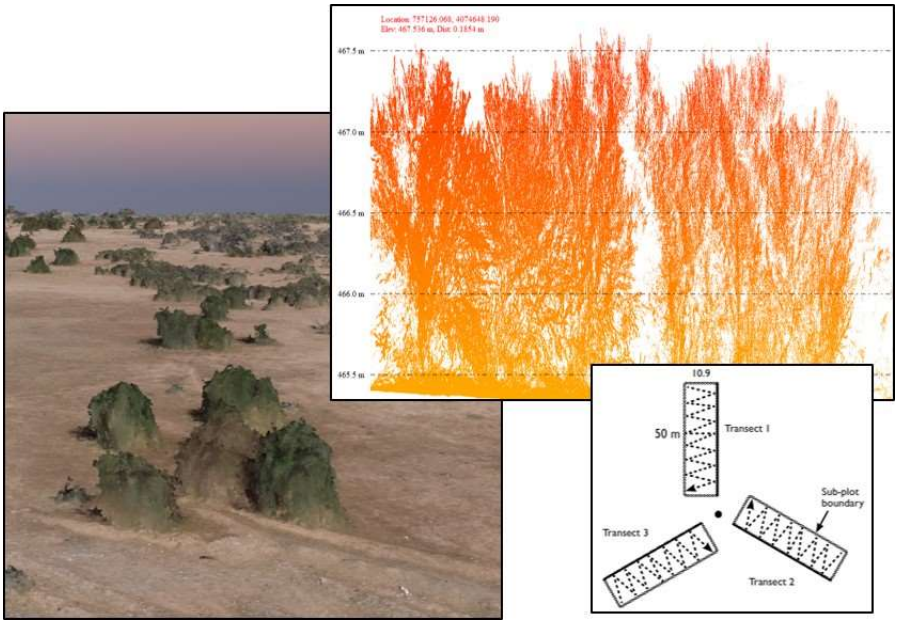
Sampling and Assessment Workshop Report

Draft



Prepared for:
Desert Conservation Program, Clark County, Nevada

January 31, 2021

Prepared by:
Alta Science and Engineering, Inc.
1220 Big Creek Road, Suite A
Kellogg, Idaho 83837
alta-se.com

Alta
Science & Engineering, Inc.

Contents

Tables

Figures

Appendices

Acronyms and Abbreviations

AIM	Assessment, Inventory, and Monitoring Strategy
ALS	Areal Laser Scanner
Alta	Alta Science & Engineering, Inc.
AMMP	Adaptive Management and Monitoring Plan
ARS	Agriculture Research Service
BLM	Bureau of Land Management
BCCE	Boulder City Conservation Easement
BGO	Biological Goals and Objectives
CRR	Canopy Relief Ratio
CWHR	California Wildlife Habitat Relationships
DCP	Desert Conservation Program
GSD	Ground Sampling Distance
LAD	Leaf Area Density
LAI	Leaf Area Index
LiDAR	Light Detection and Ranging
MSAVI	Modified Soil-Adjusted Vegetation Index
MSHCP	Multiple Species Habitat Conservation Plan
NDOW	Nevada Division of Wildlife
NDVI	Normalized Difference Vegetation Index
NIR	Near Infrared
RGB	Red, Green, Blue
SAP	Science Advisor Panel
TLS	Terrestrial laser scanner
UAS	Unmanned Aircraft System

Units

cm	centimeter
m	meter

Section 1 Introduction

The Clark County Desert Conservation Program (DCP) manages Endangered Species Act compliance on behalf of Clark County and the cities of Boulder City, Henderson, Las Vegas, North Las Vegas, Mesquite, and the Nevada Department of Transportation (collectively, the Permittees) through implementation of the Clark County Multiple Species Habitat Conservation Plan (MSHCP) and associated Section 10(a)(1)(B) incidental take permit. The MSHCP was developed to support the incidental take permit, allowing for the "take" of current or future federally listed threatened or endangered species under the Endangered Species Act (RECON 2001). The key purpose of the MSHCP is to balance long-term conservation and recovery of species and habitat within Clark County and the beneficial land use of the growing human population within Clark County (RECON 2001).

As part of the MSHCP, DCP is tasked with monitoring habitat quality. The word "quality", associated with "habitat", occurs frequently throughout Chapter 2 of the MSHCP (RECON 2001). For example, in Section 2.4.2.2 – Conservation Planning Principles (pg 2-57), the MSHCP states that the reserve system should preserve "the quality of habitat sufficient to allow for…resident species." Further, in Section 2.6 – Covered Species, Evaluation Species, and Watch List Species (pg 2-173), the MSHCP states that "Multiple species planning efforts…will be evaluated as to the extent to which the plan provides for the quality of natural habitat." The importance of general habitat quality within the MSHCP is clear, as is the biological importance of habitat quality for covered species. As habitat quality declines, individuals and populations of covered species have fewer resources necessary to maintain their populations, and thus populations will decline. Given both of these factors, the DCP chose to include monitoring habitat quality as an important component of monitoring covered species populations themselves.

One of the tools for implementing the MSHCP is the Adaptive Management and Monitoring Plan (AMMP; TerraGraphics 2017), which includes Biological Goals and Objectives (BGOs; TerraGraphics 2016). Both documents stress the importance of species and habitat monitoring. The AMMP was developed to lay out the techniques to monitor covered species and the general quality of their habitats and to incorporate the results from this monitoring in a process to ensure that should populations or habitat quality decline, mechanisms are in place to detect those declines and evaluate their causes. At the time of the development of the AMMP, however, the protocols for monitoring general habitat quality (both riparian and desert upland) remained unspecified. The BGOs and the AMMP are anticipated to be updated in 2022 and one of the focus areas for the update is to establish a protocol for long-term monitoring within the AMMP.

Prior to specifying the monitoring protocols in the revised AMMP, the types and utility of monitored variables and monitoring methods must be identified. To accomplish this, the Science Advisor Panel (SAP) organized a workshop to identify what specifically about habitat quality should be monitored and to evaluate external guidance and internal field tests on how quality will be monitored. The goal of the workshop was to come to a general consensus on what will be measured and how it will be measured to inform the AMMP revisions.

1.1 Workshop Summary

The SAP organized and attended an internal workshop with DCP staff on August 10 and 11, 2021 with the goal of outlining quantitative long-term monitoring methods that are appropriate for DCP's upland and riparian durable lands. The workshop contained three topics to focus discussion and evaluate monitoring options: 1) **Why** conduct long-term monitoring, 2) **What** attributes to monitor, and 3) **How** to monitor those attributes. Members of the SAP presented

topics and ideas within their specific expertise to inform the group on **What** to monitor and **How** to monitor in DCP habitats. The list of topics presented on included:

- Definition of habitat and the importance of scale (Jocelyn Aycrigg)
- **What** metrics national monitoring programs measure and their applicability to DCP durable lands (Jocelyn Aycrigg)
- Methods and results from previous projects on the Muddy and Virgin Rivers (Chris Rasmussen)
- Upland MSHCP-listed species habitat requirements (**What** to measure) for non-desert tortoise species (Danna Hinderle)
- MSHCP-covered bird species habitat requirements (**What** to measure), with emphasis on the California Wildlife Habitat Relationships (CWHR) program
- Upland habitats – **What** and **How** to measure, including on-the-ground techniques and remotely sensed techniques (Richard Alward)
- Riparian habitats – **What** and **How** to measure, including on-the-ground techniques and remotely sensed techniques (Richard Alward)
- Summary of findings from the Virgin River sensor comparison pilot project, including Unmanned Aircraft System (UAS [drone])-based aerial imagery, multispectral imagery, light detection and ranging (LiDAR) (Areal Laser Scanner [ALS]), and a terrestrial laser scanner (TLS) (Tarita Harju and Richard Alward)

All workshop attendees used the presentation material to draft their own version of **What** metrics to measure and **How** to measure them for both upland and riparian habitats on DCP durable lands. Everyone's proposed **What** and **How** were discussed with specific emphasis on common elements, then elements were reconciled that substantially diverged from others. The resulting metrics to monitor (**What**) and proposed methods to use in monitoring (**How**) are presented in Section 2. The following subsections describe other key information discussed and/or agreed on during the workshop that influence the long-term monitoring methods and how they are applied.

1.2 Desired Monitoring Qualities

The framework for a long-term monitoring program can vary widely. Workshop attendees used the material presented during the workshop to discuss what qualities are important to either build the monitoring program around and/or to allow for future growth and change in monitoring. The following bullets list the desirable qualities for DCPs upland and riparian long-term monitoring programs, as agreed on at the workshop:

- Adaptive Monitoring. We expect that the needs for monitoring, as well as the technologies available, will change over time. Methods used and attributes measured should be translatable to future technologies.
- Nested and opportunistic monitoring. There may be instances where short-term or project effectiveness monitoring can inform on upland and riparian habitat condition (for example, using low-altitude UAS aerial imagery or LiDAR to monitor seedling growth and establishment). These types of data should be opportunistically nested into long-term monitoring data and analysis.
- Plan for future DCP durable lands. Ideally, monitoring methods selected will be applicable to new properties that become managed by DCP.

- Comparability to other data sets. The ability to directly compare DCP long-term monitoring data to other programs' data is beneficial for several reasons: 1) Providing context in the case that DCP habitat conditions show a marked-decrease in condition, 2) Ability to combine with larger data sets to interpret trends in habitat, 3) Using established methods increases cost-effectiveness and repeatability.
- Programs should be cost-efficient.
- Interpreting data should involve straight-forward analysis.

1.3 Habitat and Habitat Terms

Habitat and habitat terms are defined a variety of ways for differing programs and professions. Our intent in discussing habitat-related terms used by the DCP (and in the AMMP) are to provide clarity when comparing similar terms as they are used in other documents and programs.

Habitat can be defined as resources and conditions present in an area that produce occupancy, including survival and reproduction, by a given organism (Hall et al. [1997] based on Morrison et al. [1992], Block and Brennan [1993], Grinnell [1917], Leopold [1933], Hutchinson [1957], Daubenmire [1968], and Odum [1971]). Essentially, wherever an organism is provided with resources that allow it to survive – that is habitat. Further explained with information from "*The habitat concept and a plea for standard terminology*" (Hall et al 1997), habitat:

- is organism-specific
- relates to presence of a species, population, or individual (plant or animal) to an area's physical and biological characteristics
- implies more than vegetation or vegetation structure
- is sum of specific resources needed by organisms

Additional habitat-related terms, with associated definitions and notes, are included in Appendix A. These terms are likely used in different capacities by different entities and professions and therefore the definitions presented in Appendix A may be challenged by others. We recognize that there is no standardized terminology for habitat-related terms and will strive to follow one of the recommendations in the Hall et., al. (1997) paper: "*Until scientists use habitat-related terms consistently, we should define habitat concepts…: i.e., words used in definitions should be measurable and accurate*". This concept will be carried forward into the AMMP revisions and we will provide information as to how habitat-related terms are being used. We recognize that even within a single program like the DCP and their contractors, who are performing monitoring, conducting studies, and implementing restoration projects, etc., it is impractical to impose standardized habitat-related terms and definitions; rather understanding and acknowledging how similar habitat-related terms are used will provide some level of clarity.

To illustrate the challenges associated with requiring a standardized set of habitat-related terms, the CWHR program can be used as an example. It is likely that parts of the CWHR method will be used to characterize riparian habitat on DCP's riparian properties (see Section 2.2.1). The following excerpt from the CWHR manual qualifies and describes their use of habitat suitability ratings: "*The* [habitat suitability] *ratings reflect the habitat's ability to support the species as measured by frequency of occurrence or population density. The ratings do not explicitly assess habitat suitability in terms of reproduction or survivorship, which ultimately are more valid measures of habitat quality (Van Horne 1983)*" (Garrison, et. al., 2017). With this statement, the CWHR is clear on their definition of habitat suitability ratings while acknowledging its

shortcomings. For DCP's purposes, it is beneficial to understand CWHR's definition, as much as it is impractical to try to force CWHR ratings to fit a standardization within DCP.

Section 2 Proposed long-term monitoring

Monitoring "habitat area conditions" is a critical component of the Adaptive Management Process and is necessary in order to fully comply with the MSHCP. Collecting quantitative data enables rigorous characterization and analysis of ecosystem status and trends. Any proposed monitoring program should be designed to be compatible with monitoring programs elsewhere in the Mojave Desert. Nonetheless, qualitative assessments (e.g., fixed-point photography) are extremely useful for communication with a broader audience and for illustrating the conclusions from quantitative analyses. Thus, the long-term monitoring program will likely include elements of both quantitative and qualitative approaches. Remotely sensed data may range from qualitative to quantitative, depending on the type of data collected and level of ground-truthing.

