. Herpetofauna

Foothill yellow-legged frog (*Rana boylii*)

Davidson, C. 2004. Declining downwind: amphibian population declines in California and historical pesticide use. *Ecological Applications*, 14(6):1892-1902.

Jennings, M.R., and M.P. Hayes. 1994. *Amphibian and reptile species of special concern in California*. California Department of Fish and Game, Sacramento, CA.

Kupferberg, S.J. 1996. Hydrologic and geomorphic factors affecting conservation of a river breeding frog (*Rana boylii*). *Ecological Applications*, 6(4):1332-1344.

Kupferberg, S.J., A. Catenazzi, K. Lunde, A.J. Lind, and W.J. Palen. 2009. Parasitic copepod (*Lernaea cyprinacea*) outbreaks in foothill yellow-legged frogs (*Rana boylii*) linked to unusually warm summers and amphibian malformations in northern California. *Copeia*, 2009(3):529-537.

Lind, A.J. 2004. *Reintroduction of a declining amphibian: determining an ecologically feasible approach for the foothill yellow legged frog (Rana boylii)*. Ph.D. dissertation, University of California, Davis.

Moyle, P.B. 1973. Effects of introduced bullfrogs, *Rana catesbeiana*, on the native frogs of the San Joaquin Valley, California. *Copeia*, 1973(1):18-22.

Foothill yellow-legged frog (*Rana boylii*) photo by P. Huber

Western spadefoot (*Spea hammondii*)

Davidson, C., H.B. Shaffer, and M.R. Jennings. 2002. Spatial tests of the pesticide drift, habitat destruction, UV-B, and climate-change hypotheses for California amphibian declines. *Conservation Biology*, 16(6):1588-1601.

Jennings, M.R., and M.P. Hayes. 1994. *Amphibian and reptile species of special concern in California*. California Department of Fish and Game, Sacramento, CA.

Morey, S.R., and D.A. Guinn. 1992. Activity patterns, food habits, and changing abundance in a community of vernal pool amphibians. pp. 149-158 In: D.F. Williams, S. Byrne, and T.A. Rado (editors), *Endangered and sensitive species of the San Joaquin Valley, California: Their biology, management, and conservation*. The California Energy Commission, Sacramento, California, and the Western Section of The Wildlife Society.

Western pond turtle (*Emys marmorata*)

Jennings, M.R., and M.P. Hayes. 1994. *Amphibian and reptile species of special concern in California*. California Department of Fish and Game, Sacramento, CA.

Rathbun, G.B., N. Siepel, and D.C. Holland. 1992. Nesting behavior and movements of western pond turtles *(Clemmys marmorata). The Southwestern Naturalist*, 37(3):319-324.

Reese, D.A., and H.H. Welsh, Jr. 1998. Comparative demography of *Clemmys marmorata* populations in the Trinity river of California in the context of dam-induced alterations. *Journal of Herpetology*, 32(4):505-515.

Spinks, P.Q., G.B. Pauly, J.J. Crayon, and H.B. Shaffer. 2003. Survival of the western pond turtle (*Emys marmorata*) in an urban California environment. *Biological Conservation*, 113(2):257-267.

Western pond turtle (*Emys marmorata*) Photo by P. Huber