2.1 Upland habitat

DCP's durable upland property includes the Boulder City Conservation Easement (BCCE) which is the focus of long-term monitoring; however, monitoring methods and attributes to measure should be adaptable to other lands that may fall under DCP management in the future. Ideally, methods, and therefore results, can be compared to surrounding lands and lend context to ecosystem trends on DCP properties. The following attributes are those selected during the workshop that attendees generally agree should be measured for long-term monitoring (note, this list is subject to change as more information is gathered):

- Cover composition, including vegetation composition, invasive species, species of management concern, and bare ground
- Vertical structure (vegetation height)
- Proportion of soil surface in large inter-canopy gaps
- Soil aggregate stability
- Weather / climate

The Bureau of Land Management (BLM) Assessment, Inventory, and Monitoring Strategy (AIM) was evaluated during the workshop and selected as the most likely base method to implement. AIM methods cover all attributes listed in the bullets above. Specific features of the AIM strategy that support its adoption by DCP include:

(a) **structured implementation** that includes guides for determining when, where, and how often data should be collected to address management questions,

(b) standardized field methods that ensure useable data and **compatibility with monitoring efforts across landscapes and agencies**,

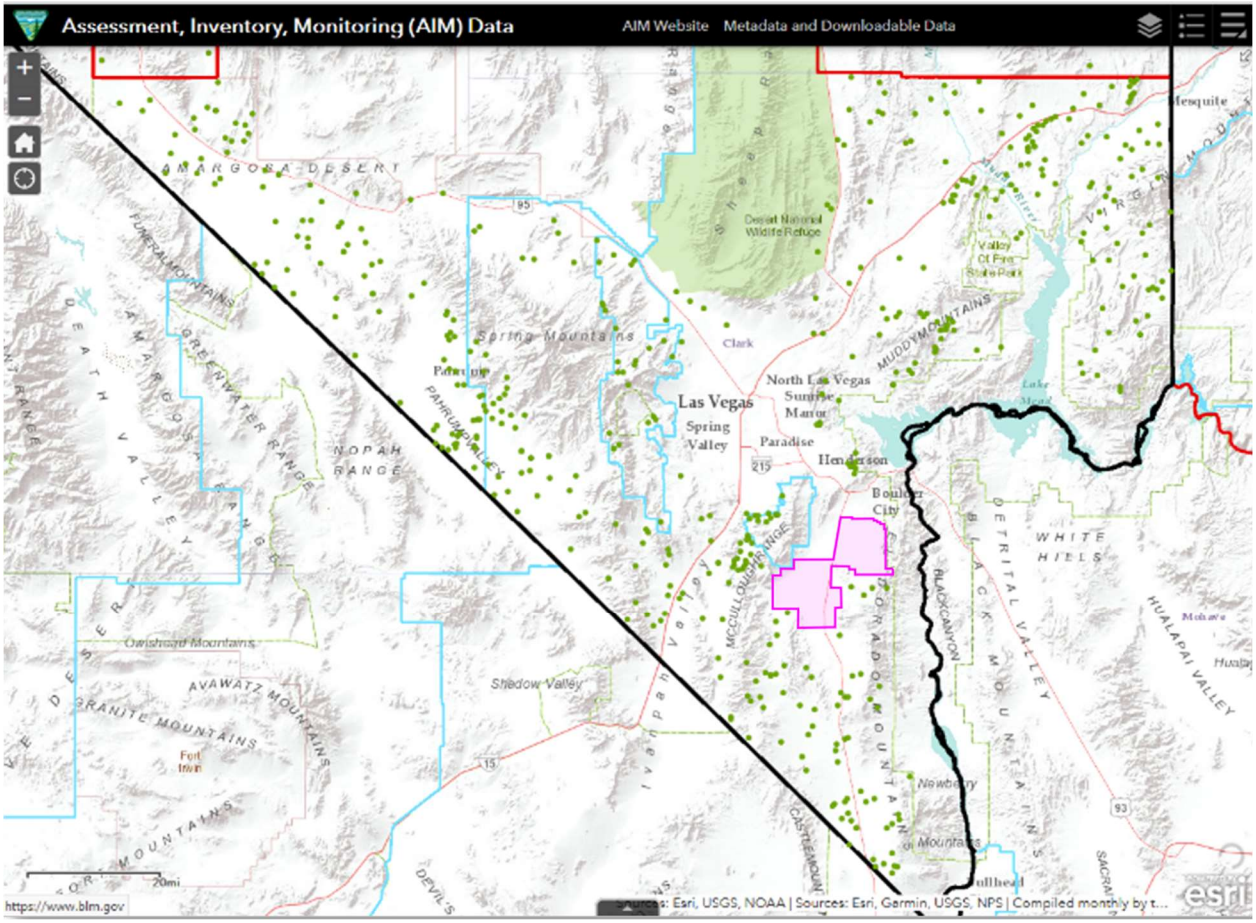
(c) appropriate sample designs that are **scalable and include optional methods** and data collection for specific management objectives,

(d) **integration with remote sensing** that facilitates interpretation and extrapolation at landscape scales.

The AIM strategy and methods are described in *Volume 1: Core Methods, Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems (*Herrick et al 2017; hereafter *Core Methods*) and additional resources that describe applications and implementation of the AIM strategy are listed in Appendix B. The AIM strategy is already being used on BLM land in Clark

County and across county and state lines throughout the Mojave Desert (Figure 1), as well as on Nevada Department of Wildlife (NDOW) lands elsewhere in Nevada. Other federal agencies, including Agricultural Research Service, United States Forest Service, and Natural Resources Conservation Service are using AIM strategies and methods, as are private organizations such as The Nature Conservancy, and researchers at the University of Nevada Reno have contributed to the development and implementation of AIM.

Figure 1. Map of Clark County and surrounding areas illustrating locations of BLM AIM monitoring locations (AIM Landscape Approach Data Portal 2021).



Notes:
1. Green dots = BLM AIM Monitoring locations
2. Magenta polygon = Boulder City Conservation Easement (BCCE).

The AIM Core Method is a quantitative approach that generally takes 2-6 hours to complete per plot (Herrick et al 2017) in the initial year. The time commitment can be expected to decrease to 1.5-3 hours in subsequent years as crews gain experience and the species list becomes more comprehensive (Table 1).

Table 1. Key attributes for the Assessment, Inventory, and Monitoring Strategy, their recommended collection methods, and estimated time requirements.

Attributes Measured or Characterized	Method	Estimated Time (hrs*) Year 1	Year 2	Additional Comments
Qualitative Record *includes recent weather, erosion signs, land use observations*	Plot characterization and observation	0.5-1.0	0.2	After initial setup only updates are necessary – recent weather, erosion signs, land use observations
	Fixed-point photographs	0.1-0.2	0.1	
Vegetation Composition *foliar cover (LPI), species richness, invasive species & rare species presence/absence*	Line point intercept (LPI)	0.5-1.5	0.5-0.75	
	Species inventory	0.25	0.25	
Vertical Structure	Vegetation height	0.25-0.5	0.2-0.5	
Bare Ground	LPI			Bare ground is collected simultaneously with the foliar LPI
Proportion of Soil Surface in Gaps	Canopy gap intercept	0.1-1.0	0.1-0.5	Canopy and basal gap methods are reported separately, but are typically performed simultaneously, thus the time to complete the gap methods is a combined 0.2-1.0 hrs
	Basal gap intercept	0.1-1.0	0.1-0.5	
Soil Aggregate Stability	Soil stability test	0.4-0.6	0.0-0.4	After Year 1, there is little benefit from repeating this measurement unless there is evidence of change in erosion/deposition, or knowledge that there may be a change in erosion susceptibility, e.g., road construction or maintenance, change in recreation activities

The *Core Methods* manual guides users through the parts of the decision-making process for setting up the sampling design, and the sampling design will need to be adjusted to fit the needs of DCP. The following are elements of the proposed upland long-term monitoring protocol that will require additional research, planning, and decision making before they are included in the revised AMMP (anticipated revision in 2022):

- Frequency of monitoring. We estimate a sampling frequency of 1-5 years for attributes being measured using AIM with the exception of the soil aggregate stability which likely will be measured on a 10-year interval. Weather/climate is the only attribute identified during the workshop that is not measured using AIM protocols (see Section 2.1.1).
- Number of plots (sample size). Power analyses (or similar statistical analysis) will be conducted to determine optimal sample frequency and number of plots (i.e., is it better to collect more samples less frequently, or fewer samples more frequently).

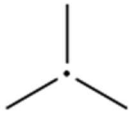
- Stratification
- Plot locations

Development of the sampling design should be a collaborative activity between DCP staff and the SAP, along with experienced BLM and NDOW personnel, to ensure implementation is feasible and that the results will be comparable with surrounding area monitoring programs.

The *Core Methods* manual provides several examples for compatible plot layouts (Figure 2). These plot layouts may be adjusted to meet monitoring objectives as the number of measurements taken remains the same. The most frequently used plot layout is panel *(a) 'spoke design'* in Figure 2. Additionally, panel *(e) 'linear feature design'* suggests a layout that may be appropriate for some riparian ecosystems.

In Nevada, the BLM has instituted protocols for using three 25 meter (m) transects radiating from a central point (panel *(a) 'spoke design'* in Figure 2, below) for collecting data on vegetation composition, vertical structure, bare ground, canopy gaps, and soil stability for each site. BLM personnel at both national and field office levels have offered to contribute their significant experience to assist DCP in making these decisions to maximize the compatibility and comparability of the DCP monitoring program with other programs throughout the Mojave Desert (Nafus and Young 2021, pers. comm.).

Figure 2. Example plot layout designs for AIM core methods. Taken from Figure 5, Core Methods, Herrick et al. 2017)

PLOT LAYOUT	DESCRIPTION	
(a) Spoke Design	25 m spoke design covers ~0.3-hectare (~0.7 acres). 50 m (~75 ft) spoke design covers a 1 hectare (~2.35 acres) area. Transects begin 5 m (15 ft) from the plot's center to focus trampling around center stake and minimize disturbance effects on transects.	
(b) Intersecting Design	The NRI intersecting transect design covers ~0.2 hectares (~0.4 acres). Two 50 m (150 ft) transects intersect at the 25 m (75 ft) mark at plot center. The transect arms are oriented 45 degrees in both directions from magnetic north.	
(c) Parallel Transect Design	Standard transect length is 25 m (75 ft). Parallel transects are evenly spaced. Transects may run perpendicular to the slope or perpendicular to a randomly selected azimuth.	
(d) Single Transect Design	Standard transect length is 25 m (75 ft); a multiple single transect design is often used to maximize replication at landscape scale.	
(e) Linear Feature Design (e.g., riparian)	Standard transect length is 25 m (75 ft); a multiple single transect design is often used to maximize replication at landscape scale. Length may vary depending on linear feature size, extent, or potential impact.	

Workshop attendees also saw the value in assessing DCP's upland durable lands qualitatively, using methods that are relatively quicker and easier to implement than AIM and can be employed on a shorter frequency. These methods will likely rely on remotely sensed data and will be specified after finalization of riparian methods in order to maximize overlapping methods between habitats (See Section 2.2).

2.1.1 Weather/Climate Monitoring

Weather and climate monitoring is anticipated for both upland and riparian properties. We proposed DCP monitor temperature, humidity, and precipitation at each of their general property locations (BCCE, Muddy River, and Virgin River). Other parameters such as soil moisture are options to add on to a weather station sensor, depending on the type selected.

Selection of an appropriate weather station should consider: 1) its ability to add on additional stations if DCP's durable land system grows, 2) cost balance and data accuracy, 3) durability in a desert environment, and 4) ease of use, maintenance, and data accessibility. With these key considerations in mind, we researched potential weather stations and selected one example to highlight. Other products, similar in nature, are likely available.

Example Product: Atmos 41 with ZL6 data logger (Figure 3).

Parameters collected: Air temperature, relative humidity, vapor pressure, barometric pressure, wind speed (including gust and direction), solar radiation, precipitation, lightning strike counter and distance.

Other features relevant to DCP: additional sensors (e.g., soil moisture) can be added; data download can be either in-person with a single-wire transfer to a laptop, Bluetooth, or via cloud connection that can be shared with collaborators; low maintenance (typical maintenance is 2-3 years) and no moving parts; and it is designed for harsh environments, is compact, and relatively inconspicuous.

Cost: We did not request a quote; but did discuss relative cost ranges. This instrument is considered mid-level and is likely in the $2,200-$2,500 range per unit (cloud connectivity for data transfer is an additional ~$180/year). High end stations are expected to cost ~$10,000 - $15,000, and low end, less-reliable and higher maintenance stations are expected to cost $600-$1,000.

Figure 3. Example Weather Station Product – Atmos41 with ZL6 data logger (METER Group, Pullman, WA)

We also researched existing weather station networks in and around Nevada and found that most use a larger station on a tower with several moving-part instruments attached. We did not research these options further because of perceived risk of vandalism and equipment maintenance. However, these could be options to further investigate (e.g., The Community Environmental Monitoring Project [CEMP] lists their instrumentation at https://cemp.dri.edu/cemp/docs/).

Additional planning and research will be required to determine the actual instrument to be used, frequency of data recording, frequency of data analysis, and clear goals and objectives associated with the monitoring. Specifically, we assume the data will be used as a partner data set to inform habitat and species trends, but there are no specific objectives related to weather data.

2.2 Riparian habitat

DCPs durable riparian properties include 25 parcels on the Muddy and Virgin Rivers (Clark County 2021). Parcels range in size from <1 acre to 100 acres, with some being contiguous and others being isolated parcels surrounded by private and/or public ownership. DCP acquires land by the parcel on a willing-seller, willing-buyer basis. One of the outcomes of a willing-seller property acquisition is that even though DCP's interest in the property is largely for its riparian habitat, acquired properties often also include upland habitat adjacent to the riparian corridor. Long-term monitoring methods described in this document focus on the health of the riparian habitat, but should be employed across the entire parcel to inform future management decisions and potential restoration opportunity.

In addition to the need to monitor overall riparian ecosystem health, the DCP is required to monitor 78 MSHCP-covered species and their habitats. For the DCP riparian properties, this includes six avian species: Southwestern willow flycatcher (*Empidonax traillii extimus*), yellow-billed cuckoo (*Coccyzus americanus*), blue grosbeak (*Passerina caerulea*), summer tanager (*Piranga rubra*), vermilion flycatcher (*Pyrocephalus rubinus*), and Arizona Bell's vireo (*Vireo bellii arizonae*). These species have diverging habitat requirements; for example the yellow-billed cuckoo requires a dense canopy >5 m tall with a diverse vertical structure; whereas the vermillion flycatcher requires open habitat with scattered trees and does not tolerate a dense understory or canopy. Designing a monitoring strategy with the aim of identifying quality habitat for all MSHCP-covered avian species is not straightforward because what may be good habitat for one species is unsuitable habitat for another. With this in mind, we evaluated the common characteristics that contribute to habitat for each species

The following attributes are those selected during the workshop that attendees generally agreed should be measured for long-term monitoring and that influence habitat quality for MSHCP-covered avian species (note, this list is subject to change as more information is gathered):

- Cover—total cover, composition of herbaceous, woody, bare ground, rock, surface water, etc., and cover by: functional group, (key) species, and understory vs. overstory.
- Height—Overall/average height and height by canopy level.
- Vegetation density—Leaf Area Index (LAI), Leaf Area Density (LAD), Canopy Relief Ration (CRR), Chlorophyll, NDVI/Modified Soil-Adjusted Vegetation Index (MSAVI), stem count, or similar.
- Vigor/Greenness—Live vs stressed vs dead plants, NDVI/MSAVI/TGI (visible bands)
- Vertical temperature gradient

- Tree diameter at breast height (DBH)
- River bank and floodplain slopes and heights
- Weather/climate (Section 2.1.1)

The focus at the workshop was on the general categories of attributes that describe riparian habitat—primarily **cover, height, density, and vigor**. The specific attributes to be measured or derived may vary depending on the method or sensor used to collect the data. Using vegetation density as an example, the workshop attendees agreed that density of vegetation is an important metric for riparian habitat quality and several specific measures of vegetation density were discussed (LAI, LAD, CRR, NDVI, stem counts, etc.); however, there is no expectation of which specific measure(s) will be implemented in the long-term monitoring plan. Each of the specific attributes (LAI, LAD, CRR, NDVI) were treated as equally desirable measures of vegetation density.

Ideally, the same (or similar) methods would be used for long-term monitoring on all DCP properties (upland and riparian properties); however, the dense vegetation in the riparian areas make traditional on-the-ground methods such as line-point-intercept (as used in AIM, Section 2.1) inaccurate and not representative of habitat conditions (we acknowledge there may be workarounds to this issue, but presently the workshop attendees' preference is to avoid ground-intensive monitoring methods). The workshop attendees generally agreed that remotely sensed data with ground-truthing will best characterize riparian habitat conditions.

The three sensors focused on during the workshop were all low-altitude UAS-flown instruments and included Red, Green, and Blue (RGB) imagery with approximately 2-centimeter (cm) resolution, aerial LiDAR (ALS) with approximately 80-500 ground returns per square meter, and a five-band multispectral imagery with approximate 7-8 cm ground sampling distance (GSD) resolution. A TLS was also tested for its capabilities in DCP's riparian habitat but was excluded from further consideration because of its limited detection range from the sensor's base (Alta 2022). At the conclusion of the workshop, DCP staff suggested they may have access to relatively low-cost satellite-based data that may achieve similar attribute measurements. This additional option is included in the bulleted discussion below.

Based on discussion of analysis examples presented at the workshop and comparison of which attributes each sensor can measure (quantitatively or qualitatively), the workshop attendees generally agree to incorporate the three sensors in the following ways for long-term monitoring:

- **Four-band minimum multispectral imagery:** Build the long-term monitoring program around this sensor and its resulting data/analyses. Frequency of data collection (including ground-truthing) is not finalized but is anticipated to be in the 4-6 year range. The four-band minimum multispectral imagery performs the best at calculating several attributes; however, it is limited to qualitative interpretation for some calculations (e.g., any attribute that depends on height). Four-band minimum is specified for the multispectral imagery, but similar high-resolution can be achieved using five-, six, and ten-band multispectral sensors also. As technology advances and becomes more accessible, the sensors available to DCP for monitoring are expected to improve as well.

  Discussion and examples at the workshop were based on data collected from a low-altitude UAS with a MicaSense RedEdge-MX sensor attached (GSD = 7.36 centimeters). DCP researched cost-effective satellite-based options available to them and found an alternative option of acquiring data from the Sentinel-2a and 2b, which has a 10-day orbit cycle and a GSD of 10 meters.

Note that the four-band multispectral data inherently includes RGB bands; the difference between the RGB collected as part of the multispectral imagery and the RGB collected using a high-resolution digital camera are the spectral widths covered by each of the red, green, and blue bands. The RGB bands collected from a high-resolution digital camera cover a broader spectral width, which makes the image appear richer and "more interpretable" to the human eye. The multispectral sensor collects a smaller spectral width for each red, green, and blue band and the resulting images are typically described as 'flat' and less interpretable (Alta 2022).

- **Low-altitude aerial LiDAR (ALS):** LiDAR data provide quantitative measurements for many attributes that cannot be accurately measured otherwise; however, its computation frequently must be combined with other sensors (e.g., RGB imagery is a companion sensor used to identify species). The frequency for obtaining LiDAR data will likely be approximately every 10 years. While the quantitative nature of these data are valuable, they likely only need to be collected at a time interval over which substantial non-extreme ecological changes are expected to occur (e.g., an event that impacts overall vegetation growth).
- **RGB imagery:** Low-altitude RGB imagery has very high resolution (e.g., ≤2-cm resolution) and is valuable in combination with the other sensors (multispectral and LiDAR) for calculating several attributes, especially for post-hoc verification such as species identification. The RGB sensor is also the most widely available and easiest to collect data with; therefore, we anticipate that it will be used for project effectiveness monitoring (e.g., before and after a restoration project and for continued monitoring of vegetation growth/success). We propose that this specific sensor (mounted on a low-altitude UAS to achieve ~2 cm resolution) should not be built into the long-term monitoring program, but rather it be acquired whenever possible and retained for use and analysis.

  DCP is currently obtaining RGB imagery that covers the riparian properties on an annual basis and could be used for interpretation. The imagery is 2nd generation Nearmap imagery and has resolution of 5.5-cm.

  Additionally, RGB data is inherently collected when a multispectral sensor is used and may be a helpful companion for analyses, but see the multispectral imagery bullet above for a discussion on the differences between standalone RGB and multispectral RGB. RGB data may also be obtained from publicly available USDA NAIP imagery (4-bands, including RGB and Near Infrared [NIR]) with 60-cm resolution.

Table 2. Relative level of quality achieved by each sensor for each analysis/attribute. Some analyses have substantially higher quality results when >1 sensor's data are combined.

General Attribute	Specific Attribute / Analysis	Sensor Type		
		4+ Band MS (~7.36 cm GSD)	ALS/TLS (Avg ≥ 80 returns/m²)	RGB (~2 cm resolution)
Cover	Vegetation and ground composition	Quant	Quant	*Qual*
	Total cover	Quant	Quant (CRR)	*Qual*
	Cover by group and/or species	Quant	*Qual*	*Qual*
	Understory vs overstory	—	Quant	—
Height	Overall/average height	*Qual*	Quant	*Qual*
	Height by canopy level	—	Quant	—
Vegetation Density	LAI/CH/LAD/TGI	Quant (LAI, CH)	Quant (LAD)	—
	NDVI/MSAVI	Quant	—	—
Vigor/ Greenness	NDVI/MSAVI/TGI (visible bands)	Quant	—	—
	Live vs stressed vs dead	*Qual*	—	*Qual*
Other	Slopes/bank height	*Qual*	Quant	*Qual*
Proposed Frequency		TBD, estimate every 4-6 years	TBD, estimate every 10 years, with focus on attributes that cannot be measured by other sensors	Opportunistic, typically obtained as part of a specific project

2.2.1 California Wildlife Habitat Relationships System (CWHR)

The attributes discussed in Section 2.2 will inform both overall riparian habitat quality and specific habitat quality for MSHCP-listed riparian species. Our intent is to collect data to inform overall riparian habitat quality and to rely on the same set of data to identify or delineate the relative quality of habitat on each riparian property for each MSHCP-listed avian riparian species. The CWHR has a depth of resources that describe each species' habitat and guidelines for identifying quality habitat for each (Garrison et al., 2017). The CWHR provides a matrix of vegetation characteristics and ranks them for species' suitability for reproductive, cover, and feeding habitat. Each matrix and rating is specific to ecosystem type (e.g., desert riparian) and to the season each species is present. Select information from the CWHR (Garrison et al., 2017) is included as Appendix C and the following text and tables provide a simplified summary of key elements that we propose to include in DCP's long-term monitoring on riparian properties. The main differentiator in determining habitat quality for each species lies with vegetation size class, height, and closure/cover class (Table 3 and Table 4). These size and cover classes should inform long-term monitoring methods in the resolution required for measurements (i.e., the smallest plant height increment listed in Table 3 is 2 feet, which informs on the sensitivity of the tool or sensor that will be quantifying plant height).

Table 3. Vegetation size class and heights to determine avian habitat quality in desert habitats (taken from the CWHR non-wooded habitat sampling datasheet in Garrison et al., 2017.)

CWHR Size Classes	Size Class Descriptions	Plant Height for Desert Habitats
1	Seedling shrub/tree Short herb Seedling tree	<2.0 ft
2	Young shrub Tall herb Small shrub/tree	2.0 - 9.9 ft
3	Mature shrub Large shrub/tree	10.0 - 19.9 ft
4	Decadent shrub	≥ 20.0 ft

Table 4. Canopy closure and cover classes to determine avian habitat quality in desert habitats (taken from the CWHR non-wooded habitat sampling datasheet in Garrison et al., 2017.)

CWHR Canopy & Cover Class	Closure Class	Ground Cover (Canopy Closure)
S	Sparse cover	10.0 - 24.9% Shrub; 2.0 - 9.9% Herb, Palm Oasis, Joshua Tree, & Desert Types
P	Open Cover	25.0 - 39.9% Shrub; 10.0 - 39.9% Herb, Palm Oasis, Joshua Tree, & Desert Types
M	Moderate Cover	40.0 - 59.9% all types
D	Dense Cover	≥ 60.0% all types

Information described in Table 3 and Table 4 can be obtained using sensors and attributes described in Section 2.2 (with some level of ground-truthing that is also required when using sensors for data collection). The CWHR uses classes listed in Table 3 andTable 4 in a cross-walk matrix to determine the level of habitat suitability for reproductive, cover, and feeding habitats for each species. Descriptions of CWHR habitat suitability classes are listed in Table 5.

Table 5. Habitat suitability ratings used by the CWHR (taken from the CWHR manual, Garrison et al., 2017.)

Habitat Suitability Rating	Description
HIGH	Habitat is optimal for species occurrence; can support relatively high population densities at high frequencies.
MODERATE	Habitat is suitable for species occurrence; can support relatively moderate population densities at moderate frequencies.
LOW	Habitat is marginal for species occurrence; can support relatively low population densities at low frequencies.
UNSUITABLE	Habitat is unsuitable for species occurrence; species is not expected to occur in the habitat.

The CWHR has also identified specific habitat elements that are known to influence or support the presence of each avian species. These elements are presented as a checklist datasheet (Appendix C) that can be completed any time while on DCP's riparian properties, but are likely not measureable using remotely derived data. Each species' information sheet indicates which habitat elements are relevant and a thorough use of the habitat element checklist is likely not required (i.e., determining presences/absence of every habitat element on the checklist may be time consuming and unwarranted when only a select few habitat elements are relevant for the six riparian MSHCP-listed avian species).

Section 3 Next Steps

This report summarizes the content and outcomes from the August 2021 Sampling and Assessment Workshop and build on those outcomes to create the framework for DCP's long-term habitat monitoring on their durable upland and riparian properties. This information and proposed methods should be evaluated and refined to determine actual protocols used in long-term habitat monitoring. Specific items that need to be addressed after a method is agreed on include:

- Upland Monitoring (from Section 2.1):
    - Frequency of monitoring (estimated at 1-5 years for most attributes).
    - Number of plots (sample size; likely determined by power analyses).
    - Stratification.
    - Plot locations.
    - Overlap in methods with riparian monitoring; this is dependent on final methods selected for riparian monitoring and is anticipated to focus on remotely derived data/sensors that will be used for qualitative characterization.
    - The role of qualitative information such as fixed-point photography.
- Riparian Monitoring (from Section 2.2):
    - Data source/sensor; An evaluation comparing resolution and possible data products derived from low-elevation UAS sensors and those derived from satellites is needed to determine the most efficient way to meet DCP's desired

monitoring qualities (Section 1.2) and that provide the resolution needed to characterize DCP's riparian properties.

- Frequency of monitoring (dependent on type of data/sensor selected).
- Level of ground-truthing and associated methods.
- Understanding of the types of comparisons that will be able to be made to future datasets, assuming technological advances will result in substantially higher resolution and resulting calculations for specific attributes may change (this is reflected in desired monitoring quality "adaptive monitoring" in Section 1.2).

- Weather Monitoring:
  - Select appropriate instrument.
  - Frequency of data collection and data analysis.
  - Determine if specific goals and objectives for its analysis are needed.

The final long-term monitoring methods will be specified in the AMMP revision (anticipated in 2022).

Section 4 References

AIM Landscape Approach Data Portal. 2021. Map of AIM monitoring locations downloaded on 8 Aug 2021. https://landscape.blm.gov/geoportal/catalog/AIM/AIM.page.

Alta Science and Engineering, Inc. (Alta). 2022. D35 – UAS Data Analysis Report – Temporal Monitoring of Riparian Vegetation Condition in Desert Ecosystems. Prepared for Clark County Desert Conservation Program, Nevada. January 3, 2022.

Block, W. M., and L.A. Brennan.1993. The habitat concept in ornithology: theory and applications. Pages 35-91 in D. M. Power, ed. Current ornithology. Vol. 11. Plenum Press, New York, N.Y.

Clark County, 2021. Riparian Reserves Management Plan, Version 1.3. July 2021.

Daubenmire, R. 1968. Plant communities: a textbook of plant synecology. Harperand Row, New York, N.Y. 300pp

Garrison, B. A, M. D Parisi, K. W Hunting, T. A Giles, J. T McNerney, R. G Burg, K. J Sernka, S. L Hooper, M Gogol-Prokurat, J Boros. 2017. 11th Edition Training Manual, California Wildlife Habitat Relationships System, CWHR Database, Version 9.0. December 2017.

Grinnell, J. 1917. The niche-relationships of the California thrasher. Auk 34:427-433.

Hall, L. S., Krausman, P. R., & Morrison, M. L. (1997). The Habitat Concept and a Plea for Standard Terminology. Wildlife Society Bulletin, 25(1), 173–182. http://www.jstor.org/stable/3783301

Herrick, J. E, J. W Van Zee, S. E McCord, E. M Courtright, J. W Karl, L. M Burkett. 2017. Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems. 2nd edition. Volume I: Core Methods. USDA-ARS Jornada Experimental Range, Las Cruces, NM.

Hutchinson, G. E. 1957. Concluding remarks. Cold Spring Harbor Symposium on Quantitative Biol. 22:415-427.

Leopold, A. 1933. Game management. Charles Scribner's Sons, New York, N.Y. 481pp.

Morrison, M. L., B. G. Marcot, and R. W. Mannan.1992. Wildlife-habitat relationships: concepts and applications. Univ. Wisconsin Press, Madison. 343pp.

Nafus, Aleta, and Quinn Young. 2021. Personal communication with Richard Alward, including phone calls and emails between August 20, 2021 and September 13, 2021.

Odum, E. 1971. Fundamentals of ecology, Third ed. W. B. Saunders Co., Philadelphia, Pa. 574pp.

RECON. 2001. Final Clark County Multiple Species Habitat Conservation Plan and Environmental Impact Statement for Issuance of a Permit to Allow Incidental Take of 79 Species in Clark County, Nevada, September 2000.

TerraGraphics Environmental Engineering, Inc. (TerraGraphics). 2016. Biological Goals and Objectives for the Clark County, NV Multiple Species Habitat Conservation Plan - Final. June 22, 2016.

TerraGraphics. 2017. Adaptive Management and Monitoring Plan. Prepared for Clark County Desert Conservation Program. January 19, 2017.

Van Horne, B. 1983. Density as a misleading indicator of habitat quality. Journal of Wildlife Management 47:893-901.

Appendix A
Habitat-related Terms Discussed at the August 2021 Sampling and Assessment Workshop

Habitat-related terms and discussion/definitions included during the August 2021 Sampling and Assessment Workshop. These definitions are based on information and concepts from Hall et. al. 1997. We recognize that varying professions and entities may use terms in different ways and may challenge information herein.

- Habitat type
  - Not the same as habitat, refers only to type of vegetation association in an area
  - Should not be used to discuss wildlife-habitat relationships
  - When only referring to vegetation that is used by an animal use vegetation association or vegetation type
- Habitat use
  - The way an animal uses a collection of physical and biological components (i.e., resources) in a habitat
- Habitat selection
  - A hierarchical process involving a series of innate and learned behavioral decisions made by an animal about what habitat it would use at different scales of the environment (Hutto 1985)
  - Process by which an animal chooses which habitat components to use (Johnson 1980)
- Habitat preference
  - Consequence of the process of habitat selection, resulting in disproportional use of some resources over others
- Habitat availability
  - Refers to accessibility and procurability of physical and biological components of a habitat by animals
  - It does not refer to abundance of habitat
  - Hall et al (1997) believe habitat abundance is commonly measured not habitat availability
- Habitat quality
  - Refers to ability of the environment to provide conditions appropriate for individual and population persistence.
  - Continuous variable (i.e., low to medium to high) based on resources available for survival, reproduction, and population persistence, respectively
  - Most useful when linked to demographic characteristics
- Suitable habitat
  - Should not be used
  - If an organism occupies an area that supports some of its needs, then it is habitat
  - By definition habitat is suitable
- Unsuitable habitat
  - Non-existent
  - Habitat quality changes not suitability
- Unused or unoccupied habitat (and the converse of these terms)
  - Appropriate when discussing threatened, endangered, or rare species
  - Not all habitat can be used because of small population sizes
- Critical habitat
  - Legal term describing physical and biological features essential to the conservation of a species
  - Can occur in areas within or outside geographic range of a species
  - Ecologically this term should be linked to high-quality habitat, which infers to an area's ability to provide resources for population persistence (see Habitat quality above)

Appendix B
Additional Resources and Examples on AIM Implementation

List of Additional Resources on AIM Implementation, taken from Herrick et. al., 2017.

Box 2. Selected references for implementing AIM and other monitoring strategies in arid ecosystems (most are available from links within the Landscape Toolbox [https://aim.landscapetoolbox.org/]).

Belnap, J, RH Webb, ME Miller, DM Miller, LA DeFalco, PA Medica, ML Brooks, TC Esque, D Bedford. 2008. Monitoring Ecosystem Quality and Function in Arid Settings of the Mojave Desert. US Geological Survey, Scientific Investigations Report 2008-5064. [https://pubs.usgs.gov/sir/2008/5064/sir2008-5064.pdf]

BLM. 2016. Terrestrial AIM Rejection Criteria Protocol. [https://aim.landscapetoolbox.org/wp-content/uploads/2016/12/RejectionCriteria_161228.pdf]

BLM. 2017. Reclamation Site Monitoring. Draft protocol consistent with the BLM Core Terrestrial Indicators and Methods. [https://aim.landscapetoolbox.org/wp-content/uploads/2016/12/Reclamation_plot_monitoring_20170914.pdf]

BLM. 2021. AIM National Aquatic Monitoring Framework: Field Protocol for Wadeable Lotic Systems. Tech Ref 1735-2, Version 2. US Department of the Interior. Bureau of Land Management. National Operations Center. Denver, CO. [https://aim.landscapetoolbox.org/wp-content/uploads/2020/05/Lotic_FieldProtocolForWadeableSystems_TR1735-2.pdf]

Elzinga, CL, DW Salzer, JW Willoughby. 1998. Measuring and Monitoring Plant Populations. BLM Technical Reference 1730-1. Bureau of Land Management. National Business Center. Denver, CO. [https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1041&context=usblmpub]

Herrick, JE, JW Van Zee, SE McCord, EM Courtright, JW Karl, LM Burkett. 2017. Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems. 2nd edition. Volume I: Core Methods. USDA-ARS Jornada Experimental Range, Las Cruces, NM. [https://www.landscapetoolbox.org/wp-content/uploads/2016/02/MMGSSE_20170614.pdf]

Herrick, JE, JW Van Zee, KM Havstade, LM Burkett, WG Whitford. 2005. Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems. Volume II: Design, supplementary methods and interpretation. USDA-ARS Jornada Experimental Range, Las Cruces, NM. [https://aim.landscapetoolbox.org/wp-content/uploads/2015/09/Monitoring-Manual-Volume-II.pdf]

MacKinnon, WC, JW Karl, GR Toevs, JJ Taylor, M Karl, CS Spurrier, JE Herrick. 2011. BLM Core Terrestrial Indicators and Methods. Technical Note 440. US Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO. [https://aim.landscapetoolbox.org/wp-content/uploads/2015/09/TN440-BLM-Core-Terrestrial-Indicators-and-Methods.pdf]

Miller, ME. 2005. The Structure and Functioning of Dryland Ecosystems—Conceptual Models to Inform Long-Term Ecological Monitoring. US Geological Survey, Scientific Investigations Report 2005-5197. [https://aim.landscapetoolbox.org/wp-content/uploads/2015/09/Structure-and-Functioning-of-Dryland-Ecosystems_Miller-2005.pdf]

NRCS. 2021. National Resources Inventory Grazing Land On-Site Data Collection: Handbook of Instructions. United States Department of Agriculture. Natural Resources Conservation Service. [https://grazingland.cssm.iastate.edu/files/inline-files/nri_grazing_land_instructions_2021_v2.pdf]

Toevs, GR, JW Karl, JJ Taylor, CS Spurrier, WC MacKinnon, MR Bobo. 2011. Bureau of Land Management Assessment, Inventory, and Monitoring Strategy: For integrated renewable resources management. BLM. National Operations Center, Denver, CO. [https://aim.landscapetoolbox.org/wp-content/uploads/2015/09/AIM_strategy.pdf]

Toevs, GR, JW Karl, JJ Taylor, CS Spurrier, M Karl, MR Bobo, JE Herrick. 2011. Consistent Indicators and Methods and a Scalable Sample Design to Meet Assessment, Inventory, and Monitoring Information Across Scales. *Rangelands* 33:14-20. [https://aim.landscapetoolbox.org/wp-content/uploads/2015/09/Consistent-Indicators-and-a-Scalable-Sample-Design-to-Meet-Assessment-Inventory-and-Monitoring-Needs-Across-Scales_Toevs.pdf]

Appendix C
Selected Information and Datasheets from the CHWR System Manual

Appendix B
Excerpts from the CWHR manual, selected supplemental information,
and non-wooded datasheet.

11th Edition

Training Manual

California Wildlife Habitat Relationships System

CWHR Database Version 9.0

by

Barrett A. Garrison, Monica D. Parisi, Kevin W. Hunting,
Terry A. Giles, John T. McNerney, Richard G. Burg, Karyn J. Sernka, Stacie L. Hooper,
Melanie Gogol-Prokurat, Joel Boros

California Wildlife Habitat Relationships Program
Biogeographic Data Branch
California Department of Fish and Wildlife
1700 9th Street, 4th Floor,
Sacramento, CA 95811

December, 2017

Example Habitat Suitability Information (from discussion at the November, 2021 quarterly meeting). This information is taken from a CWHR species information sheet with notation added to indicate where explanatory information is found in the CWHR system.

HABITAT SUITABILITY INFORMATION

HABITAT	SEASON	SIZE/AGE CLASS	REPRO	COVER	FEEDING
DESERT RIPARIAN	Summer	1 Seedling Tree/Shrub		low	high
		2P Small Tree/Shrub Open	high	high	high
		2M Small Tree/Shrub Moderate	high	high	high
		2D Small Tree/Shrub Dense	high	high	high
		3P Medium Tree/Shrub Open	med	med	high
		3M Medium Tree/Shrub Moderate	med	med	high
		3D Medium Tree/Shrub Dense	high	high	high
		4P Large Tree Open	med	med	high
		4M Large Tree Moderate	med	med	high
		4D Large Tree Dense	high	high	high

1) Classification Rules
2) Table 1 in manual

Page 15 & Table 3 in manual

Non-wooded Habitat Sampling Datasheet

Pages 7 & 8 in manual

USING THE CWHR SYSTEM

> The CWHR user is responsible for correct use of the CWHR system and correct interpretation of system output.

USER RESPONSIBILITY

Ultimately, the CWHR user is responsible for proper system use, while CDFG and CIWTG are responsible for improving the system and promoting proper use. The system is not perfect (see Accuracy of the CWHR Database), and users must acknowledge and accept these inaccuracies when using CWHR. If error-free predictions about wildlife habitat-relationships are needed for whatever reason, then CWHR should not be used. However, if relatively course-scale habitat-relationships models are needed for a variety of predictions about regularly-occurring California wildlife, then CWHR is an appropriate tool. CDFG and CIWTG are responsible for operation, maintenance, and improvement of the system, as well as training users in appropriate use. Yet, no one but the CWHR user is responsible for system use and output interpretation. The credibility of the CWHR system, its developers and managers, and wildlife biologists all suffer when the system is used inappropriately or inadequately.

CWHR DATABASE DEFINITIONS

Life Requisites. CWHR habitat-relationship models rate habitat value for three major life functions or life requisites: Reproduction, Feeding, and Cover. Water use is assumed to occur under each life requisite depending on the role of water in each species life history. Ratings for habitat suitability and habitat elements are given for all three life requisites (see respective Sections below). In many cases, habitats or elements will not have ratings for one or two life requisites, particularly for species that require special habitats or elements for a single life requisite, such as amphibians and many birds.

Habitat Suitability Ratings. All CWHR species models have suitability ratings for all habitats and stages in the system; this includes a rating of UNSUITABLE for those habitats which the species does not utilize. UNSUITABLE ratings occur when the species is not listed in the habitat relationships matrix. These ratings apply only to that species, and the ratings apply to habitats and stages throughout the species' California range. The ratings reflect the habitat's ability to support the species as measured by frequency of occurrence or population density. However, the rating definitions do not explicitly assess habitat suitability in terms of reproduction and survivorship, which ultimately are more valid measures of habitat quality than population density (Van Horne 1983). The four suitability ratings are as follows (modified from Airola 1988):

1. HIGH: Habitat is optimal for species occurrence; can support relatively high population densities at high frequencies.

2. MODERATE: Habitat is suitable for species occurrence; can support relatively moderate population densities at moderate frequencies.

3. LOW: Habitat is marginal for species occurrence; can support relatively low population densities at low frequencies.

4. UNSUITABLE: Habitat is unsuitable for species occurrence; species is not expected to occur in the habitat. The database allows users to specify habitat ratings for searches. Different ratings can be specified for any or all life requisites (Reproduction, Feeding, Cover). Unless user-specified, the database defaults to the lowest rating for suitable habitat (LOW). If specified, the database includes those species that have a life requisite suitability at or above the specified level. For example, specifying MEDIUM for Reproduction, Feeding, and Cover will result in output for species with MEDIUM and HIGH ratings. The greater the habitat rating, (i.e., HIGH > MEDIUM), the fewer the total number of species predicted for a given habitat because species with lower habitat ratings are eliminated.

Geographic Location. Database searches can be done using several different geographic location categories. These categories include: Counties, USDA Ecoregions (CIWTG Endorsed), Cal Water Hydrologic Regions, US Forest Service National Forests. Counties are the smallest geographic area to search for most of California's 58 counties. Exceptions would be large counties such as Inyo, San Bernardino, Kern, Riverside, Lassen, and Siskiyou.

Species predictions for each county are drawn from a variety of sources, including the CWHR distribution maps, published county bird lists and observations by field biologists and other users of CWHR. Some discrepancies will exist between the database models and the distribution maps as maps are not updated as often as the database. However, the distribution of a species, as represented in the database model, will always be inclusive of the area covered by the published map. When discrepancies exist -- particularly in the case of birds, where published county bird lists based on actual observations were reconciled with predictions based on distribution maps -- users should trust the database output. In the case of amphibians, reptiles and mammals, database output more closely resembles distribution maps.

Users should also note that a species in the database is predicted to occur in a county if any source of data regarding that species refers to even a small portion of the county. This holds

Table 1. Elements Assumed Absent in CWHR Habitats.

CWHR Habitat	**Dominant Species or Dominant Associates**	**Elements Assumed Absent** (CWHR users do not have to delete these elements during queries.)
Tree-Dominated Habitats (27)		
Aspen (ASP)	Willow, Alder, Black Cottonwood	kelp, salt ponds, tidepools
Blue Oak Woodland (BOW)	Interior Live Oak, Valley Oak, Juniper	kelp; salt ponds; sand dunes; tidepools; trees, fir
Blue Oak-Foothill Pine (BOP)	Interior Live Oak, Valley Oak, California Buckeye	kelp; salt ponds; sand dunes; tidepools; trees, fir
Closed-Cone Pine-Cypress (CPC)	Tecate, Cuyamaca, Foothill Pine	none
Coastal Oak Woodland (C0W)	White Oak, California Black Oak, Engelmann Oak	none
Eucalyptus (EUC)	Blue Gum, Red Gum	none
Desert Riparian (DRI)	Tamarisk, Velvet Ash, Mesquite	kelp; tidepools; trees, fir
Douglas-Fir (DFR)	Live Oaks, Tanoak, Ponderosa Pine	none
Eastside Pine (EPN)	Ponderosa Pine, Jeffrey Pine, White Fir	kelp, salt ponds, sand dunes, tidepools
Jeffrey Pine (JPN)	Ponderosa Pine, Coulter Pine, Sugar Pine	kelp, salt ponds, sand dunes, tidepools
Joshua Tree (JST)	Juniper, Singleleaf Pinyon, Mojave Yucca	kelp; log, large rotten; log, large sound; log, large hollow; snag, large rotten; snag, large sound; tidepools
Juniper (JUN)	White Fir, Jeffrey Pine, Ponderosa Pine	kelp, tidepools
Klamath Mixed-Conifer (KMC)	White Fir, Douglas-Fir, Ponderosa Pine	kelp, salt ponds, tidepools
Lodgepole Pine (LPN)	Aspen, Mountain Hemlock, Red Fir	kelp, salt ponds, sand dunes, tidepools
Montane Hardwood (MHW)	Canyon Live Oak, Douglas Fir, Knobcone Pine	kelp, salt ponds, tidepools
Montane Hardwood-Conifer (MHC)	Ponderosa Pine, Douglas Fir, Incense Cedar	kelp, salt ponds, tidepools
Montane Riparian (MRI)	Black Cottonwood, White Alder, Bigleaf Maple	kelp, salt ponds, tidepools
Palm Oasis (POS)	Coyote Willow, Velvet Ash, Sycamore	acorns; cones; kelp; tidepools; trees, fir

CWHR Habitat	Dominant Species or Dominant Associates	Elements Assumed Absent (CWHR users do not have to delete these elements during queries.)
		trees and tree interfaces, vernal pools, water – fast, slow and man created, water/agriculture
		Stages 2-4 (subtidal, intertidal, shore, respectively) – none
Riverine (RIV)	Water Moss, Algae, Duckweed	none
Non-Vegetated Habitats (1)		
Barren (BAR)	Rock, Pavement, Sand	none

It must be acknowledged that the database has no explicit way of fully accounting for element distribution, abundance, and quality. When elements are excluded, they are assumed to be absent or present in unsuitable quality or insufficient amounts and distribution. The user must determine the quality and sufficiency of the elements with field inventories of the project area.

The elements were given the following suitability ratings in the models for Reproduction, Feeding, and Cover life requisites (Airola 1988):

1. ESSENTIAL: Required for the species to exist; must be present in habitat if species is to be present.

2. SECONDARILY ESSENTIAL: Required but may be replaced by other secondarily essential elements; must be present unless compensated by presence of other secondarily essential elements in the same life requisite category.

3. PREFERRED: Used but marginally helpful for survival; enhances habitat suitability, but is not essential for species to be present; element used more than would be expected based on availability.

4. NOT RATED: May or may not be used; if used, element does not enhance habitat suitability; element used less than expected based on availability.

Seasonality. Two options exist to define queries based on seasonality: Season in Location or Season in Habitat. These options restrict predictions to those wildlife species with a given seasonal status in the selected geographic locations or habitats. Season in Location and Season in Habitat may be different for a given species depending on its residency status and movements throughout California. If a user selects nothing or selects "All Season Categories", species predictions will not be restricted based on this parameter.

The seasons used in CWHR are defined based on those used in *American Birds* for seasonal bird reports. While the seasons are based on migration and residency patterns of California birds, these seasons correspond fairly well with life history patterns of many California wildlife species. The seasons are defined as follows:

Winter:	December 1 - February 28
Spring:	March 1 - May 31
Summer:	June 1 - July 31
Fall:	August 1 - November 30

Table 3 illustrates what seasons are included under a particular CWHR season category, and the seasonal occurrence status of wildlife in the appropriate CWHR category.

Table 3. CWHR season categories, seasons included in the categories, and appropriate animal seasonality patterns.

CWHR Season Choices	Seasons				Animal Seasonality Pattern
	Winter (Dec. 1 to Feb. 28)	Spring (Mar. 1 to May 31)	Summer (Jun. 1 to Jul. 31)	Fall (Aug. 1 to Nov. 30)	
Only Species Present Yearlong	X	X	X	X	seen in all seasons, mostly residents
Only Winter Visitors	X				winter only
	X			X	fall through winter
	X	X		X	fall through spring
	X	X			winter through spring
Only Summer Visitors and Breeders			X		summer only
		X	X		spring through summer
		X	X	X	spring through fall
			X	X	summer through fall
Only Migrants				X	fall only
		X			spring only
		X		X	spring and fall

Arithmetic and Geometric Means. Two Condition queries can produce either *Habitat Value Comparison Reports* or *Weighted Habitat Value Reports*. These reports require the selection of formula to integrate habitat suitability ratings for Reproduction, Feeding, and Cover, and calculate a mean habitat suitability rating. Users must select either Arithmetic or Geometric means.

In both reports, the habitat stage life requisite ratings of HIGH, MEDIUM, LOW, or UNSUITABLE are converted to numeric values of 1.00, 0.66, 0.33, and 0.00, respectively. These values for Reproduction, Feeding, and Cover are averaged for each size/cover stage. Each formula has its advantages and disadvantages, and users should be aware of these when selecting a formula. Arithmetic means treat each life requisite rating equally, regardless of value, while

Habitat Classification Rules
California Wildlife Habitat Relationships System
California Department of Fish and Game
California Interagency Wildlife Task Group
April, 2005

Structure | **Composition** | **Geographic Region**

Tree-Dominated

≥ 10% total cover by live vegetation in an overstory position; not a desert habitat (per those listed below)

Hardwood

≥ 50% relative overstory cover by hardwoods and < 25% relative overstory cover by conifers

Hardwood Defined by Species

ASP, EUC, BOW, VOW

Hardwood Defined by Region - Upland

Generally, in non-coastal regions and dominated by montane hardwoods, with or without oaks, or in coastal regions with canyon live oak (*Quercus chrysolepis*), California black oak (*Q. kelloggii*) or Oregon white oak (*Q. garryana*) as the dominant oak. **MHW**

Generally, in coastal regions with coast live oak (*Q. agrifolia*) or Englemann oak (*Q.* engelmannii) as the dominant oak. **COW**

Hardwood-Conifer

≥ 50% relative overstory cover by hardwoods and ≥ 25% relative overstory cover by conifers

MHC, BOP
(Rule exception: Stands dominated by foothill pine crosswalk into BOP.)

Hardwood Defined by Region - Riparian

Generally, in montane regions, often intergrading with wet meadows, or in coastal and foothill regions along steep-gradient streams with black cottonwood (*Populus trichocarpa*) or bigleaf maple (*Acer macrophyllum)* dominating the overstory. May also be dominated by willows (*Salix* spp.) or alders (*Alnus* spp.) **MRI**

Generally, in valley and foothill regions along low-gradient streams with Fremont cottonwood (*P. fremontii*), California Sycamore (*Platanus racemosa*) or Valley Oak (*Q. lobata*) dominating the overstory. May also be dominated by willows (*Salix* spp.) or alders (*Alnus* spp.) **VRI**

(Note: If habitat is dominated by desert species or is in South-eastern Great Basin, Mojave, Sonoran or Colorado deserts, even if dominated by P. fremontii, see DRI under "Desert Tree/Shrub ".)

Conifer

> 50% relative overstory cover by conifers

Single Species Conifer

50% relative conifer cover by a single conifer species, regardless of the number of conifer species in the overstory

(*Note: If dominant conifer species does not have its own CWHR type, see Mixed Conifer below. Rule exception: Stands dominated by Western Hemlock, Grand Fir, and Sitka Spruce crosswalk into RDW*.)

RFR, LPN, WFR, DFR, JPN, RDW, JUN

Single Species Conifer Defined by Region

On the west side of the Sierra Nevada. **PPN**

In the Southern Cascades, Modoc Plateau and east side of the Sierra Nevada on coarse well-drained basaltic soils. **EPN**

Mixed Conifer

≤ 50% relative conifer cover by a single conifer species with ≥ 5% cover by at least one other conifer species
or
> 50% relative conifer cover by a single conifer species that does not have its own CWHR type

CPC, PJN

Mixed Conifer Defined by Region

In the Klamath Mountains, on mid-elevation slopes. **KMC**

In all other mountain ranges, on mid-elevation slopes. **SMC**

In all mountain ranges at high elevations; characterized by open canopy and trees of low to medium stature. **SCN**

Structure	Geographic Region
Shrub-Dominated 10% total cover by shrub species and < 10% cover by tree species; not a desert habitat (per those listed below)	Generally, only at the highest elevations in California, above 7,500 feet. **ADS** Generally, in mountainous terrain, from mid-to-high elevations (3,000 – 10,000 feet). **MCP** Generally, below 5000 feet in mountain ranges throughout California, except in deserts. **MCH, CRC** With a few exceptions, east of the Cascade and Sierra Nevada crests. **LSG, BBR, SGB** In coastal regions throughout the length of California. **CSC**
Desert ≥ 2% total cover by desert species and < 10% total cover by other tree or shrub species	
Desert Tree/Shrub *Desert Tree (size classes based on diameter above bulge)* – **POS, JST** *Desert Tree/Shrub (size classes based on height)* --- **DRI, DSW**	
Desert Shrub *Size classes based on % decadence as with other shrub –dominated habitats*)	Generally, in low-elevation deserts, often with creosotebush (*Larrea tridentata*) as the dominant shrub or in eastern portions of Central California Coast Ranges, often with California Ephedra (*Ephedra californica*) or buckwheat (*Eriogonum* spp).as the dominant shrub. **DSC** Generally, in low-elevation deserts with an overstory of succulents. **DSS** In the Mojave Desert and portions of the Colorado Desert, Great Basin, and southern San Joaquin Valley, dominated by various species of shrubby saltbushes. **ASC**
Herbaceous-Dominated ≥ 2% total cover by herbaceous species and < 10% total cover by tree or shrub species	Generally, statewide. **AGS, PGS, PAS, FEW** Limited to montane or northwestern regions. **WTM** Limited to tidally-influenced portion of coastal regions. **SEW**
Aquatic ≥ 98% total cover by open water and ≤ 2% total cover by vegetation in the continually-exposed shore zone *Freshwater* - **RIV, LAC** *Marine* - **EST, MAR**	
Agricultural/Developed ≥ 2% total cover by non-wildland vegetation grown for food, fiber, or landscaping and does not meet criteria for any wildland habitat *Woody Agricultural* - **DOR, EOR, VIN** *Herbaceous Agricultural* - **DGR, IGR, IRF, IRH, RIC** *Developed* - **URB**	
Barren < 2% total cover by any vegetation **BAR**	

CALIFORNIA WILDLIFE HABITAT RELATIONSHIPS SYSTEM
NON-WOODED HABITAT SAMPLING DATASHEET

Date:_____ Sample Crew:_____Plot Number:_____Location:_____

Visual estimate before sampling; CWHR habitat type:_____

Standards For Size Classes						Standards For Canopy Closure		
CWHR Class	WHR Size Classes	Shrub Habitats (% Crown Decadence)	Herb. Habitats (Plant Ht. @ Maturity)	Palm Oasis & Joshua Tree (base diam. above bulge)	Desert Habitats (Plant Ht.)	CWHR Class	WHR Closure Class	Ground Cover (Canopy Closure)
1	Seedling shrub/tree Short herb Seedling tree	Seedlings or sprouts < 3 yrs old	≤ 12.0"	< 1.5"	< 2.0'	S	Sparse cover	10.0-24.9% Shrub; 2.0-9.9% Herb, Palm Oasis, Joshua Tree, & Desert types
2	Young shrub Tall herb Small shrub/tree	< 1.0% (None)	≥ 12.1"	1.5-19.9"(PO) 1.5-5.9" (JT)	2.0'-9.9'	P	Open cover	25.0-39.9% Shrub; 10.0-39.9% Herb, Palm Oasis, Joshua Tree, & Desert types
3	Mature shrub Large shrub/tree	1.0-24.9%		≥ 20.0" (PO) ≥ 6.0" (JT)	10.0'-19.9'	M	Mod. cover	40.0-59.9% all types
4	Decadent shrub	≥ 25.0%			≥ 20.0'	D	Dense cover	≥ 60.0% all types

Species, age, % decadence, height, and/or veg. canopy hits (+) or misses (-) from plots, grids or lines.

Stem or Pt. #	Species	Age	% Decadent	Ht. (in/ft)	hit or miss (+/-)	Stem or Pt. #	Species	Age	% Decadent	Ht. (in/ft)	hit or miss
1						26					
2						27					
3						28					
4						29					
5						30					
6						31					
7						32					
8						33					
9						34					
10						35					
11						36					
12						37					
13						38					
14						39					
15						40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

VEGETATION COVER MEASUREMENT

Vegetation cover measured along line transect or point intercept with 25-30 readings
Percent vegetation cover = ____(# veg. hits/25 or 30) * 100

— —

CALIFORNIA WILDLIFE HABITAT RELATIONSHIPS SYSTEM
supported by the
CALIFORNIA INTERAGENCY WILDLIFE TASK GROUP
and maintained by the
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
Database Version: 9.0

SPECIES INFORMATION REPORT FOR: BELL'S VIREO

(Vireo bellii)

ACTIVITY/STATUS INFORMATION

IDENTIFICATION:

CWHR ID: B413 CNDDB ID: ABPBW01110

TAXONOMY:

Class: AVES Order: PASSERIFORMES
Family: VIREONIDAE

LIFE HISTORY ATTRIBUTES:

Daily Activity: Diurnal Seasonal Activity: Yearlong Migration: Distant Migrator

SPECIAL STATUS:

subspp.arizonae	California Endangered BLM Sensitive
subspp.pusillus	Federal Endangered California Endangered

LOCATION INFORMATION

LOCATION	SEASON
COUNTY	
INYO	Summer
LOS ANGELES	Summer
MONTEREY	Summer
ORANGE	Summer
RIVERSIDE	Summer
SAN BERNARDINO	Summer
SAN DIEGO	Summer
SAN LUIS OBISPO	Summer
SANTA BARBARA	Summer
VENTURA	Summer
DFG REGION	
BAY DELTA	Summer
CENTRAL	Summer
SOUTH COAST	Summer
INLAND DESERTS	Summer
HYDROLOGIC REGION	
CENTRAL COAST	Summer
SOUTH COAST	Summer
SOUTH LAHONTAN	Summer
COLORADO RIVER	Summer
NATIONAL FOREST	
ANGELES	Summer

CLEVELAND	Summer
INYO	Summer
LOS PADRES	Summer
SAN BERNARDINO	Summer

HABITAT SUITABILITY INFORMATION

HABITAT	SEASON	SIZE/AGE CLASS	REPRO	COVER	FEEDING
DESERT RIPARIAN	Summer				
		1 Seedling Tree/Shrub		low	high
		2P Small Tree/Shrub Open	high	high	high
		2M Small Tree/Shrub Moderate	high	high	high
		2D Small Tree/Shrub Dense	high	high	high
		3P Medium Tree/Shrub Open	med	med	high
		3M Medium Tree/Shrub Moderate	med	med	high
		3D Medium Tree/Shrub Dense	high	high	high
		4P Large Tree Open	med	med	high
		4M Large Tree Moderate	med	med	high
		4D Large Tree Dense	high	high	high
VALLEY FOOTHILL RIPARIAN	Summer				
		1 Seedling Tree		low	high
		2P Sapling Tree Open	high	high	high
		2M Sapling Tree Moderate	high	high	high
		2D Sapling Tree Dense	high	high	high
		3P Pole Tree Open	med	med	high
		3M Pole Tree Moderate	med	med	high
		3D Pole Tree Dense	high	high	high
		4P Small Tree Open	med	med	high
		4M Small Tree Moderate	med	med	high
		4D Small Tree Dense	high	high	high

ELEMENT INFORMATION

ELEMENT	REPRO	COVER	FEEDING
ANIMAL DIET ELEMENTS			
INSECTS - TERRESTRIAL			essential
INVERTEBRATES			essential
HABITAT EDGE ELEMENTS			
SHRUB/WATER	secondary	secondary	secondary
TREE/SHRUB	preferred	preferred	preferred
TREE/WATER	secondary	secondary	secondary
LIVE VEGETATIVE COVER			
LAYER - SHRUB	preferred	preferred	preferred
RIPARIAN INCLUSION	essential	secondary	secondary
VEGETATIVE DIET ELEMENTS			
FRUITS			preferred

CALIFORNIA WILDLIFE HABITAT RELATIONSHIPS SYSTEM
supported by the
CALIFORNIA INTERAGENCY WILDLIFE TASK GROUP
and maintained by the
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
Database Version: 9.0

SPECIES INFORMATION REPORT FOR: BLUE GROSBEAK

(Passerina caerulea)

ACTIVITY/STATUS INFORMATION

IDENTIFICATION:

CWHR ID: B476 CNDDB ID: ABPBX63010

TAXONOMY:

Class: AVES Order: PASSERIFORMES
Family: CARDINALIDAE

LIFE HISTORY ATTRIBUTES:

Daily Activity: Diurnal Seasonal Activity: Yearlong Migration: Distant Migrator

SPECIAL STATUS:

No Special Status

LOCATION INFORMATION

LOCATION	SEASON
COUNTY	
AMADOR	Summer
BUTTE	Summer
CALAVERAS	Summer
COLUSA	Summer
CONTRA COSTA	Summer
EL DORADO	Summer
FRESNO	Summer
GLENN	Summer
IMPERIAL	Summer
INYO	Summer
KERN	Summer
KINGS	Summer
LOS ANGELES	Summer
MADERA	Summer
MARIPOSA	Summer
MERCED	Summer
MONO	Summer
MONTEREY	Summer
NEVADA	Summer
ORANGE	Summer
PLACER	Summer
RIVERSIDE	Summer
SACRAMENTO	Summer
SAN BENITO	Summer
SAN BERNARDINO	Summer
SAN DIEGO	Summer
SAN JOAQUIN	Summer
SAN LUIS OBISPO	Summer
SANTA BARBARA	Summer
SHASTA	Summer
SOLANO	Summer
STANISLAUS	Summer
SUTTER	Summer

TEHAMA	Summer
TULARE	Summer
TUOLUMNE	Summer
VENTURA	Summer
YOLO	Summer
YUBA	Summer
DFG REGION	
NORTHERN	Summer
NORTH CENTRAL	Summer
BAY DELTA	Summer
CENTRAL	Summer
SOUTH COAST	Summer
INLAND DESERTS	Summer
HYDROLOGIC REGION	
NORTH COAST	Summer
SACRAMENTO RIVER	Summer
TULARE LAKE	Summer
SAN JOAQUIN	Summer
SAN FRANCISCO BAY	Summer
CENTRAL COAST	Summer
SOUTH COAST	Summer
NORTH LAHONTAN	Summer
SOUTH LAHONTAN	Summer
COLORADO RIVER	Summer
NATIONAL FOREST	
ANGELES	Summer
CLEVELAND	Summer
EL DORADO	Summer
INYO	Summer
KLAMATH	Summer
LAKE TAHOE BASIN	Summer
LASSEN	Summer
LOS PADRES	Summer
MENDOCINO	Summer
PLUMAS	Summer
SAN BERNARDINO	Summer
SEQUOIA	Summer
SHASTA-TRINITY	Summer
SIERRA	Summer
STANISLAUS	Summer
TAHOE	Summer
TOIYABE	Summer

HABITAT SUITABILITY INFORMATION

HABITAT	SEASON	SIZE/AGE CLASS	REPRO	COVER	FEEDING
ANNUAL GRASSLAND	Summer				
		1S Short Herb Sparse			high
		1P Short Herb Open			high
		1M Short Herb Moderate			high
		1D Short Herb Dense			high
		2S Tall Herb Sparse			high
		2P Tall Herb Open			high
		2M Tall Herb Moderate		med	high
		2D Tall Herb Dense		med	high
DECIDUOUS ORCHARD	Summer				

		2 Young Trees		med	high
		3 Mature Trees		med	high
DESERT RIPARIAN	Summer				
		1 Seedling Tree/Shrub		med	high
		2S Small Tree/Shrub Sparse	med	med	high
		2P Small Tree/Shrub Open	med	med	high
		2M Small Tree/Shrub Moderate	high	high	high
		2D Small Tree/Shrub Dense	high	high	high
		3S Medium Tree/Shrub Sparse	med	med	high
		3P Medium Tree/Shrub Open	med	med	high
		3M Medium Tree/Shrub Moderate	high	high	high
		3D Medium Tree/Shrub Dense	high	high	high
		4S Large Tree Sparse	low	low	med
		4P Large Tree Open	low	low	med
EUCALYPTUS	Summer				
		1 Seedling Tree		low	low
		2S Sapling Tree Sparse		low	low
		2P Sapling Tree Open		low	low
		2M Sapling Tree Moderate		low	low
		2D Sapling Tree Dense		low	low
IRRIGATED GRAIN CROPS	Summer				
		No Size or Stage Data		med	high
IRRIGATED HAYFIELD	Summer				
		No Size or Stage Data		med	high
IRRIGATED ROW AND FIELD CROPS	Summer				
		No Size or Stage Data		med	high
MONTANE RIPARIAN	Summer				
		1 Seedling Tree		low	med
		2S Sapling Tree Sparse	low	low	med
		2P Sapling Tree Open	low	low	med
		2M Sapling Tree Moderate	med	med	med
		2D Sapling Tree Dense	med	med	med
		3S Pole Tree Sparse	low	low	med
		3P Pole Tree Open	low	low	med
		3M Pole Tree Moderate	med	med	med
		3D Pole Tree Dense	med	med	med
		4S Small Tree Sparse	low	low	med
		4P Small Tree Open	low	low	med
		4M Small Tree Moderate	med	med	med
		4D Small Tree Dense	med	med	med
		5S Medium/Large Tree Sparse		low	low
		5P Medium/Large Tree Open		low	low
PALM OASIS	Summer				
		1 Seedling Tree		med	med
		2S Small Tree Sparse		med	high
		2P Small Tree Open		med	high
		3S Large Tree Sparse		med	high
		3P Large Tree Open		med	high
VALLEY FOOTHILL RIPARIAN	Summer				
		1 Seedling Tree	med	med	high

2S Sapling Tree Sparse	med	med	high
2P Sapling Tree Open	med	med	high
2M Sapling Tree Moderate	high	high	high
2D Sapling Tree Dense	high	high	high
3S Pole Tree Sparse	med	med	high
3P Pole Tree Open	med	med	high
3M Pole Tree Moderate	high	high	high
3D Pole Tree Dense	high	high	high
4S Small Tree Sparse	med	med	high
4P Small Tree Open	med	med	high
4M Small Tree Moderate	high	high	high
4D Small Tree Dense	high	high	high
5S Medium/Large Tree Sparse	low	med	med
5P Medium/Large Tree Open	low	med	med
5M Medium/Large Tree Moderate	low	low	low
5D Medium/Large Tree Dense	low	low	low

ELEMENT INFORMATION

ELEMENT	REPRO	COVER	FEEDING
ANIMAL DIET ELEMENTS			
INSECTS - TERRESTRIAL			essential
INVERTEBRATES			essential
HABITAT EDGE ELEMENTS			
SHRUB/AGRICULTURE	secondary	secondary	secondary
SHRUB/GRASS	secondary	secondary	secondary
LIVE VEGETATIVE COVER			
LAYER - HERBACEOUS		preferred	secondary
LAYER - SHRUB	secondary	secondary	secondary
LAYER - TREE	preferred	secondary	preferred
RIPARIAN INCLUSION	secondary	secondary	secondary
TREES - HARDWOOD	preferred	preferred	preferred
VEGETATIVE DIET ELEMENTS			
FRUITS			preferred
GRAIN			preferred
SEEDS			preferred

CALIFORNIA WILDLIFE HABITAT RELATIONSHIPS SYSTEM
supported by the
CALIFORNIA INTERAGENCY WILDLIFE TASK GROUP
and maintained by the
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
Database Version: 9.0

SPECIES INFORMATION REPORT FOR: SUMMER TANAGER

(Piranga rubra)

ACTIVITY/STATUS INFORMATION

IDENTIFICATION:

CWHR ID: B469 CNDDB ID: ABPBX45030

TAXONOMY:

Class: AVES Order: PASSERIFORMES
Family: CARDINALIDAE

LIFE HISTORY ATTRIBUTES:

Daily Activity: Diurnal Seasonal Activity: Yearlong Migration: Distant Migrator

SPECIAL STATUS:

species-level status California Species of Special Concern

LOCATION INFORMATION

LOCATION	SEASON
COUNTY	
IMPERIAL	Summer
INYO	Summer
KERN	Summer
LOS ANGELES	Summer
RIVERSIDE	Summer
SAN BERNARDINO	Summer
SAN DIEGO	Summer
DFG REGION	
CENTRAL	Summer
SOUTH COAST	Summer
INLAND DESERTS	Summer
HYDROLOGIC REGION	
TULARE LAKE	Summer
SOUTH COAST	Summer
SOUTH LAHONTAN	Summer
COLORADO RIVER	Summer
NATIONAL FOREST	
ANGELES	Summer
SEQUOIA	Summer

HABITAT SUITABILITY INFORMATION

HABITAT	SEASON	SIZE/AGE CLASS	REPRO	COVER	FEEDING

DESERT RIPARIAN	Summer				
		3S Medium Tree/Shrub Sparse		low	high
		3P Medium Tree/Shrub Open	med	med	high
		3M Medium Tree/Shrub Moderate	high	high	high
		3D Medium Tree/Shrub Dense	high	high	high
		4S Large Tree Sparse	med	med	high
		4P Large Tree Open	med	med	high
		4M Large Tree Moderate	high	high	high
		4D Large Tree Dense	high	high	high
DESERT WASH	Migrant				
		3S Medium Tree/Shrub Sparse		low	med
		3P Medium Tree/Shrub Open		med	med
		3M Medium Tree/Shrub Moderate		med	med
		3D Medium Tree/Shrub Dense		med	med
		4S Large Tree Sparse		med	med
		4P Large Tree Open		med	med
		4M Large Tree Moderate		med	med
		4D Large Tree Dense		med	med
PALM OASIS	Migrant				
		2S Small Tree Sparse		low	med
		2P Small Tree Open		low	med
		2M Small Tree Moderate		med	med
		2D Small Tree Dense		med	med
		3S Large Tree Sparse		med	med
		3P Large Tree Open		med	med
		3M Large Tree Moderate		med	med
		3D Large Tree Dense		med	med
VALLEY FOOTHILL RIPARIAN	Summer				
		1 Seedling Tree			low
		2S Sapling Tree Sparse		low	low
		2P Sapling Tree Open		low	low
		2M Sapling Tree Moderate		low	low
		2D Sapling Tree Dense		low	low
		3S Pole Tree Sparse	low	low	med
		3P Pole Tree Open	low	low	med
		3M Pole Tree Moderate	med	med	med
		3D Pole Tree Dense	med	med	med
		4S Small Tree Sparse	low	low	med
		4P Small Tree Open	med	med	high
		4M Small Tree Moderate	high	high	high
		4D Small Tree Dense	high	high	high
		5S Medium/Large Tree Sparse	low	low	med
		5P Medium/Large Tree Open	med	med	high
		5M Medium/Large Tree Moderate	high	high	high
		5D Medium/Large Tree Dense	high	high	high

ELEMENT INFORMATION

ELEMENT	REPRO	COVER	FEEDING
ANIMAL DIET ELEMENTS			
INSECTS - FLYING			secondary
INSECTS - TERRESTRIAL			secondary
INVERTEBRATES			essential
HABITAT EDGE ELEMENTS			
TREE/SHRUB	preferred	preferred	preferred

TREE/WATER	secondary	secondary	secondary
LIVE VEGETATIVE COVER			
RIPARIAN INCLUSION	secondary	secondary	secondary
TREES - HARDWOOD	secondary	secondary	secondary
VEGETATIVE DIET ELEMENTS			
FRUITS			preferred

CALIFORNIA WILDLIFE HABITAT RELATIONSHIPS SYSTEM
supported by the
CALIFORNIA INTERAGENCY WILDLIFE TASK GROUP
and maintained by the
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
Database Version: 9.0

SPECIES INFORMATION REPORT FOR: VERMILION FLYCATCHER

(Pyrocephalus rubinus)

ACTIVITY/STATUS INFORMATION

IDENTIFICATION:

CWHR ID: B324 CNDDB ID: ABPAE36010

TAXONOMY:

Class: AVES Order: PASSERIFORMES
Family: TYRANNIDAE

LIFE HISTORY ATTRIBUTES:

Daily Activity: Diurnal Seasonal Activity: Yearlong Migration: Non-Migrator

SPECIAL STATUS:

species-level status California Species of Special Concern

LOCATION INFORMATION

LOCATION	SEASON
COUNTY	
IMPERIAL	Summer
INYO	Summer
KERN	Summer
LOS ANGELES	Summer
ORANGE	Summer
RIVERSIDE	Summer
SAN BERNARDINO	Summer
SAN DIEGO	Summer
SANTA BARBARA	Summer
DFG REGION	
CENTRAL	Summer
SOUTH COAST	Summer
INLAND DESERTS	Summer
HYDROLOGIC REGION	
TULARE LAKE	Summer
CENTRAL COAST	Summer
SOUTH COAST	Summer
SOUTH LAHONTAN	Summer
COLORADO RIVER	Summer
NATIONAL FOREST	
ANGELES	Summer
CLEVELAND	Summer

HABITAT SUITABILITY INFORMATION

HABITAT	SEASON	SIZE/AGE CLASS	REPRO	COVER	FEEDING
DESERT RIPARIAN	Yearlong				
		1 Seedling Tree/Shrub		high	high
		2S Small Tree/Shrub Sparse	med	high	high
		2P Small Tree/Shrub Open	med	high	high
		2M Small Tree/Shrub Moderate	med	high	high
		2D Small Tree/Shrub Dense	med	high	high
		3S Medium Tree/Shrub Sparse	high	high	high
		3P Medium Tree/Shrub Open	high	high	high
		3M Medium Tree/Shrub Moderate	high	high	high
		3D Medium Tree/Shrub Dense	high	high	high
		4S Large Tree Sparse	high	high	high
		4P Large Tree Open	high	high	high
		4M Large Tree Moderate	high	high	high
		4D Large Tree Dense	high	high	high
IRRIGATED GRAIN CROPS	Yearlong	No Size or Stage Data		low	high
IRRIGATED HAYFIELD	Yearlong	No Size or Stage Data		low	high

ELEMENT INFORMATION

ELEMENT	REPRO	COVER	FEEDING
ANIMAL DIET ELEMENTS			
INSECTS - FLYING			secondary
INSECTS - TERRESTRIAL			preferred
INVERTEBRATES			essential
AQUATIC ELEMENTS			
PONDS			preferred
RIVERS			preferred
WATER			secondary
HABITAT EDGE ELEMENTS			
SHRUB/AGRICULTURE		preferred	preferred
SHRUB/GRASS		preferred	preferred
SHRUB/WATER	secondary	preferred	preferred
TREE/AGRICULTURE	secondary	preferred	preferred
TREE/GRASS		preferred	secondary
TREE/WATER	secondary	preferred	secondary
HUMAN ELEMENTS			
FENCES		preferred	preferred
WATER - CREATED BODY			preferred
LIVE VEGETATIVE COVER			
LAYER - SHRUB		secondary	preferred
LAYER - TREE	preferred	secondary	
RIPARIAN INCLUSION	secondary	secondary	secondary
TREES - HARDWOOD	preferred	preferred	preferred

CALIFORNIA WILDLIFE HABITAT RELATIONSHIPS SYSTEM
supported by the
CALIFORNIA INTERAGENCY WILDLIFE TASK GROUP
and maintained by the
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
Database Version: 9.0

SPECIES INFORMATION REPORT FOR: WILLOW FLYCATCHER

(Empidonax traillii)

ACTIVITY/STATUS INFORMATION

IDENTIFICATION:

CWHR ID: B315 CNDDB ID: ABPAE33040

TAXONOMY:

Class: AVES Order: PASSERIFORMES
Family: TYRANNIDAE

LIFE HISTORY ATTRIBUTES:

Daily Activity: Diurnal Seasonal Activity: Yearlong Migration: Distant Migrator

SPECIAL STATUS:

species-level status	California Endangered Forest Service Sensitive
subspp. brewsteri	California Endangered Forest Service Sensitive
subspp.extimus	Federal Endangered California Endangered Forest Service Sensitive

LOCATION INFORMATION

LOCATION COUNTY	SEASON
ALPINE	Summer
AMADOR	Summer
BUTTE	Summer
CALAVERAS	Summer
EL DORADO	Summer
FRESNO	Summer
INYO	Summer
KERN	Summer
LASSEN	Summer
MADERA	Summer
MARIPOSA	Summer
MONO	Summer
NEVADA	Summer
PLACER	Summer
PLUMAS	Summer
SAN DIEGO	Yearlong
SANTA BARBARA	Summer
SHASTA	Summer
SIERRA	Summer
TEHAMA	Summer
TRINITY	Summer
TULARE	Summer
TUOLUMNE	Summer
VENTURA	Summer

DFG REGION	
NORTHERN	Summer
NORTH CENTRAL	Summer
CENTRAL	Summer
SOUTH COAST	Yearlong
INLAND DESERTS	Summer
HYDROLOGIC REGION	
NORTH COAST	Summer
SACRAMENTO RIVER	Summer
TULARE LAKE	Summer
SAN JOAQUIN	Summer
CENTRAL COAST	Summer
SOUTH COAST	Yearlong
NORTH LAHONTAN	Summer
SOUTH LAHONTAN	Summer
NATIONAL FOREST	
EL DORADO	Summer
INYO	Summer
LAKE TAHOE BASIN	Summer
LASSEN	Summer
PLUMAS	Summer
SEQUOIA	Summer
SHASTA-TRINITY	Summer
SIERRA	Summer
STANISLAUS	Summer
TAHOE	Summer
TOIYABE	Summer

HABITAT SUITABILITY INFORMATION

HABITAT	SEASON	SIZE/AGE CLASS	REPRO	COVER	FEEDING
DESERT RIPARIAN	Migrant				
		1 Seedling Tree/Shrub		high	high
		2S Small Tree/Shrub Sparse		high	high
		2P Small Tree/Shrub Open		high	high
		2M Small Tree/Shrub Moderate		high	high
		2D Small Tree/Shrub Dense		high	high
		3S Medium Tree/Shrub Sparse		high	high
		3P Medium Tree/Shrub Open		high	high
		3M Medium Tree/Shrub Moderate		high	high
		3D Medium Tree/Shrub Dense		high	high
		4S Large Tree Sparse		high	high
		4P Large Tree Open		high	high
		4M Large Tree Moderate		high	high
		4D Large Tree Dense		high	high
EUCALYPTUS	Migrant				
		1 Seedling Tree		low	low
		2S Sapling Tree Sparse		low	low
		2P Sapling Tree Open		low	low
		2M Sapling Tree Moderate		low	low
		2D Sapling Tree Dense		low	low
		3S Pole Tree Sparse		low	low
		3P Pole Tree Open		low	low
		3M Pole Tree Moderate		low	low
		3D Pole Tree Dense		low	low

		4S Small Tree Sparse		low	low
		4P Small Tree Open		low	low
		4M Small Tree Moderate		low	low
		4D Small Tree Dense		low	low
		5S Medium/Large Tree Sparse		low	low
		5P Medium/Large Tree Open		low	low
		5M Medium/Large Tree Moderate		low	low
		5D Medium/Large Tree Dense		low	low
MONTANE RIPARIAN	Summer				
		1 Seedling Tree		low	low
		2S Sapling Tree Sparse		low	low
		2P Sapling Tree Open	low	med	high
		2M Sapling Tree Moderate	med	high	high
		2D Sapling Tree Dense	high	high	high
		3S Pole Tree Sparse	low	high	high
		3P Pole Tree Open	low	high	high
		3M Pole Tree Moderate	med	high	high
		3D Pole Tree Dense	high	high	high
		4S Small Tree Sparse	low	high	high
		4P Small Tree Open	low	high	high
		4M Small Tree Moderate	high	high	high
		4D Small Tree Dense	high	high	high
VALLEY FOOTHILL RIPARIAN	Summer				
		1 Seedling Tree		low	low
		2S Sapling Tree Sparse		low	low
		2P Sapling Tree Open	low	med	high
		2M Sapling Tree Moderate	med	high	high
		2D Sapling Tree Dense	high	high	high
		3S Pole Tree Sparse	low	high	high
		3P Pole Tree Open	low	high	high
		3M Pole Tree Moderate	med	high	high
		3D Pole Tree Dense	high	high	high
		4S Small Tree Sparse	low	high	high
		4P Small Tree Open	low	high	high
		4M Small Tree Moderate	high	high	high
		4D Small Tree Dense	high	high	high
		5S Medium/Large Tree Sparse	low	low	low
		5P Medium/Large Tree Open	low	low	low
		5M Medium/Large Tree Moderate	low	low	low
		5D Medium/Large Tree Dense	low	low	low
WET MEADOW	Summer				
		1S Short Herb Sparse		low	high
		1P Short Herb Open		low	high
		1M Short Herb Moderate		low	high
		1D Short Herb Dense		low	high
		2S Tall Herb Sparse		low	high
		2P Tall Herb Open		low	high
		2M Tall Herb Moderate		low	high
		2D Tall Herb Dense		low	high

ELEMENT INFORMATION

ELEMENT	REPRO	COVER	FEEDING
ANIMAL DIET ELEMENTS			
INSECTS - FLYING			essential
INVERTEBRATES			essential

HABITAT EDGE ELEMENTS			
SHRUB/GRASS	preferred	secondary	secondary
SHRUB/WATER		preferred	preferred
TREE/GRASS	preferred	secondary	secondary
TREE/WATER		secondary	preferred
LIVE VEGETATIVE COVER			
LAYER - SHRUB	secondary	secondary	preferred
RIPARIAN INCLUSION	secondary	preferred	preferred

CALIFORNIA WILDLIFE HABITAT RELATIONSHIPS SYSTEM
supported by the
CALIFORNIA INTERAGENCY WILDLIFE TASK GROUP
and maintained by the
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
Database Version: 9.0

SPECIES INFORMATION REPORT FOR: YELLOW-BILLED CUCKOO

(Coccyzus americanus)

ACTIVITY/STATUS INFORMATION

IDENTIFICATION:

CWHR ID: B259 CNDDB ID: ABNRB02020

TAXONOMY:

Class: AVES Order: CUCULIFORMES
Family: CUCULIDAE

LIFE HISTORY ATTRIBUTES:

Daily Activity: Diurnal Seasonal Activity: Yearlong Migration: Distant Migrator

SPECIAL STATUS:

subspp.occidentalis

California Endangered
Federal Proposed Threatend
BLM Sensitive
Forest Service Sensitive

LOCATION INFORMATION

LOCATION	SEASON
COUNTY	
BUTTE	Summer
COLUSA	Summer
GLENN	Summer
IMPERIAL	Summer
INYO	Summer
KERN	Summer
LAKE	Summer
ORANGE	Summer
PLACER	Summer
RIVERSIDE	Summer
SAN BERNARDINO	Summer
SAN DIEGO	Summer
SUTTER	Summer
TEHAMA	Summer
YUBA	Summer
DFG REGION	
NORTHERN	Summer
NORTH CENTRAL	Summer
BAY DELTA	Summer
CENTRAL	Summer
SOUTH COAST	Summer
INLAND DESERTS	Summer
HYDROLOGIC REGION	
NORTH COAST	Summer
SACRAMENTO RIVER	Summer

TULARE LAKE	Summer
SOUTH COAST	Summer
NORTH LAHONTAN	Summer
SOUTH LAHONTAN	Summer
COLORADO RIVER	Summer

NATIONAL FOREST	
CLEVELAND	Summer
EL DORADO	Summer
INYO	Summer
KLAMATH	Summer
LAKE TAHOE BASIN	Summer
LASSEN	Summer
LOS PADRES	Summer
MENDOCINO	Summer
PLUMAS	Summer
SAN BERNARDINO	Summer
SEQUOIA	Summer
SHASTA-TRINITY	Summer
TAHOE	Summer

HABITAT SUITABILITY INFORMATION

HABITAT	SEASON	SIZE/AGE CLASS	REPRO	COVER	FEEDING
DECIDUOUS ORCHARD	Summer				
		3 Mature Trees	high	med	med
DESERT RIPARIAN	Summer				
		1 Seedling Tree/Shrub	low	low	high
		2P Small Tree/Shrub Open	med	med	high
		2M Small Tree/Shrub Moderate	high	high	high
		2D Small Tree/Shrub Dense	high	high	high
		3P Medium Tree/Shrub Open	med	med	high
		3M Medium Tree/Shrub Moderate	high	high	high
		3D Medium Tree/Shrub Dense	high	high	high
		4P Large Tree Open	med	med	high
		4M Large Tree Moderate	high	high	high
		4D Large Tree Dense	high	high	high
VALLEY FOOTHILL RIPARIAN	Summer				
		2S Sapling Tree Sparse		low	med
		2P Sapling Tree Open		low	med
		2M Sapling Tree Moderate	low	low	high
		2D Sapling Tree Dense	low	low	high
		3S Pole Tree Sparse	low	low	med
		3P Pole Tree Open	low	low	med
		3M Pole Tree Moderate	high	med	high
		3D Pole Tree Dense	high	med	high
		4S Small Tree Sparse	med	med	med
		4P Small Tree Open	low	med	high
		4M Small Tree Moderate	high	high	high
		4D Small Tree Dense	high	high	high
		5S Medium/Large Tree Sparse	med	med	med
		5P Medium/Large Tree Open	med	med	high
		5M Medium/Large Tree Moderate	high	high	high
		5D Medium/Large Tree Dense	high	high	high

ELEMENT INFORMATION

ELEMENT	REPRO	COVER	FEEDING
ANIMAL DIET ELEMENTS			
AMPHIBIANS			preferred
INSECTS - TERRESTRIAL			essential
INVERTEBRATES			essential
REPTILES			preferred
HABITAT EDGE ELEMENTS			
TREE/SHRUB	secondary	secondary	secondary
TREE/WATER	secondary	secondary	secondary
LIVE VEGETATIVE COVER			
LAYER - SHRUB		preferred	preferred
LAYER - TREE	secondary	secondary	secondary
RIPARIAN INCLUSION	secondary	secondary	secondary
TREES - HARDWOOD	secondary	preferred	secondary
VEGETATIVE DIET ELEMENTS			
FRUITS			preferred